

# SHOP MANUAL

## JI CASE (DAVID BROWN)

### MODELS 1190-1290-1390-1490-1690

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This service manual provides specifications in both the Metric (SI) and U.S. Customary systems of measurement. 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 "0.28 mm (0.011 inch)" would indicate that the equipment was manufactured using the metric system of measurement and the U.S. system equivalent of 0.28 mm is 0.011 inch.

# CONDENSED SERVICE DATA

	MODELS				
GENERAL	1190	1290	1390	1490	1690
Engine Make	Own	Own	Own	Own	Own
No. of Cylinders	3	4	4	4	6
Bore	100 mm (3.939 inches)				
Stroke	114.3 mm (4.5 inches)	*		114.3 mm (4.5 inches)	
Turbocharger	No	No	No	Switzer or Holset	No
Displacement	2.7 liter (164 cu. in.)	*	3.6 liter (219 cu. in.)		5.4 liter (329 cu. in.)
Compression Ratio		17:1		16:1	16:1
Pistons Removed From	ABOVE				
Cylinder Sleeves	NONE				
Main Bearings, No. of	4	3	3	3	7
Alternator		LUCAS		LUCAS OR AC DELCO LUCAS	LUCAS
Starter	LUCAS	LUCAS	BOSCH		LUCAS
Forward Speeds, No. of			12		
Battery ground	NEGATIVE				

\* 1290 models with independent pto clutch manufactured before P.I.N. 11052369, or 1290 models with continuous pto clutch manufactured before P.I.N. 11052410 use a 3.2 liter (195 cu. in.) engine which has a stroke of 101.6 mm (4.0 inches). All 1290 models manufactured after these used 3.6 liter (219 cu. in.) engines which have a 114.3 mm (4.5 inches) stroke. Service procedures are the same for either engine.

## TUNE-UP

Firing Order	1-2-3	1-2-4-3			1-5-3-6-2-4
Valve Tappet Gap, Cold	0.25 mm (0.010 inch)				
Valve Face and Seat Angle	45 degrees with a 1½ degree interference angle				
Injection Timing	16° BTDC	25° BTDC	25° BTDC	19° BTDC	25° BTDC
Engine Low Idle-Rpm	750				
Engine High Idle-Rpm	2200				
Power Rating**	37 kW (49 hp)	45 kW (60 hp)	52 kW (70 hp)	66 kW (88 hp)	82 kW (110 hp)

\*\*Power rating to SAE J270

## CAPACITIES

Cooling System	8.5 liters (9 qts.)	14 liters (14.8 qts.)	14 liters (14.8 qts.)	14.2 liters (15 qts.)	15.3 liters (16 qts.)
Crankcase (With Filter)	6.25 liters (6.6 qts.)		7.4 liters (7.8 qts.)		12.5 liters (13.2 qts.)
Front Drive Axles Differential					
David Brown			7.96 liters (8.4 qts.)		
Carraro				4 liters (4.25 qts.)	
Front Drive Axles Final Drive (Each)					
David Brown			0.85 liter (0.9 qt.)		
Carraro				1.4 liters (1.5 qts.)	
Transmission, Hydraulic and Differential Case			42 liters (44.5 qts.)		
Final Drive (Each)		2.3 liters (2½ qts.)		6.8 liters (7 qts.)	7.4 liters (8 qts.)
Power Steering			1.4 liters (1.5 qts.)		
Steering Gear	1.2 liters (2.5 pts)				
Fuel Tanks, Total	60.5 liters (16 gal.)	72 liters (19 gal.)		100 liters*** (26 gal.)***	100 liters*** (26 gal.)***

\*\*\*Low profile models, high platform and cab models tank capacity is 136 liters (36 gal.).

SIZES AND CLEARANCES	1190	1290	MODELS 1390	1490	1690
Crankshaft Main Journal Diameter .....		63.474-63.487 mm (2.4990-2.4995 in.)		66.65-66.66 mm (2.6240-2.6245 in.)	69.84-69.85 mm (2.749-2.750 in.)
Crankpin Journal Diameter .....		60.27-60.29 mm (2.3730-2.3735 in.)		63.45-63.46 mm (2.4980-2.4985 in.)	60.27-60.28 mm (2.373 in.)
Piston Pin Diameter .....		31.750-31.737 mm (1.2495-1.250 in.)			
Cylinder Bore .....		100.046-100.066 mm (3.9388-3.9396 in.)			
Piston Diameter .....		99.86-99.88 mm (3.9315-3.9323 in.)			
Valve Stem Diameter .....		9.454-9.479 mm (0.3722-0.3732 in.)			
Camshaft Journal Specifications, See Paragraph .....	117	118	118	118	119
Main and Rod Bearing Running Clearance .....		0.051-0.102 mm (0.002-0.004 in.)			
Crankshaft End Play .....		0.051-0.254 mm (0.002-0.010 in.)			0.15-0.25 mm (0.006-0.010 in.)

## FRONT AXLE (TWO WHEEL DRIVE)

### FRONT WHEEL BEARINGS

#### All Models

1. A typical front wheel spindle, wheel hub and bearing assembly are shown in Fig. 1.

On 1190, 1290 and 1390 models inner wheel bearing (13-Fig. 1) and outer wheel bearing (15) are the same size. If bearings are to be reused, they should be installed in the same bearing cups from which they were removed. On 1490 and 1690 models, outer wheel bearing (15) is smaller than inner wheel bearing (13).

It is recommended that wheel bearings be lubricated using a pressure grease gun until grease is forced out past seal (12-Fig. 1) lip after every fifty hours of normal operation.

To adjust wheel bearings, tighten slotted nut (17-Fig. 1) to provide 0.080 mm (0.003 inch) end play to 0.051 mm (0.002 inch) preload and install cotter pin.

### SPINDLES

#### All Models

#### 2. REMOVE AND REINSTALL. To

remove spindle (9-Fig. 1), support front of tractor and remove wheel from side to be serviced. Remove cap screw (1) and washer (2) which retains steering arm (3) and remove steering arm from spindle.

**NOTE:** If steering arm (3) is tight on spindle (9), reinstall cap screw (1) minus washer (2) and rap head of cap screw sharply to loosen steering arm. Care should be taken not to damage cap screw or threads in spindle.

Remove spindle and upper "O" ring (4-Fig. 1). Remove thrust washer (6) on all models and thrust bearing (7) on 1490 and 1690 models. On all models remove lower "O" ring (8).

Reinstall by reversing removal procedure, making certain thrust bearing (7-Fig. 1) and thrust washer (6) are in proper sequence on 1490 and 1690 models. On all models tighten steering arm retaining cap screws (1) to 163 N·m (120 ft.-lbs.) torque. Lubricate all parts during reassembly.

**3. SPINDLE BUSHINGS.** With spindle (9-Fig. 1) removed, upper (8-Fig. 2) and lower (10) spindle bushings can be removed from axle extension (9) using a suitable puller or drift punch. New bushings should be pressed into axle extension until flush with axle extension surface. Bushings are presized and should not require reaming if carefully installed. Upper (8) and lower

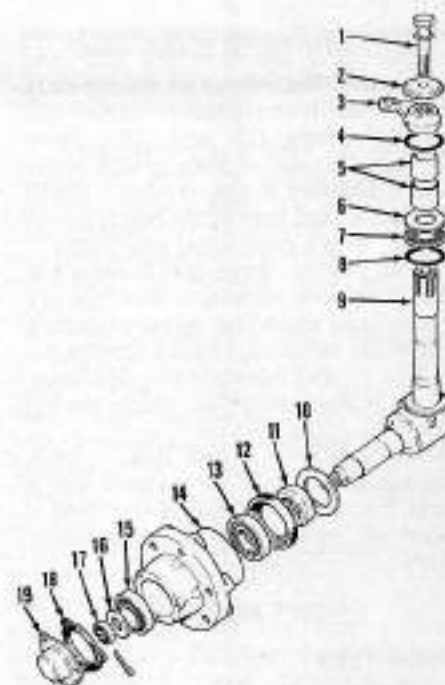


Fig. 1—Exploded view of typical front spindle assembly showing component parts and their relative positions.

- |                   |                        |
|-------------------|------------------------|
| 1. Cap screw      | 11. O-ring rear sleeve |
| 2. Special washer | 12. O-ring             |
| 3. Steering lever | 13. Bearing            |
| 4. "O" ring       | 14. Hub                |
| 5. Bushings       | 15. Bearing            |
| 6. Thrust washer  | 16. Washer             |
| 7. Thrust bearing | 17. Slotted nut        |
| 8. "O" ring       | 18. Cotter             |
| 9. Spindle        | 19. Hub cap            |
| 10. Dirt seal     |                        |



(10) bushings are the same size on 1190, 1290 and 1390 models. 1490 and 1690 models use a small bushing (8) in the upper position and a larger bushing (10) in the lower position.

## TIE RODS AND TOE-IN

### All Two Wheel Drive Models

4. Toe-in of front wheels must be 1.6-3.2 mm (1/16 to 1/8-inch) measured from wheel rim to wheel rim and can be adjusted by lengthening or shortening threaded tie rod ends equally.

Tie rod ends are serviced as a complete unit only.

## AXLE MAIN MEMBER AND TRUNNION PIN

### All Models

#### 5. REMOVE AND REINSTALL.

Disconnect drag link (manual steering), steering ram (power steering) or steering cylinder lines and cap openings, as necessary for model being serviced. Support front of tractor and loosen trunnion pin retaining cap screw (16—Fig. 3) about five turns. Rap head of cap screw four or five times to dislodge threaded insert (21). Remove cap screw and insert. Remove expansion plug from trunnion pin bore, if so equipped. Screw slide hammer into trunnion pin (22) and remove pin. Raise front of tractor until axle is clear. Remove thrust washer (20) and "O" rings (15 and 19). Drive bushings (18) out of bore noting placement if different in size or length. Model 1190 has a blind bore at the rear; remove bushing with a cape chisel and pliers.

On all models, drive new bushings in until flush with housings. Bushings are pre-sized and should not require reaming if carefully installed. Check trunnion pin for free fit and lubricate pin, bushings, thrust washer and "O" rings during assembly.

Check axle front to rear float on trunnion pin. Axle should pivot freely with a slight front to rear float. If end float is excessive, renew trunnion pin thrust washer (20—Fig. 3).

## FRONT SUPPORT

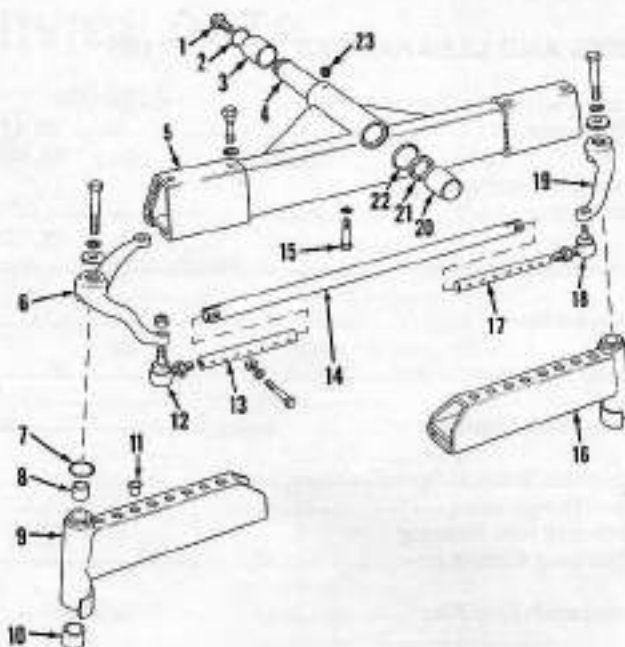
### Model 1190

#### 6. REMOVE AND REINSTALL.

Front support for Model 1190 tractors is an integral part of the main frame casting. To renew front support, first split tractor as outlined in paragraph 242. Remove side covers and engine cover support framework. Drain engine oil. Remove radiator hoses and radiator. Remove battery and battery support. Remove all engine mounting bolts,

Fig. 2—Exploded view of a Model 1190 front axle showing component parts and their relative positions.

1. Bolt adapter
2. "O" ring
3. Bushing
4. Trunnion pin
5. Center beam
6. Steering lever
7. "O" ring
8. Bushing
9. Axle extension
10. Bushing
11. Plastic plug
12. Tie rod end
13. Track rod
14. Spacer tube
15. Axle retaining bolt
16. Axle extension
17. Track rod
18. Tie rod end
19. Steering lever
20. Bushing
21. Thrust washer
22. "O" ring
23. Threaded insert



disconnect all necessary pipes, control rods and electrical wiring. Remove engine oil pan. Use a hoist and remove engine. Remove any remaining components from main frame and support with a suitable lifting device. Remove front axle as outlined in paragraph 5.

Reassembly by reversing disassembly procedure.

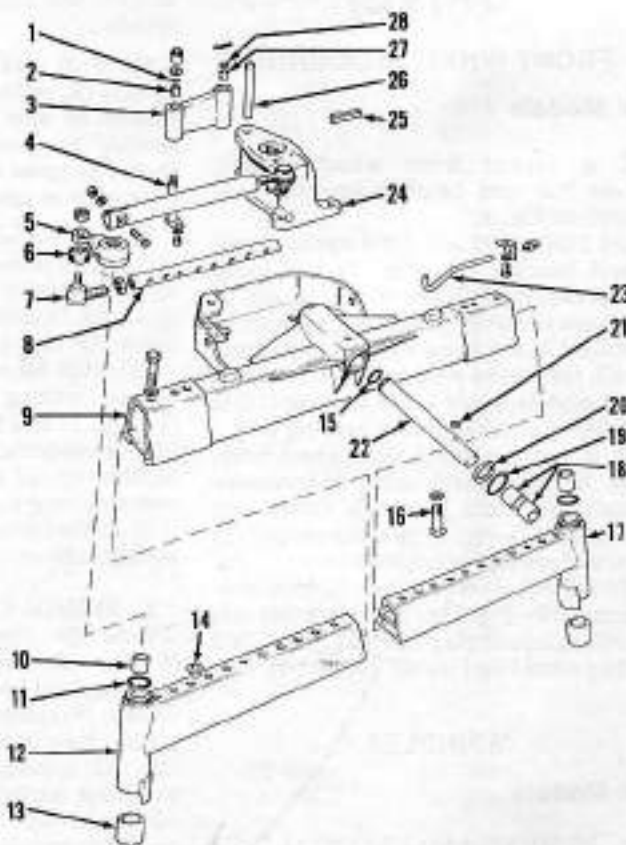
### Models 1290-1390-1490-1690

#### 7. REMOVE AND REINSTALL.

Front support (main frame extension) bolts to main frame just forward of engine. To remove front support, first remove engine side covers, air cleaner assembly, battery and supports. Drain transmission, 42 L (44 qts.) and

Fig. 3—Exploded view of typical front axle assembly used on 1490 and 1690 models.

1. "O" ring
2. Bushing
3. Pivot link
4. Pivot pin
5. Steering lever
6. Dirt seal
7. Tie rod end
8. Track rod
9. Center beam
10. Bushing
11. "O" ring
12. Axle extension
13. Bushing
14. Plastic plug
15. "O" ring
16. Trunnion pin retaining bolt
17. Axle extension
18. Bushings
19. "O" ring
20. Thrust washer
21. Threaded insert
22. Trunnion pin
23. Grease tube
24. Anchor fork
25. Roll pin
26. Pivot pin
27. Bushing
28. "O" ring



radiator. Remove oil cooler and lines (if so equipped), hydraulic pumps, lines and drive shaft. Remove radiator and hoses. Raise front of tractor and remove front axle as outlined in paragraph 5 for two wheel drive models, or paragraph 9 or

27 for models equipped with front drive axle. Attach a hoist to front support and remove retaining bolts. Remove front support.

Reassemble by reversing disassembly procedure.

## FRONT WHEEL DRIVE AXLES

All models, except 1190, are available with front wheel drive. Two different axles, David Brown and Carraro are used. Carraro axles may be equipped with standard or limited slip differential.

David Brown front drive axles with standard differentials are used on 1290, 1390 and 1490 models.

Carraro front drive axle with limited slip differential is used on 1490 and 1690 models; however, Carraro axles used on 1690 models have taper roller bearings in hubs instead of ball bearings as used for 1490 axles and 1690 axle shafts are larger diameter for added strength.

### TIE RODS AND TOE-IN

#### All Models Equipped With Front Drive Axle

8. Toe-in for David Brown or Carraro front drive axles should be 0.0-1.5 mm (0.00-0.006 inch) measured from wheel rim to wheel rim and adjusted by lengthening or shortening threaded tie rod ends equally.

Tie rod ends are serviced as a complete unit only.

### R&R AXLE ASSEMBLY

#### David Brown Axle

9. Front drive axle final drives and differential may be serviced without removing entire axle and differential housing assembly, however if housing or trunnion pin are to be serviced it will be necessary to remove axle housing assembly.

To remove assembly first disconnect all steering lines and cap openings. Loosen locknuts (6—Fig. 4) on trunnion shaft cotter pins (31) until they are even with threaded ends. Using care to avoid damaging threads drive cotter pins (31) through trunnion shaft. Remove locknuts and washers from cotter pins and remove pins (raise right-hand side of axle for more clearance). Support axle and remove core plug (7) from trunnion shaft bore with punch and hammer. Use slide hammer to pull trunnion shaft (33). Raise front of tractor enough to clear axle and remove axle. Remove thrust washer (36) and "O" rings (35 and 37).

To reinstall reverse removal procedure. Bleed steering system as outlined in paragraph 85.

#### Carraro Axle

10. To remove front drive axle assembly raise and support front of tractor

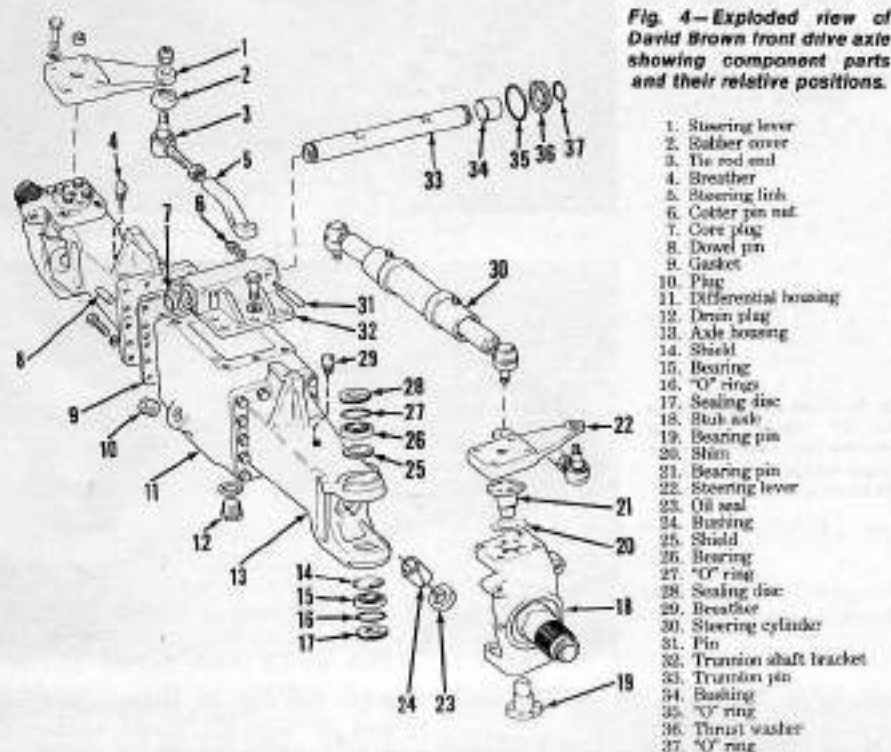


Fig. 4—Exploded view of David Brown front drive axle showing component parts and their relative positions.

1. Steering lever
2. Rubber cover
3. Tie rod end
4. Breather
5. Steering link
6. Cotter pin nut
7. Core plug
8. Dowel pin
9. Gasket
10. Plug
11. Differential housing
12. Drain plug
13. Axle housing
14. Shield
15. Bearing
16. "O" rings
17. Sealing disc
18. Stub axle
19. Bearing pin
20. Shim
21. Bearing pin
22. Steering lever
23. Oil seal
24. Bushing
25. Shield
26. Bearing
27. "O" ring
28. Sealing disc
29. Bevel gear
30. Steering cylinder
31. Pin
32. Trunnion shaft bracket
33. Trunnion pin
34. Bushing
35. "O" ring
36. Thrust washer
37. "O" ring

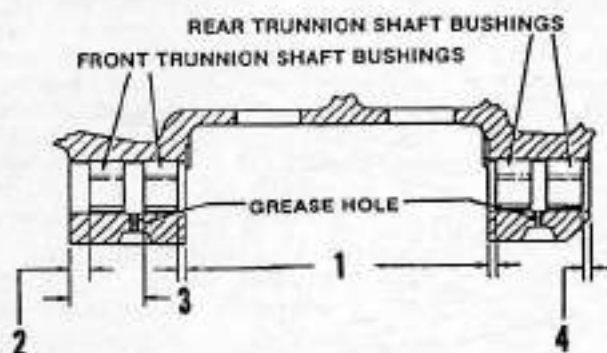


Fig. 5—Diagram showing correct dimensions for the placement of trunnion shaft bushings for models equipped with David Brown front drive axles.

1. 2.175 mm (1/8 inch)
2. 15.24 mm (9/16 inch)
3. 25.372 mm (2.189 inches)
4. 2.175 mm (1/8 inch)

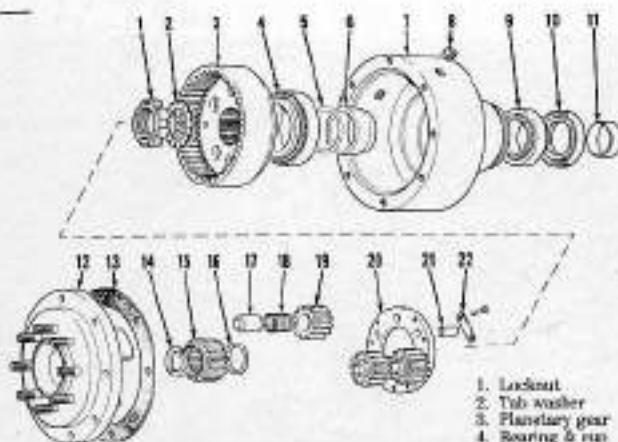


Fig. 6—Exploded view of David Brown front drive axle final drive showing relative position of its component parts.

5. Shim
6. Spacer
7. Hub
8. Plug
9. Bearing cup
10. Oil seal
11. Sleeve
12. End plate
13. Gasket
14. Split ring
15. Sun gear
16. Thrust washer
17. Bearing pin
18. Bearing
19. Planet gear
20. Planet gear carrier
21. Dowel
22. Lock plate

## Paragraphs 11-12

tor. Remove drive shaft and disconnect all steering lines and cap openings. Mark positions of bushing caps (26—Fig. 17). Support axle assembly on floor jack and remove bushing caps. Raise front of tractor and remove axle assembly.

To reinstall reverse removal procedure making certain bushing caps are reinstalled in their original positions and tighten bolts to 210 N·m (155 ft.-lbs.) torque. Bleed steering system as outlined in paragraph 65.

### RENEW TRUNNION SHAFT BUSHINGS

#### David Brown Axle

11. Remove axle assembly as outlined in paragraph 9. Remove the four trunnion shaft bushings (34—Fig. 4) using a suitable puller. Install bushings making certain grease hole in bores are between the two bushings. Refer to Fig. 5 for correct bushing placement.

If trunnion shaft bracket (32) is to be renewed, remove bracket from axle housing and remove dowel pins. Loosely bolt new bracket to housing and drive dowel pins in. Tighten bolts to 203-244 N·m (150-180 ft.-lbs.) torque.

Lubricate "O" rings and place in thrust washer grooves. When reinstalling thrust washers, "O" ring is toward front at front position and toward rear at rear position.

### RENEW PIVOT BUSHINGS

#### Carraro Axle

12. Pivot bushings (2 and 20—Fig. 17) are identical, however a metal sleeve (4) is installed between axle case (6) and

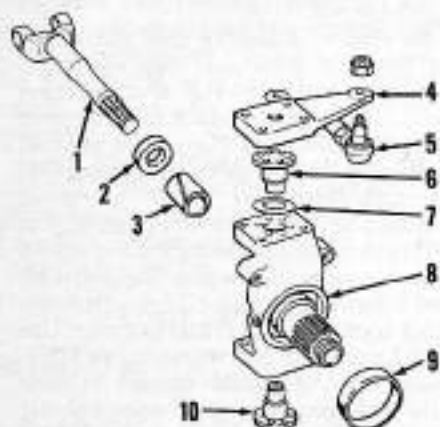


Fig. 7—Exploded view of David Brown front drive stub axle showing component parts and their relative positions.

- |                     |                 |
|---------------------|-----------------|
| 1. Axle drive shaft | 6. Bearing pin  |
| 2. O-ring           | 7. Shim         |
| 3. Bushing          | 8. Stub axle    |
| 4. Steering lever   | 9. Wear sleeve  |
| 5. Tie rod end      | 10. Bearing pin |

Fig. 8—View showing proper placement of trunnion shaft bushings for models equipped with David Brown front drive axles.

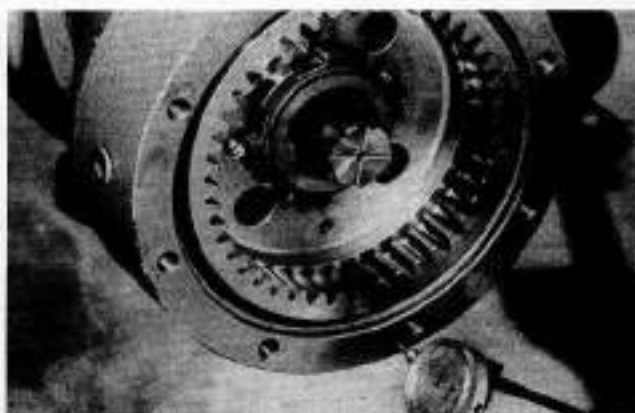
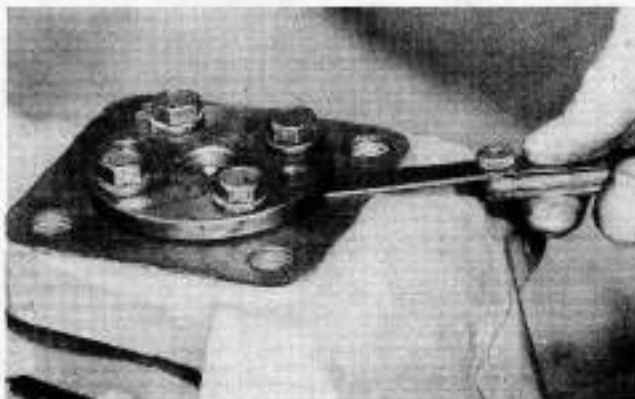


Fig. 9—View showing proper use of feeler gage to measure gap between bearing pin flange and stub axle. Measure at four locations.

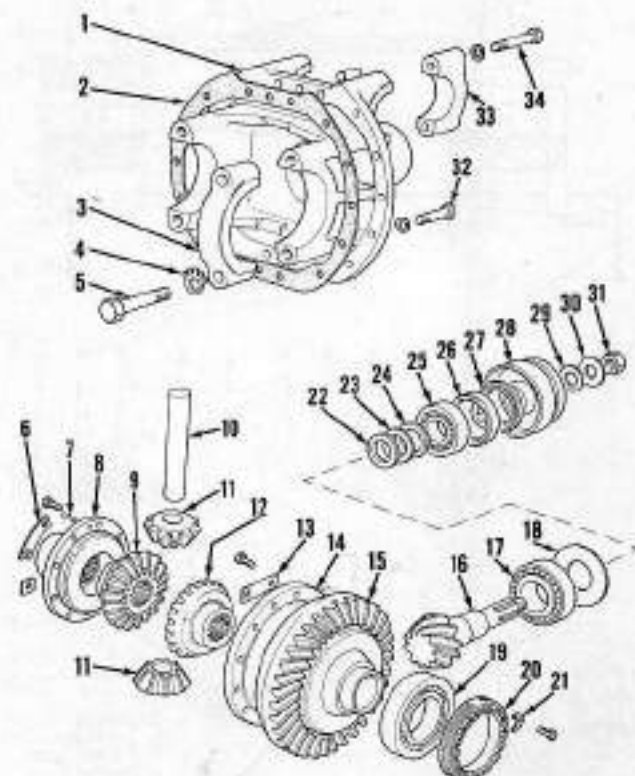


bushing (2). To renew, first remove axle as outlined in paragraph 10.

Mark location of bolt hole in bushing on carrier housing (25—Fig. 17) and axle

case (6). See Fig. 18. Remove bushings (2 and 20—Fig. 17), thrust washers (5 and 18) and sleeve (4) as necessary. Remove "O" rings from bushings.

Fig. 10—Exploded view of David Brown differential assembly showing component parts and their relative positions.



1. Differential support bracket
2. Gasket
3. Bearing cap
4. Tab washer
5. Bearing cap bolt
6. Lock plate
7. Dowel pin
8. End plate
9. Side gear
10. Differential pin
11. Differential pinion gear
12. Side gear
13. Lock plate
14. Differential cage
15. Bevel gear
16. Pinion shaft
17. Bearing & cup
18. Shim
19. Bearing & cup
20. Adjuster wheel
21. Tab washer
22. Front spacer
23. Shim
24. Rear spacer
25. Bearing & cup
26. Spacer
27. Seal
28. Flange
29. Sealing washer
30. Retaining washer
31. Locknut
32. Cap screw
33. Steering cylinder cap
34. Cap screw



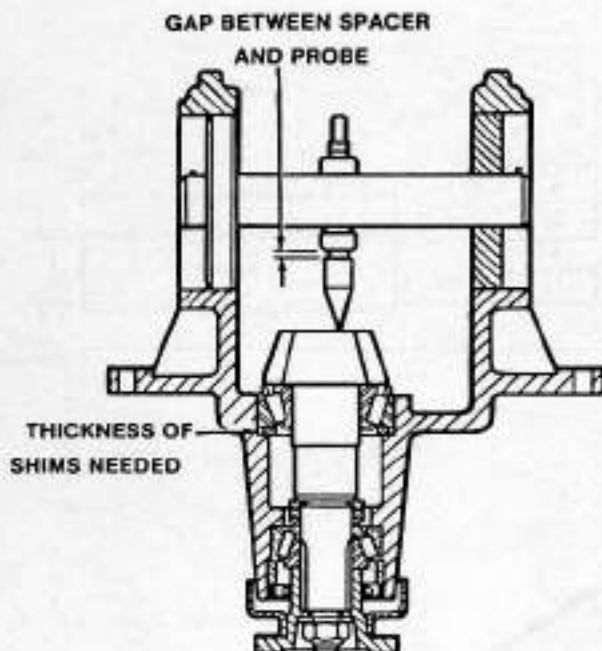


Fig. 11—Diagram showing gap between probe and spacer of special tool number DB-6208.

To reinstall reverse removal procedure making certain bolt holes in bushings are aligned with marks made previously on case and carrier housing.

### FINAL DRIVE AND STUB AXLE

#### David Brown Axle

**13. REMOVE AND REINSTALL.** Left and right final drive removal procedure is similar. To remove, raise and support side to be serviced and remove tire and wheel. Rotate hub so drain plug is at bottom and drain fluid, 0.85 L (0.9 qt.). Remove end plate (12—Fig. 6) and use pry bars to pull sun gear (15) and shaft (1—Fig. 7) out approximately 5 mm (0.190 inch).

**NOTE:** Axle shaft seals (23—Fig. 4 and 2—Fig. 7) may be damaged if shaft (2—Fig. 7) is pulled out too far.

Hold axle shaft out and push sun gear in until split rings (14—Fig. 6) can be

removed. Remove sun gear (15) and thrust washer (16).

**NOTE:** Do not push axle shaft into axle housing as oil seal damage could occur.

Bend tab washer (2—Fig. 6) away from locknut (1) and remove nut with special spanner wrench (CAS-1607). Remove tab washer (2), planetary ring gear (3) and bearing cup assembly (4). Note number and thickness of shims (5) and remove. Remove spacer (6) and hub (7). Seal (10) in hub will be tight on axle and should stay on stub axle as hub is removed. Remove bearing (9) and seal (10).

14. If damaged or worn, oil seal wear sleeve (11) may be removed using care not to damage surface of stub axle. Install edge of sleeve having inside chamfer on stub axle first for reassembly.

Remove steering lever (22—Fig. 4) and bolts retaining upper and lower

bearing pins (6 and 10—Fig. 7). Remove bearing pins using jack screws in threaded hole of bearing pins. Note number and thickness of shims (7) and remove. Keep axle shaft (1) in position to prevent oil seal damage and remove stub axle assembly. Remove axle shaft (1).

Remove upper and lower sealing discs (28 and 17—Fig. 4), "O" rings (27 and 16) and bearings (26 and 15) from axle housing (13). Use a suitable puller to remove upper and lower bearing cups (26 and 15). Remove upper and lower shields (25 and 14) noting small outside diameter side of shields enter bores first.

Remove seal (2—Fig. 7) from inside stub axle (8) and using a suitable bushing driver, drive stub axle bushing (3) so it comes out of stub axle at seal end. Install new bushing from seal end until it seats in stub axle. Install oil seal (2) with lip entering bore first.

To reassemble, reverse disassembly procedure using care not to let axle shafts damage oil seals and noting preload must be set on bearing pin bearings and stub axle bearings.

To set bearing pin preload reassemble unit MINUS shims (7—Fig. 7) and tighten lower bearing pin bolts to 68 N·m (50 ft.-lbs.) torque and upper bearing pin bolts to 20 N·m (15 ft.-lbs.) torque. Push stub axle up tight against bottom of axle housing and use a feeler gage to measure gap between upper bearing pin flange and stub axle. See mm (0.015 inch) LESS than feeler gage measurement to preload bearings to 0.100-0.150 mm (0.004-0.006 inch) when full load is on axle. Tighten upper bearing pin bolts to 68 N·m (50 ft.-lbs.) torque. Refer to paragraph 19 to set stub axle bearing preload.

#### Carraro Axle

15. Raise and support side to be serviced and remove tire and wheel. Rotate hub (4—Fig. 19) until drain plug (18) is at bottom and drain fluid, 1.4 L (1.5 qts.). Remove bolts retaining end plate (19) to hub (4) and install two guide studs opposite each other in hub. Remove end plate (19). Remove snap ring (15) and sun gear (22). Attach a chain hoist to hub.

On 1290, 1390 and 1490 models use a suitable spanner wrench and remove locknut (23) and spacer (24).

On 1690 models remove locknut (23—Fig. 20), washer (24) and shims (25).—Note number and thickness of shims.

On all models remove planetary ring gear and hub.

16. Remove felt seal (34—Fig. 17) and seal (33) from stub axle housing (32). Remove ball socket (40 or 47). Remove

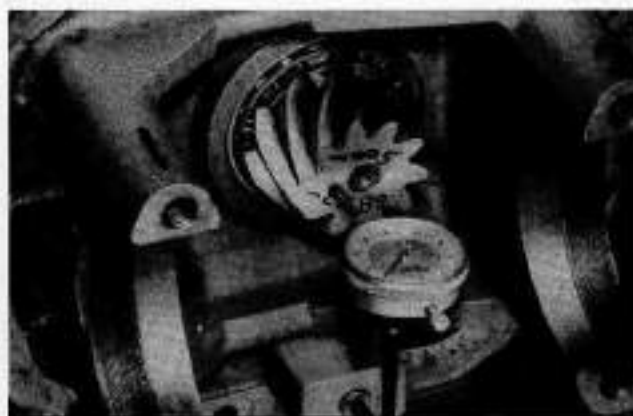


Fig. 12—View showing proper dial indicator position for setting pinion shaft bearing preload.



lower bearing pin cover (39) and shims (38). Note number and thickness of shims. Remove upper bearing pin cover (27) and shims (28). Note number and thickness of shims. Use special puller (CAS-1652) to remove upper and lower bearing pins. Remove stub axle housing.

17. Remove dust plugs (9—Fig. 17) and upper and lower locating screws. Use a suitable puller to remove axle shaft. Remove oil seal (22—Fig. 17) from axle housing (6).

Inspect all bushings, bearings and seals and renew as needed. Clean breather assembly (12—Fig. 17) in stub axle housing.

To reinstall, reverse removal procedure noting slot in stub axle mounting flange must be installed over breather hole as shown in Fig. 22.

18. To determine shim thickness to install under bearing pins reassemble unit installing all shims which were removed from upper and lower pins, plus 0.5 mm shim, under upper bearing pin. Tighten upper bearing pin bolts evenly in sequence shown (Fig. 23) until there is no longer any up or down movement of stub axle. Hit bearing pin covers and turn axle housing side to side to assure bearings and cups are seated. When all up and down stub axle movement is just removed, measure gap between upper bearing pin cover and stub axle housing and note dimension. Remove upper bearing pin cover and all shims installed. Remove thickness of shims equal to measured gap and divide remaining shim thickness by two. Place this shim thickness plus additional 0.20 mm shim under each bearing cover to give 0.40 mm bearing preload to each bearing. Tighten cover bolts to 278 N·m (205 ft.-lbs.) torque. Refer to paragraph 20 to set axle bearing preload.

## WHEEL HUB BEARING PRELOAD

### David Brown Axle

19. To set stub axle bearing preload, install shims (5—Fig. 6) having a total thickness of 2.03 mm (0.080 inch) next to spacer (6). Install planetary ring gear (3) and nut (1) minus tab washer (2). Using special spanner wrench (CAS-1607) tighten nut (1) to 203 N·m (150 ft.-lbs.) torque. Mount dial indicator so point of probe contacts outside face of hub. See Fig. 8. Measure and record amount of end play. Correct amount of bearing preload is 0.080-0.130 mm (0.003-0.005 inch). Add 0.100 mm (0.004 inch) to amount of end play noted and subtract thickness of shims equal to this total from previously installed thickness of shims to obtain correct bearing preload.

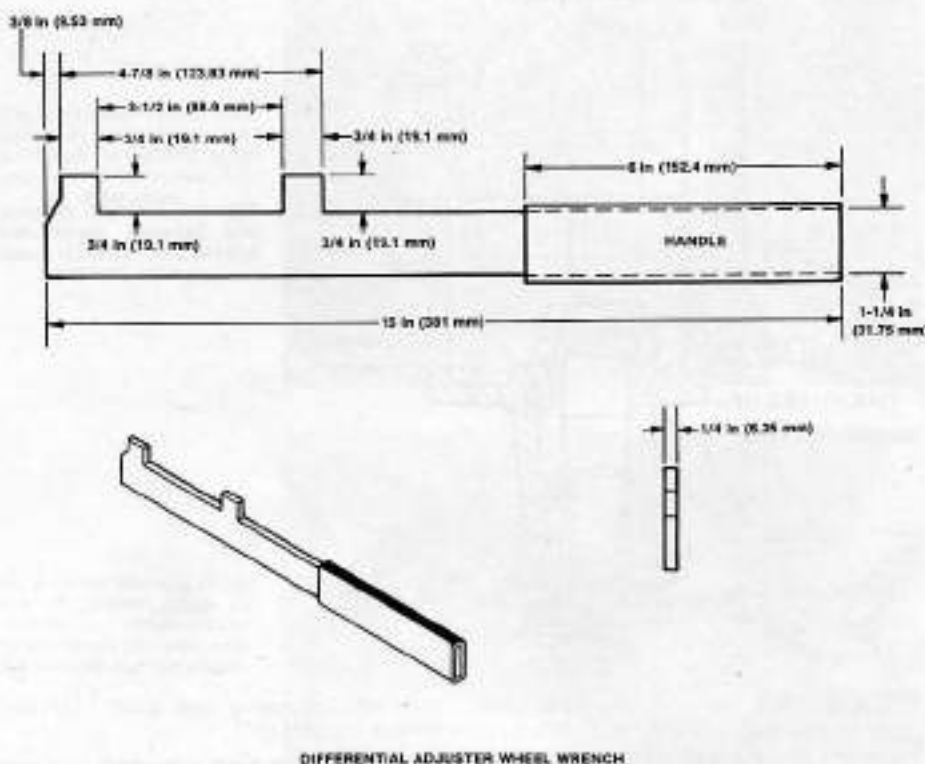


Fig. 13—Diagram of differential bearing adjuster wrench which must be fabricated locally.

Reassemble unit installing tab washer (2—Fig. 6) and tighten nut (1) to 203 N·m (150 ft.-lbs.) torque. Secure nut with tab washer and continue reassembly. Fill final drive to correct level with specified fluid.

Fig. 14—View showing proper placement of alignment marks for bearing adjustment on David Brown front drive differentials.



0.18-0.23 mm (0.007-0.009 inch)  
BACKLASH

Fig. 16—View showing proper placement of dial indicator for setting backlash in front drive differentials.



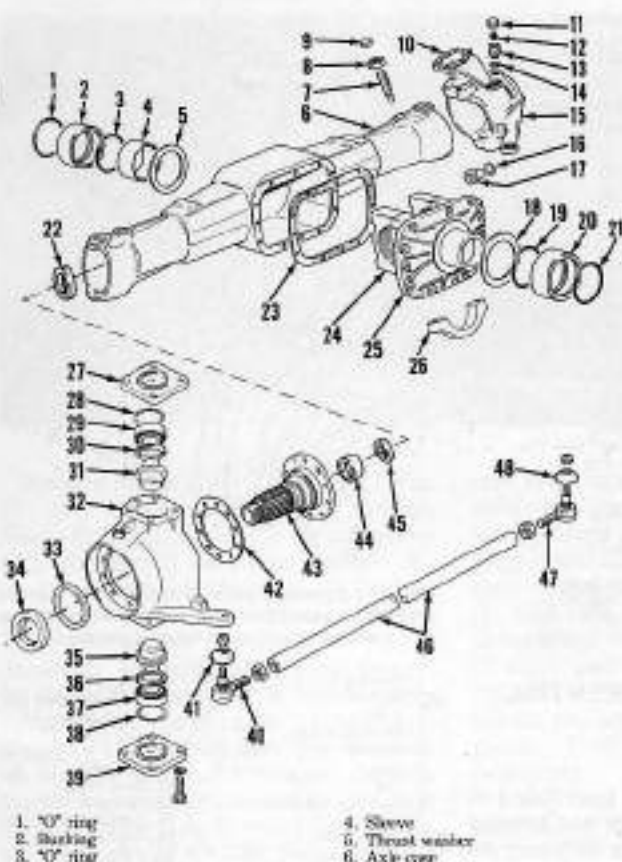


Fig. 17—Exploded view of Carraro front drive axle showing component parts and their relative positions.

### Carraro Axle

20. Model 1490 Carraro axles are equipped with ball bearing type axle bearings and preload is controlled by spacers (2 and 24—Fig. 19).

21. Model 1690 Carraro axles are equipped with taper roller bearings and bearing preload is controlled by adjusting thickness of shims (25—Fig. 20).

**NOTE:** Oil seal (33—Fig. 17) and felt seal (34) must not be installed until bearing preload has been correctly set.

Install amount of shims (25—Fig. 20)

removed during disassembly. Install washer (24) and locknut (23). Use special socket (CAS-1645) to tighten locknut to 1200 N·m (885 ft.-lbs.) torque. Install special fixture on wheel hub and measure amount of torque needed to turn hub. See Fig. 21.

Correct bearing preload requires 2.3 N·m (1.7 ft.-lbs.) torque to turn hub. Add or subtract from shim thickness (25—Fig. 20) until correct preload is reached. Install seals (33 and 34—Fig. 17) during final reassembly. Locknut (23—Fig. 20) must be tightened to 1200 N·m (885 ft.-lbs.) torque.



Fig. 18—View showing proper method for marking support housing for repositioning bushings and oil seal carrier.

## PLANETARY GEAR ASSEMBLIES

### David Brown Axle

22. Drain fluid and remove end plate (12—Fig. 6). Remove lock plates (22) and bolts retaining planetary gear carrier (20) to end plate (12). Mark gear carrier, pins (17), gears and bearings so they may be reassembled in their original positions. Remove carrier, gears and bearings.

Reassemble by reversing disassembly procedure making certain gears, bearings and pins are reinstalled in their original positions. Install lock plates so they cover dowel pin holes and tighten bolts to 40 N·m (30 ft.-lbs.) torque. Reinstall end plate, tighten bolts to 102 N·m (75 ft.-lbs.) torque and fill hub with specified fluid.

### Carraro Axle

23. Drain fluid and remove planetary gear carrier (18—Fig. 20). Mark gear pins (16), gears (10) and washers (8 and 13) so they may be reassembled in their original positions. Remove roll pin (14) and drive gear pins (16) out of gear carrier from gear side. Core plug (15) will be driven out with gear pin. Remove gear (10) thrust washers (8 and 13), spacers (9 and 12) and bearings (11). Keep these parts with their respective gear pins.

Reassemble by reversing disassembly procedure noting sealant should be applied to core plug (15) before installation. Make certain drain plug hole in gear carrier is aligned with notch in wheel hub and tighten retaining bolts to 81 N·m (60 ft.-lbs.) torque. Fill hub to correct level with specified fluid.

## AXLE HOUSINGS

### David Brown Axle

24. Axle shaft seal (23—Fig. 4) and bushing (24) may be installed with axle housings in place.

If removal of housing is necessary, raise and support front of tractor and remove tire and wheel from side to be serviced. Drain differential housing, 7.96 L (8.4 qts.) and attach hoist to axle housing so weight is equally balanced. Remove steering linkage and bolts retaining axle housing to differential. Remove axle housing.

Remove final drive as necessary and reverse removal procedure for installation. Fill differential to correct level with specified fluid.

### Carraro Axle

25. Axle housing and differential housing are a single unit only and must

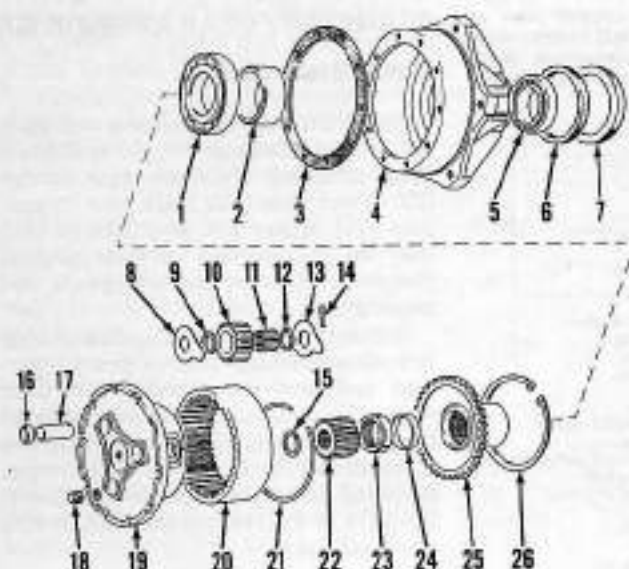


Fig. 19—Exploded view of Carraro front drive axle final drive assembly used on 1290, 1390 and 1490 models, showing component parts and their relative positions.

1. Bearing
2. Spacer
3. Gasket
4. Hub
5. Bearing
6. Seal
7. Seal
8. Bearing retainer
9. Washer
10. Planet gear
11. Bearings
12. Washer
13. Bearing retainer
14. Roll pin
15. Snap ring
16. Core plug
17. Planetary gear pin
18. Drain plug
19. Cover
20. Gear
21. Snap ring
22. Gear
23. Locknut
24. Spacer
25. Support gear
26. Snap ring

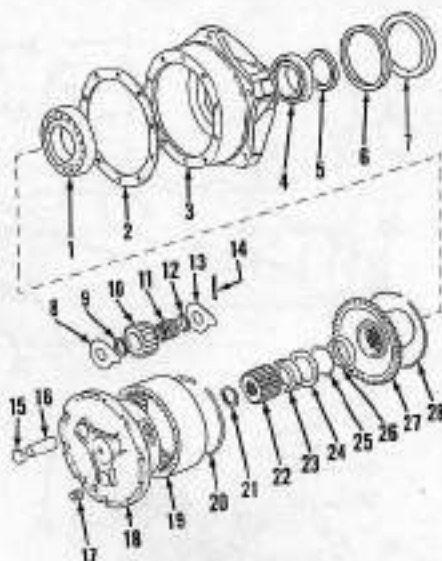


Fig. 20—Exploded view of Model 1690 Carraro front drive axle final drive unit showing component parts and their relative positions.

- |                      |                         |
|----------------------|-------------------------|
| 1. Bearing & cap     | 15. Core plug           |
| 2. Gasket            | 16. Planetary gear pin  |
| 3. Hub               | 17. Drain plug          |
| 4. Bearing & cap     | 18. Hub cover           |
| 5. Washer            | 19. Planetary ring gear |
| 6. Seal              | 20. Snap ring           |
| 7. Seal              | 21. Sun gear            |
| 8. Bearing retainer  | 22. Locknut             |
| 9. Washer            | 23. Washer              |
| 10. Planet gear      | 24. Shim                |
| 11. Bearings         | 25. Spacer              |
| 12. Washer           | 26. Support gear        |
| 13. Bearing retainer | 27. Snap ring           |
| 14. Roll pin         |                         |

be removed as such. Refer to paragraph 10 to remove entire housing assembly. Remove final drives as necessary as outlined in paragraph 15.

## R&R DIFFERENTIAL ASSEMBLY

### David Brown Axle

26. Differential assembly may be removed with differential housing and axle housing installed on tractor. It is necessary, however, to first remove left and right stub axle assemblies as outlined in paragraph 13.

With stub axle assemblies and axle drive shafts removed, remove main drive shaft and steering cylinder. Support differential unit on floor jack and remove retaining bolts. Carefully move differential assembly out of housing and lower to floor.

Reinstall by reversing removal procedure and tighten differential assembly retaining bolts to 68 N·m (50 ft.-lbs.) torque and drive shaft bolts to 54 N·m (40 ft.-lbs.) torque. Fill differential to correct level with specified fluid.

### Carraro Axle

27. To remove front differential assembly it is first necessary to remove final drives and stub axles as outlined in paragraph 15. Remove axle and differential housing as outlined in paragraph 10.

Remove differential carrier retaining bolts and remove differential assembly.

To reinstall, reverse removal procedure and tighten differential carrier retaining bolts to 87 N·m (64 ft.-lbs.) torque. Fill differential to correct level with specified fluid.

## OVERHAUL DIFFERENTIAL

### David Brown Axle

28. Remove differential assembly and place in a stand with flange end toward floor. Mark bearing caps so they may be reinstalled in their original positions and remove. Remove adjuster rings. Remove differential bevel ring gear and cage as an assembly.

Fig. 21—View showing proper method of checking torque required to turn installed hub on Carraro front drive axles.

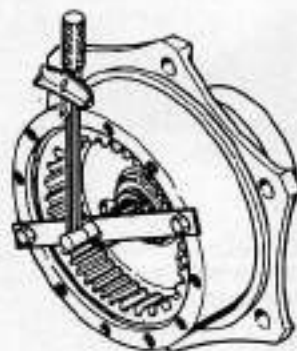
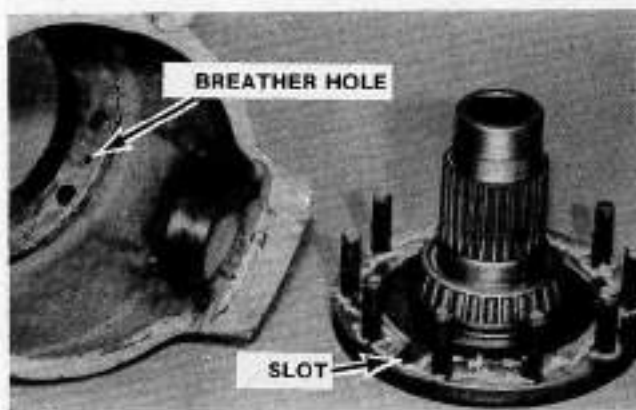


Fig. 22—View showing location of slot on stub axle which must cover breather hole of stub axle housing on Carraro front drive axles.





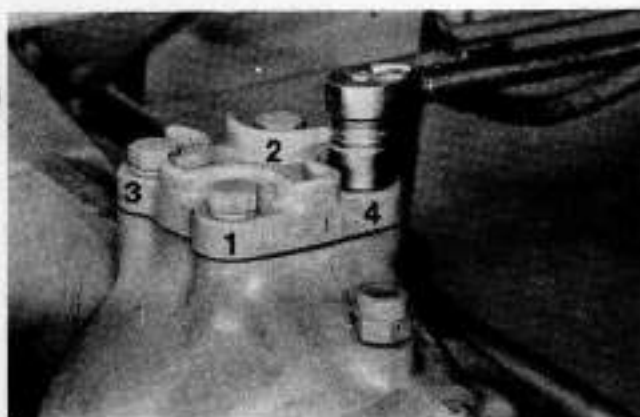


Fig. 23—Proper tightening sequence used to install bearing pin cover prior to setting bearing pin preload.

stall tool (Fig. 27) in friction plates. Tighten bolt (6—Fig. 28) of tool until tapered plug inside tool pushes side of tool against internal splines of side gear. Turn side gear so it is in full mesh with bevel pinion gears. Mount dial indicator so probe contacts head of bolt (6) of tool. See Fig. 27. Move tool inward and outward and record end play. Correct end play is 0.03-0.02 mm (0.001-0.008 inch) and is adjusted using 2.8 mm or 2.9 mm spacer plate. See Fig. 27. Renew plates if end play is not within specified range.

Repeat procedure for plates on opposite side.

Set carrier bearings and bevel gear backlash as outlined in paragraph 32.

## PINION SHAFT PROTRUSION AND BEARING PRELOAD

### David Brown Axle

30. Special tool (DB-8208) is required to set pinion shaft protrusion of David Brown differential and all bearings, cups and spacers to be used in final assembly must be installed.

Assemble pinion shaft in carrier MINUS shims (18—Fig. 10), oil seal (27), spacer (26), sealing washer (29), front spacer (22), shims (23) or rear spacer (24). Install flange (28), retaining washer (30) and locknut (31) on pinion shaft (16) and tighten locknut until all end play of pinion shaft is just removed, then tighten locknut just a small amount more to slightly preload bearings. Install special tool in carrier bearing bores as shown in Fig. 11. Install shaft (CAS-1236-6), probe and spacer (CAS-1609) and locknut (CAS-1234-4) of

Remove pinion shaft locknut (31—Fig. 10) and drive pinion shaft through flange (28) and carrier (1). Front spacer (22), shims (23) and rear spacer (24) should remain on pinion shaft as it is removed. Remove remaining bearing cups and shims from carrier (1) as necessary. Inspect bearings and spacers on pinion shaft and renew as necessary.

Mark end plate (8), cage (14) and bevel ring gear (15) so they may be reassembled in their original positions. Remove carrier bearings and separate end plate (8) from cage (14). Remove axle gears, pinion gears and pin (10). Separate bevel ring gear from cage as necessary.

Bevel ring gear and pinion shaft are serviced as matched sets only and must be installed as such.

If bevel ring gear and pinion shaft, pinion shaft bearings or carrier are renewed pinion shaft protrusion must be set as outlined in paragraph 30.

Reassemble by reversing disassembly procedure. Adjust carrier bearings and bevel gear backlash as outlined in paragraph 32.

### Carraro Axle

29. Remove differential assembly and place in a stand with flange end toward floor. Mark bearing caps so they may be reinstalled in their original positions and remove. Remove adjuster rings (8 and 35—Fig. 24) and roll pins (7 and 32). Remove differential bevel ring gear and cage as an assembly.

Mark position of oil seal carrier (Fig. 18) and remove. Using special spanner wrench (CAS-1597) remove pinion shaft locknut (16—Fig. 24). Drive pinion shaft through carrier and remove. Remove bearings, spacers and shims from carrier as necessary.

Mark end plate (37), bevel ring gear (3) and cage (4) so they may be reassembled in their original positions. Remove bearings (6 and 36) as necessary. Separate end plate (37) from cage (4) and remove side gear (20). Cross-shaft retaining pins (25 or 30) can be removed by removing

one end plate retaining stud (38) and removing one pin. Remaining two pins are removed by driving appropriate end plate locating dowel pins (33) out of cage. Drive cross-shaft (21) out of cage (4) and remove the two pinion gears. Drive short cross-shafts (24 and 31) out of cage and remove cross-shaft block (26) and remaining two pinion gears and thrust washers. Remove side gear and plates. Remove bevel ring gear as necessary.

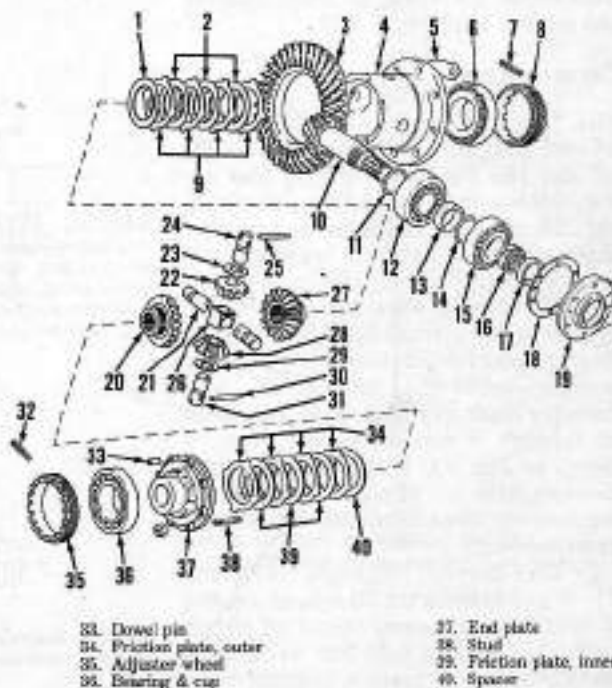
Bevel ring gear and pinion shaft are serviced as matched sets only and must be installed as such.

If bevel ring gear and pinion shaft, pinion shaft bearings or carrier are renewed pinion shaft protrusion must be set as outlined in paragraph 31.

Reassemble by reversing disassembly procedure. Friction plate end play must be checked and set. To check end play of friction plates fabricate tool to dimensions shown in Fig. 26. Place differential assembly in a vertical position and in-

Fig. 24—Exploded view of Carraro limited slip front drive axle differential showing component parts and their relative positions.

1. Spacer
2. Friction plate, inner
3. Differential bevel gear
4. Differential cage
5. Lock plate
6. Bearing & cup
7. Roll pin
8. Adjuster wheel
9. Friction plate, outer
10. Pinion gear shaft
11. Shim
12. Bearing
13. Spacer
14. Shim
15. Bearing
16. Locknut
17. Oil seal
18. Gasket
19. Oil seal carrier
20. Side gear
21. Long cross-shaft
22. Pinion gear
23. Thrust washer
24. Cross-shaft
25. Retaining pin
26. Cross-shaft block
27. Side gear
28. Pinion gear
29. Thrust washer
30. Retaining pin
31. Cross-shaft
32. Roll pin





## Paragraph 31

special tool so probe point lightly contacts face of pinion shaft gear. Using a feeler gage measure and record amount of gap between spacer and probe. See Fig. 11.

Note protrusion correction mark etched on end of pinion shaft gear. This will be "0" or a plus (+) or minus (-) dimension. Noting special tool has a built in dimension of 0.762 mm (0.030 inch) use following example to determine thickness of shim (18-Fig. 10) to correctly set pinion shaft protrusion.

Tool built in dimension 0.762 mm (0.030 in.)  
Dimension etched on pinion gear (0, + or -) x.xxx mm (x.xxx in.)  
Total is correct setting dimension x.xxx mm (x.xxx in.)  
Measured gap x.xxx mm (x.xxx in.)  
Minus correct setting dimension as determined above x.xxx mm (x.xxx in.)  
Additional shims required x.xxx mm (x.xxx in.)

Install determined thickness of shims (18-Fig. 10) and reassemble pinion shaft in carrier with 1.270 mm (0.050 inch) thick shims (23) installed but MINUS seal (27-Fig. 10), spacer (26) or sealing washer (29). Install flange (28), retaining washer (30) and locknut (31) on pinion shaft and tighten locknut to 190 N·m (140 ft.-lbs.) torque. Mount dial indicator on carrier so probe contacts end of pinion gear as shown in Fig. 12. Measure end play and remove shim (23-Fig. 10) thickness equal to amount of end play from previously installed 1.270 mm (0.050 inch) thick shims. Reassemble installing all seals, spacers and sealing washers.

## Carraro Axle

31. To set pinion shaft bearing preload first install bearings and cups (12 and 15-Fig. 24) in carrier and use bolt, flat washers and nuts as shown in Fig. 28 to hold bearings in position. Tighten bolt and nut until bearing cones are slightly difficult to turn.

Install bearing caps on carrier and tighten to 203 N·m (150 ft.-lbs.) torque. Measure and record diameter of carrier bearing surface. Place a 25 mm diameter shaft having a cross hole drilled through it across bearing bore as shown in Fig. 29. Using a depth gage measure from top of shaft to face of inner bearing cone (Fig. 28) and record measurement.

To find correct thickness of shims (11-Fig. 24) subtract 25 mm (diameter of shaft) from measurement of depth gage (C-Fig. 28). Add this to one-half the diameter of carrier bearing bore

## CASE (DAVID BROWN)

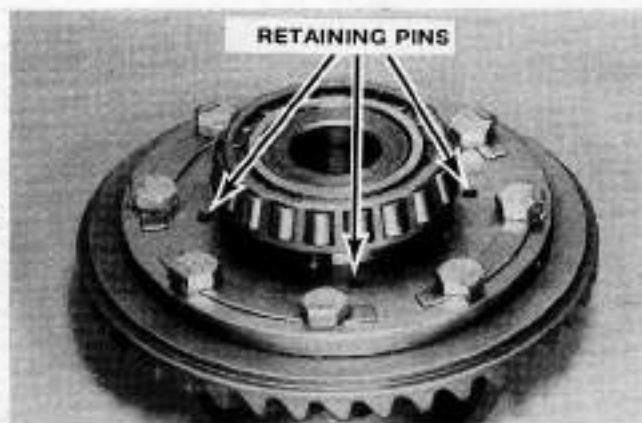


Fig. 25—View showing retaining pin locations on bevel gear assembly.

(A-Fig. 28), then subtract dimension etched on pinion shaft gear end 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 (11-Fig. 24)

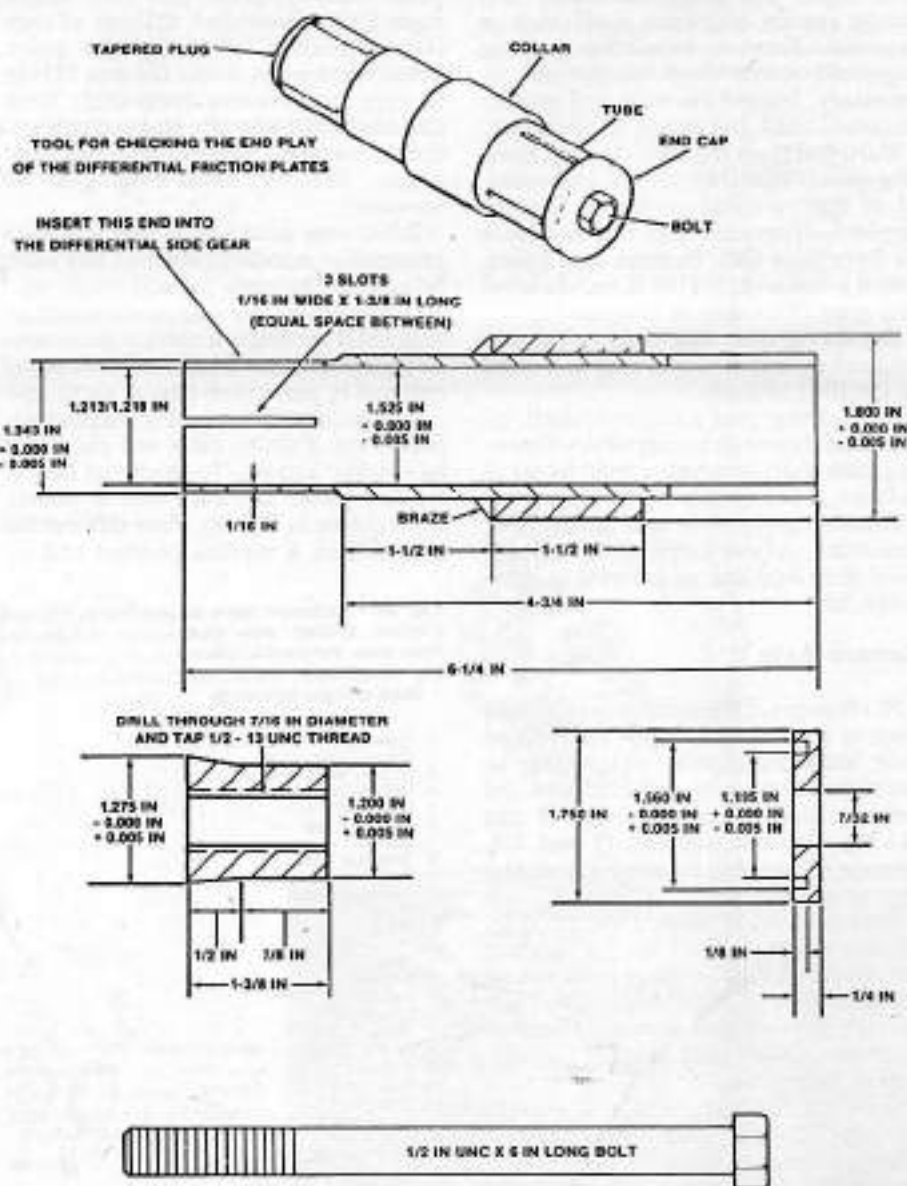


Fig. 26—Diagram showing dimensions for special tool used in checking end play in friction plates in Carraro front drive axles. This tool must be fabricated locally as it is unavailable from any other source.

thickness to install to properly set pinion shaft protrusion. See Fig. 28.

To set pinion shaft bearing preload assemble pinion shaft in carrier **MINUS** seal (17-Fig. 24) and seal carrier (19) and installing all shims (14), which were removed during disassembly, **PLUS** an additional 0.5 mm shim. Tighten locknut (16) to 450 N·m (332 ft.-lbs.) torque. Mount dial indicator so probe contacts end of pinion shaft and measure and record amount of end play. See Fig. 12. Disassemble pinion shaft and remove shim (14-Fig. 24) thickness equal to amount of end play **PLUS** 0.5 mm to obtain 0.5 mm preload on pinion shaft bearings.

Install all seals and seal carrier during final reassembly.

### DIFFERENTIAL CARRIER BEARINGS AND BEVEL GEAR BACKLASH

#### All Models

32. On all models, adjustment of differential carrier bearings to provide proper bevel gear backlash and bearing adjustment is correlated with pinion shaft protrusion adjustment as outlined in paragraph 30 for David Brown, or paragraph 31 for Carraro front drive axles.

Install differential assembly, but do not securely tighten carrier bearing caps. Install adjuster rings and turn in

until end play of differential in carrier is less than 0.050 mm (0.002 inch) without preloading bearings. Mount dial indicator as shown in Fig. 16 and move carrier assembly sideways as required to obtain correct bevel gear backlash of 0.18-0.23 mm (0.007-0.009 inch) by loosening one adjuster ring one turn at a time and tightening opposite adjuster ring the same amount each time. When bevel gear backlash and differential carrier bearings are properly adjusted, install adjuster ring locks and tighten carrier bearing cap bolts to 163 N·m (120 ft.-lbs.) torque for David Brown axles and 210 N·m (155 ft.-lbs.) torque for Carraro axles.

### MAIN DRIVE SHAFTS

#### David Brown

33. Main drive shaft consists of a sliding yoke, drive shaft tube and two universal joints. To remove sliding yoke, mark its position for reassembly on correct splines, unscrew threaded cap and slide slip yoke off splines. Use conventional procedure to renew universal joints.

Install drive shaft with slip yoke at differential end and tighten bolts to 54 N·m (40 ft.-lbs.) torque.

#### Carraro Axle

34. Carraro axle main drive shaft consists of one shaft splined on both ends

and supported by a center bearing block. Sliding couplers held in position by roll pins connect drive shaft to front differential and transfer gear box.

### TRANSFER GEAR BOXES

#### David Brown Axle

35. **REMOVE AND REINSTALL.** Remove front drive shaft and drain transfer gear box and transmission, 42 L (44 qts.). Disconnect selector cable from selector shaft (4-Fig. 30). Remove left and right selector lever housings from transmission top cover and remove cover, wedge and shims. Remove bolt (37-Fig. 30) and locknut (39) and slide coupler (38) rearward. Remove cable bracket (44) and hydraulic pump inlet pipe connector. Place jack under transfer gear box, remove bolts and lower gear box to floor.

Laminated gasket (1-Fig. 30) must be the same thickness as original gasket (1), or layers peeled off to allow coupler (38) to freely slide onto input (12) and bevel pinion shafts. Tighten gear box mounting bolts to the following torque:

Three middle	
5/8-inch bolts	203-244 N·m (150-180 ft.-lbs.)
Transmission top cover and gear box to clutch housing	
bolts	108-130 N·m (80-96 ft.-lbs.)
Drive shaft flange bolts	54 N·m (40 ft.-lbs.)

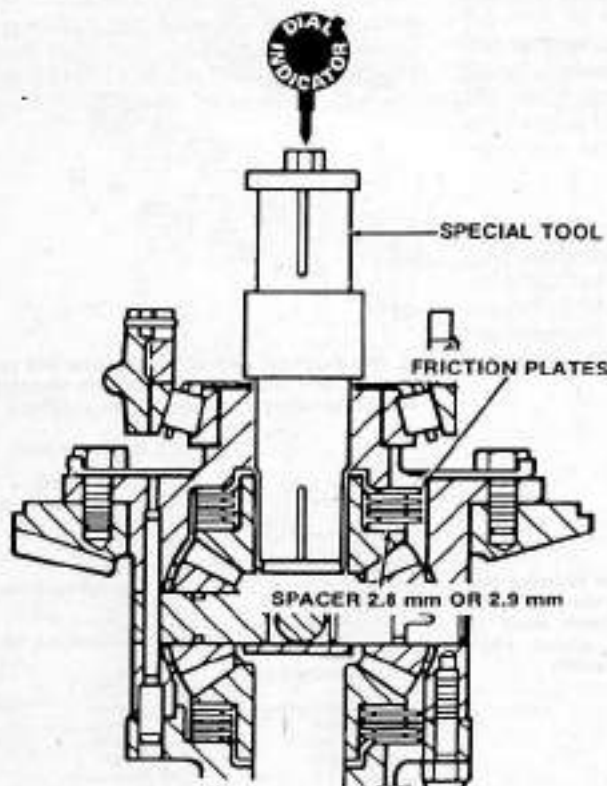


Fig. 27—View showing special tool installation and dial indicator position to check Carraro front drive limited slip differential friction plate end play.

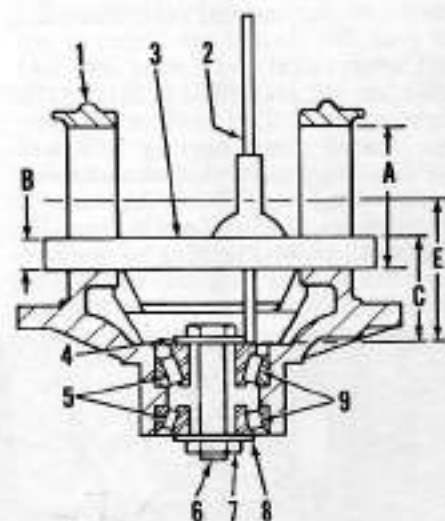


Fig. 28—Diagram showing method of securing pinion bearings in support housing to allow depth gage measurement to be taken.

- |                    |                 |
|--------------------|-----------------|
| 1. Support housing | 6. Bolt         |
| 2. Depth gage      | 7. Nut          |
| 3. Pinion shaft    | 8. Washer       |
| 4. Washer          | 9. Bearing cups |
| 5. Bearing cones   |                 |

**36. OVERHAUL TRANSFER GEAR BOX.** With transfer gear box removed, disassemble as follows: Remove end plates (3 and 46—Fig. 30) and shims (36). Note position and thickness of shims (36). Drive input shaft (12) and idler shaft (34) out of housing (2). Remove input gear (13). Remove front bearing and cup (16). Remove output flange (23), cork seal (22) and washer (21). Remove oil seal housing (26) and output shaft end cover (43). Note thickness of shims (33). Drive output shaft (19) out of housing (2), remove the six bearing pads (18) and bearing and cup (27). Remove bottom cover (9) and drive roll pin (7) out of selector fork (6) and remove selector shaft (4). Remove selector fork, fixed gear (30) and sliding gear (29). Remove output gear (17) and idler gear (15). Remove selector shaft oil seal (5) and core plug (41).

Clean and inspect all parts for excessive wear or damage. Lubricate all parts during reassembly.

**37.** Install idler gear (15—Fig. 30) into bottom of transfer gear box housing (2). Install output gear (17) into housing with hub for sliding gear engagement towards front of housing. Place fixed gear (30) inside sliding gear (29) and install output shaft (19) into rearward side of bottom hole in housing, pushing it through output gear (17) and partially through fixed gear (30). Oil slots on side of fixed gear (30) go against output gear (17). Spacer (31) and bearing (32) must already be assembled on output shaft (19). Install six bearing pads in output shaft, concave side against shaft, as it is pushed through output gear (17) and fixed gear (30). Install rear bearing cup (32), gasket (42), rear cover (43) and cable bracket (44) MINUS shims (33). Tighten bolts to 27 N·m (20 ft.-lbs.) torque. Install front bearing (27) and bushing (28) on output shaft and drive front bearing cup (27) into housing (2). Install oil seal (25) in oil seal housing (26) and install oil seal housing on transfer gear box housing. Tighten bolts to 27 N·m (20 ft.-lbs.) torque. Hit end of out-

put shaft (19) with a plastic hammer to seat bearings and cups.

Mount dial indicator on transfer gear box housing (2) so probe end contacts end of output shaft (19). Measure and record end play of output shaft.

End play tolerance is 0.000-0.050 mm (0.000-0.002 inch) for new bearings and 0.050-0.100 mm (0.002-0.004 inch) for used bearings.

To determine proper shim (33—Fig. 30) thickness add 0.050 mm (0.002 inch) to dial indicator measurement for new bearings and add 0.0762 mm (0.003 inch) to dial indicator measurement for used bearings. This results in a figure for correct shim (33) thickness.

Remove rear bearing cover (43) and install correct thickness of shims (33). Reinstall cover and tighten bolts to 27 N·m (20 ft.-lbs.) torque.

Install oil seal (5—Fig. 30) into housing (2) and place trunnion pins (40) in selector fork (6). Install selector fork in housing, making certain trunnion pins engage slot in sliding gear (29). Install selector shaft (4) through oil seal (5) and selector fork. Align roll pin holes in selector fork and shaft and install roll pin (7). Install core plug (41), bottom cover gasket (8) and bottom cover (9). Install flange (23), cork washer (22), washer (21) and locknut (20). Tighten locknut to 190 N·m (140 ft.-lbs.) torque.

Install idler shaft (34—Fig. 30) and bearing assembly through rear of housing and drive it through idler gear (15). Install rear bearing cup (35) and end plate (46). Tighten bolts to 27 N·m (20 ft.-lbs.) torque. Drive front bearing (16) onto idler shaft (34) until seated. Install bearing cup (16) and end plate (3). Tighten bolts to 27 N·m (20 ft.-lbs.) torque and hit idler shaft (34) to seat bearings.

**38.** Mount dial indicator so end of probe contacts end of idler shaft (34). Measure and record amount of end play.

End play tolerance is 0.000-0.050 mm (0.000-0.002 inch) for new bearings and 0.050-0.100 mm (0.002-0.004 inch) for used bearings.

To determine correct shim (36—Fig. 30) thickness, add 0.050 mm (0.002 inch) to dial indicator measurement for new bearings and 0.0762 mm (0.003 inch) to dial indicator measurement for used bearings and install shims to this thickness.

Remove rear end plate (46—Fig. 30) and install correct shim (36) thickness. Reinstall end plate (46) and tighten bolts to 27 N·m (20 ft.-lbs.) torque.

**39.** Install input shaft (12—Fig. 30) and bearing assembly through front of

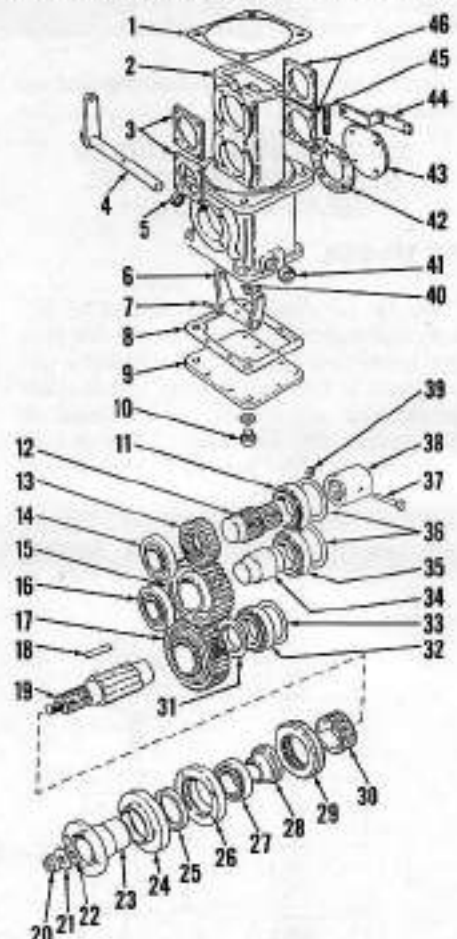


Fig. 30—Exploded view of transfer gear box used with David Brown front drive axle showing component parts and their relative positions.

- |                         |                         |
|-------------------------|-------------------------|
| 1. Gasket               | 24. Flange dust shield  |
| 2. Housing              | 25. Oil seal            |
| 3. Front end plates     | 26. Oil seal housing    |
| 4. Selector shaft       | 27. Front bearing & cup |
| 5. Oil seal             | 28. Bushing             |
| 6. Selector fork        | 29. Sliding gear        |
| 7. Roll pin             | 30. Fixed gear          |
| 8. Gasket               | 31. Spacer              |
| 9. Bottom cover         | 32. Rear bearing & cup  |
| 10. Drain plug          | 33. Shims               |
| 11. Rear bearing        | 34. Idler shaft         |
| 12. Input shaft         | 35. Rear bearing & cup  |
| 13. Input gear          | 36. Shims               |
| 14. Front bearing & cup | 37. Bolt                |
| 15. Idler gear          | 38. Coupler             |
| 16. Front bearing & cup | 39. Locknut             |
| 17. Output gear         | 40. Trunnion pin        |
| 18. Bearing pads        | 41. Core plug           |
| 19. Output shaft        | 42. Gasket              |
| 20. Locknut             | 43. Rear cover          |
| 21. Washer              | 44. Cable bracket       |
| 22. Cork seal           | 45. Stud                |
| 23. Flange              | 46. Rear end plates     |

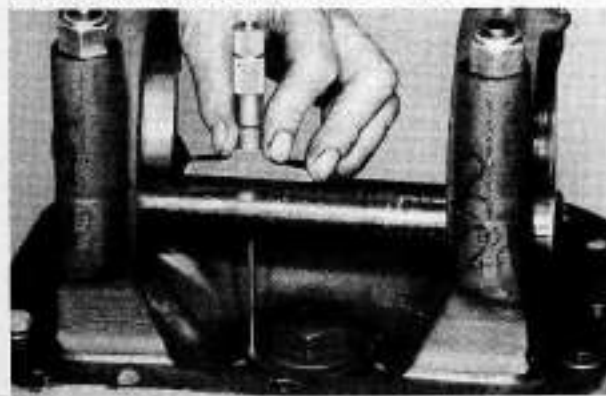


Fig. 29—View showing proper depth gage and pinion shaft placement used in determining pinion shaft protrusion.



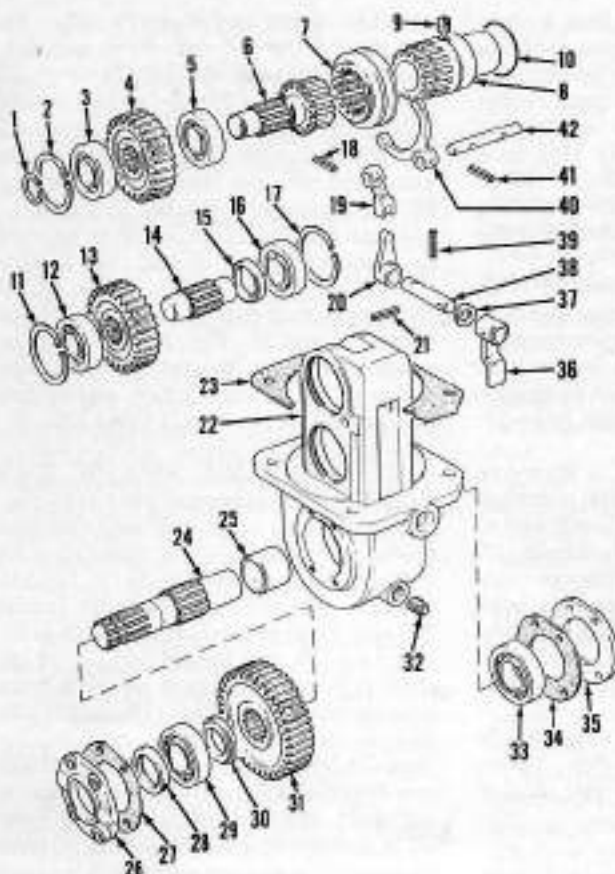


Fig. 31—Exploded view of transfer gear box used on models equipped with Carraro front drive axles.

1. Snap ring
2. Snap ring
3. Front bearing
4. Drive shaft gear
5. Rear bearing
6. Drive shaft
7. Sliding gear
8. Transmission drive coupler
9. Adjusting screw
10. Snap ring
11. Snap ring
12. Front bearing
13. Intermediate gear
14. Intermediate shaft
15. Rear spacer
16. Rear bearing
17. Snap ring
18. Roll pin
19. Selector jaw
20. Inner lever
21. Roll pin
22. Gear box housing
23. Gasket
24. Output shaft
25. Rear spacer
26. Front cover
27. Gasket
28. Oil seal
29. Front bearing
30. Front spacer
31. Output gear
32. Drain plug
33. Rear bearing
34. Gasket
35. Rear cover
36. Outer lever
37. Oil seal
38. Lower selector shaft
39. Roll pin
40. Selector fork
41. Roll pin
42. Upper selector shaft

housing (2) and input gear (13). Install bearing cup (14) and end plate (3). Tighten bolts to 27 N·m (20 ft.-lbs.) torque. Drive rear bearing (11) onto input shaft (12) until seated. Install bearing cup (11) and end plate (46). Tighten bolts to 27 N·m (20 ft.-lbs.) torque. Set end

play as outlined in paragraph 38.

#### Carraro Axle

**40. REMOVE AND REINSTALL.** Remove drive shaft, drain fuel tanks and transfer gear box. Disconnect selector

shaft arm (36—Fig. 31) from selector cable and remove cable bracket from frame. Remove fuel tank cross-over pipe and push selector arm (36) rearward to disengage sliding gear from transmission drive coupler. Support transfer gear box, remove mounting bolts, lower transfer gear box to floor.

To reinstall, note transfer gear box mounting nuts and bolts are tightened to 163 N·m (120 ft.-lbs.) torque and reverse removal procedure.

**41. OVERHAUL TRANSFER GEAR BOX.** With transfer gear box removed, disassemble as follows: Pull sliding gear (7—Fig. 31) outward and drive roll pin (41) out of selector fork (40) and shaft (42). Remove sliding gear and selector fork. Remove snap rings (1 and 2) and drive drive shaft (6) rearward, then remove shaft (6) and drive shaft gear (4). Remove snap rings (11 and 17) and drive intermediate shaft (14) rearward. Remove shaft (14) and bearing assembly (16). Remove intermediate gear (13) and rear spacer (15). Remove output shafts front cover (26) and rear cover (35). Press output shaft (24) out of front of housing. Front inner bearing race (29) and spacer (30) will come out with shaft (24). Remove roll pin (18), inner selector lever (20) and shaft (38). Remove remaining bearings by driving them inward. Remove output gear (31), rear spacer (25) and any bearing races which fell into housing (22).

Clean and inspect all parts for excessive wear or damage. Renew seals as needed.

Reassemble by reversing removal procedure and tighten all cover bolts to 27 N·m (20 ft.-lbs.) torque.

**42. TRANSMISSION DRIVE COUPLING ADJUSTMENT.** Remove transmission top cover, wedge and shims and measure clearance between transfer gear box drive shaft (6—Fig. 32) and transmission drive coupler (2). If clearance exceeds 0.3048 mm (0.012 inch) remove snap ring (3) and turn adjusting screw (4) until clearance is between 0.000-0.3048 mm (0.012 inch) measured at gap between coupler (2) and shaft (6). See 1—Fig. 32.

Reinstall snap ring (3—Fig. 32) over adjusting screw (4) and install transmission top cover.

## MANUAL STEERING GEAR

Model 1190 may be equipped with manual steering utilizing a recirculating ball type steering box bolted to the gear box cover.

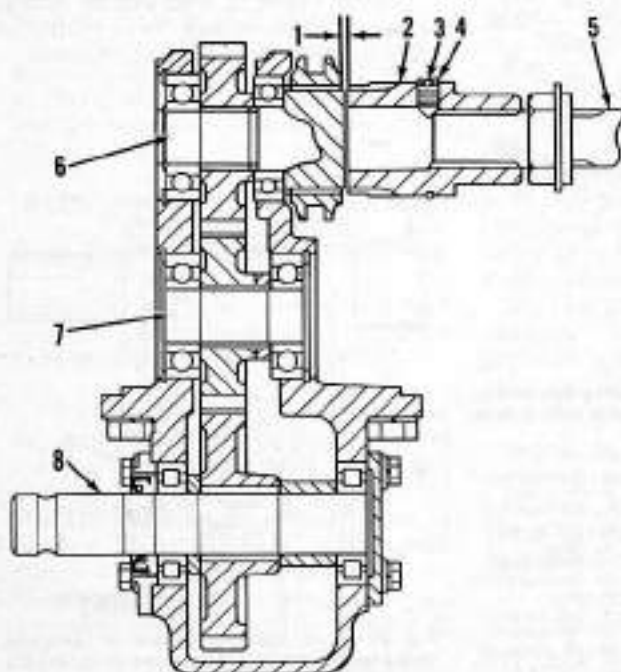


Fig. 32—Cross-sectional view of transfer gear box used on models equipped with Carraro front drive axles.

1. Clearance of 0.00-0.31 mm (0.000-0.012 inch)
2. Transmission drive coupler
3. Snap ring
4. Adjusting screw
5. Transmission bevel pinion shaft
6. Drive shaft
7. Intermediate shaft
8. Output shaft



## REMOVE AND REINSTALL

### Model 1190

59. To remove steering gear unit, remove steering wheel (4-Fig. 33) and dust seal (5). Disconnect controls and wiring to instrument panel. Remove drop arm (13-Fig. 34) and unbolt and remove instrument panel as a unit. Unbolt and remove steering gear assembly from transmission noting spacer (6, 7 and 24-Fig. 34) placement.

Reinstall by reversing removal procedure.

## STEERING GEAR AND COLUMN OVERHAUL

### Model 1190

60. **DISASSEMBLY.** With steering gear and steering wheel removed, remove locknut (6-Fig. 33) and unscrew adjustable bearing cone (7). Remove the twelve loose bearing balls (9). Remove both ball nut pegs (17 and 22-Fig. 34) and shims (18 and 21), then withdraw steering shaft (19-Fig. 33)

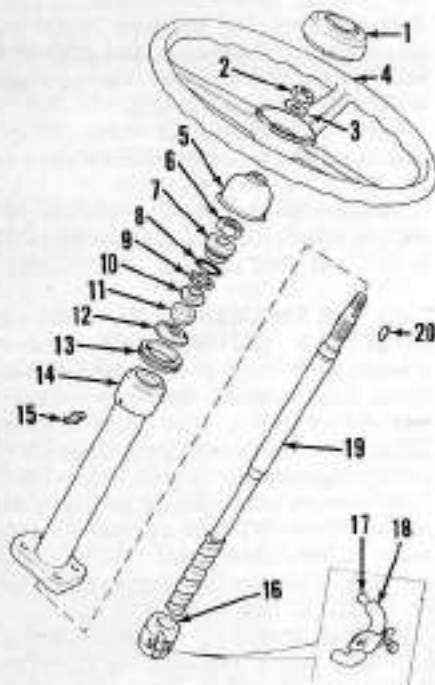


Fig. 33—Exploded view of steering column and related parts for 1190 models with manual steering.

- |                            |                     |
|----------------------------|---------------------|
| 1. Cap                     | 11. Spherical seat  |
| 2. Nut                     | 12. Rubber baffle   |
| 3. Washer                  | 13. Cross shaft     |
| 4. Steering wheel          | 14. Steering column |
| 5. Dust seal               | 15. Grease cork     |
| 6. Locknut                 | 16. Steering nut    |
| 7. Adjustable bearing cone | 17. Steel ball      |
| 8. 'O' ring                | 18. Transfer tube   |
| 9. Steel balls             | 19. Steering shaft  |
| 10. Lower bearing race     | 20. Woodruff key    |

and ball nut assembly (16) from bottom of unit. Lower bearing race (10) and spherical seat (11) can now be removed from steering column (14) and rubber baffle (12) from steering shaft (19). Unscrew ball nut assembly (16) from steering shaft (19) and retrieve the 28 loose steel balls (17). Remove locating screw (20-Fig. 34) and withdraw cross-shaft (15).

If cross-shaft bushings (1 and 25-Fig. 34) are to be renewed, note size and location before removal for proper reinstallation. Lubrication holes in bushings (1 and 25) and gear box (2) must be aligned and cross-shaft (15) must turn freely.

61. **REASSEMBLY.** Remove transfer tube (18-Fig. 33) and place ball nut (16) over ball track on lower end of steering shaft (19). Insert steel balls (17) into ball nut (16) until full, place remaining balls in transfer tube (18) with grease and fit tube (18) to ball nut (16). Place rubber baffle (12) in groove on steering shaft (19) and insert up through housing.

Position rocker arm (19-Fig. 34) in steering box (2) with stop down. Reinstall cross-shaft (15) and secure with locating screw (20).

62. **BALL NUT PEG PRELOAD.** Install one ball nut peg (8-Fig. 35)

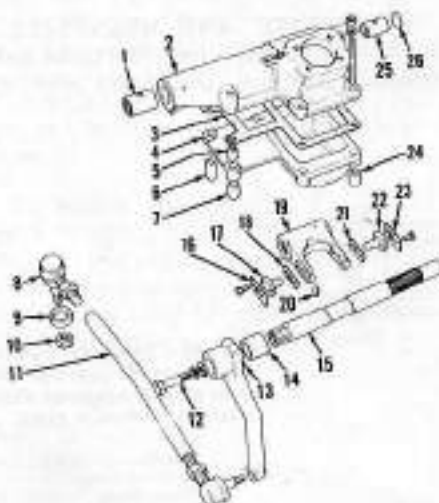


Fig. 34—Exploded view of steering box and its related parts used on 1190 models with manual steering.

- |                     |                     |
|---------------------|---------------------|
| 1. Bushing (long)   | 14. Dust shield     |
| 2. Steering box     | 15. Cross shaft     |
| 3. Gasket           | 16. Tab washer      |
| 4. Ramp             | 17. Ball nut peg    |
| 5. Dowel            | 18. Shim            |
| 6. 1/16-inch spacer | 19. Rocker arm      |
| 7. 7/8-inch spacer  | 20. Locating screw  |
| 8. Tie rod end      | 21. Shim            |
| 9. Dust shield      | 22. Ball nut peg    |
| 10. Dust shield     | 23. Tab washer      |
| 11. Nut             | 24. 7/8-inch spacer |
| 12. Drag link tube  | 25. Bushing (short) |
| 13. Bolt            | 26. Core plug       |

MINUS shims (18 and 21-Fig. 34) and tighten the two cap screws securely. Install second ball nut peg (4-Fig. 35) and tighten the two cap screws evenly only until inner end of peg (4) causes ball nut (6) to lightly bind. Using a feeler gage, measure gap between ball nut peg (4) and rocker arm (2). See 5-Fig. 35.

Shims (18 and 21-Fig. 34) to be used in final assembly should be 0.0254-0.0762 mm (0.001-0.003 inch) LESS than measured gap (5-Fig. 35). Divide shims (18 and 21-Fig. 34) as equally as possible between the two ball nut pegs (17 and 22) for installation and secure bolts with tab washers (16 and 23).

63. **STEERING SHAFT END PLAY.** Insert spherical seat (11-Fig. 33) on steering shaft (19) with flat face down, then install lower race (10) with round face in spherical seat (11). Drop in the twelve loose bearing balls (9). Install "O" ring (8) in groove of adjustable bearing cone (7) and thread onto steering shaft (19) until all play is removed from bearing assembly. Shaft (19) should still turn freely. Back off adjustable bearing cone (7) 1/8-turn to provide 0.000-0.076 mm (0.000-0.003 inch) end play of steering shaft. Hold adjustable bearing cone (7) in position and install locknut (6) with recessed side against adjustable bearing cone (7) and tighten to 163 N·m (120 ft.-lbs.) torque.

## DRAG LINK

### Model 1190

64. **ADJUSTMENT.** Drag link ends are serviced as a unit only and must be renewed as such.

Adjust length of drag link so spindle contacts stop on axle before internal steering gear stops wheel movement.

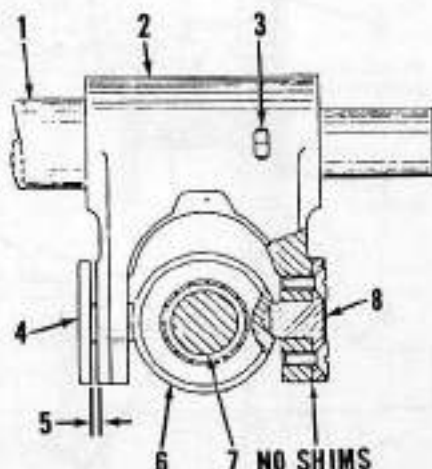


Fig. 35—View showing method of selecting shims for correct ball nut preload. Refer to paragraph 62 for procedure.

## POWER STEERING

Hydrostatic power steering is optional on Model 1190 and standard on all other models.

Hydrostatic steering systems are comprised of a pump, steering (control) valve and steering cylinder. Tractors are steered hydraulically with no mechanical link between steering wheel and front axle.

Power steering pump for 1190 models is a 15.9 L/min. (3.5 gpm) Holbourn-Eaton pump having a remote reservoir containing filter and breather assemblies. All other models use a 10.5 L/min. (2.3 gpm) Plessey pump utilizing differently arranged remote filter, breather and reservoir systems or a reservoir as an integral part of the pump.

Two wheel drive tractors are equipped with either a side mounted or transverse mounted steering cylinder. While there are some size differences in cylinders and pistons of side mounted cylinders service procedures remain the same.

Models having David Brown front drive axles have a transverse mounted steering cylinder bolted to front differential housing. Model 1490 having a Carraro front drive axle uses a standard duty steering cylinder. A heavier duty version of the same cylinder is used on 1690 models. Main differences in these two cylinders is diameter, one being 53 mm (2.087 inches) diameter and heavier duty cylinder is 60 mm (2.362 inches) diameter. Screw-on caps of the two cylinders and their seal arrangements are slightly different, but service procedures are readily apparent.

All models use Orbitrol OSP-125 steering valve, however Model 1690 may use an Orbitrol OSP-120 steering valve. Service procedures are the same for either valve.

### BLEEDING STEERING SYSTEM

#### Side Mounted Steering Cylinders

65. Fill reservoir to proper level with specified fluid and raise front of tractor until front wheels clear the ground.

66. If steering pump has been drained, renewed or overhauled it will be necessary to prime pump. Place fuel shut-off in **STOP** position and use starter to turn engine over for 10 or 15 seconds. Push fuel shutoff to **RUN** position and start and run engine for 10 or 15 seconds, then shut off engine. Repeat procedure and leave engine running at idle speed.

67. With engine running at idle speed

turn steering wheel one full turn in each direction several times, but do not allow front wheels to reach stops. Recheck fluid level in reservoir and fill as necessary.

**NOTE:** Where side mounted equal displacement rams are used oil level in remote reservoir must be 38.1 mm (1½ inches) above element when steering is turned fully to right.

With engine running at idle speed, turn steering wheel until front wheels reach stops in both directions several times. Do not hold front wheels against stops for more than a few seconds at a time.

Lower front of tractor and fill reservoir to proper level.

Repeat procedure if operation is not satisfactory.

#### Transverse Mounted Steering Cylinders

68. Fill reservoir to proper level and if pump has been drained, renewed or overhauled refer to paragraph 66.

With engine running at idle speed, reservoir filled to proper level and front wheels raised off the ground loosen bleed screw on left side of steering cylinder one full turn and turn steering wheel right until front wheels reach their stop and tighten left-hand bleed screw. Loosen bleed screw on right side of steering cylinder one full turn and turn steering wheel left until front wheels reach their stop and tighten right-hand bleed screw. Turn front wheels from stop to stop several times to check operation. Repeat procedure if operation is not satisfactory. Stop engine, lower front wheels to ground and fill reservoir to proper level.

### SYSTEM OPERATING PRESSURE

#### All Models

69. A pressure test of power steering circuit will disclose whether pump, relief valve or some other unit in system is malfunctioning.

To check pressure disconnect pump pressure line and install a suitable pressure gage into pump outlet port. Start and run engine at 1500 rpm **ONLY** long enough to read pressure gage.

**NOTE:** Do not run engine for a long period of time because steering pump is operating at maximum pressure and pump damage and steering fluid overheating will result.

If pump fails to reach its set pressure or if pressure is too high remove and examine pump.

Pump pressure for Holbourn-Eaton

pump is 4926 kPa (700 psi) and pressure for Plessey pump should be 6895 kPa (1000 psi) with fluid at operating temperature and engine running at 1500 rpm.

### REMOVE AND REINSTALL PUMP

#### Model 1190

70. A belt driven Holbourn-Eaton pump is used on Model 1190 and pump is located on right front side of engine.

To remove pump, disconnect pump lines and drain fluid. Remove fuel lift pump and lines, remove bolts fastening pump to timing gear cover and remove pump.

To reinstall reverse removal procedure and bleed steering system.

#### Models 1290-1390-1490-1690

71. These models use gear driven Plessey pump mounted on right front side of engine.

To remove pump, disconnect pump lines and drain fluid. Remove fuel lift pump and lines, remove bolts fastening pump to timing gear cover and remove pump.

To reinstall reverse removal procedure and bleed steering system.

### STEERING PUMP OVERHAUL

#### Model 1190 (Holbourn-Eaton Pump)

72. A seal kit is available for Holbourn-Eaton pumps, however pump section is serviced as an entire unit only. Service information was not available at the time of this publication.

#### Models 1290-1390-1490-1690 (Plessey Pump)

75. **DISASSEMBLY.** Remove center bolt (22—Fig. 37) and pull reservoir (21) from pump body. Remove nut (1), lockwasher (2) and use a suitable puller to remove gear (3) from shaft (10).

**NOTE:** Do not drive on end of shaft (10—Fig. 37) as damage to bearings (8 and 17) will result.

Remove the four through-bolts and separate cover (19—Fig. 37) and mounting flange (6) from pump body (16). If necessary, tap cover lightly with a soft faced hammer to remove from dowels (18). Identify bearings (8 and 17) so they can be reinstalled in their original positions and remove bearings and rotors (gears) from pump body (16). Remove snap ring (4) and seal (5) from mounting flange (6). Discard seal (5) and "O" rings (7, 12 and 14). Remove relief valve (13) and note it is a preset assembly.



76. Clean and inspect all parts. It is normal for rotors to cut a slight track on inlet side of body, however if track exceeds 0.10 mm (0.004 inch) depth, body, rotors and bearings must be renewed. Inspect bearings for wear or scoring. Pay particular attention to lubrication scrolls in shaft bores and seal bridge area between shaft bores. If bearings are worn or scored renew both bearings. Inspect journals of rotor shafts for scoring or wear. Light scoring of journal can be removed using "O" grade emery paper lubricated with kerosene. Shaft journals must be within 0.013 mm (0.0005 inch) of being equal while gear width must be within 0.005 mm (0.0002 inch) of being equal. Measure the overall width of the gears and bearings assembly and compare this with width of pump body. See Fig. 38. Width of gear body must not be more than 0.20 mm (0.008 inch) wider than width of rotors and bearings assembly.

77. **REASSEMBLY.** Press (do not drive) seal (5—Fig. 37) into mounting flange (6). Install snap ring (4) and lubricate inside diameter of seal. Install relief valve (13), then install seal rings (7 and 12) in cover (19) and mounting flange (6). Install cover (19) on dowels (18) and set pump on cover end. Lubricate inner bearing (17) and install in body (16) with recesses toward rotors and largest cut-out toward inlet side of pump. Install rotors (10 and 11), then lubricate front bearing (8) and install in body with recesses next to rotors and largest cut-out toward inlet side of pump. Install mounting flange (6), align bolt holes and install through-bolts. Tighten bolts evenly to 40 N·m (30

ft.-lbs.) torque. Install Woodruff key (9), gear (3), tab washer (2) and nut (1), then tighten nut to 61 N·m (45 ft.-lbs.) torque and secure tab washer. Install "O" ring (14), then filter (if so equipped) and reservoir (21).

## REMOVE AND REINSTALL STEERING CYLINDER

### Side Mounted Cylinders

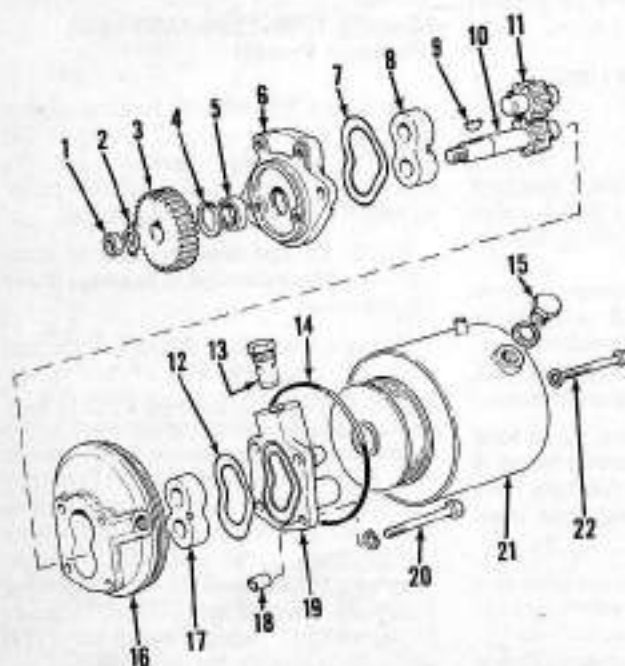
78. Removal of side mounted cylinders will be obvious after examination. Cap all open hydraulic lines.

After reinstallation bleed system as outlined in paragraph 65.

### Transverse Mounted Cylinders (2 Wheel Drive)

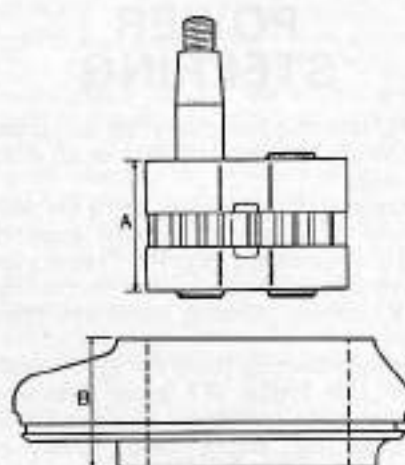
79. To remove steering cylinder first remove front axle as outlined in paragraph 5. Disconnect tie-rods from fork (38—Fig. 40) and all hydraulic lines to cylinder. Remove snap rings (25) at each end union (27), pull pipes away and remove both unions and all spacing washers (28). Remove cotter pin (6) and nut (7) from pivot pin (12) and remove pivot pin. Remove cylinder assembly. Remove screws retaining ball pegs (15 and 41), remove ball pegs and shims (40) noting position and thickness of shims. Remove cylinder from fork (38).

80. To reinstall cylinder, install sealing ring (14—Fig. 40). Put cylinder assembly in fork (38), install lower ball peg (15) and tighten screws. Install sealing ring (39), shims (40) which were removed and ball peg (41). Tighten screws and remove lube fitting (42).



**Fig. 37—Exploded view of Plessey power steering pump showing component parts and their relative positions. Note in some applications, filter is relocated to a remote reservoir.**

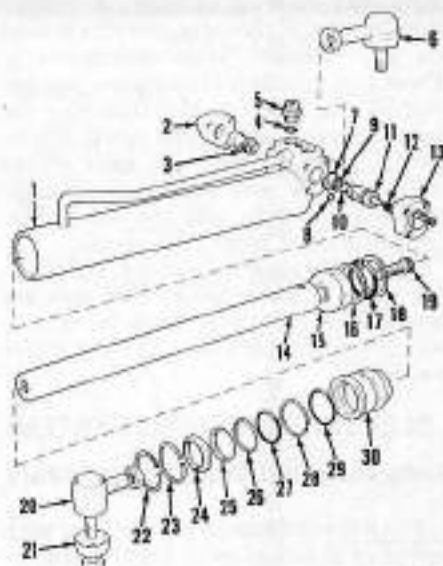
1. Nut
2. Tab washer
3. Drive gear
4. Snap ring
5. Seal
6. Mounting flange
7. Sealing rings
8. Bearing
9. Woodruff key
10. Rotor
11. Rotor
12. Sealing rings
13. Relief valve
14. "O" ring
15. Filler cap
16. Pump body
17. Bearing
18. Dowel
19. Pump cover
20. Bolt
21. Reservoir
22. Center bolt



**Fig. 38—Width (A) of rotors and bearings assembly must be not more than 0.2032 mm (0.008 inch) narrower than width (B) of pump body.**

Position dial indicator through lube fitting hole to measure cylinder movement on ball pegs. Add or remove shims to give a preload of 0.02-0.08 mm (0.001-0.003 inch). Install lube fitting (42).

Install cylinder assembly **MINUS** spacing washers (28 - Fig. 40) and install special unions (27). Move cylinder to one end and measure gap at opposite end



**Fig. 29—Exploded view of typical side mounted steering cylinder.**

- |                          |                  |
|--------------------------|------------------|
| 1. Cylinder tube         | 16. Back-up ring |
| 2. End plate             | 17. "O" ring     |
| 3. Non-return valve      | 18. Back-up ring |
| 4. "U" ring              | 19. Bolt         |
| 5. Piston                | 20. Tie rod end  |
| 6. Tie rod end           | 21. Dust shield  |
| 7. "U" ring              | 22. Snap ring    |
| 8. "U" ring              | 23. Snap ring    |
| 9. "U" ring              | 24. Scraper seal |
| 10. "U" ring             | 25. Sealing ring |
| 11. Spool valve & sleeve | 26. Back-up ring |
| 12. Spring               | 27. "O" ring     |
| 13. End plate            | 28. Back-up ring |
| 14. Piston rod           | 29. "O" ring     |
| 15. Piston               | 30. Sleeve       |

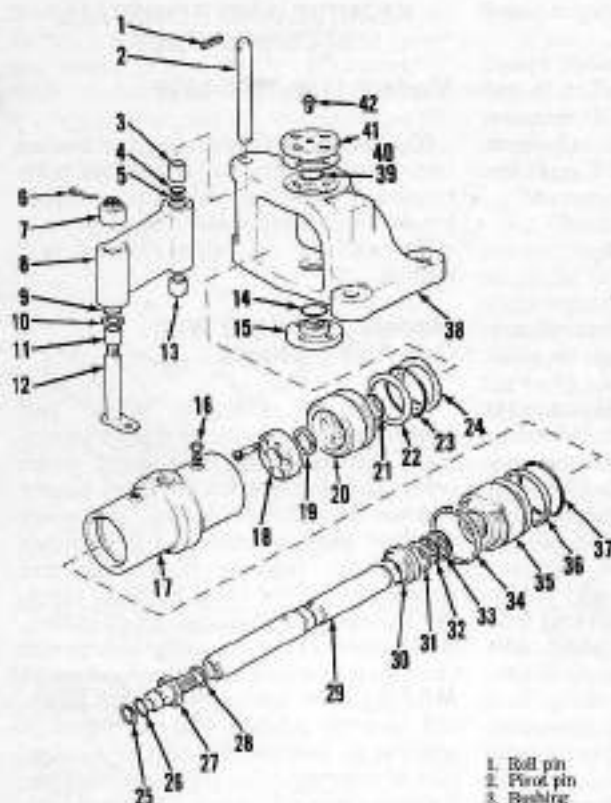


Fig. 40—Exploded view of transverse mounted steering cylinder showing component parts and their relative positions.

4. "O" ring
5. "O" ring
6. Cotter pin
7. Nut
8. Pivot link
9. "O" ring
10. Washer
11. Bushing
12. Pivot pin
13. Bushing
14. Sealing ring
15. Ball peg
16. Bleeder
17. Cylinder
18. Locking plate
19. Split rings
20. Piston
21. "O" ring
22. Back-up ring
23. "O" ring
24. Back-up ring
25. Snap ring
26. "O" ring
27. Union
28. Spacing washer
29. Piston rod
30. Wiper seal
31. Back-up ring
32. Sealing ring
33. Sealing ring
34. Snap ring
35. Sleeve
36. Leather ring
37. "O" ring
38. Fork
39. "O" ring
40. Shim
41. Ball peg
42. Lock fitting

1. Roll pin
2. Pivot pin
3. Bushing

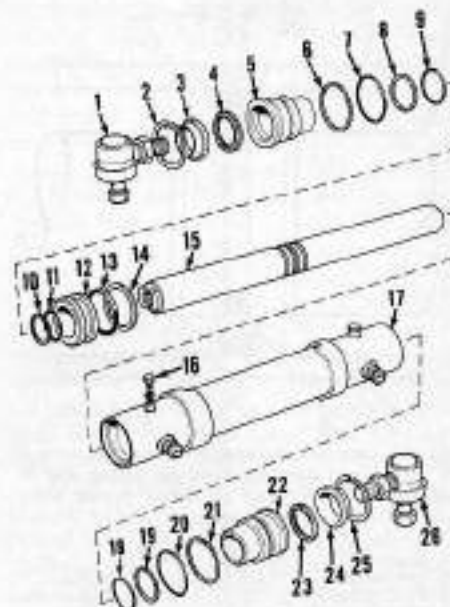


Fig. 41—Exploded view of steering cylinder used on models equipped with David Brown front drive axles.

1. Tie rod end
2. Snap ring
3. Wiper seal
4. Seal
5. Sleeve
6. Back-up ring
7. "O" ring
8. Back-up ring
9. "O" ring
10. Snap ring
11. "O" ring
12. Piston
13. "O" ring
14. Back-up ring
15. Cylinder rod
16. Bleeder screw
17. Tube assembly
18. "O" ring
19. Back-up ring
20. "O" ring
21. Back-up ring
22. Sleeve
23. Seal
24. Wiper seal
25. Snap ring
26. Tie rod end

with a feeler gage. Proper setting is between 0.127 mm (0.005 inch) clearance and 0.02 mm (0.001 inch) preload. Remove unions (27) and position equal thickness of spacing washers (28) at each end to give proper setting. Lubricate and install pivot pin (12) and nut (7). Tighten nut until there is no free end movement. Install cotter pin (6). Install "O" rings (26) on unions (27) and reinstall hydraulic lines. Install snap rings (25) on each union.

Reinstall front axle and bleed system as outlined in paragraph 65.

### All Front Drive Models

81. Removal of steering cylinders on front drive equipped models will be obvious after examination. Mark bearing caps for proper reinstallation on models having David Brown axle.

After reinstallation, bleed system as outlined in paragraph 68 for David Brown axles and paragraph 65 for Carraro axle models.

## STEERING CYLINDER OVERHAUL

### Side Mounted Cylinder

82. Clear cylinder of oil as necessary by moving piston rod through its full stroke. Remove the two snap rings (22 and 23—Fig. 39) and pull piston rod (14), piston assembly (15) and sleeve

assembly (30) from cylinder (1). Remove bolt (19) and piston (15). Remove and discard all "O" rings, back-up rings, sealing rings and scraper seal.

Remove end caps (2 and 13—Fig. 39) and remove spring (12), spool valve and sleeve (11) and non-return valve (3). Remove and discard all "O" rings.

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

Soak back-up rings in specified steering fluid for 30 minutes and allow to dry (absorb) for an additional 30 minutes prior to assembly. Lubricate all parts making sure spool (11—Fig. 39) and valve (3) move freely in bores. Reassemble by reversing disassembly procedure.

### Transverse Mounted Cylinders

84. Clear cylinder of oil as necessary by moving piston rod through its complete stroke. Remove snap ring (34—Fig. 40) and sleeve assembly (35). Mark piston rod (29) and cylinder (17) for reassembly and remove piston rod (29). Remove the six screws and locking plate (18). Remove split ring (19) and piston (20). Remove snap ring and sleeve assembly from opposite end of cylinder

(17). Remove all sealing rings and back-up rings from piston and sleeves.

Clean and inspect all parts. Cylinder bore should be smooth and free of score marks. Piston and piston rod must be free of nicks or burrs. Slight blemishes may be removed using fine emery paper lubricated with kerosene, but all parts must be thoroughly cleaned before reassembly.

Soak back-up rings in specified steering fluid for 30 minutes and allow to dry (absorb) for an additional 30 minutes prior to assembly. Lubricate all parts during assembly.

Reassemble by reversing disassembly procedure. Make certain marks on cylinder and piston rod made during disassembly are in alignment.

### David Brown Front Drive Axle Steering Cylinder

85. Clear cylinder of oil as necessary by moving piston rod through its complete stroke. Remove tie-rod ends (1 and 26—Fig. 41) and snap rings (2 and 25). Push cylinder rod (15) out of tube assembly (17). Remove sleeve assembly (5) which remained in tube assembly (17) and sleeve assembly (22) which came out on rod (15). Remove snap ring (10) and



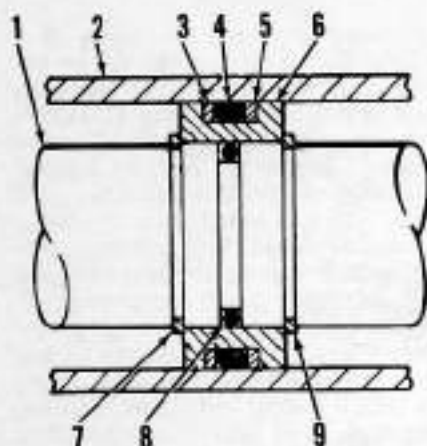


Fig. 42—Diagram showing correct placement of "O" rings and back-up rings on piston rod of steering cylinder used on David Brown front drive axles.

- |                  |              |
|------------------|--------------|
| 1. Piston rod    | 6. Piston    |
| 2. Cylinder tube | 7. Snap ring |
| 3. Back-up ring  | 8. "O" ring  |
| 4. "O" ring      | 9. Snap ring |
| 5. Back-up ring  |              |

piston (12). Remove "O" ring (11) from groove in rod (15).

86. Clean and inspect all parts. Cylinder tube must be smooth and free of score marks. Piston and piston rod must be free of nicks or burrs. Slight blemishes may be removed using fine emery cloth lubricated with kerosene,

but all parts must be thoroughly cleaned before reassembly.

Soak back-up rings in specified steering fluid for 30 minutes and allow to dry (absorb) for an additional 30 minutes prior to assembly. Lubricate all parts during assembly, referring to Fig. 42 for back-up ring and "O" ring placement.

## Carraro Front Drive Axle Steering Cylinder

87. Clear cylinder of oil as necessary by moving piston rod through its complete stroke. Unscrew end cap (8—Fig. 43) and pull piston rod (1) and piston (4) out of cylinder body (12). Remove retaining nut (2), washer (3), piston assembly (4), "O" ring (5) and washer (6). Slide end cap (8) off of piston rod (1), then remove "O" ring (7) and seals (9 and 10).

88. Clean and inspect all parts. 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 goes toward end cap and tighten nut (2—Fig. 43) on piston rod to 81 N·m (60 ft.-lbs.) torque. Lubricate all parts during reassembly.

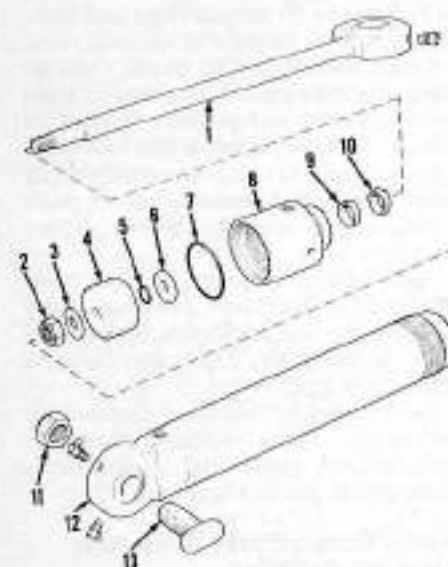


Fig. 43—Exploded view of steering cylinder used on 1490 and some 1690 models. Note differences in end cap (8) and seals (9 and 10) of this cylinder and similar cylinder pictured in Fig. 44.

- |               |                   |
|---------------|-------------------|
| 1. Piston rod | 8. End cap        |
| 2. Nut        | 9. Seal           |
| 3. Washer     | 10. Wiper seal    |
| 4. Piston     | 11. Nut           |
| 5. "O" ring   | 12. Cylinder tube |
| 6. Washer     | 13. Bolt          |
| 7. "O" ring   |                   |

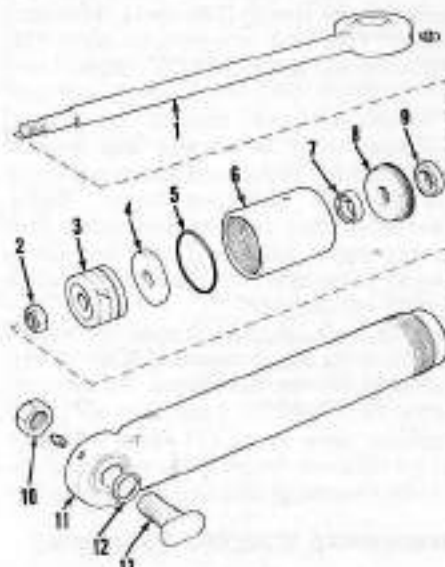


Fig. 44—Exploded view of second type steering cylinder used on Model 1690 tractors. Note differences in end cap and seal design from cylinder shown in Fig. 43.

- |               |                   |
|---------------|-------------------|
| 1. Piston rod | 8. End cover      |
| 2. Nut        | 9. Seal           |
| 3. Piston     | 10. Nut           |
| 4. Washer     | 11. Cylinder tube |
| 5. "O" ring   | 12. Washer        |
| 6. End cap    | 13. Bolt          |
| 7. Seal       |                   |

## REMOVE AND REINSTALL STEERING VALVE

### Models 1190-1290-1390

89. Locate and disconnect the four oil lines from steering valve. Remove bolts retaining steering valve to support bracket and remove steering valve.

Reinstall by reversing removal procedure.

### Models 1490-1690 With Cab And Platform

90. Remove steering wheel and screws retaining heater valve to instrument panel. Raise instrument panel cover and remove knobs from heater and ventilator control levers. Disconnect negative battery cable and tachometer drive cable. Remove floor plate and disconnect control lever for hand throttle. Pull control lever rod out of guides. Remove set screws retaining instrument panel to frame and lift instrument panel carefully over heater, ventilator levers and steering column. Support panel in position to prevent damage. Note location of steering valve pipes and remove. Remove steering column retaining bolts, then remove steering column and valve.

## OVERHAUL STEERING VALVE

### All Models

91. Clamp steering valve lightly in a vise with rotor end up. Remove the seven cap screws retaining end cap (5—Fig. 45) and remove end cap noting position of cap screw (3) which has pin. Remove spacer (6), rotor (2), stator (10), plate (12) and drive shaft (1). Remove

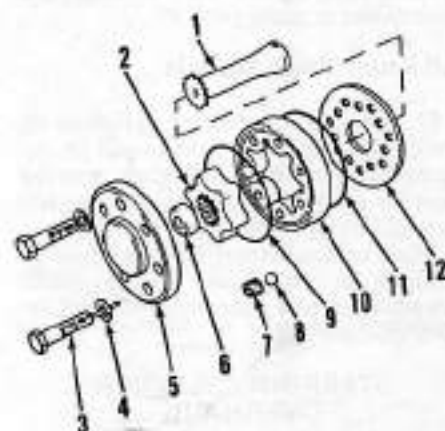


Fig. 45—Exploded view showing steering valve rotor set, drive shaft and related parts.

- |                      |                    |
|----------------------|--------------------|
| 1. Drive shaft       | 7. Threaded insert |
| 2. Rotor             | 8. Check ball      |
| 3. Cap screw (w/pin) | 9. "O" ring        |
| 4. Sealing washer    | 10. Stator         |
| 5. End cap           | 11. "O" ring       |
| 6. Spacer            | 12. Plate          |

threaded insert (7) and check ball (8). Remove valve from vise and push spool and sleeve (6 and 7—Fig. 46) assembly from bottom of housing. Remove washer (1), bearing (2), bearing race (3) and centering spring retaining ring (4)

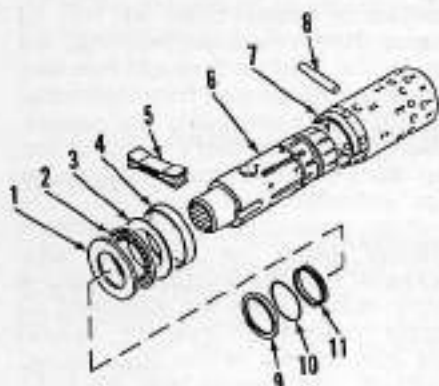


Fig. 46—Exploded view of steering valve spool, sleeve, bearings and seals.

- |                          |               |
|--------------------------|---------------|
| 1. Washer                | 7. Sleeve     |
| 2. Thrust bearing        | 8. Pin        |
| 3. Bearing race          | 9. Seal       |
| 4. Spring retaining ring | 10. "O" ring  |
| 5. Centering springs     | 11. Seal ring |
| 6. Spool                 |               |

from valve spool and sleeve. Remove drive pin (8), then push spool (6) out of sleeve (7) toward centering spring end. Remove the six centering springs (5) from spool. Carefully pry seal (9) from housing, then remove "O" ring (10) and seal ring (11) assembly.

92. Clean and inspect all parts for excessive wear or damage. Pay particular attention to matched surfaces for scuffs and scratches. Check thrust bearing and race for excessive wear or damage.

Check rotor and stator thickness as shown in Fig. 47 and rotor to stator wear as shown in Fig. 48.

Check splines for excessive wear and all parts for nicks and burrs. Centering pin must not be bent or worn and centering springs must be in good condition.

Reassemble using all new "O" rings and seals, which are available as a repair kit.

93. Lubricate all parts with specified fluid during assembly and slide spool (6—Fig. 46) into sleeve (7) and align centering spring slots. The fit of these two parts is very close and turning spool slightly while inserting will aid installation. Assemble centering springs (5) in two sets of three each. With arches facing one another insert springs through sleeve and spool.

**NOTE:** If available, Case special tool CAS-1239 will aid in installing centering springs. To use, slide tool through spring slots of sleeve and spool, assemble springs and place ends in slot of tool, then compress opposite ends of springs and slide springs into position while pushing tool out. See Fig. 49.

Install drive pin (8—Fig. 46) making certain ends of pin are flush with outer surface of sleeve. Install centering spring retaining ring (4), bearing race (3), thrust bearing (2) and washer (1) on spool with chamfer on inside diameter of

bearing race facing away from thrust bearing. Use a suitable driver to install shaft seal (9) in valve body with lip toward outside. Lubricate "O" ring (10) and install it on outside diameter of seal ring (11), then install assembly on end of spindle of Case special tool number CAS-1238. See Fig. 49. Push seal and spindle into sleeve of special tool until firm resistance is met and insert assembly into valve body until sleeve bottoms. Use a rotating motion and push on tool spindle until "O" ring seats in body and remove tool. Install sleeve, spool and bearing assembly into body and rotate assembly as it passes through seal assembly. With spool and bearing assembly installed, position so drive pin is at right angles to flat surface containing pipe (hose) ports. Place valve in soft jawed vise with bottom end up and install check ball (8—Fig. 45) and threaded insert (7). Do not overtighten threaded insert. Place new "O" ring in body and install drive shaft (1) with slot engaging drive pin. Install plate (12) and align oil holes with oil holes in body. Install rotor (2) over splines of drive shaft **MAKING CERTAIN** one valley of rotor aligns with drive pin slot of drive shaft.

**NOTE:** Failure to time rotor, as outlined, will result in tractor steering in opposite direction of steering wheel rotation.

Install spacer (6—Fig. 45) on drive shaft. Install new "O" ring (9 and 11) on each side of stator (10), install stator over rotor and align bolt holes. Use new seals (4) on cap screws and install end cap (5) making certain cap screw with pin (3) is installed in correct location (over check ball). Tighten cap screws to 27 N·m (20 ft.-lbs.) torque.

Fill steering valve with specified fluid by pouring fluid through hose ports and check assembly by measuring torque required to turn splined end of steering shaft. Torque must not exceed 24 N·m (18 ft.-lbs.)

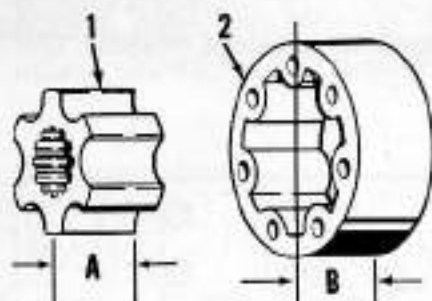


Fig. 47—Measure thickness of rotor (A) and stator (B) as shown. If rotor (A) is 0.0508 mm (0.002 inch) less than stator (B), replace complete steering valve.

- |          |           |
|----------|-----------|
| 1. Rotor | 2. Stator |
|----------|-----------|

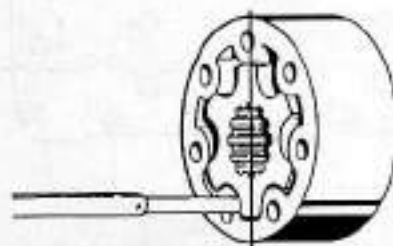


Fig. 49—View showing method of installing centering springs and shaft seal using Case special tools CAS-1238 and CAS-1239.

- |                                    |
|------------------------------------|
| 1. Special tool (CAS-1239)         |
| 2. Centering springs               |
| 3. Special tool (CAS-1238) spindle |
| 4. Special tool (CAS-1238) sleeve  |

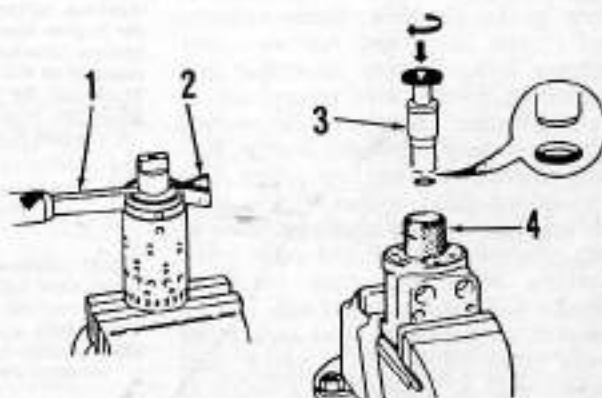


Fig. 48—Measure gap between rotor and stator with rotor and stator aligned as shown. If gap is 0.1270 mm (0.005 inch) or larger, replace steering valve.



# ENGINE

## R&R ENGINE ASSEMBLY

### Model 1190

94. Drain radiator, engine block and engine oil. Remove hood, grille, fuel tank and supporting framework. Remove battery and battery support. Remove radiator hoses, all necessary electrical connections, air breather tubes, fuel lines, tachometer drive cable and fuel and throttle control rods and cables. Remove power steering lines, if so equipped. Remove radiator, shroud and oil pan. Split tractor as outlined in paragraph 242.

Support front section of tractor securely. Remove oil pump and sump to prevent damage. Remove bolts and nuts retaining engine to main frame noting bolt locations and remove engine assembly.

Reinstall by reversing removal procedure.

### Models 1290-1390-1490-1690

95. Drain fluid from radiator and engine. Remove hood, side covers, grille and all supporting framework. Remove battery, battery support, air filter assembly and hoses and radiator hoses. Remove front mounted hydraulic pump, or pumps, as equipped and lines. Remove radiator and shroud. Disconnect power steering lines and engine wiring harnesses. Split tractor as outlined in paragraph 242 for 1290, 1390 and 1490 models and as outlined in paragraph 246 for 1690 models. Remove engine to frame retaining bolts and nuts noting length and position of bolts. Remove engine assembly.

Reinstall by reversing removal procedure.

## R&R CYLINDER HEAD

### Model 1190

96. Remove muffler, precleaner and engine hood. Remove fuel tank and hose from intake manifold. Drain radiator and engine block and remove upper radiator hose. Remove alternator and disconnect injector fuel return line at front of engine. Disconnect thermostat tube, necessary electrical wiring, fuel lines, oil return line and instrument gage connections. Remove fuel injector lines and injectors and cap openings. Remove rocker arm assembly and push rods. Remove bolts and nuts retaining cylinder head and remove head.

Install new cylinder head gasket and water pump outlet seal. Tighten head bolts to 122 N·m (90 ft.-lbs.) torque as

shown in Fig. 50. Install push rods and rocker arm assemblies and adjust valves as outlined in paragraph 100.

### Models 1290-1390-1490

97. Drain coolant from radiator and engine block. Remove muffler, pre-cleaner, air intake hose to turbocharger (if so equipped), hood and hood support frame work. Remove exhaust flange, exhaust connector (if so equipped) and turbocharger (if so equipped). Disconnect fuel lines and remove fuel filter assembly. Remove exhaust manifold, injector fuel lines and injectors. Remove upper radiator hose and disconnect all necessary electrical connections. Remove thermostat reservoir and lines and power steering breather and lines (if so equipped) from cylinder head. Disconnect tachometer drive cable and remove intake manifold. Disconnect oil supply line from cylinder head and remove rocker arm cover, rocker arm assembly and push rods. Remove cylinder head retaining bolts and lift off cylinder head.

Install new head gasket, tighten cylinder head retaining bolts and nuts to 136 N·m (100 ft.-lbs.) torque as shown in Fig. 51. Install push rods and rocker arm shaft assembly. Tighten rocker arm shaft retaining bolts to 62 N·m (45 ft.-lbs.) torque. Adjust valves as outlined in paragraph 101.

Reinstall by reversing removal procedure.

### Model 1690

98. Remove muffler, raise hood and lock in position and remove front side panels. Drain coolant from radiator and engine block. Disconnect battery and remove air filter canister and bracket. Disconnect heater hoses at rear of engine. Remove exhaust manifold, fuel return line, injector lines and injectors. Disconnect heater pipe from thermostat housing and water pump and remove. Disconnect all necessary electrical wiring. Remove rocker arm covers, rocker arm assemblies and push rods. Turn coolant connection, located between cylinder heads on left-hand side, clockwise into the front head. Remove upper radiator hose and disconnect oil supply lines from the front of front head and from the rear of rear head. Loosen fan belt and remove fan assembly. Remove cylinder head retaining nuts and bolts and remove cylinder heads.

Install new head gaskets and new seal in top recess of water pump. Install new washers under cylinder head retaining bolts and nuts noting placement of "V" groove washers between the two heads. See Fig. 53. Tighten cylinder head retaining bolts and nuts to 136 N·m (100 ft.-lbs.) torque as shown in Fig. 52. Install new "O" ring in recess of coolant connector located on left side between the heads and use "Loctite" hydraulic sealant on threads of connector. Turn connector counter-clockwise toward

Fig. 50—Tightening sequence for cylinder head bolts on three cylinder engines. Tighten bolts in three intervals of 40 N·m (30 ft.-lbs.), 81 N·m (60 ft.-lbs.), and then 122 N·m (90 ft.-lbs.) torque.

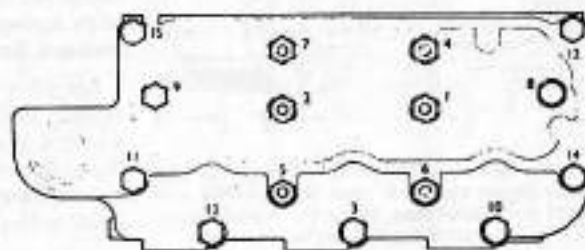


Fig. 51—Using new steel washers, tighten four cylinder engine head bolts in sequence illustrated in four steps of 40 N·m (30 ft.-lbs.), 81 N·m (60 ft.-lbs.), 108 N·m (80 ft.-lbs.), then 136 N·m (100 ft.-lbs.) torque.

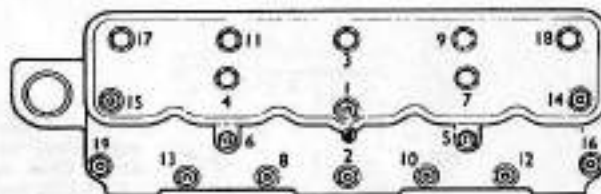
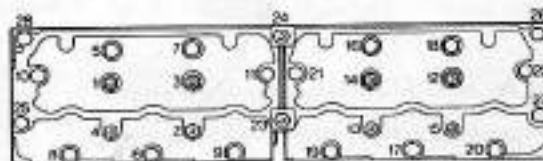


Fig. 52—Sequence for tightening head bolts on six cylinder engines. Tighten in even steps until 136 N·m (100 ft.-lbs.) torque is reached. See Fig. 53.





rear head. Install push rods and rocker arm assemblies making certain oil supply holes in rocker arm shaft supports are at the front on front shaft and at the rear on rear shaft. Tighten rocker arm shaft retaining bolts to 62 N·m (45 ft.-lbs.) torque. Adjust valve clearance as outlined in paragraph 102. Reinstall by reversing removal procedure.

## ROCKER ARMS AND SHAFTS

### All Models

99. To remove rocker arm assemblies refer to appropriate preceding paragraph on cylinder head removal for model being serviced.

With rocker arm assembly removed, remove plug (1—Fig. 54) from end of shaft. Remove end locating spring (5), right-hand rocker arm (7), locating screw (8) and rear shaft support. Remove remaining rocker arms, locating springs and shaft supports and place them in order on a clean bench.

Rocker arm shaft is 18.99-19.02 mm (0.748-0.749 inch) diameter and bushing should be 19.02-19.05 mm (0.750-0.7505 inch). Rocker arms and bushings are available as an assembly, or bushings may be renewed where shaft to bushing clearance is excessive. When renewing bushings make certain oil hole in bushing is aligned with oil hole in rocker

arm bushing bore. Ream or hone inside bushing bore for proper clearance. If valve stem contact face of rocker arm is excessively worn, it may be reground providing original curvature is maintained. Remove no more material than necessary to renew contact face.

Install shaft in rear shaft support (4—Fig. 54) with oiling holes down and secure shaft with locating screw (8). Peen bracket around screw to lock screw in position and complete assembly. Right-hand (7) and left-hand (6) rocker arms are installed in pairs at each shaft support with offset ends towards each other as shown in Fig. 54.

## VALVE GAP ADJUSTMENT

### Model 1190

100. Adjust valve (tappet) clearance to 0.25 mm (0.010 inch) with engine cold.

To adjust, rotate engine to "TDC" with No. 1 cylinder on compression stroke (No. 1 exhaust and intake valve fully closed) and adjust intake and exhaust valves on No. 1 cylinder, exhaust valve on No. 2 cylinder and intake valve on No. 3 cylinder.

Rotate engine one full revolution, again to "TDC" and with No. 1 cylinder on exhaust stroke (No. 1 exhaust and intake valves both partially open) adjust intake valve on No. 2 cylinder and exhaust valve on No. 3 cylinder. Refer to Fig. 55 and 56.

### Models 1290-1390-1490

101. Adjust valve (tappet) clearance to 0.25 mm (0.010 inch) with engine cold.

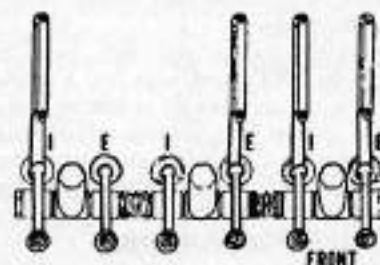


Fig. 55—With No. 1 piston on "TDC" compression stroke on three cylinder engines, adjust intake and exhaust valve gap on No. 1 cylinder, exhaust valve gap on No. 2 cylinder and intake valve gap on No. 3 cylinder. Refer to Fig. 56.

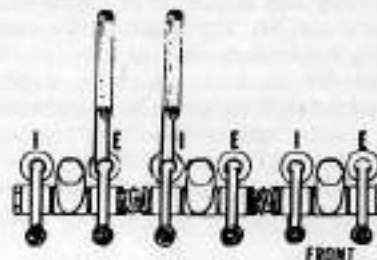


Fig. 56—With No. 1 piston on "TDC" exhaust stroke on three cylinder engines, adjust intake valve on No. 2 cylinder and exhaust valve on No. 3 cylinder. Refer to Fig. 55.

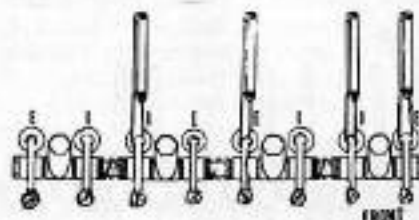


Fig. 57—With No. 1 piston on "TDC" compression stroke on four cylinder engines, adjust intake and exhaust valve gap on No. 1 cylinder, exhaust valve on No. 2 cylinder and intake valve on No. 3 cylinder. Refer to Fig. 58.

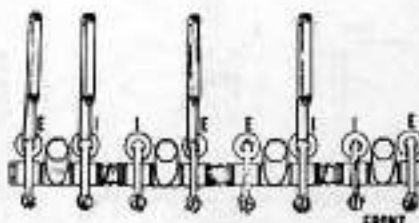


Fig. 58—With No. 1 piston on "TDC" exhaust stroke on four cylinder engines, adjust intake valve on No. 2 cylinder, exhaust valve on No. 3 cylinder and intake and exhaust valves on No. 4 cylinder. Refer to Fig. 57.

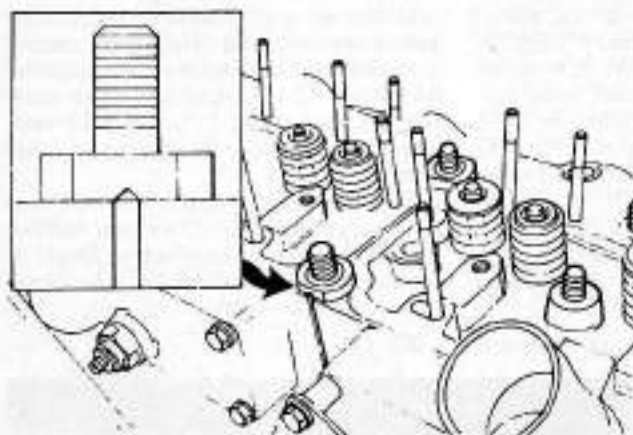


Fig. 53—Install new washers under head bolts and nuts. On center studs, "V" groove of special washer should align with ends of heads as shown.

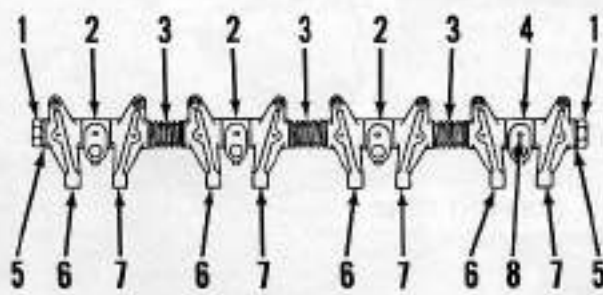


Fig. 54—View showing four cylinder engine rocker arm assembly. Three and six cylinder assemblies are basically arranged the same.

1. Plug
2. Front & intermediate shaft supports
3. Locating springs (intermediate)
4. Rear shaft support
5. Locating spring (end)
6. Left-hand rocker arm
7. Right-hand rocker arm
8. Locating screw

To adjust, rotate engine to "TDC" with No. 1 cylinder on compression stroke (No. 1 exhaust and intake valve fully closed) and adjust intake and exhaust valves on No. 1 cylinder, exhaust valve on No. 2 cylinder and intake valve on No. 3 cylinder.

Rotate engine one full revolution again to "TDC" and with No. 1 cylinder on exhaust stroke (No. 4 intake and exhaust valves fully closed) adjust intake valve on No. 2 cylinder, exhaust valve on No. 3 cylinder and intake and exhaust valves on No. 4 cylinder.

Refer to Fig. 57 and 58.

### Model 1690

102. Adjust valve (tappet) clearance to 0.25 mm (0.010 inch) with engine cold.

To adjust, rotate engine to "TDC" with No. 1 cylinder on compression stroke (No. 1 exhaust and intake valve fully closed) and adjust intake and exhaust valves on No. 1 cylinder, intake valve on No. 2 cylinder, exhaust valve on No. 3 cylinder, intake valve on No. 4 cylinder and exhaust valve on No. 5 cylinder.

Rotate engine one full revolution again to "TDC" and with No. 1 cylinder on exhaust stroke (No. 6 intake and exhaust valves fully closed) adjust exhaust valve on No. 2 cylinder, intake valve on No. 3 cylinder, exhaust valve on No. 4 cylinder, intake valve on No. 5 cylinder and exhaust and intake valves on No. 6 cylinders.

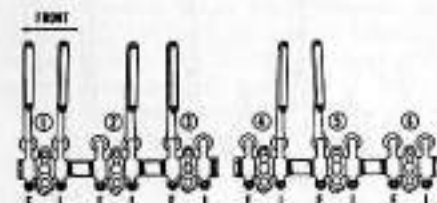


Fig. 59—With No. 1 piston on "TDC" compression stroke on six cylinder engines, adjust intake and exhaust valve gap on No. 1 cylinder, intake valve on No. 2 cylinder, exhaust valve on No. 3 cylinder, intake valve on No. 4 cylinder and exhaust valve on No. 5 cylinder. Refer to Fig. 60.

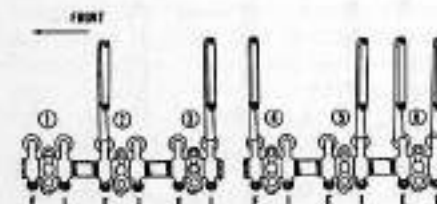


Fig. 60—With No. 1 piston on "TDC" exhaust stroke on six cylinder engines, adjust exhaust valve gap on No. 2 cylinder, intake valve on No. 3 cylinder, exhaust valve on No. 4 cylinder, intake valve on No. 5 cylinder and intake and exhaust on No. 6 cylinder. Refer to Fig. 59.

## CYLINDER HEADS, SEATS, GUIDES, VALVES AND SPRINGS

### All Models

103. **CYLINDER HEADS.** Note cylinder heads are structurally different, but service procedures are basically the same for each model.

With cylinder head, or heads removed, remove valves, springs, retainers and keepers. Place all components in order so they may be reinstalled in their original positions.

Clean cylinder head, or heads completely. Remove all traces of carbon, gasket material and other deposits. Check for cracks and using a suitable heavy, accurate straightedge and a feeler gage check for warpage. See Fig. 61. If warpage exceeds 0.762 mm (0.003 inch) cylinder head must be resurfaced. Remove only a minimum amount from head surface.

104. **SEATS.** Renewable intake and exhaust seats (inserts) are used in cylinder heads. If seats are rough or pitted they should be reground at 43½ degrees to a seat width of approximately 1.524-1.770 mm (0.060-0.070 inch). If inserts are loose, cracked or finished seat cannot be narrowed to 1.524-1.770 mm (0.060-0.070 inch) insert should be renewed. To remove old insert first crack it with a sharp chisel taking care not to damage cylinder head and covering insert with cloth to catch any flying pieces. Remove insert and clean counterbore. Chill new insert with dry ice and quickly install insert, chamfered edge first, into counterbore using a suitable driver. After insert is installed grind off flush with cylinder head surface. Lightly grind new seat at 43½ degrees, until approximately 1.524-1.770 mm (0.060-0.070 inch) wide.

105. **GUIDES.** Standard guide bores should measure 9.51-9.54 mm (0.3745-0.3755 inch) and 0.254 mm

(0.010 inch) oversize bores should measure 9.77-9.79 mm (0.3845-0.3855 inch), and 0.508 mm (0.020 inch) oversize bores should measure 10.02-10.05 mm (0.3945-0.3955 inch).

If it is necessary to ream bores to oversize, use care not to damage top edge of guide.

106. **VALVES.** Intake and exhaust valves installed in 1190, 1290, 1390 and 1690 models are all the same, however 1490 models use a different exhaust valve. Standard stem diameter is 9.454-9.479 mm (0.3722-0.3732 inch) for all valves and valves should be renewed if stem to guide clearance exceeds 0.762 mm (0.003 inch). Valves are available with 0.254 mm (0.010 inch) oversize stems having a stem diameter of 9.708-9.733 mm (0.3822-0.3832 inch) and 0.508 mm (0.020 inch) oversize stems having a stem diameter of 9.962-9.987 mm (0.3922-0.3932 inch). Guides must be reamed to fit oversize stems.

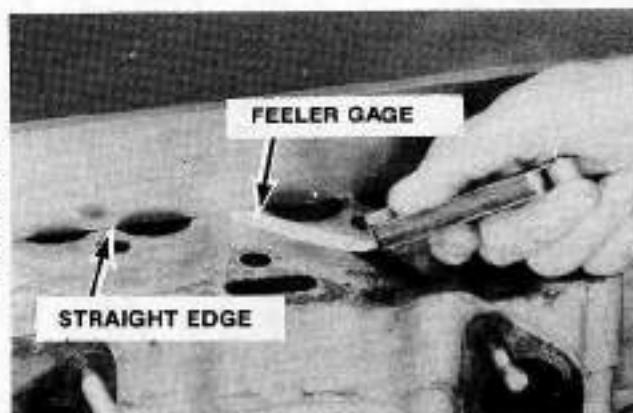
Reface all valves at 45 degrees and check valve head protrusion above cylinder head surface. If any intake valve protrudes more than 2.03 mm (0.080 inch) or any exhaust valve protrudes more than 3.04 mm (0.120 inch) it will be necessary to grind more from seat or valve face to decrease amount of protrusion.

107. **VALVE SPRINGS.** Valve springs are the same for all models, however intake and exhaust valve springs are not interchangeable.

Intake valve springs are identified by yellow spot coloring. Their part number is 921435 and they have a free length of 54.02 mm (2.127 inch) and when compressed under 342.5 N (77 lbs.) load, should measure 29.16 mm (1.148 inches).

Exhaust valve springs are identified by blue spot coloring. Their part number is 921436 and they have a free length of 54.15 mm (2.132 inches) and when com-

Fig. 61—View showing method of checking cylinder head for warpage using an accurate straightedge and a feeler gage. If more than 0.0762 mm (0.003 inch) warpage in six inches exists, head must be resurfaced.





pressed under 354.8 N (82 lbs.) load should measure 29.97 mm (1.180 inches).

Renew any weak, misshaped or corroded springs.

## TIMING GEAR COVER

### Model 1190

108. Drain cooling system. Remove engine hood, battery, grille, radiator and shroud. Remove fan blade, alternator and power steering belts. Remove crankshaft pulley. Remove timing gear cover retaining bolts noting length and location for reassembly. Remove timing gear cover.

To reinstall, clean cover and install new seal and gasket. Loosely bolt cover in place and install crankshaft pulley to center oil seal. Tighten cover bolts making certain they are in their original positions. Install "O" ring, washer and pulley retaining cap screw, then tighten to 122 N·m (90 ft.-lbs.) torque.

Reinstall by reversing removal procedure.

### Models 1290-1390-1490

109. Drain cooling system, remove hood, grille, battery and battery support. Remove radiator, shroud and fan blade. Remove alternator and belt. Remove hydraulic pump drive shaft coupling, if so equipped, from front of crankshaft. Two threaded jack screw holes are provided to aid removal. Remove rubber spacer disc located between pump and drive shaft and crankshaft and slide drive shaft rearward until free of pump drive coupling. Some force will be required to pull shaft splines past "O" ring in coupling. Remove crankshaft pulley. Remove tim-

ing gear cover retaining bolts, noting their length and location for reassembly. Remove timing gear cover.

110. To reinstall, clean cover, install new seal and gasket. Loosely bolt cover in place. Lubricate felt seal and install in cover. Install crankshaft pulley to help center oil seal and tighten timing gear cover retaining bolts to 20 N·m (15 ft.-lbs.) torque. Tighten crankshaft pulley retaining nut, or bolt, to 190 N·m (140 ft.-lbs.) torque. Place retaining "O" rings on hydraulic pump drive shaft and place flange on rear end of shaft. Insert front end of shaft into pump drive coupling, then push front "O" ring into retaining notch in coupling. Position rubber spacer between rear end of shaft and front end of crankshaft, then slide flange over spacer and into pulley.

**NOTE:** Rubber spacers are available in thicknesses of 11.112, 14.288 and 15.875 mm (7/16, 9/16 and 5/8-inch).

Tighten the four flange retaining bolts to 34 N·m (25 ft.-lbs.) torque and push rear "O" ring into retaining groove of drive flange.

Reassemble by reversing disassembly procedure.

### Model 1690

111. Remove muffler and open engine cover. Remove side panels and battery. Drain engine coolant and remove radiator. Remove hydraulic pump drive shaft coupling from front of crankshaft. Two threaded jack screw holes are provided to aid removal. Remove rubber spacer disc located between pump drive shaft and crankshaft and slide drive shaft rearward until free of pump drive coupling. Some force will be required to pull shaft splines past "O" ring in coupling. Remove crankshaft pulley. Remove timing gear cover retaining bolts, noting their length and location for reassembly. Remove timing gear cover. Refer to paragraph 110 for installation procedure.

## CRANKSHAFT FRONT OIL SEAL

### All Models

112. Crankshaft front oil seal may be replaced without removing timing gear cover. Remove necessary items to remove crankshaft pulley. Loosen, but do not remove timing gear cover retaining bolts. Remove old seal using care not to damage timing gear cover. Clean crankshaft and recess in cover, then install new oil seal and felt seal making certain seal and timing gear cover are correctly centered. Use special tool CAS-1229 for 1190, 1290, 1390 and 1490 models and special tool DB-962560 for

1690 models. Install pulley, tighten timing gear cover retaining bolts to 20 N·m (15 ft.-lbs.) torque and on 1190 models, tighten cap screw retaining crankshaft pulley to 122 N·m (90 ft.-lbs.) torque. On 1290, 1390 and 1490 models tighten crankshaft pulley retaining nut to 190 N·m (140 ft.-lbs.) torque. On 1690 models fit new "O" ring inside pulley, install pulley and tighten retaining cap screw to 190 N·m (140 ft.-lbs.) torque.

Reassemble by reversing disassembly procedure.

## TIMING GEARS

### Model 1190

113. Timing gears on 1190 models consist of a camshaft gear driven directly by the crankshaft gear. To renew timing gears, first remove timing gear cover as outlined in paragraph 108. Rotate engine to "TDC" on compression stroke of No. 1 cylinder. At this time, gear tooth marked "D" on camshaft gear should be centered between the two punch marked gear teeth of crankshaft gear. See Fig. 62. Remove lock wire and cap screw from camshaft gear. Use a suitable puller to remove camshaft gear.

**NOTE:** Do not turn camshaft or crankshaft with gears removed as damage to valve heads or piston tops could occur.

Crankshaft gear should be a snug, but not tight fit on crankshaft splines and may be removed.

Check key and keyway in camshaft for wear. Inspect gears and renew as needed. Install crankshaft gear and camshaft gear with proper teeth in mesh. See Fig. 62. Tighten camshaft gear retaining cap screw to 54 N·m (40 ft.-lbs.) torque and install new lock wire.

Reassemble by reversing disassembly procedure.

### Models 1290-1390-1490

114. Timing gears on four cylinder engine consist of crankshaft gear, camshaft gear, fuel injection pump drive gear and an idler gear. To remove timing gears, first remove timing gear

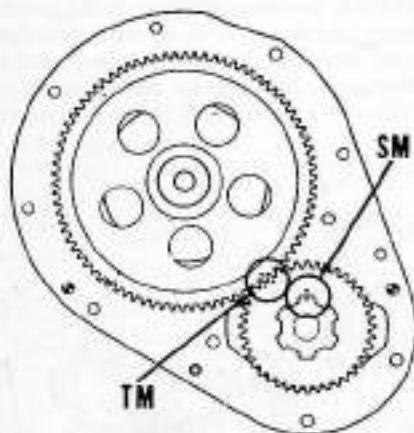


Fig. 62—View showing installation of timing gears on 1190 models. Install crankshaft gear with spline marks (SM) aligned as shown. Install camshaft gear with "D", or punch mark, meshed between the two punch marked teeth of crankshaft gear as shown (TM).

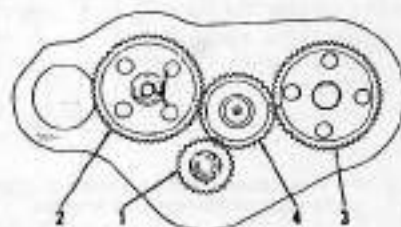


Fig. 63—View showing timing marks on crankshaft gear (1), camshaft gear (2), injection pump drive gear (3) and idler gear (4) on four cylinder engines.



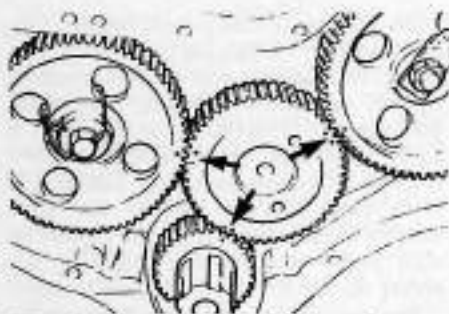


Fig. 64—View showing timing gears in proper meshed positions on six cylinder engines.

cover as outlined in paragraph 109. Rotate engine so No. 1 cylinder is at "TDC" on compression stroke. At this time, timing marks on crankshaft gear, camshaft gear and fuel injection pump drive gear should be towards center of idler gear, although timing marks on idler gear probably will not be aligned with those of other gears.

Remove locking wire and camshaft gear retaining bolt, then using a suitable puller remove camshaft gear.

**NOTE: Do not turn camshaft or crankshaft with gears removed as damage to valve heads or piston tops could occur.**

Remove idler gear shaft support bracket (2—Fig. 65), noting thickness of shims (3) for reassembly. Remove idler gear (5) from shaft (8) and remove shaft from bore of block. If necessary, remove slotted head plug (7) from end of shaft and pull shaft using adapter bolt and slide hammer.

If renewing injection pump drive gear straighten tab washer, remove three cap screws and fuel injection pump drive gear from pump drive hub. Note pump drive gear is timed to hub by a dowel pin.

Crankshaft gear is keyed and press fitted to crankshaft and should not be removed unless renewal is necessary. Remove gear using a suitable puller and

inspect Woodruff key and keyway for damage or wear.

Carefully inspect all gears for excessive wear or damage. Idler shaft (8—Fig. 65) should be smooth and free of scoring. It should measure 30.117-30.137 mm (1.1857-1.1865 inches) diameter. Idler gear bushing (10) inside diameter should measure 30.180-30.206 mm (1.1882-1.1892 inches) and should be renewed if inside diameter measures more than 30.23 mm (1.1900 inches). Reinstall slotted head plug (7) if removed, using "Loctite" on threads.

Install crankshaft gear with chamfer on inside diameter toward engine and timing mark facing away from engine. Drive gear on using short piece of pipe over crankshaft splines.

Install fuel injection pump drive gear, tighten cap screws to 27 N·m (20 ft.-lbs.) torque and secure with lock plate.

Install camshaft gear and Woodruff key, tighten cap screw to 54 N·m (40 ft.-lbs.) torque and secure with new lock wire.

All timing marks on installed gears should be pointing toward idler gear position. Install idler gear shaft in bore in cylinder block, lubricate shaft and gear and install idler gear so all timing marks are aligned as shown in Fig. 63. Install idler shaft support bracket with shims which were removed during disassembly. Tighten retaining bolts to 30 N·m (22 ft.-lbs.) torque. Check clearance between idler gear and bracket using a feeler gage. Clearance must be 0.051-0.102 mm (0.002-0.004 inch). Adjust by removing or installing shims.

Reinstall by reversing removal procedure.

### Model 1690

115. Timing gears on the six cylinder engine used in 1690 series tractors consist of crankshaft gear, camshaft gear, fuel injection pump drive gear and idler

gear. To remove timing gears, first remove timing gear cover as outlined in paragraph 111.

Rotate engine so No. 1 cylinder is at "TDC" on compression stroke. Noting position of special tab washer (8—Fig. 66), remove tab washer, locating plate (9), shims (10), noting thickness and number, and idler gear (12). Remove bolt retaining fuel injection pump drive gear (14) and using a suitable puller, remove gear from tapered shaft. Remove lock wire and retaining bolt from camshaft, then remove camshaft gear (4) and Woodruff key (3). If crankshaft gear (11) is to be renewed it will be necessary to first remove engine assembly as outlined in paragraph 95.

With engine removed, remove locating plate (6—Fig. 66). Use a suitable puller and remove idler gear shaft (15). Remove fuel injection pump from timing gear housing, then remove timing gear housing. Using special puller (DB-960604) remove crankshaft gear (11).

Install crankshaft gear on crankshaft with timing marks toward front. Remove oil supply restrictor for timing gears from engine block, clean with compressed air and reinstall. See Fig. 67. Install timing gear housing and press idler gear shaft into cylinder block. Install camshaft locating plate (6—Fig. 66) and tighten bolts to 34 N·m (25 ft.-lbs.) torque. Install camshaft gear (4) with timing marks towards front and tighten retaining bolt to 54 N·m (40 ft.-lbs.) torque. Secure with new lock wire. Install fuel injection pump on timing gear housing and install injection pump drive gear on tapered pump shaft with timing marks towards front. Tighten retaining nuts to 88 N·m (65 ft.-lbs.) torque and secure with tab washer.

All timing marks on installed gears should be pointing toward idler gear position, install idler gear making sure single punch marks on all installed gears mesh between double marks on teeth of idler gear. See Fig. 64. Install retaining plate (9—Fig. 66) and shims (10) which

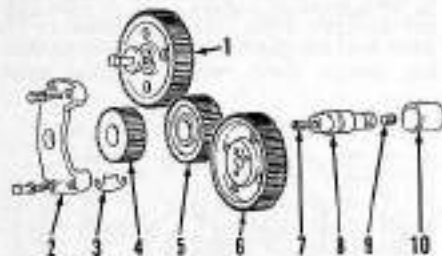
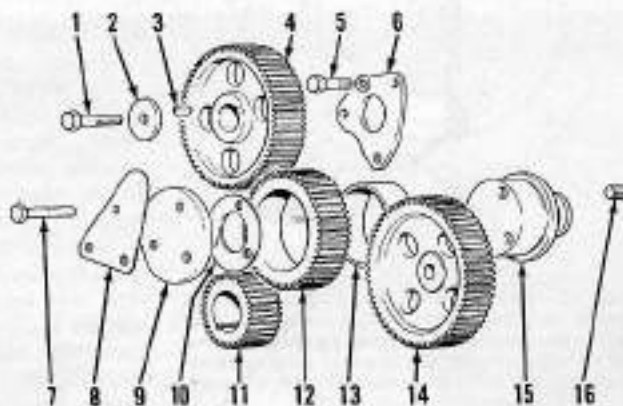


Fig. 65—View showing timing gears and related parts used on four cylinder engines.

- |                    |                              |
|--------------------|------------------------------|
| 1. Camshaft gear   | 6. Injection pump drive gear |
| 2. Bracket         | 7. Slotted head screw        |
| 3. Shim            | 8. Idler shaft               |
| 4. Crankshaft gear | 9. Slotted head screw        |
| 5. Idler gear      | 10. Bushing                  |

Fig. 66—View showing timing gears and related parts used on six cylinder engines.

- |                       |                               |
|-----------------------|-------------------------------|
| 1. Bolt               | 11. Crankshaft gear           |
| 2. Washer             | 12. Idler gear                |
| 3. Woodruff key       | 13. Bushing                   |
| 4. Camshaft gear      | 14. Injection pump drive gear |
| 5. Bolt               | 15. Idler gear shaft          |
| 6. Locating plate     | 16. Plug                      |
| 7. Bolt               |                               |
| 8. Special tab washer |                               |
| 9. Locating plate     |                               |
| 10. Shim              |                               |



were removed during disassembly. Install special tab washer (8) in position as shown in Fig. 68. Check clearance between gear and retainer plate with a feeler gage. See Fig. 68. Clearance must be 0.051-0.102 mm (0.002-0.004 inch). Adjust by adding or removing shims (10—Fig. 66). Tighten retaining plate bolts to 20 N·m (15 ft.-lbs.) torque and secure with tab washer.

Reassemble by reversing disassembly procedure.

## VALVE TAPPETS

### All Models

116. Mushroom type tappets run directly in unbushed bores in cylinder block and are the same for all models. To remove tappets it is necessary to remove camshaft. New tappet stem diameter is 15.824-15.860 mm (0.623-0.624 inch). Inspect face of tappet which runs on camshaft and renew if surface is rough, pitted or shows signs of excessive wear.

## CAMSHAFT

### Model 1190

117. Camshaft may be removed without removing engine assembly by removing timing gear cover as outlined in paragraph 108. Remove rocker arm cover, rocker arm shaft assembly and push rods. Disconnect tachometer drive cable, remove set screw in side of block retaining tachometer drive assembly and remove drive unit from cylinder block. Remove pump drive assembly and remove drive unit from cylinder block. Remove fuel lift (transfer) pump and plunger. Remove fuel injection pump. Remove pump drive assembly as outlined in paragraph 159. Remove tappet and push rod covers from side of cylinder block, lift up each tappet and retain in raised position by placing a ½-inch ID "O" ring on each tappet. Remove camshaft gear and locating plate and pull camshaft out of cylinder block.

Fuel injection pump and oil pump drive gear is renewable separately from

camshaft. Using a suitable sleeve, press gear towards rear of shaft to remove. Install gear with Woodruff key in place in camshaft. Align gear keyway with key and press onto shaft until firmly seated against shoulder of shaft.

Camshaft specifications are as follows:

Front Journal	
Diameter.....	60.261-60.287 mm (2.3725-2.3735 in.)
No. 2 Journal	
Diameter.....	47.549-47.759 mm (1.8707-1.8720 in.)
No. 3 Journal	
Diameter.....	46.759-46.792 mm (1.8409-1.8422 in.)
No. 4 Journal	
Diameter.....	45.567-45.603 mm (1.7940-1.7954 in.)
No. 5 Journal	
Diameter.....	44.386-44.419 mm (1.7474-1.7488 in.)
Camshaft End Float ...	0.051-0.152 mm (0.002-0.006 in.)

Inspect lobes for wear or pitting and gears for excessive wear. Inspect surface of tappets which run on camshaft for wear and reinstall.

Install camshaft in cylinder block, then install locating plate. Check to see that camshaft end float is within 0.051-0.152 mm (0.002-0.006 inch), then complete reassembly by reversing disassembly procedure. Retime fuel injection pump as outlined in paragraph 157.

### Models 1290-1390-1490

118. Camshaft may be removed without removing engine assembly by removing timing gear cover as outlined in paragraph 109. Remove camshaft gear and camshaft locating plate. Drain engine oil and remove oil pan and oil pump. Remove fuel lift (transfer) pump and plunger. Remove rocker arm cover, rocker arm assemblies and push rods. Remove tappet (push rod) covers from

side of cylinder block, lift up each tappet and retain in raised position by placing a ½-inch ID "O" ring on each tappet. Remove camshaft.

Camshaft specifications are as follows:

Front Journal	
Diameter.....	47.500-47.550 mm (1.870-1.871 in.)
No. 2 Journal	
Diameter.....	46.350-46.410 mm (1.825-1.827 in.)
No. 3 Journal	
Diameter.....	45.970-46.000 mm (1.810-1.811 in.)
No. 4 Journal	
Diameter.....	45.970-46.000 mm (1.810-1.811 in.)
No. 5 Journal	
Diameter.....	44.780-44.830 mm (1.763-1.765 in.)
No. 6 Journal	
Diameter.....	44.370-44.420 mm (1.747-1.749 in.)
Retainer Plate	
Thickness.....	6.096-6.223 mm (0.240-0.245 in.)
Camshaft End Float ...	0.254-0.508 mm (0.010-0.020 in.)

Inspect lobes for wear or pitting and gears for excessive wear. Inspect surface of tappets which run on camshaft for wear and reinstall.

Install camshaft in cylinder block, then install locating plate and check camshaft end float. Camshaft end float should be 0.254-0.508 mm (0.010-0.020 inch).

Reassemble by reversing disassembly procedure.

### Model 1690

119. Camshaft may be removed without removing engine assembly by removing timing gear cover as outlined in paragraph 111. Remove camshaft gear and locating plate. Remove rocker arm covers, rocker arm assemblies and push rods. Remove tappet covers from right-hand side, lift each tappet and retain in raised position by placing a ½-inch ID "O" ring on each tappet. Remove fuel lift (transfer) pump and plunger. Disconnect tachometer from drive unit, remove drive unit retaining screw from side of cylinder block and remove drive unit. Remove camshaft.

Camshaft specifications are as follows:

Front Journal	
Diameter.....	47.52-47.54 mm (1.870-1.872 in.)
No. 2 Journal	
Diameter.....	46.76-46.78 mm (1.841-1.842 in.)

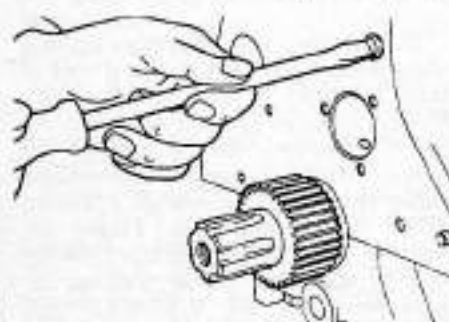


Fig. 67—View showing removal of oil supply restrictor for timing gears. Clean with compressed air and reinstall.

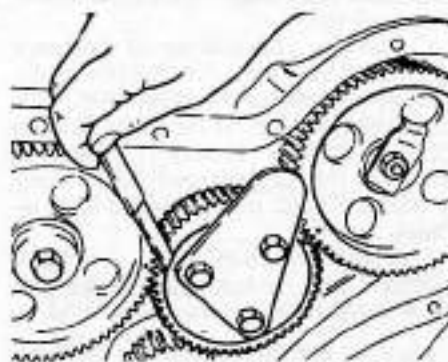


Fig. 68—View showing proper position of special tab washer and use of a feeler gage to check clearance which should be between 0.050 and 0.1016 mm (0.002 and 0.004 inch). Adjust by removing or installing shims.



No. 3 Journal	
Diameter.....	45.37-46.40 mm (1.826-1.827 in.)
No. 4 Journal	
Diameter.....	45.97-46.00 mm (1.810-1.811 in.)
No. 5 Journal	
Diameter.....	45.57-45.60 mm (1.794-1.795 in.)
No. 6 Journal	
Diameter.....	44.78-44.81 mm (1.763-1.764 in.)
No. 7 Journal	
Diameter.....	44.39-44.41 mm (1.747-1.748 in.)
Camshaft End Float	0.06-0.24 mm (0.002-0.009 in.)

Inspect lobes for wear or pitting and gears for excessive wear. Inspect surface of tappets which run on camshaft for wear and reinstall.

Install camshaft in cylinder block, then install locating plate and check camshaft end float. Camshaft end float should be 0.06-0.24 mm (0.002-0.009 inch).

Reassemble by reversing disassembly procedure.

## CAMSHAFT REAR SEAL

### All Models

120. Camshaft rear bore is sealed by an "O" ring inserted in counterbore which seals against starter support plate. To renew, separate tractor as outlined in paragraph 242 and 246. Remove clutch assembly, flywheel and starter support plate. Remove "O" ring.

Reassemble by reversing disassembly procedure.

## CONNECTING ROD AND PISTON ASSEMBLY

### All Models

121. Connecting rod and piston assemblies are removed from above after removing cylinder head, oil pan and oil pump assembly. Remove connecting rod caps only after noting cylinder numbers are stamped on camshaft side of connecting rod and connecting rod cap. Rod cap and connecting rod have been machined as an assembly and caps must be mated with original connecting rod from which it was removed.

Install piston and rod assemblies with valve recesses in piston and rod and cap numbers towards camshaft side of engine.

Cap is installed with machined notch for bearing tang to same side of assembly as notch in connecting rod. Tighten rod cap retaining cap screws to 68 N·m (50 ft.-lbs.) torque.

## PISTON PINS AND BUSHINGS

### All Models

122. Piston pin diameter is 31.737-31.750 mm (1.2495-1.250 inches) for all models, however, 1490 and 1690 model pins are heavier made and part number is different than other models.

Pins float in renewable bushings press fitted in bore of connecting rod.

To remove pin from piston, remove snap rings and immerse piston in hot water until pin slides easily out of piston bores. Measure pin bores in piston, then measure pin diameter and subtract this measurement from pin bore measurement. If difference is greater than 0.025 mm (0.001 inch) for 1190, 1290 or 1390 models, renew piston. If difference is greater than 0.050 mm (0.002 inch) for 1490 or 1690 models, renew piston.

Measure inside diameter of bushing in connecting rod. If greater than 31.78 mm (1.251 inches), bushing must be pressed out and new bushing pressed in. Align oil holes in bushing and rod as bushing is pressed into bore. Ream new bushing 0.025 mm (0.001 inch) larger than pin to be used.

When installing pistons on connecting rods, make certain valve recesses in piston and cylinder identification numbers on rod and cap are to same side of assembly, then securely install piston pin retaining snap rings.

## CONNECTING RODS AND BEARINGS

### All Models

123. Connecting rod bearings are of the slip in, precision type, renewable from below after removing oil pan, oil pump and connecting rod caps. When installing new bearing inserts make certain rod and bearing cap numbers are in register and face towards camshaft side of engine. Bearing inserts are available in 0.254, 0.508 and 0.762 mm (0.010, 0.020 and 0.030 inch) oversize as well as standard sizes.

Connecting rod bearing oil clearance is 0.038-0.063 mm (0.002-0.004 inch). Crankpin diameter for 1190, 1290, 1390 and 1690 models is 60.27-60.29 mm (2.3730-2.3735 inches). Crankpin diameter for turbocharged 1490 models is 63.449-63.462 mm (2.4980-2.4985 inches).

Lubricate bearings with a suitable lubricant and tighten retaining nuts to 68 N·m (50 ft.-lbs.) torque on all models.

Models 1190, 1290, 1390 and 1690 use the same connecting rods, however 1490 turbocharged models use a connecting rod having a larger diameter crankshaft bearing bore.

## PISTONS AND PISTON RINGS

### All Models

124. Pistons are of aluminum alloy and have a combustion chamber machined in their crowns as well as recesses to clear intake and exhaust valve heads. Three compression rings are fitted above piston pin and an oil scraper ring is located below piston pin. Piston pin is fully floating and is retained by a snap ring at each end of pin.

Piston skirt to cylinder bore clearance is 0.165-0.203 mm (0.0065-0.008 inch). Piston skirt diameter is measured at right angles to piston pin hole. While different engine model pistons have similar dimensions, they are not interchangeable. Piston specifications for all models are as follows:

Skirt diameter,  
all models ..... 99.86-99.88 mm  
(9.9315-9.9323 in.)

Available oversize pistons -

1190 Models ..... 0.508-1.016 mm  
(0.020 and 0.040 in.)

1290 and 1390 Models ..... 0.508 mm  
(0.020 in.)

1490 and  
1690 Models ... 0.254 and 0.508 mm  
(0.010 and 0.020 in.)

Ring end gap,  
all models ..... 0.28-0.40 mm  
(0.011-0.016 in.)

Ring side clearance -

1190 Models  
Compression ring ... 0.057-0.095 mm  
(0.00225-0.00375 in.)

Oil control ring ... 0.051-0.076 mm  
(0.002-0.003 in.)

1290, 1390 and 1690 Models  
Compression ring ... 0.05-0.10 mm  
(0.002-0.004 in.)

Oil control ring ..... 0.02-0.20 mm  
(0.001-0.008 in.)

1490 Models  
Compression ring ... 0.05-0.10 mm  
(0.002-0.004 in.)

Oil control ring ..... 0.04-0.09 mm  
(0.0015-0.0035 in.)

## CYLINDER BORES

### All Models

125. Pistons run directly against cylinder block having a standard bore of 99.86-99.88 mm (3.9388-3.9396 inches). Where excessive cylinder wear has occurred, cylinders can be rebored for various oversize piston assemblies, (paragraph 124), however all cylinders **MUST** be the same size. Liners are available to bring an oversize cylinder back to standard. Install with an interference fit of 0.08-0.11 mm (0.0031-0.0046 inch). Liners may be bored up to 0.508 mm (0.020 inch) for oversize pistons also.



# CRANKSHAFT AND MAIN BEARINGS

## Model 1190

**126. REMOVE.** To remove crankshaft, first remove engine assembly as outlined in paragraph 94. Remove timing gear cover, timing gears and front engine plate. Remove cylinder head, clutch assembly, flywheel and starter support plate. Remove connecting rod bearing caps and remove piston and rod assemblies.

**NOTE: Keep connecting rod caps with their mated connecting rods.**

Remove rear oil seal retaining plate from rear of cylinder block. Mark positions of main bearing caps and remove. Remove crankshaft.

If main bearings, rod bearings and thrust washers are to be re-used they must be reinstalled in their original positions.

**127. INSPECTION.** Clean and inspect crankshaft carefully. Journals should be smooth and free of scoring. Using micrometers measure each main bearing and rod bearing journal to determine if they are tapered or out-of-round. Maximum taper or out-of-round permitted is 0.0127 mm (0.0005 inch). Main bearing journals should measure 63.474-63.487 mm (2.4990-2.4995 inches) and rod bearing journals should measure 60.274-60.287 mm (2.3730-2.3735 inches) for standard ground shafts. Oversize bearings are available in 0.254, 0.508 and 0.762 mm (0.010, 0.020 and 0.030 inch) sizes.

If crankshaft journals are worn, scored or damaged, mark front and rear counter balance weight positions and remove weights.

When grinding crankshaft main and rod bearing journal fillet radius **MUST** be 3.81-4.06 mm (0.15-0.16 inch).

When reinstalling front and rear counter balance weights, install in original positions as marked, using new cap screws and tab washers. Tighten cap screws to 54 N·m (40 ft.-lbs.) torque and using a 0.05 mm (0.002 inch) feeler gage, make sure there is no gap between faces of weights and crankshaft.

**128. REINSTALLATION.** Use a suitable lubricant on all bearings during installation and apply a thin film of gasket sealer to face of front main bearing cap. See Fig. 69. Tighten main bearing cap bolts to 163 N·m (120 ft.-lbs.) torque and rod bearing cap bolts to 68 N·m (50 ft.-lbs.) torque. Oil clearance should be 0.051-0.102 mm (0.002-0.004 inch). Use "Plastigage" to accurately check clearance.

Crankshaft end play is determined by

thickness of thrust washers on number three main bearing cap. End play should be 0.051-0.254 mm (0.002-0.010 inch). Thrust washers are available in standard, 0.127 and 0.508 mm (0.005 and 0.020 inch) oversize.

Reinstall rear crankshaft oil seal and retainer as outlined in paragraph 138.

## Models 1290-1390

**129. REMOVE.** To remove crankshaft, first remove engine assembly as outlined in paragraph 95. Remove oil pump and pressure lines. Remove timing gear cover, timing gears, timing gear housing, clutch, flywheel and starter support plate. Remove cylinder head. Remove connecting rod bearing caps and remove piston and rod assemblies.

**NOTE: Keep connecting rod caps with their mated connecting rods.**

Remove rear oil seal retaining plate and mark positions of main bearing caps and remove. Remove crankshaft.

If main bearings, rod bearings and thrust washers are to be re-used they must be reinstalled in their original positions.

**130. INSPECTION.** Clean and inspect crankshaft carefully. Journals should be smooth and free of scoring. Using micrometers measure each main bearing and rod bearing journal to determine if they are tapered or out-of-round. Maximum taper or out-of-round permitted is 0.0127 mm (0.0005 inch). Main bearing journals should measure 63.474-63.487 mm (2.4990-2.4995 inches) and rod bearing journals should measure 60.27-60.29 mm (2.3730-2.3735 inches) for standard ground shafts. Oversize bearings are available in 0.254, 0.508 and 0.762 mm (0.010, 0.020 and 0.030 inch) sizes.

If crankshaft journals are worn, scored or damaged, crankshaft must be reground.

When grinding crankshaft main and

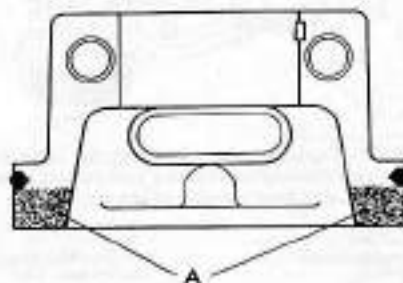


Fig. 69—When installing front main bearing cap on three cylinder engine, coat area of front of seal ring (indicated by shaded area "A") with a light film of gasket sealer.

rod bearing journal fillet radius **MUST** be 3.81-4.06 mm (0.15-0.16 inch).

**131. REINSTALLATION.** Use a suitable lubricant on all bearings during installation. Tighten main bearing cap bolts to 217 N·m (50 ft.-lbs.) torque. Oil clearance should be 0.051-0.102 mm (0.002-0.004 inch). Use "Plastigage" to accurately check clearance.

Crankshaft end play is determined by thickness of thrust washers on center main bearing cap. End play should be 0.051-0.254 mm (0.002-0.010 inch). Thrust washers are available in standard, 0.127 and 0.508 mm (0.005 and 0.020 inch) oversize.

Reinstall rear crankshaft oil seal and retainer as outlined in paragraph 138.

## Model 1490

**132. REMOVE.** Removal procedure for crankshafts in 1490 models is the same as for 1290 and 1390 models. Refer to paragraph 129.

**133. INSPECTION.** Heavier, stronger crankshafts, having larger diameter main and rod bearing journals are installed in four cylinder engines used in 1490 models to accommodate increased internal stress on engine parts created by addition of a turbocharger.

Clean and inspect crankshaft carefully. Journals should be smooth and free of scoring. Using micrometers measure each main bearing and rod bearing journal to determine if they are tapered or out-of-round. Maximum taper or out-of-round permitted is 0.0127 mm (0.0005 inch). Main bearing journals should measure 66.650-66.662 mm (2.6240-2.6245 inches) and rod bearing journals should measure 63.449-63.462 mm (2.4980-2.4985 inches) for standard ground shafts. Oversize bearings are available in 0.254 and 0.508 mm (0.010 and 0.020 inch) sizes only.

If crankshaft journals are worn, scored or damaged, crankshaft must be reground.

When grinding crankshaft main and rod bearing journal fillet radius **MUST** be 3.81-4.06 mm (0.15-0.16 inch).

**134. REINSTALLATION.** Note for four cylinder engines using heavier built crankshaft having 66.7 mm (2-5/8 inch) main bearing journal diameters, main bearing cap retaining bolts are tightened to 298 N·m (220 ft.-lbs.) torque.

Reinstall as outlined in paragraph 131.

## Model 1690

**135. REMOVE.** To remove crankshaft, first remove engine assembly as

outlined in paragraph 95. Remove timing gear cover, timing gears, timing gear housing, clutch assembly, flywheel and starter support plate. Remove cylinder heads. Remove connecting rod bearing caps and remove piston and rod assemblies.

**NOTE: Keep connecting rod caps with their mated connecting rods.**

Remove the six bolts fastening crankshaft rear oil seal housing to cylinder block and main bearing cap. Using two of the bolts removed, threaded into the two jack screw holes in seal housing, remove housing.

Mark position of main bearing caps and remove.

If main bearings, rod bearings and thrust washers are to be re-used, they must be reinstalled in their original positions.

**136. INSPECTION.** Clean and inspect crankshaft carefully. Journals should be smooth and free of scoring. Using micrometers measure each main bearing and rod bearing journal to determine if they are tapered or out-of-round. Maximum taper or out-of-round permitted is 0.0127 mm (0.0005 inch). Main bearing journals should measure 69.84-69.85 mm (2.749-2.750 inches) and rod bearing journals should measure 60.27-60.28 mm (2.3728-2.3732 inches) for standard ground crankshaft. Over-size bearings are available in 0.254, 0.508 and 0.762 mm (0.010, 0.020 and 0.030 inch) sizes.

If crankshaft journals are worn, scored or damaged, crankshaft must be reground.

When grinding crankshaft main and rod bearing journal fillet radius **MUST** be 3.81-4.06 mm (0.15-0.16 inch). Flange fillet radius **MUST** be 6.35 mm (0.250 inch).

**137. REINSTALLATION.** Use a suitable lubricant on all bearings during installation. Tighten main bearing cap bolts to 217 N·m (160 ft.-lbs.) torque and rod bearing cap bolts to 68 N·m (50 ft.-lbs.) torque. Oil clearance should be 0.05-0.10 mm (0.002-0.004 inch). Use "Plastigage" to accurately check clearance.

Crankshaft end play is determined by thickness of thrust washers installed at center main bearing cap. End play should be 0.15-0.25 mm (0.006-0.010 inch). Standard thrust washer thickness is 2.31-2.33 mm (0.091-0.092 inch).

Reinstall rear crankshaft oil seal and retainer as outlined in paragraph 139.

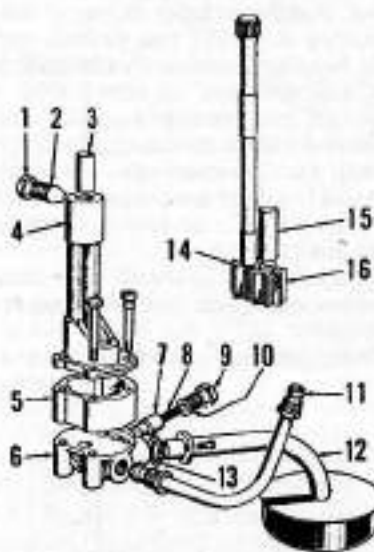
## CRANKSHAFT REAR OIL SEALS

**Models 1190-1290-1390-1490**

**138.** To install new rear oil seal, remove old packing and clean grooves of retainer. Place thin film of gasket sealer in one half of seal retainer to prevent seal from turning when installed.

**NOTE: Do not allow gasket sealer on sealing edge of seal.**

Press seals into grooves of retainer. Complete installation of seals by rolling them completely into position with a smooth bar or dowel. Use a blunt tool to push ends of seal below joint face of retainer. See Fig. 70.



**Fig. 71—Exploded view of oil pump used on three cylinder engine showing component parts and their relative positions.**

- |                         |                             |
|-------------------------|-----------------------------|
| 1. Locknut              | 10. Adjusting screw         |
| 2. Locking screw        | 11. Pressure tube           |
| 3. Bushing              | 12. Suction pipe and screen |
| 4. Bracket              | 13. Gasket                  |
| 5. Pump body            | 14. Driven gear             |
| 6. Cover Assy.          | 15. Idler shaft             |
| 7. Relief valve plunger | 16. Idler gear              |
| 8. Relief valve spring  |                             |
| 9. Locknut              |                             |

# CASE (DAVID BROWN)

**NOTE: Do not cut ends of seal off. Seals are made to correct length and leakage will occur if length is decreased.**

Stick gasket halves to retainer halves with non-hardening gasket cement and coat mating faces of retainer with film of gasket sealant and install seal assembly on crankshaft. Install socket head cap screws with heads towards top. Do not tighten socket head screws completely at this time. Install cap screws in retainer and tighten as follows: Tighten socket head screws to 20 N·m (15 ft.-lbs.) torque then loosen 1/2-turn each. Tighten retaining plate cap screws to 20 N·m (15 ft.-lbs.) torque. Tighten socket head screws to 20 N·m (15 ft.-lbs.) torque again. Loosen retaining plate cap screws 1/2-turn, wait 30 seconds, then retighten to 20 N·m (15 ft.-lbs.) torque.

## Model 1690

**139.** Press new seal into seal housing using special tool DB-1163 with lip away from tool. Lubricate seal lip and install over end of crankshaft. Align bolt holes and install cap screws. Tighten cap screws evenly.

## ENGINE OIL FILTER

### All Models

**140.** All models use screw on type filters located on side of cylinder block. Change oil and filter at 100 hour intervals. Engine oil should be at operating temperature before draining so all impurities will be in suspension and removed with old oil.

It is recommended oil and filter be changed before prolonged storage and run for a minimum of one half hour. This will remove most acids formed by moisture reacting with by products of combustion (impurities), which might otherwise damage internal engine components during storage.

## OIL PAN

### All Models

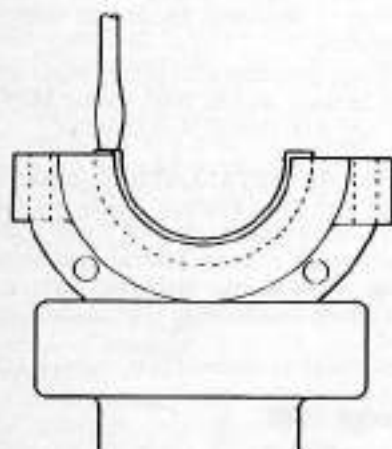
**141. REMOVE AND REINSTALL.** Oil pan is bolted to bottom of tractor main frame and can be removed after draining engine oil.

Tighten retaining cap screws to 27 N·m (20 ft.-lbs.) torque.

## REMOVE AND REINSTALL ENGINE OIL PUMP

### Model 1190

**142.** To remove oil pump, drain engine oil and remove oil pan. Remove oil pressure tube (11 - Fig. 71) and pump locating screw (2) from side of block. Us-



**Fig. 70—View showing proper method of tamping seal ends into housing.**



ing care not to lose thrust spring from counterbore in top end of oil pump drive shaft, remove oil pump.

**NOTE:** Injection pump drive shaft may fall out as oil pump is removed. Use caution to avoid damaging or losing injection pump drive shaft.

Reinstall making certain injection pump drive shaft is properly installed. Place thrust spring in top of oil pump shaft, retaining it in grease and install pump and oil tubes. Install oil pan and tighten bolts to 27 N·m (20 ft.-lbs.) torque, then install engine oil.

### Models 1290-1390-1490

143. To remove oil pump, drain engine oil and remove oil pan. Remove oil pressure tube (1-Fig. 72) and oil pump locating screw (2) from side of

cylinder block. Remove oil pump.

To reinstall, remove tachometer drive unit from cylinder block and install oil pump. Install tachometer drive unit. Install oil pressure tube and oil pan. Tighten bolts to 27 N·m (20 ft.-lbs.) torque and install engine oil.

### Model 1690

144. To remove oil pump it is necessary to first remove engine assembly as outlined in paragraph 95. Remove suction filter (20-Fig. 73), pressure pipe and bracket (7). Remove oil pump retaining bolts and remove oil pump.

Reinstall by reversing removal procedure.

## OVERHAUL OIL PUMP

### Model 1190

145. Disassembly of pump is obvious after examination of unit and reference to Fig. 71. Note number of turns required to remove adjusting screw (10-Fig. 71) for reassembly.

Check all gears, bushings, shafts and wear surfaces for scoring, damage or excessive wear. Renew as needed. Diameter of bushing surface of pump drive shaft must be 12.433-12.446 mm (0.4895-0.490 inch). Inside diameter of mating bushing (3-Fig. 71) is 12.458-12.509 mm (0.4905-0.4925 inch). Measure gear width (14 and 16). Width must be 30.112-30.137 mm (1.1855-1.1865 inches). Gear housing

depth must be 30.162-30.200 mm (1.1875-1.1890 inches).

Assemble drive shaft and driven gear (14-Fig. 71) in bracket (4). Install idler shaft (15) and idler gear (16). Use a dial indicator to measure backlash between pump gears. Backlash must be 0.508-0.660 mm (0.020-0.026 inch). Install two new gears if backlash is not correct. Install pump body (5) and place "Plastigage" on face of pump gears. See Fig. 74. Install pump cover (6-Fig. 71) and tighten retaining bolts to 10 N·m (7 ft.-lbs.) torque. Remove cover (6) and check clearance. See Fig. 74. Clearance must be 0.025-0.089 mm (0.001-0.0035 inch). Install new gears if clearance is not correct. Reinstall cover (6) and tighten bolts to 10 N·m (7 ft.-lbs.) torque.

Check relief valve spring against the following specifications:

Free length	41.275 mm (1.625 in.)
Number of coils	17.5
Outside diameter	7.137 mm (0.281 in.)
Wire diameter	1.016 mm (0.040 in.)
Test at	33.325 mm (1.312 in.) 18.2-20.9 N (4.1-4.7 lbs.)

Install plunger (7-Fig. 71), spring (8) and adjusting screw (10). Turn adjusting screw into cover (6) the same number of turns as noted at removal. An approximate setting can be made by leaving four screw threads of adjusting screw (10) showing above locknut (9). This will give approximately 276 kPa (40 psi).

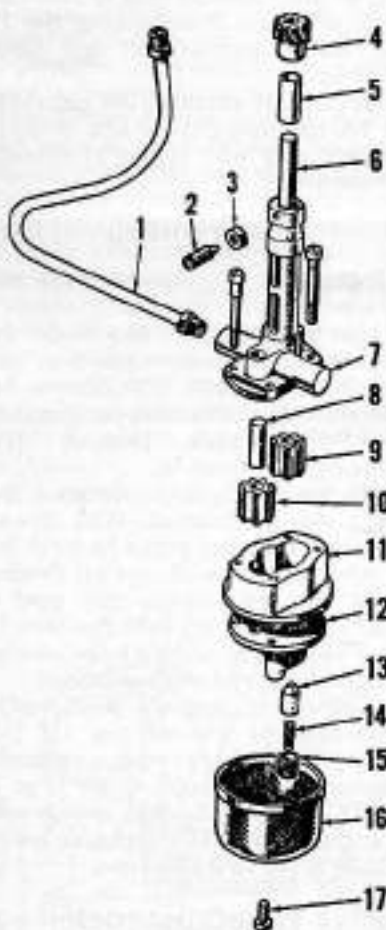
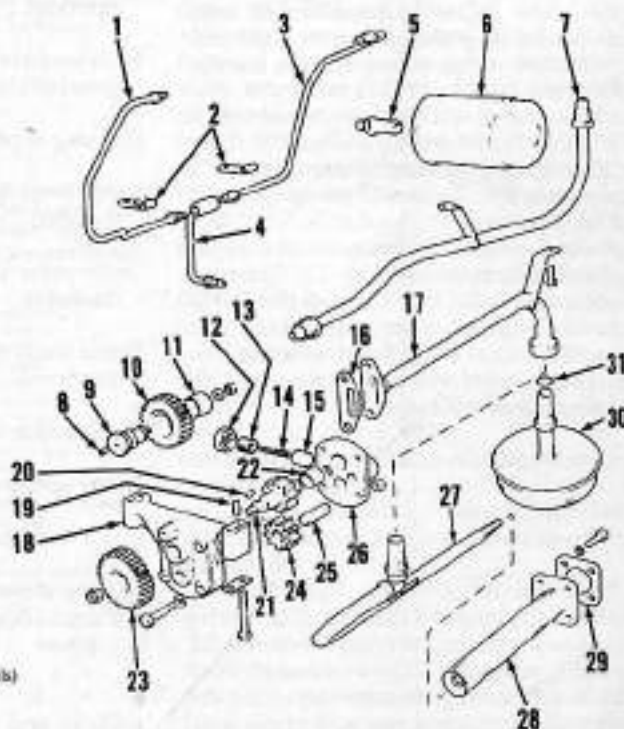


Fig. 72—Exploded view of oil pump used on four cylinder engine showing component parts and their relative positions.

1. Pressure tube
2. Set screw
3. Locknut
4. Drive gear
5. Bushing
6. Drive shaft
7. Bracket
8. Idler shaft
9. Driven gear
10. Idler gear
11. Gear body
12. Cover
13. Relief valve plunger
14. Relief valve spring
15. Adjusting screw
16. Screen
17. Screen retaining cap screw

Fig. 73—Exploded view of oil pump used on six cylinder engine showing component parts and their relative positions.

1. Front rocker pipe
2. Pipe brackets
3. Rear rocker pipe
4. Rocker supply pipe
5. Filter adapter
6. Oil filter
7. Pressure tube
8. Plug
9. Idler gear shaft
10. Idler gear
11. Bushing
12. Locknut
13. Adjusting screw
14. Spring
15. Plunger
16. Gasket
17. Suction pipe
18. Pump body, front
19. Dowel
20. Key
21. Driving rotor
22. Bushing
23. Drive gear
24. Driving rotor
25. Rotor shaft
26. Pump body, rear
27. Filter pipe (front drive axle models)
28. Filter (front drive axle models)
29. Gasket
30. Filter (2WD)
31. "O" ring





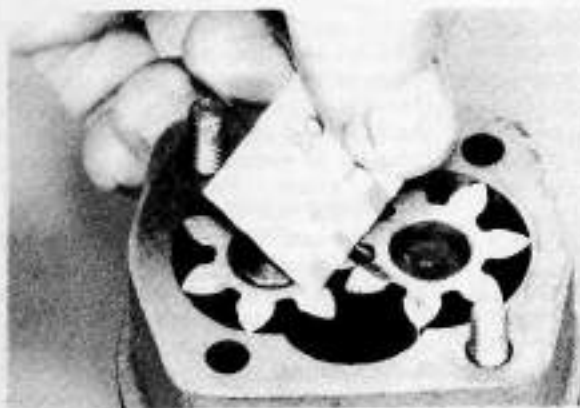


Fig. 74 - View showing proper positioning and use of "Plastigage" in checking end float of oil pump rotors. Clearance must be 0.025-0.089 mm (0.001-0.0035 inch).

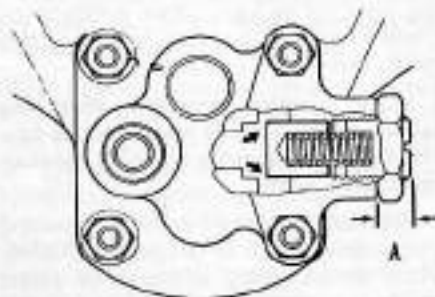


Fig. 75 - Turn adjusting screw in until end of screw is 9.902 mm (0.39 inch) (A) from pump body and secure locknut.

One full turn of adjusting screw will result in a 41 kPa (6 psi) change in pressure. Tighten locknut (9) securely.

#### Models 1290-1390-1490

146. Disassembly of pump is obvious after examination of unit and reference to Fig. 72. Note number of turns required to remove adjusting screw (15 - Fig. 72) for reassembly.

Check all gears, bushings, shafts and wear surfaces for scoring, damage or excessive wear. Renew as needed.

Press idler shaft (8 - Fig. 72) into bracket (7) until seated. Install shaft (6) and gears (9 and 10). Press spiral gear (4) onto shaft (6) leaving 0.25 mm (0.010 inch) end float. Use a feeler gage between face of spiral gear shoulder and top edge of bracket (7) to measure end float. Install bolts and pump body (11). Using a feeler gage inserted between mating gear teeth, measure backlash. Backlash should be 0.5-0.66 mm (0.020-0.026 inch). Measure gear side clearance using a feeler gage inserted between gear body (11) and outer edge of pump gears. Side clearance should be 0.025-0.05 mm (0.001-0.002 inch). Place "Plastigage" on face of pump gears as shown in Fig. 74. Install pump cover (12) and tighten bolts to 12-15 N·m (9-11 ft.-lbs.) torque. Remove cover (12) and check clearance. See Fig. 74. Clearance should be 0.025-0.089 mm (0.001-0.0035 inch). Reinstall cover and tighten bolts to 12-15 N·m (9-11 ft.-lbs.) torque.

Check relief valve spring against the following specifications:

Free length	44.45 mm (1.750 in.)
Number of coils	14
Wire diameter	1.42 mm (0.056 in.)

Install plunger (13 - Fig. 72), spring (14) and adjusting screw (15). Screw adjusting screw in same number of turns as noted during disassembly. One full turn of adjusting screw will result in 41

kPa (6 psi) change in pressure. Top of screw (15) must be 0.38-0.89 mm (0.015-0.035 inch) below screen bolt flange. Install screen (16).

#### Model 1690

147. Disassembly of pump is obvious after examination of unit and reference to Fig. 73.

Check all gears, bushings, shafts and wear surfaces for scoring, damage or excessive wear.

Oil pump specifications are as follows:

Intermediate gear shaft diameter, gear end	25.35-25.37 mm (0.998-0.999 in.)
Intermediate gear bore	25.40-25.43 mm (1.0009-1.001 in.)
Intermediate gear to shaft clearance	0.02-0.08 mm (0.0008-0.003 in.)
Intermediate shaft end float	0.05-0.15 mm (0.002-0.006 in.)
Intermediate gear to oil pump gear backlash	0.18-0.27 mm (0.007-0.011 in.)
Housing depth	20.646-20.67 mm (0.812-0.814 in.)
Drive rotor bushing bores, installed	15.621-15.64 mm (0.625-0.626 in.)
Drive rotor shaft diameter	15.545-15.59 mm (0.622-0.623 in.)
Rotor shaft to bushing clearance	0.304-0.81 mm (0.001-0.003 in.)
Rotor width	20.596-20.61 mm (0.810-0.811 in.)
Rotor end float	0.025-0.08 mm (0.001-0.003 in.)
Rotor teeth backlash	0.406-0.50 mm (0.016-0.020 in.)
Setting dimensions for relief valve:	
Face of boss to end of screw	9.9-9.95 mm (0.389-0.3916 in.)

Clean and inspect all parts, renewing

those worn beyond specifications or damaged. Bolts holding pump body together should be tightened to 20 N·m (15 ft.-lbs.) torque.

When reassembling pressure relief valve, screw adjusting screw (13 - Fig. 73) in until 9.9-9.95 mm (0.389-0.3916 inch) protrudes from housing. See Fig. 75. Install locknut (12) and tighten securely.

Oil pressure should be 207 kPa (30 psi) at 700 rpm and 276-345 kPa (40-50 psi) at 1800 rpm with engine at operating temperature.

#### FLYWHEEL

##### All Models

148. To remove flywheel, first separate tractor as outlined in paragraph 242 for 1190, 1290, 1390 or 1490 models and as outlined in paragraph 246 for 1690 models. Remove clutch assembly and flywheel.

Starter ring gear is installed from front side of flywheel. With flywheel removed, heat ring gear with torch from front side and knock gear off flywheel. Heat new gear evenly until gear expands enough to slip onto flywheel. Tap gear all the way around to be sure it is properly seated and allow to cool.

Flywheel is properly positioned on crankshaft by a dowel pin. On 1190, 1290, 1390 and 1490 models tighten retaining nuts or bolts to 68 N·m (50 ft.-lbs.) torque. On 1690 models apply "Loctite" to threads and tighten bolts to 108 N·m (80 ft.-lbs.) torque.

#### TURBOCHARGER

Holset type H1A-6020/AOSD, or Schwitzer L-185221 turbochargers are used on 1490 models. Mounted on exhaust manifold they are driven by exhaust gases.

149. REMOVE AND REINSTALL. Remove engine cover and clean area surrounding turbocharger. Loosen

clamps and remove hoses between air cleaner and turbocharger and turbocharger and intake manifold. Remove oil supply and oil return lines. Unbolt exhaust elbow from manifold and remove elbow and coupling which is between elbow and turbocharger. Unbolt and remove turbocharger.

Reinstall turbocharger by reversing removal procedure. Before connecting oil supply line, fill oil chamber with oil to provide initial lubrication.

**150. INSPECTION.** Always determine cause of turbocharger failure before installing turbocharger.

Contact damage to turbine indicates bearing damage and/or excessive shaft motion. Compressor wheel will probably be damaged. This is caused by lack of lubricant or oil contamination as a result of over extended service intervals. Shaft movement must be 0.08-0.15 mm (0.003-0.006 inch).

Center housing or bearing failure caused by sludge or hardened deposits in oil passages are results of over fueling, over loading or improper cool down period before engine shut off, causing high exhaust temperatures. Shaft and bearing scoring are also caused by lack of oil or over extended service intervals.

Any foreign material in either exhaust or intake will cause compressor or turbine wheel damage.

Flakes of engine bearing material imbedded in turbocharger bearings indicate possible engine bearing failure.

If conditions which caused turbocharger failure are not corrected, premature failure of new turbocharger will result.

#### 151. OVERHAUL HOLSET TUR-

**BOCHARGER.** Remove turbocharger unit as outlined in paragraph 149. Mark compressor cover, center housing, turbine housing and clamp positions for reassembly. Remove clamp (6-Fig. 76) and lift core from turbine housing (7). Remove screws (3), then separate from compressor cover (20). Clamp a 5/8-inch 12 point wrench in vise, locate hub of turbine wheel (9) in wrench and remove nut (16). Carefully slide compressor wheel (17) from shaft. Turbine wheel and shaft (9) and bearing (10) can be removed from housing. Use snap ring pliers to remove large retaining ring (19), then pry insert (18) from housing bore. Remainder of parts can be lifted out. Oil deflector (12) and thrust plate (5) are located by two groove pins which should not be removed.

Clean all parts using care not to bend, scratch or damage.

Inspect all parts and renew as needed. See paragraph 150. **NEVER** attempt to straighten any bent parts.

Use care to not over-expand ring (8-Fig. 76) when installing in groove. Lubricate turbine shaft (9) and ring (8), then assemble in bore of housing (13). Lubricate bearing (10), then install over turbine shaft and into housing bore. Lubricate thrust plate (5), then install in housing with bronze side up and holes engaging groove pins. Install thrust ring (11) over shaft and onto thrust plate, then position oil deflector over shaft and groove pins. Install ring (14) in groove of spacer sleeve (15), lubricate parts and slide spacer sleeve into bore of insert (18). Install "O" ring (4) in groove, lubricate outside diameter, then slide insert (18) with spacer sleeve (15) and "O" ring installed into bore of housing.

**NOTE:** Use care to prevent spacer sleeve from falling out of insert when installing.

Install snap ring (19) with beveled side out. Slide compressor wheel (17) over shaft, coat threads with graphite grease and install nut (16). Using wrench in vise to hold turbine shaft, tighten nut to 18 N·m (13 ft.-lbs.) torque, then spin rotor wheels. Turbine and compressor wheels should spin freely with no rubbing or binding. Disassemble and recheck if any binding or rubbing is noted. Reassemble turbine housing (7), clamp (6) and compressor cover (20) making certain previously made alignment marks are in register. Coat threads and back face of screw and nut on clamp (6) with graphite grease, then tighten nut to 13 N·m (10 ft.-lbs.) torque. Coat machined flange of compressor cover (20) with graphite grease and install special screws (3), lockwashers (2) and flat washers (1). Tighten screws (3) to 7 N·m (5 ft.-lbs.) torque.

#### 152. OVERHAUL SCHWITZER

**TURBOCHARGER.** Remove turbocharger as outlined in paragraph 149. Mark compressor cover, bearing housing and turbine housing for reassembly. Clamp turbocharger mounting flange (exhaust inlet) in vise and remove cap screws (2-Fig. 77), lockwashers (1) and clamp plates (19). Remove compressor cover (12). Remove nut from clamp ring (4), expand clamp ring and remove bearing housing assembly from turbine housing (6).

**CAUTION:** Never allow weight of bearing housing assembly to rest on either turbine or compressor wheel vanes. Lay bearing housing assembly on a bench so turbine shaft is horizontal.

Remove locknut (11-Fig. 77) and slip compressor wheel (10) from end of shaft. Withdraw turbine wheel and shaft (5) from bearing housing. Place bearing housing on bench with compressor side up. Remove snap ring (16) and pry flinger plate insert (15) from bearing housing. Push spacer sleeve (13) from insert. Remove oil deflector (9), thrust ring (20), thrust plate (18) and bearing (8). Remove "O" ring (17) from flinger plate insert (15) and remove seal rings (14) from spacer sleeve and turbine shaft.

Clean all parts using care not to bend, scratch or damage. Inspect all parts and renew as needed. See paragraph 150. **NEVER** attempt to straighten any bent parts.

Install seal ring on turbine shaft, lubricate seal ring and install turbine wheel and shaft in bearing housing. Lubricate ID and OD of bearing (8), install bearing over end of turbine shaft and into bearing housing. Lubricate

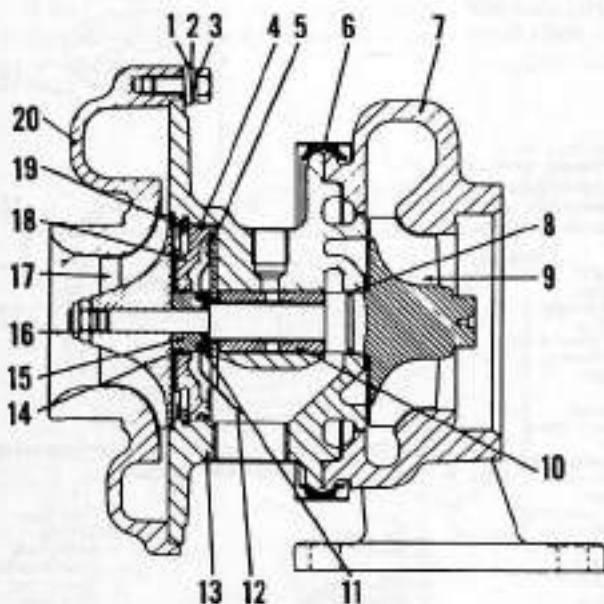


Fig. 76—Sectional view of Holset turbocharger showing component parts and their relative positions.

1. Washer
2. Lockwasher
3. Special screw
4. "O" ring
5. Thrust plate
6. "V" clamp
7. Turbine housing
8. Sealing ring
9. Turbine wheel & shaft
10. Bearing
11. Thrust ring
12. Oil deflector
13. Bearing (center) housing
14. Sealing ring
15. Spacer sleeve
16. Nut
17. Compressor wheel
18. Compressor insert
19. Snap ring
20. Compressor cover



both sides of thrust plate (18) and install plate (bronze side out) on aligning dowels. Install thrust ring (20) and oil deflector (9), making certain holes in deflector are positioned over dowel pins. Install new seal ring on spacer sleeve (13), lubricate seal ring and press spacer sleeve into flinger plate insert (15). Position new "O" ring (17) on insert, lubricate "O" ring and install insert and spacer sleeve assembly in bearing housing, then secure with snap ring (16). Place compressor wheel on turbine shaft, coat threads and back side of nut (11) with graphite grease, then install and tighten nut to 18 N·m (13 ft.-lbs.) torque. Assemble bearing housing to turbine housing and align punch marks. Install clamp ring, apply graphite grease on threads and install nut, tighten to 13 N·m (10 ft.-lbs.) torque. Apply graphite grease around machined flange of compressor cover (12). Install compressor cover, align previously made marks and secure cover with cap screws, washers and clamp plates. Tighten cap screws to 7 N·m (5 ft.-lbs.) torque.

Check for free rotation.

## DIESEL FUEL SYSTEM

Diesel fuel systems consist of three basic components; fuel tank and filters, injection pump and injection nozzles. When servicing any unit associated with fuel systems, maintenance of absolute cleanliness is of the utmost importance. Of equal importance is avoidance of nicks or burrs on any working parts.

Probably the most important precaution service personnel can impart to owners of diesel powered tractors is to urge them to use an approved fuel which is absolutely clean and free from foreign

material. Extra precautions should be taken to prevent water from entering fuel storage tanks or fuel system.

### FUEL FILTERS

#### All Models

**153. REMOVE AND REINSTALL.** Fuel filter head is fitted with two renewable type elements. Primary and secondary filter elements are identical and are used on all models. It is recommended both filters be changed at 500 hour intervals under normal operating conditions.

Clean area around filters and remove cap screws (2 and 4—Fig. 78) which retain elements and bases. Remove base (7 and 12) and elements (6 and 10). Discard all sealing rings and clean base with diesel fuel.

Install small "O" ring (8—Fig. 78) in groove around protrusion which centers filter element on filter head. Install sealing ring (9) in groove around outer edge of filter head and sealing ring (11) in base. Place element on base and sealing ring, push onto protrusion on filter head and tighten cap screw (4). Repeat the procedure for remaining filter.

Remove sediment bowl on fuel lift pump, clean screen and reassemble. Bleed system as outlined in paragraph 154.

**154. BLEEDING SYSTEM.** Make sure fuel tank contains at least 7.6 L (two gallons) of fuel and turn engine over until primer pump lever will operate fuel lift pump for a full stroke. Open filter bleed screw (1—Fig. 79) and actuate primer lever (5) until air-free fuel flows freely from bleeder screw opening. Tighten filter bleed screw (1) and open pump bleed screws (3 and 4) or (6—Fig. 80) on 1690 models. Actuate primer lever until air-free fuel flows

freely through bleed screw opening. Tighten pump bleed screws and loosen high pressure fuel line nuts at injector nozzles. Place fuel shut-off in RUN position and open throttle. Crank engine until fuel is ejected at all injector nozzles, then tighten high pressure fuel line nuts at injector nozzles. Start engine and check for leaks.

### THERMOSTART SYSTEM

#### All Models

Thermostart systems are available as an aid for cold weather starting on all diesel models.

System consists of a reservoir in line with fuel return line, thermostart unit located in intake manifold and a switch which is an integral part of the starter switch. See Fig. 81.

When starter key (8—Fig. 81) is turned to HEAT position electrical current energizes thermostart unit (2) in intake manifold. Current heats coil (5) which opens fuel valve (4) and changes fuel into

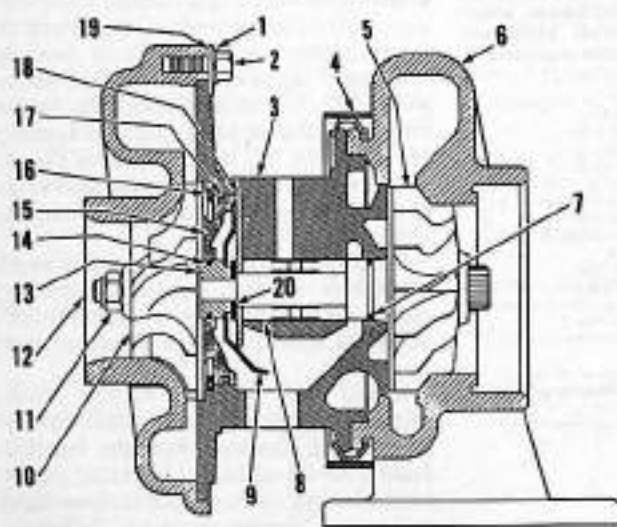


Fig. 77—Sectional view of Schwitzer turbocharger showing component parts and their relative positions.

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

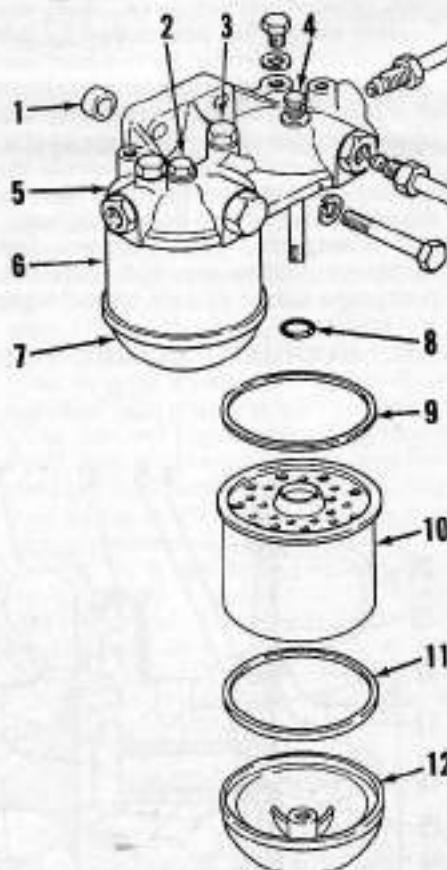


Fig. 78—View of typical fuel filter arrangement used on all models.

1. Spacer
2. Cap screw
3. Bleeder screw
4. Cap screw
5. Filter head
6. Filter element
7. Filter base
8. "O" ring
9. Sealing ring
10. Filter element
11. Sealing ring
12. Filter base



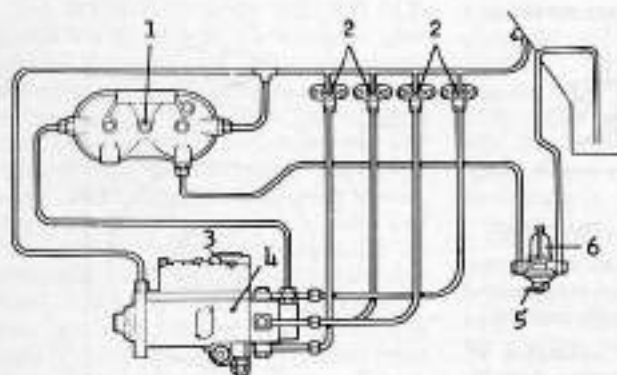


Fig. 79—View showing four cylinder engine fuel system. Three cylinder engine system is similar.

1. Filter bleed screw
2. Injector nozzles
3. Bleeder screw
4. Bleeder screw
5. Primer pump lever
6. Sediment bowl

vapor. Another coil (3) ignites fuel vapor which burns inside intake manifold and warms air going into the cylinders. This makes engine easier to start in very cold weather.

**CAUTION:** Never spray either into air intake system if thermostart unit is to be or has been activated. Unit remains energized when starter is being operated.

Operator must manually hold key in **HEAT** position for 10 to 25 seconds to activate thermostart unit.

**155. TROUBLESHOOTING.** Thermostart system is relatively simple and easy to check. To determine if system is working, hold key in **HEAT** position for 10 to 25 seconds while hose from air cleaner to intake manifold is removed. Light from burning fuel should be visible inside manifold.

If unit is not activated, check for voltage at thermostart unit using a test light and holding key in **HEAT** position. If test light does not light, check wiring, connections and switch.

If test light shows current reaching thermostart unit, disconnect fuel line and check for restricted fuel flow.

If fuel is flowing to thermostart unit remove unit and visually inspect. Renew as necessary.

## FUEL LIFT PUMP

### All Models

156. Fuel lift (transfer) pump is actuated by a lobe on engine camshaft which transmits via a short push rod running in a bore of cylinder block to diaphragm type pump. Overhaul of pump is conventional and diaphragm is removed by turning it 90 degrees in either direction.

When installing diaphragm hold priming lever to compress spring as cover screws are tightened.

## FUEL INJECTION PUMP

### Model 1190

**157. PUMP TIMING.** Provided injection pump drive gear to camshaft timing (paragraph 159) has not been disturbed, CAV fuel injection pump is properly timed when timing marks on drive housing flange and pump flange are aligned as shown in Fig. 82. If pump drive gear has been removed refer to paragraph 159.

**158. REMOVE AND REINSTALL INJECTION PUMP.** Disconnect throttle and fuel shut-off controls. Thoroughly clean pump, lines and surrounding area. Remove fuel injector

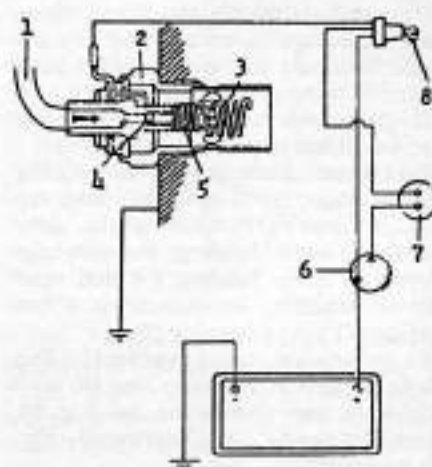


Fig. 81—Diagram of typical thermostart unit showing component parts and their relative positions.

1. Fuel line from reservoir
2. Thermostart unit
3. Burner coil
4. Fuel valve
5. Valve coil
6. Starter solenoid
7. Starter safety switch
8. Starter switch

lines and disconnect fuel inlet and return lines from injection pump. Cap all openings. Unbolt and remove pump from drive housing. Splined drive shaft may be lifted out with pump; if so, take care not to drop shaft. Remove shaft and thrust spring from bore in end of oil pump shaft.

To reinstall pump, first install thrust spring (1—Fig. 83) in bore in top end of oil pump shaft and insert splined (quill) shaft in drive gear with chamfered end up. Install injection pump and gasket, align timing marks as shown in Fig. 82 and tighten pump retaining nuts. Reconnect fuel lines leaving injector line connections loose at injectors. Install throttle and stop controls and bleed system as outlined in paragraph 154.

**159. INJECTION PUMP DRIVE GEAR.** To remove drive gear and housing assembly, first remove injection

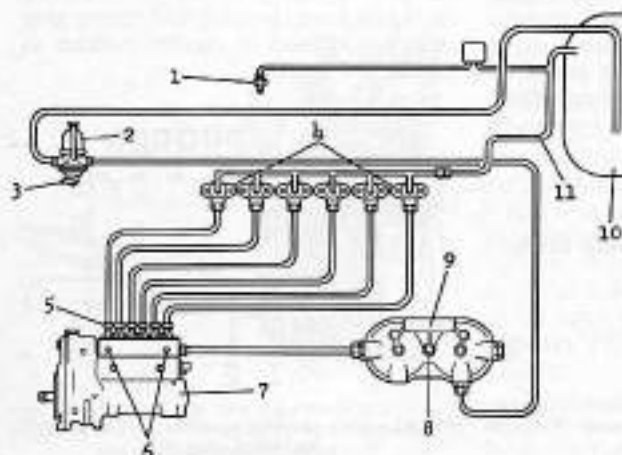


Fig. 80—View showing six cylinder engine fuel system.

1. Thermostart
2. Sediment bowl
3. Primer pump lever
4. Injector nozzles
5. High pressure fuel lines
6. Bleeder screws
7. Fuel injection pump
8. Filter bleed screw
9. Filter head
10. Fuel tank
11. Fuel return line



Fig. 82—View showing timing mark alignment on fuel injection pump for 1190 models. Four cylinder model injection pumps are marked in the same manner, however injection pump mounting and location are different.

pump, splined (quill) shaft and drive shaft thrust spring as outlined in paragraph 158 and lift gear and housing assembly from cylinder block.

If drive gear on camshaft is to be renewed refer to paragraph 117.

To remove drive gear from housing remove snap ring (6—Fig. 83) from top end of gear (10) and press gear downward out of housing. Remove caged needle roller bearing (9) and snap ring (8) retaining lower bearing. Press bearing (7) out of housing (2).

To reassemble, install bearing (7—Fig. 83) first, then install snap ring (8) with chamfered edge downward. See Fig. 84. Press new needle roller bearing (9—Fig. 83) into position.

**NOTE:** If needle roller bearing is removed a new bearing **MUST** be installed. Press, do not drive, bearing into place.

Install drive gear (10—Fig. 83) into housing assembly and install snap ring (6) with chamfered edge downward. See Fig. 85.

To install gear and housing assembly turn engine so No. 1 piston is at TDC on compression stroke. Install gear and housing with master spline at "4-o'clock"

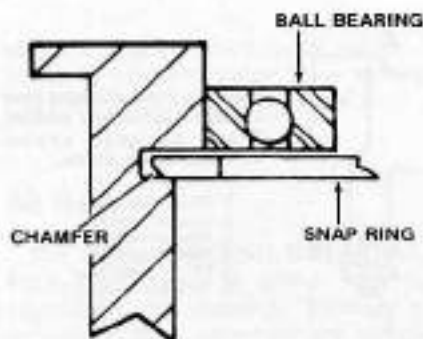


Fig. 84—View showing proper installation of snap ring retaining bearing in housing. Refer to paragraph 159.

position (A—Fig. 86); as gear engages drive gear on camshaft, master spline should move to "6-o'clock" position (B).

**NOTE:** If not possible to position gear at exact "6-o'clock" position use tooth mesh that will position master spline at just after this timing position.

With injection pump drive gear properly meshed with camshaft gear reinstall injection pump as outlined in paragraph 158.

## Models 1290-1390-1490

**160. PUMP TIMING.** Providing mesh position of injection pump drive gear and idler gear are correct injection pump is properly timed when timing marks on pump housing and engine front plate are aligned as in Fig. 82.

**161. REMOVE AND REINSTALL INJECTION PUMP.** Clean timing gear cover, pump, lines and surrounding area. Remove pump drive gear cover plate from timing cover. Turn engine over until single timing mark on injection pump drive gear is between double timing marks on idler gear. Remove throttle and fuel shut-off controls at injection pump and disconnect all fuel injector nozzle lines, supply lines and return lines from injection pump. Cap all openings. Bend tab washer and remove the three bolts retaining pump drive gear to pump. Note gear is timed to pump with roll pin. Remove nuts retain-

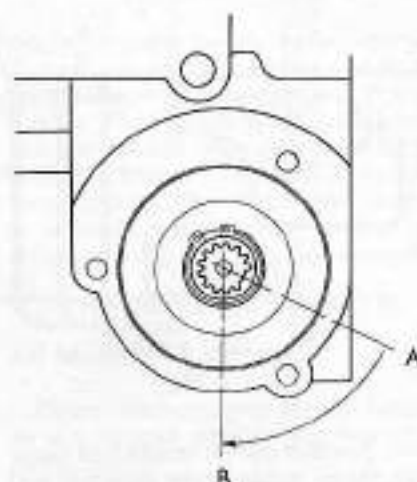


Fig. 86—View showing "4 o'clock" position (A) and "6 o'clock" position (B) used in pump drive assembly installation. Refer to paragraph 159.

ing pump to front engine plate and remove pump.

Complete installation by reversing removal procedure making certain timing marks are properly aligned and bleed system as outlined in paragraph 154.

**NOTE:** Once injection pump drive gear is removed, do not turn engine over as there are more than one set of double timing marks on idler gear.

## Model 1690

**162. PUMP LUBRICATION.** In line CAV injection pump contains an oil reservoir which must be drained and new oil installed when engine oil is changed.

Drain oil at drain plug (2—Fig. 87), reinstall plug (2) and refill at filler plug (1) with new engine oil until level with lower edge of plug (1).

**163. PUMP TIMING.** Providing mesh position of injection pump drive gear and idler gear are correct, injection pump is properly timed when timing marks on pump housing and timing gear case are aligned in similar manner as marks in Fig. 82.

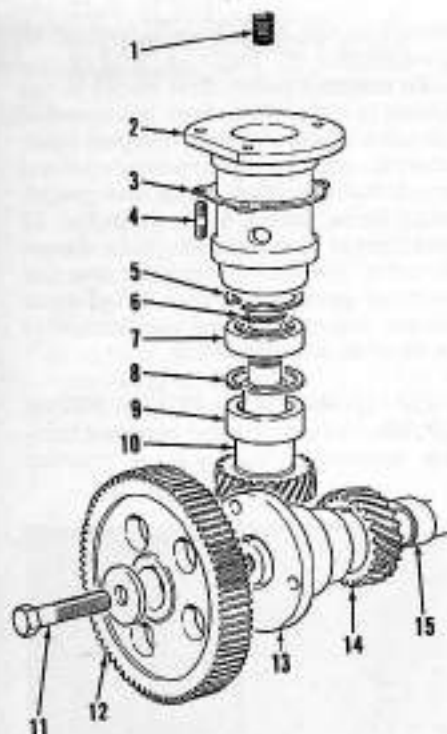


Fig. 83—Exploded view showing three cylinder diesel fuel injection pump drive assembly and related parts.

- |                    |                               |
|--------------------|-------------------------------|
| 1. Spring          | 8. Snap ring                  |
| 2. Bearing housing | 9. Needle roller bearing      |
| 3. Gasket          | 10. Gear                      |
| 4. Shaft           | 11. Bolt                      |
| 5. Snap ring       | 12. Camshaft gear             |
| 6. Snap ring       | 13. Locating housing          |
| 7. Bearing         | 14. Injection pump drive gear |
|                    | 15. Camshaft                  |

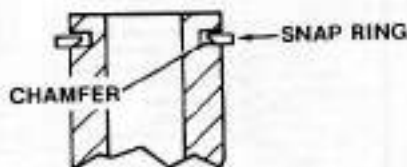


Fig. 85—View showing proper installation of snap ring retaining drive gear in housing. Refer to paragraph 159.

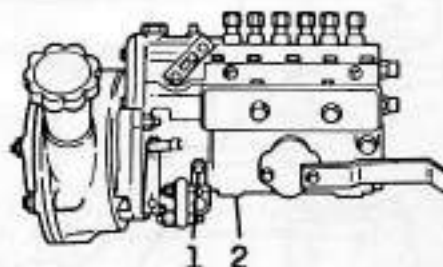


Fig. 87—View showing location of filler plug (1) and drain plug (2).



**164. REMOVE AND REINSTALL INJECTION PUMP.** Turn engine over until No. 1 piston is at TDC on compression stroke. Clean timing gear cover, injection pump, lines and surrounding area. Drain radiator and remove lower radiator hose. Remove pump drive gear cover plate from timing gear cover. Mark injection pump drive gear and idler gear so pump drive gear can be reinstalled with same teeth meshing. Bend tab washer away from pump drive gear retaining nut and remove nut. Using a suitable puller free drive gear from tapered pump shaft (drive gear will stay inside timing gear cover). Remove throttle and fuel shut-off controls at pump. Disconnect fuel injector nozzle lines, supply lines and return lines. Cap all openings. Remove pump retaining nuts and remove pump.

**NOTE:** Do not turn engine after removing injection pump drive gear.

Reassemble by reversing disassembly procedure making certain drive gear and idler gear are repositioned as marked at disassembly. Tighten pump drive gear retaining nut to 61 N·m (45 ft.-lbs.) torque.

Bleed system as outlined in paragraph 154.

**NOTE:** Check lubricating oil level in pump and fill to proper level. Refer to paragraph 162.

## HIGH AND LOW SPEED ADJUSTMENTS

### All Models

**165.** Start engine and bring to normal operating temperature. Make certain fuel shut-off at pump is fully open, remove throttle control rod from injection pump lever and hold lever against slow speed stop screw. Using an accurate tachometer check that engine speed is 750 rpm. If necessary, loosen jam nut on stop screw and adjust to 750

rpm. Move lever through its full length of travel until high speed stop screw is reached. Check engine speed. Maximum engine rpm should be 2200 rpm for 1190, 1290 and 1390 models and 2300 rpm for 1490 and 1690 models. If high speed is not correct, stop screw should be adjusted.

**CAUTION:** High speed stop screw adjustment is sealed with a sealing wire at factory; this seal should only be broken by authorized diesel service personnel if tractor is within factory warranty period.

Connect throttle control and check to make sure it allows lever to contact both high and low speed stop screws. Adjust for correct travel if necessary.

## FUEL INJECTORS

### All Models

All models, except 1490, use Lucas direct fuel injectors and 1490 models use a similar CAV injector. Overhaul procedures are the same.

On all models, multi-hole nozzles extend through cylinder head and inject fuel into combustion chamber and should be checked at 400-500 hour intervals.

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

**166. LOCATING FAULTY NOZZLE.** If rough or uneven engine operation or misfiring indicates a faulty injector, defective unit can be located by running engine at speed defect is more noticeable. Loosen high pressure connection at each individual injector, note change if any, in running and tighten connection. Check each injector in turn. As in checking spark plugs, faulty unit is one which 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 injectors be removed and serviced.

**167. REMOVE AND INSTALL INJECTORS.** Clean injectors, lines and surrounding area until free of all loose dirt, grease or foreign material. Remove return lines and high pressure lines. Cap all openings. Remove stud nuts at each injector. Note location of each injector as an aid in locating any sealing washers which may stay in cylinder head and remove injectors. Remove sealing washers.

Clean nozzle recesses in cylinder head using care not to damage seating surfaces. Renew sealing washer, coat injec-

tor body and nozzle retaining cap with heat resistant anti-sieze compound and insert carefully into cylinder head. Torque each of the two nozzle holder stud nuts in 3 N·m (2 ft.-lbs.) increments until reaching a final torque of 12-16 N·m (9-12 ft.-lbs.). Reinstall all lines leaving high pressure lines loose at injectors. With fuel shut-off in RUN position turn engine over with starter until fuel flows from each injector line. Tighten lines, start and run engine to check for leaks.

**168. NOZZLE TESTING.** A complete job of testing and adjusting fuel injectors requires use of a special pressure tester as shown in Fig. 88. Use only clean approved testing oil in the tester tank.

When checking injectors use slow firm downward pressure on tester handle. Rapid lever movement often allows nozzle leaking at lower pressures to appear normal.

Make certain all four of the following checks are performed on each individual injector.

**169. OPENING PRESSURE.** Connect injector to tester and operate lever several times to bleed air. Slowly operate lever and observe pressure at which injection spray occurs. Check against the following specifications:

Models 1190, 1290, 1390 and 1490	
Old injectors .....	17.72 MPa (2570 psi)
New injectors .....	18.78 MPa (2720 psi)
Model 1690	
Old injectors .....	17.25 MPa (2500 psi)
New injectors .....	18.22 MPa (2642 psi)

**170. SPRAY PATTERNS.** Operate tester handle several times and observe spray pattern. Four finely atomized, equally spaced, conical sprays should emerge from nozzle tip, with equal penetration into surrounding atmosphere.

If pattern is uneven, ragged or not finely atomized, overhaul or replace nozzle.

**171. SEAT LEAKAGE.** Wipe nozzle tip dry and operate tester handle until pressure gage reads 980 kPa (142 psi) **BELOW** specified opening pressure and hold pressure for five seconds. If any fuel appears on nozzle tip overhaul or renew nozzle.

**172. NOZZLE LEAKBACK.** Operate tester handle until pressure gage reads pressure specified for model being serviced (paragraph 169), as pressure falls, note time from 16.75 MPa (2430 psi) to



Fig. 88—An accurate fuel injector tester is required to check and adjust both old and new fuel injectors before installation.



9.86 MPa (1430 psi). This should be between 6 and 25 seconds. If time is not as specified, overhaul or renew nozzle.

**NOTE:** A leaking tester connection, check valve or pressure gage will show up in this test as excessively fast leakback. If, in testing a number of nozzles, all fail to pass this test, tester rather than injectors should be suspected.

**173. OVERHAUL.** Maintenance of absolute cleanliness in the overhaul of injector assemblies is of the utmost importance. Of equal importance is avoidance of nicks, scratches or handling damage on any lapped or polished surfaces. To avoid damage only recommended cleaning kits and carbon cleaning solvents should be used. Nozzle valve and body are individually fit and lapped and must be kept together as a unit. Do not intermix parts from one injector to another.

Before disassembling any injector thoroughly clean with a brass wire

brush, cap openings if necessary and soak in approved carbon cleaning solvent. Rinse injectors in clean diesel fuel, dry with lint free cloth and check as outlined in paragraphs 168 through 172. Never disassemble an injector which can be adjusted and returned to service.

To disassemble a faulty injector clamp body in holding fixture or soft jawed vise with only enough pressure to keep injector from slipping. Remove cap (1—Fig. 89) and washer (2). CAV injectors have a locknut which is removed next. On all injectors back off pressure adjusting screw (3) until all tension is removed from pressure spring (5). Remove nozzle retaining cap (12) and nozzle (10). Remove nozzle (10) from retaining cap (12) and needle (9) from nozzle. Place in approved cleaning solvent. Remove adjusting screw (3), using care not to lose shim (4). Remove spring (5) and spindle (6). Place in cleaning solvent.

Examine lapped pressure faces where nozzle mates with body and surfaces of needle for nicks, scratches or heat discoloration. Clean small feed channel bores using a small wire as shown in Fig. 90. Insert special groove scraper into nozzle body until nose of scraper enters

fuel gallery. Press nose of scraper hard against side of cavity and rotate nozzle to clear carbon deposits as shown in Fig. 91. While pressing seat scraper against needle seat, rotate scraper and clean carbon off seat as shown in Fig. 92. Remove carbon from dome cavity with dome cavity cleaner as shown in Fig. 93. Place proper size cleaning pin in pin vise. Cleaning pin should protrude from pin vise only enough to enter nozzle orifice. Caution should be used not to break cleaning pin off in orifice. Clean orifices as shown in Fig. 94.

Clean all parts using clean diesel fuel and install needle (9—Fig. 89) into nozzle (10). Place washer (11) on nozzle (10),

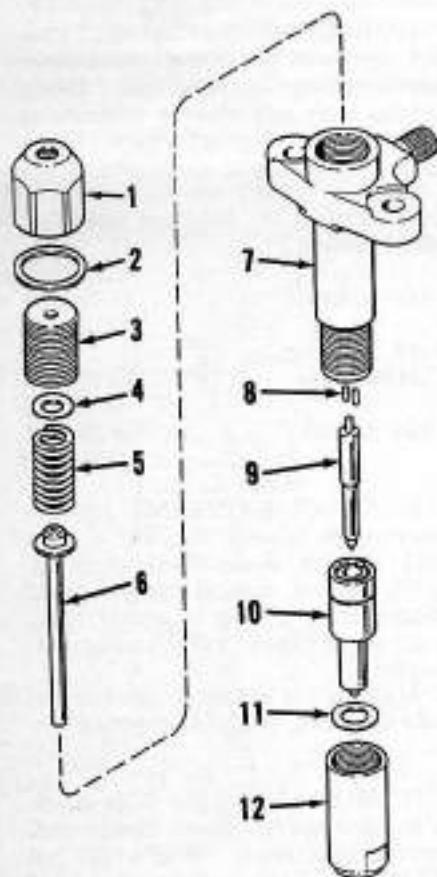


Fig. 89—Exploded view of Lucas fuel injector used on 1190, 1290, 1390 and 1990 models. 1490 models use a CAV injector of similar construction.

- |                     |                          |
|---------------------|--------------------------|
| 1. Cap              | 7. Body                  |
| 2. Washer           | 8. Nozzle                |
| 3. Adjusting sleeve | 9. Needle                |
| 4. Shim             | 10. Nozzle               |
| 5. Spring           | 11. Washer               |
| 6. Spindle          | 12. Nozzle retaining cap |



Fig. 90—Clean small feed channel bores with drill or wire as shown. These bores are rarely choked and insertion of drill or wire by hand will be sufficient.

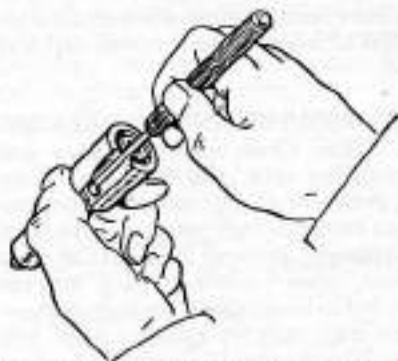


Fig. 91—Insert special groove scraper until hooked nose of scraper enters fuel gallery. Press scraper hard against side of gallery and rotate nozzle to clear any carbon deposit from this area.

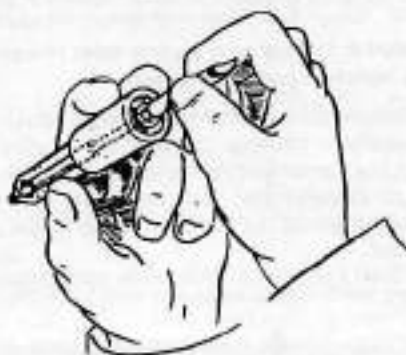


Fig. 92—Use a seat scraper to clean all carbon from needle seat in tip of nozzle by rotating scraper while pressing it against seat.

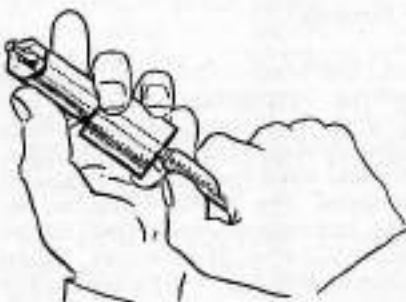


Fig. 93—Remove any carbon from dome (tip) cavity with dome cavity cleaner as shown.



Fig. 94—Use a pin vise and proper size cleaning wire to probe all carbon from the four injection spray holes in each nozzle tip.

(CAV nozzles DO NOT use sealing washer on nozzle). For all nozzles, place nozzle on injector body (7) making certain dowel pins (8) are in proper holes. Install retaining cap (12). Place spindle (6) in injector body and install spring (5), shim (4) and adjusting sleeve (3).

Connect injector to tester and test. Turn adjusting sleeve into injector body until specified pressure is reached. If seat leakage, leakback, proper pattern or correct pressure cannot be attained after servicing injector, renew nozzle assembly.

Install sealing washer, (and locknut on CAV injectors), and cap (1—Fig. 89).

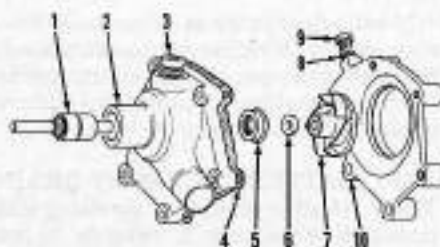


Fig. 95—Exploded view of typical water pump showing component parts and their relative positions. Pump body design varies, but basic assembly is the same.

- |                  |                      |
|------------------|----------------------|
| 1. Bearing Assy. | 6. Sealing ring      |
| 2. Pump body     | 7. Impeller          |
| 3. Rubber seal   | 8. Filter washer     |
| 4. Gasket        | 9. Plug              |
| 5. Seal          | 10. Impeller housing |

## COOLING SYSTEM

Several changes were made in various models to improve efficiency of cooling system over previous models.

Most notable of these is addition of two additional ports in upper cylinder block face improving coolant circulation in 3 cylinder engines. A different water pump housing and improved water passage to cylinder head are used to improve circulation also.

More efficient water pumps with larger diameter shafts and bearings are used on 1190, 1290, 1390 and 1490 models and a coolant recovery type cooling system is used on 1490 and 1690 models.

Coolant capacity is 8.5 L (9 qts.) for 1190 models, 14 L (14.8 qts.) for 1290 and 1390 models, 14.2 L (15 qts.) for 1490 models and 15.3 L (16 qts.) for 1690 models. It is recommended coolant be changed at 1000 hour intervals.

## EXPANSION TANK

### Models 1490-1690

174. Models 1490 and 1690 cooling systems are of the coolant recovery type incorporating an expansion tank into which surplus coolant is retained or used as operating temperature dictates. Expansion tank is connected to the sealed radiator by a flexible rubber hose and coolant level should be maintained at level indicated on tank.

Removal is obvious after examination. Make certain all connections are tight and system is at proper operating level for reinstallation.

## RADIATOR

### All Models

175. REMOVE AND REINSTALL. Drain radiator and remove complete

engine cover assemblies, side panels and supporting frame. Remove battery and battery support as necessary. Disconnect upper and lower radiator hoses at radiator. Disconnect hose to expansion tank, if so equipped. Remove shroud bolts and bolts retaining radiator. Models 1190, 1290, and 1390 may be equipped with a radiator blind for cold weather operation. If so, remove blind, hangers and control tube and cord. On all models remove any electrical wiring necessary and remove radiator.

Reinstall by reversing removal procedure.

## THERMOSTAT

### All Models

176. Thermostat is located at front of cylinder head and may be removed after draining cooling system, removing upper radiator hose and thermostat housing.

To test, place thermostat and a suitable thermometer in a container of water. Heat water and observe and note at what temperature thermostat begins to open, and when it is fully open.

Standard thermostat should begin to open at 79-83° C (174-181° F).

Maintaining proper engine operating temperature is essential for economic as well as extended diesel engine service.

Install new gaskets and "O" rings and reinstall by reversing removal procedure.

## WATER PUMP

### All Models

#### 177. REMOVE AND REINSTALL.

Drain cooling system and remove necessary radiator, heater or manifold hoses at water pump. Loosen all belts. Remove fan blade and slip belts off water pump pulley. On some models it will be necessary to remove shroud bolts and reach between shroud and radiator to gain access to fan bolts. Remove alternator as required. Remove water pump. Remove impeller housing, if so equipped.

Install new gaskets and seals and reinstall by reversing removal procedure.

## WATER PUMP OVERHAUL

### All Models

178. To disassemble water pump, first note spindle end position in water pump pulley for reassembly. Using a suitable puller, remove pulley from spindle. Press bearing assembly (1—Fig. 95) out of pump body (2) and impeller (7) from impeller end. Remove impeller, seal ring (6) and seal (5) from pump body (2).

Clean and inspect all parts for wear, scores, cracks or other damage. Renew as necessary.

To reassemble, press bearing assembly (1—Fig. 95) into body (2) with smaller diameter spindle end entering pulley side of housing first, until outer race of bearing assembly is flush with housing as shown in Fig. 96. Support pump on impeller end of spindle and press pulley on spindle to depth noted

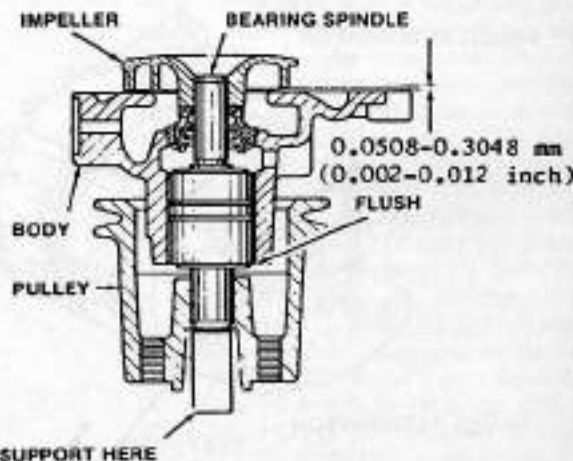


Fig. 96—Sectional view of typical water pump showing parts location and assembly information. Refer to paragraph 178 for additional clarification.



during disassembly. Install new seal (5—Fig. 95) in pump body (2). Fit sealing ring (6) over spindle end and slide down against seal. Smooth sealing faces must be together. Support pump on spindle at pulley end (Fig. 96) and press impeller on until 0.0508-0.3048 mm (0.002-0.012 inch) clearance between impeller (7) and pump body (2) is attained. See Fig. 96. Rotate pulley to assure smooth operation.

## ELECTRICAL SYSTEM

Electrical system consists of five basic systems which are: Battery system, charging system, starting system, wiring system including protective circuit and accessory systems.

### BATTERY

#### All Models

179. Before any electrical system service is performed, a thorough check of battery condition, condition of cable connections and condition of alternator drive belt and pulleys should be made.

Battery should be checked for individual cell voltage, total voltage and voltage drop under rated load.

All relative connections should be checked for excessive resistance using an ohmmeter.

If battery voltage is excessively low, they should be recharged to rated level. Failure to do so causes alternator to overheat resulting in premature failure of alternator, regulator or both.

**180. BATTERY CURRENT DRAIN TEST.** If after checking, servicing and installing a battery it returns to an undercharged condition when tractor is not in use, current drain should be suspected. To check, disconnect negative battery terminal and connect a voltmeter lead to negative battery post and the other lead to negative cable end. Make sure all electrical systems are off. Any reading on voltmeter indicates current leakage. Check for lights, radio or accessories being on, or shorted electrical wiring or components.

### CHARGING SYSTEM

#### All Models

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

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

Alternator warning light should not come on when key switch is in **OFF** position. If light fails to go out when key is in **OFF** position, test circuits as outlined in paragraph 182.

Normal operation of warning light is to come on only when key switch is in **ACC** or **IGN** position, engine **NOT** running. If engine is started while throttle is in low idle position, light may stay on until engine speed is increased for the first time. Light should not come on at any time after engine is running and initial engine speed increase was sufficient to shut light off. If operation of warning light is not normal, test circuits as outlined in paragraph 182.

**182. WARNING LIGHT CIRCUIT TEST.** If warning light fails to go out with key switch in **OFF** position, disconnect plug at alternator. If light goes out after plug is removed at alternator, replace rectifier assembly in alternator.

If light stays on after disconnecting plug at alternator, there is an electrical short between the brown and yellow wire and another positive wire in wiring harness. Repair as necessary.

If light fails to come on with key switch in **ACC** or **IGN** position, engine **NOT** running, disconnect plug from alternator and connect a jumper wire at number one terminal (brown and yellow wire) in connector and ground it to alternator housing. If light comes on at this time, alternator warning light bulb and wiring are good and problem is in alternator. Check as outlined in paragraph 183. If light still fails to come on check bulb, bulb socket, current supply to socket and wiring from socket to alternator.

If warning light functions normally with engine not running, but fails to go off when engine is running at various speeds, check alternator as outlined in paragraph 183.

**183. ALTERNATOR VOLTAGE OUTPUT TEST.** Make certain all wiring connections are in place and connect voltmeter positive lead to **BAT** terminal

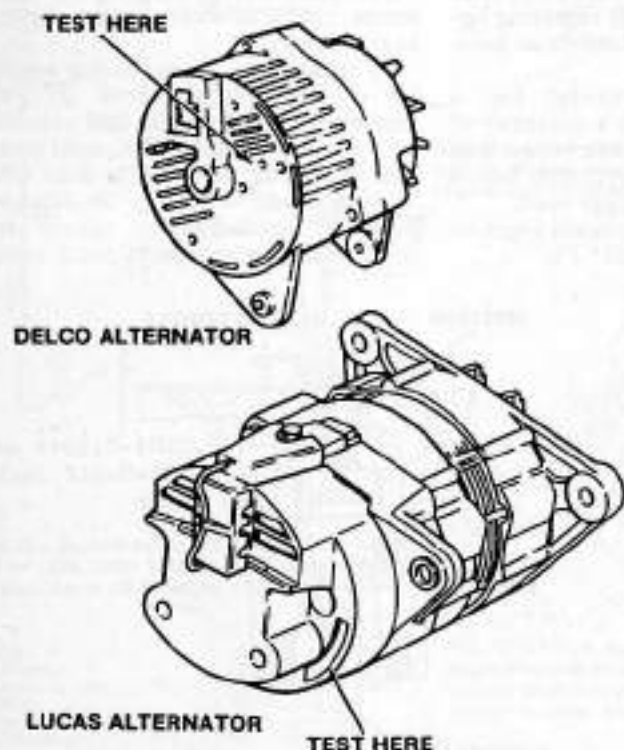


Fig. 97—View showing hole location for by-passing voltage regulator. Refer to paragraph 184.

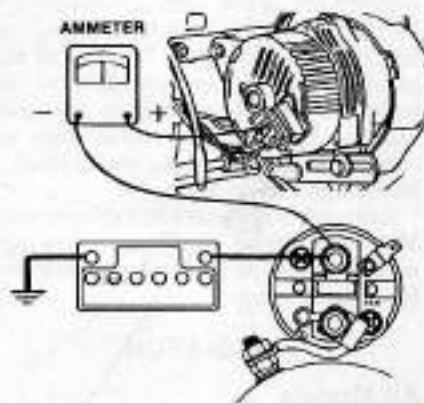


Fig. 98—View showing proper hook-up of ammeter for performing amperage output test. Refer to paragraph 185.



of alternator in conjunction with battery wiring and ground negative lead to adequate ground. Start engine and run at

1500 rpm. Voltmeter should read between 13 and 15 volts. If voltage is less than 13 volts, by-pass regulator and

check as outlined in paragraph 184. Voltage in excess of 15 volts indicates either a grounded brush inside alternator or faulty voltage regulator. Repair as necessary.

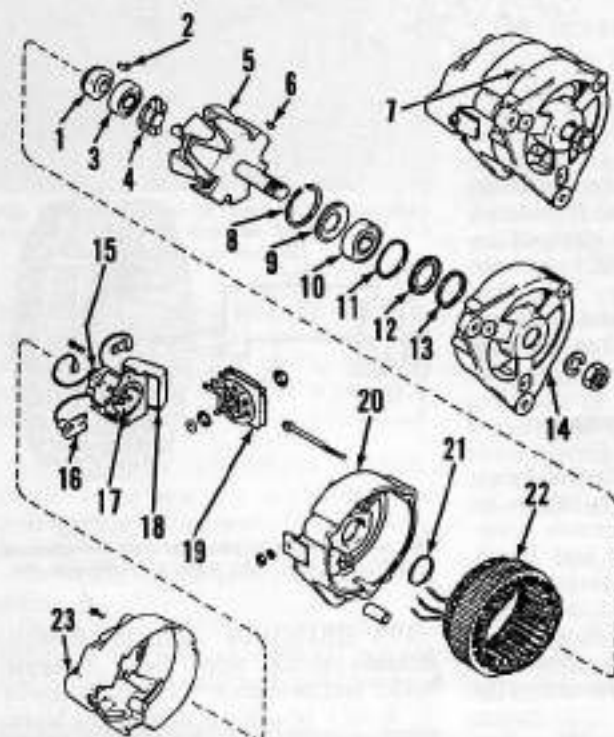


Fig. 99—Exploded view of standard duty Lucas alternator showing component parts and their relative positions.

1. Slip ring
2. Seal
3. Bearing
4. Seal
5. Rotor
6. Key
7. Scribe marks
8. Snap ring
9. Retaining plate
10. Bearing
11. Pressure ring
12. Retainer
13. Felt seal
14. Housing
15. Regulator
16. Isolation diode
17. Brushes
18. Brush holder
19. Rectifier assembly
20. Housing
21. Pressure ring
22. Stator
23. Cover

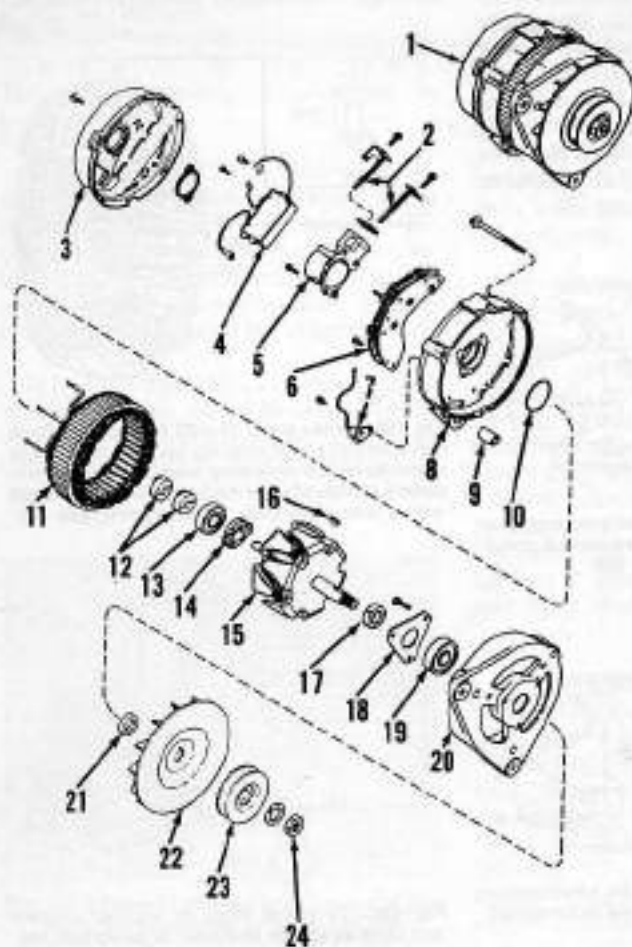


Fig. 100—Exploded view of heavy duty Lucas alternator used on models having cab or high electrical requirements.

1. Scribe marks
2. Brushes
3. Cover
4. Regulator
5. Brush holder
6. Rectifier
7. Surge protection diode
8. Housing
9. Collar
10. Pressure ring
11. Stator
12. Slip ring
13. Bearing
14. Seal
15. Rotor
16. Key
17. Collar
18. Retainer plate
19. Bearing
20. Housing
21. Collar
22. Fan
23. Pulley
24. Nut

**184. VOLTAGE REGULATOR BY-PASS TEST.** With voltmeter connected as outlined in paragraph 183, start and run engine at 1500 rpm. Ground voltage regulator to alternator case using probe with ground wire (Lucas) or small screwdriver (Delco) inserted through test hole in back of alternator case. See Fig. 97. If voltage before by-passing regulator was not between 13 and 15 volts, but is between 13 and 15 volts while regulator is being by-passed, renew voltage regulator. If voltage fails to be between 13 and 15 volts while by-passing regulator, remove alternator and overhaul as outlined in paragraphs for appropriate model.

**185. ALTERNATOR AMPERAGE OUTPUT TEST.** Disconnect brown wires from alternator and connect ammeter in alternator output circuit as shown in Fig. 98. Start and run engine at full rated speed (2200 rpm on 1190, 1290 and 1390 models and 2300 rpm on 1490 and 1690 models). Turn on head lights and flood lights (if so equipped) and check ammeter reading.

Amperage output must not be more than 10 amps below rating stamped on alternator identification plate or case.

## ALTERNATOR

Lucas alternators are used on all models, however some 1490 models are equipped with an AC Delco alternator.

Both Lucas and AC Delco alternators used have non-adjustable internal type voltage regulators.

### Lucas Standard Duty Alternator

**186. DISASSEMBLY.** Scribe locating marks on alternator housings (7—Fig. 99) and remove end cover (23). Note location of stator leads and unsolder leads from rectifier (19). Use **CAUTION** to not overheat diodes. Remove brush, regulator and rectifier assemblies. Remove retaining bolts and separate drive end housing (14) and rotor assembly (5) from rear housing (20) and stator assembly (22). Remove drive pulley, fan and shaft key and press rotor and shaft (5) out of drive end housing (14) and front bearing (10). Remove snap ring (8), plate (9), bearing (10), pressure ring (11), plate (12) and felt seal (13). Unsolder field winding connections and remove slip ring (1) if rear bearing (3) or seal (4) are to be renewed. Press off rear bearing (3). Separate stator assembly (22) from rear housing (20).

**187. BRUSHES AND SPRINGS.** Brushes should work freely in brush holder and be clean and free of grease or oil. Renew if overall length is less than 7.9 mm (5/16-inch). Spring pressure should be 2.5-3.6 N (9-13 oz.). Light sanding of rotor slip rings is permissible.

**188. ROTOR WINDING TESTS.** Check rotor winding continuity and resistance simultaneously by connecting a battery operated ohmmeter (Fig. 102) leads to slip rings. Resistance should be 3.3 ohms. Check rotor winding insulation by connecting a 110 volt, 15 watt AC current test light between each slip ring and rotor body. See Fig. 103. If test light comes on, rotor should be renewed.

**189. STATOR WINDING TESTS.** Short circuiting between windings is indicated by burnt insulating varnish covering winding. Renew stator assembly if damage is apparent.

Continuity of stator windings may be checked by connecting any two of the three stator winding leads in series with a 12 volt test light of not less than 36 watts. If test light comes on, transfer one of test light leads to remaining stator winding lead. See Fig. 104.

Test light should come on at each position, if not, renew stator assembly.

Insulation of stator winding may be checked by connecting a 110 volt, 15 watt AC current test light lead at stator laminations and touch each of the three stator lead wires in turn with remaining test light lead. See Fig. 105. If test light comes on, stator is short circuited and must be renewed.

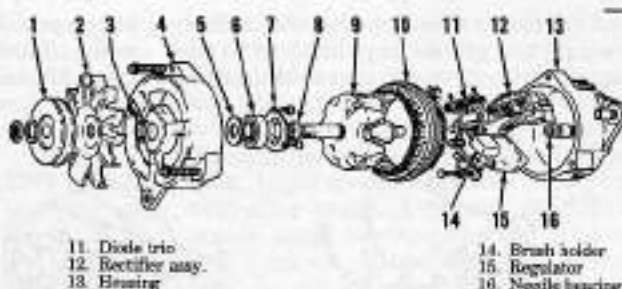
**190. DIODE TESTS.** Diodes act as one-way gates for electrical current by allowing current to pass through in one direction only. They may be checked using a 12 volt battery and 1.5 watt test light. Connect one lead of test light to battery and remaining lead to diode to be checked. Connect remaining diode lead to battery. Observe light. Reverse leads of diode and observe light. Light should come on during only one-half of this test. If test light fails to come on, or comes on when diode is connected either way, diode is faulty and should be renewed.

To test rectifier diodes, connect 12 volt battery and 1.5 watt test light in series with each separate diode using heat sink plate in which diode is mounted as one point of connection. See Fig. 106. Observe light and reverse connections. Light should come on during only one-half of this test. Test each diode separately and renew rectifier if any of the three check bad.

**191. REASSEMBLY.** Note some

Fig. 191—Exploded view of AC Delco alternator used on some 1490 models.

1. Pulley
2. Fan
3. Spacer
4. Housing
5. Dust seal
6. Bearing
7. Retainer plate
8. Spacer
9. Rotor
10. Stator
11. Diode trio
12. Rectifier assy.
13. Housing
14. Brush holder
15. Regulator
16. Needle bearing



type of heat sink should be used between diode and connections to be resoldered (needle nose pliers lightly clamped on diode lead) to protect diode from heat damage. Reassemble by reversing disassembly procedure and re-align scribe marks when joining housing halves.

### Lucas Heavy Duty Alternator

**192. DISASSEMBLY.** Scribe locating marks on alternator housings as shown (1—Fig. 100) and remove cover (3). Remove regulator (4) and brush holder (5). Unsolder stator (11) leads and remove rectifier assembly and surge (isolation) protection diode. Remove retaining bolts and separate drive end housing (20) and rotor assembly (15) from rear housing (8) and stator assembly (11). Remove nut (24), pulley (23), fan (22) and collar (21), then press rotor assembly (15) out of drive end housing bearing (19). Remove retaining plate (18) and bearing (19) from housing (20). Disconnect rotor leads and remove slip rings (12) from rotor shaft. Remove bearing (13) and seal (14). Remove stator (11) from rear housing (8).

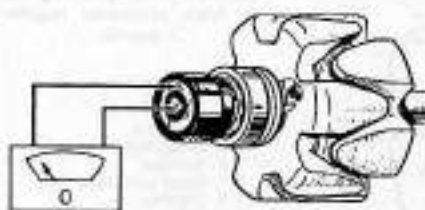


Fig. 102—View showing proper connection of ohmmeter (O) to slip ring for resistance check. Refer to paragraph 188.

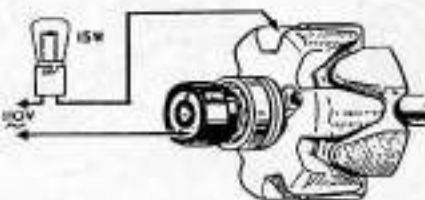


Fig. 103—Check rotor winding for short circuit to body using test light as outlined in paragraph 188.

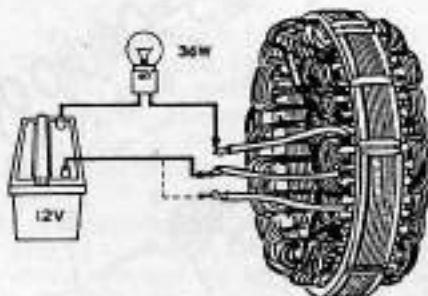


Fig. 104—Continuity check of stator winding using 36 watt test light. Refer to paragraph 189.

**193. BRUSHES AND SPRINGS.** Brushes should work freely in brush holder and be clean and free of grease or oil. Renew brushes if excessively worn. Springs should apply 2.5-3.6 N (9-13 oz.)

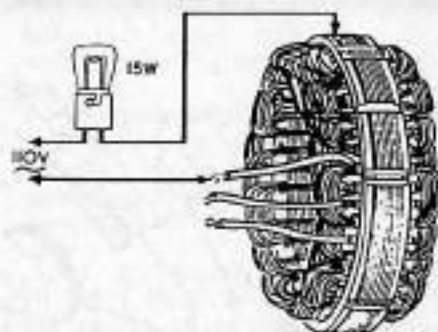


Fig. 105—When using 15 watt test light to check insulation of stator winding, connect one lead to stator body and remaining lead to 110 volt power source. Connect remaining 110 volt lead to each stator lead separately. Refer to paragraph 189.

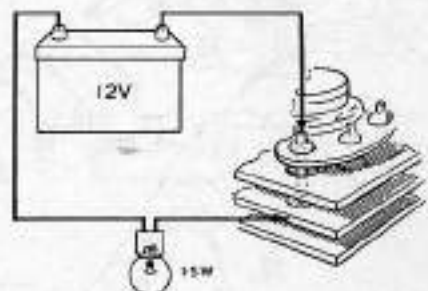


Fig. 106—To check diode in rectifier connect test light as shown and refer to paragraph 190.





Fig. 107—Screws at "A" and "B" connections must use insulating washers. Screw at "C" is a ground connection.

pressure to brushes, and slip ring surface of rotor should be clean and smooth. Light sanding of slip rings to remove scores or scratches is permissible.

**194. ROTOR WINDING TESTS.** Check rotor winding continuity and resistance simultaneously by connecting battery operated ohmmeter leads to rotor leads. Resistance should be 4.3 ohms.

Check rotor winding insulation by connecting a 110 volt, 15 watt AC current test light lead to rotor body, and remaining lead to separate rotor winding leads each in turn. If test light comes on, rotor should be renewed.

**195. STATOR WINDING TESTS.** Test stator windings as outlined in paragraph 189.

**196. DIODE TESTS.** Note rectifier assembly construction is different. Basic testing procedures are the same as for standard duty Lucas alternators. Locate individual diode leads and test rectifier assembly and surge (isolation) protection diodes as outlined in paragraph 190.

**197. REASSEMBLY.** Note some type of heat sink should be used between diode and connections to be resoldered (needle nose pliers lightly clamped on diode lead) to protect diode from heat

damage. Reassemble by reversing disassembly procedure and re-align scribe marks when joining housing halves.

### Delco Alternator

**198. DISASSEMBLY.** Scribe locating marks on alternator housing as shown (1—Fig. 100) and remove nut, pulley (1—Fig. 101), fan (2) and spacer (3). Remove retaining bolts and separate drive end housing (4) and rotor assembly (9) from rear housing (13) and stator assembly (10). Press rotor (9) from drive end housing (4) and bearing (6). Remove retaining plate (7), bearing (6) and dust seal (5). Note location of insulating washers under screws at "A" and "B" connections (Fig. 107) at brush holder and remove retaining screws and nuts and remove diode trio (11—Fig. 101), brush holder (14), regulator (15) and rectifier assembly (12). Press needle bearing (16) out of rear housing (13) and renew as required.

**199. BRUSHES, SPRINGS AND SLIP RINGS.** Brushes should work freely in holder and have sufficient spring pressure to maintain brush to slip ring contact. Brushes, springs and holder are serviced as an assembly only, and should be renewed if excessively worn or damaged.

Rotor slip rings should be smooth and free of grease or oil. Mount rotor in lathe and check slip ring runout. If runout exceeds 0.051 mm (0.002 inch) or surface is scored, surfaces may be trued on a lathe. Finish with 400 grit (non-metallic) sandpaper or finer polishing cloth until scratches or machine marks are removed.

**200. ROTOR WINDING TESTS.** Check rotor winding continuity and resistance simultaneously by connecting battery operated ohmmeter leads to each brush contact surface of slip rings. Resistance must be 3.3 ohms for standard duty alternators and 4.3 ohms for heavy duty alternators.

Check rotor winding insulation by connecting a 110 volt, 15 watt AC current test light lead to rotor body and remaining lead to separate slip ring surfaces. If test light comes on, rotor should be renewed.

**201. STATOR WINDING TESTS.** Test stator as outlined in paragraph 189.

**202. DIODE TESTS.** To test diode trio (Fig. 108) connect a battery operated ohmmeter lead to diode trio at "D", Fig. 108 and remaining lead to "A", "B" and "C", Fig. 108, in succession, noting ohmmeter reading at each connection. Reverse ohmmeter connection

and check each diode again. Ohmmeter reading should be high for each diode during one-half of test and low during the other half of test. If reading is equal, or no reading is registered renew rectifier assembly.

**203. REASSEMBLY.** Note position of insulated washers (Fig. 107) and reassemble by reversing disassembly procedure.

### STARTING MOTOR

With the exception of 1390 models Lucas starting motors are used. 1490 models may be equipped with a standard duty Lucas starter or a heavy duty Lucas starter, which is standard equipment on 1690 models.

1390 models are equipped with Bosch starting motors.

### STARTING MOTOR OVERHAUL

#### Lucas Starter

**204. DISASSEMBLY.** To disassemble Lucas starter, first remove solenoid assembly and copper link connecting solenoid to starter. Remove through-bolts (30—Fig. 110) and end cover (29). Use caution to avoid losing brake shoes (25) and springs (24). Remove brushes (23) from brush boxes and remove brush holder (22). Inspect brush springs (21) and renew as needed. Remove field housing (18). Remove eccentric pin (1) and remove drive end housing (3). Push thrust collar (12) off of snap ring (11) and remove snap ring and thrust collar. Remove starter drive (13), intermediate support (14) and shims (16). Note thickness and number of shims (16) for reassembly. Inspect bushings (2, 15 and 27) for excessive wear or damage. Renew as required. Soak new bushings in oil for 24 hours prior to installation.

**205. ARMATURE.** Inspect armature commutator and if worn, rough or pitted, it may be trued in a lathe. Minimum commutator diameter is 38.1 mm (1.50 inches). Polish commutator with non-

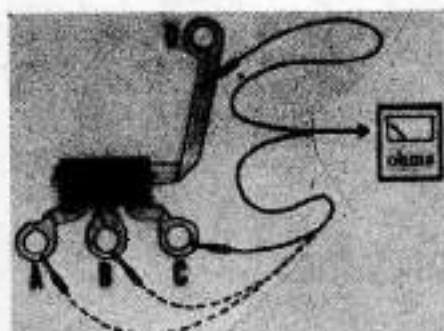


Fig. 108—Connect ohmmeter as shown to test diode trio as outlined in paragraph 202.



Fig. 109—Screw "A" on rectifier assembly is a ground connection, "B", "C" and "D" are individual diode leads and "E" must be insulated and connected to output terminal. Refer to paragraph 202.



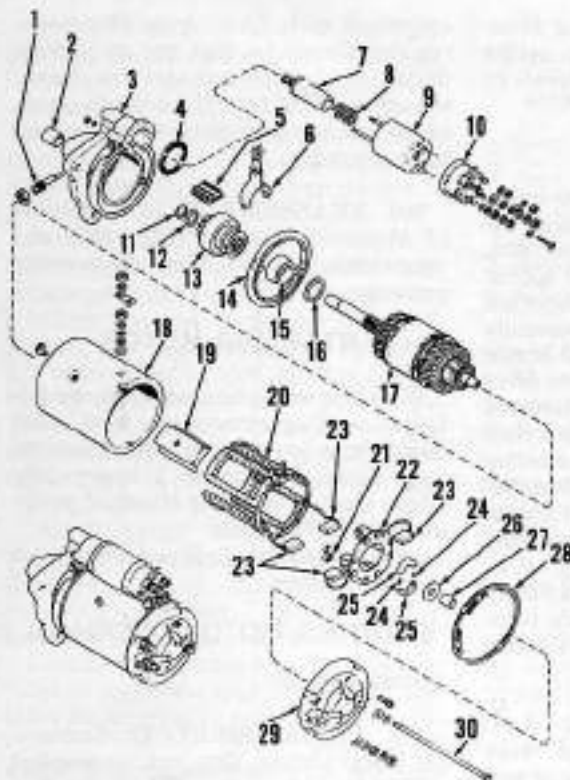


Fig. 110—Exploded view of typical Lucas starter assembly. Note construction may vary slightly according to model, but basic design remains the same.

1. Pivot bolt
2. Bushing
3. Drive end housing
4. Gear
5. Solenoid
6. Link
7. Plunger
8. Spring
9. Solenoid
10. Solenoid end cap
11. Retaining ring
12. Thrust collar
13. Starter drive
14. Intermediate support
15. Support bushing
16. Shims
17. Armature
18. Field housing
19. Pole shoe
20. Field coils
21. Brush spring
22. Brush holder
23. Brushes
24. Brake springs
25. Brake shoes
26. Thrust washer
27. Bushing
28. Seal
29. End cover
30. Through-bolt

conductive emery cloth. Do NOT undercut insulators between commutator segments.

**206. ARMATURE INSULATION TEST.** Armature insulation may be tested by using a 110 volt, 15 watt AC current test light connected as shown in Fig. 111. Touch each commutator segment in turn with test light lead. If test light comes on at any segment, windings are shorted and must be repaired or renewed.

**207. FIELD COIL TEST.** Field coil insulation may be tested using a 110 volt, 15 watt AC current test light connected as shown in Fig. 112. Brushes must not touch field housing and power terminal insulation must not allow voltage to short to housing. If test light comes on and brushes are not touching housing and insulation is good at power terminal, there is a short between field coils (20—Fig. 110) and field housing (18). Repair or renew as necessary.

**208. INSULATED BRUSH BOX TEST.** Two of the brush boxes on brush holder assembly must be insulated from the assembly itself. Connect a 110 volt, 15 watt AC current test light as shown in Fig. 113 and touch test light lead to each insulated brush holder in turn. If test light comes on, insulation between brush box and brush holder assembly is faulty and brush holder assembly must be renewed.

**209. REASSEMBLY.** Reassemble by reversing disassembly procedure. Make certain slots in brake shoes align with cross pin in armature shaft.

Armature end play must be 0.127-0.635 mm (0.005-0.025 inch) and is controlled by thickness of shims (16—Fig. 110) between intermediate support and armature core.

Pinion clearance is set by connecting a 6 volt battery to solenoid on assembled starter to activate solenoid. Push back lightly on starter drive clutch (1—Fig. 114) to remove any free play. Measure with a feeler gage as shown in Fig. 114. Turn pivot bolt (1—Fig. 110) to adjust clearance and when set, lock pivot bolt in place with locknut. Standard duty starter pinion clearance must be 0.127-0.381 mm (0.005-0.015 inch) and heavy duty starter pinion clearance is 0.127-1.143 mm (0.005-0.045 inch).

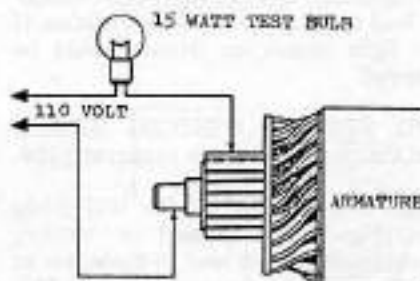


Fig. 111—When checking insulation each commutator segment must be checked separately. Refer to paragraph 205.

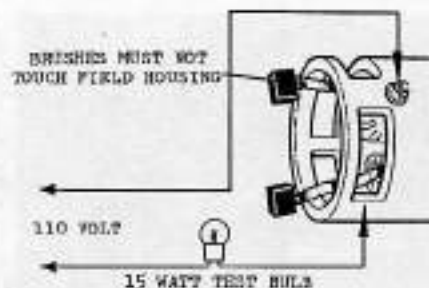


Fig. 112—Brushes must not touch housing and insulation at terminals must be good when checking field coils. Refer to paragraph 205.

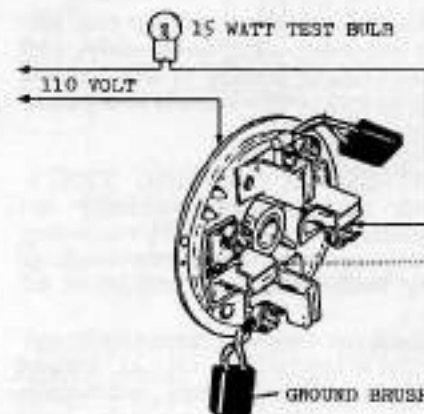


Fig. 113—Check both insulated brush holders as outlined in paragraph 205.

## Bosch Starter

**210. DISASSEMBLY.** Remove solenoid assembly (1—Fig. 115) and pivot pin (6). Remove through-bolts and end cover (15). Lift brushes (13) from brush boxes and remove brush holder assembly and note number and thick-

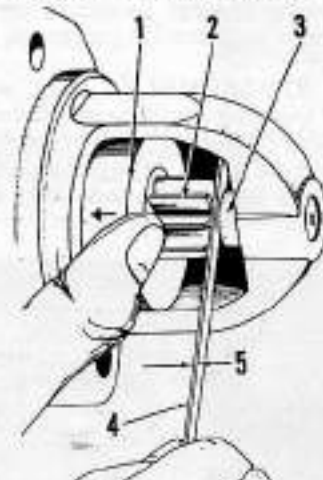


Fig. 114—Measure pinion clearance with a feeler gage as shown. Refer to paragraph 209 for specifications.

1. Starter drive clutch
2. Starter drive
3. Thrust collar
4. Feeler gage
5. Clearance (refer to paragraph 209)

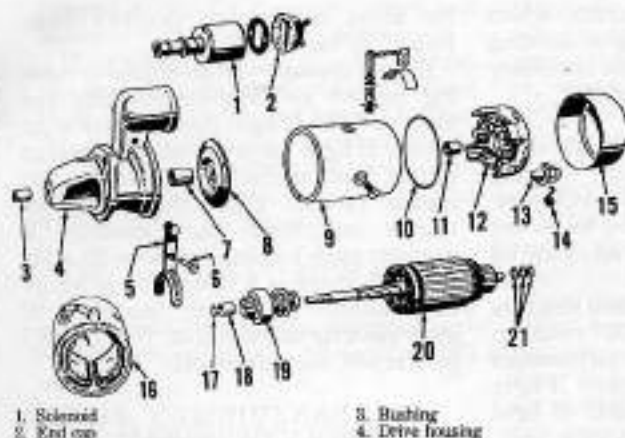


Fig. 115—Exploded view of Bosch starter showing component parts and their relative positions.

1. Solenoid
2. End cap
3. Bushing
4. Drive housing
5. Link
6. Pivot pin
7. Bushing
8. Intermediate support
9. Field housing
10. Sealing ring
11. Brush holder
12. Brush
13. Brush spring
14. End cover
15. Field coil
16. Snap ring
17. Starter drive
18. Armature
19. Shim

ness of shims (21). Remove field housing (9) and drive housing (4). Remove starter drive (19) and intermediate support (8). Inspect bushings (3, 7, 11 and 18) for excessive wear or damage. Renew as required. Soak new bushings in oil for 24 hours prior to installation. Inspect brushes and springs and renew if excessively worn or damaged.

**211. ARMATURE.** Inspect armature commutator for wear, roughness or pitting. Light sanding with non-conductive emery cloth to clean and smooth surface is permissible. Check insulation as outlined in paragraph 206.

**212. FIELD COIL.** Inspect field coil for overheating and burnt insulating wrap. Test as outlined in paragraph 207.

**213. INSULATED BRUSH BOX TEST.** Locate the two insulated brush boxes on brush holder assembly and test as outlined in paragraph 208.

**214. REASSEMBLY.** Reassemble by reversing disassembly procedure. Renew shims (21—Fig. 115) to thickness noted during disassembly.

## SOLENOID

### All Models

215. Solenoids differ slightly in appearance but basic construction and operating principles are the same. When electrical current is applied to start terminal it energizes closing coils. This pulls plunger in which energizes hold in coil and maintains starter drive engagement. If solenoid fails to hold starter drive in engaged position, hold in coil circuit of solenoid is faulty.

All models have serviceable end caps and service kits include new terminals, insulating and sealing washers and nuts, washers and contact strips. If an excessive voltage drop between solenoid and starter is apparent, contact surfaces in end cap should be cleaned or renewed.

## WIRING

### All Models

216. When a problem is suspected in wiring harness, follow an orderly, step by step check of the problem circuit. Always check protective circuits (fuses, circuit breakers and diodes) first, then refer to appropriate wiring diagram and locate the primary point of current supply for circuit in question. Using a 12 volt test light or voltmeter check for adequate voltage at this point. If voltage is present at this point continue to check for voltage at appropriate connections along harness working towards unit malfunctioning until problem area is isolated. Harness connectors (plugs), sockets and connection terminals being corroded, loose or broken are most often the cause for interruptions in power supply.

If voltage was not present at primary point of current supply, check wiring moving toward battery until interruption of current is isolated. Repair as needed.

## PROTECTIVE CIRCUITS

### All Models

217. FUSES. Fuses are installed in

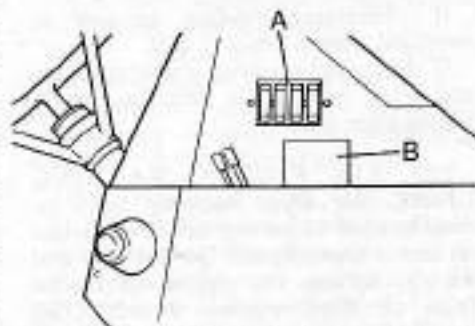


Fig. 121—Fuse holder (A) and cover (B) are located on right side of 1190 model tractors. Replace fuses with specified size and amperage fuse only.

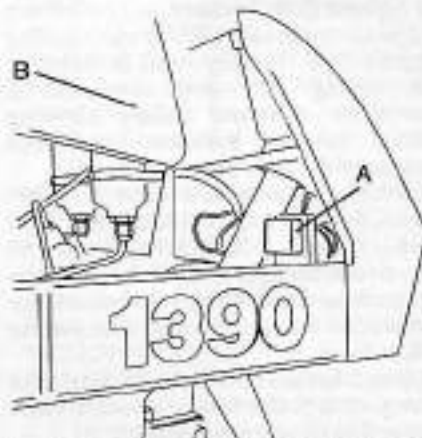


Fig. 122—Engine cover (B) must be raised to gain access to fuse holder (A). Replace fuses with specified size and amperage fuse only.

circuits to protect wiring from damage in event of shorted wiring and when "blown" (fuse strip melted) must be renewed with a fuse of the same size and amperage rating. Locate and repair problem which caused fuse failure.

**218. FUSE LOCATIONS.** Model 1190 fuse box is located at right side of instrument panel (Fig. 121).

All models except 1190, which do not have cabs, have fuse boxes located inside instrument panel on left-hand side. Lift hood to gain access to fuses. See Fig. 122.

Fuse holders on cab equipped models are located inside front headliner (Fig. 123). To renew fuses remove defroster air louvers, then remove front left air louver to gain access to fuse panel. These models also have a fuse panel in same location as models not equipped with cab.

**219. CIRCUIT BREAKERS.** Circuit breakers perform the same function as fuses, however a circuit breaker will cut

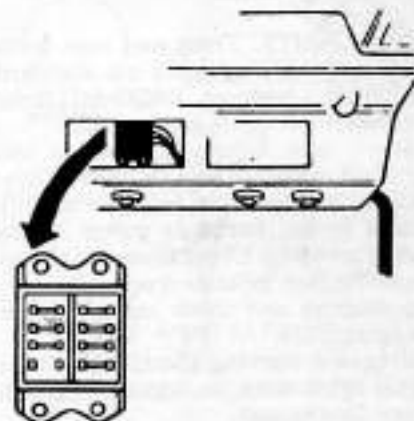


Fig. 123—Cab fuse holder is located in headliner for cab equipped models. Refer to paragraph 218.



off current flow, breaker will cool down and reset automatically, re-establishing current flow. Usually used in lighting, cab wiring and gage circuits, it eliminates complete failure allowing limited use of systems considered necessary for safe operation.

Circuit breakers are used on 1490 models from P. I. N. 11185693 and 1690 models from P. I. N. 11213470, and a 50 amp circuit breaker is used on cab equipped models. A retrofit kit is available for installation on early models eliminating in-line fuses.

Circuit breakers will be in line with brown wire connected to positive cable connection of starter solenoid.

Under normal operation with voltage at **BAT** connection of circuit breaker, voltage should pass through breaker to remaining terminal.

**220. DIODE.** Diodes act as one way gates for electrical current, allowing current to pass through in one direction only. In addition to the diodes used in alternators of all models, 1190 and 1290 models have a diode installed in the brown and yellow wire running from instrument panel wiring harness connector to join with brown and yellow wire running to the alternator.

To test diode, expose wire on opposite sides of diode and touch leads of battery powered ohmmeter to exposed wire, one lead on each side of diode. Reverse position of leads. Ohmmeter should show continuity through diode during only one-half of test. If current passes through diode in both directions, or fails to pass through either direction, diode is faulty and should be renewed.

## ACCESSORY SYSTEMS

### All Models

Accessory systems include lights, gages and warning systems, windshield wipers, cab ventilating, heating and air conditioning system.

**221. LIGHTS.** Front and rear work lights and warning lights are standard equipment, however additional front and rear work lights are available.

Single light failure is usually a bad light bulb, poor ground or current connection. Multiple light failure is usually caused by bad switch or power source wiring problems. Check fuses and circuit breakers, then refer to appropriate wiring diagram and check as outlined in paragraph 216.

If hazard warning (flashing) or turn signal lights come on, but do not flash renew flasher unit.

**222. GAGES AND WARNING SYSTEMS.** Gage and warning systems con-

sist of three basic components, which are the gage or warning light, sending unit or activating switch and necessary wiring to connect all components.

**223. OIL PRESSURE LIGHT.** Normal operation of oil pressure warning light is to light when key is in **ACC** position, engine not running and to go out when engine is running and adequate oil pressure is reached.

If light fails to come on when key is in **ACC** position, engine not running, remove white/brown wire from pressure switch and ground it to engine. If light comes on, renew sending unit. If light still fails to come on check wiring, bulb, printed circuit and power source.

If light fails to go out with wire removed, there is a short circuit between wiring and tractor. Repair as necessary. If light goes out when wire is removed, stop engine, remove sending unit and install pressure gage. Start engine and check gage reading. If pressure is above 62-89 kPa (9-13 psi), renew pressure sending unit. If pressure is below 62-89 kPa (9-13 psi), check engine lubricating system.

**224. HEAT GAGE.** Remove radiator cap and place an accurate thermometer in coolant.

**CAUTION:** Use care if system has been running as pressure build-up in radiator could cause hot coolant to spray out.

Start engine and watch temperature. If thermometer and gage reading vary greatly, disconnect wire from temperature sending unit and connect positive lead of ohmmeter to sending unit and ground negative lead. Note ohmmeter reading at temperatures listed below and compare to correct ohmmeter reading specified.

Coolant temperature—	Correct ohmmeter reading—
38° C (100° F)	1365.0 ohms
104° C (220° F)	95.9 ohms
116° C (240° F)	71.5 ohms
138° C (280° F)	43.5 ohms

If ohmmeter reading is not as specified, renew sending unit.

If ohmmeter readings are as specified and gage reading is still inaccurate, renew gage unit.

**225. AIR FILTER WARNING LIGHT.** Air filter warning light indicates need to service air filters when on and is normally off. To test bulb and wiring, remove the yellow/white wire from air filter vacuum switch (1690 models have two switches) and ground to engine. Light should light.

If light fails to light when yellow/white wire is grounded, check circuit wiring

for short and check indicator bulb. Repair as necessary.

If light comes on while engine is running remove air filter momentarily and observe light. If light goes off, renew air filters. If light stays on, remove vacuum switch from manifold and install an accurate vacuum gage. Start and run engine and note gage reading. If vacuum gage reading is above 29.5 Hg (8.7 psi), there is a restriction in air intake system. Repair as necessary. If gage reading is lower than 29.5 Hg (8.7 psi), renew vacuum switch.

**226. TRANSMISSION FILTER WARNING LIGHT.** Models 1190 and 1290 are equipped with a transmission filter warning light which is normally off even with engine running. If light is on, remove the black/light green wire from transmission filter vacuum switch located on manifold in bottom of pto housing. Light should go out, indicating wiring and bulb are good. If light failed to go out, there is a short in wiring between light and switch. Repair as necessary.

If light went out after wire is disconnected, but is on when connected, remove vacuum switch and install an accurate vacuum gage. Start tractor and note vacuum reading. Each switch has rating stamped on its side, compare to gage reading. If gage reading is lower than rating on switch, renew switch. If gage reading is higher than switch rating, service transmission filter system.

To test bulb and wiring, remove black/light green wire from switch and ground it to the tractor. Light should come on. If light fails to come on, check bulb, wiring and power source. Repair as needed.

**227. FUEL LEVEL GAGE.** If fuel gage reading is inaccurate, remove tank sending unit and connect the two ohmmeter leads to senders terminals. With float at "empty" position ohmmeter reading should be 0 to 1 ohm. With float at "half" position ohmmeter should read 44 to 46 ohms. With float at "full" position ohmmeter should read 83 to 92 ohms. If ohmmeter is not as specified at all positions, renew sending unit. If readings are as specified and wiring is good, but gage is still inaccurate, renew gage.

**228. DIFFERENTIAL LOCK WARNING LIGHT.** Differential lock indicator light is located in lower left-hand corner of indicator light section and should light with key on, differential lock pedal engaged. If light stays on when pedal is disengaged, disconnect yellow/black wire at differential lock indicator switch. If light goes out, renew switch, if light stays on, wiring is



shorted to tractor between switch and indicator light. Repair as necessary.

If light fails to come on with differential lock pedal engaged, remove yellow/black wire at switch and ground to tractor. If test light comes on, renew switch. If light fails to come on with wire grounded, check bulb, power source and wiring. Repair as necessary.

**229. ALTERNATOR WARNING LIGHT.** Normal alternator warning light operation, testing and repair procedures are outlined in paragraphs 181 and 182.

**230. WINDSHIELD WIPERS.** Normal operation of windshield wipers on cab equipped models is with key on, move wiper switch to **LO** and **HI** positions, wiper should operate at each position. Move wiper switch to **OFF** position and wiper should automatically return to **PARK** position.

If wiper motor does not operate in one, or all positions check cab relay, circuit breaker and 15 amp fuse at No. 2 fuse position of fuse panel. Use a voltmeter and check for voltage at "B" terminal of wiper switch. If current is present at "B" terminal, move wiper switch control to **LO** position and check voltage of "L" terminal, then move control to **HI** position and check voltage at "H" terminal. If no voltage is found at "B" connection, check wiring, ignition switch and fuses. If voltage reaches "B" terminal but does not reach "L" or "H" terminal as switch is operated, renew wiper switch. If voltage is present at each terminal and switch is in proper position, test for voltage in wires as close to wiper motor as possible. If voltage is present at wiring but motor does not run, renew motor. If no voltage is present, check wiring between switch and motor.

If wiper motor operates but does not return to park position, use voltmeter and with wiper switch in **OFF** position

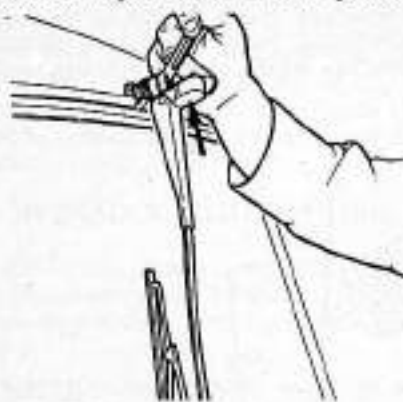


Fig. 124 - To remove wiper arm, pull top of arm forward as shown and remove nut retaining arm to motor shaft. Remove wiper arm complete with wiper blade.

check for voltage at "P" terminal of wiper switch. If voltage is present at "P" terminal, check wire to motor and repair or renew motor as necessary. If no voltage is present at "P" terminal, renew wiper switch.

**231. REMOVE AND REINSTALL WIPER MOTOR.** To remove wiper motor, first move top of arm forward (Fig. 124) and remove nut retaining wiper arm to motor shaft. Remove wiper arm. Remove seal, washer and nut retaining wiper motor to cab roof from motor shaft. Remove panel covering wiper motor from cab roof inside cab, note positions of wires and disconnect and remove wiper motor.

Reinstall by reversing removal procedure, connecting wires in positions noted during removal.

**232. CAB FAN MOTOR.** Cab fan (blower) motor is used for cab ventilation, heater or air conditioning system fan as models are equipped.

If motor fails to operate with key on and blower switch turned to **LO**, **MED** or **HI** position, use voltmeter and check for voltage at "B" terminal of blower switch. If no voltage is present, check wiring, fuses, ignition switch and circuit breakers. Repair as needed. If voltage is present at "B" terminal check for voltage at "L", "M" and "H" terminals as blower switch is turned to **LO**, **MED** or **HI**. If voltage is not present at all locations with blower switch in proper position, renew switch.

If voltage is present at all terminals, locate resistor block and with blower switch on, check voltage at resistor block terminal where blue wire from blower switch "B" terminal is connected. If voltage is present, check for voltage at resistor block terminal where red and green wires are connected. If no voltage is present at blue wires terminal, check wire between blower switch and resistor block. If voltage is to resistor block but fails to pass through resistor, renew resistor block.

If voltage passes through resistor block, check wiring for voltage as close to blower motor as possible. If voltage is present, make sure motor ground is good and renew motor as needed.

If voltage is not present, check noise suppressor in wire from resistor to motor and wire. Repair as needed.

**233. HEATER AND AIR CONDITIONING.** Heater and air conditioner blower motor testing procedures are the same as outlined in paragraph 232, however the air conditioning system compressor clutch, high and low pressure switches and temperature control switch may be checked as individual units.

Before attempting to diagnose electrical problems in air conditioning system make certain compressor belt is tight, clean condenser and evaporator cores to insure maximum air flow and check refrigerant level in sight glass.

Refrigerant level may be checked after operating system for ten minutes when ambient temperature is 21° C (70° F) or above. If slow moving, steady stream of bubbles are visible in sight glass system may be low on refrigerant. Foam or heavy flow of bubbles indicate a very low refrigerant level. Oil streaks or dark spots on inside of sight glass indicate no refrigerant in system.

A clear sight glass usually indicates an adequately charged system, however a completely empty system can have a clear sight glass also. If in doubt, shut compressor on and off while watching sight glass. A slight, momentary stream of bubbles should appear in even a full system as compressor starts. See Fig. 125.

Slightly low systems should be recharged and checked for leaks. Extremely low systems need to have refrigerant oil level checked, receiver dryer renewed and system evacuated and recharged. Check for leaks.

**234. COMPRESSOR CLUTCH CIRCUIT TEST.** With tractor running and system recharged, set temperature control switch to coldest position and turn blower control switch to **MED** or **HI**. Clutch should engage as blower switch is turned on. If clutch does not engage, use voltmeter to check for voltage at compressor clutch. If voltage is present, renew compressor clutch.

If no voltage is present at clutch disconnect light blue wires on high pressure switch located at compressor and install jumper wire as shown in Fig. 126. If compressor clutch engages, check system pressure or renew high pressure switch as necessary.

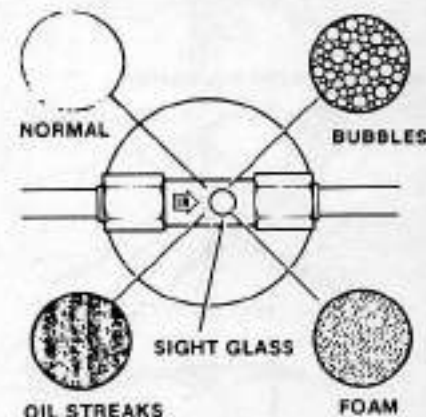


Fig. 125 - Sight glass is located in receiver dryer. Refer to paragraph 232.

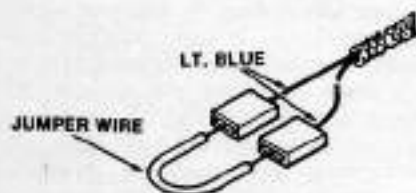


Fig. 126 - By-pass high or low pressure switches using jumper wire as shown. Refer to paragraph 233.

If clutch still fails to engage, disconnect light blue wires from low pressure switch located at receiver dryer and install jumper wire as shown in Fig. 126. If clutch engages, check system pressure and refrigerant level or renew low pressure switch as necessary.

If clutch still fails to engage, use 12 volt test light and check for voltage at temperature control switch as shown in Fig. 127. If light comes on at both terminals, switch is good, if light comes on at only one terminal, renew switch.

If light fails to come on at either terminal and blower motor is working, check black wire from temperature control switch to blower motor switch. Repair as necessary.

## CLUTCH

When equipped with continuous type clutch 1190 and 1290 models use Borg and Beck double clutch assemblies which are similar in construction, however 1190 model transmission and pto driven plates are 254 mm (10 inches) in diameter while 1290 driven plates are 304.8 mm (12 inches) in diameter.

All models having independent type clutch use Laycock double clutch assemblies of various construction and driven and pto plate diameters.

### TEMPERATURE CONTROL SWITCH

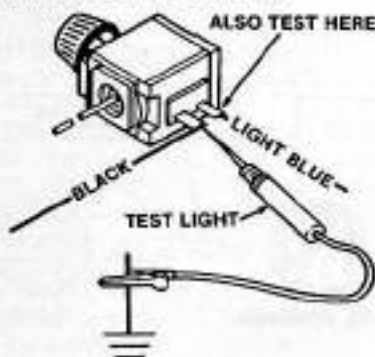


Fig. 127 - Check both terminals of temperature control switch as outlined in paragraph 233.

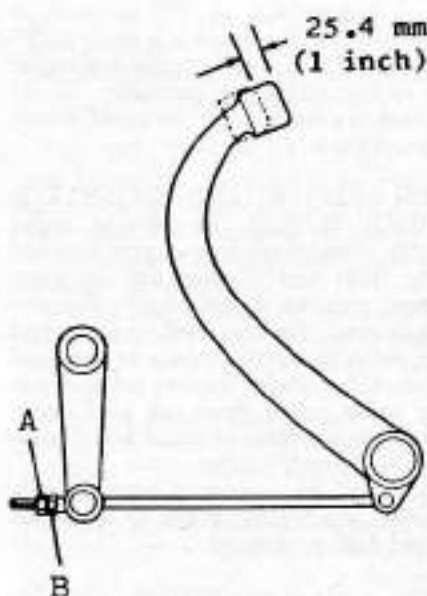


Fig. 128 - Turn jam nuts "A" and "B" until 25.4 mm (one inch) free play is measured in clutch pedal as shown.

## ADJUSTMENTS

### Models 1190-1290-1390 With Continuous Clutch

235. Check amount of free travel in clutch pedal (Fig. 128) and loosen jam nuts (A) and (B) until 25.4 mm (one inch) free travel is in clutch pedal. Tighten jam nuts at this position.

### Models 1190-1290-1390 With Independent Pto Clutch

236. Adjust transmission clutch pedal to 25.4 mm (one inch) clearance as outlined in paragraph 235.

Adjust pto clutch lever until 38 mm (1½ inches) free travel is measured as shown in Fig. 129.

### Low Profile Model 1490

237. Adjust transmission clutch free travel to 4 mm (5/32-inch) measured at

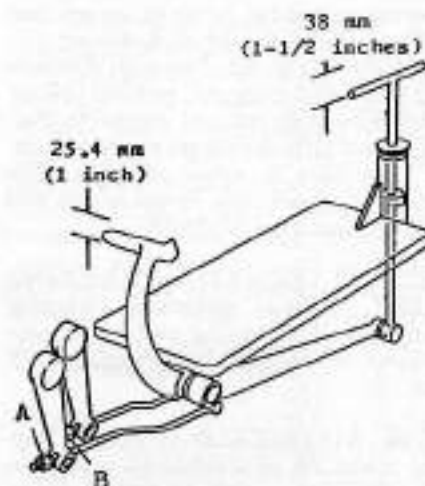


Fig. 129 - Adjust independent pto clutch lever until 38 mm (1½-inches) free travel is measured as shown by turning adjusting nut "A". Adjust foot clutch until 25.4 mm (one inch) free travel is measured by turning adjusting nut "B".

D, Fig. 130 by loosening locknut (B) and turning adjusting sleeve (C) on rod (A). Tighten locknut (B) against sleeve (C).

To adjust pto clutch lever disengage pto clutch lever until catch is engaged. Check angle between centerline of crank lever and cable as shown in Fig. 131. This angle must be 90 degrees and is adjusted by loosening locknut (A) and turning cable adjusting sleeve (B) until angle is 90 degrees. Tighten locknut (A).

Adjust free movement of pto clutch lever to 63 mm (2½ inches) as shown in Fig. 132 by adjusting nuts (D and E - Fig. 131) on operating rod.

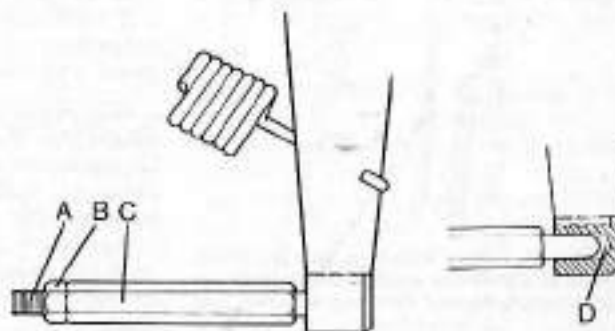
**CAUTION:** Do not operate tractor if free movement is less than 45 mm (1¾ inches).

### Models 1490-1690 With Cab Or Platform

238. It is recommended that transmission clutch linkage be checked and adjusted every 60 hours of normal operation. Adjust at slave cylinder push

Fig. 130 - View showing transmission clutch adjustment linkage for 1490 low profile tractors.

- A. Push rod
- B. Locknut
- C. Adjusting sleeve
- D. Free movement of 4 mm (5/32-inch)





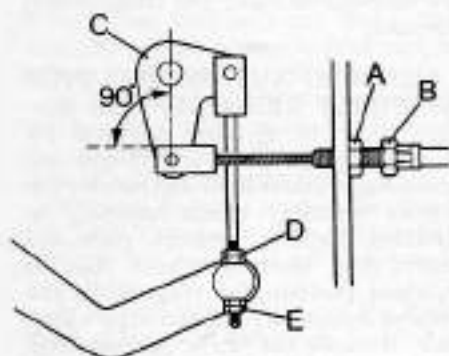


Fig. 131 - View showing pto adjustment linkage for 1490 low profile tractors.

A. Locknut  
B. Cable adjusting sleeve  
C. Crank lever  
D. Locknut  
E. Locknut

rod. Make certain slave cylinder is fully retracted. If return spring (A - Fig. 133) is weak, install new spring. Move cross-shaft lever away from push rod using wrench (Fig. 133) until release bearing is against thrust plate. Estimate amount of clearance between end of push rod and cross-shaft lever. Clearance must be 4 mm (5/32-inch). Loosen locknut (B - Fig. 134) and turn adjusting sleeve (C) until correct clearance is reached. Tighten locknut against sleeve.

Because of difficulty in accurately measuring clearance between push rod end and cross-shaft, an alternate method of adjusting clearance is to turn adjuster sleeve (C - Fig. 134) until any clearance between push rod end and cross-shaft lever is just removed. Turn adjuster in opposite direction **FOUR REVOLUTIONS** and tighten locknut.

To adjust pto clutch linkage, place pto clutch lever in engaged position and remove return spring from clutch cross-shaft lever. Loosen locknut (A - Fig. 135) on cable adjuster (B). Turn cable adjuster (B) counter-clockwise to just remove any free movement in linkage, then turn adjuster clockwise one full turn. Free movement at end of cross-shaft lever must be 3-5 mm (1/8-1/4 inch). Tighten locknut (A) and connect return spring.

### HYDRAULIC CLUTCH FLUID

239. Early models used Tellus 37 fluid in clutch and brake hydraulic systems, then later started using Agricastrol FBS fluid.

**CAUTION:** These fluids must not be mixed.

If system is filled with Agricastrol FBS fluid, brake and clutch fluid reservoirs will have green colored covers or

Fig. 132 - 1490 low profile models pto clutch lever must have 63 mm (2 1/2 inches) free movement as shown.

63 mm  
(2-1/2 inches)

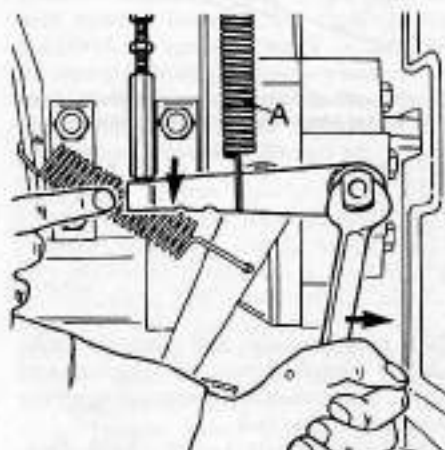
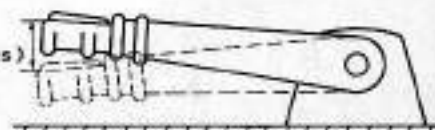


Fig. 133 - View showing use of wrench to move cross-shaft lever until release bearing is against thrust plate.

green tape will be attached to covers. If neither of these is present, Tellus 37 fluid has been used. Add correct type of fluid.

It is recommended fluid be changed every two years. Refill systems with Agricastrol FBS fluid or equivalent.

### BLEEDING AIR FROM SYSTEM

#### All Models With Hydraulic Clutch

240. Clean a pressure oil can and keep for this purpose only. Fill pressure oil can (A - Fig. 136) with specified fluid and connect to air screw (C) on slave cylinder using flexible tube (B). Open reservoir and loosen air screw and

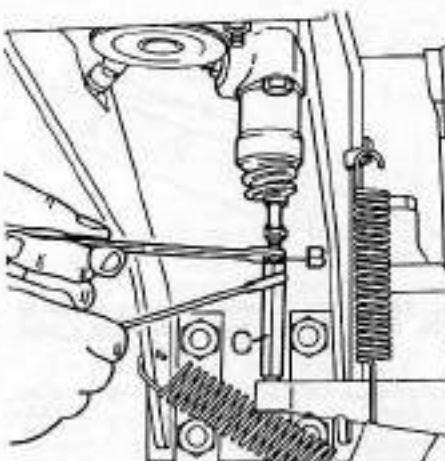


Fig. 134 - View showing adjusting sleeve (C) and locknut (B).

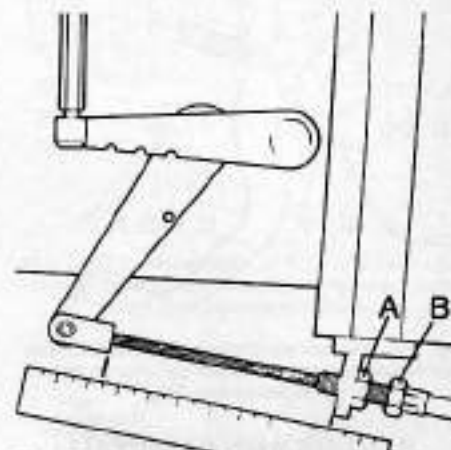


Fig. 135 - Adjust free play by loosening locknut (A) and turning adjusting sleeve (B) until free play is 3-5 mm (1/8-1/4 inch).

operate pressure can to push fluid into reservoir. Continue until fluid entering reservoir is free of air bubbles. Tighten air screw and fill reservoir to correct level. Adjust clutch and master cylinder as needed.

### MASTER CYLINDER ADJUSTMENT

#### All Models With Hydraulic Clutch

241. Overhaul kits are available for clutch master cylinder and slave cylinder. If cylinders are rebuilt or renewed, master cylinder must be adjusted.

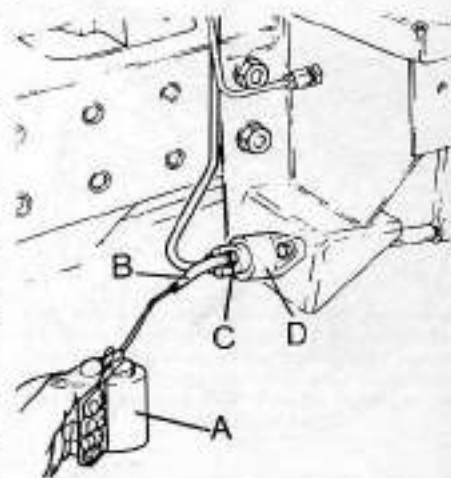


Fig. 136 - Use pressure oil can (A) connected to air screw (C) of slave cylinder (D) by flexible tube (B) to bleed air from clutch hydraulic system.

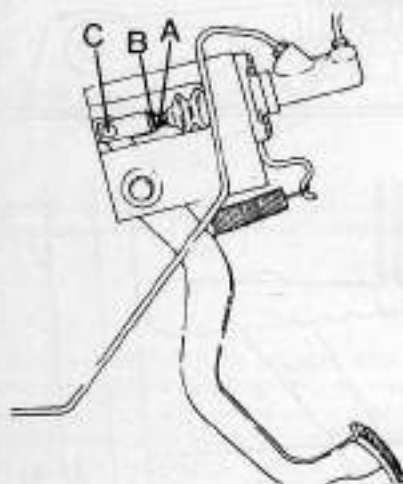


Fig. 137 - Remove pin (C) from rod (A) and loosen locknut (B) and adjust master cylinder as outlined in paragraph 241.

## REMOVE AND REINSTALL CLUTCH

### Models 1190-1290-1390-1490 Without Cab Or Flat Deck

242. Disconnect battery and remove muffler and precleaner. Open engine cover and remove the two upper bolts at rear supports and push cover forward. Disconnect wires from fuel tank sending unit and necessary fuel lines and leak-off reservoir and remove fuel tank. Disconnect steering lines and cap openings. Remove the three starter retaining bolts and tachometer drive cable. Remove engine speed control pedal to gain access to top right-hand side frame bolt. Disconnect transmission and pto linkage at cross-shaft under foot plate. Disconnect engine stop and throttle control rods. Remove bolts holding gear box cover to clutch cover on 1190, 1290 and

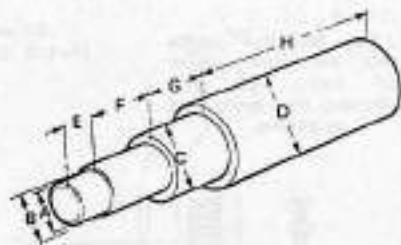


Fig. 139 - When installing Borg and Beck clutch use a pilot shaft made to dimensions shown.

A. 22.25 mm  
(0.874 in.)  
B. 23.24 mm  
(0.915 in.)  
C. 36.07 mm  
(1.420 in.)  
D. 44.98 mm  
(1.771 in.)

E. 15.88 mm  
(0.625 in.)  
F. 28.10 mm  
(1.1 in.)  
G. 44.45 mm  
(1.750 in.)  
H. 127 mm  
(5.0 in.)

1390 models only and remove bolts holding clutch cover to engine and frame. On models with manual steering disconnect drag link.

On 1490 models remove both footplates, disconnect fuel tank filler pipe and air balance pipe. Disconnect all necessary brake and clutch lines and linkage. Disconnect left-hand steering line at center connection and remove upper portion.

Remove front drive shaft and axle breathers on four wheel drive models.

On models having front mounted hydraulic pumps drain transmission, 42 L (44 qts.) and disconnect hydraulic pump inlet and outlet lines.

On all models support front section with a suitable wheeled stand and place wedges on both sides between axle beam and frame. Place stationary support under rear section. Remove all front to rear frame bolts noting that two lower bolts cannot be completely removed, engage pto and roll front section forward 25 mm (one inch). Remove clutch cover, wedge and shims.

On 1290 and 1390 models with independent clutch remove left-hand trunion pin.



Fig. 138 - Use transit staples (A) to retain release levers as shown. Do not use soft wire or welding rod as they will not retain pressure of release levers and may break, come off and cause injury.

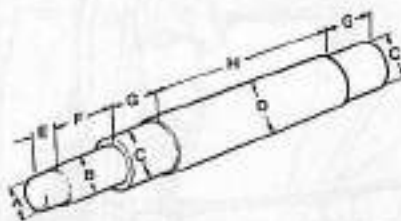


Fig. 140 - When installing Laycock clutch in 1190, 1290, 1390 and 1490 models use a pilot shaft made to dimensions shown.

A. 22.25 mm  
(0.874 in.)  
B. 23.17 mm  
(0.912 in.)  
C. 38.10 mm  
(1.50 in.)  
D. 74.93 mm  
(2.95 in.)

E. 19.05 mm  
(0.75 in.)  
F. 50.86 mm  
(2.00 in.)  
G. 38.10 mm  
(1.50 in.)  
H. 152.4 mm  
(6.0 in.)

## CASE (DAVID BROWN)

On all models make certain all parts are disconnected and roll front section forward.

243. **BORG AND BECK CLUTCH ASSEMBLY REMOVAL.** Mark pressure plate to flywheel position for reassembly and place a 7/16-inch nut under each release lever and remove cap screws retaining clutch assembly to flywheel. Remove pressure plate and clutch disc. Mark separator plate to flywheel position for reassembly and remove separator plate and inner clutch disc. Remove the three springs from flywheel. To reinstall refer to paragraph 245.

244. **LAYCOCK CLUTCH ASSEMBLY REMOVAL.** Mark pressure plate to flywheel position for reassembly. Install transit staples (A - Fig. 138) on pto release levers.

**CAUTION:** Obtain transit staples from J. I. Case dealer or V. L. Churchill Limited, Churchill tool number 86308. Do not make staples from soft wire or welding rod as they will not retain pressure of release levers and may break, come off and cause injury.

Loosen bolts fastening clutch assembly to flywheel evenly to prevent any distortion and remove clutch assembly.

**NOTE:** Clutch assembly is very heavy, use caution to prevent dropping.

245. **REINSTALLATION.** Using appropriate clutch alignment tool (Fig. 139 or 140) to correctly position clutch discs, install by reversing removal procedure. Tighten clutch assembly to flywheel retaining bolts to 27 N·m (20 ft.-lbs.) torque on Borg and Beck clutches and 40 N·m (30 ft.-lbs.) torque on Laycock clutches.

### Model 1690

246. **REMOVE AND REINSTALL.** Remove muffler and precleaner. Use square wrench supplied with tractor and open engine cover until locked in position. Disconnect battery ground cable and drain transmission.

Drain cooling system, if equipped with cab heater.

On left-hand side of tractor disconnect engine throttle linkage at cross-shaft and hand throttle linkage at center of cross-shaft. Disconnect engine stop control at fuel injection pump and remove front portion of rod. Disconnect steering line at connection forward of clutch housing and remove steering line clamp from engine back plate. Disconnect wiring harness at main plug connection and remove throttle cross-shaft bracket



from clutch housing. Disconnect heater hoses (if so equipped) and fuel return line. Disconnect hydraulic inlet pipe at rubber joint on inlet filter housing.

On right-hand side of tractor remove starter and throttle cross-shaft bracket from clutch housing. Disconnect throttle linkage and return spring.

On cab of flat deck models disconnect the three steering lines at flexible pipe connections forward of cab and remove pipe clamp.

On non-cab models remove the three steering lines and disconnect fuel line at lift pump. Disconnect tachometer drive cable.

Support front and rear sections with stands suitable for separating tractor and place wedges between front axle beam and front frame (remove axle vents on front axles of front wheel drive models).

Remove front drive shaft on front wheel drive models.

On all models engage pto selector lever, lift front of rubber mat and remove plate from front lower part of floor. Remove bolts retaining top of clutch housing to engine and bolt from front left-hand side of clutch housing which is fitted through engine back plate behind left-hand steering line. Remove all bolts and nuts retaining front and rear frames together. Roll front section forward carefully making sure all connections are disconnected.

Remove clutch assembly as outlined in paragraph 244.

Using appropriate clutch alignment tool (Fig. 141) to correctly position clutch discs, install by reversing removal procedure. Tighten clutch assembly to flywheel retaining bolts to 40 N·m (30 ft.-lbs.) torque.

## OVERHAUL CLUTCH

### Borg And Beck Clutch Assembly

247. Mark clutch pressure plate to inner housing position and release lever to pressure plate lug position for reassembly.

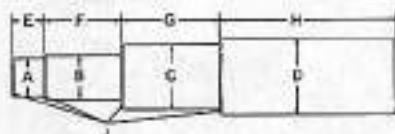


Fig. 141 - Use a pilot shaft made to dimensions shown when installing clutch assembly in 1690 models.

A. 22.29 mm (0.874 in.)	F. 44.9 mm (1.74 in.)
B. 25.552-25.854 mm (1.006-1.010 in.)	G. 50.86 mm (2.00 in.)
C. 40.107-40.583 mm (1.583-1.596 in.)	H. 191.5 mm (7.5 in.)
D. 44.467-44.547 mm (1.749-1.754 in.)	J. 15 degrees by 1.5 mm (0.06 in.)
E. 19.65 mm (0.774 in.)	

bly in original positions and remove springs (20 - Fig. 142), then remove release lever actuating plate (14). Remove adjusting screws (16).

**NOTE:** Following procedure for clutch overhaul assumes shop is not equipped with special David Brown clutch fixture K-912817. If special fixture is available disregard following procedure and use the special tool for disassembly, reassembly and adjustment of clutch as outlined in instructions furnished with tool kit.

Remove engine flywheel and place flywheel on bench with clutch friction surface up. Bolt clutch assembly on flywheel with plates (3, 4 and 5 - Fig. 142) properly positioned using long stud bolts and nuts instead of regular clutch cover retaining cap screws. Tighten nuts equally until cover is tight against flywheel removing 7/16-inch nuts placed under release levers during removal of clutch assembly as stud nuts are tightened. Remove pins (23) from levers catching needle roller bearings (24) as each pin is removed. Taking care studs do not turn, evenly loosen stud nuts until clutch springs are free. Then, remove studs and nuts and disassemble clutch unit. Remove snap ring (13) and bearing (12).

Check release levers for wear on tips of fulcrum points and renew as needed. Check all clutch springs and renew if rusty, discolored or weak. Spring specifications are as follows:

**Transmission Clutch Outer Spring -**  
Part Number ..... 902512  
Color ..... Brown  
Test at ..... 66.04 mm (2.60 inches)  
556 N (125 lbs.)

**Transmission Clutch Inner Spring -**  
Part Number ..... 928922  
Color ..... Red  
Test at ..... 35.8 mm (1.41 inches)  
601 N (135 lbs.)

**Pressure Plate Spring -**  
Part Number ..... 902513  
Color ..... Brown  
Test at ..... 66.04 mm (2.60 inches)  
356-378 N (80-85 lbs.)

**Pto Clutch Spring -**  
Part Number ..... 902514  
Color ..... Pink  
Test at ..... 57.4 mm (2.26 inches)  
521 N (117 lbs.)

Inspect pressure plate for cracks or discoloration. Light scores may be removed by resurfacing, however maximum amount of material removed must not exceed 0.381 mm (0.015 inch).

If separator plate shows wear only on transmission side further life may be obtained by reversing separator plate. If separator plate is scored or cracked it may be resurfaced providing amount of material removed does not exceed 0.762 mm (0.030 inch) total for both sides.

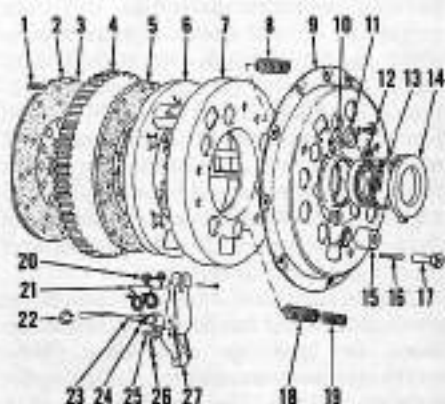


Fig. 142 - Exploded view of Borg and Beck continuous type clutch showing component parts and their relative positions.

- |                               |                                       |
|-------------------------------|---------------------------------------|
| 1. Flywheel spring            | 15. Spring cover                      |
| 2. Dowel                      | 16. Adjusting screw                   |
| 3. Driven plate, pto          | 17. Lockout                           |
| 4. Separator plate            | 18. Thrust spring, transmission outer |
| 5. Driven plate, transmission | 19. Thrust spring, transmission inner |
| 6. Pressure plate             | 20. Retainer spring                   |
| 7. Inner cover                | 21. Spring, anti-rattle               |
| 8. Thrust spring, pto         | 22. Retainer ring                     |
| 9. Outer cover                | 23. Pin                               |
| 10. Shim                      | 24. Needle roller bearing             |
| 11. Adjusting pad             | 25. Pin, release lever                |
| 12. Bearing                   | 26. Cotter pin                        |
| 13. Snap ring                 | 27. Release lever                     |
| 14. Release lever plate       |                                       |

Make certain separator plate is a free sliding fit in flywheel teeth. A tight plate will cause power take-off clutch spin and a very loose plate may rattle when pedal is fully depressed. A rattle in separator plate is not detrimental to clutch operation.

Install pressure plate into inner and outer covers and check side clearance

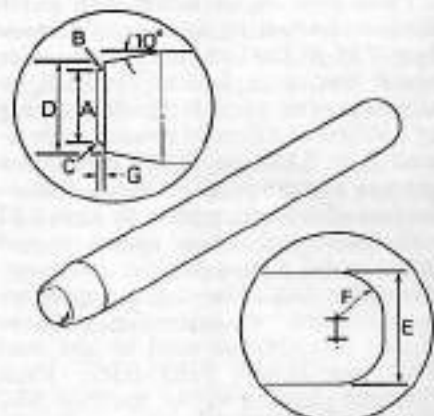


Fig. 143 - A swage tool must be made from silver steel with approximately 1 percent carbon to dimensions shown. Heat treat tool by heating until bright red and cooling in oil. Polish spigot end and heat until steel is purple color. Let cool naturally by air.

A. 11.11 mm (0.438 in.)	E. 15.65 mm (0.75 in.)
B. 1.016 mm (0.040 in.)	F. 7.93 mm (0.312 in.)
C. 0.635 mm (0.025 in.)	G. 1.65 mm (0.065 in.)
D. 15.47 mm (0.609 in.)	

## Paragraph 248

between pressure plate lugs and their respective slots in cover. Side clearance must be 0.152-0.305 mm (0.006-0.012 inch). Cover slot clearance may be increased by filing and slots should be filed smooth if wear is light. If slots are filed to increase clearance, adjusting screw holes must be enlarged in outer cover to 17.5 mm (11/16-inch) to prevent locknuts from interfering with outer cover and breaking adjusting screws.

Check threaded bushings in inner cover and renew bushings if threads are worn or bushings are loose. New bushings are available under part number 962449. New bushings have a 5/16-inch UNF thread instead of 1/4-inch UNF threads as old bushings had and all bushings must be renewed together to maintain balance. A swage tool must be made as shown in Fig. 143 to install new bushings. Drill out old bushings using 12.7 mm (1/2-inch) diameter drill. Countersink bushing holes on outside of cover to 15.48 mm (39/64-inch) diameter at an angle of 90 degrees. Press bushings in from inside cover until bushing shoulder is pressed tight against cover. Turn cover over, support bushing on an anvil and flare hollow end of bushing using round end of swage tool. Reverse tool and use spigot end to firmly swage bushing into position. Align end of bushing with outside face of cover using a smooth file.

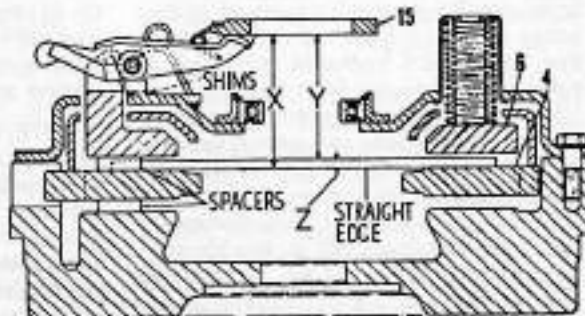
Cover and bushing must be supported on anvil during swage operation and a press capable of at least 45 kN (five ton) capacity must be used.

Check push off springs (1 - Fig. 142) and make certain drive plates slide freely on shaft splines.

Place flywheel on bench with clutch friction surface up and equally space four 7.87 (0.310 inch) thick spacers on clutch friction surface of flywheel. Install separator plate in flywheel on top of 7.87 mm (0.310 inch) spacers, then install four 8.87 mm (0.349 inch) thick spacers of transmission clutch friction surface of separator plate so each 8.87 mm (0.349 inch) thick spacer is just above each 7.87 mm (0.310 inch) spacer. See Fig. 144. Place a straightedge across center of separator plate as shown; straightedge must be less than 8.87 mm (0.349 inch) thick. Place pressure plate on top of the four 8.87 mm (0.349 inch) thick spacers.

Place clutch inner cover down over release lever lugs on pressure plate and insert the six outer (large) transmission clutch springs through holes of inner cover. Insert inner springs inside outer springs. Place the six pto clutch springs on bosses of inner cover, then place spring cups over springs. Carefully place clutch cover down over spring cups and lugs of pressure plate. Turn assembly as necessary so clutch cover bolt and dowel

**Fig. 144—Cross-sectional view showing placement of spacers and straightedge for assembly adjustment of clutch. Add thickness (Z) of straightedge to measurement (Y) to obtain release lever height (X). Vary shims at location shown to adjust lever height to dimensions outlined in text. Refer to Fig. 142 for numerical legend.**



pin holes are aligned with flywheel, taking care spacers and straightedge are not moved out of proper position. Insert long studs through cover bolt holes into flywheel, then install and evenly tighten stud nuts until cover flange is tight against flywheel.

Install needle roller bearings and roller into each release lever and install release levers, anti-rattle springs, release plate and springs. Using a press, or some other means, actuate release levers six times to be certain release linkage is seated. Take care spacers and straightedge are not dislodged.

Referring to Fig. 144, measure distance (Y) between lower face of release plate (15) and top of straightedge. This measurement added to thickness (Z) of straightedge gives clutch release lever setting (X) which should be 84.96 mm (3.345 inches) on 1190 models and 77.34 mm (3.045 inches) on 1290 and 1390 models. Shims (10 - Fig. 142) are added between clutch cover and release lever stops (11) to increase release lever setting or removed to decrease setting. Shims are available in thicknesses of 0.05, 0.07, 0.25 and

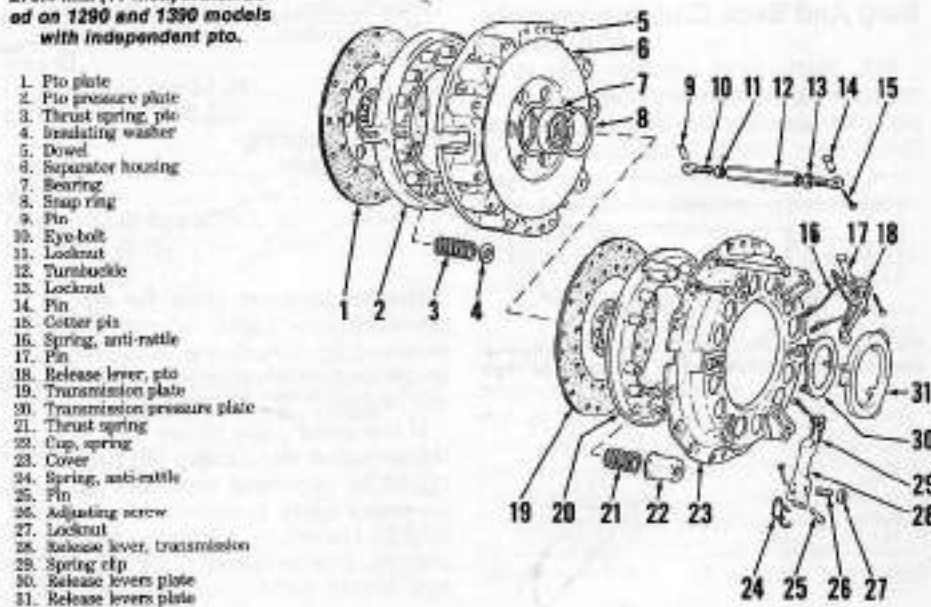
0.50 mm (0.002, 0.003, 0.010 and 0.020 inch). A variation of 0.05 mm (0.001 inch) in shim pack thickness will change release lever adjustment approximately 0.1143 mm (0.0045 inch). Take release lever measurement at each lever and adjust all levers to as near equal height as possible.

With release lever stops correctly shimmed, place 7/16-inch nuts between outer ends of release levers and clutch cover, then loosen stud nuts until spacers (7/16-inch nuts) take up spring tension. Remove stud nuts and studs and catch the eight spacers and straightedge. Install flywheel and clutch assembly as outlined in paragraph 245.

## Models 1290-1390 With Independent Pto

248. With clutch removed, remove engine flywheel and place flywheel on bench with clutch friction surface up. Place pto friction disc on flywheel then install clutch assembly on flywheel using nine 5/16-inch UNC x 7 inch long stud bolts, flat washers and nuts. Remove the six cap screws retaining clutch cover to

**Fig. 145—Exploded view of 279.4 mm (11 inch) clutch used on 1290 and 1390 models with independent pto.**





separator housing, disconnect pto release levers (18—Fig. 145) from eye bolts and disconnect transmission clutch release levers (28) from lugs on transmission clutch pressure plate. Hold stud bolts from turning while evenly loosening stud nuts. When free of all spring pressure remove nuts and disassemble clutch.

Transmission clutch friction disc thickness (new) is 8.89 mm (0.350 inch) and pto friction disc thickness (new) is 8.13 mm (0.320 inch). Check clutch springs against the following specifications:

<b>Transmission Clutch Springs—</b>	
Part Number (Standard Duty)	625262
Color	Violet/Black
Test at	42.93 mm (1.69 inches)
	668 N (150 lbs.)
Part Number (Heavy Duty)	625211
Color	Buff/Black
<b>Pto Clutch Spring—</b>	
Part Number	625209
Color	Red
Test at	35.81 mm (1.41 inches)
	583-623 N (131-140 lbs.)

Reassemble clutch with new parts as required by reversing disassembly procedure. After clutch is fully assembled on flywheel, adjust transmission release lever adjusting screws so face of release plate (30—Fig. 145) is 132.46-136.78 mm (5.215-5.383 inches) from face of flywheel. Adjust pto clutch links so pto release plate (31) face is 159.26-161.80 mm (6.27-6.37 inches) from face of flywheel. Be sure linkage locknuts and clutch cover to separator housing cap screws are tight, then remove clutch from flywheel. Install flywheel on engine crankshaft and reinstall clutch.

### Laycock Clutch Assemblies

249. With clutch assembly removed, remove engine flywheel and place flywheel on a bench with clutch friction surface up. Place pto clutch disc (1—Fig.

146) in flywheel, then bolt clutch assembly to flywheel. Mark clutch cover and both pressure plates so clutch can be reassembled with parts in same position to maintain balance. Remove transit staples installed during removal of clutch. Remove pto release lever pins (22—Fig. 146) and anti-rattle springs (21), then swing pto release levers (20) outward beyond clutch cover. Remove transmission release lever pins (17) and pull springs (14) out until they clear holes in release plate (9). Then, lift release plate from levers (15) and complete removal of levers with rollers (16). Loosen bolts retaining clutch to flywheel evenly until all spring pressure is relieved, then remove locknuts using an Allen wrench and remove adjusting screws (13). If necessary, complete removal of retaining bolts and separate clutch assembly while noting position of Belleville washer (3) and insulators (11). Links (18) can be removed from pto pressure plate (2), if necessary, and note holes in links are offset toward center of clutch.

Check all pivot holes, release levers, adjuster screws and lever thrust plate for wear. Check pressure plates for distortion, heat cracks and scoring. Make certain friction surface is flat. Transmission pressure plate minimum thickness is 24.55 mm (0.966 inch). Any or all of these components may be machined providing total maximum material removed does not exceed 1.02 mm (0.040 inch) and minimum thickness and maximum depths are maintained.

Check side clearance between lugs of pressure plate and slots in cover. Clearance should be 0.254-0.457 mm (0.010-0.018 inch). Check thrust springs against the following specifications:

Part Number	K-951917
Color	Pink
Free Length	38.35 mm (1.51 inches)
Test at	35 mm (1.38 inches)
	396-409 N (89-92 lbs.)

Check Belleville spring against the following specifications:

Part Number	K-952509
Free Height	10.13-9.80 mm (0.399-0.388 inch)
Test at	4.85 mm (0.191 inch)
	5696-6453 N (1280-1450 lbs.)

Check all bearings for smoothness of operation, fit in bores or damage. Renew as needed.

With flywheel on bench, clutch friction surface up, place pto clutch disc (1—Fig. 146) in flywheel with long hub toward flywheel. Place pto pressure plate (2) on pto clutch disc with friction face down and install insulating washers (11) and pressure springs (10). Place Belleville spring on pressure plate with concave side up (outside diameter higher than inside diameter).

**NOTE:** Belleville spring is located only by recesses in pressure plate.

Assemble pto levers (20—Fig. 146) and links (18) making certain links are installed to pto pressure plate with offset of holes toward center of clutch. Place remaining insulating washers (11) in spring seats of pressure plate (4). Then, while aligning previously made alignment marks, set pressure plate (4) on pressure springs. Make certain all springs (10) are on insulating washers (11). Place transmission disc (5) on pressure plate (4) with dished hub toward pressure plate. Insert appropriate pilot shaft through both clutch discs and into pilot bearing in flywheel. Install bearing (7) in cover (6), align locating marks and install cover over pressure plates. Insert retaining bolts in their holes turning assembly as necessary to align bolts with correct holes in flywheel. Tighten bolts using a criss-cross pattern until pto release levers (20) and springs (21) can be installed in cover.

**NOTE:** While tightening bolts it is essential no binding occurs between pressure plate lugs and clutch cover and that Belleville washer is correctly seated in recess of transmission pressure plate. Belleville washer can be seen through ventilation slots in cover.

With pto levers and springs installed continue to tighten cover bolts until cover is tight against flywheel, then remove pilot tool. Install adjusting screws (13), but do not tighten. Assemble rollers (16) in transmission release levers (15), position levers in cover, then position release lever plate (9) over release levers so ends of plate enter cut-outs in ends of release levers. Push long ends of springs (14) into levers (over roller) and insert end of springs into holes in ends of release plate. Align spring loops, holes in release levers and

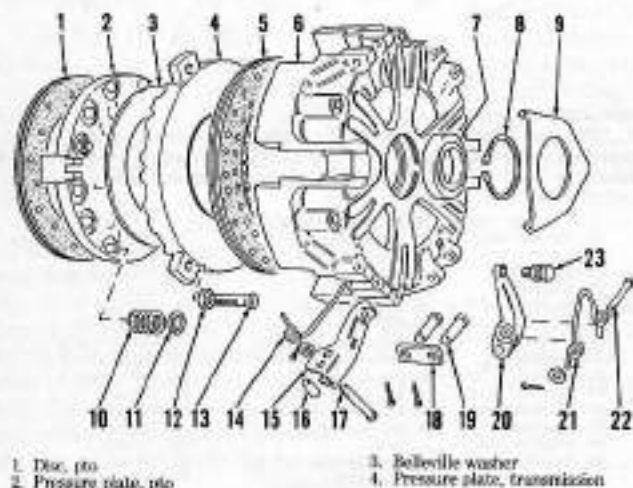


Fig. 146—Exploded view of Laycock double disc clutch showing component parts and their relative positions.

5. Disc, transmission
6. Clutch cover
7. Bearing
8. Snap ring
9. Release lever plate
10. Thrust spring
11. Insulating washer
12. Locknut
13. Adjusting screw
14. Spring, anti-rattle
15. Release lever, transmission
16. Roller
17. Pin
18. Link
19. Pin
20. Release lever, pto
21. Spring, anti-rattle
22. Press pin
23. Adjusting bolt

1. Disc, pto
2. Pressure plate, pto
3. Belleville washer
4. Pressure plate, transmission

holes in cover, install pins (17) and secure with washers and cotter pins.

While clutch is still mounted on flywheel adjust release levers (20) by turning adjusting screws (23) while holding release levers down until distance from adjusting screw to face of flywheel is 130.18 mm (5.125 inches), then tighten locknut. Hold down firmly on release lever plate and using square end of adjusting screw (18), turn adjusting screw as required until distance from flywheel face to release plate is 104.84 mm (4.125 inches). Then, tighten locknut.

Be sure each set of levers are adjusted equally and install transit staples to pto levers to ensure Belleville washer does not slip when removing clutch flywheel or during subsequent handling.

With release levers adjusted and transit staples installed on pto release levers, remove clutch assembly from flywheel. Install flywheel on crankshaft and install clutch as outlined in paragraph 245 or 247.

assembly end plates. Refer to transmission overhaul procedure for removal and assembly of shift rods and forks.

## REMOVE AND REINSTALL TRANSMISSION

### Models 1190-1290-1390

**251. REMOVE.** Remove muffler, pre-cleaner, engine side covers and engine cover. Remove throttle hand and foot control rods and return springs. Disconnect fuel lines, necessary power steering lines, tachometer drive cable and all necessary electrical connections to remove fuel tank and instrument panel. Remove retaining bolts from instrument panel and fuel tank and remove.

If equipped with platform or cab, remove as outlined in paragraph 415 or 416.

On all models remove remote valve couplers, hoses and bracket. Disconnect draft sensing cable at upper link connection. Remove drawbar support and drain transmission.

On 1190 and 1290 models, remove

vacuum switch from bottom of pto housing.

On all models attach a hoist to pto housing, remove retaining bolts and install two guide studs. Slide housing back on studs and remove. Remove steering cylinder bracket, if so equipped, and pto drive shaft.

**252.** On 1190 and 1290 models remove hydraulic pump, bolts from bracket on pressure line and pump support plate.

On all models, support each side of tractor and raise back end and support at center. Remove left and right tires, wheels and final drive assemblies. Remove brake assemblies, right-hand seal, differential lock sleeve and spring. Remove transmission dipstick and transmission and range selector lever assemblies from cover. Remove mounting bolts from transmission cover and rear axle case. Remove wedge and shim from in front of transmission cover and remove cover.

**253.** Disconnect differential lock and hand brake linkage. Connect hoist to

## TRANSMISSION

All models with synchromesh transmission have a three forward and one reverse gear section and a four speed range section providing twelve forward and four reverse gear choices. A synchromesh hub between second and third gear permits on the move gear shifts from first to second, second to third and a down shift on the move from third to second by depressing foot clutch and shifting.

Power shift is available on 1490 and 1690 models and consists of a three forward, one reverse mechanical gear section coupled with a four speed power shift section providing twelve forward and four reverse speed choices. Front four speed planetary section is hydraulically controlled and changes between any of the ratios can be made while tractor is in motion without use of transmission clutch or engine speed change. Gear (range) speeds are selected in conventional manner and transmission clutch must be used.

### SHIFT LEVERS

#### All Models

**250.** Transmission or range selector lever (Fig. 147) assemblies may be removed as separate units from transmission top cover. Models equipped with platforms or cabs vary in construction, however basic design is similar to 1190, 1290 and 1390 models shown in Fig. 147.

Shift rods are carried in transmission

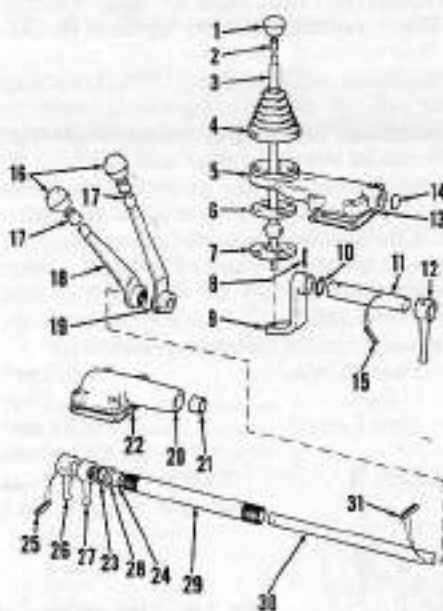


Fig. 147—Exploded view of range and transmission selector levers for 1190, 1290 and 1390 models. Platform and cab equipped Models 1490 and 1690 are similar.

- |                       |                    |
|-----------------------|--------------------|
| 1. Knob               | 17. Retainer ring  |
| 2. Retaining ring     | 18. Lever          |
| 3. Lever              | 19. Lever          |
| 4. Boot               | 20. Housing        |
| 5. Housing            | 21. Housing        |
| 6. Ball housing       | 22. Gasket         |
| 7. Ball housing       | 23. Snap ring      |
| 8. Ball pin           | 24. Bushing        |
| 9. Selector shaft arm | 25. Roll pin       |
| 10. Oil seal          | 26. Selector lever |
| 11. Selector shaft    | 27. Selector lever |
| 12. Selector lever    | 28. Washer         |
| 13. Gasket            | 29. Selector tube  |
| 14. Core plug         | 30. Selector shaft |
| 15. Roll pin          | 31. Roll pin       |
| 16. Knob              |                    |

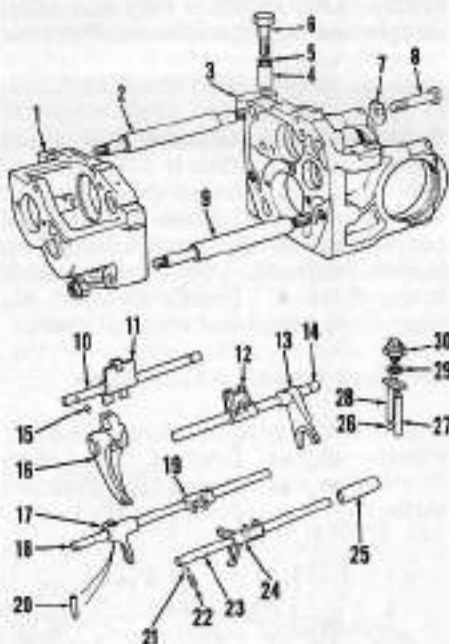


Fig. 148—Exploded view showing end plates, shift rods and shift forks used on 1190, 1290 and 1390 models. Models 1490 and 1690 are similar.

- |                              |                           |
|------------------------------|---------------------------|
| 1. Front end plate           | 14. 2nd & 3rd shift fork  |
| 2. Top spacer bar            | 15. Shift fork            |
| 3. Rear end plate            | 16. Slow/normal shift rod |
| 4. Bushing                   | 17. Selector              |
| 5. Shim                      | 18. Roll pin              |
| 6. Mounting bolts            | 19. Detent ball           |
| 7. Tab washer                | 20. Detent spring         |
| 8. Differential cap bolt     | 21. Range shift rod       |
| 9. Bottom spacer bar         | 22. Shifter fork          |
| 10. 2nd & 3rd shift rod      | 23. Sleeve                |
| 11. 2nd & 3rd selector       | 24. Steel ball            |
| 12. 1st & reverse selector   | 25. Flange                |
| 13. 1st & reverse shift fork | 26. Flange                |
| 14. 1st & reverse shift rod  | 27. Shim                  |
| 15. Gear lock                | 28. Safety start switch   |



rear housing, remove retaining bolts and remove rear housing assembly from main frame.

Remove lubrication line from transmission. Remove mounting bolts (6—Fig. 148) and bushings (4) from transmission, correct hoist just ahead of differential assembly, remove retaining bolts from front bearing carrier and remove transmission assembly.

**254. REINSTALLATION.** Clean all foreign material from gasket and mating surfaces. Using a hoist, install transmission in main frame. Install mounting bolts (6—Fig. 148) and bushings (4) and tighten bolts to 163 N·m (120 ft.-lbs.) torque. Using a feeler gage measure gap between end plate (3) and lower face of mounting bolts (6) head as shown in Fig. 149. Correct clearance is 0.0762-0.5080 mm (0.003-0.020 inch) and is determined by number and thickness of shims (5) between mounting bolt (6) and spacer (4). Apply silicone base sealer to "O" ring on support sleeve and install sleeve retaining bolts. Tighten to 23-27 N·m (17-20 ft.-lbs.) torque. Apply gasket sealer to front mating surface of rear axle assembly and using a hoist, install assembly. Tighten 1/2-inch mounting bolts to 108-130 N·m (80-96 ft.-lbs.) torque and 5/8-inch mounting bolts to 203-244 N·m (150-180 ft.-lbs.) torque. Connect differential lock linkage and brake rod adjusting and locking nuts.

On 1190 and 1290 models, install pump support plate and gasket.

**255.** On all models apply gasket sealer to upper surface of rear axle housing, install lubricating line and transmission cover and gasket. Install all side and rear cover bolts, but do not tighten. Drive wedge and shim into gap at front of cover and install cover front bolts. Tighten rear, then side and front cover mounting bolts to 108-130 N·m (80-96 ft.-lbs.) torque and push new sealing strips into each side in front of transmission cover.

**256.** On 1190 and 1290 models install hydraulic line bracket and mounting bolts, "O" ring and hydraulic pump. Connect intake tube and tighten pump mounting bolts to 48-57 N·m (35-42 ft.-lbs.) torque and install lubricating line bracket.

On all models, install spring for differential lock in right side axle opening and install differential locking sleeve using special tool (CAS-1633). Wire differential lock pedal down until final drive is installed. Install left and right axle housing seals and brake shoes. Install final drive assemblies and tighten mounting bolts to 68 N·m (50 ft.-lbs.) torque. Connect parking brake linkage

and install tires and wheels. Tighten wheel nuts to 190 N·m (140 ft.-lbs.) torque and remove all stands and supports. Install steering cylinder bracket (if so equipped).

**257.** Install guide studs and new gasket on rear mounting face of differential housing. Install pto drive shaft using care not to damage oil seals. Place pto in gear and using a hoist install pto housing assembly, turning pto shaft during installation to engage pump gear. Remove guide studs, install mounting bolts and tighten to 102 N·m (75 ft.-lbs.) torque.

On 1190 and 1290 models install "O" ring on vacuum switch, lubricate and install switch and gasket.

On all models install drawbar support brackets and drawbar, then connect draft sensing cable. Install remote hoses, couplers and brackets. Install transmission dipstick and range and transmission gear selector lever assemblies. Tighten mounting bolts to 23-27 N·m (17-20 ft.-lbs.) torque. Install fuel tank, instrument panel and make all necessary connections. Connect supply lines to power steering control valve, if so equipped, then connect throttle linkage and return spring. Install engine cover, cab or platform as equipped, engine side covers, muffler and pre-cleaner.

Change transmission filter, fill transmission with specified fluid and adjust brakes.

#### **Models 1490-1690**

**258. REMOVE.** Remove cab or platform as outlined in paragraph 415 or 416. Remove fuel tanks and drain transmission. Disconnect all hydraulic hoses and lines from remote valve and remove remote valve assembly. Disconnect the two hydraulic oil line couplings at right side of frame. Remove support bracket, remote couplers and hoses. Remove cable from draft sensing unit. Remove oil filter housing and oil lines. Remove check chains from drawbar support bracket, stabilizer bars, lift links and lift arms. Remove hitch plates from pto housing noting thickness and location of shims. Connect a hoist to each side of pto assembly. Remove pto housing mounting bolts, installing two guide studs and remove pto housing. Remove pto shaft.

**259.** Lift and support rear of tractor so tires are off ground. Install support stand on each side of tractor.

Remove rear tires and wheels and cab or platform supports and attach a hoist to final drive. Disconnect brake lines and cap openings. Remove left and right final drive assemblies.

On 1490 models, push differential lock sleeve in and down to disengage from selector fork and remove sleeve and spring.

On 1690 models use two pry bars, going through axle housing rear opening and move differential lock return spring out of differential and into lock sleeve. Spring and sleeve must be completely disconnected from differential so rear axle housing can be removed.

Remove transmission and range selector assemblies and transmission cover bolts. Remove wedge and shims between transmission cover and clutch housing. Note number and thickness of shims. Use a hoist and remove cover. Remove transmission lubrication line. Attach a hoist to axle housing, remove mounting bolts and housing. Remove differential lock return spring and lock sleeve from inside rear axle housing of 1690 models.

**260.** On all models, remove snap ring from groove in clutch shaft and move coupling forward.

On 1490 models equipped with David Brown front drive axles, remove self-locking nut (39—Fig. 30) and bolt (37) and move coupler rearward toward transmission.

On all models, remove neutral start plunger (27 and 28—Fig. 148) and steel ball (26) from each plunger hole. Attach a hoist to transmission just ahead of differential and remove mounting bolts and bushings. Remove transmission from frame.

Remove transfer gear box coupling from transmission output shaft on models equipped with front drive axles.

**261. REINSTALLATION.** Clean all foreign material from gasket and mating surfaces.

On models equipped with David Brown front drive axles install transfer gear box drive coupler with end having smaller outside diameter end toward transmission.

On all models, use a hoist and install transmission. Install transmission mounting bolts only, leave bushings (4—Fig. 148) off. Tighten bolts to 163 N·m (120 ft.-lbs.) torque and check to see that both front housing lugs are in contact with frame.

If front housing lugs do not contact frame loosen all four transmission housing self-locking nuts and push transmission housing down to frame. With both front housing lugs contacting frame tighten housing self-locking nuts to 95 N·m (70 ft.-lbs.) torque.

Remove transmission mounting bolts and install bushings. Reinstall bolts and tighten to 163 N·m (120 ft.-lbs.) torque. Using a feeler gage check clearance between mounting bolt head and rear hous-

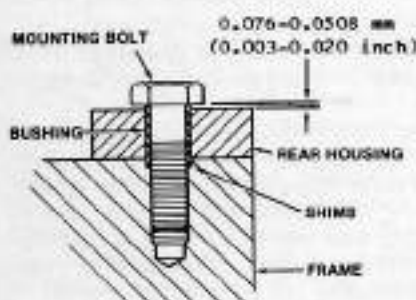


Fig. 149—View showing gap of 0.0762-0.508 mm (0.003-0.020 inch) between mounting bolt and rear housing. Clearance is determined by number and thickness of shims.

ing surface as shown in Fig. 149. Clearance should be 0.0762-0.5080 mm (0.003-0.020 inch) and is determined by number and thickness of shims.

Slide clutch shaft coupling onto input gear and install snap ring in groove on clutch shaft. Measure clearance between clutch shaft coupler and snap ring and add or subtract shims until proper space of 0.203-1.016 mm (0.008-0.040 inch) is reached. See Fig. 150.

On models equipped with David Brown front drive axles, push transfer gear box coupler forward and install bolt (39—Fig. 30) and self-locking nut (37).

On models equipped with Carraro front drive axles, adjust transfer gear box shaft to transmission drive coupler clearance as outlined in paragraph 42.

On all models, install transmission lubrication lines and place one steel ball in each neutral start switch plunger hole. Install plungers for neutral start switch.

Apply gasket sealer around each hole and down center of transmission mounting flange.

On 1690 models, install differential lock sleeve into right-hand side of rear axle housing. Groove in differential lock sleeve must be aligned with differential lock selector fork inside housing.

On all models, install rear axle housing to transmission housing making certain lubrication supply tube in axle assembly

is connected with transmission lubrication tube in transmission case.

**NOTE:** On 1690 models, make certain small diameter lubrication tube in rear axle housing is installed into small hole in lubrication flange for pto shaft.

On all models install mounting bolts and nuts as guide studs are removed, but do not tighten excessively at this time.

On 1690 models, install one end of differential lock return spring into right-hand side of differential assembly and compress and install remaining end into differential lock sleeve. Insert special tool CAS-1633 into right-hand side of rear axle housing so it engages internal splines of differential lock sleeve. Lift sleeve and engage with differential lock gear ring by turning tool. Outer groove in sleeve must be engaged with differential lock selector fork. Look through right-hand rear side of axle housing and make certain sleeve is engaged with selector fork. Wire differential lock linkage in engaged position and remove tool.

On 1490 models, install differential lock return spring into carrier cover through axle hole in right side of axle housing. Place special tool CAS-1633 into internal splines of differential lock sleeve and insert through axle hole in right side of axle housing. Push sleeve in and down with tool and engage fork with groove on sleeve. Push sleeve in until it engages internal splines of differential carrier cover. Wire differential lock linkage in engaged position and remove tool.

On all models, tighten 1/2-inch rear axle mounting bolts to 108-130 N·m (80-96 ft.-lbs.) torque and 5/8-inch nuts and bolts to 203-244 N·m (150-180 ft.-lbs.) torque. Lubricate and install "O" rings on left and right final drive mounting flanges and install final drives, tightening mounting bolts and nuts to 108-130 N·m (80-96 ft.-lbs.) torque. Remove wire from differential lock linkage, install brake lines and cab or platform rear supports. Tighten support bolts to 203 N·m (150 ft.-lbs.) torque. Remove support stands and jacks.

Make certain all shift rods are in neutral position and install gasket and transmission top cover. Install wedge and shims between transmission cover and clutch housing, loosely install all transmission cover bolts and tighten 1/2-inch transmission to axle housing bolts to 108-130 N·m (80-96 ft.-lbs.) torque and 5/8-inch bolts to 203-244 N·m (150-180 ft.-lbs.) torque. Tighten transmission cover to frame bolts to 108-130 N·m (80-96 ft.-lbs.) torque. Drive wedge and shims down until tight and tighten bolts to 108-130 N·m (80-96 ft.-lbs.) torque.

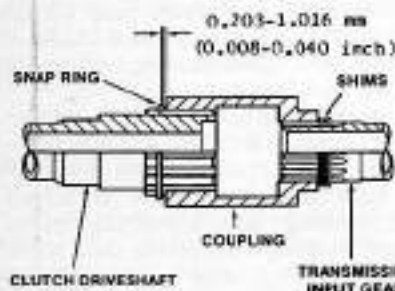


Fig. 150—View showing proper space of 0.203-1.016 mm (0.008-0.040 inch) between snap ring and coupler. Add or subtract shims until correct.

Install transmission and range selector assemblies making certain selector rods engage actuators and tighten retaining bolts to 23-27 N·m (17-20 ft.-lbs.) torque.

Inspect pto shaft and remove any burrs or sharp edges and install with larger pilot bearing diameter, ten spline end, engaging clutch. Install two guide studs in axle housing and install gasket. Place pto in engaged position and turn pto output shaft to engage splines of sliding gear as pto assembly is installed. Tighten mounting bolts to 73 N·m (54 ft.-lbs.) torque.

Install "O" rings and gasket and install remote valve assembly tightening mounting bolts to 48-57 N·m (35-42 ft.-lbs.) torque. Install "O" rings in oil line flanges and bolt line, from front pump outlet to combining valve, loosely in position. Install hydraulic oil filter housing and oil line from filter housing to combining valve, then tighten bolts. Connect coupling between oil filter line and relief valve line and coupling between combining valve line and relief valve line. Tighten couplings and tighten loosely installed bolts at front oil pump outlet on combining valve. Install cable for draft sensing unit and connect hydraulic line from rockshaft cylinder on remote valve. Connect all remote coupler hydraulic hoses and coupler support bracket.

Install drawbar hitch plates and shims, lower links, lift arms, check chains and stabilizer bars.

Clean internal inlet oil filter and fill transmission with 42 L (44 qts.) of specified fluid.

Bleed air from brake system and adjust brakes as necessary. Install fuel tanks and if equipped with platform or cab install as outlined in paragraph 415 or 416.

### Power Shift Models 1490-1690

**262. REMOVE.** Remove platform or cab, if so equipped, as outlined in paragraph 415 or 416. Remove fuel tanks and drain transmission, 42 L (44 qts.). Attach support stands on each side of tractor ahead of steps. Disconnect wiring at connector located at instrument panel just above brake pedals and remove harness bracket just below pedals. Disconnect neutral start switch and remove transmission dipstick. Remove range and power shift selector assemblies. Remove transmission cover front bolts and drive a wedge and shims from between front of cover and clutch housing. Note number and thickness of shims.

Disconnect all hoses, supply lines and linkage from remote valve assembly. Remove all bolts retaining transmission cover and use a hoist to remove cover.



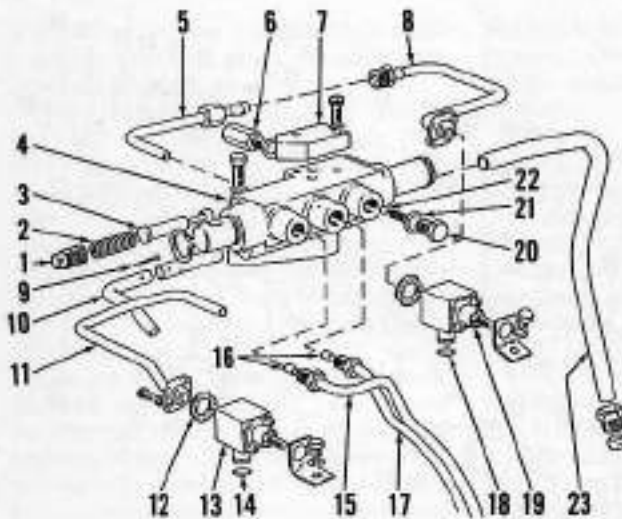


Fig. 151 - View of power shift control valve, front and rear sequence valves and related oil lines.

1. Adjusting screw
2. Spring
3. Relief valve plunger
4. Control valve
5. Pipe
6. Plug
7. Restrictor plate
8. Pipe, rear sequence
9. Cotter pin
10. Pipe, front lubrication
11. Pipe, front sequence
12. Sealing washer
13. Sequence valve
14. "O" ring
15. Pipe, front brake band cylinder
16. Restrictors
17. Pipe, rear brake band
18. "O" ring
19. Sequence valve
20. Plug
21. Defeat spring
22. Defeat ball
23. Pipe, connector to valve inlet

Disconnect all oil lines from power shift control valve (4—Fig. 151), mark sequence valves so they may be reinstalled in their original positions and remove front (13) and rear (19) sequence valves. Remove power shift control valve assembly. Remove rear lubrication line and transmission mounting bolts (6—Fig. 148) and bushings (4).

Disconnect both hydraulic lines at unions on right side of main frame. Remove draft sensor cable and hydraulic

oil filter assembly. Remove all remote coupler hoses and mounting bracket. Remove drawbar and drawbar support.

Remove pto housing mounting bolts, install two guide studs, engage pto and use a hoist to remove pto housing assembly. Remove pto drive shaft.

A connector plate (Fig. 152) must be made locally to dimensions shown and installed as shown in Fig. 153.

Connect a hoist and chain to upper front corner bolts of power shift unit,

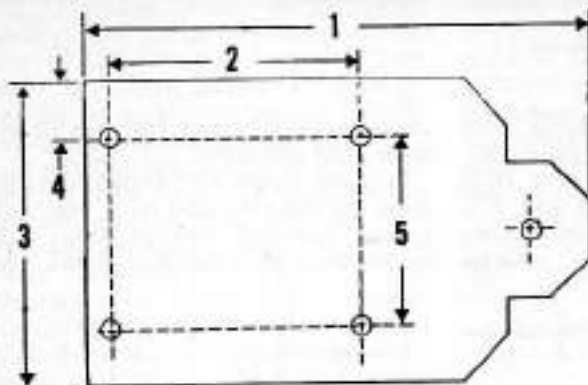


Fig. 152 - A connector plate must be fabricated locally from 1/4-inch thick steel plate to specifications shown and used to split tractors equipped with power shift transmissions.

1. 304.8 mm (12 in.)
2. 149.225 mm (5-7/8 in.)
3. 190.5 mm (7-1/2 in.)
4. 34.325 mm (1-3/8 in.)
5. 139.7 mm (5-1/2 in.)

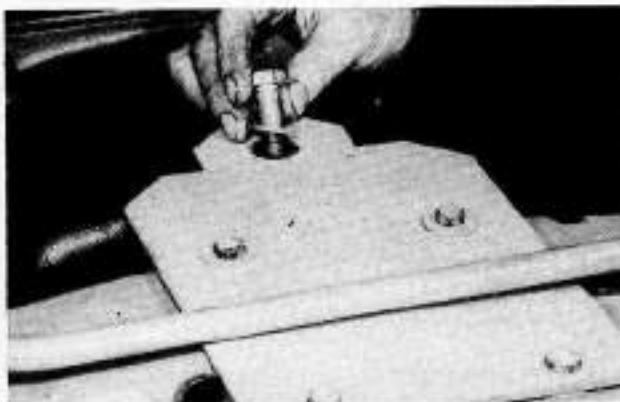


Fig. 153 - Mount connector plate as shown. Refer to text.

remove connecting bolts and stud nuts from rear axle housing and roll rear section out of main frame. Place support stand under range gear box and remove hoist.

Attach a hoist to power shift unit so it will be balanced when removed, remove the four 1/2-inch stud nuts at each front corner and pull power shift assembly forward and off the studs to remove.

**263. REINSTALL.** Clean all foreign material from gasket and mating surfaces and use a hoist to power shift unit on mounting studs. Tighten all retaining nuts to 102 N·m (75 ft.-lbs.) torque. Apply gasket sealer to end of main frame and silicone base sealer to the two front "O" rings at front of power shift. Using a hoist roll rear section of tractor forward engaging power shift shaft in splines of clutch disc until main frame ends contact rear axle housing. Install and tighten all retaining bolts and nuts to 102 N·m (75 ft.-lbs.) torque. Install transmission mounting bushings and bolts and tighten to 163 N·m (120 ft.-lbs.) torque. Remove connecting plate (Fig. 153).

Remove any burrs or sharp edges on pto drive shaft and install. Install two guide studs and gasket at rear axle housing and use a hoist to install pto housing. Turn pto output shaft with pto engaged to engage pto drive shaft splines with pto sliding gear. Tighten retaining bolts to 73-87 N·m (54-64 ft.-lbs.) torque. Install drawbar support and drawbar.

Connect draft sensing cable and install remote couplers, hoses and support bracket. Tighten support bracket retaining bolts to 108-130 N·m (80-96 ft.-lbs.) torque.

Install hydraulic filter assembly and tighten retaining bolts to 48-57 N·m (35-42 ft.-lbs.) torque. Place "O" ring in flange of filter supply line and connect line tightening bolts to 48-57 N·m (35-42 ft.-lbs.) torque. Connect both hydraulic lines at unions on right side along main frame and install rear lubrication line on top of range gear box.

Install power shift control valve and tighten mounting bolts to 46-57 N·m (35-42 ft.-lbs.) torque. Connect control valve supply line (23—Fig. 151), front lubrication line (10) and retaining cotter pin (9), front sequence valve (13) and supply line (11), rear sequence valve (19) and supply line (8) and making certain restrictor plugs (16) are in front (15) and rear (17) planetary brake lines install both planetary brake lines. Apply gasket sealer to rear axle sealing surface and install new gasket and transmission cover leaving mounting bolts loosely installed. Clean remote valve mounting surface, install "O" rings on valve spools and install gasket and remote valve assembly. Tighten mounting bolts to

46-57 N·m (35-42 ft.-lbs.) torque. Connect hydraulic line from hitch cylinder to remote valve. Install remote valve supply line and tighten retaining bolts to 23-27 N·m (17-20 ft.-lbs.) torque. Connect valve linkage.

Tighten the three 1/2-inch rear transmission cover retaining bolts and all cover side bolts to 108-130 N·m (80-96 ft.-lbs.) torque. Tighten cover 5/8-inch rear retaining bolts to 203-244 N·m (150-180 ft.-lbs.) torque. Install wedge and shim between front of transmission cover and clutch housing, install bolts and tighten to 108-130 N·m (80-96 ft.-lbs.) torque. Install range and power shift selector assemblies making certain selector rods engage actuators and tighten mounting bolts to 23-27 N·m (17-20 ft.-lbs.) torque. Connect wiring harness and install harness bracket. Install transmission dipstick.

Install fuel tanks and platform or cab as outlined in paragraphs 415 or 416.

Change transmission filter and fill transmission, 42 L (44 qts.) with specified fluid. Remove all support stands.

## TRANSMISSION OVERHAUL

### Models 1190-1290-1390 With Synchronesh Transmission

**264. DISASSEMBLY.** Place transmission in a suitable transmission support stand and remove mounting bolts from rear bearing carrier (3—Fig. 154), then remove input shaft (1). Remove snap rings and front bearing carrier. Remove rear bearing carrier (3). Remove seal (8) and "O" ring (7) from inside input gear (5). Remove snap rings (2 and 6) and remove input gear (5). Remove "O" ring from front bearing carrier and seal from inside front bearing carrier.

Remove roll pins from shift fork and selector jaw on high/low and low/slow shift rail. See Fig. 155. Use a soft metal rod to drive high/low and low/slow shift rail toward rear of transmission just far enough to remove detent ball and spring. Remove shift rail, selector jaw and shift fork.

Remove roll pin from high/low range shift fork (Fig. 155) and remove shift rail, detent ball and spring, spacer and shift fork.

Use wooden wedge to lock differential assembly and noting pinion nut (31—Fig. 154) has left-hand threads, remove nut (31), washer (32) and bearing cone (33).

Remove the three roll pins from shift rails and remove rails using care to catch detent balls and springs and shift interlock plug (15—Fig. 148).

Remove the four nuts from spacer rods and remove front end plate

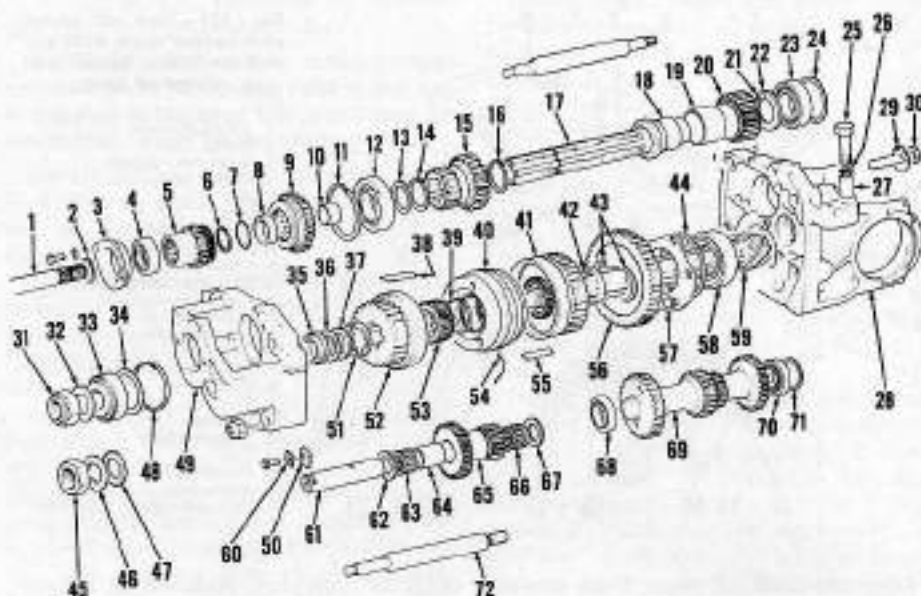


Fig. 154—Exploded view of 12 speed synchronesh transmission used on 1190, 1290 and 1390 models.

1. Front input shaft	20. Reverse idler gear	39. Snap ring	54. Centraliser spring
2. Snap ring	21. Dowel pin	40. Synchronizer	55. Bearing pad
3. Rear bearing carrier	22. Washer	41. Second gear	56. First/reverse gear
4. Bearing	23. Bearing	42. Retaining collar	57. Retainer plate
5. Input gear	24. Shim	43. Split rings	58. Bearing
6. Snap ring	25. Mounting bolt	44. Shim	59. Pinion shaft
7. "O" ring	26. Shim	45. Locknut (used with front drive)	60. Tab washer
8. Seal	27. Bushing	46. Tab washer (used with front drive)	61. Idler shaft
9. High/low slow gear	28. Rear end plate	47. Washer (used with front drive)	62. Thrust washer
10. Bushing	29. Tab washer	48. Snap ring	63. Bearing
11. Snap ring	30. Bolt	49. Front end plate	64. Spacer
12. Bearing	31. Locknut	50. Locating plate	65. Idler gear
13. Spacer	32. Washer	51. Thrust washer	66. Bearing
14. Snap ring	33. Bearing & cup	52. Third gear	67. Thrust washer
15. Range pinion	34. Shim	53. Front synchronizer gear	68. Bearing & cup
16. Snap ring	35. Spacer		69. Intermediate gear
17. Rear input shaft	36. Shim		70. Bearing & cup
18. Gear carrier	37. Spacer		71. Shim
19. Bushing	38. Bearing pad		72. Spacer bar

(49—Fig. 154). Remove high/low slow gear (9). Remove locating plate (50), idler shaft (61) and idler gear (65). Remove thrust washers (62 and 67). Remove bearings (63 and 66) and spacer (64). Remove all remaining bearing

cups, snap rings and spacer washers from front end plate.

Remove neutral start switch rods and plate and the two steel balls from rod holes. Remove first/reverse and second/third shift rail assemblies. See

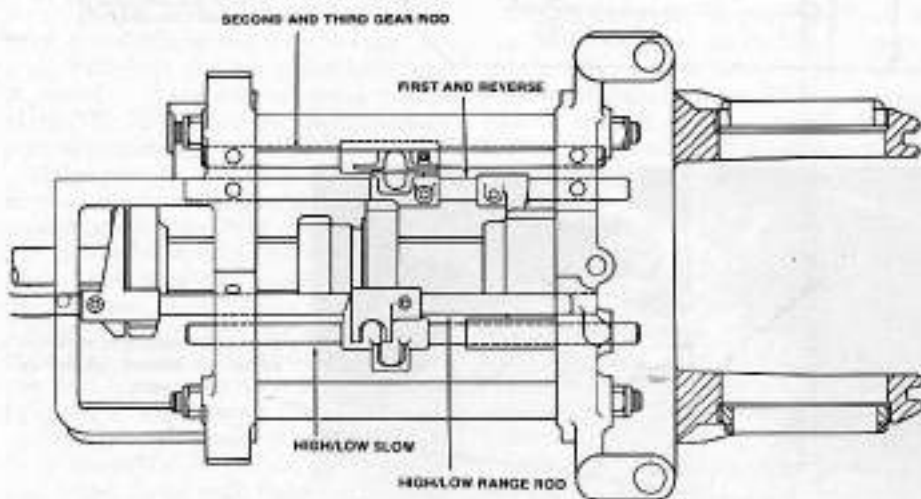


Fig. 155—View showing shift rod positions in 1190, 1290 and 1390 model synchronesh transmissions.



Fig. 155. Remove intermediate shaft assembly (69—Fig. 154). Remove rear input shaft assembly (17).

Press front bearing (12) off of rear input shaft (17) and remove spacer (13), snap ring (14) and range pinion (15). Press reverse idler gear carrier (18), gear (20), washer (22) and bearing (23) off of rear input shaft (17) together. Use care not to lose dowel pin (21). Press bushing (19) from reverse idler gear (20). Remove bushing (10) from inside end of rear input shaft.

Remove first/reverse gear shift fork. Remove spacer (35—Fig. 154), note number and thickness of shims (36) and remove shims. Remove spacer (37), washer (51), third gear (52) and the six bearing pads (38). Remove shift fork and synchronizer together, sliding shift fork off of spacer bar. Remove front synchronizer gear (53), snap ring (39), rear synchronizer gear (not shown), second gear (41) and the six bearing pads (55). Remove retaining washer (42) and split rings (43). Remove first/reverse gear (56). Remove pinion shaft retainer plate (57) and note number and thickness of shims (44), then remove shims. Remove pinion shaft (59) and press bearing (58) off shaft.

**265. INSPECTION.** Clean and inspect all parts. Examine bearings and bushings for wear or damage. If renewing a bearing, renew its respective mating cup. Gear teeth should be evenly marked along length of teeth. If gear teeth have been shaved or show irregular wear pattern, gear should be renewed along with its mating gear.

If shifting into second or third has been difficult, examine synchronizer friction surfaces and the six synchronizer springs (55—Fig. 154). Slight radial clearance (looseness) in synchronizer is normal and the six springs should slide easily into their grooves with no binding. No attempt should be made to disassemble synchronizer assembly as the six centralizer springs are the only renewable parts.

If jumping out of gear has been a problem and gears appear good, examine fit of detent balls in grooves of shifter rails. See Fig. 156. Shift rail grooves should have straight 60 degree sides and balls must be smooth with no pits, rust or flat spots. If necessary, grind groove taking care not to damage sides until detent

ball has sufficient clearance at bottom of groove. Check detent spring length which should be 31.75 mm (1.250 inches).

Examine all thrust washers and spacers for excessive wear or damage and renew as necessary.

If pinion shaft, end plates, center housing, or pinion shaft bearings or cups are renewed, pinion shaft protrusion must be set before transmission reassembly.

**266. REASSEMBLY.** If pinion shaft protrusion must be set, refer to paragraph 314.

With pinion shaft (59—Fig. 154), bearing (58) and correct thickness of shims (44) in position install retainer plate (57) and tighten retaining bolts to 40 N·m (30 ft.-lbs.) torque. Install first/reverse gear (56) with shift fork groove toward retainer plate (57). Install split rings (43) and retaining collar (42). Apply grease to the six bearing pads (55) and install pads in splines of pinion shaft (59). Install second gear (41) on pinion shaft and bearing pads with gear side toward retainer plate (57). Install rear synchronizer gear (not shown) with slotted side against second gear (41). Install snap ring (39) and front synchronizer gear (53) with slotted side of gear away from snap ring (39). Make certain front and rear synchronizer splines (teeth) are aligned. Place shift fork in groove on synchronizer and install synchronizer and shift fork together making certain shift fork slides easily on spacer bar. Apply grease to the six bearing pads (38) and install in splines of pinion shaft (59). Install third gear (52) on pinion shaft and bearing pads with gear side towards threaded end of pinion shaft. Install thrust washer (51) and spacer (37). **DO NOT** install shims (36) or spacer (35) at this time.

Place first/reverse gear shift fork in groove of first/reverse gear (56).

**267. REAR INPUT SHAFT ASSEMBLY.** Press bushing (10—Fig. 154) into rear input shaft (17). Press bushing (19) into reverse idler gear (20).

Install snap ring (16) in groove of rear input shaft at bushing carrier (18) end. Install bushing carrier (18) on rear input shaft (17) with largest outside diameter next to snap ring (16). Lubricate and install reverse idler gear (20). Install

dowel pin (21), if so equipped. Install thrust washer (22) with flat side toward reverse idler gear and dowel pin through hole. Install bearing (23).

Install high/low range gear (15) with larger diameter gear on shaft first. Install snap ring (14), spacer (13) and bearing (12). Install input shaft assembly in position on rear end plate (28) **MINUS** shims (24). Install front end plate (49) and tighten spacer bar nuts to 95 N·m (70 ft.-lbs.) torque. Mount dial indicator on front end plate so probe touches end of rear input shaft. Measure end play and determine thickness of shims necessary to obtain 0.051-0.432 mm (0.002-0.016 inch) end play. Remove front end plate and rear input shaft. Install proper thickness of shims (24) and reinstall rear input shaft assembly.

**268. INTERMEDIATE SHAFT ASSEMBLY.** Install bearings (68 and 70—Fig. 154) on intermediate shaft (69). Remove shims (71) from under bearing cup in rear end plate (28) and reinstall bearing cup. Place intermediate shaft in position and install front end plate (49). Tighten spacer bar nuts to 95 N·m (70 ft.-lbs.) torque. Mount dial indicator on rear end plate so probe contacts rear gear of intermediate shaft. Measure and note amount of end play in intermediate shaft. Remove front end plate, intermediate shaft and rear bearing cup and install thickness of shims (71) to provide 0.051-0.102 mm (0.002-0.004 inch) end play. Install bearing cup and intermediate shaft.

Install first/reverse and second/third gear shift rail assemblies.

**269. FRONT END PLATE ASSEMBLY.** Install bearings (63 and 66—Fig. 154) and spacer (64) into range idler gear (65). Bearing cages should both be slightly below end surface of range idler gear when installed. Spacer (64) may be carefully shortened, if necessary. Measure assembled length of range idler gear (65) plus thickness of both thrust washers (62 and 67). Measure gear mounting space in front end plate. Gear mounting space in front end plate must be 0.254-1.270 mm (0.010-0.050 inch) more than assembled length of range idler gear and thrust washers to assure clearance for bearing cages to rotate. Lubricate as assembling and install range idler gear and thrust washers in front end plate. Install idler shaft (61), locating plate (50), tab washer (60) and bolt. Tighten bolt and secure with tab washer. Place high/low slow gear (9) in front end plate with shift fork groove up. Make certain all bearing cups, snap rings and spacers are in place and install front end plate assembly on transmission assembly making certain

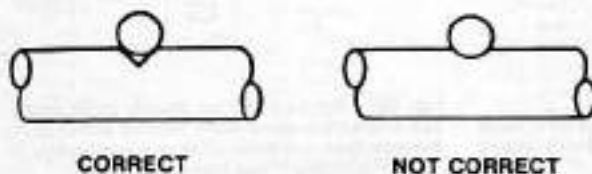


Fig. 156—Shift rod grooves must have straight 60 degree sides and allow clearance under detent balls.

rear input shaft (17) goes through high/low slow gear (9) during front end plate installation. Tighten spacer rod nuts to 95 N·m (70 ft.-lbs.) torque.

**270. PINION SHAFT END PLAY.** Install all shims (36—Fig. 154) removed during disassembly PLUS an additional 0.254 mm (0.010 inch) thick shim. Install shoulder washer (35) with flat side against shims (36). Install bearing cone (33), washer (32) and nut (31). Tighten nut (31) to 271 N·m (200 ft.-lbs.) torque. Mount dial indicator on front end plate so probe contacts end of pinion shaft. Measure and note amount of end play. Remove nut, washer, bearing and shoulder washer and remove shim thickness equal to measured amount of end play. Reinstall shoulder washer, bearing, washer and nut. Tighten nut to 271 N·m (200 ft.-lbs.) torque and check end play. Correct end play is 0.051 mm (0.002 inch) end play to 0.051 mm (0.002 inch) preload.

**271. FRONT INPUT SHAFT ASSEMBLY.** Install oil seal (5—Fig. 157) in support sleeve (2) and place "O" ring (1) on support sleeve.

Place input gear (12) on input shaft (4) and install snap ring (13). Slide gear against snap ring (13) and install snap ring (11). Install "O" ring (14) and seal (15) inside input gear (12). Press needle bearing assembly (10) into rear bearing carrier (9) and slide carrier onto bearing surface of input gear (12). Place snap ring (3) over input shaft, then install snap ring (8) in lower snap ring groove of input shaft (4), install bearing (7) and remaining snap ring (6). Lubricate seal (5) in support sleeve (2) and carefully slide sleeve over shaft (4) and onto bearing (7). Slide snap ring (3) up shaft (4) and install in support sleeve.

**272. SHIFT RODS AND DETENT ASSEMBLY.** To facilitate installation of detent balls and springs fabricate an installation tool as shown in Fig. 158.

Install detent ball and spring for first/reverse shift rod (rail) using tool as shown in Fig. 159. Push detent ball down with tool while moving shift rod into rod hole as shown.

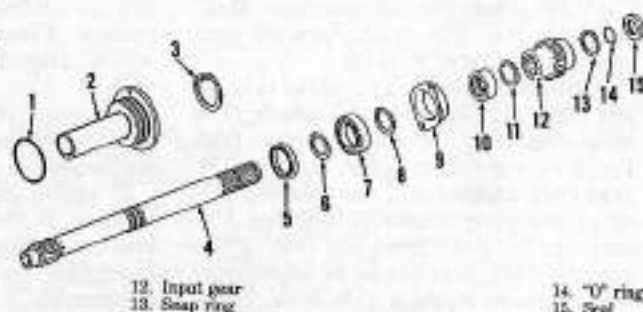
Install shift interlock plug (15—Fig. 148) by placing in position through second/third gear shift rod bore. With shift interlock plug in position install detent ball and spring for second/third shift rod using tool as shown.

Install the three roll pins in shift forks and shift rods.

Install high/low range shift rod (23—Fig. 148) through rear end plate, install spacer (25) on shift rod, place shift fork (24) in groove of high/low gear and push shift rod through shift fork and

Fig. 157—Exploded view of Models 1190, 1290 and 1390 front input shaft.

1. "O" ring
2. Support sleeve
3. Snap ring
4. Front input shaft
5. Seal
6. Snap ring
7. Bearing
8. Snap ring
9. Rear bearing carrier
10. Bearing
11. Snap ring
12. Input gear
13. Snap ring
14. "O" ring
15. Seal



install detent ball and spring. Install roll pin through shift fork and shift rod.

Install remaining shift rods, shift forks, detent balls and springs in similar manner and install neutral start switch balls, rods, plate and switch.

Install front input shaft and tighten rear bearing carrier retaining bolts to 23-27 N·m (17-20 ft.-lbs.) torque.

Shift transmission and range section through all gears and check to be certain all gears and detents work properly.

### Model 1490 With Synchromesh Transmission

**273. DISASSEMBLY.** Place transmission in a suitable transmission support stand and remove roll pins from slow/normal shift fork (74—Fig. 160) and selector jaw (75). Push slow/normal shift rod (72) rearward just far enough to remove detent ball and spring. Remove shift rod, selector jaw and shift fork. Remove high/low shift fork, sleeve, detent ball and spring and shift rod (73). Remove roll pins from shift fork and selector jaw on second/third shift rod (57) and move rod toward rear of transmission just enough to remove detent ball and spring. Remove shift interlock plug (55).

Noting pinion nut (27—Fig. 160) has left-hand threads, remove nut (27), washer (28) and bearing cone (29) from pinion shaft (54). Remove stud bolt nuts and separate and support front end plate (31) approximately 40 mm (1.5 inches) from transmission center housing (56). Push first/reverse shift rod (58) rearward just enough to remove detent ball and spring. Lift front end plate (31) off transmission center housing (56).

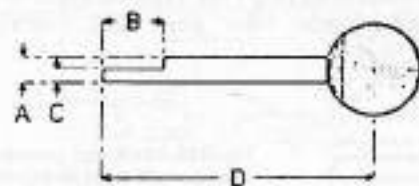


Fig. 158—As an aid for installing detent balls and springs fabricate a tool to specifications shown.

Remove slow/normal sliding gear (10) from inside front end plate. Remove input shaft front bearing cup (12) from front end plate and place cup on input shaft front bearing cone (12).

Remove roll pin (60—Fig. 160) and remove idler shaft (59). Remove snap ring (1) from input gear (8) and snap ring (2) from front end plate (31). Carefully remove input gear assembly out of front end plate. Do not use force as damage to bearings may result. Remove idler gear (65) and both thrust washers (62 and 67). Remove bearings (63 and 66) and spacer (64) from inside idler gear (65). Remove input gear bearing cup and outer spacer (6) from front end plate. Remove remaining bearing cups, spacer, bearings and snap rings from front end plate.

Remove stud bolts and remove center housing (56) by rotating center housing towards intermediate shaft to gain clearance and remove.

Remove intermediate shaft (69) from rear end plate (42). Remove retaining bolt (23), high/low shift fork from sliding gear (16) and remove input shaft assembly (17) from rear end plate (42). Use care not to lose retainer (21). Remove snap ring (26) and press rear bearing (25), thrust washer (24) and reverse idler gear (20) off together. Move snap ring (14) away from bearing (12) and press bearing (12) and spacer (13) off input shaft (17). Remove snap ring (14) and high/low sliding gear (16). Remove bushing (15) from inside input shaft (17).

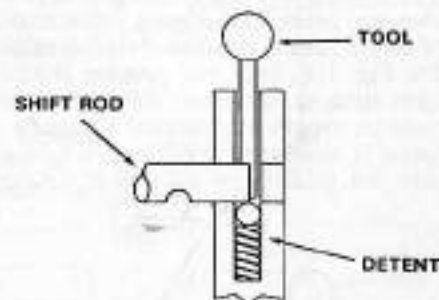


Fig. 159—Position tool as shown, push detent ball and spring down while moving shift rod in. Remove tool and push shift rod completely in rod bore.



Remove second/third shift fork from synchronizer (37). Remove shoulder spacer (46), shims (33), spacer (47) and third gear thrust washer (34). Remove third gear (48) and the six bearing pads (35). Remove synchronizer (37) and front synchronizer gear (49). Remove snap ring (36) and rear synchronizer gear (not shown). Remove second gear (38), the six bearing pads (51), split ring retainer washer (39) and split rings (40). Remove first/reverse sliding gear (52) and shift rod assembly together.

If pinion shaft (54) is to be renewed, mark differential bearing cap positions and remove differential assembly. Remove pinion shaft (54).

**274. INSPECTION.** Refer to paragraph 265 for inspection procedures.

**275. REASSEMBLY.** If pinion shaft protrusion must be set, refer to paragraph 314.

**276. INPUT SHAFT ASSEMBLY.** Install bushing (15-Fig. 160) in input

shaft (17). Place high/low sliding gear (16) on input shaft with larger diameter gear toward bushing surface end (18). Install snap ring (14), spacer (13) and bearing (12) on input shaft. Bearing (12) must be installed with the side on which bearing numbers are stamped toward front end of input shaft. Press bushing (19) into reverse idler gear (20) and install gear (20) on input shaft with beveled edge of gear teeth towards front of input shaft. Install thrust washer (24) with flat side towards reverse idler gear. Install bearing (25) and snap ring (26). Place input shaft in position on rear end plate (42) and install retainer (21), tab washer (22) and bolt (23). Make certain retainer (21) is correctly positioned and tighten bolt (23) to 11 N·m (8 ft.-lbs.) torque. Secure with tab washer (22).

**277. PINION SHAFT ASSEMBLY.** With first/reverse shift fork and selector jaw assembled on shift rod, place first/reverse sliding gear (40-Fig. 160) on fork with gear side towards selector jaw and install gear on pinion shaft and

make certain shift rod enters rod hole nearest input shaft retaining washer. Install split rings (40), retaining washer (39) and second gear (38). Second gear is installed with synchronizer ring toward front end of pinion shaft. Lubricate the six bearing pads (51) and install in pinion shaft splines under second gear. Install rear synchronizer gear (not shown) with gear alignment marks toward second gear and note position of alignment marks. Install snap ring (36), align marks of rear synchronizer gear and front synchronizer gear and install front synchronizer gear (49) with slotted side toward front end of input shaft. Install synchronizer (37). Install third gear (48) with synchronizer ring towards synchronizer. Lubricate the six bearing pads (35) and install in pinion shaft splines under third gear. Install thrust washer (34) and flat spacer (47). **DO NOT** install shims (33) or shoulder spacer (46) at this time.

**278. INTERMEDIATE SHAFT ASSEMBLY.** Install bearings (68 and 70-Fig. 160) on intermediate shaft (69). Install a 0.254 mm (0.010 inch) thick shim (71) in rear end plate (42) in intermediate shaft bearing bore and install bearing cup. Install bearing cup in front end plate (31) and place intermediate shaft in position on rear end plate (42). Install center housing (56), stud bolts and front end plate (31). Tighten stud bolt nuts to 95 N·m (70 ft.-lbs.) torque. Mount dial indicator so probe contacts rear gear of intermediate shaft. Measure and note end play of intermediate shaft. Remove front end plate, stud bolts, center housing, intermediate shaft and bearing cup from rear end plate. Add or subtract to thickness of the 0.254 mm (0.010 inch) thick shim (71) to obtain correct intermediate shaft end play of 0.051-0.102 mm (0.002-0.004 inch). Reinstall bearing cup and intermediate shaft.

Place second/third gear selector fork into groove on synchronizer and place high/low selector fork into groove on high/low sliding gear (16). Install center housing (56) and rotate until stud bolt holes in rear end plate and center housing (56) are aligned. Apply "Loctite" to stud bolt threads and install stud bolts in rear end plate. Tighten stud bolts to 122 N·m (90 ft.-lbs.) torque.

**279. FRONT END PLATE ASSEMBLY.** Install bearing (7-Fig. 160) on input gear (8) with the side on which bearing numbers are stamped towards splined end of input gear. Install inner spacer (5) on input gear (8).

Install snap ring (4), bearing (3) and snap ring (2) in front end plate (31). Install outer spacer (6) and outer race for

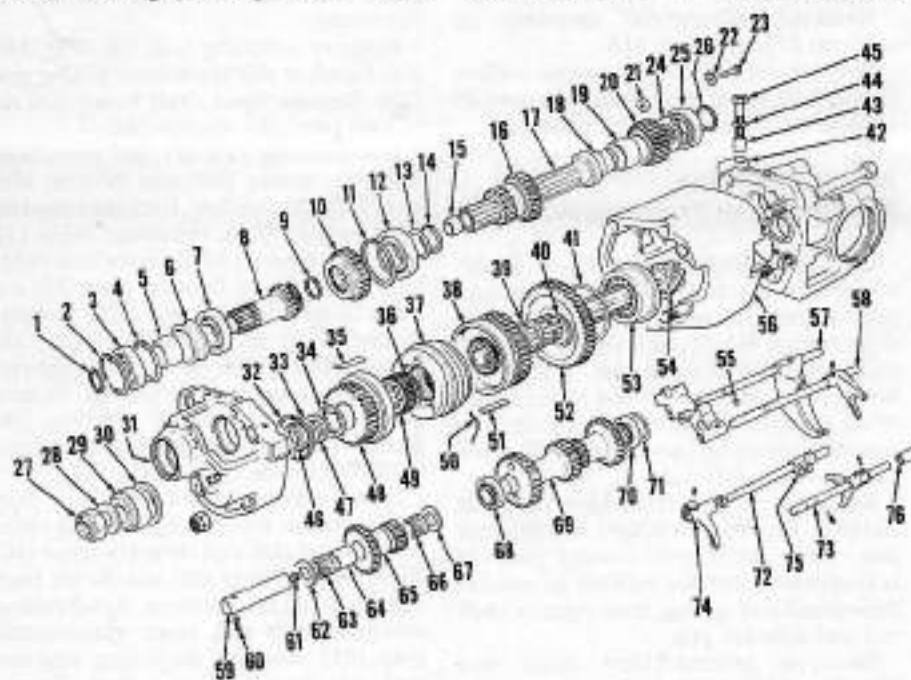


Fig. 160—Exploded view of 12 speed synchromesh transmission used on 1490 models.

- |                              |                        |                                |                             |
|------------------------------|------------------------|--------------------------------|-----------------------------|
| 1. Snap ring                 | 19. Bushing            | 39. Retaining washer           | 67. Second/third shift rod  |
| 2. Snap ring                 | 20. Reverse idler gear | 40. Split rings                | 68. First/reverse shift rod |
| 3. Bearing                   | 21. Retaining washer   | 41. Shim                       | 69. Idler shaft             |
| 4. Snap ring                 | 22. Tab washer         | 42. Rear end plate             | 70. Roll pin                |
| 5. Inner spacer              | 23. Bolt               | 43. Bushing                    | 71. Plug                    |
| 6. Outer spacer              | 24. Thrust washer      | 44. Shim                       | 72. Thrust washer           |
| 7. Bearing                   | 25. Bearing            | 45. Mounting bolt              | 73. Bearing                 |
| 8. Input gear                | 26. Snap ring          | 46. Shoulder spacer            | 74. Idler gear              |
| 9. Sealing ring              | 27. Locknut            | 47. Washer                     | 75. Bearing                 |
| 10. Synchromesh sliding gear | 28. Washer             | 48. Third gear                 | 76. Thrust washer           |
| 11. Snap ring                | 29. Bearing & cup      | 49. Front synchronizer gear    | 77. Bearing & cup           |
| 12. Bearing & cup            | 30. Shim               | 50. Centralizer spring         | 78. Intermediate shaft      |
| 13. Spacer                   | 31. Front end plate    | 51. Bearing pad                | 79. Bearing & cup           |
| 14. Snap ring                | 32. Snap ring          | 52. First/reverse sliding gear | 80. Shim                    |
| 15. Bushing                  | 33. Shims              | 53. Bearing                    | 81. Synchromesh shift rod   |
| 16. High/low sliding gear    | 34. Thrust washer      | 54. Pinion shaft               | 82. Shift fork              |
| 17. Input shaft              | 35. Bearing pad        | 55. Shift interlock            | 83. Selector jaw            |
| 18. Bushing surface          | 36. Snap ring          | 56. Center housing             | 84. Sleeve                  |
|                              | 37. Synchronizer       |                                |                             |
|                              | 38. Second gear        |                                |                             |

bearing (7) in front end plate input gear bearing cavity.

Install bearings (63 and 66) and spacer (64) in range idler gear (55). Bearing cages should both be slightly below end surfaces of range idler gear when installed. Spacer (64) may be carefully shortened, if necessary. Measure assembled length of range idler gear (65) plus thickness of both thrust washers (62 and 67). Measure gear mounting space in front end plate. The gear mounting space in front end plate must be 0.254-1.270 mm (0.010-0.050 inch) more than assembled length of range idler gear and thrust washers to assure clearance for bearing cages to rotate. Lubricate during reassembly, then install range idler gear and thrust washers in front end plate.

Lubricate sealing ring (9) and install in input shaft cavity. Carefully install input gear and bearing assembly (8) in front end plate (31). Do not force input gear past idler gear teeth or bearing damage may result. Install snap ring (1) on input gear (8).

Clean oil passage in idler gear shaft (59), apply "Loctite" to threads of plug (61) and install plug in idler gear shaft (59). Align roll pin hole in idler shaft with hole in front end plate and install idler shaft through end plate, thrust washers and idler gear assembly. Install roll pin (60). Install snap ring (32), spacer (30) and bearing cup (29) in front end plate.

Place slow/normal sliding gear (10—Fig. 160) in position in front end plate cavity with selector fork groove toward input gear. Install front end plate on center housing until first/reverse shift rod just enters rod hole in front end plate and support in this position. Use tool shown in Fig. 158 and install detent ball and spring (Fig. 159) while joining front end plate and center housing. Make certain input shaft (17) has entered slow/normal sliding gear (10) and tighten front end plate retaining locknuts to 95 N·m (70 ft.-lbs.) torque.

Install high/low shift rod (73) making certain it passes through shift fork, then install spacer (76) and detent ball and spring. Install roll pin in shift fork.

Install slow/normal shift rod (72), shift fork (74), spacer and selector jaw (75). Install detent ball and spring and roll pins in shift fork and selector jaw.

Install second/third shift rod making certain end with neutral start switch groove is toward rear of transmission. Push rod through shift fork slightly and install selector jaw with flat side toward first/reverse selector jaw. Install shift interlock plug (55) and detent ball and spring.

Engage third gear and install roll pin

in second/third selector jaw. Engage second gear and install roll pin in second/third shift fork.

**280. PINION SHAFT BEARING PRELOAD.** Install all shims (33—Fig. 160) removed during disassembly **PLUS** an additional 0.254 mm (0.010 inch) thick shim. Install shoulder washer (46) with flat side against shims (33). Install bearing cone (29), washer (28) and nut (27). Note nut has left-hand threads and tighten to 271 N·m (200 ft.-lbs.) torque. Mark differential bearing caps and remove differential assembly. Mount dial indicator so probe contacts end of pinion shaft, then measure and note amount of pinion shaft end play.

Remove nut (27), washer (28), bearing (29) and shoulder washer (46). Remove thickness of shims (33) 0.051 mm (0.002 inch) thicker than amount of measured end play to obtain correct bearing **PRELOAD** of 0.051 mm (0.002 inch). Reinstall spacer, bearing, washer and nut. Tighten nut to 271 N·m (200 ft.-lbs.) torque.

Reinstall differential assembly as outlined in paragraph 313.

Shift transmission and range section through all gears and check to be certain all gears and detents work properly.

### Model 1690 With Synchronesh Transmission

**281. DISASSEMBLY.** Place transmission in a suitable transmission support stand and remove roll pins from slow/normal shift rod (84—Fig. 161) shift fork and selector jaw. Use a soft metal rod to drive shift rod toward rear of transmission just far enough to remove detent ball and spring. Remove slow/normal shift rod.

Remove roll pins from high/low shift rod (85—Fig. 161) shift fork and selector jaw. Drive shift rod toward rear of transmission just far enough to remove detent ball and spring, then remove shift rod and selector jaw.

Remove second/third shift rod (69—Fig. 161), shift fork, selector jaw, detent ball and spring and shift interlock plug (68).

Note pinion nut (39) has left-hand threads and remove nut (39), washer (40) and bearing cone (41). Remove snap ring (1) and spacer (2). The row of smaller gear teeth on input gear (8) has a missing tooth. Align this gap with a gear tooth on slow/normal idler gear (77) and remove input gear and bearing assembly.

Remove self-locking nuts from stud bolts and raise front end plate (43) approximately 40 mm (1.5 inches), use blocks to support front end plate in this position.

Push first/reverse shift rod (70) toward rear of transmission just far enough to remove detent ball and spring. Remove sliding collar (9), snap ring (10) and collar gear (11). Remove slow range gear (12), the six bearing pads (28) and thrust washer (13). Remove front end plate (43).

Remove input shaft front bearing cup from front end plate and place cup on input shaft front bearing (16) to protect bearing from damage.

Remove roll pin (72) and idler shaft (71). Remove thrust washers (74 and 79) and idler gear (77).

To disassemble input gear (8—Fig. 161), remove snap ring (3). Press bearings (4 and 7) and spacers (5 and 6) off of input gear (8).

Remove remaining bearing cups, snap rings and spacers from front end plate.

Remove stud bolts and rotate housing (53) toward intermediate shaft to gain gear clearance and remove center housing (53).

Remove intermediate shaft (81) and press bearings (80 and 82) off as necessary.

Remove retaining bolt (56—Fig. 161) and high/low shift fork from sliding gear (20). Remove input shaft using care not to lose retaining washer (54).

Remove snap ring (35) and press bearing (34), spacer (33) and reverse idler gear (32) off together. Remove snap ring (14), bearing (16), retaining collar (17) and split rings (18). Remove low range gear (19), the six bearing pads (29) and front sliding collar gear (21). Remove sliding collar (20), snap ring (22) and rear sliding collar gear (23). Remove high range gear (24), the six bearing pads (30) and thrust washer (25). Remove snap ring (26). Remove bushing (27) from inside input shaft (31).

Remove second/third shift fork from synchronizer. Remove spacer (44), shims (45), spacer (59) and thrust washer (46). Remove third gear (60) and the six bearing pads (47). Remove synchronizer assembly (62) and front synchronizer gear (61). Remove snap ring (48) and rear synchronizer gear (not shown). Remove second gear (50) and the six bearing pads (63). Remove retaining collar (51) and split rings (64). Remove first/reverse sliding gear (52) and shift rod assembly (70).

If pinion shaft (67) or bearing (66) are to be renewed, mark bearing caps and remove differential assembly. Remove pinion shaft.

**282. INSPECTION.** Refer to paragraph 265 for inspection procedure.

**283. REASSEMBLY.** If pinion shaft protrusion must be set, refer to paragraph 314.



**284. INPUT SHAFT ASSEMBLY.** Press bushing (26—Fig. 161) into input shaft (31). Install snap ring (26), thrust washer (25), high range gear (24) and lubricate and install the six bearing pads (30) in input shaft splines under high range gear (24).

Rear sliding collar gear (23) has lubrication slots and a punch marked tooth for alignment on one side of gear. Slotted side of gear goes toward high range gear and install with punch marked tooth aligned with input shaft spline which has a hole. Install snap ring (22) and sliding collar (20). Install front sliding collar gear (21) with side having slots facing away from snap ring (22) and align punch marked gear tooth of front gear with punch marked tooth of rear gear (23). When correctly installed gear splines will engage sliding collar (20) splines.

Install low range gear (19) with smaller gear teeth toward sliding collar gear (21). Lubricate and install the six bearing pads (29) in input shaft splines

under low range gear (19). Install split rings (18), retaining collar (17) and bearing (16). Bearing (16) is installed with side on which bearing numbers are stamped toward front end of input shaft. Bearing (16) must seat against retaining collar (17). Install snap ring (14).

Press bushing into reverse idler gear (32) and install gear (32) on input shaft with beveled gear teeth toward front of input shaft. Install thrust washer (33) with flat side against reverse idler gear. Install bearing (34) and snap ring (35).

Install input shaft assembly on rear end plate (57). Install retaining washer (54), tab washer (55) and bolt (56) making certain retaining washer (54) is correctly positioned, then tighten bolt (56) to 11 N·m (8 ft.-lbs.) torque. Secure bolt with tab washer (55).

**285. PINION SHAFT ASSEMBLY.** With pinion shaft in position through rear end plate (57—Fig. 161), place first/reverse sliding gear (52) on first/reverse shift fork and rod assembly

and install on pinion shaft. When installed, shift rod will enter rod hole nearest retaining washer (54) and shift fork will be in groove in first/reverse sliding gear on rear end plate side of gear (52). Install split rings (64) and retaining collar (51). Install second gear (50) with synchronizer ring toward threaded end of pinion shaft. Lubricate and install the six bearing pads (63) in pinion shaft splines under second gear (50). Install rear synchronizer gear (not shown) with side which has slots and alignment mark on gear tooth toward second gear (50). Note location of alignment mark. Install snap ring (48). Install front synchronizer gear (61) with side of gear having slots and alignment mark on gear tooth toward threaded end of pinion shaft. Make certain front gear and rear gear tooth alignment marks are aligned. Install synchronizer (62). Install third gear (60) with synchronizer ring toward synchronizer. Lubricate and install the six bearing pads (47) in splines on pinion shaft under third gear (60). Install thrust washer (46) and spacer (59).

**286. INTERMEDIATE SHAFT ASSEMBLY.** Install a 0.254 mm (0.010 inch) thick shim (83—Fig. 161) and bearing cup (82) in rear end plate (57). Install bearing cup (80) in front end plate (43). Install bearings (80 and 83) on intermediate shaft (81) and position intermediate shaft in rear end plate. Install center housing (53) and rotate housing until stud bolt holes in housing and rear end plate are aligned. Install stud bolts and front end plate (43). Install stud nuts and tighten nuts to 95 N·m (70 ft.-lbs.) torque. Mount dial indicator on center housing so probe contacts rear gear of intermediate shaft. Measure and note amount of end play in intermediate shaft.

Remove front end plate, stud bolts, center housing and intermediate shaft. Remove bearing cup (82) from rear end plate and add or subtract to thickness of 0.254 mm (0.010 inch) shim (83) to obtain 0.051-0.102 mm (0.002-0.004 inch) end play. Reinstall bearing cup and intermediate shaft.

Place second/third gear shift fork in synchronizer shift fork groove. Place high/low shift fork in groove on high/low sliding gear. Reinstall center housing. Apply "Loctite" to stud bolt threads and install. Tighten stud bolts to 122 N·m (90 ft.-lbs.) torque.

**287. FRONT END PLATE ASSEMBLY.** Install bearings (75 and 78—Fig. 161) and spacer (76) in range idler gear (77). Bearing cages should both be slightly below end surfaces of range idler gear when installed. Spacer (76) may be carefully shortened, if

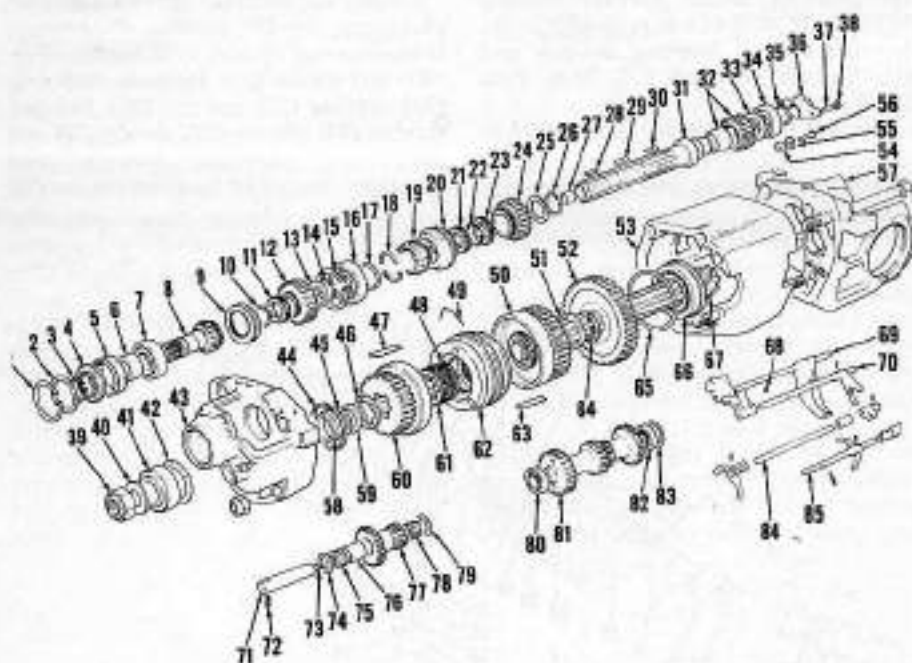


Fig. 161—Exploded view of 12 speed synchromesh transmission used on 1690 models.

- |                               |                              |                                |                             |
|-------------------------------|------------------------------|--------------------------------|-----------------------------|
| 1. Shim                       | 23. Rear sliding collar gear | 43. Front end plate            | 63. Bearing pad             |
| 2. Snap ring                  | 24. High range gear          | 44. Snap ring                  | 64. Split rings             |
| 3. Snap ring                  | 25. Thrust washer            | 45. Shim                       | 65. Shim                    |
| 4. Bearing                    | 26. Snap ring                | 46. Thrust washer              | 66. Bearing                 |
| 5. Outer spacer               | 27. Bushing                  | 47. Bearing pad                | 67. Pinion shaft            |
| 6. Inner spacer               | 28. Bearing pad              | 48. Snap ring                  | 68. Shift interlock plug    |
| 7. Bearing                    | 29. Bearing pad              | 49. Centralizer spring         | 69. Second/third shift rod  |
| 8. Input gear                 | 30. Bearing pad              | 50. Second gear                | 70. First/reverse shift rod |
| 9. Sliding collar             | 31. Input shaft              | 51. Retaining washer           | 71. Idler shaft             |
| 10. Snap ring                 | 32. Reverse idler gear       | 52. First/reverse sliding gear | 72. Roll pin                |
| 11. Collar gear               | 33. Spacer                   | 53. Center housing             | 73. Plug                    |
| 12. Low range gear            | 34. Snap ring                | 54. Retaining washer           | 74. Thrust washer           |
| 13. Thrust washer             | 35. Snap ring                | 55. Tab washer                 | 75. Bearing                 |
| 14. Snap ring                 | 36. Lubrication muff         | 56. Bolt                       | 76. Spacer                  |
| 15. Snap ring                 | 37. Stud                     | 57. Rear end plate             | 77. Idler gear              |
| 16. Bearing                   | 38. Nut                      | 58. Shoulder washer            | 78. Bearing                 |
| 17. Retaining collar          | 39. Locknut                  | 59. Spacer                     | 79. Thrust washer           |
| 18. Split rings               | 40. Washer                   | 60. Third gear                 | 80. Bearing & cup           |
| 19. Low range gear            | 41. Bearing & cup            | 61. Front synchronizer gear    | 81. Intermediate shaft      |
| 20. Sliding collar            | 42. Shim                     | 62. Synchronizer               | 82. Bearing & cup           |
| 21. Front sliding collar gear |                              |                                | 83. Shim                    |
| 22. Snap ring                 |                              |                                | 84. Slownormal shift rod    |
|                               |                              |                                | 85. High/low shift rod      |

necessary. Measure assembled length of range idler gear (77) plus thickness of both thrust washers (74 and 79). Measure gear mounting space in front end plate. The gear mounting space in front end plate must be 0.254-1.270 mm (0.010-0.050 inch) more than assembled length of range idler gear and thrust washers to assure clearance for bearing cages to rotate. Lubricate during reassembly, then install range idler gear and thrust washers in front end plate. **DO NOT** install idler shaft (71) at this time.

Install bearing (7) on input gear (8) with side of bearing on which bearing numbers are stamped toward splined end of input gear. Install spacers (6 and 5) on input gear. Install bearing (4) on input gear so snap ring groove on outer bearing race is toward splined end of input gear. Install snap ring (3).

Install front end plate using blocks to support end plate 40 mm (1.5 inches) from center housing. Install thrust washer (13) and slow range gear (12). Slow range gear is installed with smaller gear teeth toward front of transmission. Lubricate and install the six bearing pads (28) in input shaft splines under slow range gear (12). Install sliding collar gear (11) with side of gear having two grooves toward slow range gear (12). Install sliding collar (9).

Install first/reverse detent ball and spring using tool shown in Fig. 158 while joining front end plate to center housing. Tighten front end plate retaining locknuts to 95 N·m (70 ft.-lbs.) torque.

Install snap ring (10) on input shaft (31) and install input gear and bearing assembly into front end plate. As an aid to installation, align gap in smaller gear teeth of input gear with tooth of idler gear. Push input gear in until snap ring on bearing race is in contact with front end plate. Install spacer (2) and snap ring (1).

Make certain oil passage in idler shaft (71) is clean, apply "Loctite" to threads of plug (73) and install plug in idler shaft. Mesh teeth of input gear (8) and idler gear (77), align idler shaft bores of front end plate (43), thrust washers (74 and 79) and idler gear (77). Install idler shaft (71) aligning roll pin holes in shaft and front end plate. Install roll pin (72).

Install high/low shift rod (85) making certain rod goes through shift fork and selector jaw. Install detent ball and spring and install roll pins in shift fork and selector jaw.

Install slow/normal shift rod (84), shift fork, spacer and selector jaw. Install detent ball and spring and roll pins in shift fork and selector jaw.

Making certain neutral start switch groove in second/third shift rod (69) is

toward rear of transmission, install second/third shift rod until just through shift fork, install selector jaw with flat side toward first/reverse selector jaw. Install shift interlock plug (68). Install detent ball and spring. Install roll pins in shift fork and selector jaw.

**288. PINION SHAFT BEARING PRELOAD.** Install all shims (45—Fig. 161) removed during disassembly **PLUS** an additional 0.254 mm (0.010 inch) thick shim. Install shoulder washer (58) with flat side against shims (45). Install bearing cone (41), washer (40) and nut (39). Note nut has left-hand threads and tighten to 271 N·m (200 ft.-lbs.) torque. Mark differential bearing caps and remove differential assembly. Mount dial indicator so probe contacts end of pinion shaft, then measure and note amount of pinion shaft end play.

Remove nut (39), washer (40), bearing (41) and shoulder washer (58). Remove thickness of shims (45) 0.051 mm (0.002 inch) thicker than amount of measured end play to obtain correct bearing **PRELOAD** of 0.051 mm (0.002 inch). Reinstall spacer, bearing, washer and nut. Tighten nut to 271 N·m (200 ft.-lbs.) torque.

Reinstall differential assembly as outlined in paragraph 313.

Shift transmission and range section

through all gears and check to be certain all gears and detents work properly.

## Models 1490-1690 With Power Shift Transmission

**289. REMOVE PLANETARY ASSEMBLIES.** Place transmission in a suitable support stand and remove support sleeve (20—Fig. 162), "O" rings (21) and end plate (23). Disconnect brake line from front planetary brake cylinder and remove brake cylinder (35). Loosen all front brake band locating screws (47) and remove adjusting nut (6) and washer (7). Remove snap ring (34), washer (33) and nut (37). Remove washer (38), sleeve (39), spring (40) and seat (41). Remove input shaft (1). Remove planetary brake band (42) by withdrawing fixed end first, piston end last. Carefully remove front planetary assembly. Remove hydraulic line for planetary brake cylinder from center carrier (48). Remove abutment plate (17) and free wheel (18).

Loosen all locating screws for rear planetary brake bands. Disconnect brake line and remove cylinder (29—Fig. 163) and piston (30). Remove snap ring (28), washer (27) and nut (26). Remove washer (31), sleeve (32), spring (33) and seat (34). Carefully remove rear planetary assembly from center carrier

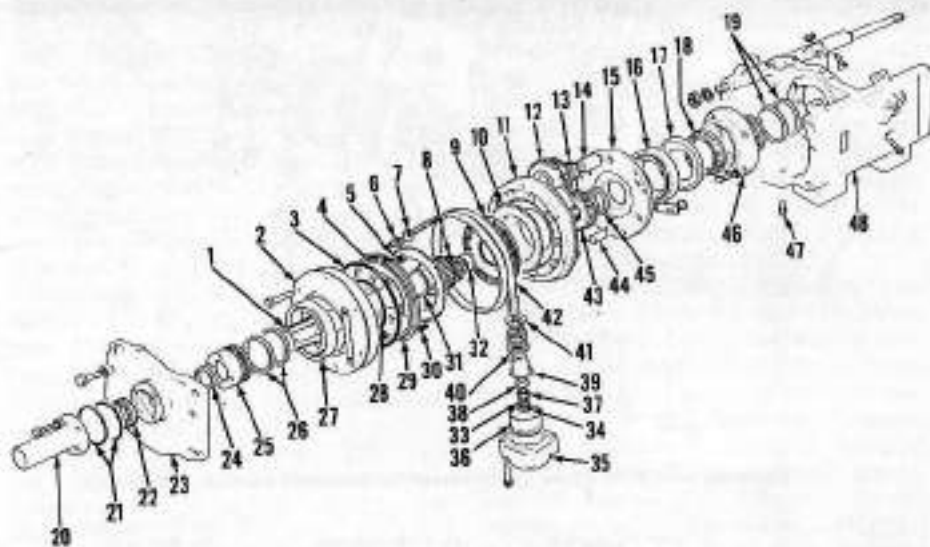


Fig. 162—Exploded view of front planetary assembly of power shift transmission. See Fig. 163 for view of rear planetary assembly.

- |                           |                       |                      |
|---------------------------|-----------------------|----------------------|
| 1. Input shaft            | 17. Abutment plate    | 33. Washer           |
| 2. Clutched cylinder      | 18. Free wheel clutch | 34. Snap ring        |
| 3. "O" ring               | 19. Sealing rings     | 35. Cylinder         |
| 4. Spring, inner          | 20. Support tube      | 36. Piston           |
| 5. Clutch plate, steel    | 21. "O" rings         | 37. Locknut          |
| 6. Locknut                | 22. Seal              | 38. Spherical washer |
| 7. Conical washer         | 23. Front end plate   | 39. Sleeve           |
| 8. Seal                   | 24. Bushing           | 40. Spring           |
| 9. Clutch plate, bronze   | 25. Support sleeve    | 41. Seat             |
| 10. Backing plate         | 26. Sealing rings     | 42. Brake band       |
| 11. Carrier & cylinder    | 27. Bearing           | 43. Set gear         |
| 12. Planet gear           | 28. "O" ring          | 44. Dowel            |
| 13. Needle roller bearing | 29. Piston            | 45. Thrust washer    |
| 14. Bearing pin           | 30. Spring, outer     | 46. Bearing carrier  |
| 15. Seal cover            | 31. Thrust washer     | 47. Locating screw   |
| 16. Bearing               | 32. Bushing           | 48. Center carrier   |



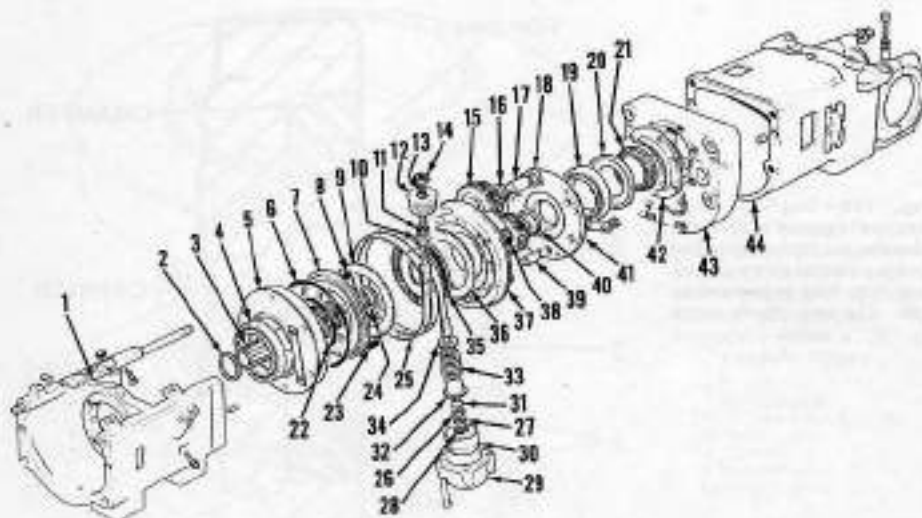


Fig. 163—Exploded view of rear planetary assembly of power shift transmission. See Fig. 162 for view of front planetary assembly.

- |                        |                           |                    |                          |
|------------------------|---------------------------|--------------------|--------------------------|
| 1. Center carrier      | 12. Taper plug            | 23. Spring, outer  | 34. Seat                 |
| 2. Thrust washer       | 13. Stop screw            | 24. Thrust washer  | 35. Clutch plate, bronze |
| 3. Rear input shaft    | 14. Locknut               | 25. Brake band     | 36. Backing plate        |
| 4. Bearing             | 15. Planet gear           | 26. Locknut        | 37. Carrier & cylinder   |
| 5. Carrier & cylinder  | 16. Needle roller bearing | 27. Washer         | 38. Sun gear             |
| 6. O-ring              | 17. Bearing pin           | 28. Snap ring      | 39. Dowel pin            |
| 7. Piston              | 18. Spacer                | 29. Cylinder       | 40. Thrust washer        |
| 8. Spring, inner       | 19. Bearing               | 30. Piston         | 41. End cover            |
| 9. Clutch plate, steel | 20. Abutment plate        | 31. Special washer | 42. Center plate housing |
| 10. Conical washer     | 21. Free wheel clutch     | 32. Sleeve         | 43. End plate            |
| 11. Locknut            | 22. O-ring                | 33. Spring         | 44. Case                 |

(1). Remove planetary brake band (25) by withdrawing fixed end first, piston end last. Remove hydraulic line for planetary brake cylinder from center carrier (1). Remove housing (46—Fig. 162) from center carrier.

**290. FRONT PLANETARY OVERHAUL.** Thickness of backing plate (10—Fig. 162) is chosen by manufacturer to match piston (29). **DO NOT** interchange backing plates or clutch plates from another clutch assembly. If renewing backing plate (10) make certain new plate is same thickness as old plate.

**291. DISASSEMBLY.** Mark clutch cylinder (2—Fig. 162), carrier (11) and end cover (15) so they may be reassembled to original positions. Bend lock plates away from bolt heads, remove bolts and separate planetary halves. Remove inner and outer springs (4 and 30). Keep clutch plates in order and together, then remove. Separate carrier (11) from end cover (15). Remove sun gear (43) and noting location for reassembly, remove planetary gears (12) and bearings (13). Mark bearing pin (14) locations for reassembly and remove pins. Remove thrust washer (45) and renew bearing (16) and dowels (44) as necessary.

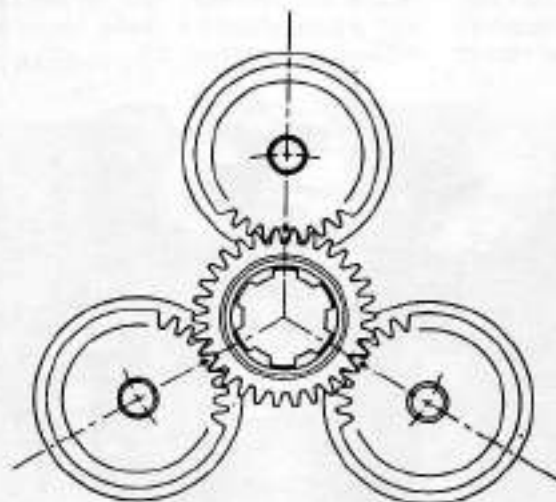


Fig. 164—Planet gears must be timed as shown with punch marked tooth of each gear pointing to sun gear.

Separate planetary piston (29) from cylinder (2) and remove "O" rings (3 and 28). Renew bearing (27) as necessary.

**292. INSPECTION.** Clutch plates must be free of cracks, discoloration, distortion or excessive wear. Renew as necessary.

Inner springs (4—Fig. 162) should conform to the following specifications:

Number of coils ..... 1.2 to 1.7  
Free length ..... 10.922-11.150 mm  
(0.430-0.439 inch)  
Test at ..... 10.033 mm (0.395 inch)  
289 N (65 lbs.)

Outer spring (30—Fig. 162) should conform to the following specifications:

Number of coils ..... 11.5  
Free length ..... 31.750 mm  
(1.250 inches)  
Test at ..... 18.719 mm (0.737 inch)  
228.5 N (51 lbs.)

Renew any broken, rusty or weak springs.

Inspect all bearings, bearing pins and bearing mounting surfaces for wear or damage and renew as necessary.

Inspect all gears for excessive wear or damage and install new "O" rings during assembly.

**293. REASSEMBLY.** Install ball bearing (27—Fig. 162) on cylinder (2). Lubricate "O" rings (3 and 28) and install on piston (29). Carefully install piston (29) in cylinder (2). Some force may be required. Install inner springs (4) using thick grease to hold springs in position during assembly.

Install bearing pins (14) in their original positions and install bearings (13) on each pin (14). Install planetary gears on their original pins and bearings with timing marks pointing toward center. See Fig. 164. Install sun gear (43—Fig. 162) aligning timing marks during installation. See Fig. 164. Install bearing (16—Fig. 162) on end cover (15). Install thrust washer, with oil groove toward gear side, in end cover and install cover on planetary gears aligning previously made alignment marks. Install lock plates and bolts. Tighten bolts to 27 N·m (20 ft.-lbs.) torque and secure with lock plates.

Install thick clutch backing plate (10), slotted bronze clutch plate (9), thin steel clutch plate (5), remaining slotted bronze plate (9) and thin steel plate (5). Install outer springs (30), align previously made alignment marks and install cylinder (2). Install lock plates and bolts. Tighten bolts to 27 N·m (20 ft.-lbs.) torque and secure lock plates.

**294. CENTER CARRIER.** Place bearing carrier (46—Fig. 162) on a clean work surface and remove thrust washer (2—Fig. 163) and sealing rings (19—Fig.

## Paragraphs 295-299

162). Install thrust washer in carrier with oil groove up and install sealing rings in grooves as shown in Fig. 165. When reinstalling bearing carrier (46-Fig. 162) in center carrier (48) make certain lubrication holes are in alignment. See Fig. 166. Tighten bearing carrier mounting bolts to 40 N·m (30 ft.-lbs.) torque and lubricate sealing rings with clean transmission fluid.

**295. REAR PLANETARY OVERHAUL.** Thickness of backing plate (36-Fig. 163) is chosen by manufacturer to match piston (29). **DO NOT** interchange backing plates or clutch plates from another clutch assembly. If renewing backing plate (36) make certain new plate is same thickness as old plate.

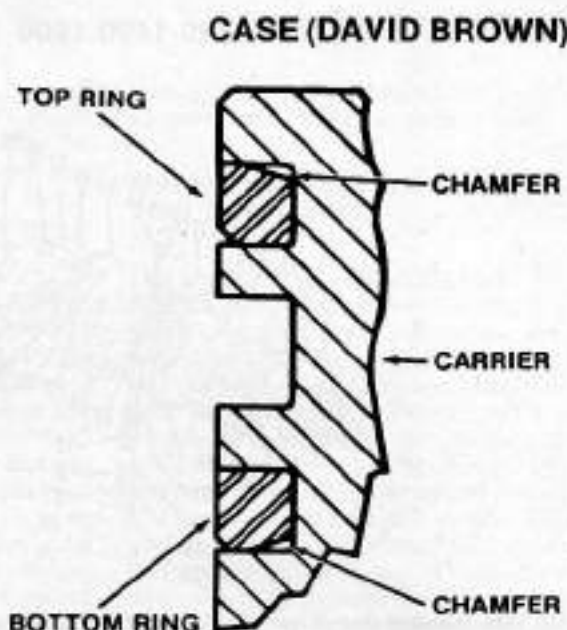
**296. DISASSEMBLY.** Mark clutch cylinder (5-Fig. 163), carrier (37) and end cover (41) so they may be reassembled to their original positions. Bend lock plates away from bolt heads, remove bolts and separate planetary halves. Remove inner and outer springs (8 and 23). Lift input shaft (3) and clutch plates (9 and 35) from carrier (37). Keep clutch plates in order and together and remove from input shaft. Remove backing plate (36) from carrier (37). Turn assembly over and remove lock plates, bolts and end cover (41). Note position of individual planetary gears (15) for reassembly and remove gears. Remove thrust washer (24) from sun gear (40). Remove bearings (16) and washers (18) from planetary gears. Remove piston (7) from cylinder (5) and remove "O" rings (6 and 22) from cylinder (5). Inspect bearings and renew as necessary. If bearing pins (17) or dowels (39) are removed, make certain they are reinstalled in their original positions. Remove thrust washer (40) from end cover (41).

**297. INSPECTION.** Refer to paragraph 292 for inspection procedure.

**298. REASSEMBLY.** Install bearing (4-Fig. 163) on cylinder (5) and lubricate "O" rings (6 and 22) and install on piston (7). Carefully install piston (7) in cylinder (5). Some force may be required. Install inner springs (8) using thick grease to hold springs in position during assembly.

Install bearing pins (17) in carrier (37) making certain they are in their original positions. Install a short bearing (16), thrust washer (17) with oil groove away from short bearing and long bearing on bearing pins (17). Bearings should be installed on same pins from which they were removed. Install planetary gears on their original pins and bearings with

**Fig. 165—Sealing rings must be installed with inside chamfer up on top ring and inside chamfer down on bottom ring. Ring gaps must be 180 degrees from each other.**



timing marks pointing toward center. See Fig. 164. Install thrust washer (24-Fig. 163) in sun gear (38) with oil groove away from gear. Install sun gear in planetary gears aligning timing marks during installation. See Fig. 164. Sun gear is installed with thrust washer (24-Fig. 163) toward carrier (37). Install bearing (19) on end cover (41) and install thrust washer (40) in end cover (41) toward carrier (37). Tighten bolts to 40 N·m (30 ft.-lbs.) torque and secure with lock plates. Install input shaft (3) in planetary assembly.

Install backing plate (3-Fig. 167) into carrier (4). There are four thin steel clutch plates (2), three grooved bronze clutch plates (5) and one smooth bronze clutch plate (6). Install one grooved bronze plate into carrier on top of backing plate, then one thin steel plate, another grooved bronze plate, a thin steel plate, then **SMOOTH** bronze plate (6), a thin steel plate, a grooved bronze plate and remaining thin steel plate should be last. See Fig. 167.

Install outer clutch springs (23-Fig. 163). Align previously made alignment marks and install cylinder (5) on carrier

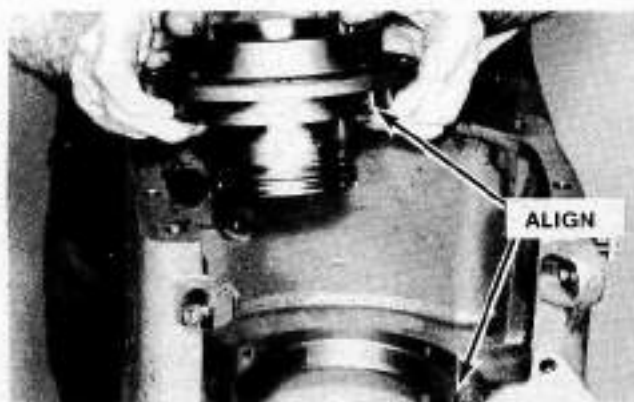
(37). Tighten bolts to 27 N·m (20 ft.-lbs.) torque and secure with lock plates.

**299. REINSTALLATION OF PLANETARY ASSEMBLIES.** Make certain the three locating screws for front bands and the four locating screws for rear band are in place in center carrier. See Fig. 168. Note free wheel assembly (21-Fig. 163) is installed with wide edge toward bearing carrier (42) and make certain thrust washer (31-Fig. 162), bushing (32) and seal (8) are in front input shaft (1).

Install bushing (24-Fig. 162) in support sleeve (25), apply gasket sealer to support sleeve and front end plate mating surface and install support sleeve. Tighten bolts to 20 N·m (15 ft.-lbs.) torque. Install sealing washers (26) as shown in Fig. 165. Install oil seal (22) in front end plate (23). Front end plate bolt is tightened to 20 N·m (15 ft.-lbs.) torque and support tube bolt is tightened to 12 N·m (9 ft.-lbs.) torque.

Reinstall by reversing removal procedure for planetary gear assemblies and adjust planetary brake bands as outlined in paragraph 300.

**Fig. 166—Align lubrication holes in bearing carrier and center carrier as shown during installation. Tighten retaining bolts to 40 N·m (30 ft.-lbs.) torque.**





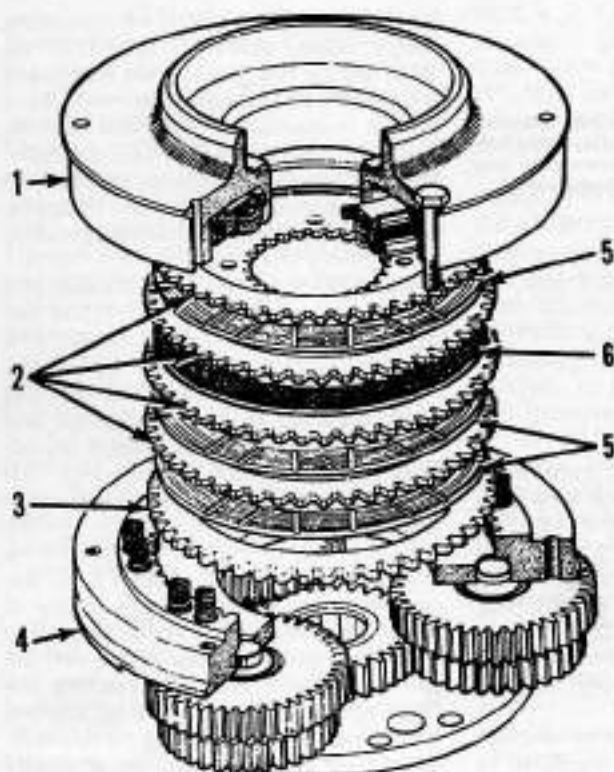


Fig. 167—Install backing plate, grooved bronze clutch plates, smooth bronze clutch plate and thin steel clutch plates for rear planetary clutch in sequence shown.

1. Cylinder assy.
2. Thin steel clutch plates
3. Backing plate
4. Carrier
5. Grooved bronze clutch plates
6. Smooth bronze clutch plate

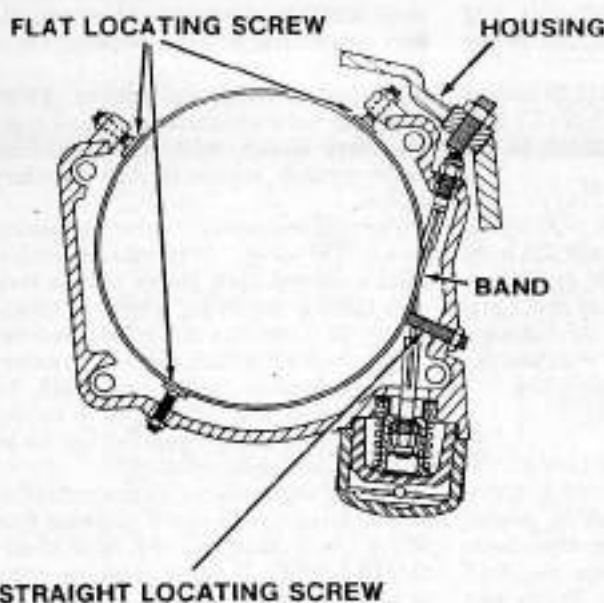


Fig. 168—View of rear planetary brake band and housing showing location of the four locating screws. Front assembly is similar with only three locating screws.

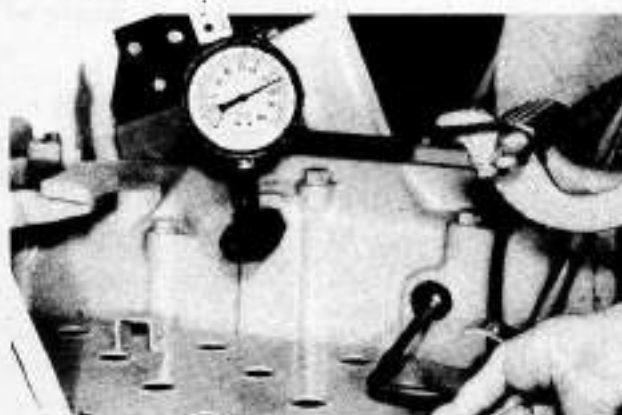


Fig. 169—View showing gage placement for adjusting planetary brake bands and location of adjustment screw for front planetary brake bands.

**300. PLANETARY BRAKE SPRING ADJUSTMENT.** Check front (40—Fig. 162) and rear (33—Fig. 163) planetary brake springs against the following specifications before adjusting planetary brake bands.

Number of coils ..... 6  
Free length ..... 76.962 mm (3.031 inches)  
Test at ..... 53.975 mm (2.125 inches)  
1245 N (280 lbs.)

Install seat, spring, cone washer and front band adjusting nut. Tighten nut until distance from cylinder mounting surface of center carrier to outer surface of spring sleeve is 33.338 mm (1-5/16 inches) if new brake bands were installed and 35 mm (1-3/8 inches) if used brake bands were installed. Measurement must be taken at four points on sleeve surface. Install washer, snap ring, piston and cylinder. Tighten cylinder retaining bolts to 23-27 N·m (17-20 ft.-lbs.) torque. Connect hydraulic line. Turn all locating screws clockwise until they contact brake bands, then turn counter-clockwise 1/2-turn. Tighten lock-nuts.

Repeat procedure for rear planetary brake band noting locating screws are turned counter-clockwise 1/2-turn after contacting brake band. Tighten locknuts.

Final planetary brake band adjustment must be made with tractor running as outlined in paragraph 301, 302 and 303.

**301. PLANETARY BRAKE BAND ADJUSTMENT.** Planetary brake bands provide braking on over-run and wear will be indicated by delay in shifting down or failure to hold in gear. Brake bands may be adjusted, if not worn beyond limits of adjustment. It may be necessary to adjust planetary brake springs, as outlined in paragraph 300, before planetary brake bands are adjusted to make up for brake band wear. Transmission fluid must be at normal operating temperature, 40-50° C (104-122° F) and engine off. Remove plugs from transmission cover, special plug (6—Fig. 151) from control valve and install gage manifold (CAS-1242) and a 0-690 kPa (0-100 psi) gage in control valve. See Fig. 169.

**302. FRONT PLANETARY BRAKE BAND ADJUSTMENT.** Start engine, place range selector in neutral and power shift in fourth gear. Increase engine speed until pressure gage reads 517 kPa (75 psi), note engine rpm. Maintain this rpm, remove plug from transmission cover and tighten adjusting nut until engine speed drops 25 rpm. Depress foot clutch and **LOOSEN** adjusting nut four turns. Apply sealer to

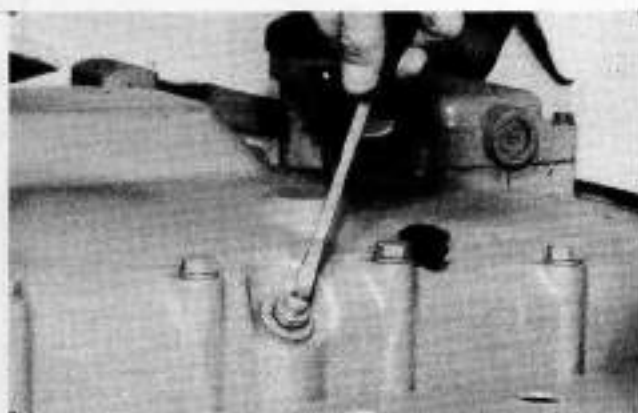


Fig. 170—View showing location of adjustment hole plug and screw for rear planetary brake bands.

plug which covers adjusting nut. Install and tighten plug until it contacts end of brake band, then loosen plug 1/4-turn.

**303. REAR PLANETARY BRAKE BAND ADJUSTMENT.** Remove jam nut, adjusting screw and plug from transmission cover. See Fig. 170. Start engine, place range selector in neutral and power shift in fourth gear. Increase engine speed until pressure gage reads 517 kPa (75 psi), note engine rpm. Maintain this rpm and go through plug opening and tighten adjusting nut until engine speed drops 25 rpm. Depress foot clutch and **LOOSEN** adjusting nut four turns. Apply sealer to plug and install. Install adjusting screw into plug and tighten screw until it contacts end of brake bands, then loosen 1/2-turn. Lock screw in this position with jam nut.

Remove gage and manifold, reinstall special plug (6—Fig. 151) in control valve and plug in transmission cover.

**304. POWER SHIFT CONTROL VALVE.** Power shift control valve spool and body (4—Fig. 151) are serviced as an assembly only, however relief valve spring (2) and spool (3), detent spring (21) and ball (22) are available separately.

With control valve removed, disassemble by removing lock wire from relief valve adjusting screw (1—Fig. 151) and remove screw (1), noting number of turns for reassembly, spring (2) and spool (3). Remove detent plug (20), spring (21) and ball (22). Remove snap rings from control valve spool and remove spool. Remove test port plug (6) and restrictor plate (7).

Inspect all parts for wear or scoring. Relief valve spring should conform to the following specifications:

Number of coils ..... 12  
Free length ..... 43.78 mm  
(1.718 inches)

Test at ..... 31.75 mm (1.25 inches)  
34.2 N (7.7 lbs.)

Detent spring should conform to the following specifications:

Number of coils ..... 10  
Free length ..... 22.22 mm (0.875 inch)  
Test at ..... 18.644 mm (0.734 inch)  
129 N (29 lbs.)

Make certain control valve spool and bore are free of scores or damage, lubricate all parts during reassembly and reverse disassembly procedure.

**305. SETTING CONTROL VALVE PRESSURE.** Reinstall control valve and reassemble tractor leaving power shift lever assembly off at this time. Remove plug and install gage manifold (CAS-1242) and 0-690 kPa (0-100 psi) gage. See Fig. 169. Start engine and bring

ing transmission fluid to operating temperature, 40-50° C (104-122° F). With engine running at 1500 rpm insert a screwdriver through power shift lever hole in transmission cover and turn adjustment sleeve (1—Fig. 151) for relief valve clockwise to increase pressure or counter-clockwise to decrease pressure. Set pressure to the following specifications:

Model 1490 ..... 350-558 kPa  
(77-81 psi)  
Model 1690 ..... 599-627 kPa  
(87-91 psi)

Stop engine, remove manifold and gage. Remove transmission cover and wire relief valve adjusting sleeve in position, reinstall special plug (6—Fig. 151) and transmission top cover. Reassemble tractor.

**306. SEQUENCE VALVES.** Sequence valves control release timing of front and rear clutch units and while front and rear sequence valves are the same they have different pressure settings and therefore should be marked before removal so they may be reinstalled in their original positions. Normally these valves will not require any adjustment and adjustment of valves will not cure other malfunctions, however slight adjustment may be necessary to match individual transmission actions. Front sequence valves control release of front planetary clutch, while rear sequence valve controls release of rear planetary clutch.

Turning sequence valve adjusting screw (11—Fig. 171) out (counter-clockwise) will slow clutch release time and turning adjusting screw in (clockwise) will result in a faster release time.

Sequence valves are serviced as a complete assembly only, but may be disassembled and cleaned. It is recommended adjustment screw setting not be changed during disassembly.

All new sequence valves are set at factory to 234-248 kPa (34-36 psi) with flow of 1.9 L/min (1/2-gpm) with oil at 45-50° C (113-122° F). If a new sequence valve is to be installed in front position, increase factory setting by turning ad-

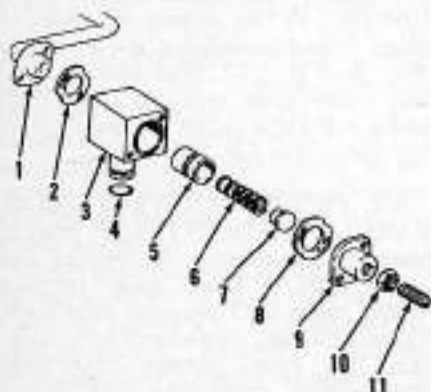
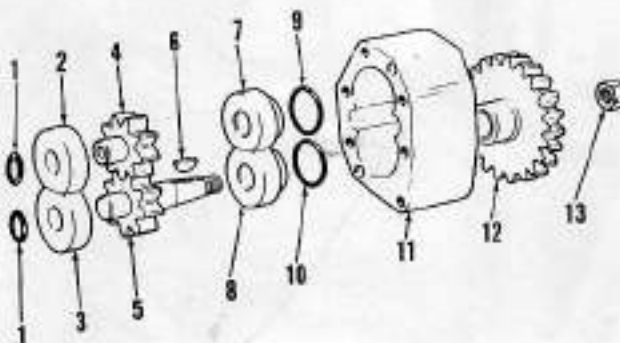


Fig. 171—Exploded view of sequence valve. Adjustment screw (11) position should not be changed unless valve pressure is to be reset as outlined in paragraph 306.

Fig. 172—Exploded view of power shift hydraulic pump showing component parts and their relative positions.

1. "O" rings
2. Bearing
3. Bearing
4. Rotor (driven)
5. Rotor (drive)
6. Key
7. Bearing
8. Bearing
9. "O" ring
10. "O" ring
11. Pump body
12. Drive gear
13. Nut





juster screw IN two full turns. If valve is installed in rear position factory setting is correct.

Pressure setting of sequence valves may be checked by removing valves, blocking orifice in piston (5-Fig. 171) with masking tape, reassemble valve and attach to a 0-414 kPa (0-60 psi) gage and suitable hand pressure pump. Operate hand pump smoothly and slowly and note pressure release point on gage. Adjust screw (11-Fig. 171) until pressure release point is 210-220 kPa (32-33 psi). If valve is to be installed in rear position, secure screw (11) in position with jam nut (10). If valve is to be installed in front position, turn screw (11) IN two full turns and secure with jam nut (10). Remove masking tape from piston orifice, reassemble valve and install in proper position.

**307. POWER SHIFT HYDRAULIC PUMP.** Power shift hydraulic pump is mounted on lower right-hand corner of end plate (43-Fig. 163) and is gear driven from reverse gear of range gear box.

Use a gear puller to remove drive gear (12-Fig. 172) and note rotor assembly

(2, 3, 4, 5, 7 and 8) is serviced as a complete unit. Oil grooves in bushings (2, 3, 7 and 8) are installed against rotor gears (4 and 5). Install new "O" rings. Gear retaining nut (13) is tightened to 73-87 N·m (54-64 ft.-lbs.) torque.

**308. POWER SHIFT RANGE GEAR BOX.** Power shift transmissions incorporate a three-speed range gear box to increase the four-speeds available from the power shift to twelve speeds. To remove range gear box, it is first necessary to remove power shift unit as outlined in paragraph 262. Disconnect and remove hydraulic supply line at power shift hydraulic pump manifold. Remove roll pin (20-Fig. 173) and noting nuts (6 and 7) are left-hand thread, remove nuts. Remove spacer (21) and bearing (22). Remove abutment plate (20-Fig. 163) and free wheel (21). Remove end plate (8-Fig. 173) retaining bolts, end plate and mounting studs. Remove thrust washer (23), note number and thickness of shims (24) and remove. Remove spacer (25). Remove second gear (27), the two needle roller bearings (9) and race (26). Remove shift rod, shift fork, sliding collar (11) and gear (10) as an assembly. Remove bear-

ing race (12) and bearing (28). Remove input shaft assembly (4). Remove reverse gear (29), thrust washer (13), third gear (15), bearing (30) and race (14). Remove shift rod, shift fork and sliding collar (16) and gear (31) as an assembly. Remove idler shaft assembly (39). Remove bearing (33), race (32), first gear (17) and thrust washer (34). Remove shift interlock plug (43), detent ball (45), spring (44) and neutral start switch, rods and balls.

**309. INSPECTION.** Inspect all gears, thrust washers and bearings for excessive wear or damage. Inspect bearing cups in range housing and end plate. If bearings are renewed, renew mating race or cup. If renewal of bearing or cup on input shaft or idler shaft is necessary, end play must be reset.

If renewal of pinion shaft or bearing is required, pinion shaft bearing protrusion must be set as outlined in paragraph 314.

**310. REASSEMBLY.** With pinion shaft protrusion set and pinion shaft installed make certain bearing cups are installed in end plate (omit shims 2 and 37) if setting input shaft and idler shaft end play.

**311. IDLER SHAFT AND INPUT SHAFT END PLAY.** Install bearings on idler and input shafts. Install spacer (1-Fig. 173) and bearing cup MINUS shim (2) in end plate (8). Install bearing cup (38) MINUS shim (37) in end plate. Place idler shaft assembly and input shaft assembly in position in range housing, install end plate and install four bolts in place of mounting studs. Tighten bolts to 95 N·m (70 ft.-lbs.) torque.

Mount dial indicator so probe contacts end of idler shaft through hole in end plate. Measure and record amount of end play.

Mount dial indicator so probe contacts end of input shaft. Measure and record amount of end play.

Remove end plate (8) and install correct thickness of shims under each bearing cup to obtain 0.051-0.102 mm (0.002-0.004 inch) end play for each shaft. Make certain spacer (1-Fig. 173) is in place. Remove idler shaft and input shaft from range housing (36).

**312. PINION SHAFT ASSEMBLY.** Install thrust washer (34-Fig. 173) on pinion shaft (19) with oil grooves facing away from bearing (35). Install first gear (17), bearing (33) and race (32). Install idler shaft assembly (39) and input shaft assembly (4). Install shift interlock plug (43) in bore between shift rod holes in range housing. Install sliding collar

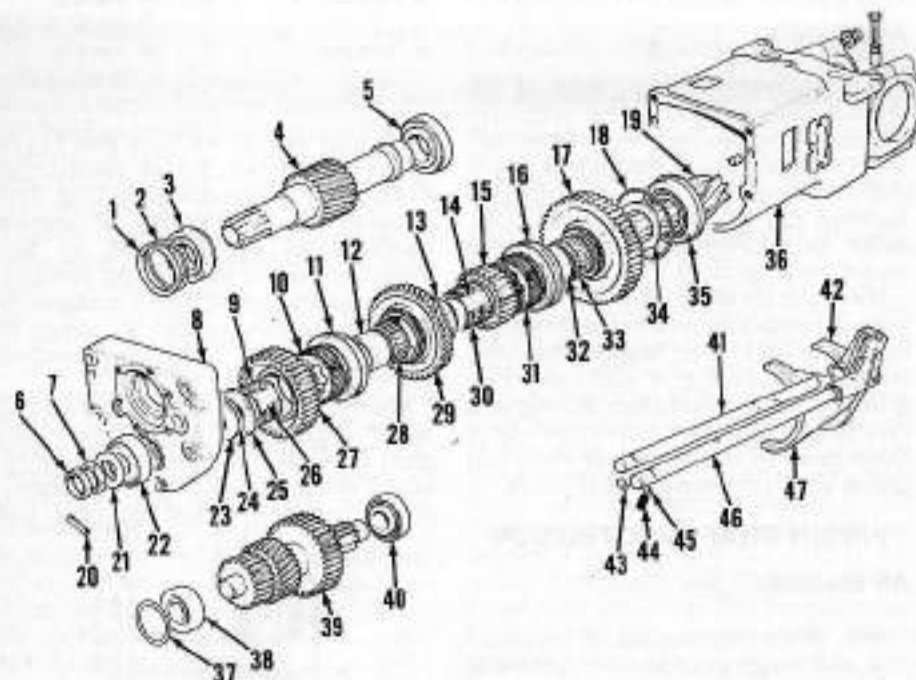


Fig. 173—Exploded view of power shift transmission showing component parts and their relative positions.

- |                           |                        |                           |                                    |
|---------------------------|------------------------|---------------------------|------------------------------------|
| 1. Spacer                 | 14. Bearing inner race | 26. Bearing inner race    | 38. Bearing & cup                  |
| 2. Shim                   | 15. Third range gear   | 27. Second range gear     | 39. Idler shaft                    |
| 3. Bearing & cup          | 16. Sliding collar     | 28. Needle roller bearing | 40. Bearing & cup                  |
| 4. Input shaft            | 17. First range gear   | 29. Reverse range gear    | 41. Second reverse range shift rod |
| 5. Bearing & cup          | 18. Shim               | 30. Needle roller bearing | 42. Second reverse shift fork      |
| 6. Slotted nut            | 19. Pinion shaft       | 31. Sliding collar gear   | 43. Shift interlock plug           |
| 7. Nut                    | 20. Roll pin           | 32. Bearing inner race    | 44. Detent spring                  |
| 8. End plate              | 21. Washer             | 33. Needle roller bearing | 45. Detent ball                    |
| 9. Needle roller bearings | 22. Bearing & cup      | 34. Thrust washer         | 46. First/third range shift rod    |
| 10. Sliding collar gear   | 23. Thrust washer      | 35. Bearing               | 47. First/third shift rod          |
| 11. Sliding collar        | 24. Shim               | 36. Range housing         |                                    |
| 12. Bearing inner race    | 25. Spacer             | 37. Shim                  |                                    |

gear (31). Place sliding collar (16) in appropriate shift fork and install shift rod, shift fork and sliding collar as an assembly. Use tool shown in Fig. 158 and install detent ball and spring. Install third gear (15), two bearings (30) and race (14). Install thrust washer (13) with oil grooves facing away from third gear (15). Install reverse gear (29), bearing (28) and race (12). Install sliding collar gear (10). Place sliding collar (11) in remaining shift fork and install shift rod, shift fork and sliding collar as an assembly. Install detent ball and spring. Install second gear (27), bearing (9) and race (26). Install spacer (25) with larger outside diameter against gear (27). Install shim (24) removed during disassembly and thrust washer (23). Flat side of thrust washer goes against

shims. Install end plate (8) and tighten retaining bolts to 40 N·m (30 ft.-lbs.) torque. Install bearing (22), washer (21) and nut (7). Noting nut has left-hand threads tighten to 271 N·m (200 ft.-lbs.) torque. Mount dial indicator so probe contacts end of pinion shaft. Measure and record end play. Correct end play is 0.051 mm (0.002 inch) end play to 0.051 mm (0.002 inch) preload. Adjust by adding or subtracting shim thickness (24).

With correct thickness shims (24) installed and gear box reassembled, install nut (6) and tighten against nut (7) to 271 N·m (200 ft.-lbs.) torque. Back off nut (6) just until roll pin (20) may be installed and install roll pin. Reinstall oil supply line, free wheel and abutment plate.

Reassemble by reversing disassembly procedure.

## MAIN DRIVE BEVEL GEARS AND DIFFERENTIAL

Models 1190, 1290, 1390 and 1490 are equipped with similar differential assemblies having two spider gears (6—Fig. 174). Model 1490 uses thrust washers (8) on axle gears (5 and 7). With exception of installation of thrust washers (8) on axle gears of 1490 models, service procedures are identical.

Model 1690 is equipped with a four spider gear (8—Fig. 175) differential which utilizes a slightly different differential lock mechanism.

Procedure for setting pinion shaft protrusion or carrier bearing and bevel gear backlash is similar for all models.

### R&R DIFFERENTIAL ASSEMBLY

#### All Models

313. To remove pinion shaft of differential assembly, it is first necessary to remove and disassemble synchromesh transmission or range gear box of power shift transmission if so equipped. Remove pto housing and rear axles. Refer to appropriate paragraphs for model being serviced.

Make certain differential bearing caps are marked before removal as they must be reinstalled in their original positions. Note pinion shaft gear and bevel ring gear are matched and available only as a matched set, **DO NOT** renew just one of these gears as improper gear mesh and pinion shaft protrusion would result.

#### PINION SHAFT PROTRUSION

#### All Models

314. While construction of transmission and range gear box are different, method for determining correct pinion shaft protrusion is the same. It is not necessary to install gears on pinion shaft, however bearings and cups to be used for final assembly **MUST** be installed to set pinion shaft protrusion.

Assemble pinion shaft in transmission or range housing, install end plate and tighten pinion shaft nut until all free play is just removed. Note pinion shaft protrusion dimension etched on pinion

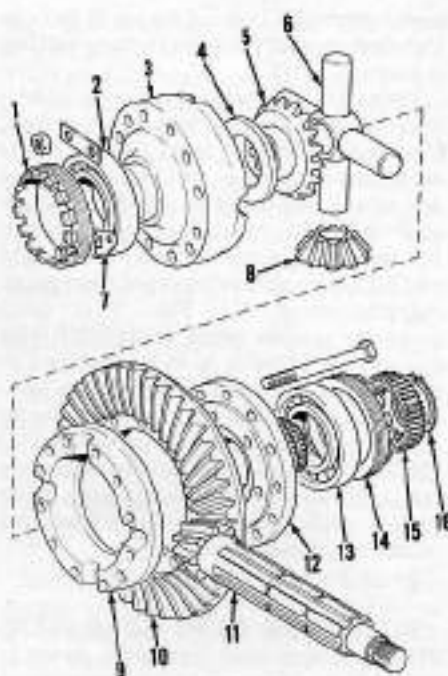


Fig. 175—Exploded view of four pinion gear differential assembly showing component parts and their relative positions.

- |                       |                       |
|-----------------------|-----------------------|
| 1. Adjuster ring nut  | 9. Inner carrier half |
| 2. Bearing            | 10. Bevel ring gear   |
| 3. Outer carrier half | 11. Pinion shaft      |
| 4. Thrust washer      | 12. End plate         |
| 5. Axle gear          | 13. Bearing           |
| 6. Pinion gear cross  | 14. Adjuster ring nut |
| 7. Lock               | 15. Gear              |
| 8. Pinion gear        | 16. Snap ring         |

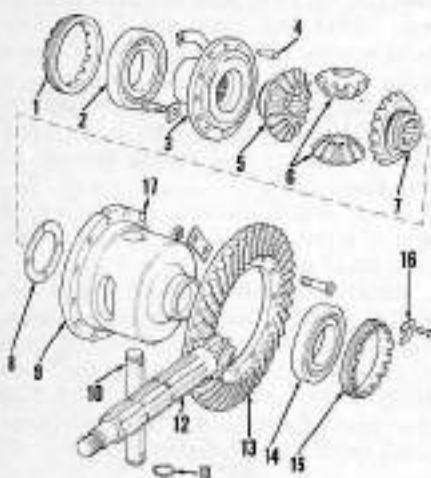


Fig. 174—Exploded view of typical two pinion gear differential showing component parts and their relative positions. Note thrust washers (8) are not used on 1190, 1290 and 1390 models.

- |                      |                       |
|----------------------|-----------------------|
| 1. Adjuster ring nut | 10. Pin               |
| 2. Bearing           | 11. Snap ring         |
| 3. End plate         | 12. Pinion shaft      |
| 4. Dowel pin         | 13. Bevel ring gear   |
| 5. Axle gear         | 14. Bearing           |
| 6. Pinion gears      | 15. Adjuster ring nut |
| 7. Axle gear         | 16. Lock              |
| 8. Thrust washer     | 17. Special shawl     |
| 9. Carrier           |                       |

shaft gear end. It will be a plus (+) or minus (-) number. Install special tool (CAS-1234) noting spacer (2—Fig. 176) installed on tool **MUST** be correct thickness as recommended by tool manufacturer for model being serviced. Adjust tool so probe lightly contacts inner bearing race surface as shown in Fig. 176. Using a feeler gage measure and record gap (1—Fig. 176).

Special tool (CAS-1234) has a built-in specified dimension of 0.762 mm (0.030 inch) when used with correct spacer for model being serviced. Use this dimension, dimension etched on gear and

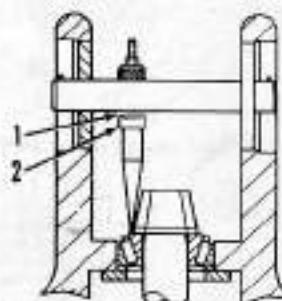


Fig. 176—View showing proper use of special tool CAS-1234 and location of gap (1) to be measured. Spacer (2) thickness is determined by tool manufacturer according to model being serviced.



feeler gage dimension to determine correct shim thickness to be installed at pinion shaft bearing by substituting appropriate dimension in the following example:

Specified dimension	0.762 mm (0.030 in.)
Etched number (+ or -)	x.xxx mm (x.xxx in.)

Total is correct setting dimension

Measured gap	x.xxx mm (x.xxx in.)
Correct setting dimension	-x.xxx mm (x.xxx in.)
Additional shims required	x.xxx mm (x.xxx in.)

If correct setting dimension is larger than measured gap, shims equal to this must be removed.

Pinion shaft bearing shim location for 1190, 1290 and 1390 models is (44 - Fig. 154), for 1490 and 1690 models (41 - Fig. 160) and for power shift models (18 - Fig. 173).

Recheck pinion shaft setting after changing shims.

## DIFFERENTIAL CARRIER BEARINGS AND BEVEL GEAR BACKLASH

### All Models

315. On all models, adjustment of differential carrier bearings to provide proper bevel gear backlash and bearing adjustment is correlated with pinion protrusion adjustment as outlined in paragraph 314.

Install differential assembly, but do not securely tighten differential bearing caps. Install adjuster rings (1 and 15 - Fig. 174) and turn in until end play of differential in carrier is less than 0.051 mm (0.002 inch) without preloading bearings. Mount dial indicator as shown in Fig. 16 and move carrier assembly sideways as required to obtain correct bevel gear backlash of 0.178-0.229 mm (0.007-0.009 inch) by loosening one adjuster ring nut one turn at a time and tightening opposite adjuster nut the same amount each time. When bevel gear backlash and differential carrier bearings are properly adjusted, install adjuster ring nut locks (16 - Fig. 174) and tighten differential bearing cap retaining bolts to 163 N·m (120 ft.-lbs.) torque.

## OVERHAUL DIFFERENTIAL ASSEMBLY

### Two Pinion Gear Differential

316. Remove carrier bearings (2 and 14 - Fig. 174). Mark end plate (3), carrier (9) and bevel ring gear (13) positions

for reassembly and remove snap ring (11) and drive pin (10) in until special dowel (17) may be removed. Remove pin (10). Remove bevel ring gear retaining bolts and remove bevel ring gear (13). Remove end plate (3), axle gear (5), pinion gears (6) and axle gear (7). Remove thrust washers (8) from each axle gear, if so equipped.

317. Inspect all gears for wear, chips or damage. Pinion shaft (12 - Fig. 174) and bevel ring gear (13) are matched and must be renewed in matched sets only. Thrust washers (if so equipped) and mating surfaces must be smooth and free of scores or excessive wear. Examine pin (10) for wear on pinion gear running surfaces. Inspect carrier bearings for roughness or wear. Renew parts as needed.

318. Lubricate all parts during reassembly with specified transmission fluid, make certain previously made position marks are in alignment and reverse disassembly procedure. Tighten bevel ring gear retaining bolts to 68 N·m (30 ft.-lbs.) torque and secure with lock plates.

### Four Pinion Gear Differential

319. Mark positions of outer carrier half (3 - Fig. 175), inner carrier half (9), bevel ring gear (10) and end plate (12) for reassembly and remove axle gear (5), cross (6) and four pinion gears (8) and remaining axle gear. Remove thrust washers (4) from each axle gear. Remove inner carrier half (9), bevel ring gear (10) and end plate (12). Remove snap ring (16) and gear (15).

320. Inspect all gears for wear, chips or damage. Pinion shaft (11 - Fig. 175) and bevel ring gear (10) are matched and must be renewed in matched sets only. Thrust washers and mating surfaces must be smooth and free of scores or excessive wear. Examine pinion gear cross (6) for wear on pinion gear running surfaces. Inspect carrier bearings for roughness or wear. Renew parts as needed.

321. Lubricate all parts during reassembly with specified transmission fluid, make certain previously made position marks are in alignment and reverse disassembly procedure. Tighten bevel ring gear and carrier retaining bolts to 102 N·m (75 ft.-lbs.) torque and secure with lock plates.

## DIFFERENTIAL LOCK

### All Models

322. Depressing differential lock foot pedal causes sleeve (12 - Fig. 177) on 1690 models or sleeve (13) on all other

models to engage gear (1690 models) or splines (all other models) of differential end plate. This overrides pinion and axle gear action causing both final drives to turn with equal power and speed for improved traction under adverse conditions. When pedal is released spring (11) pushes locking sleeve out of engagement and differential resumes normal operation. It is sometimes necessary to slightly depress one wheel brake to enable spring (11) to overcome binding of sleeve caused by engagement and release differential lock.

Locking sleeve (12 or 13) and release spring (11) may be removed after removal of right final drive assembly as outlined in paragraph 324. Differential engagement gear (1690 models) or sleeve (all other models) is an integral part of differential assembly and differential must be removed and disassembled for service. Refer to appropriate paragraph for model being serviced.

With final drive assembly and pinion shaft inner seal retainer removed, work through axle housing opening and remove locking sleeve (12 or 13) and spring (11). It may be necessary to manipulate differential lock pedal to disengage fork (10) from groove in locking sleeve. Remove snap ring (1), lever (2), key (7) and "O" ring (3). Push shaft and fork assembly (6 and 10) into axle housing and remove through axle housing opening. Fork (10) may be removed from shaft (6), if necessary. Remove snap ring (5) and bushing (4).

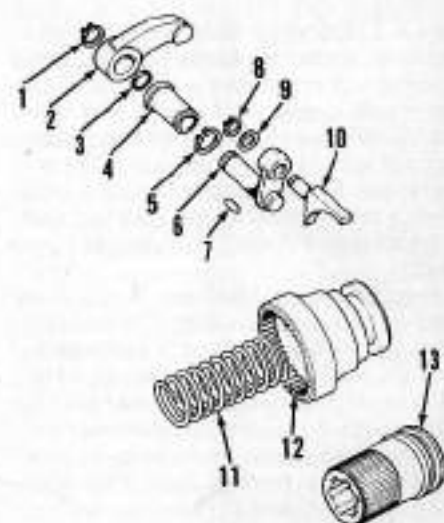


Fig. 177 - Exploded view of differential lock component parts. Note pedal and linkage arrangement varies from model to model.

- |              |                         |
|--------------|-------------------------|
| 1. Snap ring | 8. Snap ring            |
| 2. Lever     | 9. Washer               |
| 3. "O" ring  | 10. Fork                |
| 4. Bushing   | 11. Spring              |
| 5. Snap ring | 12. Sleeve, 1690        |
| 6. Shaft     | 13. Sleeve, 1190, 1290, |
| 7. Key       | 1490 and 1490 models    |

Inspect splines, bushings and linkage for wear and check spring (11) against the following specifications:

Maximum free length	133.4 mm
	(5-1/4 inches)
Minimum free length	127 mm
	(5 inches)
Test at	61.9 mm (2-7/16 inches)
	169 N (38 lbs.)
Test at	36.5 mm (1-7/16 inches)
	227 N (50 lbs.)

Reverse removal procedure noting special tool (CAS-1633) is available to aid installation of locking sleeve and spring. Install spring in differential end plate, place sleeve on end of special tool (CAS-1633) and push sleeve and spring in until sleeve splines engage differential end plate splines and fork (10 - Fig. 177) is in groove of sleeve. Wire lever (2) in engaged position to hold sleeve and spring in place during remainder of reassembly.

## FINAL DRIVE

Final drive assembly consists of rear axle, axle (bull) gear, spur (bull) pinion, brake drum or discs and housing. Stub axle, bearings and bull gear can be serviced without removal of entire final drive assembly; however if axle shaft, brake drum or discs are to be serviced entire final drive assembly must be removed.

### LUBRICATION AND BREATHER

#### All Models

323. Lubricating fluid for final drive gears is contained in each final drive housing and other than a breather, final drive unit is sealed. It is recommended fluid be changed at 800-1000 hour intervals. Models 1190, 1290 and 1390 require 2.3 L (2 1/2 qts.) per unit, 1490 models require 6.8 L (7 qts.) per unit and 1690 models require 7.4 L (8 qts.) per unit.

Breather assemblies are located in final drive covers (32 - Fig. 178) on 1190, 1290 and 1390 models and in brake housings on 1490 and 1690 models (1 - Fig. 179 or 180). Breathers must remain open and free of obstruction or gear motion will cause pressure build-up in final drive housing forcing fluid past axle shaft seals.

A grease fitting is located in rear axle seal housing. This fitting is not for bearing lubrication; lubricant passage leads to seal cavity and fresh grease is used to force dirt from axle shaft seal. Fitting should be lubricated every 50 hours until grease appears from seal housing. Twine, wire, grass or dirt build-up in this area or lack of regular lubrication

will result in premature seal failure. Signs of seal failure will be excessive leakage of final drive lubricating fluid at seal area.

### R&R FINAL DRIVE

#### All Models

324. Raise and support tractor tire and wheel from side to be serviced. If equipped with cab or platform, remove rear support bracket bolts and lift and support cab or platform with a suitable stand until there is a small clearance between support bracket and final drive housing. On models having drum brakes, loosen brake adjustment so brake drum will not drag on brake shoes during removal. On models having disc brakes, disconnect brake rod and remove cotter pin and clevis pin from cam lever end. Tap rod to be certain it is free. For all models, wire differential lock pedal in engaged position if removing right final drive to keep locking sleeve and spring in correct position. Attach a hoist to final drive housing, unbolt housing from rear axle casting and remove final drive assembly.

Reinstall by reversing removal procedure and tighten mounting bolts to 102 N·m (75 ft.-lbs.) torque on all models except 1490 and 1690. Tighten 1490 and 1690 models to 136 N·m (100 ft.-lbs.) torque.

### AXLE SHAFT, AXLE GEAR, BEARINGS AND SEALS

#### Drum Brake Models

325. **DISASSEMBLY.** Raise and support tractor and remove tire and wheel from side to be serviced. Drain

final drive housing and remove cover (34 - Fig. 178). Bend tabs of tab washer (19) away from nut (18) and use special wrench (CAS-1666 for 1190 or CAS-1210 for 1290 and 1390 models) loosen nut (18) on stub axle shaft (31). Place block or cushion under bull gear (20) to prevent damage when stub axle is removed and using two jack screws, washers and nuts through the two holes in flange of stub axle, remove stub axle. Turn jack screws evenly during removal of stub axle. Remove bull gear (20), tab washer (19), nut (18), bearing cone (17) and spacer (21) from inside final drive housing (10). Remove oil seal housing (26) and shim (24). Use a suitable puller to remove bearing (23) and bearing cup (17) from housing. Remove seal (22). Remove collar (28), dust shield (30) and "O" ring (29) from stub axle (31). Remove seal (27) from seal housing (26). If axle shaft (9) is to be removed, remove final drive housing as outlined in paragraph 324.

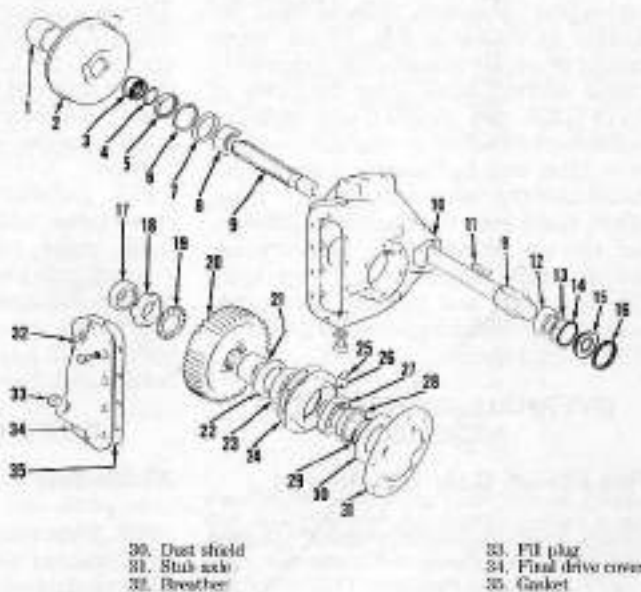
Remove snap ring (16) and press axle (9) out of housing toward wheel side. Remove end cover (15), "O" ring (14), shims (13) and bearing cup (12). Remove collar (1), drum (2) and complete removal of axle (9). Remove bearing cup (8), spacer (7) and snap ring (6). Remove seal (5). Remove the two keys (11), collar (3), "O" ring (4) and bearings (8 and 12) from shaft (9).

326. **INSPECTION.** Clean and inspect all parts. Renew all seals and "O" rings. Make certain bearings, cups and gears are not worn or damaged. Inspect brake components.

327. **REASSEMBLY.** Install bearing cones (8 and 12 - Fig. 178) on axle shaft (9). Lubricate "O" ring (4) and install in

Fig. 178 - Exploded view of final drive assembly used on drum brake models.

- Sleeve
- Brake drum
- Collar
- "O" ring
- Seal
- Snap ring
- Spacer
- Bearing & cup
- Final drive housing
- Key
- Bearing & cup
- Shim
- "O" ring
- End cover
- Snap ring
- Bearing & cup
- Nut
- Tab washer
- Bull gear
- Spacer
- Seal
- Bearing & cup
- Shim
- Grease fitting
- Seal housing
- Seal
- Sleeve
- "O" ring





collar (3). Press collar, "O" ring end first, onto axle (9) until collar seats against bearing. Install the two keys (11) in axle (9). Install bearing cup (8), spacer (7), snap ring (6) and seal (5) in housing (10). Lip of seal (5) must be toward snap ring (6). Place axle (9) into housing (10) from wheel side and install bearing cup (12). Place final drive housing and axle assembly in press and support bearing end of axle (9), align keyways of drum (2) and use steel tube 2 inches in diameter and 20-1/2 inches long to press drum onto axle until seated against collar (3). Apply hydraulic sealant to inside of collar (1) and use steel tube to press collar onto axle until seated against drum. Install cover (15) and snap ring (16) MINUS shims (13) and "O" ring (14). Mount dial indicator and measure end play of axle shaft (9). Make certain bearing cups (8 and 9) are seated against snap ring and spacer. Add 0.076 mm (0.003 inch) to end play measurement and install that thickness of shims (13) between bearing cup (12) and cover (15) to **PRELOAD** bearing 0.076 mm (0.003 inch). Install "O" ring (14), cover (15) and snap ring (16). Make certain brake drum is clean and brake shoes are in good condition, then reinstall final drive assembly on tractor.

Install "O" ring (29), dust shield (30) and collar (28) on stub axle (31). Install

seal (27) in housing (26) with lips of seal toward outside of housing. Lubricate seal and install housing and seal assembly on stub axle. Install bearing cup and bearing (23) and spacer (21). Make certain chamfered end of spacer is away from bearing.

Install bearing cup (17) and seal (22). Lip of seal must be toward inside of housing and installed to a depth of one inch from outer face of housing. Lubricate bearing (17) and install in cup. Install bull gear (20) in final drive housing and support on block or cushion. Install stub axle assembly, rotating stub axle to engage splines of bull gear. Install tab washer (19) and nut (18) as stub axle is installed. Install three bolts, at equal distance, in seal housing (26) making certain grease fitting (25) is toward rear of tractor. **DO NOT** tighten bolts at this time. Start nut (18) on threads and tighten with special spanner wrench. Tighten by hand, then use a hammer on wrench to tighten even more. This nut must be very tight or premature bearing failure will result. Secure nut (18) with tab washer (19).

Hit flange of stub axle (31) as the three bolts are evenly tightened on seal housing (26). Tighten bolts until all end play is removed from stub axle. Measure gap between oil seal housing and final drive housing at three places and adjust bolts

until all three measurements are the same. Install a thickness of shims (24) 0.13 mm (0.005 inch) **THICKER** than measured gap to preload bearings 0.13 mm (0.005 inch). Install seal housing retaining bolts and tighten to 68 N·m (50 ft.-lbs.) torque. Lubricate fitting (25) until grease is forced past seal lips. Make certain breather (32) is clean and install in cover (34). Install cover and tighten bolts to 34 N·m (25 ft.-lbs.) torque. Fill each final drive housing with 2.3 L (2½ qts.) of specified fluid and reinstall tire and wheel. Tighten wheel nuts to 203 N·m (150 ft.-lbs.) torque and adjust brakes as necessary.

### Model 1490

**328. DISASSEMBLY.** It is not necessary to remove cab or platform to service final drives.

Raise and support tractor and remove tire and wheel from side to be serviced. Disconnect brake lines and cap openings. Remove parking brake cable and final drive cover (38—Fig. 179). Bend tab washer (25) and using special wrench (CAS-1210) loosen nut (24). Remove oil seal housing (31) retaining bolts and pull stub axle (36) partially out. Remove shims (30), nut (24) and washer (25). Remove stub axle completely and remove bull gear (26) and bearing (23) from housing. Remove seal (28) and bearing cup (23) from final drive housing (6). If axle shaft (7) is to be removed, remove final drive housing as outlined in paragraph 324.

Remove parking brake lever return spring and brake cover (17) retaining bolts. Drive roll pin (13—Fig. 181) from parking brake lever (14) and remove lever and dust shield (15). Remove snap ring (7) and drive pin (8) out of actuator links. Remove brake cylinder (21—Fig. 180). Remove brake discs on top of brake actuator. Remove actuator assembly and remaining brake discs. Install brake hub puller adapter (CAS-1644-3) on brake hub (3—Fig. 179). Make certain counterbore side of adapter (CAS-1644-3) is installed toward shorter hub splines and remove brake hub (3—Fig. 179). Remove snap ring (13) and press axle shaft (7) out of final drive housing (6). End cover (12), "O" ring (11), shims (10) and bearing cup (9) will be pressed out of final drive housing along with axle (7). Remove brake hub keys (8), spacer (4) and bearings (5 and 9), if necessary, from axle shaft. Remove remaining bearing cup from final drive housing and the two pinion shaft oil seals (14 and 15) from brake cover (17). Remove spacer (27) from stub axle (36) and press stub axle out of bearing (29). Remove seal housing (31), dirt shield (35) and "O" ring (34). Remove seal (32) from housing (31).

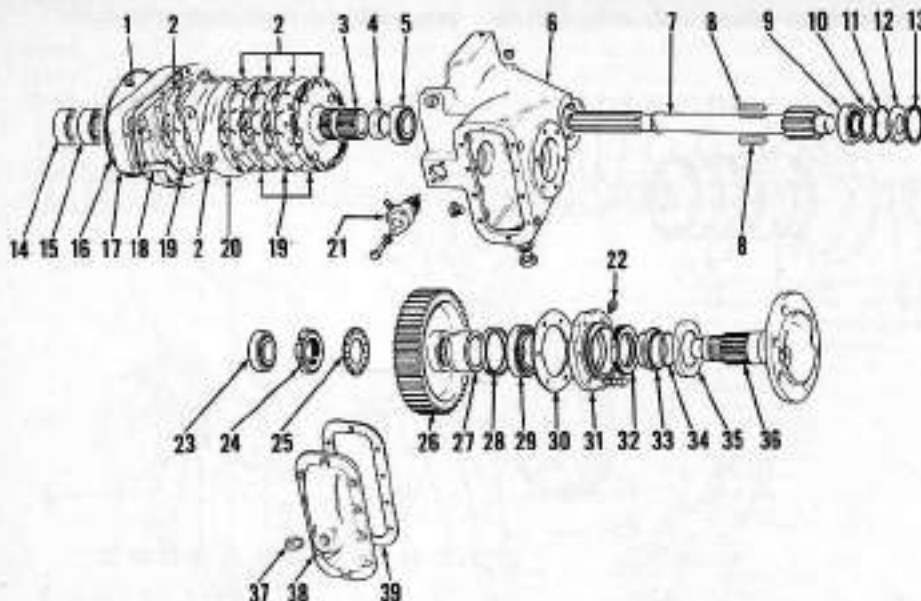


Fig. 179—Exploded view of Model 1490 final drive showing component parts and their relative positions.

- |                        |                     |                       |
|------------------------|---------------------|-----------------------|
| 1. Breather            | 14. Outer seal      | 27. Spacer            |
| 2. Rotating disc       | 15. Inner seal      | 28. Seal              |
| 3. Brake hub           | 16. "O" ring        | 29. Bearing & cup     |
| 4. Spacer              | 17. Brake cover     | 30. Shim              |
| 5. Bearing & cup       | 18. Gasket          | 31. Seal housing      |
| 6. Final drive housing | 19. Stationary disc | 32. Seal              |
| 7. Axle shaft          | 20. Actuator assy.  | 33. Sleeve            |
| 8. Keys                | 21. Brake cylinder  | 34. "O" ring          |
| 9. Bearing & cup       | 22. Grease fitting  | 35. Dust shield       |
| 10. Shims              | 23. Bearing & cup   | 36. Stub axle         |
| 11. "O" ring           | 24. Nut             | 37. Filler plug       |
| 12. End cover          | 25. Tab washer      | 38. Final drive cover |
| 13. Snap ring          | 26. Bull gear       | 39. Gasket            |

329. **INSPECTION.** Refer to paragraph 326 for inspection procedures.

330. **REASSEMBLY.** Install bearing cones on axle shaft (7—Fig. 179). Install spacer (4) with chamfer edge toward bearing. Install bearing cup (5) in final drive housing (6) and install axle assembly (7) in final drive housing. Install outer bearing cup (9), end cover (12) and snap ring (13) MINUS shims (10) and "O" ring (11). Make certain bearing cup (9) is seated against end cover (12) and snap ring (13) and bearing cup (5) is seated in final drive housing (6). Mount dial indicator and measure and record end play of axle shaft (7). Remove snap ring (13), end cover (12) and install shim thickness 0.076 mm (0.003 inch) **THICKER** than measured end play to **PRELOAD** bearings 0.076 mm (0.003 inch). Install "O" ring (11), end cover (12) and snap ring (13). Install brake hub keys (8) and brake hub (3) making certain wider splines are next to bearing end. Install brake discs as outlined in paragraph 337. Install axle shaft inner seal (15) in brake cover (17) with seal lip toward inside surface of cover. Install outer seal with seal lip toward outside surface of cover. Lubricate seals, install gasket (18) and cover (17). Tighten bolts to 102 N·m (75 ft.-lbs.) torque. Reinstall final drive housing on tractor. Tighten mounting bolts to 136 N·m (100 ft.-lbs.) torque.

Lubricate "O" ring (34) and install on stub axle (36). Place shouldered end of oil seal sleeve (33) into dirt shield (35) and install on stub axle as an assembly. Install oil seal (32) in seal housing (31). Lubricate seal and install housing assembly on stub axle. Install outer bearing cup and cone (29) and spacer (27) on stub axle. Install inner bearing cup (23) in final drive housing. Install seal (28) in final drive housing with lip toward inside of housing. Seal must be even with inner surface of housing. Lubricate seal and install inner bearing cone (23) in its installed cup using heavy grease to hold it in position. Install bull gear (26) in final drive housing and install stub axle through final drive housing, bull gear, washer (25) and nut (24). Hand tighten nut (24) as stub axle is driven into position. Turn oil seal housing (31) until grease fitting is toward rear and install three bolts to equal distances around oil seal housing. Tighten nut (24) using special spanner wrench (CAS-1210).

**NOTE:** Nut (24) must be very tight or rapid wear and damage to gears and bearings will result.

Tighten the three oil seal housing bolts evenly until inner bearing cone seats against stub axle shoulder. Measure gap

between seal housing and final drive housing at three locations. Adjust the three bolts until gap measurement is the same at all locations. Install shim (30) thickness 0.15 mm (0.006 inch) **LESS** than measured gap. Install seal housing bolts and tighten to 68 N·m (50 ft.-lbs.) torque. Bend tab washer (25) to secure nut (24) and install cover (38) with new gasket (39). Tighten cover bolts to 40 N·m (30 ft.-lbs.) torque.

Reinstall brake lines, cab or platform mounts and wheel and tire. Tighten cab mounting bolts to 102 N·m (75 ft.-lbs.) torque and wheel nuts to 190 N·m (140 ft.-lbs.) torque. Lubricate fitting (22) until grease is forced out around dirt shield and fill final drive housing with 6.8 L (7 qts.) of specified fluid. Reinstall park brake cable and bleed brakes as necessary.

### Model 1690

331. **DISASSEMBLY.** It is not necessary to remove cab or platform to service final drives.

Raise and support tractor and remove tire and wheel from side to be serviced. Remove drain plugs from final drive housing and brake disc section and drain fluid 7.4 L (8 qts.). Remove final drive cover (41—Fig. 180) and place cushion or support under bull gear (25) to prevent damage when stub axle (39) is

removed. Remove seal housing (34) bolts and pull stub axle using care bull gear (25) does not fall out of housing. Remove bull gear (25), spacer (24), bearing (23) and spacer (27). Remove lock screw (26) and nut (28). Use press to remove stub axle from seal housing and remove sleeve (36), dirt shield (38) and "O" ring (37). Remove seal (29), bearing and cup (30) and seal (35) from housing (34). Remove "O" ring (32) from housing. If axle shaft (13) is to be removed, remove final drive housing as outlined in paragraph 324.

Remove parking brake lever return spring and brake cover (3) retaining bolts. Drive roll pin (13—Fig. 181) from parking brake lever (14) and remove lever and dust shield (15). Remove brake cylinder (19) and snap ring (7). Drive pin (8) out of actuator links and remove brake discs which are on top of brake actuator. Remove actuator assembly and remaining brake discs. Remove snap ring (19—Fig. 180) and using a soft hammer drive axle (13), cover (18), "O" ring (17), shims (16) and bearing (15) from final drive housing (12). Remove all remaining bearing cups, spacers and snap rings from final drive housing. Press axle shaft (13) out of brake hub (7) and remove two keys (14). Remove spacer (8) and bearings (11 and 15) as necessary.

332. **INSPECTION.** Refer to paragraph 326 for inspection procedures.

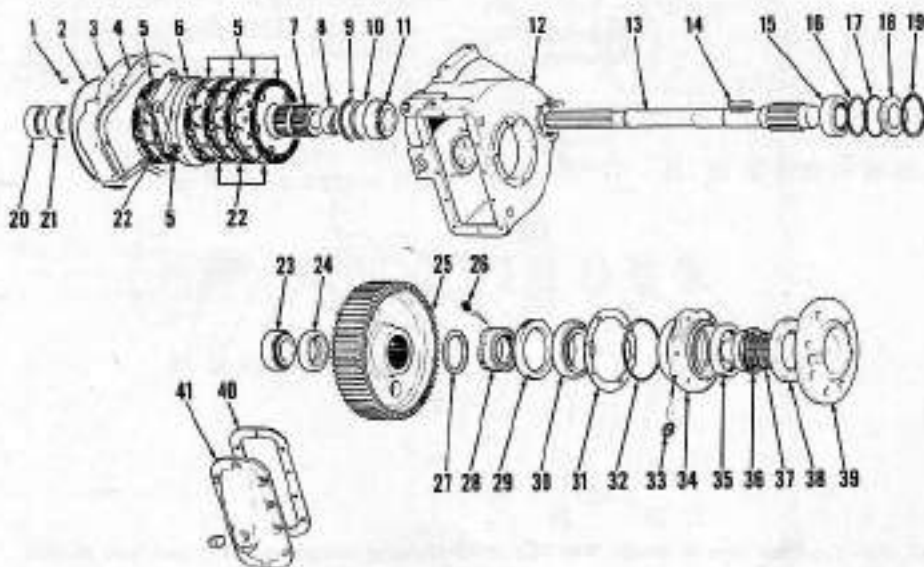


Fig. 180—Exploded view of Model 1690 final drive showing component parts and their relative positions.

- |                   |                         |                     |                       |
|-------------------|-------------------------|---------------------|-----------------------|
| 1. Breather       | 12. Final drive housing | 22. Stationary disc | 32. "O" ring          |
| 2. "O" ring       | 13. Axle shaft          | 23. Bearing & cup   | 33. Grease fitting    |
| 3. Brake cover    | 14. Key                 | 24. Spacer          | 34. Seal housing      |
| 4. Gasket         | 15. Bearing & cup       | 25. Lock screw      | 35. Seal              |
| 5. Rotating disc  | 16. Shim                | 26. Nut             | 36. Sleeve            |
| 6. Actuator assy. | 17. "O" ring            | 27. Spacer          | 37. "O" ring          |
| 7. Brake hub      | 18. End cover           | 28. Nut             | 38. Dust shield       |
| 8. Spacer         | 19. Snap ring           | 29. Seal            | 39. Stub axle         |
| 9. Snap ring      | 20. Outer seal          | 30. Bearing & cup   | 40. Gasket            |
| 10. Spacer        | 21. Inner seal          | 31. Shim            | 41. Final drive cover |



**333. REASSEMBLY.** Install bearing cones (11 and 15—Fig. 180) on axle shaft (13). Install spacer (8), two keys (14) and brake hub (7). Brake hub is installed with wider splined section against spacer. Install inner bearing snap ring (9), spacer (10) and bearing cup (11) into final drive housing (12). Make certain bearing cup is seated against spacer and snap ring. Install axle shaft (13) assembly into final drive housing. Install outer bearing cup (15), end cover (18) and snap ring (19) MINUS shims (16) and "O" ring (17). Hit end of axle shaft to seat outer bearing cup against end cover and snap ring. Mount dial indicator and measure and record amount of end play of axle shaft. Select thickness of shims (16) 0.127 mm (0.005 inch) **THICKER** than measured amount of end play and install under end cover (18). Install "O" ring (17), end cover (18) and snap ring (19). Install brake discs and actuator as outlined in paragraph 337. Install brake cover (3) and tighten retaining bolts to 102 N·m (75 ft.-lbs.) torque. Install seal (16—Fig. 181), dirt shield (15) and lever (14). Install roll pin (13) and brake return spring. Reinstall final drive housing on tractor. Tighten mounting bolts to 136 N·m (100 ft.-lbs.) torque.

Install bearing and cup (30—Fig. 180) into oil seal housing (34) until cup is seated. Install outer seal (35) with lip facing outward. Install inner oil seal (29) into seal housing with lip facing outward. Install "O" ring (37) on stub axle. Install dirt shield (38) with flat side toward stub axle flange. Install sleeve

(36) with flange side against shield. Lubricate seals and install seal housing (34). Use a smooth sided punch to drive bearing and housing down far enough to start nut (28) on threads of stub axle. Secure stub axle and using special spanner wrench (CAS-1241) fully tighten nut (28).

**NOTE: Nut (28) must be very tight or rapid wear and damage to gears and bearings will result.**

Apply "Loctite" to threads of lock screw (26) and install screw in hole of nut (28) which is opposite a spline groove in stub axle. Tighten lock screw (screw head must be approximately 0.03125 mm (1/32-inch) below surface of nut) and peen head of screw to lock in position. Lubricate and install "O" ring (32) on housing (34). Install original spacer (27).

**NOTE: Spacer (27) is available in two thicknesses, 5.2324 and 5.842 mm (0.206 and 0.230 inch) and original thickness spacer must be reinstalled.**

Install inner bearing cup (23) in final drive housing and place bearing in cup using heavy grease to retain bearing in position. Install bull gear (25) in final drive housing and partially install stub axle assembly through housing and bull gear. Install collar (24) and complete stub shaft installation. Rotate seal housing until fitting (33) is toward rear and install three retaining bolts at equal distances from each other. Tighten bolts evenly until all end play in stub axle is just eliminated. Measure and record gap

between oil seal housing and final drive housing using a feeler gage at three locations around seal housing. Measurement should be the same at each location. Select shim (31) thickness 0.127 mm (0.005 inch) less than measured gap and install between seal housing and final drive housing. Install retaining bolts and tighten to 68 N·m (50 ft.-lbs.) torque. Mount dial indicator and measure lateral (side to side) movement of bull gear. If lateral movement is not between 0.1016-0.6604 mm (0.004-0.026 inch), adjust thickness of spacer (27). Lubricate fitting (33) until grease is forced out at dirt seal (38). Install cover (41) and tighten retaining bolts to 40 N·m (30 ft.-lbs.) torque.

Reinstall brake lines, cab or platform mounts and wheel and tire. Tighten cab mounting bolts to 102 N·m (75 ft.-lbs.) torque. Fill final drive with 7.6 L (8 qts.) of specified fluid. Reinstall park brake cable and bleed brakes as necessary.

## BRAKES

### ADJUSTMENT

#### Drum Brake Models

**334.** Align left and right brake pedal height by adjusting screws (6—Fig. 182). Tighten locknuts to retain adjustment.

To adjust brakes, raise tractor until both rear wheels are off the ground and are free to turn. Make certain park brake is fully released. Turn adjusting screw (3—Fig. 182) on one brake rod only until wheel becomes difficult to turn on that side, then loosen nut (3) until wheel just begins to turn freely and tighten locknut (4).

Repeat procedure for remaining side.

Check operation of park brake as adjusting brake rods provides adjustment

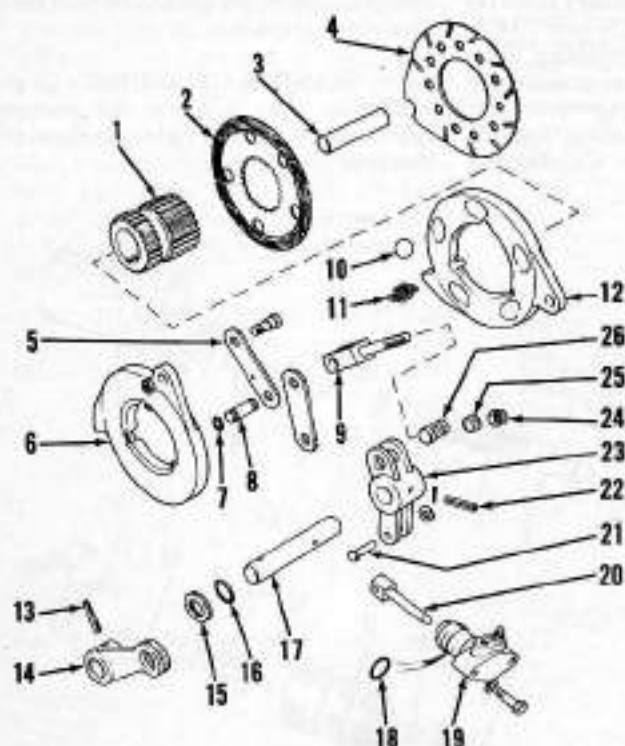


Fig. 181—Exploded view of component parts for disc brake systems showing their relative positions.

1. Brake hub
2. Rotating disc
3. Stationary disc
4. Actuating lever
5. Actuating plate
6. Snap ring
7. Pin
8. Brake adjusting fork
9. Spring
10. Ball
11. Actuating plate
12. Roll pin
13. Lever
14. Dirt shield
15. Seal
16. Brake shaft
17. "O" ring
18. Brake cylinder
19. Push rod
20. Pin
21. Roll pin
22. Ball
23. Nut
24. Spacer
25. Pivot pin

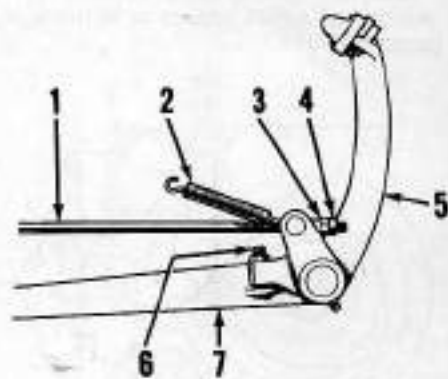


Fig. 182—View of typical brake pedal and related parts.

1. Brake rod
2. Spring
3. Adjusting nut
4. Locknut
5. Brake pedal
6. Adjusting screw
7. Park brake lever

## Paragraphs 335-339

for both foot pedals and park brake lever and road test for satisfactory operation.

### Disc Brake Models

335. Clean area around brake adjustment hole plug (1 - Fig. 183) and remove plug. Raise tractor until both rear wheels are off the ground and are free to turn. Make certain park brake is fully released. While turning wheel, turn brake adjusting nut (1) clockwise until wheel cannot be turned by hand. Turn brake adjusting nut two and one half turns counter-clockwise. Reinstall plug (2) and tighten to 81 N·m (60 ft.-lbs.) torque.

Repeat procedure for remaining side.

Check operation of park brake as adjustment will be affected and road test for satisfactory operation.

### R&R BRAKE SHOES AND DRUMS

#### All Models

336. Brake shoes and drum may be removed after first removing final drive assembly as outlined in paragraph 324.

Brake shoes and linings are available separately or as an assembly. Upper and lower shoes are interchangeable.

Use special drum removing tool kit (CAS-1211), or adapt a leg type puller to remove brake drum from axle shaft.

To install brake drum, snap ring (16 - Fig. 178), end cover (15), "O" ring (14) and shims (13) must be removed. Note number and thickness of shims (13) for reassembly. Place final drive and axle assembly in press and support bearing end of axle (9), align keyways of drum (2) and use steel tube 2 inches in diameter and 20½ inches long to press drum onto axle until seated against collar (3).

Reinstall by reversing removal procedure and adjust brakes as outlined in paragraph 334.

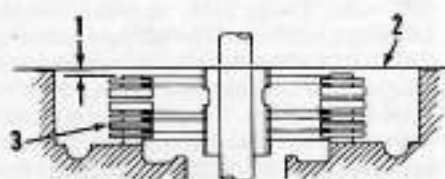


Fig. 184 - Sectional view showing space (1) to be measured under straightedge (2). Place extra stationary plate at location (3) only if necessary to bring disc height within specifications.

### R&R BRAKE DISCS

#### All Models

337. Brake discs may be removed after first removing final drive assembly as outlined in paragraph 324.

Remove parking brake lever return spring and remove brake cover (17 - Fig. 179) retaining bolts. Remove roll pin (13 - Fig. 181) and parking brake lever (14). Remove dirt shield and brake cover. Remove wheel cylinder (19). Remove snap ring (7) and drive pin (8) out of adjuster rod (9). Remove adjuster rod and bellcrank (23) assembly. Remove brake discs on top of actuator assembly, actuator assembly and brake discs which were under actuator assembly.

338. INSPECTION AND REASSEMBLY. Inspect friction surfaces in final drive housing and on brake cover. Inspect surfaces of actuator plates (6 and 12 - Fig. 183), steel ball ramp surfaces and steel balls (11) for wear or damage.

Check thickness of stationary discs (4) and renew if less than 1.9 mm (0.075 inch). Check condition of rotating discs (2) and renew all discs if one or more are worn to the point that grooves are almost gone. When reinstalling discs install a rotating disc, then a stationary

## CASE (DAVID BROWN)

disc. Install another rotating disc and stationary disc until there are four rotating discs and three stationary discs. Last disc installed must be a rotating disc. Install actuator assembly, then a rotating disc, a stationary disc and remaining rotating disc. Place straightedge across brake cover mounting surface (Fig. 184) and use a feeler gage to measure distance between straightedge and friction surface to top rotating disc. Maximum clearance is 3.12 mm (0.123 inch) and minimum clearance is 0.43 mm (0.017 inch). If disc clearance is more than 3.12 mm (0.123 inch) an extra stationary disc (3 - Fig. 184) may be installed in location shown in Fig. 184. Use this method only when new discs fail to bring clearance within specifications and note minimum clearance must still be 0.43 mm (0.017 inch).

Reinstall by reversing removal procedure and adjust brakes as outlined in paragraph 335. Bleed brakes as outlined in paragraph 342.

### DISC BRAKE HYDRAULIC SYSTEM

Disc brakes are hydraulically activated with system components being a reservoir, left and right wheel master cylinders, balance valve, left and right wheel cylinders and connecting lines. Brake fluid reservoir is located under steering console cover and master cylinders are mounted on brake pedal support bracket. Balance valve is located under hood of low profile models and under platform on all other models. Wheel cylinders are located on each rear final drive housing.

339. MASTER CYLINDERS. Overhaul kits are available for master cylinders and left and right cylinders are identical.

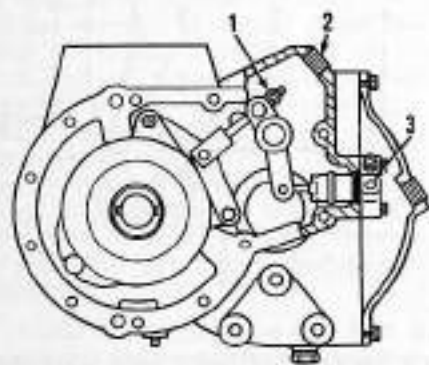
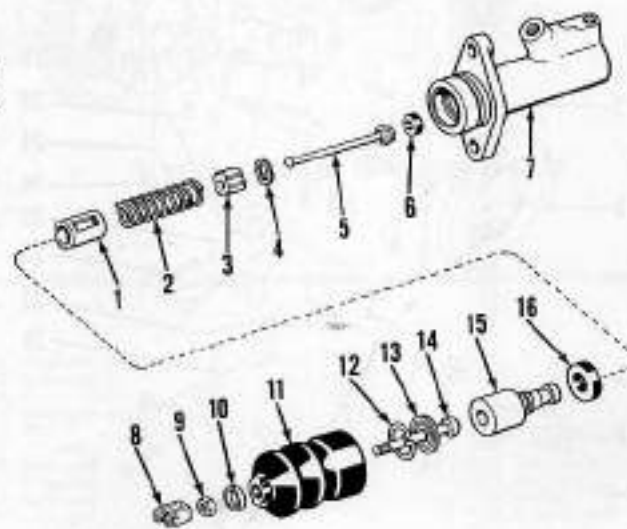


Fig. 183 - Sectional view of disc brake housing.

1. Adjusting nut  
2. Plug  
3. Wheel cylinder

Fig. 185 - Exploded view of master cylinder showing component parts and their relative positions.

1. Retainer  
2. Return spring  
3. Cap  
4. Wave washer  
5. Return spring rod  
6. Seal  
7. Master cylinder body  
8. Yoke  
9. Locknut  
10. Retainer ring  
11. Rubber boot  
12. Snap ring  
13. Washer  
14. Actuating rod  
15. Piston  
16. Piston seal





multi-speed pto assembly is shown in Fig. 188. Note gear (8—Fig. 188) replaces gear (8—Fig. 187) and gear (18—Fig. 188) replaces spacer (18—Fig. 187) for multi-speed pto. Service procedures are the same for either assembly.

Remove pto housing assembly as outlined in paragraph 343. Remove draft sensor housing and metal gasket from top of pto housing. Remove safety shields and end plate (28—Fig. 187). Remove spacer (22) and shims (21) from output shaft (24). Note number and thickness of shims. Remove snap ring (1) and drive gear (2). Remove snap ring (12), shims (13) and idler gear assembly (14). Note number and thickness of shims (13). Remove special pin (8—Fig. 191) and using care not to lose detent ball (11) and spring (10), remove shaft (7). Remove fork (12) and spacer (6). Remove rear snap ring (11—Fig. 187) and drive input shaft (9) out of bearing (10). Remove inner snap ring (11), gear (8) and shaft (9). Drive output shaft (24) out of front bearing (16) and remove shaft (24). Remove output gear (17), split rings (19) and spacer or gear if so equipped.

Inspect all gears and shafts for wear or damage. Inspect bearings and races and note if needle bearing (3) is removed a new bearing must be installed. All snap rings must be reinstalled with cupped side of snap ring toward gear, bearing race or bearing.

**346. REASSEMBLY.** Install bearing cone (20—Fig. 187) on output shaft (24). Smaller outside diameter of bearing cone must be toward rear of shaft. Install spacer (18) or gear, as equipped, and split rings (19). Apply grease to split rings so they will retain their position. Apply grease to front bearing cone (16) and place cone in cup installed in housing. Place output gear (17) in housing and install input shaft making certain split rings fit inside shoulder of output gear and shaft seats against front bearing (16). Install rear bearing cup (20). Install bearing race (4) and snap rings (5) on input shaft (9). If needle bearing (3) was removed, install new bearing using bearing driver against numbered side of bearing. Start input shaft through housing, install gear (8) and inner snap ring (11) on shaft. Reassemble shift fork, detent and shaft. Install special pin (end of pin with hole must be up). Install idler gear and bearing assembly on idler shaft, install snap ring (12) MINUS shims (13). Mount dial indicator so probe contacts inner race of idler gear bearing and measure gear movement. Remove snap ring (12) and install shims (13) with thickness 0.10 mm (0.004 inch) LESS than measured gear movement and reinstall snap ring (12). Install drive gear (2) and snap ring (1). Install all shims (21) removed during disassembly PLUS an additional 0.508 mm (0.020 inch) shim. Install spacer (22), gasket (27) and end plate (28). Rotate output shaft by hand while evenly tightening

end plate retaining bolts. Continue to rotate shaft and tighten bolts until resistance to shaft rotation is felt. Use a feeler gage to measure gap between end plate and housing at four opposite sides. Gap measurement will be the same if bolts were evenly tightened. Remove end plate and install shims (21) with thickness 0.0762 mm (0.003 inch) LESS than gap measurement to provide 0.05-0.10 mm (0.002-0.004 inch) end play. Install seal (23) in end plate and reinstall end plate tightening bolts to 68 N·m (50 ft.-lbs.) torque. Reinstall metal gasket and draft sensor housing, then reinstall pto assembly on tractor.

Reinstall by reversing removal procedure.

### Models 1390-1490-1690

**347. DISASSEMBLY.** Single speed and multi-speed pto assemblies are similar and service procedure is the same. Input shaft (8—Fig. 189) and output gear (13) are different in single speed assemblies.

Remove pto housing as outlined in paragraph 343. Remove draft sensor housing and metal gasket from top of pto housing. Remove safety shields and end plate (18—Fig. 189). Remove shims (10 and 15) noting number and thickness

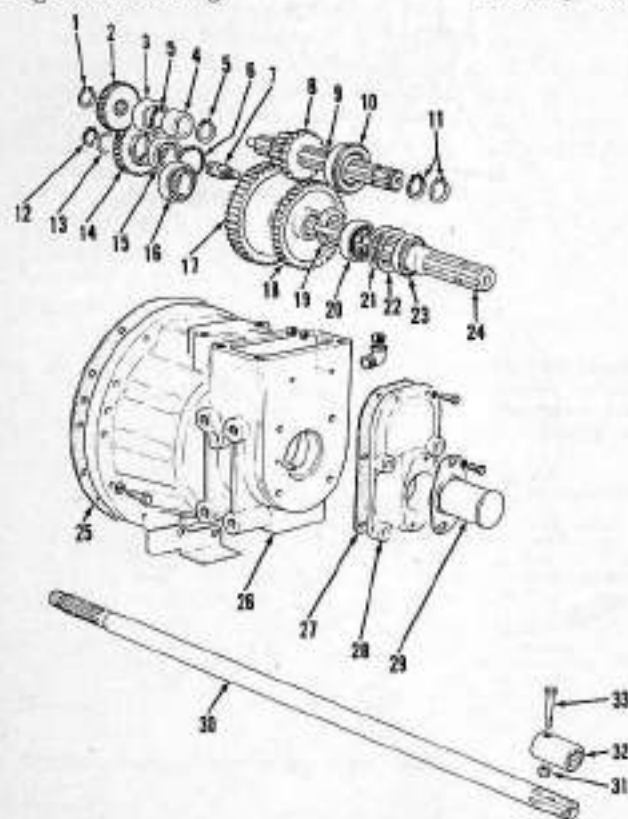


Fig. 188—Exploded view of multi-speed pto housing assembly showing component parts and their relative positions.

1. Snap ring
2. Drive gear
3. Needle bearing
4. Inner race
5. Snap ring
6. Snap ring
7. Idler shaft
8. Speed change gear
9. Input shaft
10. Bearing
11. Snap ring
12. Snap ring
13. Shim
14. Idler gear
15. Bearing & cup
16. Output gear (low)
17. Output gear (high)
18. Split ring
19. Bearing
20. Shim
21. Spacer
22. Seal
23. Output shaft
24. Gasket
25. Housing
26. Gasket
27. End plate
28. Cover
29. Shaft
30. Nut
31. Coupler
32. Bolt

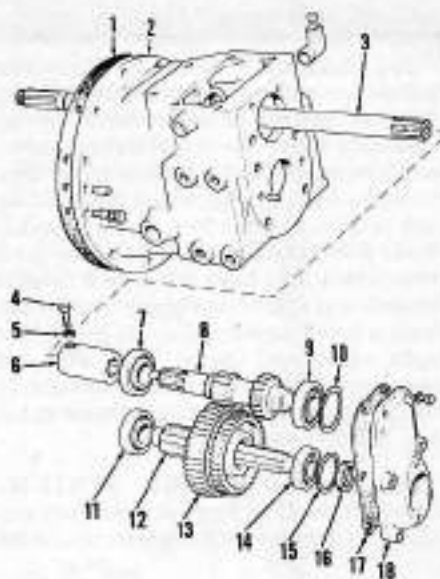


Fig. 189—Exploded view of single speed and multi-speed pto assembly for 1390, 1490 and 1690 models showing component parts and their relative positions. Note shaft (8) and gear (13) are different in single speed assemblies, but service procedure is the same.

- |                  |                   |
|------------------|-------------------|
| 1. Gasket        | 10. Shim          |
| 2. Housing       | 11. Bearing & cup |
| 3. Shaft         | 12. Output shaft  |
| 4. Bolt          | 13. Output gear   |
| 5. Nut           | 14. Bearing & cup |
| 6. Coupler       | 15. Shim          |
| 7. Bearing & cup | 16. Seal          |
| 8. Input shaft   | 17. Gasket        |
| 9. Bearing & cup | 18. End plate     |

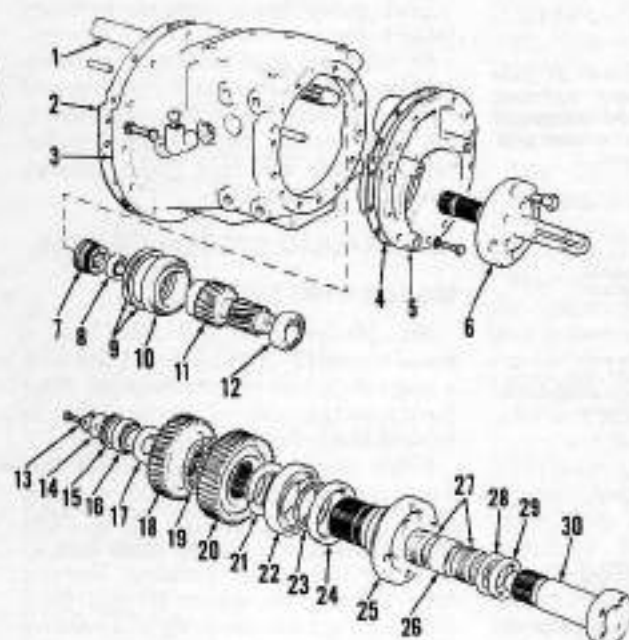


Fig. 190—Exploded view of reversible shaft pto assembly showing component parts and their relative positions.

1. Shaft
2. Gasket
3. Housing
4. Gasket
5. End plate
6. Reversible shaft
7. Sliding gear
8. Bearing
9. Shim
10. Bearing & cup
11. Input shaft
12. Bearing & cup
13. Tab washer
14. Bearing retainer
15. Shim
16. Bearing & cup
17. Special washer
18. Output gear (high)
19. Thrust bearing
20. Output gear (low)
21. Split ring
22. Bearing & cup
23. Special washer
24. Seal
25. Output shaft (low)
26. Spacer
27. Bearings
28. Plate
29. Seal
30. Output shaft (high)

for each location. Drive input shaft (8) rearward out of housing. Remove shift rod and shift fork using care to catch detent ball and spring as rod is removed. Drive output shaft rearward out of housing, then remove output gear (13) and front bearing cone (11) from housing.

Inspect all bearings and cups on shafts and in housings and renew as necessary. Inspect all gears for wear or damage.

**348. REASSEMBLY.** Reassemble by reversing disassembly procedure noting end play must be checked and set for input and output shafts. Install all shims (10 and 15—Fig. 189) removed during disassembly, gasket (17) and end plate (18). Mount dial indicator and measure end play of input and output shafts. End play must be 0.05-0.10 mm (0.002-0.004 inch) and is adjusted by adding or removing shim (10) for input shaft or shim (15) for output shaft.

### Reversible Shaft Pto

**349. DISASSEMBLY.** Remove pto housing assembly as outlined in paragraph 343. Remove shaft (6—Fig. 190). Remove retaining bolts and end plate (5) and output shaft as an assembly. Remove input shaft assembly (11). Bend tabs of tab washer (13) away from bolt heads and remove bolts and washers. Use a puller under gear (18) and remove gear, washer (17) and bearing cone (16). Remove thrust bearing (19). Remove high speed output shaft (30), bearings (27) and spacer (26). Remove gear (20) and split rings (21). Press low speed shaft (25) out of bearing (22) and remove bearing (22), special washer (23) and shaft (25).

Inspect all bearings and cups on shafts and in housings and renew as necessary. Inspect all gears for wear or damage and install new seals.

**350. REASSEMBLY.** Reassemble by reversing disassembly procedure, noting end play of input and output shafts must be checked and set. Install all shims (9 and 15—Fig. 190). Mount dial indicator and position probe to contact end of output shaft (6). Measure and record amount of end play. Mount dial indicator so probe contacts end of input shaft (11). Measure and record amount of end play. Correct end play for both shafts is 0.05-0.10 mm (0.002-0.004 inch) and is adjusted by adding or removing shims

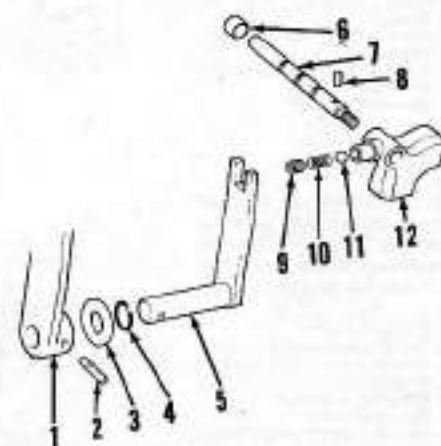


Fig. 191—Exploded view of typical pto shift linkage.

1. Engagement lever
2. Roll pin
3. Shims
4. "O" ring
5. Shaft & lever
6. Spacer
7. Shift rod
8. Special pin
9. Screw
10. Detent spring
11. Ball
12. Shift fork

(15) for output shaft or shims (9) for input shaft.

### PTO SHIFT LEVER

#### All Models

351. The pto shift lever and linkage varies according to type of pto, model tractor and cab or platform equipped. Lever and shaft (5—Fig. 191) is common on most models and end play must be 0.127-0.254 mm (0.005-0.010 inch) and is adjusted by adding or removing shim (3). Always renew "O" ring (4) during service.

While pto is held in position by detent ball (11) and spring (10), excessive end play in output or input shafts can cause pto disengage under load.

Make certain all linkage is adjusted so pto completely engages and disengages.

## HYDRAULIC SYSTEM

Selectamatic hydraulic system is used on all models, pump type and location will vary according to model. Models 1190 and 1290 hydraulic pumps are mounted internally in pto housing and driven by a gear on pto input shaft. See Fig. 192. All other models have either single (Fig. 193) or tandem (Fig. 194) pumps mounted externally in front of radiator and driven by a drive shaft coupled to engine crankshaft front pulley.

It is very important to understand the relationship of various valves and how they should be positioned for proper operation or testing of selected hydraulic mode.

### HYDRAULIC SYSTEM OPERATING PRINCIPLES

#### Rear Mounted Pump

352. Hydraulic pump is mounted to back of rear axle between axle and pto unit. Pump is driven by a gear on pto input shaft and is operating only when pto clutch is engaged.

Pressure relief valve (9—Fig. 192) is located on top of pump.

Pump lifts oil from transmission reservoir through a full flow filter (7). Oil is pumped through pipe to distribution block (4) located on top of rear axle case on right-hand side of tractor. Oil goes first to remote valve (3), if so equipped, then to selectamatic valve.

If equipped with remote valve (3) all oil goes to selectamatic valve (5) when remote valve is in neutral (center) position. Movement of remote valve (3) lever



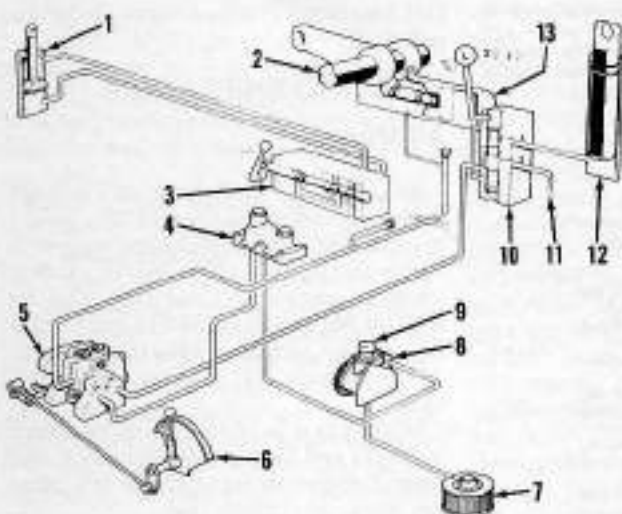


Fig. 192—View of rear mounted pump hydraulic system showing component parts and their relative positions.

1. External double acting ram
2. Rockshaft
3. Remote outlet (double acting)
4. Distribution block
5. Selectamatic valve
6. Control quadrant
7. Filter
8. Pump
9. Relief valve
10. Three-way valve
11. Remote outlet (single acting)
12. External single acting cylinder
13. Rockshaft cylinder

forward or backward from neutral position directs oil flow to external equipment.

If equipped with a three-way valve (10), oil flow may be used to operate linkage and supply external equipment at the same time when lever is in "L/I" position. Remaining positions provide linkage only, or external only operation.

This system also supplies lubrication oil for upper transmission bearings, therefore it is essential to maintain correct fluid level.

### Front Mounted Single Pump

353. Hydraulic pump (9—Fig. 193) is mounted in front of radiator and driven by a drive shaft connected to engine crankshaft front pulley. Oil pump pulls oil through an external metal tube connected to filter (10) under transmission housing. Oil is then pushed through filter (5) to distribution block (4).

When remote valve (2) lever is in neutral (center) position oil flow is directed to selectamatic valve (6). Selectamatic valve will direct oil flow to rockshaft cylinder (15) and three-way valve (14).

When remote valve (2) lever is moved from neutral position oil flow is cut off from selectamatic valve and directed instead to remote valve to operate external equipment.

### Front Mounted Tandem Pumps

354. This system is similar to single pump systems except two pumps are coupled together as a single unit and may be used separately or together according to position of combining valve (8—Fig. 194).

When pumps are used together (combining valve set for combined operation) output of both pumps is directed to remote valve only, oil does not flow

through external pressure filter (1) and no oil goes to rockshaft cylinder.

When pumps are used separately (combining valve control set for separate operation) one pump supplies oil to rockshaft cylinder and remaining pump supplies oil to remote valve (3). Oil going to remote valve does not go through external pressure filter (1) or distribution block (9). Linkage system may be used at the same time as external equipment.

Fig. 193—View of single front mounted pump hydraulic system showing component parts and their relative positions.

1. Rockshaft
2. Remote valve (double acting)
3. External double acting cylinder
4. Distribution block
5. Pressure filter
6. Selectamatic valve
7. Air relief valve
8. Relief valve
9. Pump
10. Filter
11. Remote outlet (single acting)
12. Oil cooler
13. Remote cylinder (single acting)
14. Three-way valve
15. Rockshaft cylinder

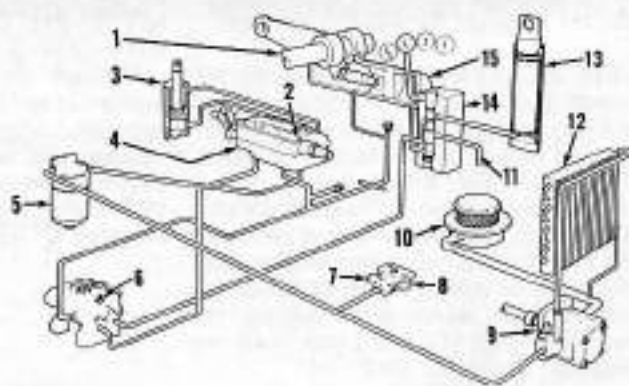
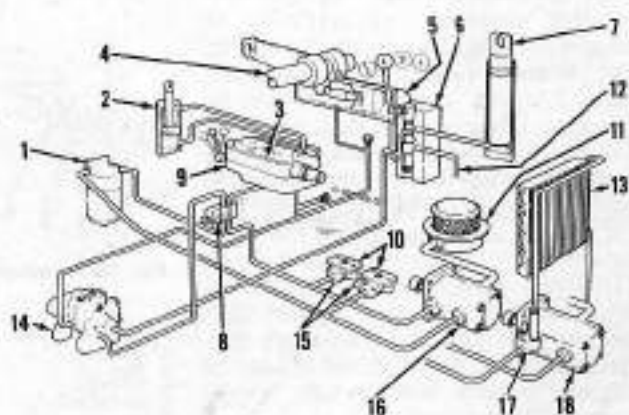


Fig. 194—View of tandem front mounted pumps hydraulic system showing component parts and their relative positions.

1. Pressure filter
2. Double acting remote cylinder
3. Remote valve (double acting)
4. Rockshaft
5. Rockshaft cylinder
6. Three-way valve
7. Remote cylinder (single acting)
8. Combining valve
9. Connector plate
10. Relief valves
11. Filter
12. Remote outlet (single acting)
13. Oil cooler
14. Selectamatic valve
15. Air relief valve
16. Pump (1290 and 1490)
17. Cooler and flow valve
18. Pump (1690)



Each pump has a separate pressure relief valve.

On 1390 and 1490 models, front pump supplies oil to rockshaft cylinder and rear pump supplies oil to remote valve. On 1690 models front pump supplies remote valve and rear pump supplies rockshaft cylinder.

### HYDRAULIC SYSTEM FILTERS

#### Models 1190-1290

355. Models 1190 and 1290 have a metal screen (2—Fig. 195) equipped with a magnet (7) and renewable paper filter (5) on suction side of pump. Filter is located under transmission housing.

Filter should be changed every 500 hours and fluid should be changed every 1000 hours. To change filter, first remove drain plug (3) and drain fluid 42 L (44 qts.) into clean container. Remove filter housing (9), screen (2) and filter (5). Clean screen assembly and remove all metal particles from magnet (7). Install new "O" rings and gasket. Install filter, screen and filter housing. Tighten retaining bolts to 23-27 N·m (17-20 ft.-lbs.) torque.

If reusing fluid, let settle and reinstall all but the last 3.8 L (one gallon) which should contain most of the settled out foreign material. Add new Case TFD or

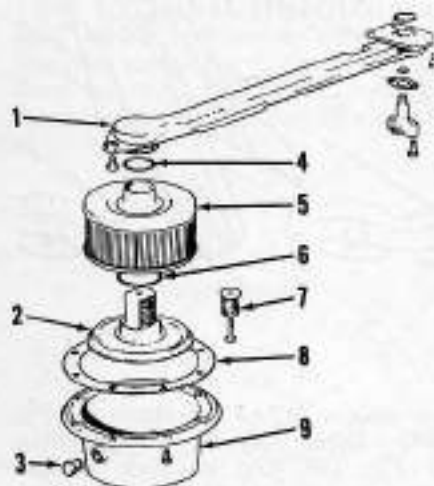


Fig. 195—Exploded view of hydraulic pump suction filter and cover used on 1190 and 1290 models. Model 1390 filter assembly is similar.

- |                 |                   |
|-----------------|-------------------|
| 1. Suction pipe | 6. "O" ring       |
| 2. Metal screen | 7. Magnet         |
| 3. Drain plug   | 8. Gasket         |
| 4. "O" ring     | 9. Filter housing |
| 5. Filter       |                   |

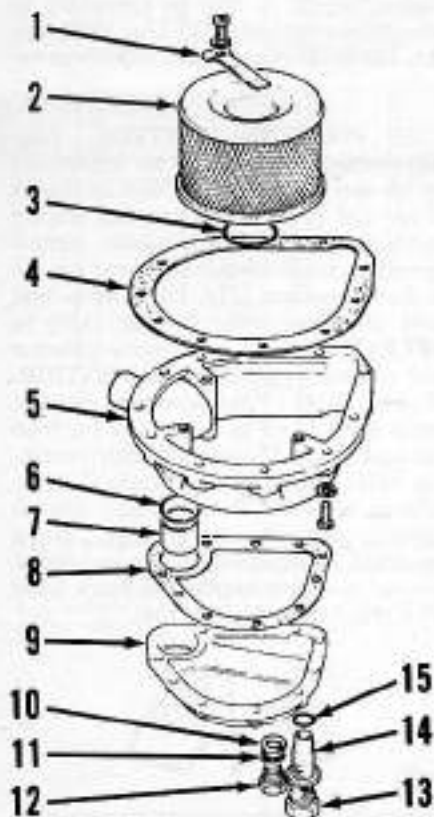


Fig. 196—Exploded view of hydraulic pump suction filter and cover used on 1490 and 1690 models.

- |                   |                     |
|-------------------|---------------------|
| 1. Retainer plate | 9. Cover            |
| 2. Filter element | 10. Sealing washer  |
| 3. "O" ring       | 11. "O" ring        |
| 4. Gasket         | 12. Drain plug      |
| 5. Housing        | 13. Filter assembly |
| 6. "O" ring       | 14. Sealing washer  |
| 7. Sleeve         | 15. "O" ring        |
| 8. Gasket         |                     |

equivalent fluid to bring fluid level to correct operating level. Bleed air from system as outlined in paragraph 357.

### Models 1390-1490

356. Filtering system consists of a fine metal filter element (2—Fig. 196) on suction side of pump and a renewable element (12—Fig. 197) on pressure side.

Suction filter (2—Fig. 196) is located on underside of transmission housing and pressure filter (12—Fig. 197) is located in cannister mounted on rear axle on right-hand side of tractor.

Filters should be changed every 500 hours and fluid should be changed every 1000 hours. To clean suction filter, first remove drain plug (12—Fig. 196) and drain fluid, 42 L (44 quarts) into clean container. Note on some power shift models filter (13) must be removed for drain plug. Remove filter housing cover (9) and filter (2). Remove "O" ring (6) and sleeve (7) from suction port. Remove and clean filter (2). Clean power shift filter (14), if so equipped.

On all models, install new "O" rings and gaskets. Note sleeve (7) end with chamfered edge is installed in suction port first. Reinstall housing cover (9) and tighten retaining bolts to 27 N·m (20 ft.-lbs.) torque.

Change pressure filter element (12—Fig. 197) by unscrewing cannister (13) from head (8) and remove filter. Install new "O" rings and back-up rings,

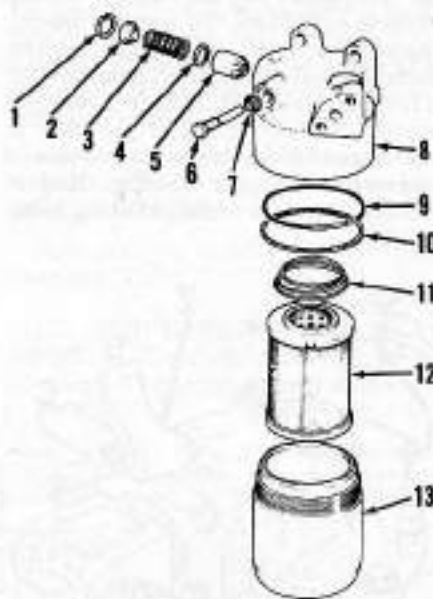


Fig. 197—Exploded view of hydraulic system pressure side filter.

- |                   |                      |
|-------------------|----------------------|
| 1. Seal ring      | 8. Filter head       |
| 2. Retainer       | 9. Sealing ring      |
| 3. Spring         | 10. Back-up ring     |
| 4. Washer         | 11. Spring           |
| 5. Plunger        | 12. Filter element   |
| 6. Set screw      | 13. Filter cannister |
| 7. Sealing washer |                      |

clean cannister and make certain spring (11) is in place during installation. Tighten cannister to 34 N·m (25 ft.-lbs.) torque.

If reusing fluid, let settle and reinstall all but the last 3.8 L (one gallon) which should contain most of the settled out foreign material. Add new Case TFD or equivalent fluid to bring fluid level to correct operating level. Bleed air from system as outlined in paragraph 357.

### BLEEDING AIR FROM HYDRAULIC SYSTEM

#### All Models

357. Make certain transmission fluid level is at correct operating level and select draft control position on hydraulic controls as outlined in paragraph 358. Push quadrant lever (5—Fig. 198) to LOWER (forward) position. Place clean container below pump outlet pipe at pressure relief valve and disconnect pipe. See Fig. 199. Place engine stop control in STOP position, engage starter and turn engine over until oil flowing from relief valve is free of air. Reconnect pipe. On all models equipped with dump valve except 1690, remove dump valve (1—Fig. 200) and plate (2). Reinstall dump valve and open by pulling knob up. Turn plug for by-pass valve, which was under plate (2), open

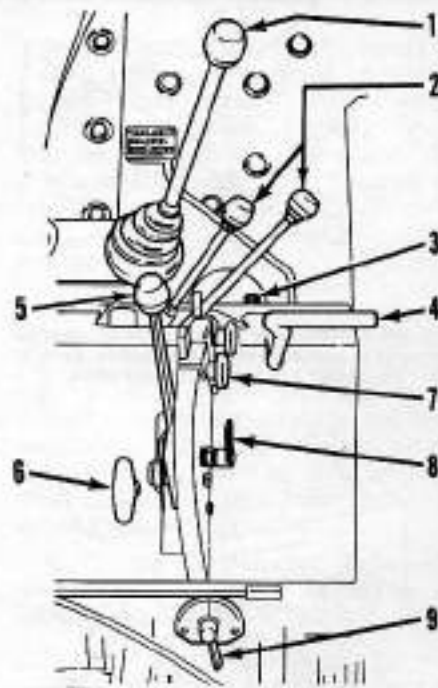


Fig. 198—View showing typical control lever arrangement. Location may vary according to model and equipment.

- |                           |                   |
|---------------------------|-------------------|
| 1. Gear selector lever    | 6. Quadrant lever |
| 2. Remote valve levers    | 7. Dump valve     |
| 3. Lowering control valve | 8. Lever stop     |
| 4. Park brake lever       | 9. Catch lever    |
|                           | 10. Selector dial |



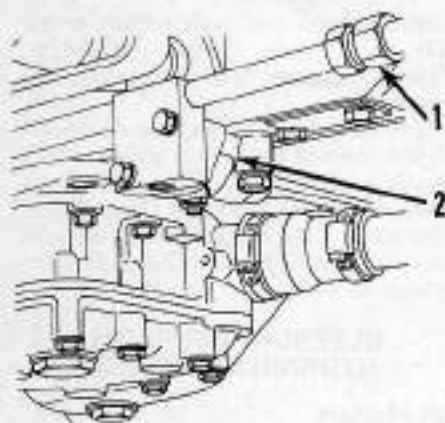
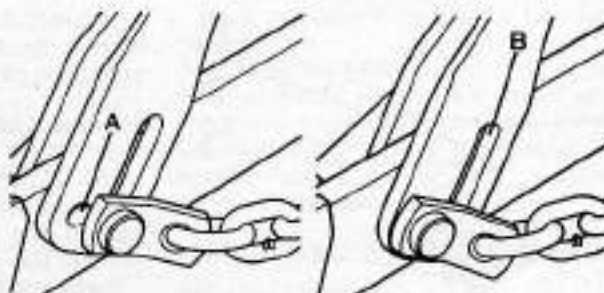


Fig. 199 - View showing location of line connection (1) and relief valve (2).

two turns. Move quadrant lever (5 - Fig. 198) fully rearward to **SELECT** position. Start and run engine until air free oil flows from by-pass valve plug. Move quadrant lever forward out of **SELECT** position, tighten by-pass valve plug, remove dump valve, reinstall plate (2) and dump valve.

Fig. 202 - Pins fastening check chains to lift arms also go through lift rods. There are two positions for these pins. Holes "A" are for fixed position while slots "B" allow implement to move (float) three inches up or down. Always check implement operators manual for correct location.



On all models without dump valve there will be two plugs under plate (2 - Fig. 200) which must be loosened. Place quadrant lever in **SELECT** position, run engine until air free oil flows from each plug, then move quadrant lever out of **SELECT** position and stop engine.

On 1690 models open dump valve, start engine, move quadrant lever to **SELECT** position for 20 seconds, release lever, close dump valve and stop engine.

## SYSTEM CONTROL SETTINGS

### All Models

**358. DRAFT CONTROL.** Draft control is used to maintain a constant desired operating depth for ground engaging type implements without gage wheels and to provide weight transfer for increased traction under certain working conditions. To prepare tractor hydraulic system for draft control operation make certain lift arms are set in fixed position (Fig. 202). Set selective sensing unit lever (2 - Fig. 203) in desired sensitivity range and move and hold quadrant lever (5 - Fig. 204) in **SELECT** position while switching selec-

tor dial to **DRAFT** position (1 - Fig. 204). Turn lowering control knob (3 - Fig. 198) fully in, then out four turns. If equipped with combining valve, place control knob (1 - Fig. 203) in separate flow position. On all models attach implement and while tractor is in motion begin moving quadrant lever toward **LOWERING** position until implement reaches desired working depth. Mark position of quadrant lever with lever stop (7 - Fig. 198). After raising implement return quadrant lever to this position, implement will return to desired depth. It may be necessary to adjust lowering valve (3 - Fig. 198) to attain lowering rate to suit individual requirements.

**359. POSITION CONTROL.** Position control is used for an implement which should maintain a certain height above the ground. To prepare tractor hydraulic system for position control operation make certain lift arms are set in fixed position (Fig. 202), move and hold quadrant lever (5 - Fig. 198) in **SELECT** position and move selector dial control to **POSITION CONTROL** (2 - Fig. 204). Turn lowering control valve knob (3 - Fig. 198) fully in, then out four turns. If equipped with combining valve, place control knob (1 - Fig. 203) in separate flow position. On all models attach implement, move quadrant lever until implement is at desired working height and mark lever with lever stop (7 - Fig. 198).

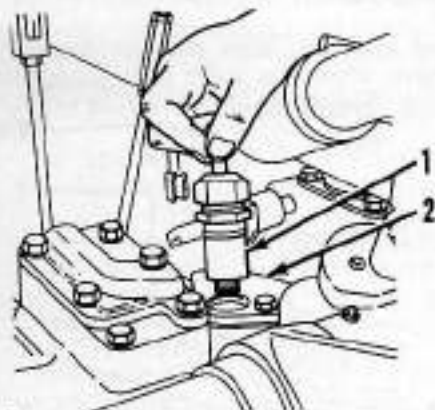


Fig. 200 - Dump valve (1) and plate (2) must be removed to gain access to bleed points. Refer to paragraph 357 for correct procedure.

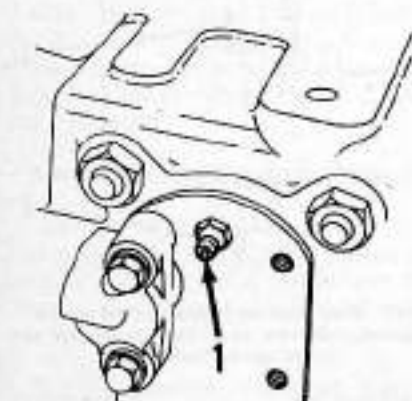


Fig. 201 - Location of hydraulic system bleed valve (1) is shown. Refer to paragraph 357 for correct procedure.

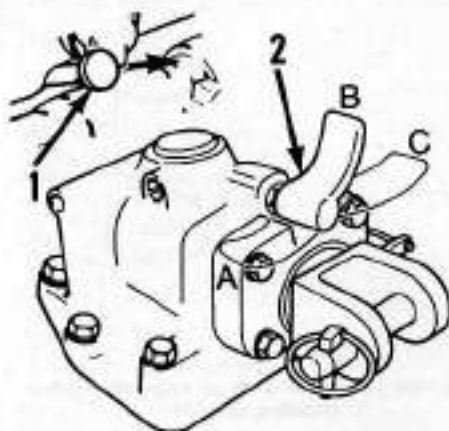


Fig. 203 - View showing typical location of combining valve control knob (1) and sensitivity selector position (2). Note sensitivity selector position "A" is for light draft loads, "B" is for medium draft loads and "C" is for heavy draft loads.

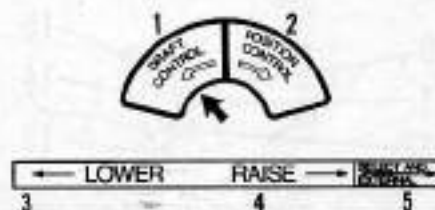


Fig. 204 - Position for selector dial and quadrant lever are indicated. Selector dial position (1) is for draft control and (2) is for position control. Quadrant lever must be in **SELECT** position (5) to change selector dial position. Move quadrant lever toward **LOWER** position (3) to lower implement and toward **RAISE** position (4) to raise implements.

**360. EXTERNAL POSITION.** Some early models and models built for all countries except North America have a third position, **EXTERNAL**, on the selector dial. See Fig. 205. When set in

this position quadrant lever (5—Fig. 198) will operate a single acting remote cylinder. Fluid pressure is directed to remote cylinder instead of rockshaft cylinder using the three-way valve (10—Fig. 192). A remote control valve for operating remote cylinders independently from lift control system is also available.



Fig. 205—Early production and tractors produced for all countries except North America have a third position, **EXTERNAL**, for selector dial. This position allows quadrant lever to activate a single acting remote cylinder. Oil supply to rockshaft cylinder is cut-off in this position.

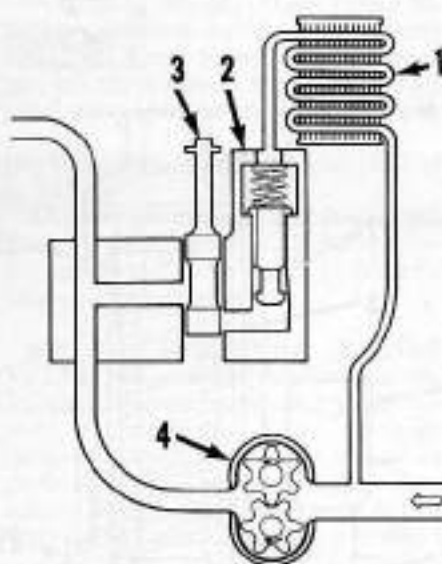


Fig. 206—View of typical hydraulic oil cooler system used on models equipped with power shift transmission.

1. Oil cooler
2. Flow valve
3. Control valve
4. Pump

## HYDRAULIC OIL COOLER

### Power Shift Models

**361.** Power shift models are equipped with a hydraulic oil cooler mounted to right-hand side of large "T" bracket fastened to frame in front of battery. It is located in hydraulic system between hydraulic pump and external pressure filter; a cooler valve (3—Fig. 206) which must be manually opened or closed and a flow valve (2) which automatically opens or closes in response to system pressure to protect cooler against higher system pressures is installed between pump and cooler.

## HYDRAULIC PUMPS

### Rear Mounted Pump

**362. REMOVE.** Hydraulic pump is located internally in pto housing at rear of tractor. Remove pto housing as outlined in paragraph 343 and remove pump.

**363. DISASSEMBLY.** To disassemble pump, scribe a mark across mounting plate (13—Fig. 207), pump body (12) and end plate (5) to aid in reassembly. Remove nut (1) and washer (2). Use a suitable puller to remove gear (3).

**NOTE:** Do not attempt to remove gear with a hammer or pry bar as damage to bearings will result.

Note position of rotors (8 and 9) and bearings (7 and 10).

**364. INSPECTION AND REASSEMBLY.** Carefully clean and inspect all parts. If bearings are not excessively

worn, they may be lightly polished by lapping with "O" grade emery paper lubricated with kerosene; be certain emery paper is on a perfectly flat surface. Bearing thickness must not vary more than 0.508 mm (0.002 inch). Outer face of bearings may be lightly polished to obtain free movement in pump body. Examine rotor track in pump body for scoring or excessive wear, especially on intake side of pump. It is normal for rotors to cut a light track on intake side of body. If body is reusable, remove any burrs at edge of rotor track with fine emery cloth. Inspect rotors for scoring, wear or damage to teeth or journals. Journals must be within 0.127 mm (0.005 inch) of each other and gear widths equal to within 0.076-0.178 mm (0.003-0.007 inch) less than depth of rotor pocket of pump body. Make certain scroll lubrication grooves in bearings are free of damage or foreign material.

When reassembling renew all "O" rings, sealing rings and seals. Lubricate all parts with clean hydraulic fluid and align previously made alignment marks. Tighten retaining bolts to 54 N·m (40 ft.-lbs.) torque and secure with tab washer. Pump should turn with a light, even drag with no tight or rough spots.

Reassemble tractor and bleed hydraulic system.

### Front Mounted Pumps

**365. REMOVE.** Hydraulic pump or pumps are located at front of tractor just forward of radiator. Remove grille, battery and battery support. Drain transmission fluid 42 L (44 quarts) into clean container and disconnect pump inlet and outlet lines. Remove pump drive shaft and pump retaining bolts, then remove pump.

**366. DISASSEMBLY.** Disassembly of Plessey or Dowty single and tandem pumps is similar and the same procedure may be followed for either pump. Scribe a mark across pump and plates and body as an aid to reassembly. Remove nut retaining coupler (7—Fig. 208) to pump shaft and use a suitable puller to remove coupler and key from shaft.

**NOTE:** Do not attempt to remove coupler with a hammer or pry bar as damage to bearings will result.

Remove pump through-bolts and separate end plates from pump body.

**NOTE:** Tap flanges with mallet if difficult to remove, do not pry apart.

Note positions of rotors and bearings, which must be reinstalled in their original positions, then remove from pump body.

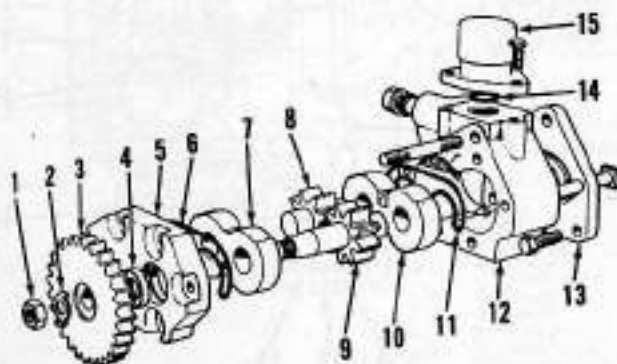


Fig. 207—Exploded view of rear mounted hydraulic pump used for 1190 and 1290 models.

1. Nut
2. Tab washer
3. Gear
4. Seal
5. End plate
6. Sealing ring
7. Bearing
8. Driven rotor
9. Drive rotor
10. Bearing
11. Sealing ring
12. Pump body
13. Front plate
14. "O" ring
15. Relief valve



**367. INSPECTION AND REASSEMBLY.** Refer to paragraph 364 for inspection and reassembly procedure.

## HYDRAULIC VALVES AND CONTROLS

### All Models So Equipped

**368. OIL COOLER CONTROL AND FLOW VALVE.** Hydraulic oil cooler control and flow valve assembly (Fig. 209) are connected to oil cooler by flexible hoses and located at front of tractor just below radiator.

Oil from hydraulic pump is directed toward cooler control valve (3—Fig. 206). When control valve knob (4—Fig. 209) is pulled out, valve is closed and no oil flows through cooler. When knob (4) is pushed in oil is directed to flow valve (2—Fig. 206). If system pressure is less than 5515 kPa (800 psi) a spring in flow valve holds plunger off seat allowing a portion of oil to flow through cooler (1). If system pressure becomes greater than 5515 kPa (800 psi) it seats plunger and no oil flows through cooler.

**369.** To disassemble valve, remove spring clip and pull knob from spindle. Remove core plug (12—Fig. 209) and felt pad (11). Remove seal housings (5) and push spindle (8) out of valve body (14) through core plug end. Unscrew flow control valve from valve body lifting plunger sleeve out with valve. Unscrew end cap (1).

**CAUTION:** Do not dismantle any further without carefully marking exact positions of spring retainer plug (22) and spring housing (3). It is essential that original factory setting be maintained when valve is reassembled.

Separate plunger sleeve (16) from valve body (21) and remove "O" ring (17). Mark EXACT position and remove spring retainer plug (22) and spring (2). Mark EXACT position of spring housing (3) and unscrew from valve body. Remove plunger (18) by removing snap ring (19) and washer (20).

**370.** Inspect all parts for scoring, wear or damage. Renew all sealing washers and "O" rings. Plunger and sleeve are match ground and must be renewed as a unit.

To reassemble flow valve, reverse disassembly procedure making certain nylon coated threads of plug (22) and spring housing (3) adequately hold parts in their EXACT original positions. Tighten end cap and valve assembly to 81 N·m (60 ft.-lbs.) torque.

**371.** To reassemble cooler control valve, install spindle in valve body and push out of body at each end only far

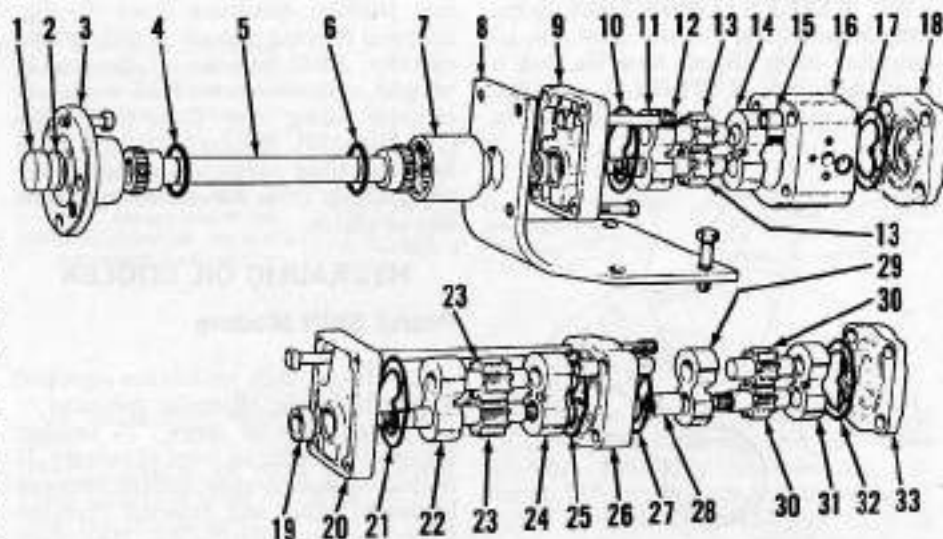
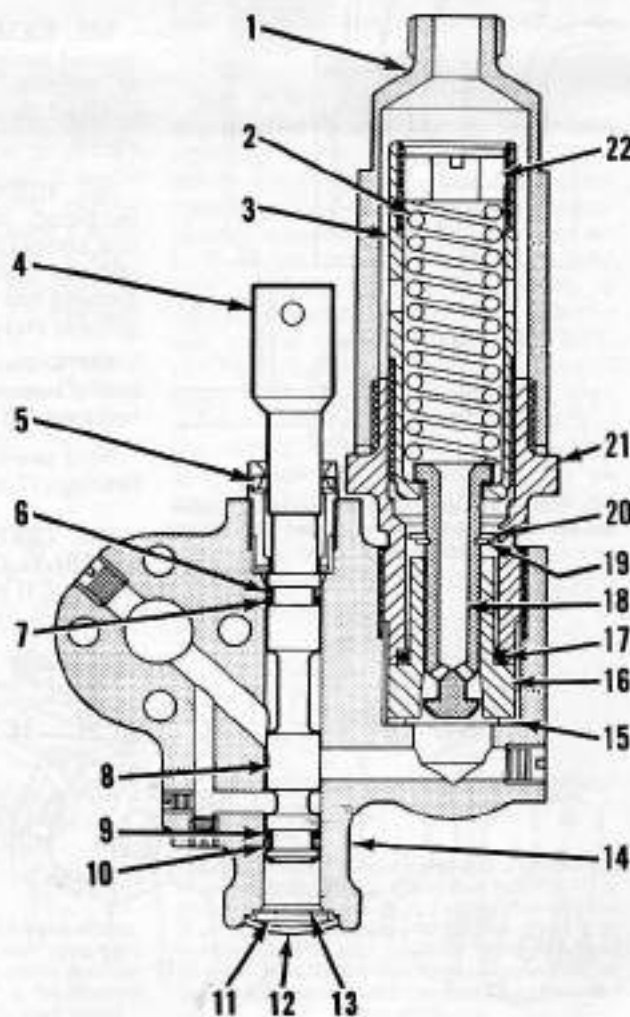


Fig. 208—Exploded view of front mounted single and tandem hydraulic pump.

- |                   |                  |                     |
|-------------------|------------------|---------------------|
| 1. Rubber disc    | 12. Bolt         | 23. Drive rotor     |
| 2. Metal disc     | 13. Driven rotor | 24. Bearing         |
| 3. Drive flange   | 14. Bearing      | 25. Sealing rings   |
| 4. "O" ring       | 15. Dowel        | 26. Separator plate |
| 5. Drive shaft    | 16. Pump body    | 27. Sealing rings   |
| 6. "O" ring       | 17. Sealing ring | 28. Coupler         |
| 7. Coupling       | 18. End plate    | 29. Bearing         |
| 8. Bracket        | 19. Seal         | 30. Rotors          |
| 9. End plate      | 20. End plate    | 31. Bearing         |
| 10. Sealing rings | 21. Sealing ring | 32. Sealing washer  |
| 11. Bearing       | 22. Bearing      | 33. End plate       |

Fig. 209—Sectional view of hydraulic oil control and flow control valve.

- |                    |
|--------------------|
| 1. Cap             |
| 2. Spring          |
| 3. Spring housing  |
| 4. Knob            |
| 5. Seal housing    |
| 6. Backup ring     |
| 7. "O" ring        |
| 8. Spindle         |
| 9. "O" ring        |
| 10. Backup ring    |
| 11. Felt pad       |
| 12. Core plug      |
| 13. Washer         |
| 14. Valve body     |
| 15. Sealing washer |
| 16. Sleeve         |
| 17. "O" ring       |
| 18. Plunger        |
| 19. Snap ring      |
| 20. Washer         |
| 21. Body           |
| 22. Retainer plug  |



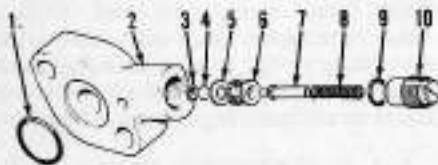


Fig. 210—Exploded view of air relief valve.

- |                   |             |
|-------------------|-------------|
| 1. "O" ring       | 6. Seat     |
| 2. Body           | 7. Plunger  |
| 3. Retainer       | 8. Spring   |
| 4. Steel ball     | 9. "O" ring |
| 5. Special washer | 10. Plug    |

enough to install "O" rings and back-up rings. Back-up rings and "O" rings must not be pushed through valve body as sharp edges of oil ports could cause damage. Reassemble by reversing disassembly procedure. Tighten seal housing to 81 N·m (60 ft.-lbs.) torque.

**372. AIR RELIEF VALVE.** Air relief valves are used for front mounted pump systems between hydraulic pump and oil pressure relief valve. Its function is to remove any air from hydraulic system. Steel ball (4—Fig. 210) is held off seat (6) by plunger (7) and spring (8). In this position air is allowed to pass into reservoir. When system is operating, oil and any air in system is pushed into air relief valve. Air, having little pressure, goes past steel ball and into reservoir. Oil, having pressure, pushes steel ball on to its seat.

All parts are available and free length of spring (8) is 5.6 mm (0.221 inch). Closing pressure of valve should be 221 kPa (32 psi).

**373. OIL PRESSURE RELIEF VALVE.** Oil pressure relief valves are installed in all hydraulic systems to prevent oil pressure from reaching dangerous levels when there is little or no flow. When oil pressure is more than spring (4—Fig. 211) pressure, plunger (2) is pushed off its seat (6) and oil flows

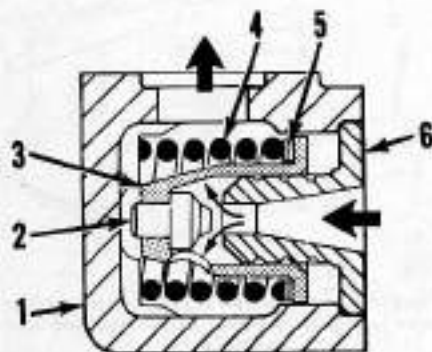


Fig. 211—Sectional view of hydraulic oil pressure relief valve.

- |            |           |
|------------|-----------|
| 1. Body    | 4. Spring |
| 2. Plunger | 5. Shim   |
| 3. Cap     | 6. Seat   |

back into reservoir. Maximum pressure is controlled by shim (5) thickness, however relief valves are serviced as a preset assembly only. Free length of spring (4) should be 40.6 mm (1.6 inches) and relief valve opening pressure is 13.8 MPa (2000 psi).

**374. REMOTE CYLINDER VALVE (DOUBLE ACTING).** Remote valve is located on top of rear right-hand side of axle case. One or more valves may be bolted together at this location to operate double acting remote cylinders. Valves are equipped with detent assembly for raise and lower side which release automatically when pressure reaches maximum level. A check valve to prevent remote cylinder leak-down, when tractor is not running, is built into valve.

Oil flows from pump, through pressure filter (if so equipped), to distribution block. If operating lever of remote valve is in neutral (center) position oil will flow to selectamatic valve. When remote valve lever is moved to raise or lower position, all oil flow is blocked off from selectamatic valve and directed through remote valve to remote cylinder.

**375.** To remove valve, first disconnect and remove control linkage to expose remote valves. Disconnect all lines and remove the four rear bolts which retain remote and combining valves to trans-

mission cover. Remove remote and combining valve assemblies.

**376.** Remove retaining bolts and separate top cover, valves and combining (priority) valve or distribution block, if so equipped. Remove non-return valve plug (22—Fig. 212), spring (23) and spool (25). Remove all line fittings, lever (27) and link (30). Remove cover (1), loosen control spool body (2) and remove snap ring (3). Remove spool body. Remove detent washer (4) from spool body. Remove detent spring (5), plunger (6) and the three steel balls (9). Remove spool assembly (10). Remove bushing (19), "O" ring (20) and seal. Remove seal (29) and "O" ring (28). Remove detent retainer (10), spring (17) and spool (18). Remove washers (12 and 14) and spring (13). Remove shim (11) and restrictor (12). Remove release plunger (7) and "O" ring (8).

**377.** Inspect parts for wear or damage, renew all "O" rings and seals and reassemble by reversing disassembly procedure. Tighten retaining bolts to 48 N·m (35 ft.-lbs.) torque.

**378. COMBINING (PRIORITY) VALVE.** Combining valve either combines or separates oil flow from tandem hydraulic pump according to position of valve spool. This allows simultaneous operation of lift linkage and remote valves when in separate position.

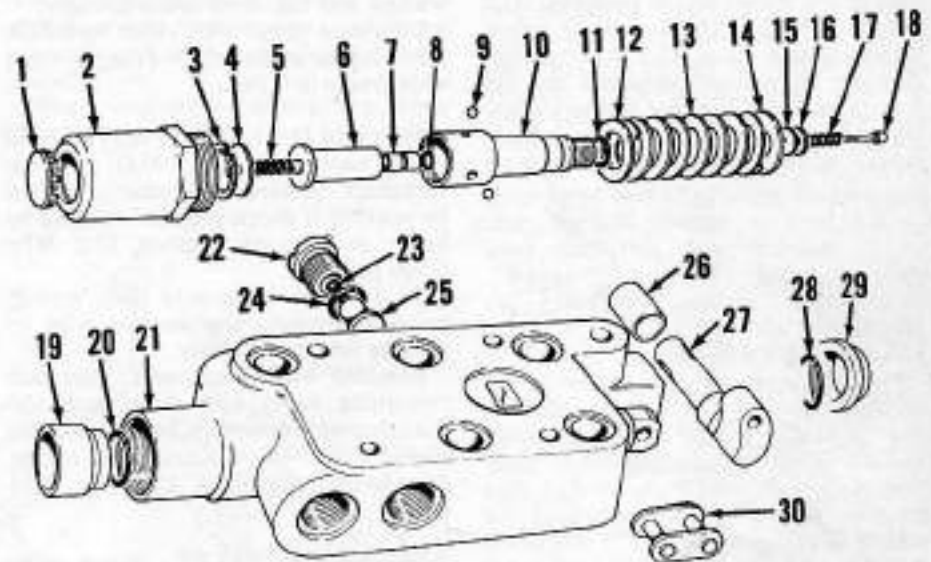


Fig. 212—Exploded view of double acting remote control valve showing component parts and their relative positions.

- |                |                |                        |
|----------------|----------------|------------------------|
| 1. Plug        | 11. "O" ring   | 21. Valve body         |
| 2. Cap body    | 12. Washer     | 22. Plug               |
| 3. Snap ring   | 13. Spring     | 23. Spring             |
| 4. Washer      | 14. Washer     | 24. "O" ring           |
| 5. Spring      | 15. Restrictor | 25. Plunger            |
| 6. Plunger     | 16. Shim       | 26. Bushing            |
| 7. Piston      | 17. Spring     | 27. Hand lever spindle |
| 8. "O" ring    | 18. Valve      | 28. "O" ring           |
| 9. Detent ball | 19. Bushing    | 29. Seal               |
| 10. Retainer   | 20. "O" ring   | 30. Link               |



Operating position on 1490 models is **IN** for combined pump flow and **OUT** for separate pump flow. However, 1690 models are just the opposite, **IN** for separate flow and **OUT** for combined flow.

379. Remove valve as outlined in paragraph 375. Remove retaining bolts and separate cover, remote valves and combining valve.

380. Remove pins and valve control linkage. Remove control spool spacer (5—Fig. 213) and pull control spool from valve body. Remove end cap (2) and breather (3). Remove "O" rings (4 and 9) from spool.

381. Inspect spool for wear, scoring or damage. Renew all "O" rings and lubricate parts with clean hydraulic fluid as assembled. Note extension (6) must be installed using "Loctite" on threads if removed. Reassemble by reversing disassembly procedure and tighten valve retaining bolts to 48 N·m (35 ft.-lbs.) torque.

382. **SELECTAMATIC VALVE.** Selectamatic control valve is located inside rear axle housing on right-hand side. It contains seven different valves in one body which are used to control and regulate various hydraulic functions.

To remove, clean area around rear axle and rockshaft. Remove controls, covers and rockshaft. If equipped with dump valve located over hold valve, remove dump valve and cap opening. Remove right-hand rockshaft bracket from rockshaft. Working through opening in rockshaft bracket remove guide bracket of sliding bars. Remove bolts re-

taining selectamatic valve to rockshaft bracket and separate valve and bracket. Do not pry apart, if necessary, use a rubber hammer to loosen valve if tight on dowels.

If complete disassembly of valve is necessary, keep all individual valve component parts together. Do not mix parts from one valve with another. Remove rocker lever plate (6—Fig. 214) and shims (7). Note number and thickness of shims.

383. **BY-PASS VALVE.** By-pass valve (2—Fig. 214) controls flow of hydraulic fluid from pump, directing flow to rockshaft cylinder when necessary to raise linkage and to lubrication circuit at other times.

To disassemble, remove plug over by-pass valve and remove ball, washer and spring. Use wood or plastic dowel to remove by-pass valve plunger. Remove plug, restrictor washer and filter. Model 1690 **DOES NOT** have filter in by-pass valve.

Lubricate parts with clean hydraulic fluid when reassembling, noting plunger must slide freely in bore.

384. **HOLD VALVE.** Hold valve (1—Fig. 214) retains fluid in rockshaft cylinder until necessary to lower lift linkage, then opens allowing fluid in cylinder to return to sump.

To disassemble, remove plug and spring. Use wood or plastic dowel to remove plunger. Remove retaining washer and ball from inside plunger.

Lubricate parts with clean hydraulic fluid during reassembly. Plunger must slide freely in bore.

385. **HOLD RELIEF VALVE.** Hold relief valve (11—Fig. 214) protects rockshaft cylinder and hydraulic system by opening if shock pressure created by heavy implements exceeds 17.2 MPa (2500 psi).

To disassemble remove plug, spring, valve and shim. Use hooked wire to remove seat and washer.

Reinstall washer and seat. Lubricate remaining parts with clean hydraulic fluid during reassembly. Install all shims which were removed and note spring free length should be 18.6 mm (0.73 inch).

386. **SPOOL VALVE.** Spool valve (5—Fig. 214) is activated by quadrant lever and controls operation of by-pass and hold valves to raise or lower linkage according to quadrant lever position.

To disassemble, remove the two nuts from end of spool and withdraw spool and spring from valve body. Remove spring from spool.

Lubricate spool with clean hydraulic

fluid, install spring and spool through valve bore. Spool must slide easily with no binding or tight spots. Loosely install nuts on end of spool. Final adjustment is made as outlined in paragraph 399.

387. **NON-RETURN VALVE.** Non-return valve (8—Fig. 214) prevents oil in rockshaft cylinder from returning to pump outlet passage when hold valve is closed and by-pass valve is open.

To disassemble remove plug, spring and plunger.

Lubricate parts with clean hydraulic fluid during reassembly. Plunger must slide freely in bore.

388. **SENSING VALVE.** Sensing valve (3—Fig. 214) functions when lift arms are in raised position and weighted with implement. Leakage in rockshaft cylinder circuit causes linkage to lower slowly, gradually placing spool valve in raise position. Sensing valve will then snap closed, providing a sharp response of by-pass valve.

To disassemble remove plug, spring and plunger.

Lubricate parts with clean fluid during reassembly. Plunger must slide freely in bore and spring free length is 19 mm (0.75 inch).

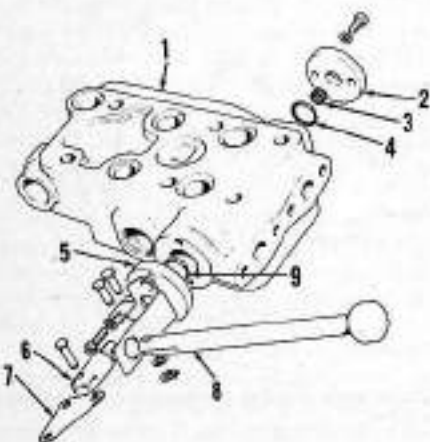


Fig. 213—Exploded view of combining valve. Note valve spool is not shown.

- |                 |              |
|-----------------|--------------|
| 1. Valve body   | 6. Extension |
| 2. End cap      | 7. Lever     |
| 3. Breather pad | 8. Lever     |
| 4. "U" ring     | 9. "O" ring  |
| 5. End cap      |              |

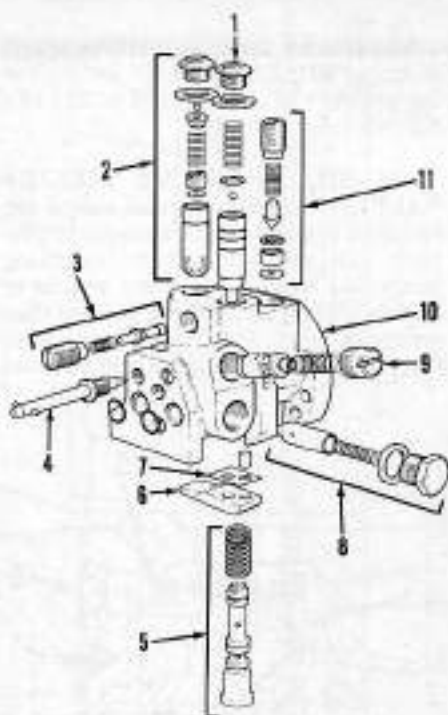


Fig. 214—Exploded view of selectamatic control valve showing separate valve locations and related parts.

- |                                  |                             |
|----------------------------------|-----------------------------|
| 1. Hold valve                    | 7. Shim                     |
| 2. By-pass valve                 | 8. Non-return valve         |
| 3. Sensing valve                 | 9. Rate of lowering valve   |
| 4. Rate of lowering valve needle | 10. Selectamatic valve body |
| 5. Spool valve                   | 11. Relief valve            |
| 6. Abutment plate                |                             |

**389. RATE OF LOWERING VALVE.** Rate of lowering valve (9—Fig. 214) is a flow control valve regulated by opening and closing needle valve (4), thus regulating flow of oil

returning from rockshaft cylinder to sump. Rate (time required) to lower lift linkage can be controlled regardless of implement weight.

To disassemble remove plug, spring and plunger.

Lubricate parts with clean hydraulic fluid during reassembly. Plunger must slide freely in bore and spring free length is 35.6 mm (1.40 inches).

**390. DUMP VALVE.** Dump valves are installed in hydraulic system to enable rapid lowering of lift arms under no load or light load conditions. It also aids cold weather starting by eliminating drag created by cold hydraulic fluid.

Valve is located on top of hold valve on all models, except 1690. Model 1690 uses a slightly different dump valve mounted on front end of rockshaft cylinder.

When knob is in down position on either valve, it is closed and hydraulic system will operate normally. When knob is in up position, valve is open and hydraulic system will not develop pressure.

Disassembly and reassembly of valves is obvious after examination.

**391. THREE-WAY VALVE.** Three-way valve (Fig. 215) mounts on front end of rockshaft cylinder and is used to control flow of oil either to rockshaft cylinder or a single acting remote cylinder.

When valve control lever is in "1" position, quadrant lever will actuate a single acting cylinder connected to number one remote outlet only. Lift linkage will not operate.

When valve control lever is in number "2" position, quadrant lever will actuate

a single acting cylinder connected to number two remote outlet only. Lift linkage will not operate.

When valve control lever is in "L" position, quadrant lever operates lift linkage only. Remote cylinders will not operate.

When control valve lever is in "L/I" position, quadrant lever will actuate lift linkage and single acting cylinder connected to number one remote outlet simultaneously.

Valve spool (17—Fig. 215) and body (8) are serviced as a complete unit only. Make certain breather (11) is clean and not damaged. Detent balls (7 and 16) and springs (6 and 15) are located in bore of lever bracket (1). Install one spring and ball in blind hole and hold ball depressed with pin punch while installing lever bracket on valve and valve body assembly. Install second detent ball and spring and retain with plug (5).

## ROCKSHAFT, CONTROL LINKAGE AND CYLINDERS

### All Models

Rockshaft cylinder connecting rod moves rockshaft and lift links to raise and lower implements. Some 1490 models are also equipped with a support cylinder mounted at right-hand lift arm and draw bar frame to increase the lifting capabilities of the three-point linkage.

### 392. OVERHAUL ROCKSHAFT AND CYLINDER.

Rockshaft cylinder piston may be removed without removing rockshaft cylinder from axle housing. Support lift linkage in fully raised position. Remove rockshaft cylinder cover (22—Fig. 216) and drive pin (12) from connecting rod and remove rod. Remove three-way valve or connector from front end of cylinder, insert small diameter rod through oil feed hole to push piston (10) out of cylinder.

Inspect piston and cylinder for scoring. Piston and seals are available in 0.254 mm (0.020 inch) oversize and cylinder can be honed 0.254 mm (0.020 inch) oversize if scoring is severe.

Soak new leather back-up rings in clean hydraulic oil for one-half hour prior to installation. Install new leather ring with rough side towards front (closed) end of piston. Install "O" ring at front side of leather ring and let piston set for one-half hour to allow leather rings to settle into groove. Lubricate piston and cylinder with clean hydraulic fluid and install piston. Cylinder bore is chamfered to compress sealing rings as piston is installed.

Install new rockshaft bushings as needed making certain grease holes in bushings are aligned with grease fitting holes in cover.

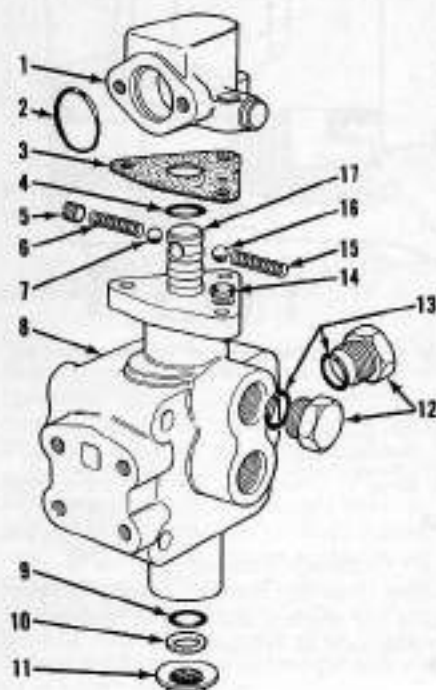


Fig. 215—Exploded view of three-way valve showing component parts and their related positions.

- |               |                   |
|---------------|-------------------|
| 1. Cover      | 10. Back-up ring  |
| 2. "O" ring   | 11. Breather      |
| 3. Gasket     | 12. Hinge         |
| 4. "O" ring   | 13. "O" ring      |
| 5. Plug       | 14. Breather post |
| 6. Spring     | 15. Spring        |
| 7. Ball       | 16. Steel ball    |
| 8. Valve body | 17. Spool         |

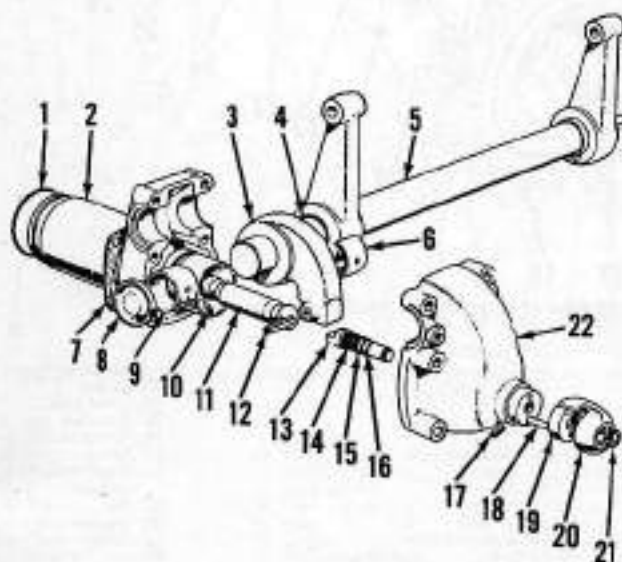


Fig. 216—Exploded view of rockshaft cylinder, brackets and rockshaft.

- |                              |
|------------------------------|
| 1. "O" ring                  |
| 2. Rockshaft cylinder        |
| 3. Rockshaft cylinder arm    |
| 4. "O" ring                  |
| 5. Rockshaft                 |
| 6. Bushing half              |
| 7. Gasket                    |
| 8. Plug                      |
| 9. Bushing                   |
| 10. Piston                   |
| 11. Rod                      |
| 12. Roll pin                 |
| 13. Latch plunger            |
| 14. Spring                   |
| 15. Spacer                   |
| 16. "O" ring                 |
| 17. Locating screw           |
| 18. Pin                      |
| 19. Dust shield              |
| 20. Latching lever           |
| 21. Snap ring                |
| 22. Rockshaft cylinder cover |



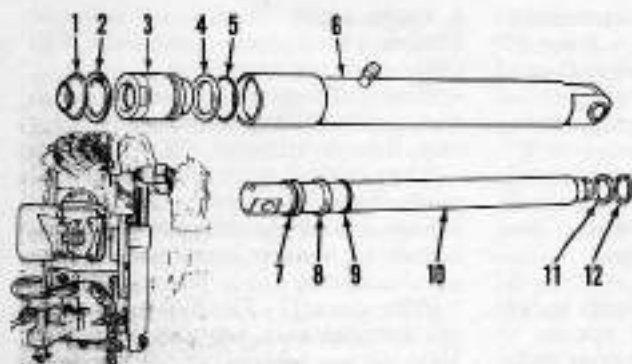


Fig. 217—View showing Model 1490 support cylinder location and exploded view of cylinder.

1. Scupper seal
2. Snap ring
3. Sleeve
4. Leather ring
5. "O" ring
6. Cylinder case
7. Seal
8. Leather ring
9. "O" ring
10. Ram rod
11. Snap ring
12. Snap ring

**393. MODEL 1490 SUPPORT CYLINDER.** Support cylinder (Fig. 217) is installed on some 1490 models to increase lifting capacity of rockshaft cylinder. It is connected to number one remote outlet port of three-way valve and works in conjunction with rockshaft cylinder.

To disassemble cylinder work through cut-out sleeve (3) and compress snap ring (2). Pull rod (10), sleeve and snap ring from case (6).

Soak new seals in clean hydraulic fluid for 30 minutes prior to installation and reassemble by reversing disassembly procedure.

**394. LIFT LATCH.** Lift latch is installed on early models to mechanically hold lift linkage in raise position. During normal operation of hydraulic system, latch (4—Fig. 218) is held in retracted position by lever (3) riding out on pins (8). To engage latch, raise lift arms and turn lever (3) so pins enter recesses and latch is pushed forward to engage rockshaft cylinder arm (3—Fig. 216).

To disassemble, make certain latch is not supporting weight and remove rockshaft cylinder cover (22—Fig. 216). Remove snap rings (9) and remove lever, spacer, spring and latch. Remove "O" ring (7). Pins (8) are needle bearing rollers and extremely hard. If broken off in holes, new holes may be drilled at slightly offset position from old holes and new rollers installed.

**395. SELECTOR DIAL MECHANISM.** Selector dial control position (Fig. 204 and 205) determines hydraulic operation of selectamatic valve. Quadrant lever must be held in **SELECT** position as selector dial is moved to **DRAFT** or **EXTERNAL** positions. Refer to appropriate paragraph for description of each positions operation.

To disassemble remove draft sensing cable, rockshaft assembly and right rockshaft bracket. Remove guide bracket (23—Fig. 219) and push rods (31 and 30), then unbolt and remove control valve assembly from bracket. Unbolt

and remove cam (28) and withdraw rockshaft from bracket. Remove snap ring (8) and connecting rod (9) from shaft (12). Drive pin (14) from selector fork (15) and remove expansion plug (20). Drive selector rod (7) out and remove fork (15), catching detent ball (13) as rod is removed. Extract spring (6) using wire hook.

Remove shaft locating screw (11) (screw may be hidden by gasket) and slide rocker arm (17) from shaft and remove shaft. Remove pin (35) and pull selector control (1) from shaft (4). Remove dial (34), breather pad (3) and "O" ring (2).

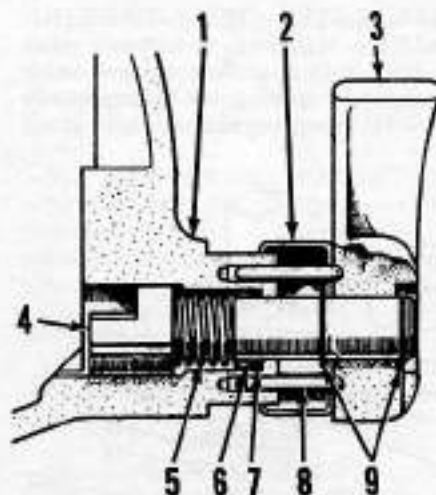


Fig. 218—Sectional view of lift-latch used on early production models.

1. Cover
2. Dust shield
3. Latching lever
4. Latching plunger
5. Spring
6. Spacer
7. "O" ring
8. Pin
9. Snap rings

If rockshaft bushing (21) is worn, renew making certain grease fitting holes are aligned and split in bushing is to rear side of bracket.

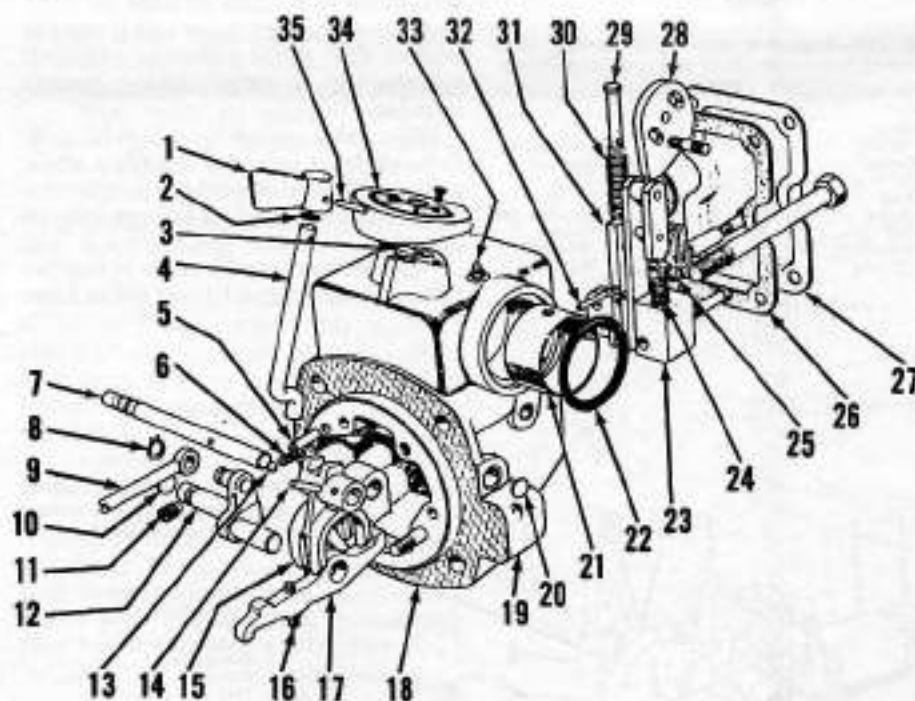


Fig. 219—Exploded view of selector dial mechanism and control.

1. Selector knob
2. "O" ring
3. Breather pad
4. Selector rod
5. Dowel
6. Spring
7. Selector shaft
8. Snap ring
9. Connecting rod
10. Core plug
11. Locating screw
12. Rocker shaft
13. Detent ball
14. Pin
15. Selector fork
16. Screw
17. Rocker lever
18. Gasket
19. Rockshaft right support
20. Core plug
21. Bushing
22. "O" ring
23. Guide bracket
24. Spring
25. Actuating lever
26. Gasket
27. Cover plate
28. Rockshaft cam
29. Spring anchor
30. Spring
31. Depth control push rod
32. Pin
33. Grease fitting
34. Selector dial
35. Pin

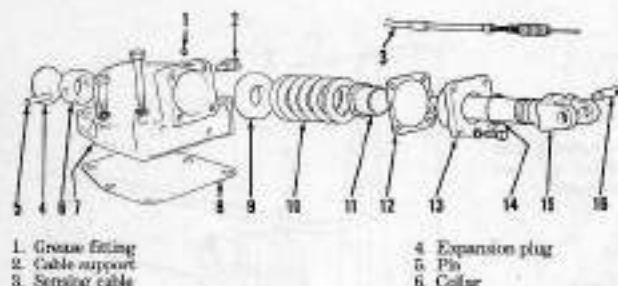


Fig. 220—Exploded view of single rate sensing unit component parts and their relative positions.

7. Housing
8. Plate
9. Thrust washer
10. Spring
11. Sleeve
12. Shim
13. End plate
14. "O" ring
15. Pin
16. Collar

Reassemble by reversing disassembly procedure and adjust as outlined in paragraph 404 and 405.

**396. DRAFT SENSING UNIT.** Individual models may be equipped with single rate sensing unit (Fig. 220) or a selective rate sensing unit (Fig. 221). Sensing unit function is to maintain a set operating depth for ground engaging implements which have no gage wheels. Pressure exerted by implement being pulled through the ground is transmitted from implement, through hitch upper link which connects to draft sensing unit. This pressure causes movement in draft sensing spring which is relayed through linkage to selectamatic valve causing lift arms to raise, stay in position or lower in accordance with amount of pressure causing spring movement.

Selective sensing units enable operator to select a light, medium or heavy draft control spring which offers greater range of sensitivity for varying implement sizes.

**397. SINGLE RATE SENSING UNIT.** To disassemble, disconnect draft sensing cable (3—Fig. 220). Slowly and

evenly loosen and remove the four end plate retaining cap screws and remove shaft and spring assembly. Remove retaining pin (5) and remove collar, thrust washer, spring and sleeve. Clamp flats of sleeve (11) in a vise and unscrew shaft (15) to remove end plate. "Loctite" is applied to threads during reassembly.

During reassembly, spring (10) end play on assembled shaft should not exceed 0.127 mm (0.010 inch) and is adjusted by varying thickness of thrust washer (9).

As shaft assembly is being reinstalled in housing, check end play of shaft assembly as end plate (13) retaining bolts are evenly tightened. End play should be at a minimum when bolts are fully tightened. If end play decreases as bolts are tightened, then starts to increase when bolts are fully tightened, shim (12) thickness is not sufficient and shims must be added. If end play is at minimum when bolts are fully tightened, but exceeds 0.127 mm (0.005 inch), shim thickness is too great and shim thickness equal to amount of excessive end play must be removed. Shims are available in 0.13, 0.25 and 0.76 mm (0.005, 0.010 and 0.030 inch).

After unit is reinstalled, adjust draft sensing cable as outlined in paragraph 410.

**398. SELECTIVE SENSING UNIT.** To remove unit, clean area and disconnect draft sensing cable. Remove unit retaining bolts and remove unit.

To disassemble, remove core plug (4—Fig. 221) and place selector lever in vertical position. Remove the four end plate bolts and withdraw shaft assembly far enough for rack to be disengaged from pinion. Rotate shaft assembly far enough for rack to be disengaged from pinion, then rotate shaft until rack teeth are aligned with cut-out in housing and withdraw shaft assembly. Remove pin (17) and collar (18). Slide spring, carrier, thrust washer and shims off of shaft. Note location and thickness of shims. Remove end plate by holding flats of sleeve (28) and unscrewing shaft (32). "Loctite" is applied to threads during reassembly.

When reassembling check to be certain ends of both springs protrude 0.127-0.250 mm (0.005-0.010 inch) past ends of carrier. Adjust by varying shim (22 or 24) thickness for appropriate spring.

When spring, shims, carrier, thrust washers, collar and pin are all assembled, end play of spring carrier must not exceed 0.3048 mm (0.012 inch). Adjust by varying thrust washer (20) thickness.

Place shaft assembly into housing without shim (29), hold end plate against housing and measure gap between end plate and housing. Install shim (29) thickness equal to gap measurement.

Continue reversing removal procedure and adjust draft sensing cable as outlined in paragraph 410.

## HYDRAULIC SYSTEM ADJUSTMENTS

### All Models So Equipped

**399. SELECTAMATIC CONTROL VALVE SPOOL ADJUSTMENT.** Place selectamatic valve in a vise and mount dial indicator so probe contacts valve spool end as shown in Fig. 222. Push spool into valve against spring pressure until it stops, set dial indicator to zero, slowly allow spring pressure to push spool back out of bore. Note amount of movement shown on dial indicator. Compare amount of movement with dimension etched on end of spool. If movement is greater than given dimension, tighten nuts (5—Fig. 222). If movement is less, loosen nuts (5). Repeat procedure until movement is no more than 0.254 mm (0.001 inch) greater than given dimension. Securely tighten nuts (5) in this position.

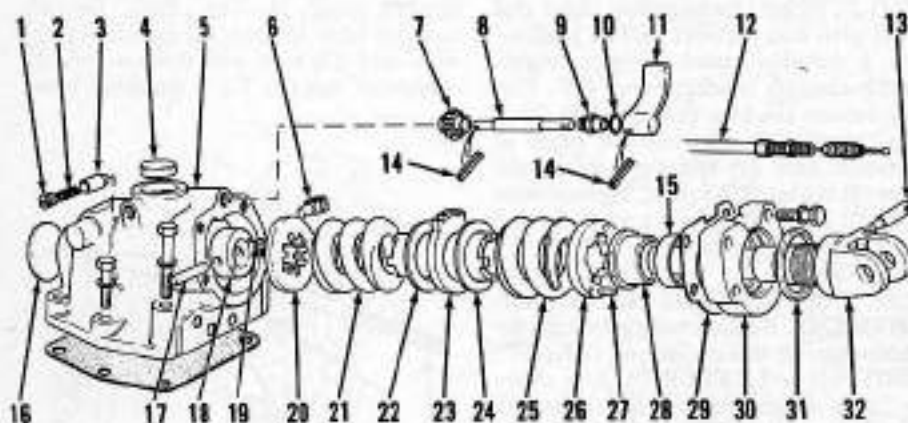


Fig. 221—Exploded view of selective rate sensing unit showing component parts and their relative positions.

1. Screw
2. Detent spring
3. Detent plunger
4. Core plug
5. Housing
6. Cable support
7. Pinion
8. Spindle
9. Bushing
10. Wiper ring
11. Selector lever
12. Sensing cable
13. Cable support
14. Pin
15. Bushing
16. Expansion plug
17. Pin
18. Collar
19. Stepped dowel
20. Thrust washer
21. Spring
22. Shim
23. Shim support
24. Shim
25. Spring
26. Thrust washer
27. Dowel
28. Sleeve
29. Shim
30. End plate
31. Seal
32. Yoke shaft



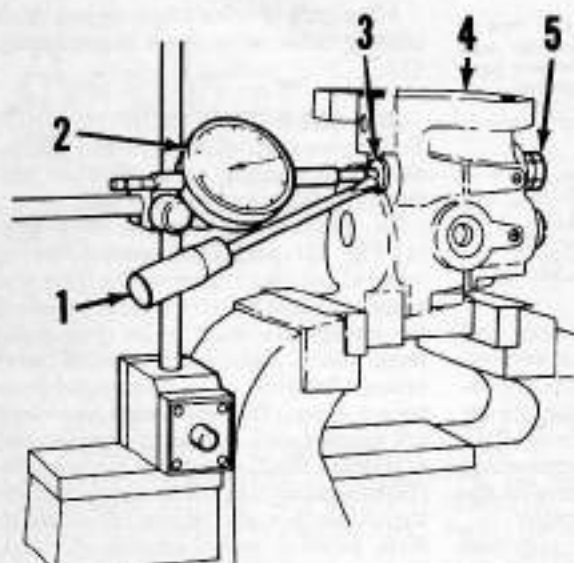


Fig. 222—View showing dial indicator position to set spool movement.

1. Screwdriver
2. Dial indicator
3. Spool
4. Selectamatic valve
5. Adjustment nut

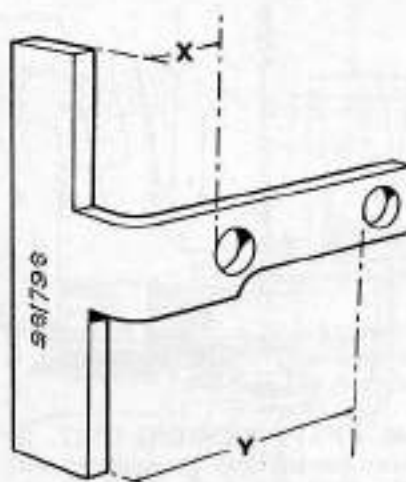


Fig. 223—Adjusting gage (DB-961796) for hydraulic control mechanism. Dimension "X" is 11.1 mm (0.437 inch); dimension "Y" is 60.1 mm (2.366 inches).

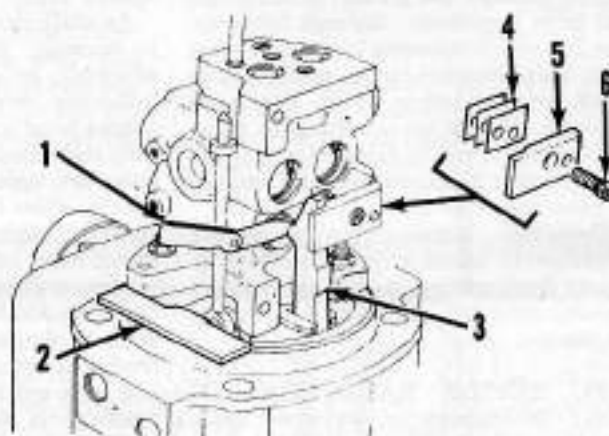
#### 400. ROCKSHAFT BRACKET/CONTROL VALVE ADJUSTMENT.

Adjustment procedure for models having three positions (**DRAFT**, **POSITION** and **EXTERNAL**) on selector dial is different from models having two positions (**DRAFT** and **POSITION**). Refer to appropriate paragraph for model being serviced.

**401. THREE POSITION SELECTOR DIAL.** Special tool DB-961796 (Fig. 223) is required to adjust selectamatic control valve to rockshaft bracket. Install stop plate (5—Fig. 224) and all shims (4) which were removed during disassembly of selectamatic valve making certain shims and plate are properly seated. Install valve on rockshaft bracket and select **EXTERNAL** position on selector dial. Fit pin for rocker shaft into top hole of special tool and push tool downward until it is against shoulder of rockshaft bracket. See Fig. 224. Hold rocker (3—Fig. 224) against stop plate and use a feeler gage (1) to measure gap between rocker and spool valve end. Add or remove shims (4) as necessary to obtain 0.25-0.51 mm (0.001-0.003 inch) clearance. Make certain stop plate and shims are on their seat and screw (6) is tight.

Fig. 224—View showing use of adjustment gage and feeler gage to adjust abutment plate.

1. Feeler gage
2. Adjusting gage
3. Rocker lever
4. Shim
5. Abutment plate
6. Screw



linkage to fully raised position, lower 40 mm (1.75 inches) measured at outer end of lift arm and support in this position with a suitable stand. Remove right-hand rockshaft bracket cover (27—Fig. 219), loosen the two nuts (3—Fig. 225), place punch (2) into hole in edge of rockshaft cam (4) and turn cam until roller (1) is seated in notch. Tighten nuts (3) to 10 N·m (7 ft.-lbs.) torque. Install cover and remove stand.

**403. CONNECTING LINK ADJUSTMENT.** Adjustment procedure for models having three positions (**DRAFT**, **POSITION** and **EXTERNAL**) on selector dial is different from models having two positions **DRAFT** and **POSITION**. Refer to appropriate paragraph for model being serviced.

**404. THREE POSITION SELECTOR DIAL.** Hold quadrant lever in **SELECT** position and switch selector dial to **EXTERNAL** position. On cab or flat deck models remove control housing

cover (4—Fig. 226). On all other models remove plug (4—Fig. 227). On all models, turn locknut (2) counter-clockwise until it is even with threaded end of connector link (3). Have quadrant lever

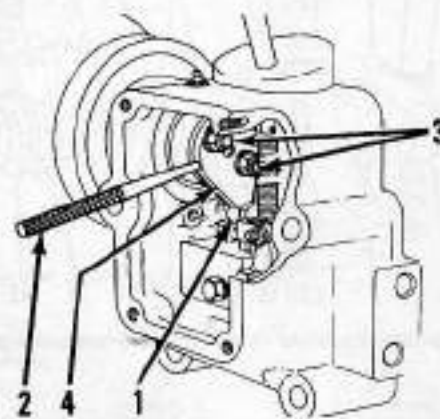


Fig. 225—View showing rockshaft cam location in rockshaft bracket.

1. Roller
2. Punch

3. Note
4. Rockshaft cam

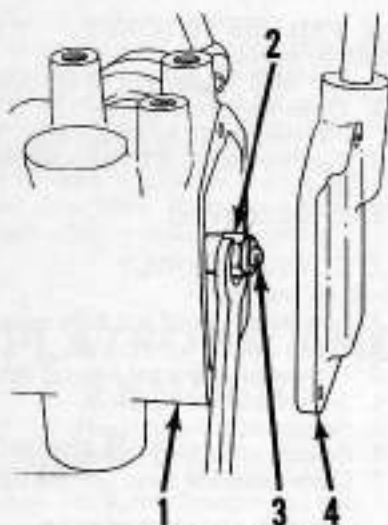


Fig. 226—View showing location of locknut used to adjust connecting link on cab or platform equipped models.

- |                    |                    |
|--------------------|--------------------|
| 1. Control housing | 3. Connecting link |
| 2. Locknut         | 4. Cover           |

held in **SELECT** position, start and run engine at 1800 rpm. Slowly turn locknut (2) one more full turn clockwise. Make certain selector dial can be set for **POSITION** and **EXTERNAL** operation. If necessary, locknut may be turned  $\frac{1}{4}$ -turn in either direction to make control movement easier. Install cover or plug.

**405. TWO POSITION SELECTOR DIAL.** Hold quadrant lever in **SELECT** position and switch selector dial to **POSITION** control position. Remove control housing cover (4—Fig. 226) on cab and platform equipped models, or plug (4—Fig. 227) on all other models. On all models, turn locknut (2—Fig. 226 or 227) counter-clockwise until it is even with threaded end of connector link (3). Remove right-hand rockshaft bracket

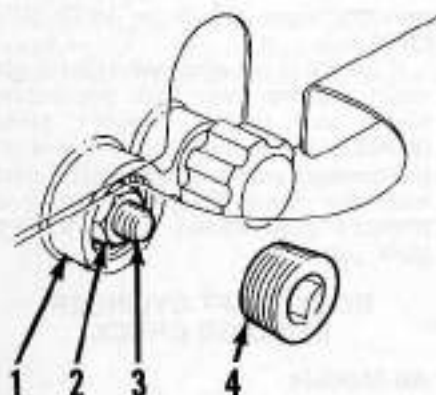


Fig. 227—View showing location of locknut used to adjust connecting link on low profile models.

- |                          |                    |
|--------------------------|--------------------|
| 1. Control housing cover | 3. Connecting link |
| 2. Locknut               | 4. Plug            |

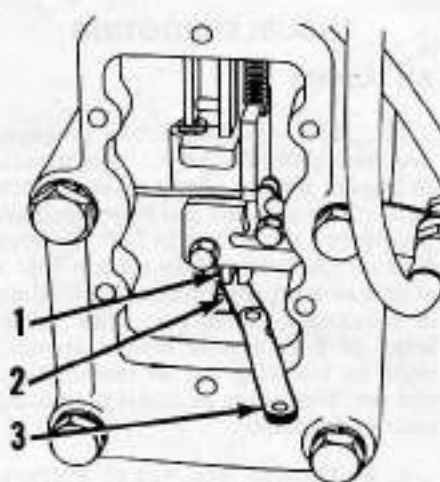


Fig. 228—View showing use of a feeler gage to adjust rocker lever in rockshaft bracket housing.

- |                 |                |
|-----------------|----------------|
| 1. Push rod     | 3. Feeler gage |
| 2. Rocker lever |                |

cover (27—Fig. 219). Have quadrant lever held in **SELECT** position, raise lift arms by hand until roller (1—Fig. 225) is seated in notch of cam (4). Use a suitable stand to support lift arms in this position. Place a 0.051 mm (0.002 inch) feeler gage between rocker lever (2—Fig. 228) and push rod (1) for position control. Turn locknut (2—Fig. 226 or 227) clockwise just until feeler gage can be removed.

Install covers and plug and remove stands supporting lift arms.

**406. CONTROL LEVER FRICTION DISC ADJUSTMENT.** If quadrant lever moves from set position, tighten nuts (4—Fig. 229) to tighten friction disc (3) pressure. Nuts should never be so tight that quadrant lever fails to move from **SELECT** position when released.

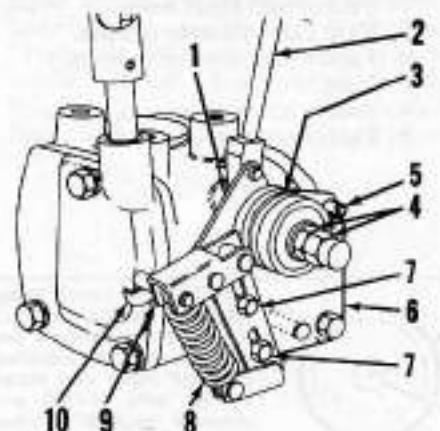


Fig. 229—View of linkage control lever and related parts in position to adjust select stop.

- |                  |                   |
|------------------|-------------------|
| 1. Plate         | 5. Plate          |
| 2. Shaft         | 7. Bolts          |
| 3. Friction disc | 8. Spring         |
| 4. Jam nuts      | 9. Spring carrier |
| 5. Pin           | 10. Plate         |

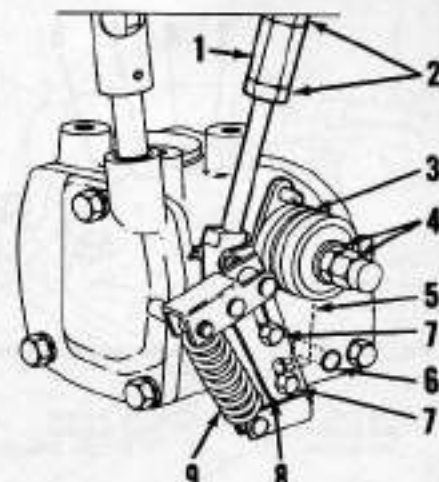


Fig. 230—View of linkage control lever and related parts in position to adjust linkage control lever.

- |                  |                   |
|------------------|-------------------|
| 1. Adjuster      | 6. Pin            |
| 2. Jam nuts      | 7. Bolts          |
| 3. Friction disc | 8. Spring carrier |
| 4. Jam nuts      | 9. Spring         |
| 5. Plate         |                   |

**407. SPRING CARRIER ADJUSTMENT.** Start engine and run at 1800 rpm. Select **POSITION** on selector dial and hold quadrant lever in **SELECT** position until linkage is at full height and pump relief valve just closes but lift arms do not lower. Hold quadrant lever in this position and loosen the two bolts (7—Fig. 229) and move spring carrier (9) until it contacts plate (10). Tighten bolts (7) and stop engine.

**408. QUADRANT CONTROL LEVER ADJUSTMENT.** Select **POSITION** on selector dial and move quadrant lever forward (**LOWER**) until it is 3 mm (1/8-inch) from end of its travel. Loosen jam nuts (2—Fig. 230) and turn adjuster (1) until plate (5) contacts pin (6). Tighten jam nuts (2) securely against adjuster (1).

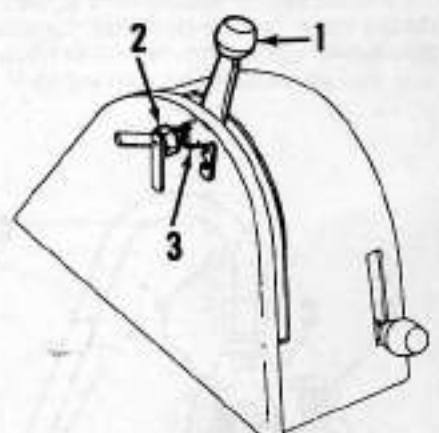


Fig. 231—View showing quadrant lever and stop.

- |                   |         |
|-------------------|---------|
| 1. Quadrant lever | 3. Stop |
| 2. Jam nut        |         |



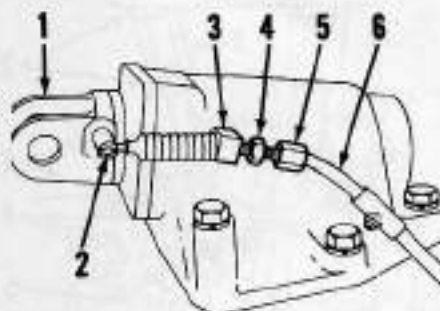


Fig. 232 - View of sensing cable and its adjustment points.

1. Yoke shaft  
2. Cable bracket  
3. Cable support

4. Jam nut  
5. Adjuster  
6. Cable & housing

## TROUBLESHOOTING

### All Models

411. When troubleshooting problems are encountered with selectamatic hydraulic system first make certain dump valve is closed and all controls are properly positioned for desired hydraulic function. Make certain fluid is at proper level and hydraulic filters are in serviceable condition. With knowledge of how system should operate, refer to following list of malfunctions and possible causes as an aid in locating source of trouble.

#### A. FAILURE TO LIFT UNDER ALL CONDITIONS, PUMP IS QUIET.

Could be caused by:

1. Hold relief valve leakage.
2. Spool valve seizure.
3. Air in system.
4. Plugs for by-pass or hold valves leaking.

#### B. FAILURE TO LIFT UNDER ALL CONDITIONS, PUMP NOISY.

Could be caused by:

1. Low oil level.
2. Suction filter plugged.
3. Non-return valve seat loose.

#### C. FAILURE TO HOLD IN DRAFT POSITION BUT HOLDS IN EXTERNAL POSITION.

Could be caused by:

1. Sensing cable adjustment.
2. Seizure of sensing cable or unit.
3. Cable bellcrank lever bolt too tight.

#### D. FAILURE TO HOLD WHEN SELECTOR DIAL IS IN EXTERNAL POSITION.

Could be caused by:

1. Hold valve sealing washer leaking.
2. Faulty hold relief valve.
3. Hold valve plunger seizure.
4. Faulty rockshaft cylinder piston seals.
5. Faulty "O" ring seals or pipes.
6. Faulty non-return valve.

#### E. FAILURE TO LOWER.

Could be caused by:

1. Lift latch engaged (if so equipped).
2. Three-way valve in position "1" or "2" position (if so equipped).
3. Selector dial in **EXTERNAL** position.
4. Rockshaft seized.

#### F. LOWERS SLOWLY.

Could be caused by:

1. Lowering control not fully open.
2. Loose control lever pivot.
3. Incorrectly adjusted sensing cable.
4. Seizure of sensing cable.
5. Seizure of valve plungers.
6. Seizure of sensing valve.
7. Cable bellcrank lever bolt too tight.

## HYDRAULIC SYSTEM PRESSURE CHECK

### Models 1190-1290

412. If tractor is equipped with remote outlet, plug a 0-27.58 MPa (0-4000 psi) pressure gage into outlet, start engine and run at idle speed and work remote outlet control. Reading on pressure gage should be 13.79 MPa (2000 psi).

If tractor is not equipped with remote outlet, remove distribution block (C - Fig. 233) and install special plug (P), part number (DB-961977) as shown, then reinstall distribution block with sealing rings. Install 0-27.58 MPa (0-4000 psi) pressure gage (G) and start engine, run at idle speed and observe pressure reading on gage. Gage reading should be 13.79 MPa (2000 psi).

### Models 1390-1490-1690

413. If tractor is equipped with remote outlet, plug 0-27.58 MPa (0-4000 psi) pressure gage into outlet, start engine and run at idle speed and work remote outlet control. Reading on pressure gage should be 13.79 MPa (2000 psi).

If tractor is not equipped with remote outlet, remove cover from distribution block and install adapter plate (K-962234). Install 0-27.58 MPa (0-4000 psi) pressure gage in adapter plate, start and run engine at idle speed. Reading on pressure gage should be 13.79 MPa (2000 psi).

## ROCKSHAFT CYLINDER LEAKAGE CHECK

### All Models

414. If tractor is equipped with a three-way control valve, raise lift arms with heavy implement attached. Place three-way valve control lever in number "1" position. If linkage lowers, rockshaft

409. **SELECT STOP ADJUSTMENT.** Select **POSITION** on selector dial, loosen nut (2 - Fig. 231) and move stop assembly (3) to bottom of slot. Move quadrant lever (1) fully rearward (**SELECT**) until pin (5 - Fig. 229) contacts plate (6). Move stop (3 - Fig. 231) until it just contacts quadrant lever (1). Tighten nut (2) with stop in this position. Release quadrant lever.

410. **DRAFT SENSING CABLE ADJUSTMENT.** Remove upper link and install weight bar and weights on lower lift arms only. Select **DRAFT** on selector dial and turn jam nut (4 - Fig. 232) clockwise until it almost touches adjuster (5). Turn adjuster until it stops against select spring. This position should be just before lever enters **SELECT** position. Start engine and when weighted lift arms reach their highest position, turn adjuster (5) until lift arms just begin to lower.

On 1190 models, tighten jam nut (4) against bracket (3) to maintain this adjustment and stop engine. On all remaining models, turn adjuster (5) 5/4 turns counter-clockwise, tighten jam nut (4) against bracket (3) to maintain this adjustment and stop engine.

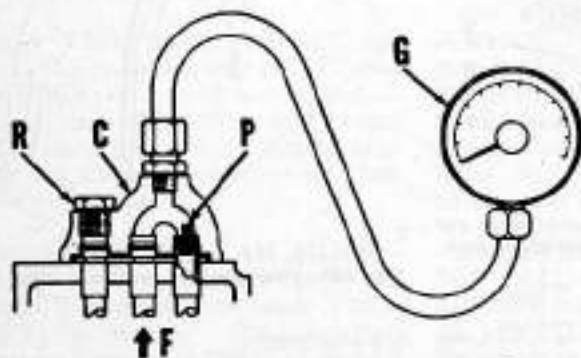


Fig. 233 - To check pump pressure distribution block (C) must be removed and special plug (P) installed. Reinstall cover and install 0-27.58 MPa (0-4000 psi) pressure gage (G). Return port (R) is for external use only.

cylinder seals are leaking.

If tractor is not equipped with a three-way valve, remove connector at front side of rockshaft cylinder and install special connector with shut-off valve (DB-961821). With valve open raise lift arms with heavy implement attached and close valve. If linkage lowers, rockshaft cylinder seals are leaking.

## PLATFORM AND FENDERS

### Platform Models

415. Platform, fenders and seat may be removed as an entire unit as necessary to perform certain service procedures.

To remove platform, as an assembly, first disconnect negative battery cable. Remove the two bolts at lower front side of fenders on each side and the three rear step bolts located under step plate on each side. Remove quadrant lever cover and disconnect linkage. Remove remote valve cover, disconnect linkage and remove rods which connect control levers to remote valve. Remove lowering control valve knob and disconnect pto linkage. Disconnect all necessary electrical wiring and harness. Remove all nuts from platform mounting studs, attach hoist to platform and raise platform approximately ten inches. Disconnect neutral start switch and remove platform assembly.

Reinstall by reversing removal procedure.

## CAB

### All Models So Equipped

416. Most service procedures may be performed without removing cab assembly. If it is necessary to remove

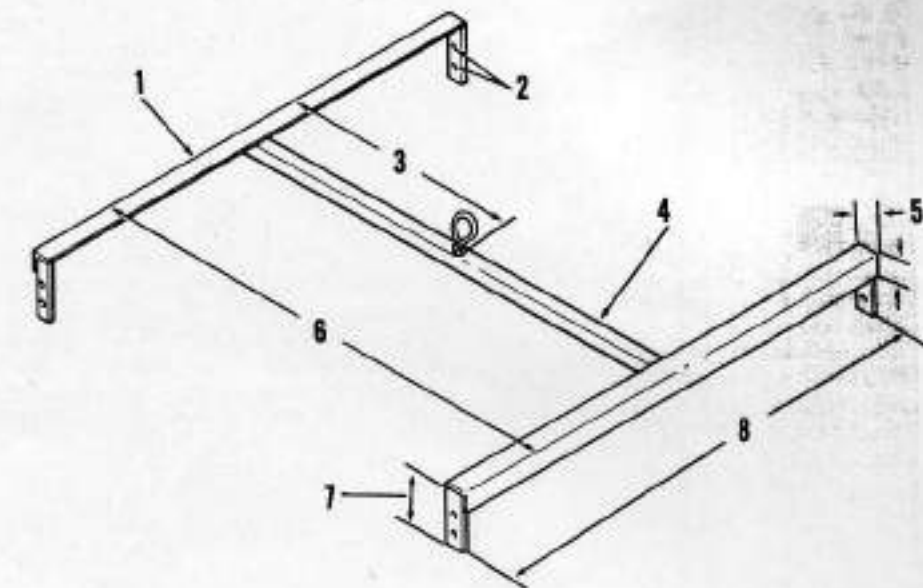


Fig. 234—Cab removal bracket to be fabricated locally to dimensions shown.

- |   |  |                            |
|---|--|----------------------------|
| 1. 6.35 mm (1/4-inch) x 50.8 mm (2 inches) angle iron | 3. 685.8 mm (27 inches)                                | 5. 50.8 mm (2 inches)      |
| 2. 19.1 mm (3/4-inch) holes                           | 4. 6.35 mm (1/4-inch) x 50.8 mm (2 inches) square tube | 6. 1283 mm (50 3/4 inches) |
|   |  | 7. 165.1 mm (6 1/2 inches) |
|   |  | 8. 1219 mm (48 inches)     |

cab disconnect negative battery cable, drain coolant from radiator and engine block and discharge air conditioning system.

**CAUTION:** Refrigerant in air conditioning system is under extreme pressure. Use Proper procedure and wear eye and hand protection.

Remove muffler and precleaner and raise hood. Remove bolts from frame brace at front of cab just behind engine and remove brace. Disconnect air conditioning, power steering and heater hoses. Disconnect all necessary electrical wiring and harness. Disconnect fuel return line and clutch hydraulic line. Disconnect fuel shut-off rod and remove handle and rod. Disconnect all throttle linkage and tachometer drive cable. Remove shift lever cover and shift lever.

Remove cab step. Remove fuel tank ventilation tube from cab frame. Disconnect pto cable and remove as necessary. Disconnect brake lines and remove brackets. Remove hitch control rod and disconnect park brake cables. Remove the four bolts from shift levers, disconnect dial selector rod, dump valve rod and remote valve rod. Remove fuel filter pipe and cap opening. Disconnect all remaining linkage, remove the four cap plugs from cab (two on each side along top at front and rear) and attach cab lifting bracket (Fig. 234) and hoist. Remove cab floor mat and fuel sender cover and disconnect fuel sender wires. Remove all cab retaining bolts and nuts and lift cab a few inches. Disconnect main wiring harness and remove cab.

Reinstall by reversing removal procedure.