SHOP MANUAL

CASE INTERNATIONAL

(DAVID BROWN)

MODELS

1190-1194-1290-1294-1390-1394-1490-1494-1594-1690

INDEX (By Starting Paragraph)

INDEX CONT.

DUAL DIMENSIONS

This service manual provides specifications in both metric (SI) and U.S. customary systems of measurement. The first specification is given in the measuring system perceived by us to be the preferred system when servicing a particular component, 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 we feel the preferred measurement in this instance is the metric (SI) system of measurement and the U.S. customary equivalent of 0.28 mm is 0.011 inch.

CONDENSED SERVICE DATA

	MODELS				
	1190	1290	1390	1490	1690
GENERAL					
Engine Make	Own				
No. of Cylinders	3	4	4	4	6
Bore	100 mm (3.939 in.)				
Stroke	114.3 mm (4.5 in.)	*	114.3 mm (4.5 in.)		
Displacement	2.7 liter (164 cu. in.)	*	3.6 liter (219 cu. in.)	3.6 liter (219 cu. in.)	5.4 liter (329 cu. in.)
Compression Ratio	17:1	17:1	17:1	16:1	16:1
Battery	12-Volt, Negative Ground				
No. of Forward Speeds	12				

* 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 Clearance (Cold)	0.25 mm (0.010 in.)				
Injection Timing	16° BTDC	17° BTDC	17° BTDC	20° BTDC	25° BTDC
Engine Low Idle Rpm	750				
Engine High Idle (No-Load) Rpm	2350-2375				2450
Engine Rated Speed (Full Load)	2200				2300
Power Rating	37 kW (49 hp)	45 kW (60 hp)	52 kW (70 hp)	66 kW (88 hp)	82 kW (110 hp)
SIZES AND CLEARANCES					
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 (2.3728-2.3732 in.)
Main and Rod Bearing Running Clearance	0.05-0.10 mm (0.002-0.004 in.)				
Crankshaft End Play	0.05-0.25 mm (0.002-0.010 in.)				0.15-0.25 mm (0.006-0.010 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	97	98	98	98	99
CAPACITIES					
Cooling System	8.5 liters (9 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.)
Transmission, Hydraulic and Differential Case	27.5 liters (29 U.S. qts.)			42 liters (44.5 U.S. qts.)	
Fluid Type	Case PTF Fluid or Hy-Tran Plus				

CONDENSED SERVICE DATA CONT.

	MODELS				
	1190	1290	1390	1490	1690
CAPACITIES (Cont.)					
Final Drive (Each)	2.3 liters (2.5 U.S. qts.)			6.8 liters (7 U.S. qts.)	7.5 liters (8 U.S. qts.)
Fluid Type	Case ET HB Fluid				
Power Steering	0.9 liters (1 U.S. qt.)	1.25 liters (1.5 U.S. qts.)			
Fluid Type	Case TCH Fluid				
Manual Steering Gear	1.2 liters (1.3 U.S. qts.)	....	....	....	....
Fluid Type	Case FDL SAE 140	....	....	....	....
Front Drive Axle Differential—					
David Brown	....	8 liters (8.5 U.S. qts.)			....
Fluid Type	....	Case FDL SAE 90			....
Carraro	....	....	....	4 liters (4.25 U.S. qts.)	
Fluid Type	....	....	....	Case FDL SAE 90	
Front Drive Axle Final Drive (Each)—					
David Brown	....	0.9 liters (1 U.S. qt.)			....
Fluid Type	....	Case FDL SAE 90			....
Carraro	....	....	....	1.4 liters (1.5 U.S. qts.)	
Fluid Type	....	....	....	Case FDL SAE 90	

	MODELS				
	1194	1294	1394	1494	1594
GENERAL					
Engine Make	Own				
No. of Cylinders	3	4	4	4	6
Bore	100 mm (3.939 in.)				
Stroke	114.3 mm (4.5 in.)				
Displacement	2.7 liter (164 cu. in.)	3.6 liter (219 cu. in.)			5.4 liter (329 cu. in.)
Compression Ratio	17:1	17:1	16:1		
Battery	12 volts, Negative Ground				
No. of Forward Speeds	12				
TUNE-UP					
Firing Order	1-2-3	1-2-4-3			1-5-3-6-2-4
Valve Clearance (Cold)	0.25 mm (0.010 in.)				
Injection Timing	16° BTDC	17° BTDC	17° BTDC	20° BTDC	25° BTDC
Engine Low Idle Rpm	750	600-650			
Engine High Idle (No-Load) Rpm	2350-2375				2450
Engine Full Load Rpm	2200				2300
Power Rating	35 kW (49 hp)	45 kW (62 hp)	53 kW (77 hp)	61 kW (85 hp)	72 kW (97 hp)

CONDENSED SERVICE DATA CONT.

	MODELS				
	1194	1294	1394	1494	1594
SIZES AND CLEARANCES					
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.)
Main and Rod Bearing Running Clearance	0.05-0.10 mm (0.002-0.004 in.)				
Crankshaft End Play	0.05-0.25 mm (0.002-0.010 in.)				0.15-0.25 mm (0.006-0.010 in.)
Cylinder Bore	100.46-100.66 mm (3.9388-3.9396 in.)				
Piston Diameter	99.86-99.88 mm (3.9315-3.9323 in.)				
Camshaft Journal Specifications, Refer to Paragraph	97	98	98	98	99
CAPACITIES					
Cooling System	8.5 liters (9 U.S. qts.)		14.2 liters (15 U.S. qts.)		15.3 liters (16 U.S. qts.)
Crankcase (with Filter)	6.25 liters (6.6 U.S. qts.)		7.4 liters (7.8 U.S. qts.)		12.5 liters (13.2 U.S. qts.)
Transmission, Hydraulic and Differential Case—Synchromesh	27.5 liters (29 U.S. qts.)	27.5 liters (29 U.S. qts.)	36.5 liters (38.5 U.S. qts.)	42 liters (44.5 U.S. qts.)	42 liters (44.5 U.S. qts.)
Power Shift	....	....	42 liters (44.5 U.S. qts.)	42 liters (44.5 U.S. qts.)	42 liters (44.5 U.S. qts.)
Fluid Type	Case PTF Fluid or Hy-Tran Plus				
Final Drive (Each)	2.3 liters (2.5 U.S. qts.)			6.8 liters (7 U.S. qts.)	7.5 liters (8 U.S. qts.)
Fluid Type	Case ETHB Fluid				
Power Steering	0.9 liters (1 U.S. qt.)	1.25 liters (1.5 U.S. qts.)			
Fluid Type	Case TCH Fluid				
Front Drive Axle Differential	....	6 liters (6.25 U.S. qts.)	NOTE 1	NOTE 2	NOTE 3
Fluid Type	....	Case FDL SAE 90			
Front Drive Axle Final Drive (Each)	....	1.4 liters (1.5 U.S. qts.)	NOTE 1	NOTE 2	NOTE 3
Fluid Type	....	Case FDL SAE 90			

NOTE 1: Prior to P.I.N. 11503001, differential capacity is 6 liters (6.25 U.S. qts.) and final drive capacity is 1.4 liters (1.5 U.S. qts.). P.I.N. 11503001 and after, differential capacity is 4 liters (4.25 U.S. qts.) and final drive capacity is 1 liter (1.06 U.S. qt.).

NOTE 2: Prior to P.I.N. 11518001, differential capacity is 6 liters (6.25 U.S. qts.). and final drive capacity is 1.4 liters (1.5 U.S. qts.). P.I.N. 11518001 and after, differential capacity is 4 liters (4.25 U.S. qts.) and final drive capacity is 1 liter (1.06 U.S. qt.).

NOTE 3: Prior to P.I.N. 11221501, differential capacity is 5 liters (5.25 U.S. qts.) and final drive capacity is 1.7 liters (1.75 U.S. qts.). P.I.N. 11221501 and after, differential capacity is 4 liters (4.25 U.S. qts.) and final drive capacity is 1 liter (1.06 U.S. qt.).

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.

It is recommended that wheel bearings be lubricated with multipurpose lithium base grease using a pressure grease gun after every 50 hours of normal operation.

To adjust wheel bearings, tighten slotted nut (17—Fig. 1) to 95 N·m (70 ft.-lbs.) torque while turning the wheel. Loosen the nut, then retighten to 40 N·m (30 ft.-lbs.) torque while turning the wheel. Make certain wheel turns freely. Loosen nut, if necessary, to align hole for cotter pin, then install a new 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, 1494, 1594 and 1690 models. On all models remove lower "O" ring (8).

With spindle removed, upper and lower spindle bushings (8 and 10—Fig. 2) 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 outer surface of axle extension. Bushings are presized and should not require reaming if carefully installed.

Reinstall by reversing removal procedure making certain thrust bearing (7—Fig. 1) and thrust washer (6) are in proper sequence on 1490, 1494, 1594 and 1690 models. On all models, tighten steering arm retaining cap screw (11) to 163 N·m (120 ft.-lbs.) torque.

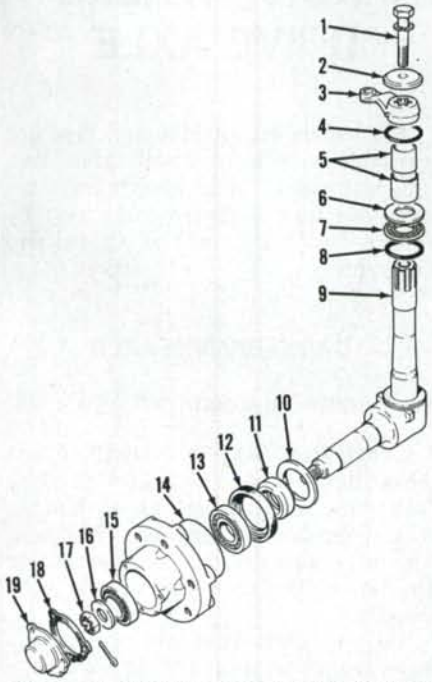


Fig. 1—Exploded view of typical front spindle assembly showing component parts and their relative positions.

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

TIE RODS AND TOE-IN

All Models

3. Toe-in of front wheels should be 3 mm (⅛ inch), measured between wheel rims at front and rear of wheels. Toe-in can be adjusted by lengthening or shortening threaded tie rod ends equally.

Tie rod ends are nonadjustable. If excessively worn, they must be renewed as complete units.

AXLE MAIN MEMBER

All Models

4. **REMOVE AND REINSTALL.** Refer to appropriate Fig. 2, 3 or 4 for an exploded view of front axle assembly. Disconnect drag link (manual steering), steering cylinder lines (power steering) or steering cylinder as necessary for model being serviced. Support front of tractor with suitable stand. Loosen trunnion pin retaining bolt (15) about five turns, then rap head of bolt with a hammer to dislodge threaded insert (23). Remove bolt and insert. Remove expansion plug from trunnion pin bore if so equipped. Screw slide hammer puller into trunnion pin (4) and remove pin. Raise front of tractor until axle is clear. Remove thrust washer (21) and "O" rings (2 and 22). Drive bushings (3 and 20) out of bore noting placement if different in size or length. Models 1190 and 1194 have a blind hole at the rear, remove bushing with a chisel.

On all models, drive new bushings in until flush with housings. Bushings are presized and should not require reaming if carefully installed. Check trun-

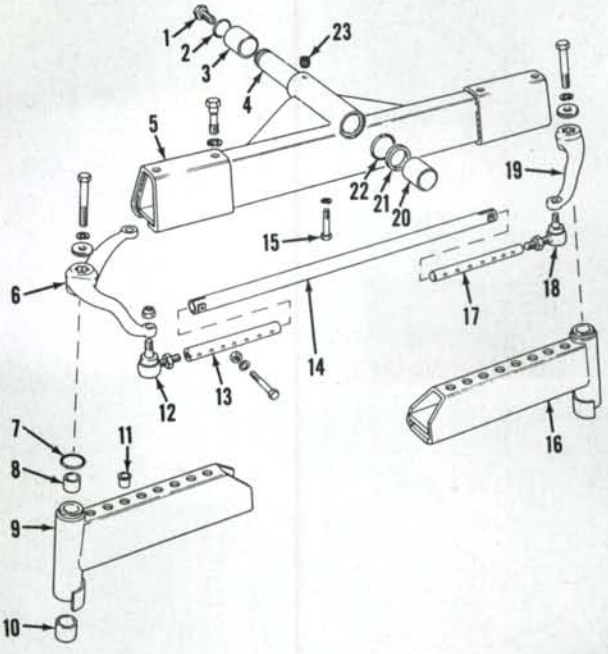


Fig. 2—Exploded view of front axle used on Models 1190 and 1194. Front axle used on Model 1294 and early Model 1394 (before P.I.N. 11504412) is similar.

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. Tie rod
14. Spacer tube
15. Axle retaining bolt
16. Axle extension
17. Tie rod
18. Tie rod end
19. Steering lever
20. Bushing
21. Thrust washer
22. "O" ring
23. Threaded insert

nion 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.

FRONT SUPPORT

Models 1190 and 1194

5. REMOVE AND REINSTALL. Front support for Models 1190 and 1194 is an integral part of the main frame casting. To renew front support, first split tractor as outlined in paragraph 217. 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. 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 4.

Reassemble by reversing disassembly procedure.

Models 1290-1294-1390-1394-1490-1494-1594-1690

6. 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 and 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 4 for two-wheel drive models, or paragraph 8 or 25 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.

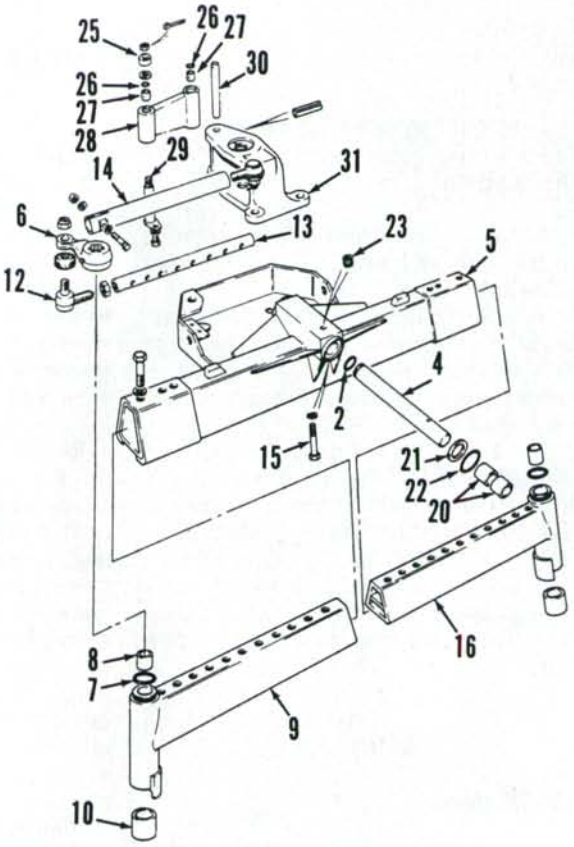


Fig. 4—Exploded view of typical front axle assembly used on 1490, 1494, 1594 and 1690 models.

2. "O" ring
4. Trunnion pin
5. Center beam
6. Steering lever
7. "O" ring
8. Bushing
9. Axle extension
10. Bushing
12. Tie rod end
13. Tie rod
14. Spacer tube
15. Axle retaining bolt
16. Axle extension
20. Bushings
21. Thrust washer
22. "O" ring
23. Threaded insert
25. Spacer
26. "O" ring
27. Bushing
28. Pivot link
29. Pivot pin
30. Pivot pin
31. Anchor fork

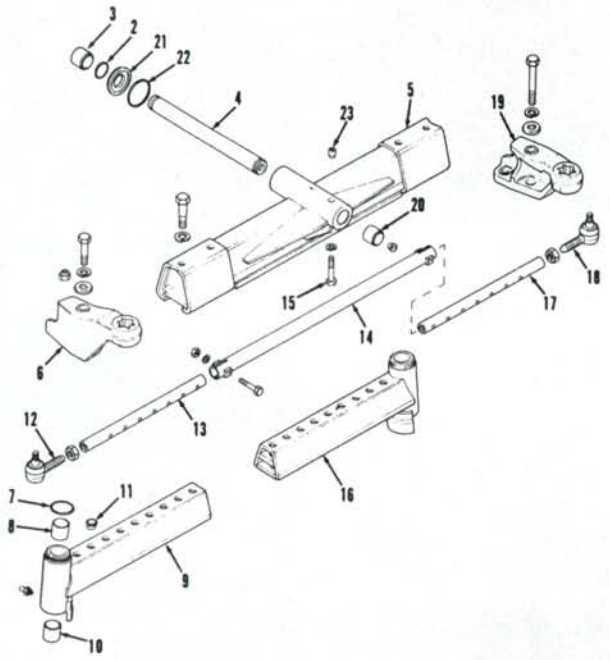


Fig. 3—Exploded view of front axle used on late Model 1394 (P.I.N. 11504412 and after). Refer to Fig. 2 for legend.

FRONT-WHEEL DRIVE AXLE

All models except 1190 and 1194 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 AXLE

All Models So Equipped

7. TIE RODS AND TOE-IN. Front wheel toe-in should be 0-1.5 mm (0-1/16 inch) measured from wheel rim to wheel rim at front and rear of wheels. Toe-in is adjusted by lengthening or shortening the threaded tie rod ends equally.

Tie rod ends that are excessively worn must be renewed as complete units.

8. R&R AXLE. 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. 5) 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 end 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 washers (36) and "O" rings (35 and 37).

To reinstall, reverse removal procedure. Bleed steering system as outlined in paragraph 58.

9. RENEW TRUNNION SHAFT BUSHINGS. Remove axle assembly as outlined in paragraph 8. Remove the four trunnion shaft bushings (34—Fig. 5) using a suitable puller. Install bushings making certain grease hole in each bore is between the two bushings. Refer to Fig. 6 for correct bushing placement.

If trunnion shaft bracket (32—Fig. 5) 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 (36), "O" ring is toward front at front position and toward rear at rear position.

10. FINAL DRIVE AND STUB AXLE. 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. Remove end plate (12—Fig. 7) and use pry bars to pull sun gear (15) and shaft (1—Fig. 8) out approximately 5 mm (3/16 inch).

NOTE: Axle shaft seals can be damaged if axle shaft is pulled out too far.

Hold axle shaft out and push sun gear in until split rings (14—Fig. 7) can be removed. Remove sun gear (15) and thrust washer (16).

NOTE: Do no push axle shaft into axle housing as oil seal damage could occur.

Bend tab washer (2—Fig. 7) 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).

Oil seal wear sleeve (11) should be renewed if damaged or worn. Use a chisel to cut through wear sleeve being careful not to damage surface of stub axle. Install new sleeve on axle making sure side with inside chamfered edge goes onto axle first.

Remove steering lever (4—Fig. 8) and bolts retaining upper and lower bearing pins (6 and 10). Remove bearing pins

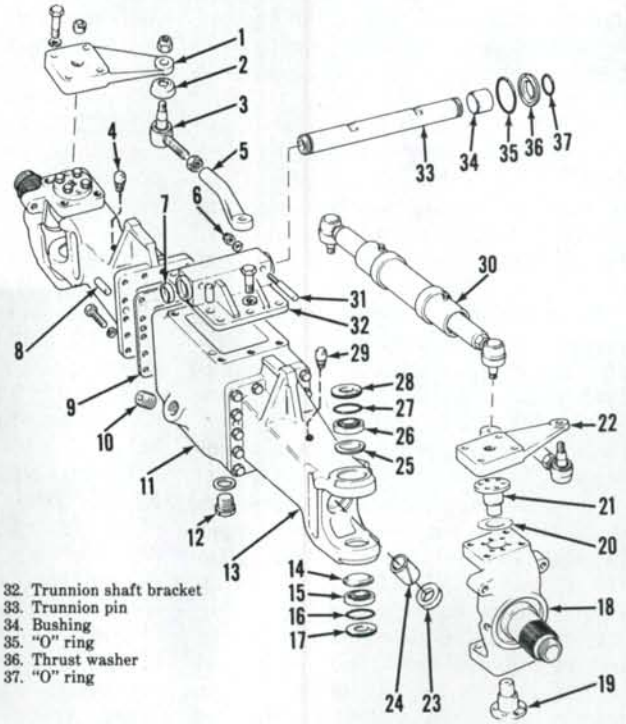


Fig. 5—Exploded view of David Brown front drive axle used on some models showing component parts and their relative positions.

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. Breather
30. Steering cylinder
31. Pin
32. Trunnion shaft bracket
33. Trunnion pin
34. Bushing
35. "O" ring
36. Thrust washer
37. "O" ring

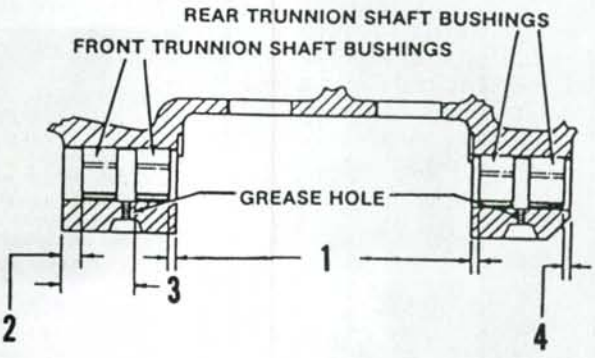


Fig. 6—Diagram showing correct dimensions for the placement of trunnion shaft bushings for models equipped with David Brown front drive axles.

1. 3 mm (1/8 inch)
2. 15 mm (19/32 inch)
3. 55 mm (2 3/16 inches)
4. 3 mm (1/8 inch)

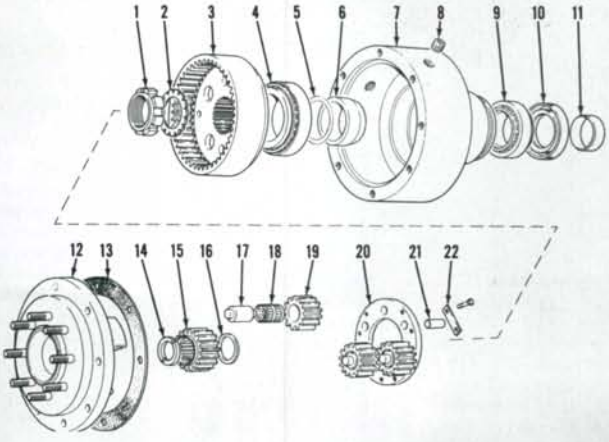


Fig. 7—Exploded view of David Brown front drive axle final drive showing relative position of its component parts.

1. Locknut
2. Tab washer
3. Planetary gear
4. Bearing
5. Shim
6. Spacer
7. Hub
8. Plug
9. Bearing
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. Lockplate

using jack screws in threaded hole of bearing pins. Retain shims (7) for use in reassembly. Hold axle shaft in place while removing stub axle assembly to prevent damage to oil seals. Remove axle shaft from housing.

Remove upper and lower sealing discs (28 and 17—Fig. 5), "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 from axle housing. Remove upper and lower shields (25 and 14).

Remove seal (2—Fig. 8) from inside stub axle (8). Using a suitable bushing driver, drive bushing (3) out oil seal end of stub axle. Install new bushing from seal end until it seats in stub axle. Install new oil seal with lip of seal 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. 8). Tighten lower bearing pin mounting bolts to 68 N·m (50 ft.-lbs.) torque and upper bearing pin mounting 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 Fig. 9. Remove upper bearing pin, then assemble shims so total thickness is 0.381 mm (0.015 inch) less than feeler gage measurement. This will correctly preload bearings to 0.10-0.15 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 11 to set stub axle bearing preload.

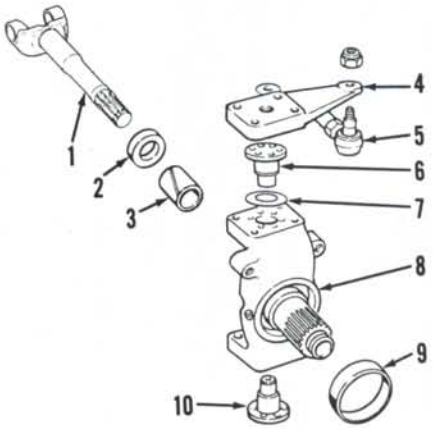


Fig. 8—Exploded view of David Brown front drive stub axle showing component parts and their relative positions.

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

11. WHEEL HUB BEARING PRELOAD. To set stub axle bearing preload, install shims (5—Fig. 7) having a total thickness of 2 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. 10. Measure and record amount of end play. Correct amount of bearing preload is 0.08-0.13 mm (0.003-0.005 inch). Subtract shims equal to measured end play plus 0.10 mm (0.004 inch) from previously installed shim pack to obtain correct bearing preload.

Reassemble unit installing tab washer (2—Fig. 7) and making sure flat side of nut (1) faces inward. Tighten nut to 203 N·m (150 ft.-lbs.) torque, then secure with tab washer. Fill each final drive with 0.9 L (1 quart) of Case FDL SAE 90 gear lubricant or equivalent.

12. PLANETARY GEAR ASSEMBLIES. Drain fluid, then remove end plate (12—Fig. 7). Remove lockplates (22) and bolts retaining planetary gear carrier (20) to end plate (12). Mark gear carrier, pins, gears and bearings prior to disassembly so they can 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 lockplates so they cover dowel pin holes and tighten bolts to 40 N·m (30 ft.-lbs.) torque. Reinstall end plate, tighten bolts to 100 N·m (75 ft.-lbs.) torque and fill hub to proper level with Case FDL SAE 90 gear lubricant or equivalent.

13. AXLE HOUSINGS. Axle shaft seal (23—Fig. 5) and bushings (24) can be renewed 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 oil from differential housing. Capacity is approximately 8 L (8.5 quarts). Attach hoist to axle housing so weight is equally balanced. Disconnect steering linkage and remove bolts retaining axle housing to differential housing, then remove axle housing. Remove final drive from axle housing if necessary.

To reinstall axle housing, reverse the removal procedure. Tighten housing mounting bolts to 110-130 N·m (80-95 ft.-lbs.) torque. Fill differential housing to correct level with Case FDL SAE 90 gear lubricant or equivalent.

14. R&R DIFFERENTIAL ASSEMBLY. 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 10.

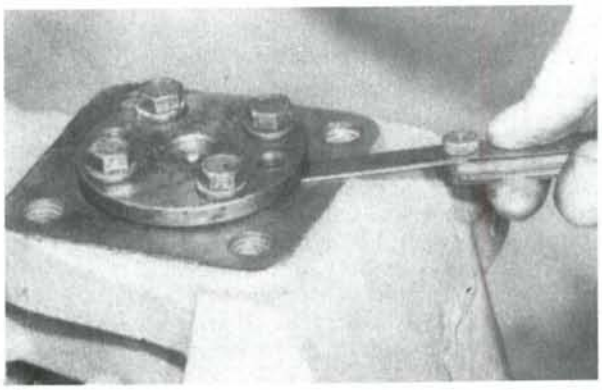


Fig. 9—To set bearing pin preload, use a feeler gage to measure gap between bearing pin flange and stub axle housing. Refer to text.

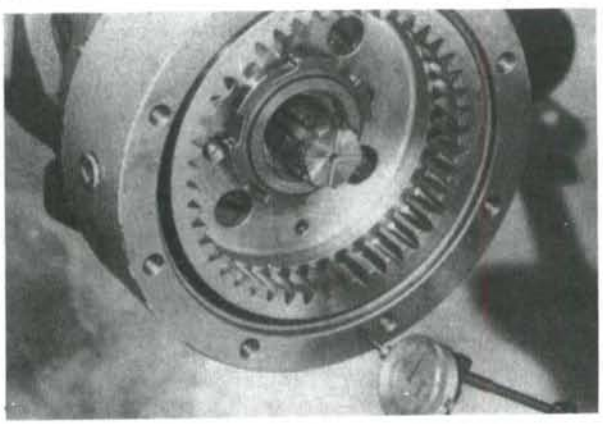


Fig. 10—To set stub axle bearing preload, mount a dial indicator so probe contacts face of wheel hub. Measure end play and refer to text.

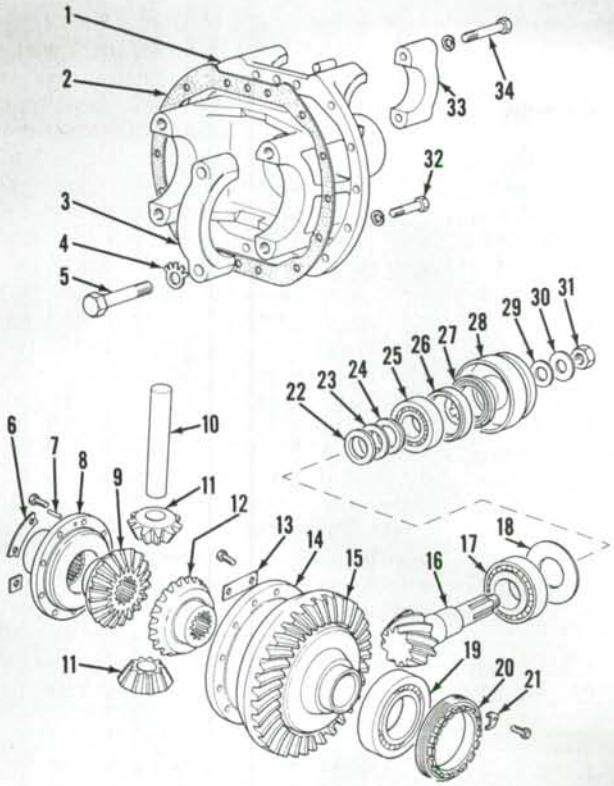


Fig. 11—Exploded view of David Brown differential assembly showing component parts and their relative positions.

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

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. 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 Case FDL SAE 90 gear lubricant or equivalent.

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

Remove pinion shaft locknut (31—Fig. 11), then 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 16. Reassemble by reversing disassembly procedure. Adjust carrier bearings and bevel gear backlash as outlined in paragraph 17.

16. PINION SHAFT PROTRUSION AND BEARING PRELOAD. Special tool (DB-8208) is required to set pinion shaft protrusion on David Brown axle, and all bearings, cups and spacers to be used in final assembly must be installed.

Assemble pinion shaft in carrier minus shims (18—Fig. 11), 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. 12. Install shaft (CAS-1236-6), probe and spacer (CAS-1609) and locknut (CAS-1234-4) of special tool so probe point lightly contacts face of pinion shaft gear. Tighten locknut to lock probe in this position. Using a feeler gage, measure and record amount of gap between spacer and probe. See Fig. 13.

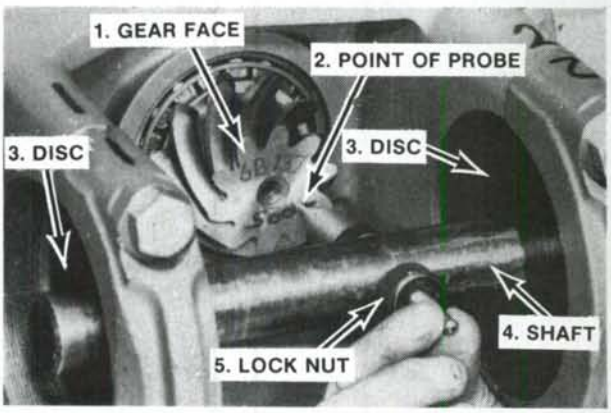


Fig. 12—To set pinion shaft protrusion, install special tool set (DB-8208) in carrier housing as shown. Refer to Fig. 13 and to text to determine thickness of shims required to correctly set shaft protrusion.

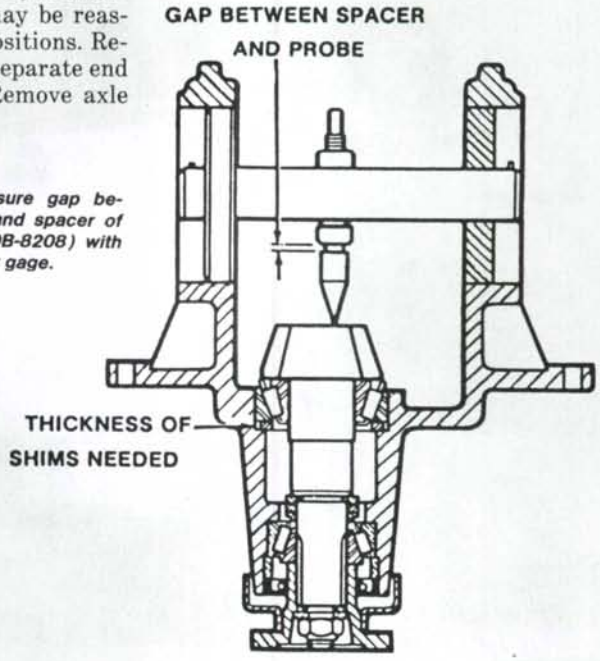


Fig. 13—Measure gap between probe and spacer of special tool (DB-8208) with a feeler gage.

Note protrusion correction mark etched on end of pinion shaft gear. This will be "O" or a plus (+) or minus (−) dimension. Note that dimension is given in thousandths of an inch.

Noting that special tool has a built in dimension of 0.030 inch (0.76 mm), substitute actual gap measurement and shaft correction number for figures shown in the following example to determine thickness of shims (18—Fig. 11) needed to correctly set pinion shaft protrusion.

Tool built in dimension	0.030 in. (0.76 mm)
Add or subtract dimension etched on pinion shaft	-0.005 in. (0.13 mm)
Result is setting dimension "A"	0.025 in. (0.63 mm)
Measured gap	0.055 in. (1.40 mm)
Minus setting dimension "A" determined above	-0.025 in. (0.63 mm)
Result is thickness of shims required	0.030 in. (0.77 mm)

Remove special tool, pinion shaft and inner bearing cup. Assemble correct thickness of shims into housing bore, then reinstall inner bearing cup. Be sure cup seats against shims and housing counterbore.

Reassemble pin shaft with spacers (22 and 24—Fig. 11) using 1.27 mm (0.050 inch) thick shims (23), but without spacer (26), oil seal (27) and sealing washer (29). Install flange (28), washer (30) and nut (31) on pinion shaft and tighten nut to 190 N·m (140 ft.-lbs.) torque. Turn shaft in both directions to seat bearings, then mount a dial indicator on carrier so probe contacts end of pinion gear as shown in Fig. 14 and measure shaft end play. Remove pinion shaft and reduce thickness of shims (23—Fig. 11) an amount equal to measured end play. This procedure will provide zero end play and zero preload. However, a tolerance of plus or minus 0.05 mm (0.002 inch) is acceptable.

Reinstall pinion shaft with all spacers and seals. Tighten retaining nut to 190 N·m (140 ft.-lbs.) torque.

17. DIFFERENTIAL CARRIER BEARINGS AND BEVEL GEAR BACKLASH. 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 16.

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 0.05 mm (0.002 inch) without preloading bearings. Mount dial indicator as shown in Fig. 15, then 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 notch 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.

18. MAIN DRIVE SHAFT. 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.

19. R&R TRANSFER GEARBOX. Drain oil from transfer case and transmission. Capacity is approximately 42 L (44 quarts). Remove front drive shaft. Engage front-wheel drive, then remove output shaft flange retaining nut (20—Fig. 16). Remove platform or cab, if equipped, as outlined in paragraph 348 or 349. Remove fuel tanks. Disconnect selector cable from selector shaft (4). Remove left and right shift lever housings from transmission top cover. Remove bolts from transmission top cover, remove wedge and shims between top cover and clutch housing, and remove top cover using a suitable hoist. Remove bolt (37) and locknut (39), then slide coupler (38) connecting transfer gearbox input shaft to transmission bevel pinion shaft rearward. Remove selector cable bracket (44) and hydraulic pump inlet pipe connector. Support transfer gearbox with a hydraulic jack, then remove gearbox mouting bolts and lower gearbox from transmission housing.

When reinstalling, laminated gasket (1—Fig. 16) must be the same thickness as original gasket, or layers peeled off to allow coupler (38) to slide freely onto input shaft (12) and bevel pinion shaft. Tighten transfer gearbox mounting bolts to 165 N·m (120 ft.-lbs.) torque. Tighten output shaft flange nut (20) to a torque of 190 N·m (140 ft.-lbs.). Install transmission top cover with wedge and same thickness of shims that were removed. Tighten three middle ⅝ inch bolts securing rear axle housing to top cover to 205-245 N·m (150-180 ft.-lbs.) torque. Tighten re-

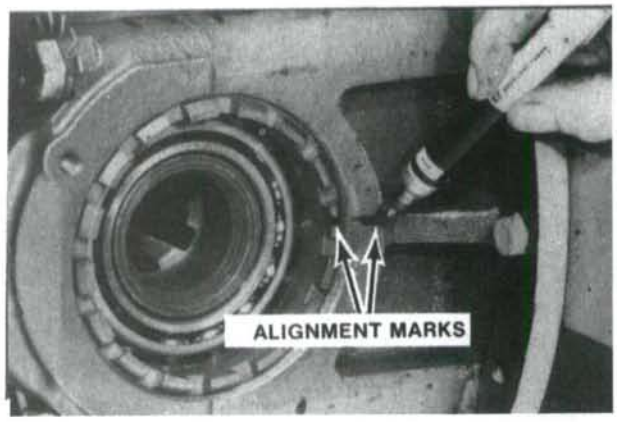


Fig. 14—View showing proper dial indicator position for setting pinion shaft bearing preload.

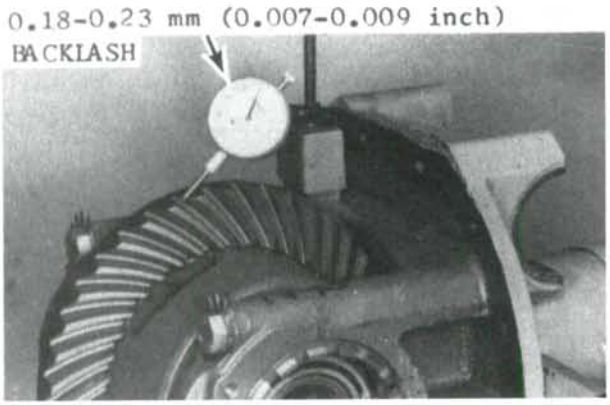


Fig. 15—View showing proper placement of dial indicator for setting backlash in front drive differentials.

mainder of top cover mounting bolts to 110-130 N·m (80-95 ft.-lbs.) torque. Tighten drive shaft flange bolts to 54 N·m (40 ft.-lbs.) torque. Complete installation by reversing removal procedure.

20. OVERHAUL TRANSFER GEARBOX. With transfer gearbox removed, disassemble as follows: Remove end plates (3 and 46—Fig. 16) 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.

21. Install idler gear (15—Fig. 16) into bottom of transfer gearbox 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 gearbox housing. Tighten bolts to 27 N·m (20 ft.-lbs.) torque. Hit end of output 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 0-0.05 mm (0-0.002 inch) for new bearings and 0.05-0.10 mm (0.002-0.004 inch) for used bearings.

To determine proper shim (33—Fig. 16) thickness, subtract 0.025 mm (0.001 inch) from dial indicator measurement if new bearings were installed, or subtract 0.076 mm (0.003 inch) from dial indicator measurement if original bearings are reused. The result is the required shim thickness to provide recommended end play.

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. Recheck end play and adjust shim thickness, if necessary, if not withint tolerance.

Install oil seal (5—Fig. 16) 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.

22. Install idler shaft (34—Fig. 16) 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.

Mount dial indicator so end of probe contacts end of idler shaft (34—Fig. 16). Measure and record amount of end play. End play tolerance is 0-0.05 mm (0-0.002 inch) for new bearings and 0.05-0.10 mm (0.002-0.004 inch) for used bearings.

To determine correct shim (36—Fig. 16) thickness, subtract 0.025 mm (0.001 inch) from dial indicator measurement if new bearings are used, or subtract 0.076 mm (0.003 inch) from dial indicator measurement if original bearings are reused. The result is the required thickness of shims needed to obtain desired end play.

Remove rear end plate (46—Fig. 16) and install correct shim (36) thickness. Reinstall end plate (46) and tighten bolts to 27 N·m (20 ft.-lbs.) torque. Recheck end play and adjust shim thickness, if necessary, if not within required tolerance.

23. Install input shaft (12—Fig. 16) and bearing assembly through front of housing (2) and input gear (13). Install bearing cup (14) and end plate (3). Tighten bolts to 27 N·m (10 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 in the same manner as outlined in paragraph 22.

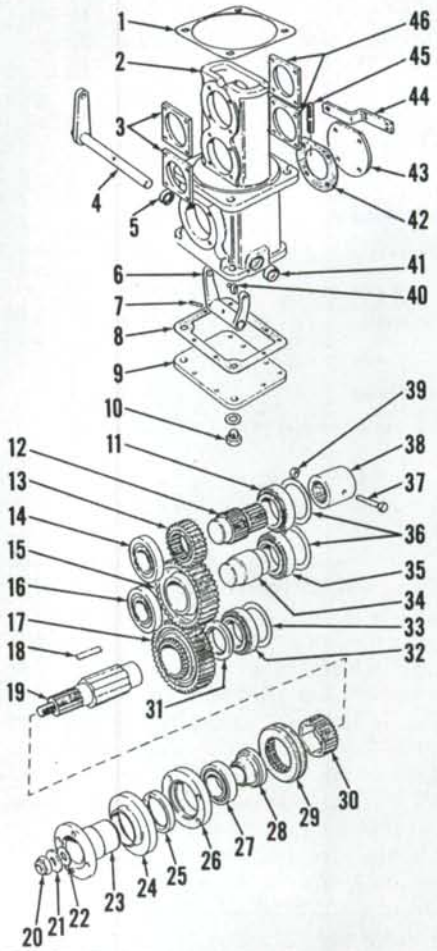


Fig. 16—Exploded view of transfer gearbox used with David Brown front drive axle showing component parts and their relative positions.

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

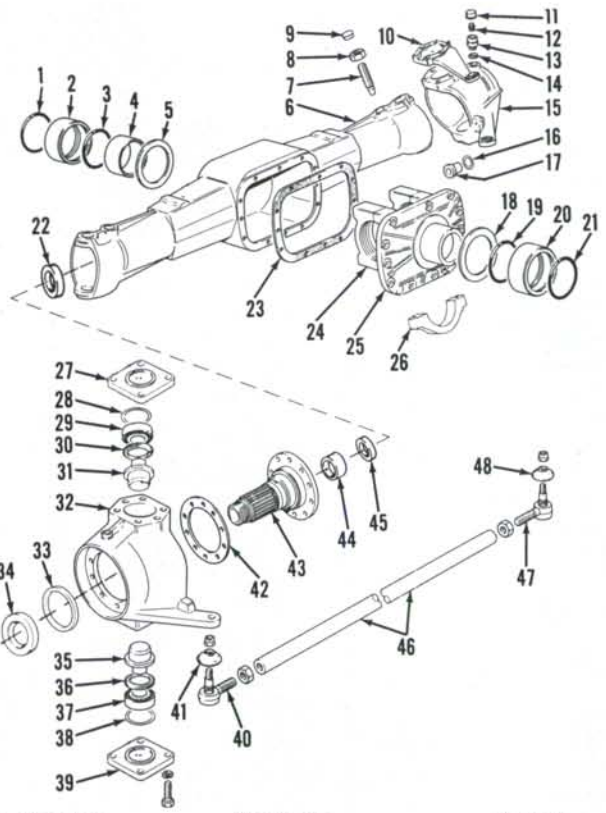


Fig. 17—Exploded view of Carraro front drive axle typical of AEl, AE2 and AE3 type axles showing component parts and their relative positions.

1. "O" ring
2. Bushing
3. "O" ring
4. Sleeve
5. Thrust washer
6. Axle case
7. Locating screw
8. Locknut
9. Dust cover
10. Steering lever
11. Cover
12. Breather
13. Retainer
14. Washer
15. Stub axle housing
16. Shims
17. Stop
18. Thrust washer
19. "O" ring
20. Bushing
21. "O" ring
22. Seal
23. Gasket
24. Differential carrier bearing cap
25. Differential carrier housing
26. Bushing cap
27. Bearing pin cover
28. Shim
29. Bearing
30. Seal
31. Bearing pin
32. Stub axle housing
33. Seal
34. Seal
35. Bearing pin
36. Seal
37. Bearing
38. Shim
39. Bearing pin cover
40. Tie rod end
41. Dirt seal
42. Gasket
43. Stub axle
44. Bushing
45. Stub axle seal
46. Tie rod
47. Tie rod end
48. Dirt seal

CARRARO AXLE

On tractors so equipped, a Carraro Type 790/19 mechanical front drive axle is used on Model 1394 with product identification number (P.I.N.) 11503001 and after, Model 1494 with P.I.N 11518001 and after and Model 1594 with P.I.N. 11221501 and after. A Carraro AE3 front drive axle is used on Model 1594 prior to P.I.N. 11221501 and all 1690 tractors so equipped. On all other models equipped with a Carraro mechanical front drive axle, either an AEl or an AE2 axle is used. Service procedures for AEl, AE2 and AE3 axles are the same.

All Models So Equipped

24. TIE RODS AND TOE-IN. Front wheel toe-in is measured from wheel rim to wheel rim at front and rear of wheels. Toe-in should be 0-5 mm (0-3/16 inch) on tractors with Type 709/19 axle. On all other tractors, toe-in should be 0-1.5 mm (0-1/16 inch). Toe-in is adjusted by lengthening or shortening the threaded tie rod ends equally.

Tie rod ends that are excessively worn must be renewed as complete units.

25. R&R AXLE ASSEMBLY. To remove front drive axle assembly, raise and support front of tractor. 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. Tighten mounting bolts to 210 N·m (155 ft.-lbs.) torque. Bleed steering system as outlined in paragraph 59.

26. PIVOT BUSHINGS. To renew axle pivot bushings (2 and 20—Fig. 17), first remove axle as outlined in paragraph 25. On AEl, AE2 and AE3 axles, put marks (B—Fig. 18) on oil seal carrier and differential carrier so seal carrier can be reinstalled in original position. On all axles, put mark (A) on differential carrier and axle housing in line with hole in bushings prior to removing bushings. Remove oil seal carrier, then pry bushings from housings. Remove sleeve (4—Fig. 17) and thrust washers (5 and 18) as necessary.

Install new "O" rings in pivot bushings and lubricate with grease before reinstalling bushings. Make certain holes in bushings are aligned with marks made previously on case and carrier housing (Fig. 18). Install oil seal carrier aligning mark on carrier with mark on differential carrier.

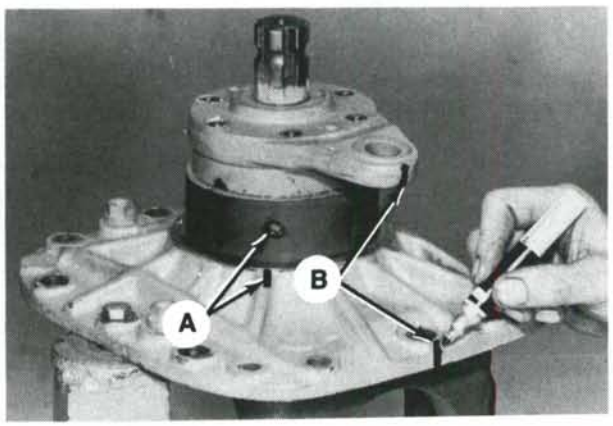


Fig. 18—Before disassembling differential carrier, place alignment marks (A and B) as shown for repositioning of bushings and oil seal carrier. On Type 709/19 axles, oil seal carrier (B) alignment is not required.

Models With AEl, AE2 or AE3 Carraro Axle

27. FINAL DRIVE AND STUB AXLE. Raise and support front of tractor, then remove tire and wheel. Rotate hub (4—Fig. 19) until drain plug (18) is at bottom, then drain oil from housing. Remove bolts retaining end plate (19) to hub (4) and install two guide studs opposite each other in hub. Remove end plate (19) with planetary gears. Remove snap ring (15) and sun gear (22). Support hub with a chain hoist. Remove locknut (23) and spacer (24). On Model 1690 and early Model 1594, remove and retain shims (25—Fig. 20). On all models, remove planetary ring gear and hub assembly.

To remove stub axle (43—Fig. 17) and pivot housing (32), remove felt seal (34) and oil seal (33). Loosen nuts securing stub axle to housing. Disconnect tie rod ends (40 and 47). Disconnect steering cylinder from right-hand steering arm. Remove bearing pin covers (27 and 39) and shims (28 and 38). Use special puller (CAS-1652) to remove bearing pins (31 and 35). Remove stub axle and housing assembly.

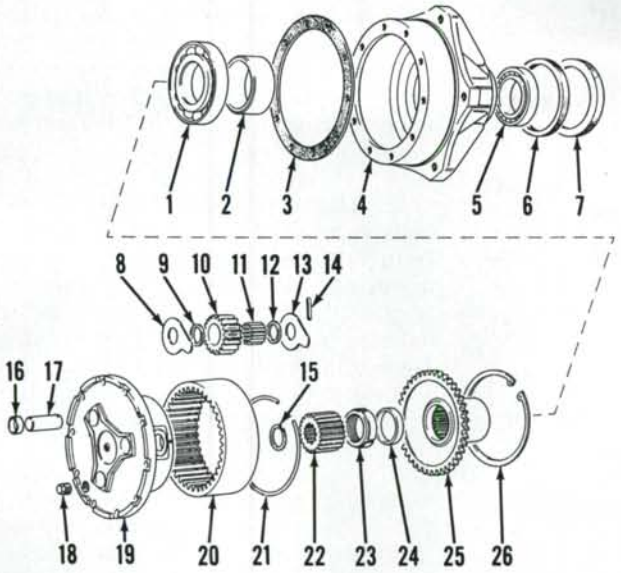


Fig. 19—Exploded view of Carraro front drive axle final drive assembly used on 1290, 1294, 1390 and 1490 models and early 1394, 1494 and 1594 models showing component parts and their relative positions

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 gear
22. Gear
23. Locknut
24. Spacer
25. Support gear
26. Snap ring

Remove stub axle mounting nuts and separate axle from pivot housing. Remove bearing, thrust spacer, bushing (44) and oil seal (45) as necessary.

When reassembling, be sure lip of oil seal is towards inside of stub axle and chamfered side of thrust spacer faces away from bearing. Heat bearings to 120°C (250°F) maximum prior to installation.

To reinstall, reverse removal procedure while noting that slot in stub axle mounting flange must be installed over breather hole in swivel housing as shown in Fig. 21.

NOTE: If stub shaft bearing is renewed on Model 1690 and early Model 1594, bearing preload must be set as outlined in paragraph 29 before installing oil seal (33—Fig. 17) and felt seal (34).

Install stub axle and swivel housing onto axle housing, then install upper and lower bearing pins (31 and 35—Fig. 17) with bearings. Be sure flange of bearing pins seats against the housing. Adjust swivel bearing preload as outlined in paragraph 28. Complete reassembly by reversing disassembly procedure. Tighten ring gear retaining nut to 1200 N·m (885 ft.-lbs.). Lubricate swivel bearings with multipurpose lithium base grease. Fill hubs with correct amount of Case FDL SAE 90 gear lubricant or equivalent.

28. SWIVEL BEARING PRELOAD. Shims (28 and 38—Fig. 17) are used between swivel bearing cups and bearing covers (27 and 39) to adjust bearing preload. Correct setting is 0.40 mm (0.016 inch) preload on each bearing. To set bearing preload, install lower bearing cover without shims and tighten mounting bolts to 280 N·m (205 ft.-lbs.) torque. Install all shims which were removed from upper and lower pins, plus an additional 0.5 mm (0.020 inch) shim, on the upper bearing cup. Install upper bearing cover and tighten mounting bolts evenly in sequence shown (Fig. 22) until all up and down movement of swivel housing is eliminated. Tap bearing pin cover and turn swivel housing from side to side to assure bearings are seated. Continue to tighten upper cover bolts, if necessary, until all up and down movement is just removed, then measure gap between upper bearing cover and axle housing using a feeler gage. Remove upper and lower bearing covers and all shims. Remove thickness of shims equal to measured gap, then divide remaining shims equally between upper and lower bearing covers. Install an additional 0.20 mm (0.008 inch) shim under each bearing cover to provide specified 0.40 mm (0.016 inch) bearing preload, then tighten cover bolts to 280 N·m (205 ft.-lbs.) torque. Tighten stub axle mounting nuts to 130 N·m (95 ft.-lbs.) torque.

29. WHEEL HUB BEARING PRELOAD. Model 1690 and early Model 1594 equipped with Carraro AE3 axles are equipped with taper roller bearings and bearing preload is set by adjusting thickness of shims (25—Fig. 20). On all other models, axles are equipped with ball bearings and preload is controlled by spacers (2 and 24—Fig. 19). Preload is not adjustable on these models.

NOTE: Bearing preload must be set before installing oil seal (33—Fig. 17) and felt seal (34).

To set preload, install ring (26—Fig. 20) and original amount of shims (25)

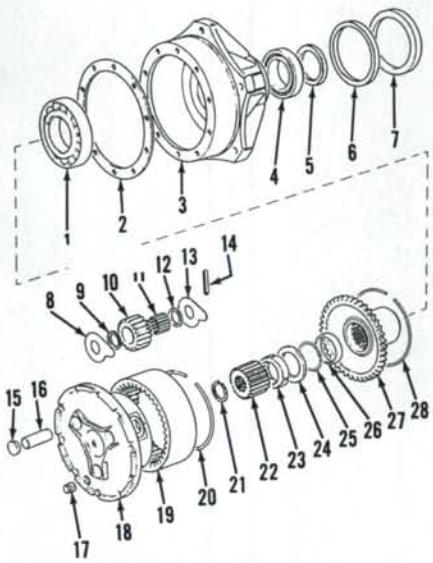


Fig. 20—Exploded view of AE3 Carraro front drive axle final drive unit used on 1690 and early 1594 tractors showing component parts and their relative positions.

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

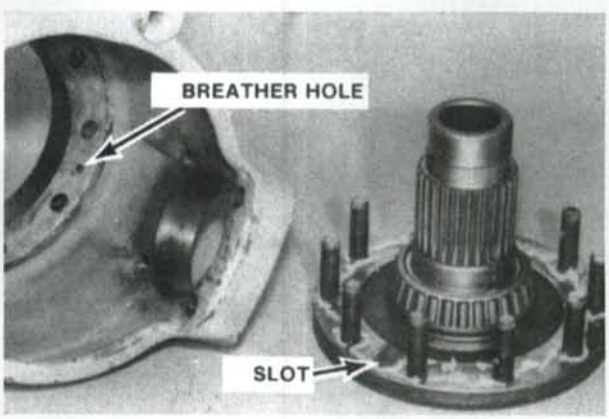


Fig. 21—View showing location of slot on stub axle which must cover breather hole of stub axle housing on Carraro front drive axles.

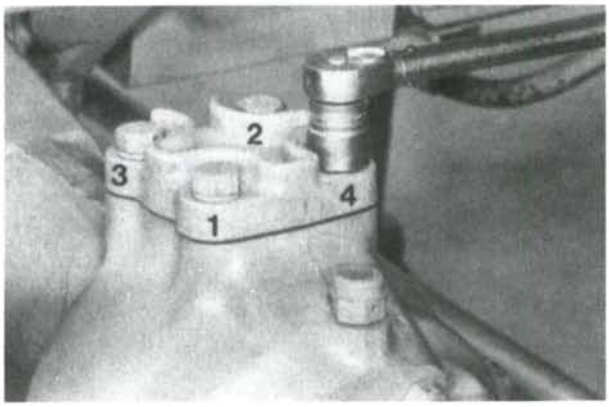


Fig. 22—Proper tightening sequence used to install bearing pin cover prior to setting bearing pin preload.

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 as shown in Fig. 23 on wheel hub, then use a torque wrench to measure amount of torque needed to turn wheel hub.

Correct bearing preload requires 2.3 N·m (20 in.-lbs.) torque to turn hub. Add or subtract from shim thickness (25—Fig. 20) until correct preload is obtained.

After preload is correctly adjusted, remove ring gear assembly and install oil seal and felt seal in hub. Reinstall ring gear with correct amount of shims and tighten locknut to 1200 N·m (885 ft.-lbs.) torque.

30. PLANETARY GEARS. Drain oil from hub, then remove planetary gear carrier (19—Fig. 19 or 18—Fig. 20). Mark location of planetary gear pins and gears in the carrier so they can be reassembled in their original positions. Remove roll pins (14), then drive planetary gear pins outward from gear carrier. Cup plugs (16—Fig. 19 or 15—Fig. 20) will be driven out with pins. Remove gears, thrust washers, spacers and bearing rollers. Keep these parts with their respective gear pins.

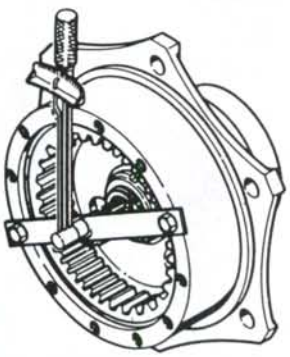


Fig. 23—When setting wheel hub bearing preload on Models 1594 and 1690, use special fixture and a torque wrench to check torque required to turn wheel hub.

Reassemble by reversing disassembly procedure. Apply sealant to cup plugs before installation. Make certain that notch in carrier gasket and drain hole in carrier is aligned with notch in wheel hub. Tighten retaining bolts to 80 N·m (60 ft.-lbs.) torque. Fill hub to correct level with Case FDL SAE 90 gear lubricant or equivalent.

31. AXLE SHAFTS. Axle halfshafts (7 and 12—Fig. 24), bearing (6) and oil seal (4) can be renewed with axle housing in place. Refer to paragraph 27 for removal of final drive, swivel housing and stub axle. Loosen bearing lock screws (3), then pull axle shaft from housing using a suitable slide hammer puller. Use a puller to remove oil seal from housing.

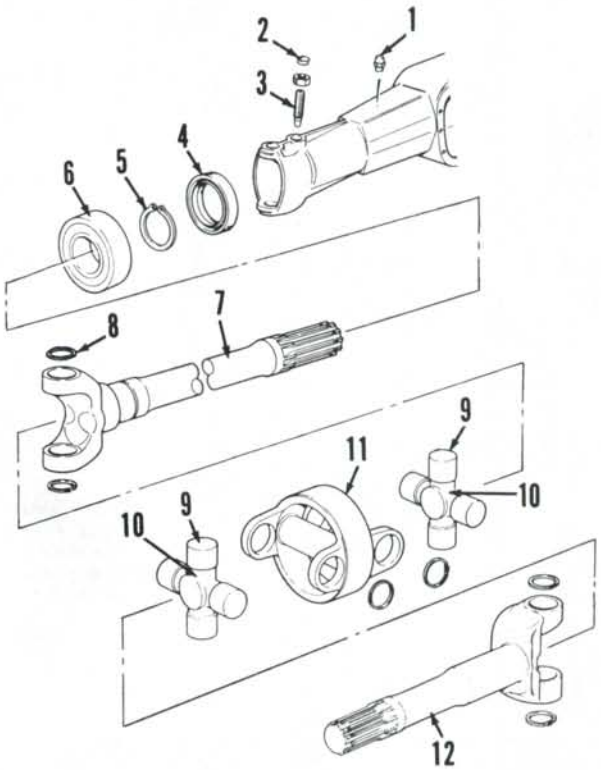


Fig. 24—Exploded view of typical front axle shafts used AEI, AE2 and AE3 Carraro axles.

1. Breather
2. Dust plug
3. Bearing lock screw
4. Oil seal
5. Snap ring
6. Bearing
7. Long shaft
8. Snap ring
9. Bearing cup
10. Cross
11. Housing
12. Short shaft

Install new oil seal with lip facing inward. Lubricate seal lip before installing axle shaft. Be sure bearing is seated in housing bore, then tighten upper and lower bearing lock screws (3) to secure bearing.

32. R&R DIFFERENTIAL. To remove front drive differential assembly, it is first necessary to remove final drives and stub shafts as outlined in paragraph 27. Remove axle shafts as outlined in paragraph 31. Remove axle housing as outlined in paragraph 25. Remove differential carrier mounting bolts and remove differential assembly from housing.

To reinstall differential, reverse the removal procedure. Tighten differential carrier retaining bolts to 87 N·m (65 ft.-lbs.) torque. Fill axle housing to correct level with Case FDL SAE 90 gear lubricant or equivalent.

33. OVERHAUL DIFFERENTIAL. Place differential unit in a stand with pinion shaft pointing downward. Mark bearing caps and carrier housing so caps can be reinstalled in their original positions. Remove bearing caps and bearing adjuster rings (8 and 35—Fig. 25). Remove bevel ring gear and differential assembly from carrier housing.

Mark position of oil seal carrier as shown in Fig. 18, then remove carrier. Using special spanner wrench (CAS-1597), remove pinion shaft locknut

(16—Fig. 25). Use a soft hammer to drive pinion shaft out of bearings and carrier. Remove bearings, shims and bushing from pinion shaft and carrier as necessary.

Mark end plate (37), bevel ring gear (3) and cage (4) so they can be reassembled in their original positions. Remove carrier bearings (6 and 36) as necessary. Separate end plate from cage and remove side gear (20) and friction plates. To remove cross-shaft retaining pins (25 or 30), remove the cage stud (38) that is aligned with one of the pins. The remaining two pins are aligned with end plate locating dowels (33). Use a punch to drive the two retaining pins and dowel pins out of cage. Drive long cross-shaft (21) out of cage, then remove the two pinion gears (22 and 28) and thrust washers. Drive short cross-shafts (24 and 31) out of cage, then remove cross-shaft block (26) and remaining two pinion gears and thrust washers. Remove side gear (27) and friction plates. Remove bevel ring gear (3) as necessary.

Bevel ring gear and pinion shaft are serviced as a matched set only. If bevel ring gear and pinion shaft, pinion shaft bearings or carrier are renewed, pinion shaft protrusion must be set as outlined in paragraph 35.

Reassemble by reversing the disassembly procedure while noting the following special instructions: Be sure tabs of friction plates (9 and 34—Fig. 25) engage the grooves in differential cage (4) and end plate (37). Tighten end plate nuts to 48 N·m (35 ft.-lbs.) torque. When renewing carrier bearings (6 and 36), heat bearings to 120°C (250°F) maximum before installing. Heat ring gear before installing on differential cage. Tighten retaining bolts to 90 N·m (65 ft.-lbs.) torque.

Check and set friction plate end play as outlined in paragraph 34. Set pinion shaft protrusion as outlined in paragraph 35. Adjust differential carrier bearings and bevel gear backlash as outlined in paragraph 36.

34. DIFFERENTIAL FRICTION PLATE END PLAY. To check end play of friction plates, mount a dial indicator so probe extends through axle shaft opening and contacts end of one of the side gears. Insert a screwdriver or other suitable tool through opening in side of differential cage, pry side gear upward and measure end play.

Correct end play is 0.03-0.20 mm (0.001-0.008 inch). End play can be adjusted by replacing 2.8 mm spacer with a 2.9 mm spacer (1 and 40—Fig. 25). Renew friction plates if end play is still excessive.

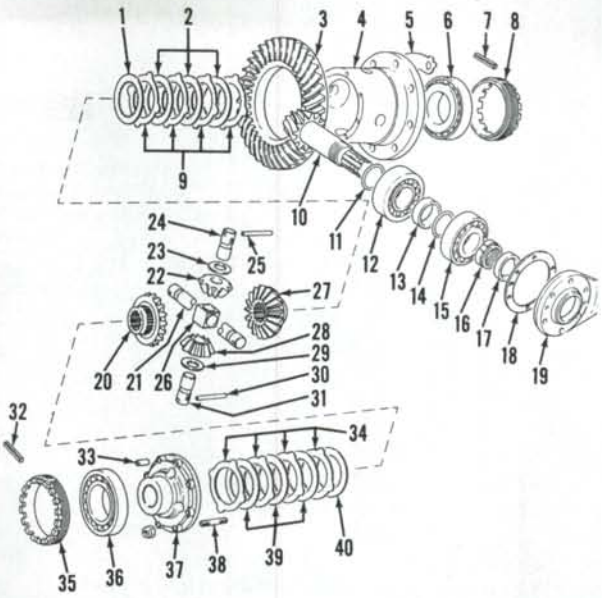


Fig. 25—Exploded view of Carraro Type AE1, AE2 and AE3 limited slip front drive axle differential showing component parts and their relative positions.

1. Spacer
2. Friction plate, inner
3. Differential bevel gear
4. Differential cage
5. Lockplate
6. Bearing
7. Roll pin
8. Adjusting 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
33. Dowel pin
34. Friction plate, outer
35. Adjusting ring
36. Bearing
37. End plate
38. Stud
39. Friction plate, inner
40. Spacer

Repeat procedure for friction plates and side gear on opposite side.

35. PINION SHAFT PROTRUSION AND BEARING PRELOAD. To set pinion shaft protrusion, install bearing cups and cones in carrier housing. Use a bolt, washers and nut as shown in Fig. 27 to hold bearing cones in place. Tighten bolt and nut until bearing cones are difficult to turn.

Install carrier bearing caps (1—Fig. 27) on carrier housing and tighten nuts to 205 N·m (150 ft.-lbs.) torque. Measure and record diameter of bearing bore (A). Place a shaft (3), having a diameter of at least 25 mm (1 inch) and having a cross hole drilled through it, across bearing bores as shown in Fig. 27. Measure and record diameter (B) of shaft. Using a depth gage measure from top of shaft to face of inner bearing cone (Fig. 28) and record measurement (C—Fig. 27).

To determine correct thickness of shims (11—Fig. 25) required to obtain desired shaft protrusion, use the following calculations: Subtract diameter of shaft (B—Fig. 27) from depth gage measurement (C). Add this figure to one-half the diameter of carrier bearing bore (A). The result is dimension (E). Then subtract dimension etched on pinion shaft gear face (dimension is in millimeters) from dimension (E). The resulting dimension will be correct shim (11—Fig. 25) thickness to install to properly set pinion shaft protrusion.

Install correct thickness shim (11—Fig. 25) on pinion shaft with chamfered side towards gear end of shaft. Press inner bearing onto shaft until seated against shim.

To set pinion shaft bearing preload, assemble pinion shaft in carrier minus seal (17—Fig. 25) and seal carrier (19). Install spacer (13) and a shim (14) that is 0.5 mm (0.020 inch) thicker than original shim removed during disassembly. Install outer bearing cone and old locknut (16). Tighten locknut to 450 N·m (330 ft.-lbs.) torque. Rotate pinion shaft to seat bearings, then mount a dial indicator so probe contacts end of pinion shaft. Move pinion shaft and record end play. Disassemble pinion shaft and reduce shim (14—Fig. 25) thickness an amount equal to measured end play plus 0.5 mm (0.020 inch) to

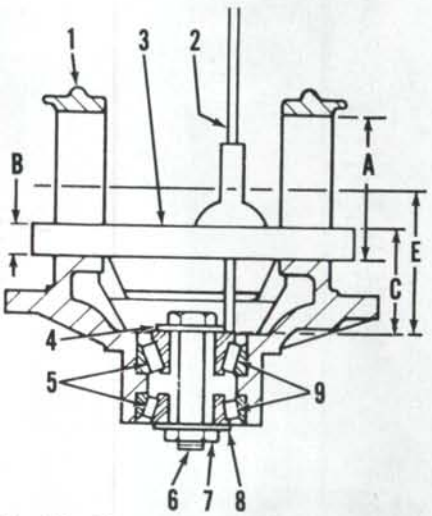


Fig. 27—Diagram showing method of securing pinion bearings in support housing to allow depth gage measurement to be taken.

1. Bearing cap
2. Depth gage
3. Pilot shaft
4. Washer
5. Bearing cones
6. Bolt
7. Nut
8. Washer
9. Bearing cups

obtain desired preload of 0.5 mm (0.020 inch) on pinion shaft bearings.

After correct shim thickness is determined, reinstall pinion shaft assembly using a new locknut. Tighten locknut to 450 N·m (330 ft.-lbs.) torque. Stake nut to groove in shaft to prevent loosening of nut.

36. DIFFERENTIAL CARRIER BEARINGS AND BEVEL GEAR BACKLASH. Pinion shaft protrusion and bearing preload must be properly set before adjusting differential carrier bearings. Install differential unit in carrier housing making certain ring gear is aligned with drain hole in carrier as shown in Fig. 29. Install bearing support caps, but do not tighten retaining nuts securely at this time. Install bearing adjuster rings and turn adjuster ring on ring gear side of differential until ring gear contacts pinion gear. Then turn adjuster ring on side opposite ring gear until all bearing end clearance is removed, but do not preload bearings. Mount dial indicator as shown in Fig. 30, then hold pinion shaft and move ring gear to check backlash. Turn adjuster rings as needed to move ring gear sideways to obtain recommended backlash of 0.15-0.25 mm (0.006-0.010 inch). Loosen adjuster ring one notch at a time and tighten opposite adjuster ring the same amount when setting backlash.

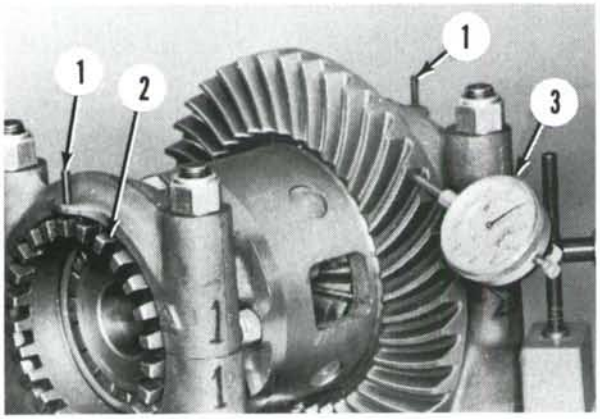


Fig. 30—Dial indicator probe should be against outer tip of ring gear tooth when measuring backlash.
1. Roll pins
2. Adjuster ring
3. Dial indicator

After bevel gear backlash is properly adjusted, turn adjuster ring on each side of differential clockwise two notches to provide recommended bearing preload. Tighten bearing cap mounting nuts to 210 N·m (155 ft.-lbs.) torque, then recheck for correct backlash. Drive roll pin (1—Fig. 30) into notch of each adjuster ring to secure adjustment.

Models With Type 709/19 Carraro Axle

37. FINAL DRIVE. Left and right final drive removal procedure is similar. Raise and support front of tractor, then remove tire and wheel. Remove drain plug from end plate and drain oil. Remove the two screws securing hub cover (22—Fig. 31) to hub housing (5). Pry cover loose and remove cover and planetary gears. Remove snap ring, sun gear (19), spacer (18) and washer (17). Remove bolts retaining planetary ring gear hub (8), then install four of the bolts into threaded holes in ring gear hub to remove ring gear. Remove outer bearing (6), then tap hub assembly (5) off swivel housing.

To remove swivel housing (1—Fig. 32), disconnect steering cylinder from left-hand steering arm. Disconnect tie rod end from swivel housing arm. Remove upper and lower swivel pins (9) and shims (10). Withdraw swivel housing from axle housing.

Inspect bushings, bearings and oil seals and renew if necessary.

To reinstall, reverse the removal procedure while noting the following items: Refer to paragraph 38 to set swivel bearing preload. Lubricate lip of oil seals prior to reassembly. Tighten planetary ring gear bolts evenly in steps to a final torque of 88 N·m (65 ft.-lbs.).

Lubricate swivel bearings with multipurpose lithium base grease. Fill hubs to correct level with Case FDL SAE 90 gear lubricant or equivalent.

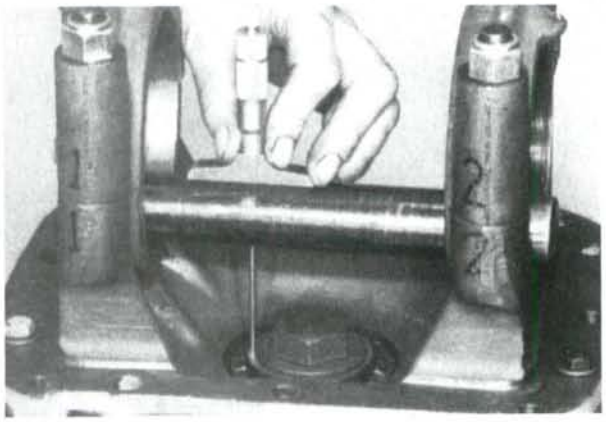


Fig. 28—View showing proper depth gage and pilot shaft placement used in determining pinion shaft protrusion.

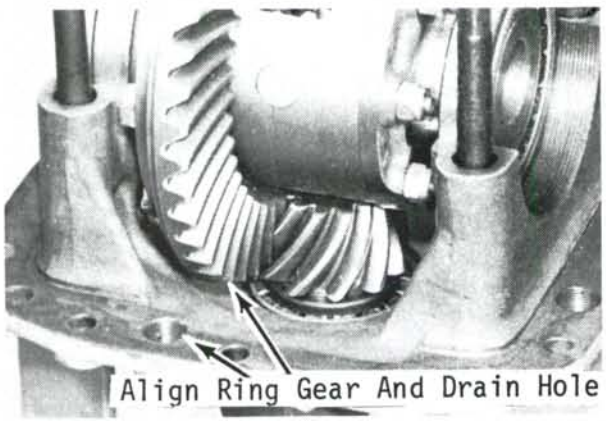


Fig. 29—When installing differential unit in carrier, make sure ring gear is on same side as drain hole in carrier.

38. SWIVEL BEARING PRELOAD. Shims (10—Fig. 32) are used between swivel pin (9) and housing (1) to adjust bearing preload. Correct preload setting is 0.2 mm (0.008 inch). To adjust, install bottom pin without shims and tighten bolts to 83 N·m (60 ft.-lbs.) torque. Support the weight of the axle with a jack under bottom pin. Install top pin without shims or bolts making sure bearing cone is fully seated in cup. Measure the gap between flange of swivel pin and swivel housing (Fig. 33). Select shim pack which is 0.1-0.2 mm (0.004-0.008 inch) less than the gap measurement. Divide shim pack equally and install half of the shims

under top pin and other half under bottom pin.

NOTE: If unable to divide shims equally, install thicker shims under top pin.

Tighten pin mounting bolts to 83 N·m (60 ft.-lbs.) torque.

39. PLANETARY GEARS. To remove, raise and support front axle, then remove tire and wheel. Drain oil from wheel hub. Remove two screws securing cover (22—Fig. 31) to hub, then pry cover loose and remove cover and planetary gears.

Remove retaining rings (12) and retaining plate (16). Mark each gear and shaft so the gears can be reinstalled in their original positions if reused. Remove gears, bearing rollers and thrust washers.

Inspect parts and renew as necessary. To reassemble, reverse the disassembly procedure. Fill wheel hub to correct level with Case FDL SAE 90 gear lubricant or equivalent.

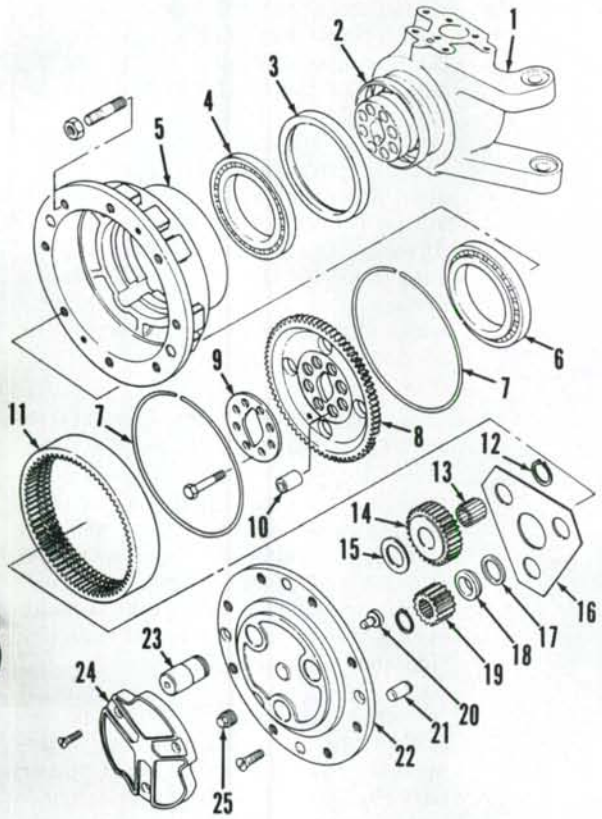


Fig. 31—Exploded view of final drive assembly used on Type 709/19 Carraro front drive axle.

1. Swivel housing
2. Wear sleeve
3. Oil seal
4. Bearing
5. Wheel hub
6. Bearing
7. Retaining rings
8. Ring gear carrier
9. Retaining plate
10. Ring dowel
11. Planetary ring gear.
12. Snap ring
13. Needle bearings
14. Planet gear
15. Thrust washer
16. Thrust plate
17. Thrust washer
18. Spacer
19. Sun gear
20. Thrust button
21. Dowel
22. Hub cover & planetary carrier
23. Planet gear shaft
24. Cover
25. Drain plug

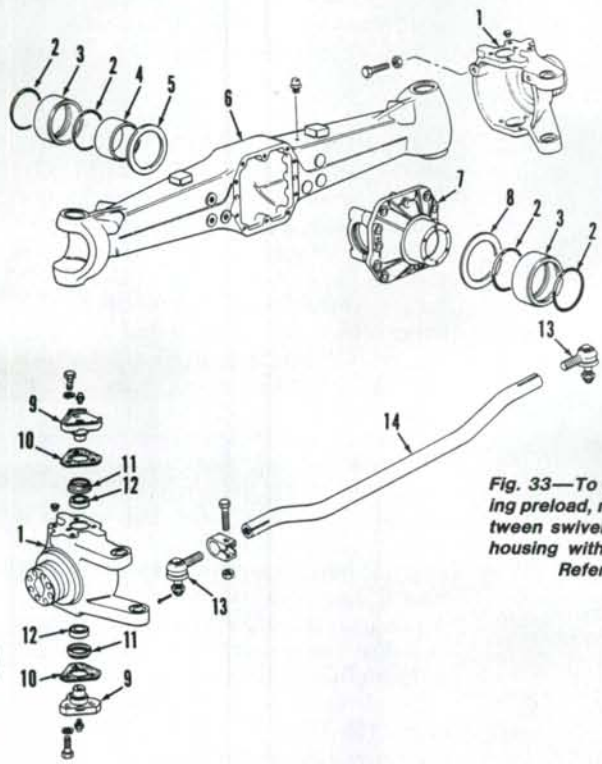


Fig. 32—Exploded view of Carraro Type 709/19 front drive axle used on late Models 1394, 1494 and 1594.

1. Swivel housings
2. "O" rings
3. Trunnion bushings
4. Sleeve
5. Thrust washer
6. Axle housing
7. Differential carrier housing
8. Thrust washer
9. Bearing pin
10. Shim
11. Seal
12. Bearing
13. Tie rod ends
14. Tie rod

Fig. 33—To set swivel bearing preload, measure gap between swivel pin and swivel housing with a feeler gage. Refer to text.

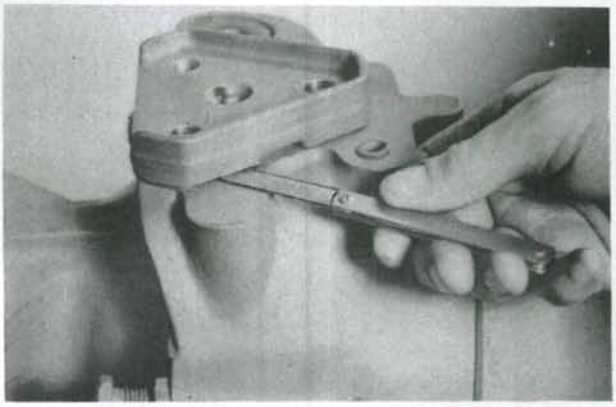
40. AXLE SHAFTS. Axle halfshafts (4 and 9—Fig. 34), oil seal (3) and bushing (2) can be renewed with axle housing in place. Refer to paragraph 37 for removal of final drive and swivel housing. Pull axle shaft from housing. Remove oil seal and bushing using suitable slide hammer puller.

Install new seal with lip facing inward. Lubricate seal lip before reinstalling axle shaft. Complete installation by reversing removal procedure.

41. R&R DIFFERENTIAL. To remove front differential, drain oil from axle housing and remove axle assembly from tractor as outlined in paragraph 25. Support swivel housing and wheel hub as an assembly using a suitable hoist and sling. Remove swivel pins, then remove each final drive as a complete assembly from axle housing. Withdraw axle shafts from housing. Remove differential carrier housing mounting nuts, then use two M10 bolts in threaded holes in carrier housing to separate carrier from axle housing. Use a suitable hoist to lift differential assembly out of axle housing.

42. OVERHAUL DIFFERENTIAL. Place differential assembly in a stand with flange end pointing downward. Put identification marks on bearing caps and carrier housing so caps can be reinstalled in their original positions. Remove adjuster locking plates (1—Fig. 35), bearing caps (9) and adjuster rings (3). Remove differential from carrier.

Remove oil seal carrier (17). Using special spanner wrench (CAS 1597), re-



move pinion shaft locknut (15), then drive pinion shaft (7) out of carrier. Remove bearings (11), spacer (12) and shims (10 and 13) as necessary.

Remove carrier bearings (4) using a suitable puller. Remove bevel ring gear mounting bolts that are aligned with pinion gear shaft (24), then turn housing so retaining pin (25) falls out through ring gear bolt hole. Remove remaining ring gear mounting bolts and remove gear from housing if necessary. Push pinion shaft out of housing, then withdraw pinion gears (22), side gears (21) and friction plates from housing. Remove axle shaft bushings from differential case as necessary.

Bevel ring gear (6) and pinion shaft (7) are serviced as a matched set only and must be installed as such. If bevel ring gear and pinion shaft, pinion shaft bearings or carrier housing are renewed, pinion shaft protrusion must be set as outlined in paragraph 44.

Reassemble by reversing the disassembly procedure while noting the following special instructions: Install backing plate (20) on side gears first, then alternately assemble friction plates beginning and ending with a plate with tabs (19). Align pin hole in pinion shaft (24) with hole in case, then install retaining pin (25). Apply Loctite 270 to threads of ring gear mounting bolts, then tighten to 70 N·m (52 ft.-lbs.) torque.

Check friction plate end play as outlined in paragraph 43. Adjust pinion shaft protrusion and bearing preload as outlined in paragraph 44. Reinstall differential in carrier housing making sure ring gear is aligned with housing drain plug (Fig. 36). Adjust bevel gear backlash and carrier bearing preload as outlined in paragraph 45.

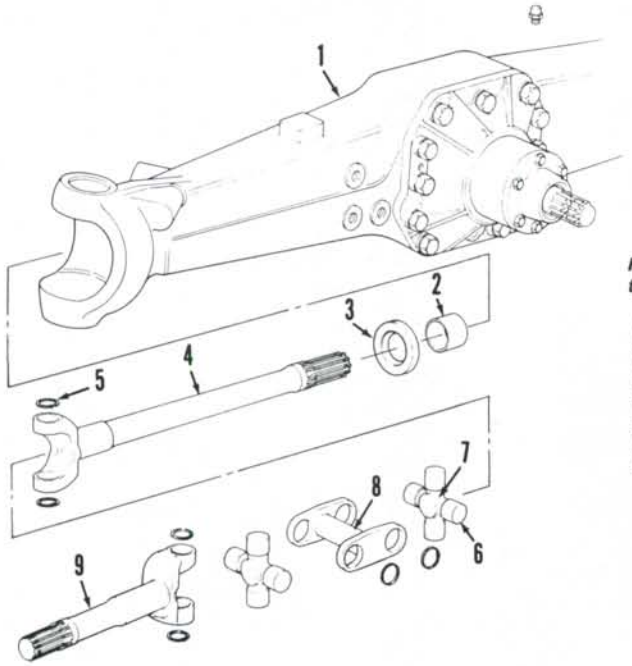


Fig. 34—Exploded view of typical axle shafts used on Carraro 709/19 axle.

1. Axle housing
2. Bushing
3. Oil seal
4. Long shaft
5. Retaining ring
6. Bearing cap
7. Cross
8. Housing
9. Short shaft

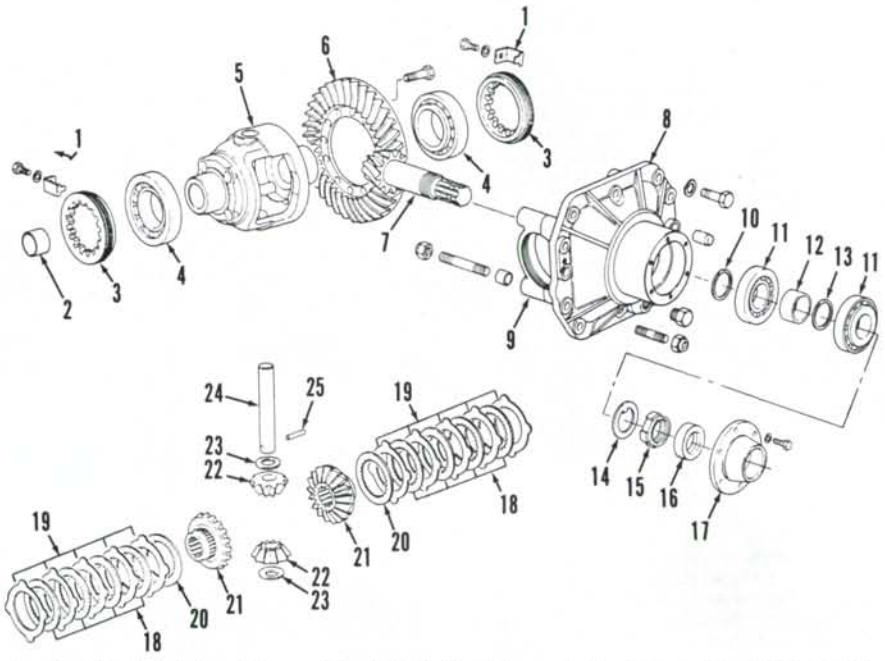


Fig. 35—Exploded view of Carraro Type 709/19 front drive axle limited slip differential assembly.

1. Adjuster locking plates
2. Bushing
3. Adjuster rings
4. Carrier bearings
5. Differential case
6. Bevel ring gear
7. Bevel pinion gear
8. Differential carrier housing
9. Bearing cap
10. Shim
11. Bearings
12. Spacer
13. Shim
14. Washer
15. Locknut
16. Oil seal
17. Seal carrier
18. Friction plates, splined
19. Friction plates with tabs
20. Backing plate
21. Side gear
22. Pinion gear
23. Thrust washer
24. Pinion shaft
25. Retaining pin

43. DIFFERENTIAL FRICTION PLATE END PLAY. To check friction plate end play, place differential assembly in a vertical position. Mount a dial indicator so probe extends through axle shaft opening and contacts the end of one of the side gears. Insert a screwdriver or other suitable tool through opening in side of differential cage, pry side gear upward and measure end play.

Correct end play is 0.03-0.20 mm (0.001-0.008 inch). End play can be adjusted by replacing 2.8 mm thick spacer (20—Fig. 35) with a 2.9 mm thick spacer plate. Renew friction plates if end play is still not within specified tolerance.

Repeat procedure for plates on opposite side.

44. PINION SHAFT PROTRUSION AND BEARING PRELOAD. To set pinion shaft protrusion, install bearing cups in carrier housing. Install carrier bearing caps (9—Fig. 35) and tighten nuts to 198 N·m (145 ft.-lbs.) torque. Install bearing cones in carrier using a bolt, flat washers and nut (Fig. 38) to hold bearings in place. Tighten nut and bolt until bearing cones are difficult to turn.

Measure and record diameter of carrier bearing cap bore (A—Fig. 38). Place a shaft (3), having a diameter of at least 25 mm (1 inch) and having a cross hole drilled through it, across bearing bores as shown. Measure and record diameter (B) of shaft. Insert a depth gage through hole in shaft and measure distance (C) from top of shaft to face of inner bearing cone.

To determine correct thickness of shims (10—Fig. 35) required to provide desired pinion shaft protrusion, use the

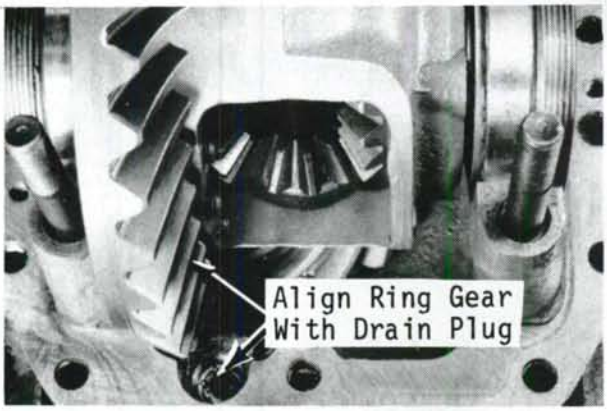


Fig. 36—When installing differential unit in carrier housing, make certain ring gear is on same side as housing drain plug.

following calculations: Subtract diameter of shaft (B—Fig. 38) from depth gage measurement (C). Add this figure to one-half the diameter of carrier bearing bore (A). The result is dimension (E). Then subtract dimension etcned on gear end of pinion shaft (dimension is in millimeters) from dimension (E). The resulting dimension will be correct shim (10—Fig. 35) thickness to install to properly set pinion shaft protrusion.

Install correct thickness shim (10) on pinion shaft with chamfered side towards gear end of shaft. Press inner bearing cone onto shaft until seated against shim.

To set pinion shaft bearing preload, assemble pinion shaft in carrier minus seal (16) and seal carrier (17). Install spacer (12) and a shim 0.5 mm (0.020 inch) thicker than original shim removed during disassembly. Install outer bearing cone and the old locknut (15). Tighten locknut to 450 N·m (330 ft.-lbs.) torque. Rotate pinion shaft to seat bearings, then mount a dial indicator so probe contacts end of pinion shaft. Move pinion shaft and record end play. Disassemble pinion shaft and reduce shim thickness an amount equal to measured end play plus 0.5 mm (0.020 inch) to obtain desired bearing preload of 0.5 mm (0.020 inch).

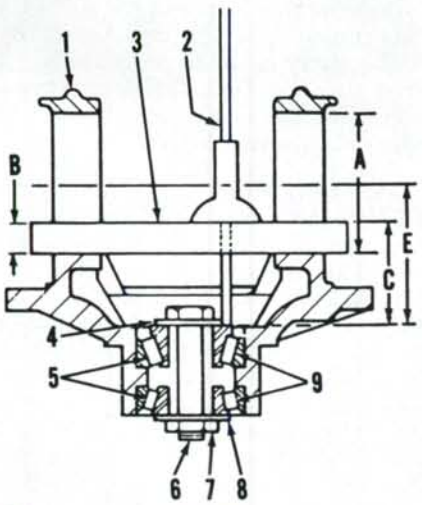


Fig. 38—Diagram showing method of securing pinion shaft bearings in carrier housing to allow depth gage measurement to be taken when setting pinion bearing preload. Refer to text.

1. Bearing cap
2. Depth gage
3. Pilot shaft
4. Washer
5. Bearing cones
6. Bolt
7. Nut
8. Washer
9. Bearing cups

45. DIFFERENTIAL CARRIER BEARINGS AND BEVEL GEAR BACKLASH. Pinion shaft protrusion and bearing preload must be properly set before adjusting differential carrier bearings.

Install differential assembly in carrier housing (Fig. 36). Install bearing adjuster rings and carrier bearing caps, but do not tighten bearing cap nuts to final torque at this time. Turn adjuster ring on ring gear side clockwise until ring gear contacts pinion gear. Turn adjuster ring on opposite side clockwise until all bearing end clearance is removed. Tap on bearing caps with a plastic mallet to align bearings. Mount a dial indicator so probe contacts outer tip of ring gear tooth, then hold pinion shaft and move ring gear in each direction to check backlash. Move ring gear sideways to obtain recommended backlash of 0.15-0.25 mm (0.006-0.010 inch) by loosening one adjuster ring one notch at a time and tightening opposite adjuster ring the same amount each time.

After bevel gear backlash is correctly set, turn the adjuster ring on each side one-half to one notch clockwise to provide desired bearing preload. Tighten carrier bearing cap nuts to 210 N·m (155 ft.-lbs.) torque, then recheck for correct backlash. Install locking plates in notches of adjuster rings to secure adjustment.

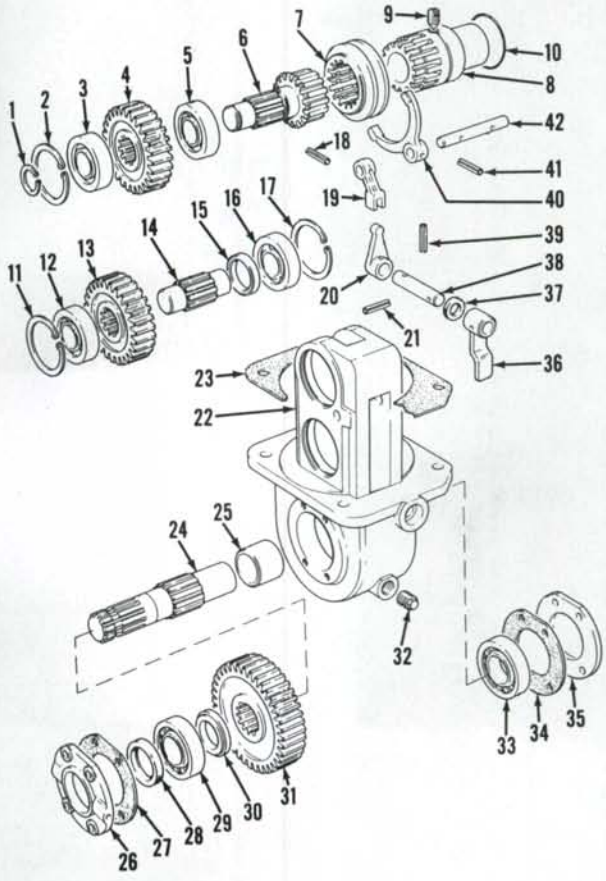


Fig. 39—Exploded view of transfer gearbox used on some models equipped with Carraro front drive axles and synchromesh transmissions.

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 coupling
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 level
21. Roll pin
22. Gearbox 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

TRANSFER GEARBOX

All Synchromesh Models With Carraro Axle

46. REMOVE AND REINSTALL. Remove drive shaft. Drain oil from transfer gearbox and transmission case. Drain fuel tanks. Remove drive shaft. Disconnect selector cable from gearbox selector arm, then remove cable bracket from frame. Remove fuel tank crossover pipe. Push selector arm rearward to disengage gearbox sliding clutch from transmission drive coupling. Support transfer gearbox, remove mounting bolts and lower gearbox from transmission housing.

To reinstall, reverse the removal procedure. Tighten mounting nuts and bolts to 163 N·m (120 ft.-lbs.) torque. Fill transmission housing with Case PTF Fluid, Hy-Tran Plus or equivalent fluid.

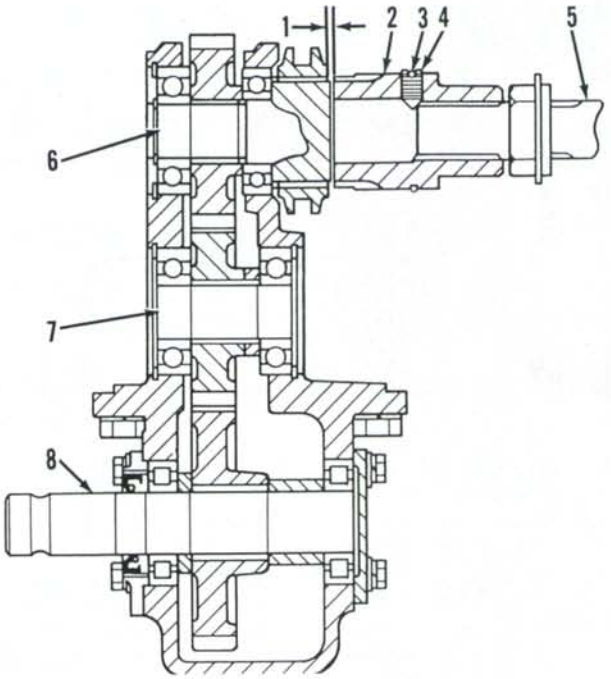


Fig. 41—Cross-sectional view of transfer gearbox used on some models equipped with Carraro front drive axle. Clearance (1) between shaft and drive coupling must not exceed 0.3 mm (0.012 inch).

2. Transmission drive coupling
3. Snap ring
4. Adjusting screw
5. Transmission bevel pinion shaft
6. Input shaft
7. Intermediate shaft
8. Output shaft

47. OVERHAUL. With transfer gearbox removed, disassemble as follows: Drive roll pin from selector fork (40—Fig. 39 or 58—Fig. 40) and shaft. Remove sliding clutch and selector fork. Remove snap rings (1 and 2), then drive input shaft (6) rearward from housing.

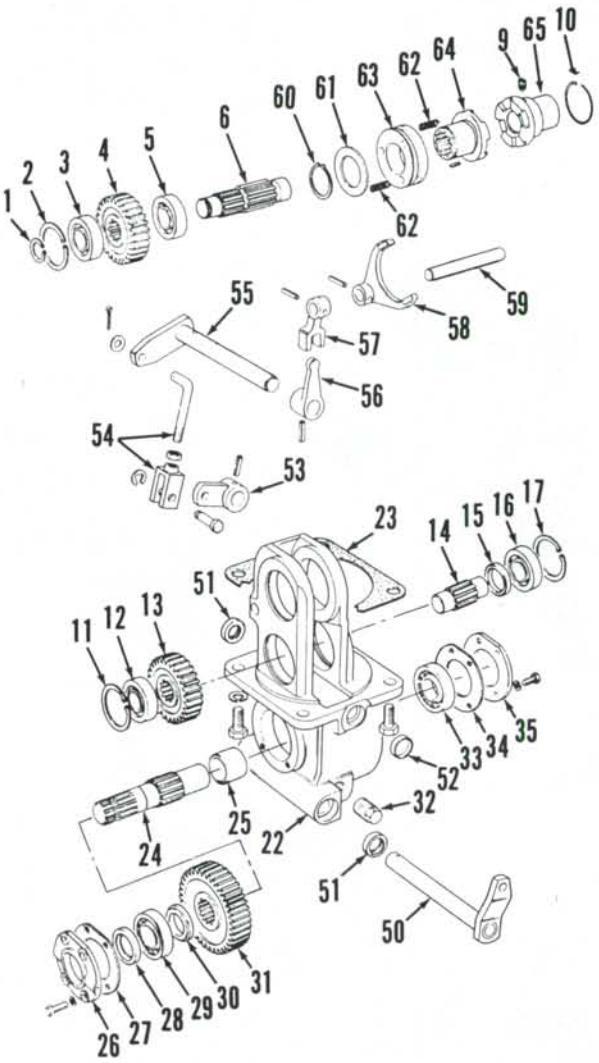


Fig. 40—Exploded view of transfer gearbox used on Models 1294, 1394, 1494 and 1594 equipped with synchromesh transmission and Carraro front drive axle. Shift linkage is slightly different on Model 1594. Refer to Fig. 39 for legend except for the following items.

50. Lower selector shaft
51. Oil seals
52. Plug
53. Operating lever
54. Operating link & clevis
55. Upper selector shaft
56. Selector lever
57. Selector jaw
58. Selector fork
59. Shaft
60. Snap ring
61. Thrust washer
62. Springs
63. Clutch sleeve
64. Sliding clutch
65. Drive coupling

Remove drive gear (4) and bearings. Remove snap rings (11 and 17), then drive intermediate shaft (14) rearward from housing. Remove gear (13), spacer (15) and bearing. Remove output shaft front and rear covers (26 and 35). Press output shaft (24) out through front of housing. Drive roll pins out of selector linkage and disassemble linkage as necessary.

Clean all parts and inspect for excessive wear or damage. Renew output shaft oil seal (28) and selector shaft oil seals. Lubricate lip of seals with grease before reinstalling shafts.

Reassemble by reversing the disassembly procedure. Tighten output shaft cover mounting bolts to 27 N·m (20 ft.-lbs.) torque. If a new input shaft (6), sliding clutch assembly or transmission drive coupling is installed, transmission drive coupling clearance must be adjusted as outlined in paragraph 48.

48. TRANSMISSION DRIVE COUPLING ADJUSTMENT. The transmission top cover must be removed to measure clearance (1—Fig. 41) between transfer gearbox input shaft and transmission drive coupler (2). If clearance exceeds 0.3 mm (0.012 inch), disengage snap ring (3) that holds drive coupling adjusting screw (4). Turn adjusting screw until clearance is less than 0.3 mm (0.012 inch), then reinstall snap ring over adjusting screw.

Power Shift Models With Carraro Axle

49. R&R AND OVERHAUL. To remove transfer gearbox, first drain oil from gearbox and transmission case.

Remove main drive shaft. Disconnect selector cable from selector arm (23—Fig. 42). Remove mounting bolts and lower gearbox from transmission case.

To disassemble, remove selector shaft (1) and forks (3). Remove front and rear covers (21 and 18). Drive output shaft (10) out of housing and withdraw drive gear (17) and sliding clutch assembly.

Inspect parts and renew if necessary. Renew oil seal (20) in front cover.

To reassemble, reverse the disassembly procedure.

MANUAL STEERING GEAR

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

REMOVE AND REINSTALL

Model 1190

50. To remove steering gear unit, remove steering wheel (4—Fig. 43) and dust seal (5). Disconnect controls and wiring to instrument panel. Remove drop arm (13—Fig. 44) and unbolt and remove instrument panel as a unit. Unbolt and remove steering gear assembly from transmission noting spacer (6, 7 and 24—Fig. 44) placement.

Reinstall by reversing removal procedure.

STEERING GEAR AND COLUMN OVERHAUL

Model 1190

51. DISASSEMBLY. With steering gear and steering wheel removed, remove locknut (6—Fig. 43) and unscrew adjustable bearing cone (7). Remove the 12 loose bearing balls (9). Remove both ball nut pegs (17 and 22—Fig. 44) and shims (18 and 21), then withdraw steering shaft (19—Fig. 43) 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. 44) and withdraw cross-shaft (15).

If cross-shaft bushings (1 and 25—Fig. 44) are to be renewed, note size and location before removal for proper in-

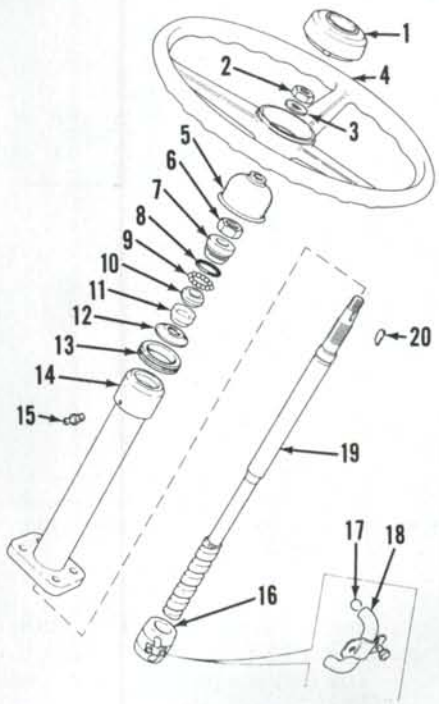


Fig. 43—Exploded view of steering column and related parts for 1190 models equipped with manual steering.

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

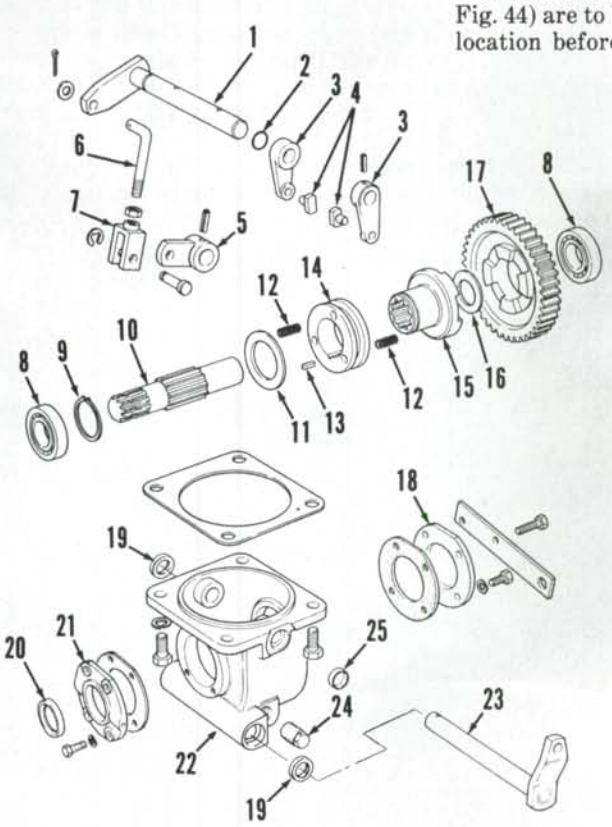


Fig. 42—Exploded view of transfer gearbox used on models with powershift transmission and Carraro front drive axle. Note that selector linkage is slightly different on 1594 models.

1. Selector shaft
2. "O" ring
3. Selector arms
4. Trunnion pins
5. Selector lever
6. Link
7. Clevis
8. Bearing
9. Snap ring
10. Output shaft
11. Thrust washer
12. Springs
13. Key
14. Clutch sleeve
15. Sliding clutch
16. Thrust washer
17. Drive gear
18. Rear cover
19. Oil seals
20. Oil seal
21. Front cover
22. Housing
23. Selector shaft
24. Drain plug
25. Plug

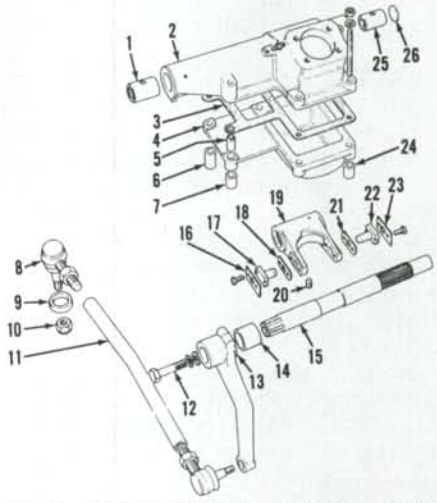


Fig. 44—Exploded view of steering box and its related parts used on 1190 models with manual steering.

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

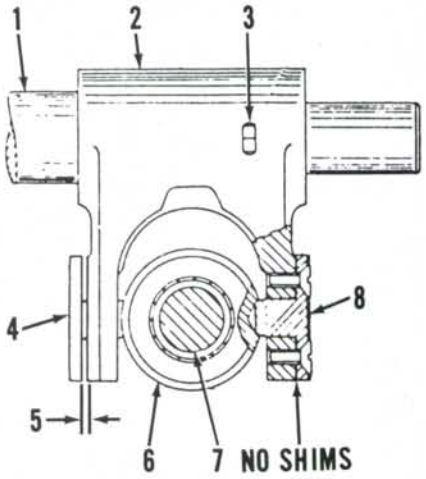


Fig. 45—View showing method of selecting shims for correct ball nut preload. Refer to paragraph 53 for procedure.

stallation. Lubrication holes in bushings (1 and 25) and gearbox (2) must be aligned and cross-shaft (15) must turn freely.

52. REASSEMBLY. Remove transfer tube (18—Fig. 43) and place ball nut (16) over ball track on lower end of steering shaft (19). Insert steel balls (17) into ball nut until full, place remaining balls in transfer tube (18) with grease and fit tube to ball nut. Place rubber baffle (12) in groove on steering shaft and insert up through housing.

Position rocker arm (19—Fig. 44) in steering box (2) with stop down. Reinstall cross-shaft (15) and secure with locating screw (20).

53. BALL NUT PEG PRELOAD. Install one ball nut peg (8—Fig. 45) minus shims (18 and 21—Fig. 44) and tighten the two cap screws securely. Install second ball nut peg (4—Fig. 45) and tighten the two cap screws evenly only until inner end of peg causes ball nut to lightly bind. Using a feeler gage, measure gap between ball nut peg (4) and rocker arm (2). See 5—Fig. 45. Shims (18 and 21—Fig. 44) to be used in final assembly should be 0.025-0.076 mm (0.001-0.003 inch) less than measured gap (5—Fig. 45). Divide shims as equally as possible between the two ball nut pegs (17 and 22—Fig. 44) for installation and secure bolts with tab washers (16 and 23).

54. STEERING SHAFT END PLAY. Insert spherical seat (11— Fig. 43) on steering shaft (19) with flat face down, then install lower race (10) with round face in spherical seat (11). Drop in the 12 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) ⅛ turn to provide 0-0.076 mm (0.000-0.003 inch) end play of steering shaft. Hold adjustable bearing cone in position, install locknut (6) with recessed side against adjustable bearing cone and tighten to 163 N·m (120 ft.-lbs.) torque.

DRAG LINK

Model 1190

55. ADJUSTMENT. Drag link ends are serviced as a unit only and must be renewed as such. Adjust length of drag link (11—Fig. 44) so spindle contacts stop on axle before internal steering gear stops wheel movement.

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 and 1194 models is a 16 L/min. (4.2 gpm) Hobourn-Eaton pump having a remote reservoir containing filter and breather assemblies. All other models use a 10.5 L/min. (2.8 gpm) Sundstrand pump utilizing differently arranged remote filter, breather and reservoir systems or a reservoir as an integral part of the pump.

All models use an Orbitrol OSP-100 or OSP-125 steering valve. Service procedures are similar for either valve.

FILTER

All Models

56. The steering system oil filter (17—Fig. 49) is located in the reservoir (19). Note that in some applications, filter is relocated to a remote reservoir. Manufacturer recommends renewing steering system oil and oil filter after every 400 hours of operation. Recommended oil is CASE TCH Fluid or equivalent. Refer to the following table for approximate system capacities.

1190-1194	0.9 L (1.0 qt.)
All Other Models	1.25 L (1.5 qt.)

BLEEDING STEERING SYSTEM

Side Mounted Steering Cylinders

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

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 shut-off 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.

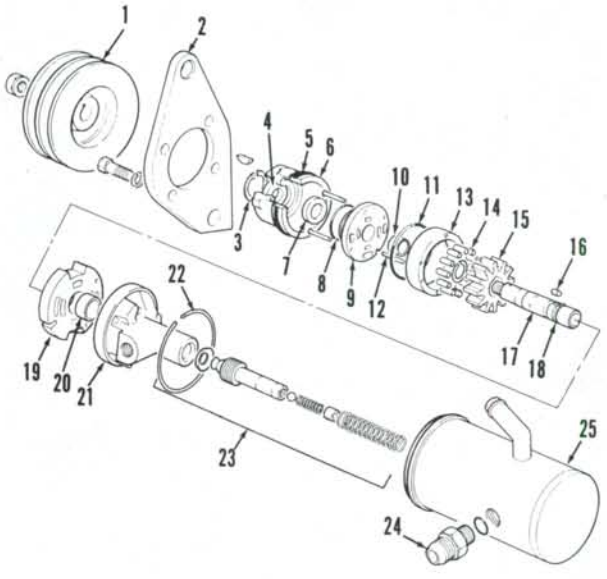


Fig. 46—Exploded view of Hobourn-Eaton steering pump used on Models 1190 and 1194.

1. Pulley
2. Mounting plate
3. Retaining ring
4. Bearing
5. "O" ring
6. Body
7. Oil seal
8. "O" ring
9. End plate
10. Bushing
11. "O" ring
12. Alignment pin
13. Cam ring
14. Rollers
15. Carrier
16. Drive pin
17. Shaft
18. Retaining ring
19. Manifold plate
20. Bushing
21. Cover
22. Retaining ring
23. Relief valve assy.
24. Outlet union
25. Reservoir

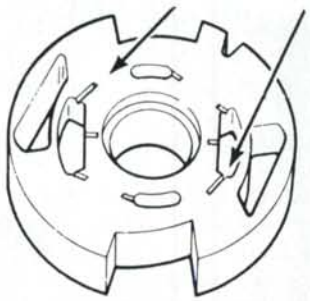


Fig. 47—When installing manifold plate, be sure side with port timing grooves faces away from pump cover.

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 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

58. Fill reservoir to proper level and if pump has been drained, renewed or overhauled, prime pump as follows: With fuel shut-off in **STOP** position, crank engine with starter for about 15 seconds. Move fuel shut-off to **RUN** position. Start engine and run for about 15 seconds, then stop engine. Check reservoir fluid level, then start engine and operate at idle speed.

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. Turn steering wheel right until front wheels reach their stop, then tighten left-hand bleed screw. Loosen bleed screw on right side of steering cylinder one full turn. Turn steering wheel left until front wheels reach their stop, then 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.

All Other Models

59. The steering hydraulic system on models equipped with standard steering cylinders is basically self-bleeding. To purge trapped air from the system, first be sure reservoir is filled to proper level. With engine running, turn steering wheel from lock to lock several times until steering operation is satisfactory. Check reservoir for correct oil level again and fill if necessary.

SYSTEM OPERATING PRESSURE

All Models

60. 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 outlet line and install a 0-20000 kPa (0-3000 psi) pressure gage into pump outlet port.

NOTE: Run engine only long enough to note pressure gage reading. Pump is operating at maximum pressure during test and fluid overheating and pump damage may result if engine is operated for a long period of time.

Start and run engine at 1500 rpm only long enough to read pressure gage. Pump pressure for 1190 and 1194 models should be 7930 kPa (1150 psi). Pressure for all other models should be 10340 kPa (1500 psi). If pump fails to reach specified pressure, remove and examine pump.

STEERING PUMP

Models 1190-1194

61. R&R AND OVERHAUL. The belt driven pump is mounted on left side of engine. To remove pump, first remove air intake precleaner and muffler. Raise the hood and remove left side panel and rail. Disconnect pump inlet and outlet lines and drain oil. Loosen pump retaining bolts and remove drive belt from pulley. Remove mounting bolts and remove pump.

To disassemble, remove pulley (1—Fig. 46) and mounting plate (2). Remove outlet union (24). Tap around edge of oil reservoir (25) to separate reservoir from pump body. Remove retaining ring (22), then remove body (6) from shaft and cover assembly. Remove two screws from end plate (9). Carefully separate end plate, cam ring (13), manifold plate (19), rollers (14), carrier (15) and shaft (17).

NOTE: Disassembly of relief valve (23) is not recommended as replacement parts are not available. If valve is disassembled for cleaning and inspecton, note exact position of valve plug. The plug must be installed in its original position or relief pressure setting will be affected.

Inspect all parts for excessive wear and damage. An "O" ring and seal kit, front bearing and pumping element and shaft assembly are available for service.

To reassemble, install drive key (16) and carrier (15) on shaft. Position manifold plate on the cover with timing grooves (Fig. 47) facing up. Assemble shaft into bore of manifold plate. Install cam ring (Fig. 48) with cam mark towards drive end of shaft as shown, then install rollers in carrier. Position alignment pin in smallest hole in cam ring. Install end plate (9—Fig. 46) and the two retaining screws, but do not tighten screws.

It is recommended that an alignment tool be made from an old pump body by drilling two holes through end of the body to align with end plate screws. Install tool over pumping element to align components. Check for free rotation of shaft, then securely tighten the two screws through the holes of the tool. Remove the tool.

Install new "O" rings and shaft oil seal and lubricate with clean oil before reassembling. Protect lip of seal, then install body (6—Fig. 46) over pump assembly. Install cover retaining ring (22). Install reservoir (25) aligning outlet holes in pump and reservoir. Install outlet union (24) with a new "O" ring. Install pulley and tighten retaining nut to 16 N·m (12 ft.-lbs.) torque. Be sure pump shaft turns freely.

To reinstall pump, reverse the removal procedure.

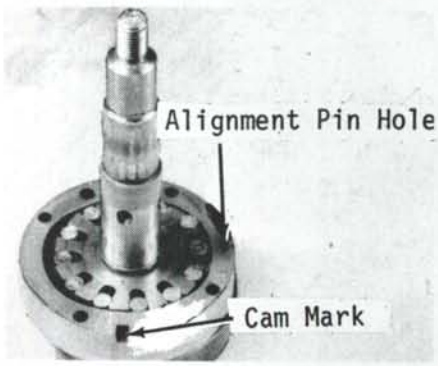


Fig. 48—Install cam ring with cam mark towards drive end of shaft. Install alignment pin in smallest hole in cam ring.

All Other Models

62. R&R AND OVERHAUL. The steering pump is mounted on right side of the engine and is gear driven by the engine timing gears. To remove pump, remove right side panel and rail. Clean pump and surrounding area, then disconnect oil lines from pump and drain oil from reservoir. Remove fuel supply pump. Remove pump mounting nuts and remove pump.

Scribe match marks on all parts prior to disassembly to ensure correct alignment when reassembling. Remove drive gear (2—Fig. 49) from pump shaft using a suitable puller.

NOTE: Do not drive on end of pump shaft as damage to bearings (7 and 11) will result.

Remove center bolt from reservoir (19) and pull reservoir from pump body. Remove and discard filter element (17). Remove four through-bolts and separate end cover (14) from pump body (10). Remove bearings and rotors (8) as a unit with flange (5). Identify bearings (7 and 11) so they can be reinstalled in their original positions, then separate from flange. Remove snap ring (3) and oil seal (4) from flange. Discard seal rings and all "O" rings.

Inspect rotors, bearings and bore of body for wear or scoring and renew if necessary. Light scoring of rotor journals can be removed using "O" grade emery cloth lubricated with kerosene. Assemble rotors and bearings in pump body (Fig. 50), then measure distance from top surface of body to top bearing surface. If distance (D) exceeds 0.2 mm (0.008 inch), renew bearings and/or rotors. Relief valve (16—Fig. 49) is a preset assembly and should not be disassembled.

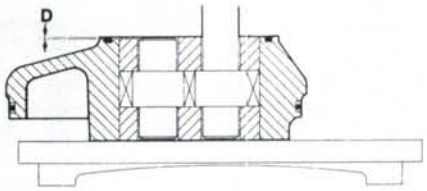


Fig. 50—With pump rotors and bearings installed in body, measure distance (D) from top surface of body to face of bearings. Distance must not exceed 0.2 mm (0.008 inch)

To reassemble, press a new oil seal into pump flange (5—Fig. 49) and install retaining ring. Lubricate seal lip with high melting point grease. Install new seals (6 and 12) in flange and end cover. Assemble bearings and rotors making sure cutaway side of bearings is toward rotors. Install flange over shaft being careful not to damage oil seal. Install body over rotors and bearings. Using new "O" rings (13), install end cover and four through-bolts. Tighten bolts to 50 N·m (37 ft.-lbs.) torque. Install a new filter element. Align reservoir and body as shown in Fig. 51. Install drive gear and tighten retaining nut to 61 N·m (45 ft.-lbs.) torque. Bend tab washer to lock the nut.

Reinstall pump and tighten mounting nuts to 34 N·m (25 ft.-lbs.) torque. Install fuel supply pump and tighten bolts to torque 34 N·m (25 ft.-lbs.) torque. Fill reservoir with Case TCH Fluid. Start engine and bleed air from system, then recheck oil level.

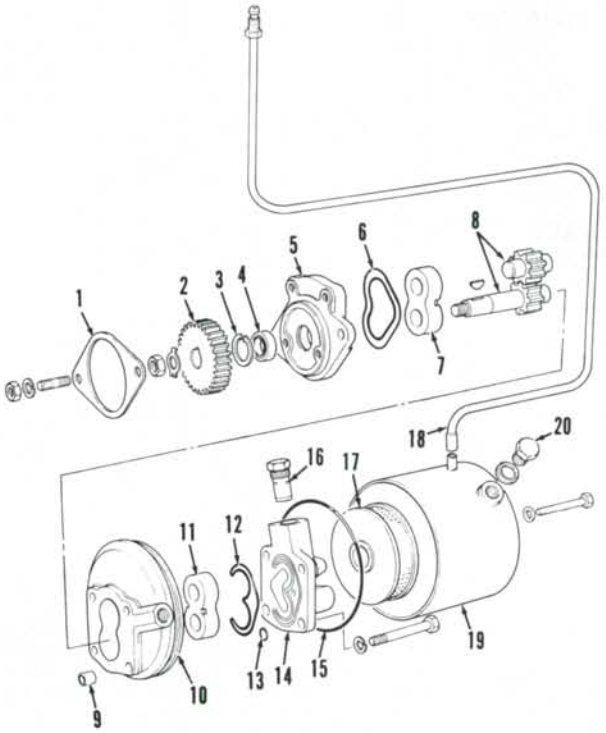


Fig. 49—Exploded view of typical Sundstrand steering pump used on some models. Note in some applications, filter is relocated to a remote reservoir.

1. Gasket
2. Drive gear
3. Retaining ring
4. Seal
5. Flange
6. Seal ring
7. Bearing
8. Rotors
9. Dowel
10. Pump body
11. Bearing
12. Seal ring
13. "O" ring
14. End cover
15. "O" ring
16. Relief valve
17. Filter
18. Breather pipe
19. Reservoir
20. Fill/level plug

STEERING VALVE

Models Without Cab

63. REMOVE AND REINSTALL. To remove valve, first disconnect four oil lines from valve and identify to ensure correct reassembly. Immediately plug all openings to prevent entry of dirt. Remove bolts securing valve to support bracket, then remove steering valve.

To reinstall, reverse the removal procedure. Tighten mounting bolts to 47-57 N·m (35-42 ft.-lbs.) torque. Be sure oil lines are connected properly. Bleed air from system as previously outlined.

Models With High Platform or Cab

64. REMOVE AND REINSTALL. To remove steering valve, first remove steering wheel. Remove heater valve knob and screws that hold heater valve to instrument panel. Raise instrument panel cover and disconnect negative battery cable and tachometer drive cable. Remove knobs from heater and ventilation control cables. Remove the floor plate and disconnect control lever for hand throttle. Pull throttle control rod out of guides. Remove screws retaining instrument panel, then lift instrument panel over steering column. Identify steering valve oil pipes for correct reassembly, then disconnect pipes from valve and plug all openings. Remove bolts retaining valve, then withdraw valve assembly.

To reinstall, reverse the removal procedure. Tighten valve mounting bolts to 34 N·m (25 ft.-lbs.) torque. Tighten steering torque wheel nut to 61 N·m (45 ft.-lbs.) torque. Start engine and bleed air from system as outlined previously.

All Models

65. OVERHAUL. To disassemble, clamp valve lightly in a vise with rotor end up. Remove seven cap screws re-

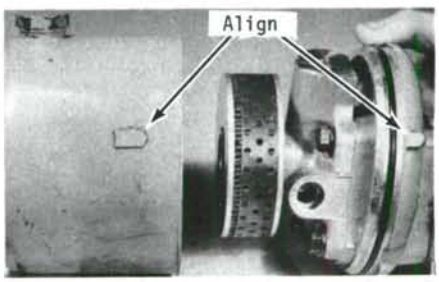


Fig. 51—Align oil reservoir and pump body as shown when reinstalling reservoir.

taining end cap (5—Fig. 52). Separate end cap, stator (10), rotor (2), spacer (6), valve plate (12) and drive shaft (1) from valve body. Remove bushing (7) and check ball (8). Remove spool (6—Fig. 53) and sleeve (7) assembly, thrust bearing assembly, "O" ring (10) and backup ring (11) and oil seal (9) from body. Remove pin (8), retaining ring (4) and centering springs (5) from sleeve. Separate spool from sleeve.

Clean all parts and inspect for excessive wear, scoring or other damage. Renew complete valve assembly if stator and rotor, sleeve and spool or bore in valve body are damaged. Measure thickness of rotor (1—Fig. 54) and stator (2). Renew complete valve if rotor thickness (A) is 0.05 mm (0.002 inch) less than stator thickness (B). Measure gap between rotor and stator as shown in Fig. 55. Renew steering valve if gap exceeds 0.13 mm (0.005 inch).

Reassemble using new "O" rings and seal, which are available as a repair kit. Lubricate all parts with clean Case TFD oil during assembly. Slide spool into sleeve and align centering spring slots as shown in Fig. 56. Note that the fit of these two parts is very close and turning spool slightly while inserting will aid installation. Assemble centering springs (Fig. 56) in two sets of three each. With arches facing one another, insert springs through slot in 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. 57.

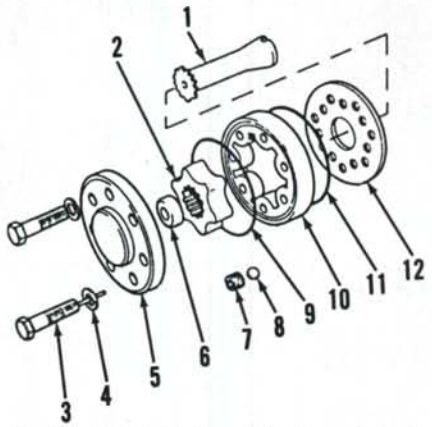


Fig. 52—Exploded view of steering valve rotor set, drive shaft and related parts.

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

Install centering spring retainer ring (4—Fig. 53) and pin (8). Install chamfered washer (3) onto spool with chamfered face towards sleeve. Install thrust bearing (2) and washer (1) onto spool.

Install a new oil seal (9) in body with seal lip facing inward. Lubricate "O" ring (10) and install it on outside diameter of backup ring (11), then install assembly in valve body bore. If available, Case special tool (CAS-1238) should be used to ensure correct installation of "O" ring and backup ring. To use, install "O" ring and backup ring on end of spindle (3—Fig. 57). Push spindle with seal ring into sleeve of special tool, then insert assembly into valve body until sleeve bottoms. Use a rotating motion while pushing on tool spindle until "O" ring seats in valve body, then withdraw tool.

Install sleeve, spool and thrust bearing into valve body, and position spool so pin is at right angle (90°) from side of body with fittings (Fig. 58).

NOTE: Installation of sleeve in body will be easier if sleeve is chilled first in dry ice or a freezer.

Install check ball (8—Fig. 52) and bushing (7) in body. Install drive shaft

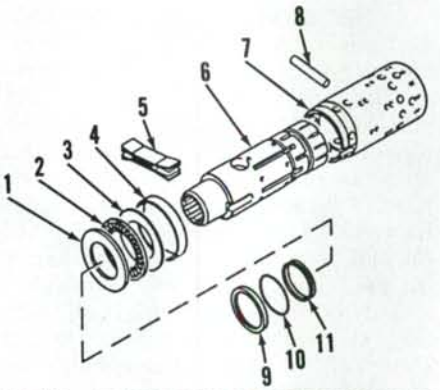


Fig. 53—Exploded view of steering valve spool, sleeve, bearings and seals.

1. Washer
2. Thrust bearing
3. Chamfered washer
4. Spring retaining ring
5. Centering springs
6. Spool
7. Sleeve
8. Pin
9. Backup ring
10. "O" ring
11. Oil seal

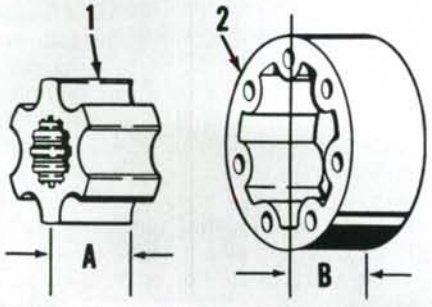


Fig. 54—Measure thickness of rotor (1) and stator (2). Renew steering valve assembly if thickness (A) is 0.05 mm (0.002 inch) less than stator thickness (B).

making certain slot in shaft engages drive pin in spool. Install valve plate (12) and align holes in plate with oil holes in body. Install rotor and stator set engaging splines in rotor with drive shaft splines in such a way that one of the valleys (Fig. 59) in rotor is aligned with drive pin slot in drive shaft.

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

Install spacer (6—Fig. 52) in rotor. Install end cap (5) and retaining bolts using new seal washers (4). Make certain bolt with pin (3) is installed in hole over check ball (8). Tighten bolts to 27 N·m (20 ft.-lbs.) torque.

Fill pump with clean Case TFD oil, then check assembly by measuring torque required to turn splined end of steering shaft. Torque must not exceed 19 N·m (14 ft.-lbs.) on OSP-100 valve or 24 N·m (18 ft.-lbs.) on OSP-125 valve.

STEERING CYLINDER

Models 1190-1194-1290-1294-1390-1394 With Side Mounted Cylinder

66. REMOVE AND REINSTALL. Removal of side mounted cylinder will be obvious after examination. Plug all

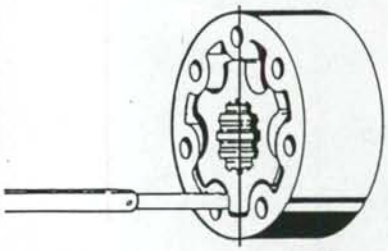


Fig. 55—Measure gap between rotor and stator with rotor and stator aligned as shown. If gap exceeds 0.13 mm (0.005 inch), renew steering valve.

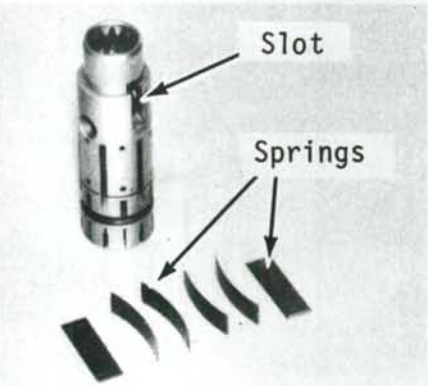


Fig. 56—Assemble centering springs with arches facing one another and insert through slot in sleeve and spool. See Fig. 57.

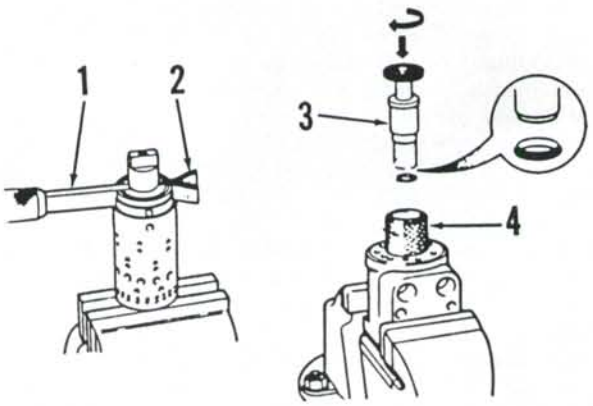


Fig. 57—View showing method of installing centering springs and shaft seal rings using Case special tools.

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

open hydraulic fittings to prevent entry of dirt.

After reinstalling cylinder, bleed system as outlined in paragraph 57.

67. OVERHAUL. Clear cylinder of oil as necessary by moving piston rod through its full stroke. Remove two snap rings (22 and 23—Fig. 60), then pull rod (14), piston (15) and sleeve (30) from cylinder (1). Remove bolt (19) and piston (15). Remove and discard all "O" rings, backup rings, seal rings and scraper seal.

Remove end caps (2 and 13) and remove spring (12), spool valve and sleeve (11) and nonreturn valve (3). Remove and discard "O" rings.

Cylinder must be smooth and free of score marks. Piston and 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 clean before reassembly.

Soak backup rings in clean hydraulic oil for a minimum of 30 minutes prior to reassembly. Lubricate all parts during assembly. Make sure spool (11) moves freely. Reassemble by reversing disassembly procedure.

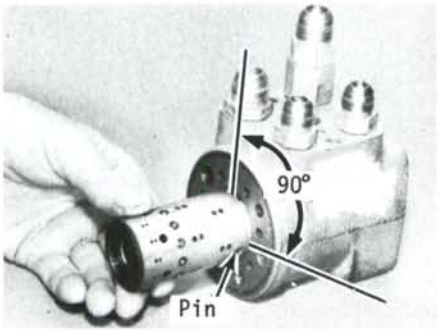


Fig. 58—Install sleeve into body with drive pin at right angle (90°) to fitting side of body.

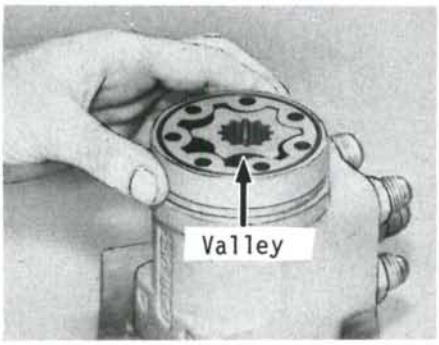


Fig. 59—Rotor is properly "timed" to valve spool by engaging drive shaft splines in such a way that one of the valleys in rotor is aligned with drive pin slot in drive shaft.

Models 1490-1494-1594-1690 With Transverse Mounted Cylinder (Two-Wheel Drive)

68. REMOVE AND REINSTALL. To remove steering cylinder, first remove front axle as outlined in paragraph 4. Disconnect tie rods from fork (15—Fig. 61). Disconnect hydraulic pipes from each union (35). Note that a snap ring (37) retains the pipes on some models. Remove both unions and spacing washers (34). Remove retaining nut (5) and pivot pin (10), then withdraw cylinder and fork assembly from axle.

Remove screws securing ball pegs (12), then remove ball pegs. Retain shims (13) for use in reassembly. Remove cylinder from fork.

If original cylinder, ball pegs and fork are being reused, reinstall cylinder in fork using new seal rings (14) and original shims (13).

If cylinder, ball pegs or fork is renewed, ball peg shim thickness should be adjusted to provide preload of 0.025-0.076 mm (0.001-0.003 inch) as follows: Assemble cylinder in fork using new seal rings (14). Install lower ball peg and tighten retaining screws. Install upper ball peg with sufficient amount of shims (13) to ensure cylinder movement on ball pegs. Remove relief valve (11) and position dial indicator probe through relief valve hole so it contacts cylinder. Raise and lower cylinder and measure movement. Remove shims equal to dial indicator reading plus 0.05 mm (0.002 inch) to provide desired preload. Reinstall relief valve (11).

Install cylinder and fork assembly without spacing washers (34). Install special unions (35), then move cylinder to one end and measure gap at opposite end with a feeler gage. Proper setting is between 0.13 mm (0.005 inch) clearance and 0.025 mm (0.001 inch) preload. Remove unions and position spacing washers (34) of equal thickness at each end to obtain proper setting. Install unions and tighten to 205 N·m (150 ft.-lbs.) torque. Install pivot pin (10) and tighten nut (5) until there is no free end movement, then install cotter pin. Complete installation, reinstall front axle and bleed system as previously outlined.

69. OVERHAUL. Clear cylinder of oil as necessary by moving piston rod through its complete stroke. Remove snap ring (28—Fig. 61) and sleeve assembly (27) from each end of cylinder. Pull piston rod and piston from cylinder. On early models, remove retaining bolts, locking plate (22), split ring (21) and piston (20). On all models, remove and discard all "O" rings, backup rings and seal rings.

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 cloth lubricated with kerosene.

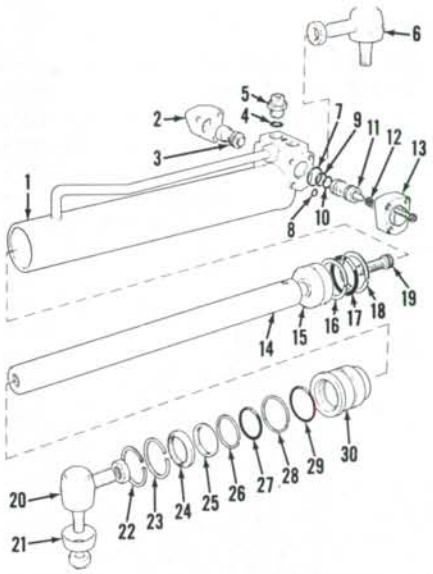


Fig. 60—Exploded view of typical side mounted steering cylinder used on some two-wheel drive tractors.

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

Prior to assembly, soak backup rings in Case TCH fluid for a minimum of 30 minutes. Lubricate all parts during assembly. Reassemble by reversing disassembly procedure.

Model 1394 With Dual Steering Cylinders (P.I.N. 11504412 and After)

70. R&R AND OVERHAUL. Removal of steering cylinders will be obvious after examination.

To disassemble, first clear cylinder of oil by moving piston through its complete stroke. Clamp cylinder (6—Fig. 62) in a vise, then unscrew cylinder sleeve (9) and withdraw sleeve and piston rod (14) from cylinder. Remove piston rod cap (12) and "O" ring (13). Remove and discard "O" ring (8), backup ring (7), oil seal (10) and scraper seal (11).

To reassemble, reverse the disassembly procedure. Lubricate all parts during assembly. Reinstall cylinders and bleed air from system as previously outlined.

All Front Drive Models

71. REMOVE AND REINSTALL. Removal of steering cylinders on front drive equipped models will be obvious after examination. Mark bearing caps for proper reassembly on models having David Brown front axle.

After installation, bleed air from system as previously outlined.

Models 1290-1390-1490 With David Brown Axle

72. OVERHAUL. To disassemble, first drain oil from cylinder by moving piston rod through its complete stroke. Remove tie rod ends (1 and 26—Fig. 63) and snap rings (2 and 25) from both ends of cylinder. Pull cylinder rod (15) and piston out of cylinder. Remove sleeve assemblies (5 and 22). Remove snap ring (10), then remove piston from

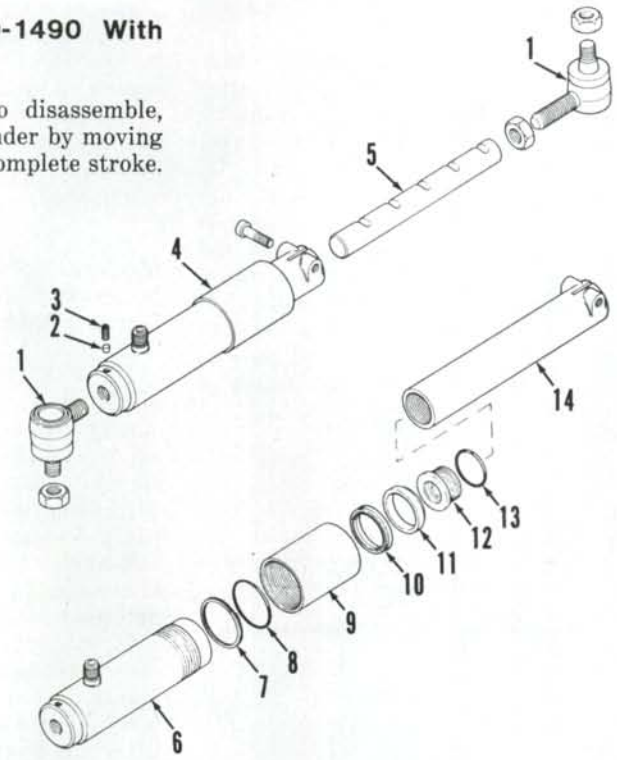


Fig. 62—Exploded view of steering cylinder used on Model 1394 (P.I.N. 11504412 and after) equipped with standard front axle.

1. Ball socket
2. Nylon pad
3. Set screw
4. Cylinder assy.
5. Extension rod
6. Cylinder tube
7. Backup ring
8. "O" ring
9. Sleeve
10. Oil seal
11. Scraper seal
12. Cap
13. "O" ring
14. Piston rod

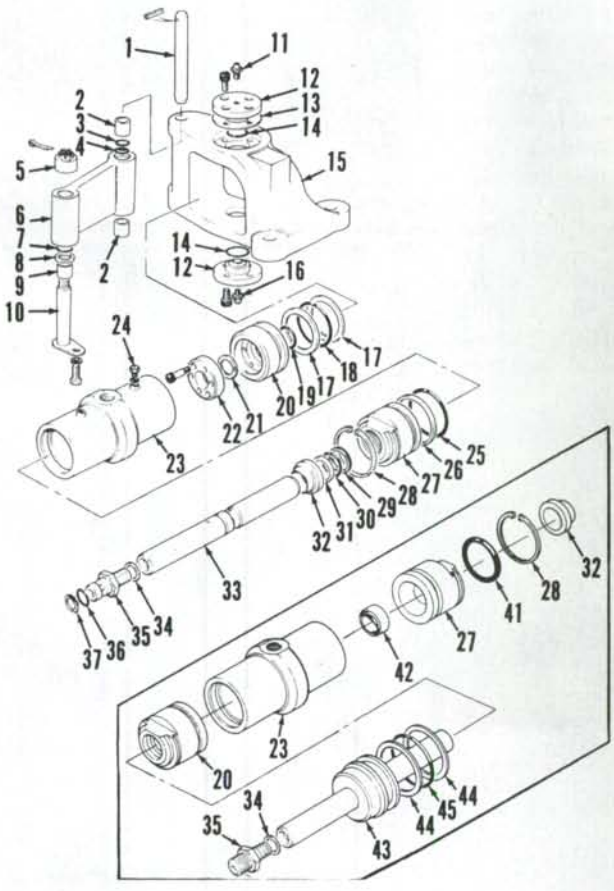


Fig. 61—Exploded view of typical transverse mounted steering cylinder used on some models. On some late models, a one-piece piston and rod assembly (43) with different seal arrangement (shown in inset) is used.

1. Pivot pin
2. Bushing
3. "O" ring
4. "O" ring
5. Nut
6. Pivot link
7. "O" ring
8. Washer
9. Bushing
10. Pivot pin
11. Relief valve
12. Ball peg
13. Shim
14. Seal ring
15. Fork
16. Grease fitting
17. Backup ring
18. "O" ring
19. "O" ring
20. Piston
21. Split ring
22. Locking plate
23. Cylinder
24. Vent screw
25. "O" ring
26. Leather ring
27. End sleeve
28. Snap ring
29. Seal ring
30. "O" ring
31. Backup ring
32. Wiper seal
33. Piston rod
34. Spacing washer
35. Union
36. "O" ring
37. Snap ring
41. "O" ring
42. Oil seal
43. Piston & rod assy.
44. Backup rings
45. "O" ring

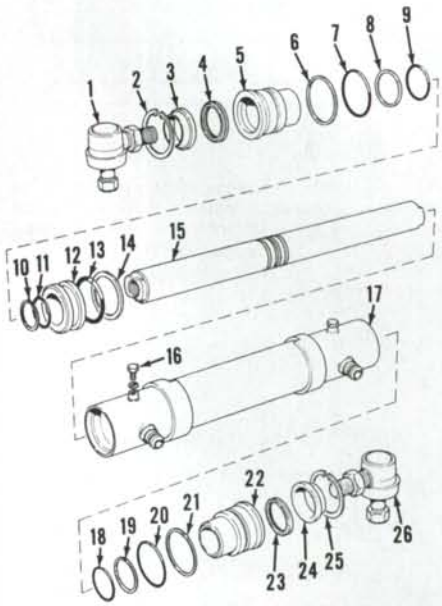


Fig. 63—Exploded view of steering cylinder used on models equipped with David Brown front drive axles.

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

rod. Remove and discard all "O" rings, backup rings and seals.

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.

Soak backup rings in clean hydraulic oil for a minimum of 30 minutes prior to assembly. Lubricate all parts during assembly. Refer to Fig. 64 for correct placement of backup rings and "O" rings. Assemble oil seal, backup rings and "O" rings in sleeves as shown in Fig. 65. Install sleeves and piston and rod assembly into cylinder and secure with two snap rings in each end.

Install tie rod ends on each end of piston rod. Adjust one of the ends so distance from center of ball socket to end of cylinder rod is 41.3-42.9 mm (1⅝ to 1 11/16 inches), measured as shown in Fig. 66. Then adjust the other tie rod end so distance from center of one ball socket to center of the other ball socket is 727-730 mm (28⅝ to 28¾ inches). Tighten locknuts when adjustment is complete. Make certain tops of ball sockets are aligned with air bleed screws on cylinder as shown in Fig. 66.

Reinstall cylinder and tighten cylinder cap mounting bolts to 68 N·m (50 ft.-lbs.) torque. Bleed air from system as outlined in paragraph 58.

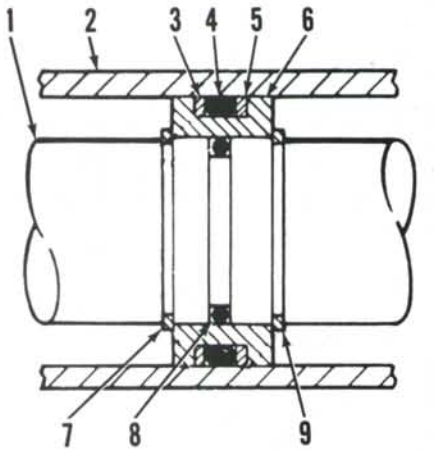


Fig. 64—Diagram showing correct placement of "O" rings and backup rings on piston and rod of steering cylinder used on David Brown front drive axles.

1. Piston rod
2. Cylinder tube
3. Backup ring
4. "O" ring
5. Backup ring
6. Piston
7. Snap ring
8. "O" ring
9. Snap ring

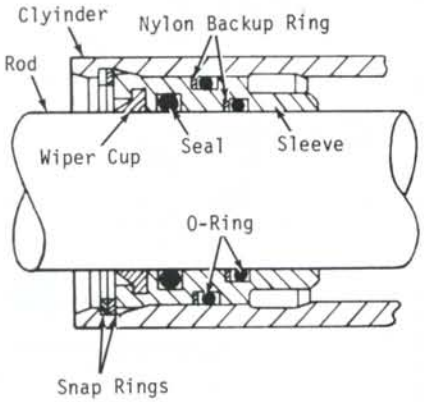


Fig. 65—Diagram showing correct placement of "O" rings and backup rings on sleeves of steering cylinder used on David Brown front drive axle.

Models 1294-1490-1690 and Early Models 1394-1494-1594 With Carraro Axle

73. OVERHAUL. Clear cylinder of oil as necessary by moving piston rod through its complete stroke. Unscrew end cap (8—Fig. 67) 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).

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.

Lubricate all parts during assembly, install thick washer (6) and a new "O" ring (5) on piston rod. Install piston (4) with chamfered side towards end cap. Install thin washer (3) and a new nut (2). Tighten nut to 80 N·m (60 ft.-lbs.) torque. Install end cover and piston rod assembly into cylinder. Turn cylinder into end cap and align oil ports.

Reinstall cylinder and tighten retaining nuts to 353 N·m (260 ft.-lbs.) Bleed air from system as outlined in paragraph 59.

Fig. 66—Tie rod ends must be adjusted to obtain correct distance between centers of ball sockets. Refer to text for details.

Late Models 1394-1494-1594 With Carraro Axle

74. OVERHAUL. Clear cylinder of oil as necessary by moving piston rod through its complete stroke. Remove outer retaining ring (11—Fig. 69). Push end cap (7) inward to clear inner retaining ring (10). Insert a small diameter rod through hole in side of cylinder to disengage inner retaining ring from its groove, then pry inner retaining ring out using a small screwdriver or similar tool. Pull piston rod assembly and end cap from cylinder. Remove piston nut (3) and separate piston and end cap from piston rod.

Cylinder bore, piston and piston rod must be free of score marks, nicks and

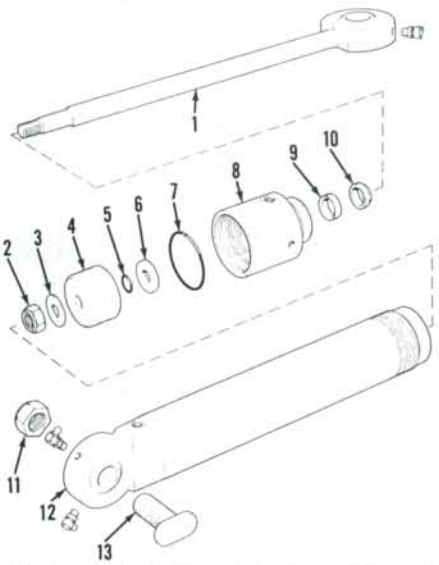


Fig. 67—Exploded view of steering cylinder used on 1490 models, some 1690 models and early 1394, 1494 and 1594 models equipped with Carraro front drive axle.

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

burrs. Slight blemishes may be removed using fine emery cloth lubricated with kerosene.

Lubricate all parts during assembly. Renew all seals on piston and end cap. Install a new piston retaining nut and tighten to 85 N·m (62 ft.-lbs.) torque. Assemble piston, rod and end cover in cylinder and install inner and outer retaining rings.

Reinstall cylinder and bleed air from system as outlined in paragraph 59.

ENGINE

R&R ENGINE ASSEMBLY

Models 1190-1194

75. Drain coolant from radiator and oil from engine. Remove hood, grille, fuel tank and supporting framework. Remove battery and battery support. Remove radiator and fan shroud. Remove all necessary electrical connections, fuel lines, tachometer drive cable and engine stop and throttle controls. Remove power steering lines if so equipped. Split tractor between engine and transmission as outlined in paragraph 217.

Remove engine to frame upper and lower mounting bolts. Lift engine from frame using a suitable hoist.

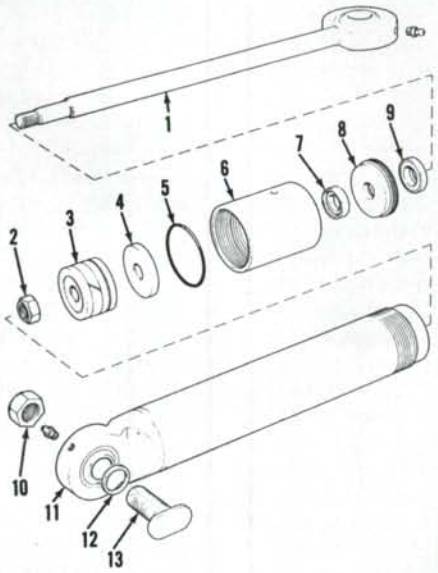


Fig. 68—Exploded view of second type steering cylinder used on Model 1690 tractors. Note differences in end cap and seal design from cylinder shown in Fig. 67.

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

Reinstall by reversing removal procedure. Tighten engine upper and lower mounting bolts to 40 N·m (30 ft.-lbs.) torque.

Models 1290-1294-1390-1394-1490-1494-1594-1690

76. Drain engine oil, coolant and transmission oil. Remove hood, side covers, grille and all supporting framework. Remove battery, battery support and air filter assembly. Remove radiator, fan shroud and oil cooler (if equipped). Remove air conditioner compressor and condenser (if equipped). Remove front mounted hydraulic pump, pump drive shaft and oil lines. Disconnect power steering lines. Disconnect electrical wiring, fuel lines and injection pump control linkage as necessary. Split tractor between engine and transmission as outlined in paragraph 217 or 218.

Remove starter motor and engine oil filter. Unbolt and remove clutch cover from main frame. Remove engine to frame upper and lower mounting bolts. Lift engine from frame using a suitable hoist.

Reinstall by reversing the removal procedure. Tighten engine upper and lower mounting bolts to 40 N·m (30 ft.-lbs.) torque.

R&R CYLINDER HEAD

Models 1190-1194

77. Remove muffler, air intake stack, hood and side panels. Disconnect battery ground cable. Drain coolant from radiator and engine block. Disconnect fuel lines and remove fuel tank. Remove air intake hose, upper radiator hose, alternator and thermostart unit. Disconnect injector fuel return line at front of engine. Remove injector lines and injectors. Disconnect oil return line from cylinder head Disconnect exhaust manifold drain pipe. Remove intake and exhaust manifolds if desired. Remove breather pipe and valve cover. Remove rocker arm assembly and push rods. Mark push rods so they can be reinstalled in their original positions. Remove nuts and bolts retaining cylinder head, then lift head from engine.

Make certain engine block and cylinder head surfaces are clean before reinstalling head. Install a new head gasket with side stamped "TOP" facing up. Install a new water pump outlet gasket, then position cylinder head on engine block. Following sequence shown in Fig. 70, tighten head bolts and nuts in four steps to the following torques: first step to 40 N·m (30 ft.-lbs.), second step to 80 N·m (60 ft.-lbs.), third step to 110 N·m (80 ft.-lbs.) and fourth step to 135 N·m (100 ft.-lbs.). Install push rods and rocker arm assembly. Adjust valve clearance as outlined in paragraph 80. Complete installation by reversing removal procedure. Bleed air from fuel system as outlined in paragraph 131.

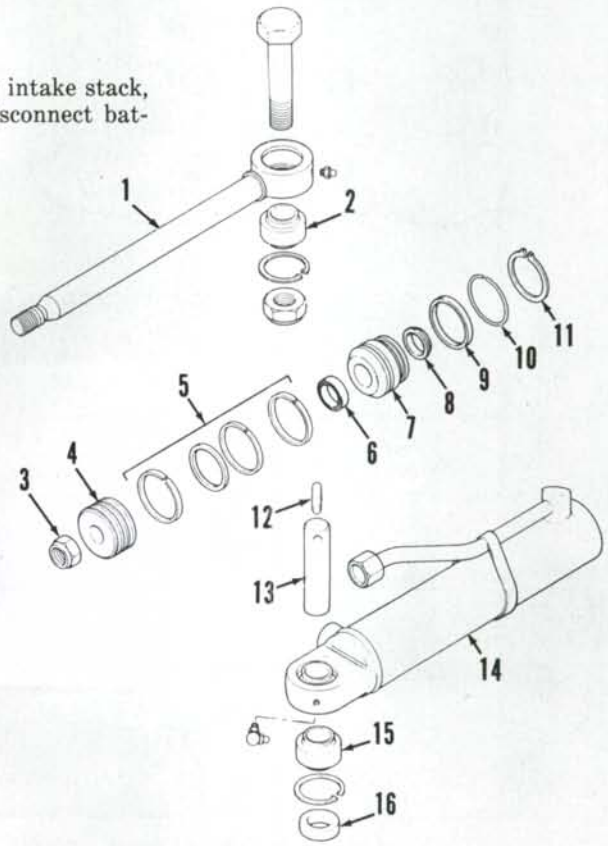


Fig. 69—Exploded view of steering cylinder used on late Models 1394, 1494 and 1594 equipped with Carraro front drive axle.

1. Piston rod
2. Bearing
3. Locknut
4. Piston
5. Piston seals
6. Oil seal
7. End cap
8. Scraper seal
9. Outer seal
10. Inner retaining ring
11. Outer retaining ring
12. Locking pin
13. Pivot pin
14. Cylinder tube
15. Bearing
16. Spacer

Models 1290-1294-1390-1394-1490-1494

78. Drain coolant from radiator and engine block. Remove hood and side panels. Disconnect battery ground cable. Remove air intake hose. On turbocharged engines, remove exhaust flange, connector and turbocharger. On all models, disconnect fuel lines and remove fuel filters and filter bracket. Plug all openings in fuel system to prevent entry of dirt. Remove exhaust manifold. Remove injector high pressure lines and fuel return lines, then remove injectors from cylinder head. Remove upper radiator hose. Remove thermostart reservoir and power steering pump breather (if equipped) from cylinder head. Disconnect electrical wiring as necessary. Disconnect tachometer drive cable and cylinder head oil supply line. Remove intake manifold if desired. Remove rocker arm cover, rocker arm assembly and push rods. Mark push rods so they can be reinstalled in their original positions. Remove cylinder head retaining bolts and nuts, then lift head from engine.

Remove cylinder head gasket and thoroughly clean surfaces of cylinder block and cylinder head. Install a new head gasket making sure side marked "TOP" faces up. Install a new water pump outlet gasket, then position head on cylinder block. Install retaining bolts and nuts with new steel washers. Following sequence shown in Fig. 71, tighten nuts and bolts in four steps to the following torques: first step to 40 N·m (30 ft.-lbs.), second step to 80 N·m (60 ft.-lbs.), third step to 110 N·m (80 ft.-lbs.) and fourth step to 135 N·m (100 ft.-lbs.). Install push rods and rocker arm assembly. Tighten rocker arm mounting bolts to 60 N·m (45 ft.-lbs.) torque. Adjust valve clearance as outlined in paragraph 81. Complete installation by reversing removal procedure. Tighten injector retaining nuts to 20 N·m (15 ft.-lbs.) torque and intake and exhaust manifold nuts to 34 N·m (25 ft.-lbs.) torque. Tighten turbocharger (if so equipped) mounting nuts to 34 N·m (25 ft.-lbs.) torque. Bleed air from fuel system as outlined in paragraph 131.

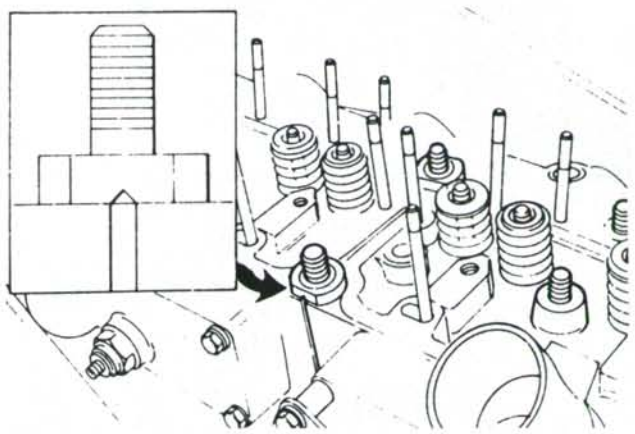


Fig. 73—Install new washers under head bolts and nuts. Note that "V" groove of special washers should align with ends of heads as shown on six-cylinder engines.

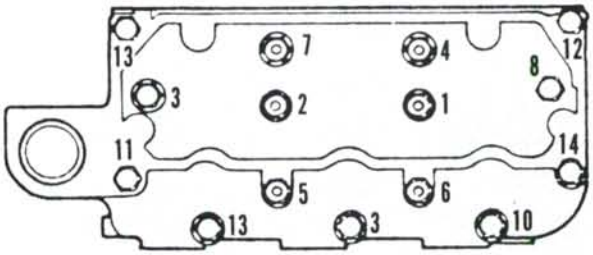


Fig. 70—Tightening sequence for cylinder head bolts on three-cylinder engines. Tighten bolts in four steps as outlined in text.

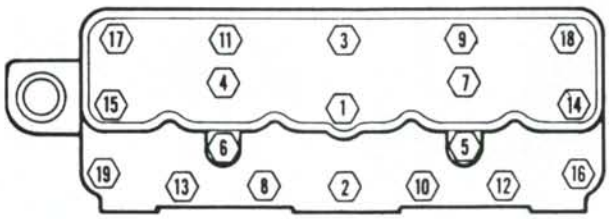


Fig. 71—Tighten four-cylinder engine head bolts in four steps following sequence illustrated.

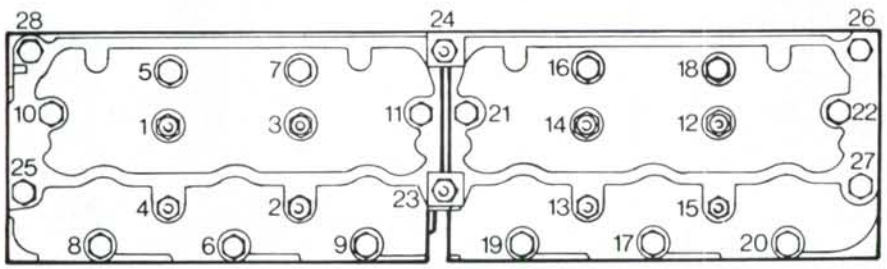


Fig. 72—Use sequence shown when tightening head bolts on six-cylinder engines.

Models 1594-1690

79. Remove muffler, hood and side panels. Disconnect battery ground cable. Drain coolant from radiator, then disconnect upper radiator hose. Disconnect and remove cab heater pipes (if so equipped) from engine. Remove fan assembly from thermostat housing. Disconnect oil supply pipes from front and rear of cylinder heads. Remove air cleaner assembly and hose. Remove connecting tube from intake manifolds on Model 1594. On all models, remove exhaust manifold. Remove fuel injector leak-off pipe and high pressure pipes, then remove injectors. Plug all openings in fuel system to prevent entry of dirt. Disconnect wires and pipes from intake manifolds. Turn coolant connector (2—Fig. 74), located between cylinder heads on left-hand side, clockwise into the front head. Remove valve covers, rocker arm assemblies and push rods. Identify push rods in order of removal so they can be reinstalled in their original positions. Remove cylinder head retaining nuts and bolts, then remove cylinder heads and gaskets.

Thoroughly clean cylinder block and cylinder head surfaces before reinstalling head. Install new head gaskets and a new water pump outlet gasket. Install new washers under cylinder head retaining bolts and nuts noting placement of "V" groove of washers between the two neads (Fig. 73). Tighten cylinder head retaining bolts and nuts evenly in steps, following sequence shown in Fig. 72, to a final torque of 135 N·m (100 ft.-lbs.). Install a new "O" ring (1—Fig. 74) in recess of coolant connector (2), located between the heads, and use Loctite hydraulic sealant on threads of connector. Turn connector counter-

clockwise toward rear head. Install push rods and rocker arm assemblies making certain oil supply holes in rocker shaft supports are positioned at the front on front shaft and at the rear on rear shaft. Tighten rocker shaft retaining bolts to 61 N·m (45 ft.-lbs.) torque. Adjust valve clearance as outlined in paragraph 82. Complete installation while noting the following special instructions: Use new injector seal washers and tighten injector retaining nuts evenly to 20 N·m (15 ft.-lbs.) torque. Tighten exhaust manifold nuts evenly to 34 N·m (25 ft.-lbs.) torque. Bleed air from fuel system as outlined in paragraph 131.

VALVE ADJUSTMENT

Models 1190-1194

80. Adjust valve 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). Adjust intake and exhaust valves on No. 1 cylinder, exhaust valve on No. 2 cylinder and intake valve on No. 3 cylinder. Refer to Fig. 75.

Rotate engine one full revolution, again to "TDC", but 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. 76.

Models 1290-1294-1390-1394-1490-1494

81. Adjust clearance between valve stem ends and rocker arms 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). Adjust intake and exhaust valves on No. 1 cylinder, exhaust valve on No. 2 cylinder and intake valve on No. 3 cylinder. Refer to Fig. 77.

Rotate engine one full revolution, again to "TDC", but 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. 78.

Models 1594-1690

82. Adjust clearance between valve stem ends and rocker arms 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). 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. Refer to Fig. 79.

Rotate engine one full revolution, again to "TDC", but 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. Refer to Fig. 80.

ROCKER ARMS AND SHAFT

All Models

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

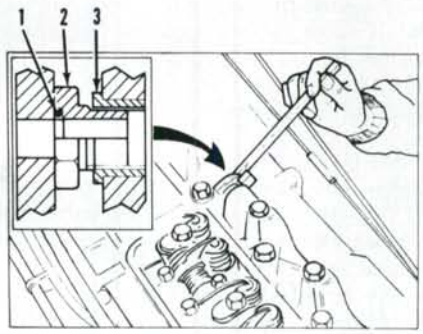


Fig. 74—On six-cylinder engines, a connector (2) joins coolant passages between front and rear cylinder heads.

1. "O" ring
2. Connector
3. Threaded bushing

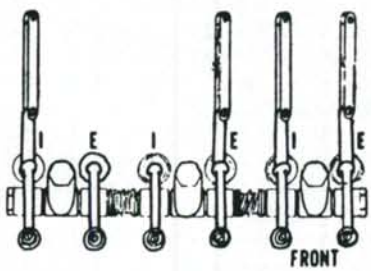


Fig. 75—With No. 1 piston on TDC compression stroke on three-cylinder engines, adjust intake and exhaust valve clearance on No. 1 cylinder, exhaust valve on No. 2 cylinder and intake valve on No. 3 cylinder. Refer to Fig. 76.

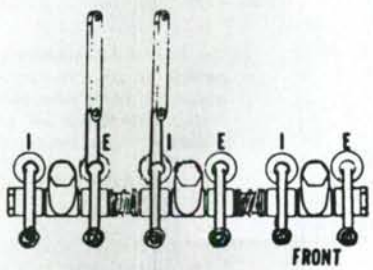


Fig. 76—With No. 1 piston on TDC exhaust stroke on three-cylinder engines, adjust intake valve on No. 2 cylinder and exhaust valve on No. 3 cylinder.

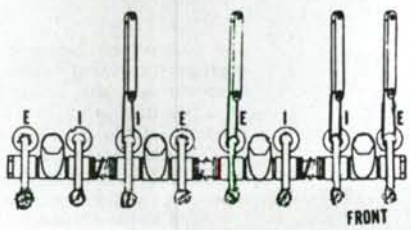


Fig. 77—With No. 1 piston on TDC compression stroke on four-cylinder engines, adjust intake and exhaust valve clearance on No. 1 cylinder, exhaust valve on No. 2 cylinder and intake valve on No. 3 cylinder. Refer to Fig. 78.

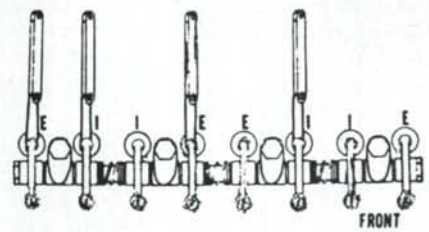


Fig. 78—With No. 1 cylinder on TDC exhaust stroke on four-cylinder engines, adjust intake valve on No. 2 cylinder, exhaust valve on No. 3 cylinder and intake and exhaust valves on No. 4 cylinder.

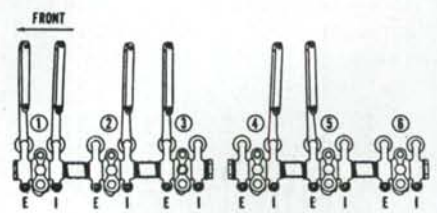


Fig. 79—With No. 1 piston on TDC compression stroke on six-cylinder engines, adjust intake and exhaust valve clearance on No. 1 cylinder, intake valve on No. 2 cylinder, exhaust valve on No. 3 cylinder, intake valve on No. 4 cylinder and exhaust valve on No. 5 cylinder. Refer to Fig. 80.

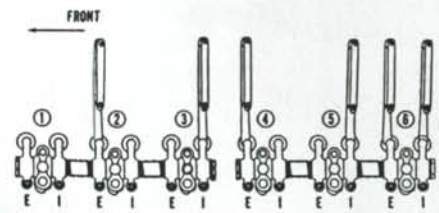


Fig. 80—With No. 1 piston on TDC exhaust stroke on six-cylinder engines, adjust exhaust valve on No. 2 cylinder, intake valve on No. 3 cylinder, exhaust valve on No. 4 cylinder, intake valve on No. 5 cylinder and intake and exhaust valves on No. 6 cylinder.

With rocker arm assembly removed, remove plugs (1—Fig. 81) from ends of shaft. Remove end locating spring (5), right-hand rocker arm (7), locating screw (8) and rear shaft support (4). Remove remaining rocker arms, locating springs and shaft supports and place them in order on a clean bench.

Rocker arm shaft diameter should be 18.99-19.02 mm (0.748-0.749 inch). Renew shaft if diameter is less than 18.89 mm (0.744 inch). Inside diameter of rocker arm bushings should be 19.05-19.06 mm (0.750-0.7505 inch). Renew bushings if inside diameter exceeds 19.06 mm (0.7505 inch). When renewing bushings, make certain oil hole in bushing is aligned with oil hole in rocker arm bore. Ream or hone bushing bore for proper clearance after installation.

Be sure oil holes in shaft and rocker arms are open. Install shaft in rear locating support bracket (4—Fig. 81) and secure with locating screw. Peen bracket around screw to lock screw in position, then complete reassembly. Note that right-hand (7) and left-hand (6) rocker arms are installed in pairs at each shaft support with offset ends toward each other as shown in Fig. 81. Intermediate springs (3) are slightly longer than center spring (9).

CYLINDER HEAD, SEATS, GUIDES, VALVES AND SPRINGS

All Models

84. CYLINDER HEAD. Service procedures for cylinder heads are basically the same for all models.

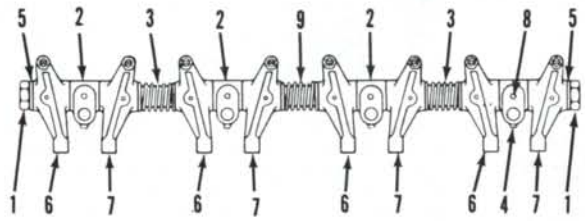


Fig. 81—View showing four-cylinder engine rocker arm assembly Three and six-cylinder assemblies are basically arranged the same.

1. Plugs
2. Front & intermediate supports
3. Intermediate springs
4. Rear support
5. End springs
6. Left-hand rocker arms
7. Right-hand rocker arms
8. Locating screw
9. Center spring

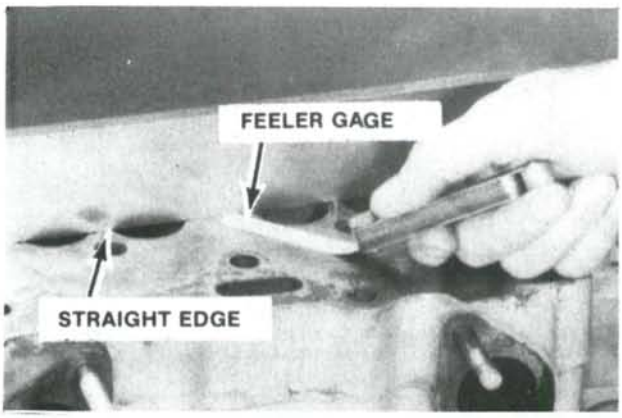


Fig. 82—View showing method of checking cylinder head for warpage using a straightedge and feeler gage. If a 0.075 mm (0.003 inch) feeler gage can be inserted between surface of head and straightedge, head must be resurfaced.

With cylinder head or heads removed, remove keepers, retainers, springs and valves. Place all components in order as they are removed so parts can be reinstalled in their original positions if reused.

Clean cylinder head thoroughly removing all traces of carbon, gasket material and other deposits. Check for cracks and other damage. Check for warpage using a suitable straightedge or surface plate and a feeler gage. See Fig. 82. If surface is warped in excess of 0.075 mm (0.003 inch), cylinder head must be resurfaced. The maximum amount of material that can be removed from cylinder head is 0.76 mm (0.030 inch).

85. SEATS. Renewable intake and exhaust valve 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 1.52-1.78 mm (0.060-0.070 inch).

NOTE: If valve guides are worn and oversize valves are being installed, ream valve guides to correct size before machining valve insert seats.

If inserts are loose, cracked or seat cannot be narrowed to desired width, insert should be renewed. Be careful not to damage cylinder head counterbore when removing seat inserts. Cylinder head counterbore diameter should be 41.28-41.30 mm (1.625-1.626 inches) which provides an interference fit of 0.038-0.089 mm (0.0015-0.0035 inch) for standard diameter inserts. Cylinder

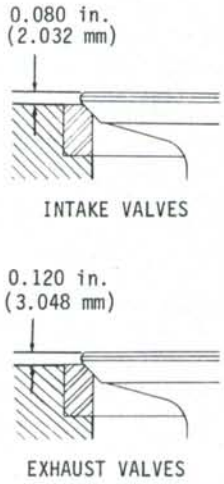


Fig. 83—Measure valve head protrusion above surface of cylinder head when servicing cylinder head and valves. If protrusion exceeds dimensions shown, regrind or renew valve seat.

head counterbore depth should be 3.96-4.03 mm (0.156-0.159 inch).

Chill new insert with dry ice, then quickly install insert chamfered edge first, into counterbore using a suitable driver. When correctly installed, top of insert should be 0.10-0.28 mm (0.004-0.011 inch) below surface of cylinder head. Lightly grind new seats to obtain desired seat width.

Insert valves into cylinder head and measure distance valve heads protrude above surface of cylinder head. See Fig. 83. If valve protrusion exceeds 2.03 mm (0.080 inch) for intake valves, or 3.05 mm (0.120 inch) for exhaust valves, regrind valve seat.

86. GUIDES. Standard diameter of valve guide bores is 9.51-9.54 mm (0.3745-0.3755 inch). If guide bores are excessively worn, the bores may be reamed oversize for installation valves with oversize stem diameter. Valves are available in oversizes of 0.25 mm (0.010 inch) and 0.50 mm (0.020 inch). When reaming bores to oversize, use care not to damage sharp edge at top of guide bores.

87. VALVES. Standard stem diameter is 9.454-9.479 mm (0.3722-0.3732 inch) for all valves. Valves should be renewed if stem to guide clearance exceeds 0.08 mm (0.003 inch). Valves are available with 0.25 mm (0.010 inch) and 0.50 mm (0.020 inch) oversize stem diameter. Guides must be reamed to fit oversize stems.

Renew valves if retainer groove or valve stem end is worn. Reface all valves at 45 degrees.

88. VALVE SPRINGS. Valve springs are the same for all models,

however intake and exhaust valve springs are not interchangeable.

Intake valve springs are color coded with a yellow dot. Spring free length should be approximately 54 mm (2.125 inches). When compressed under load of 342.5 N (77 pounds), spring length should be 29.16 mm (1.148 inches).

Exhaust valve springs are color coded with a blue dot. Spring free length should be approximately 54 mm (2.125 inches). When compressed under load of 365 N (82 pounds), spring length should be 29.97 mm (1.180 inches).

Renew springs if weak, distorted or corroded.

TIMING GEAR COVER

Models 1190-1194

89. 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. Complete installation by reversing removal procedure.

Models 1290-1294-1390-1394-1490-1494

90. Drain cooling system. Remove hood, grille, battery and battery support. Remove radiator, engine oil cooler (if so equipped), 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 in coupler to aid removal. Remove rubber spacer disc located between pump drive shaft and crankshaft pulley, then 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.

Clean cover and install a new front oil seal and felt seal in cover. Loosely bolt cover in place, then install crankshaft pulley to center oil seal. Tighten cover mounting bolts to 25 N·m (19 ft.-lbs.) torque. Tighten crankshaft pulley retaining nut to 190 N·m (140 ft.-lbs.) torque. Complete installation by reversing removal procedure.

Models 1594-1690

91. Remove muffler, engine cover and support frame. Remove side panels, then disconnect and remove battery. Drain engine coolant, then remove radiator, engine oil cooler (if so equipped) and transmission oil cooler (if so equipped). Remove hydraulic pump drive shaft coupling from front of crankshaft. Two threaded jack screw holes are provided in coupler flange to aid removal. Remove rubber spacer disc located between pump drive shaft and end of crankshaft. Remove drive belts and fan assembly. Remove alternator and water pump. Remove crankshaft pulley, using a suitable puller if necessary. Remove timing gear cover retaining bolts noting their length and location for reassembly. Remove timing gear cover.

Clean cover and install a new oil seal, felt seal and gasket. Loosely bolt cover in place, then install crankshaft pulley to center oil seal. Tighten cover mounting bolts to 20 N·m (15 ft.-lbs.) torque. Install crankshaft pulley retaining bolt and spacer with a new "O" ring and tighten to 190 N·m (140 ft.-lbs.) torque. Complete installation by reversing removal procedure.

CRANKSHAFT FRONT OIL SEAL

All Models

92. Crankshaft front oil seal may be renewed without removing timing gear cover. Remove necessary items to remove crankshaft pulley. Loosen, but do not remove timing gear cover retaining bolts. Remove oil seal using care not to damage timing gear cover.

Use special tool (CAS-1229) to correctly center cover and install oil seal. If tool is not available, install crankshaft pulley to center oil seal and cover, then tighten cover retaining screws. On Models 1190 and 1194, tighten crankshaft pulley retaining bolt to 122 N·m (90 ft.-lbs.) torque. On all other models, tighten pulley retaining nut or bolt to 190 N·m (140 ft.-lbs.) torque.

TIMING GEARS

Models 1190-1194

93. Timing gears on 1190 and 1194 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 89. 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. 84. 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. Timing marks (SM) on gear and crankshaft must be aligned.

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. 84. Tighten camshaft gear retaining cap screw to 54 N·m (40 ft.-lbs.) torque and install new lock wire.

Reassemble by reversing disassembly procedure.

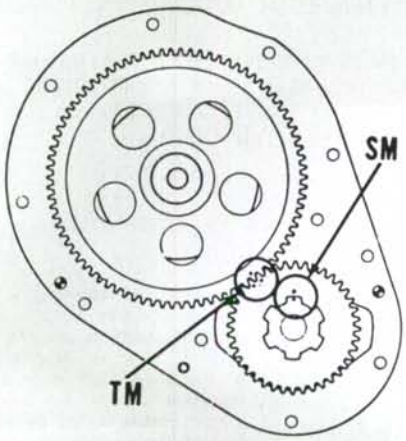


Fig. 84—View showing timing gears used on Models 1190 and 1194. Install crankshaft gear with spline marks (SM) aligned as shown. Install camshaft gear with "D" or punch marked tooth between the two punch marked teeth of crankshaft gear as shown at (TM).

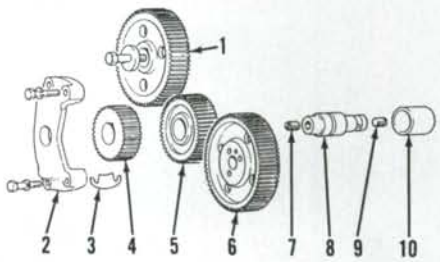


Fig. 85—View showing timing gears and related parts used on four-cylinder engines.

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

Models 1290-1294-1390-1394-1490-1494

94. Timing gears on four-cylinder engines consist of crankshaft gear, camshaft gear, fuel injection pump gear and an idler gear (Fig. 85).

To remove timing gears, first remove timing gear cover as outlined in paragraph 90. Rotate crankshaft so No. 1 piston is at "TDC" on compression stroke.

Remove idler gear support bracket (2—Fig. 85) and shims (3). Withdraw idler gear (5) from shaft (8). To remove idler shaft, remove plug from end of shaft and install a bolt and flat washer. Use a suitable slide hammer puller to remove shaft.

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

To remove injection pump drive gear, straighten tab washer and remove three retaining bolts. Note that gear is timed to injection pump hub by a dowel pin.

Crankshaft gear is keyed and press fitted to crankshaft. If necessary, remove gear using a suitable puller. Inspect Woodruff key and keyway for damage or wear.

Inspect all gears for excessive wear or damage. Idler shaft should be smooth and free of scoring. Shaft diameter should be 30.117-30.137 mm (1.1857-1.1865 inches). Inner diameter of idler gear bushing should be 30.180-30.206 mm (1.1882-1.1892 inches). Renew bushing (10) if inner diameter exceeds 30.23 mm (1.190 inches).

Reinstall plugs, if removed, in idler shaft using Loctite 271 on threads of plugs. Install idler shaft with oil holes (Fig. 86) facing downward toward crankshaft.

Install crankshaft gear with chamfered side towards engine. Install injection pump gear, tighten retaining bolts to 27 N·m (20 ft.-lbs.) torque and secure by bending lockplate tabs. Install camshaft gear and tighten retaining bolt to 54 N·m (40 ft.-lbs.) torque. Secure with a new lock wire.

All timing marks on installed gears should be pointing toward idler gear position. Install idler gear so all timing marks are aligned as shown in Fig. 87. If marks are not clear or a gear is not marked, the numbers shown on gears in Fig. 87 correspond to tooth numbers to be aligned. Count teeth from tooth number "O" in the direction of arrows, then put mark next to tooth for future reference. Note that on idler gear any tooth can be marked as "O" tooth, then count clockwise and counterclockwise from that tooth to locate the two timing marks.

Install idler gear support bracket (1—Fig. 88) with original shims removed during disassembly. Tighten bracket retaining bolts to 30 N·m (22 ft.-lbs.) torque. Check clearance between idler gear and bracket using a feeler gage as shown in Fig. 88. Clearance should be 0.05-0.10 mm (0.002-0.004 inch). Adjust clearance by adding or removing shims as necessary.

Complete installation by reversing removal procedure.

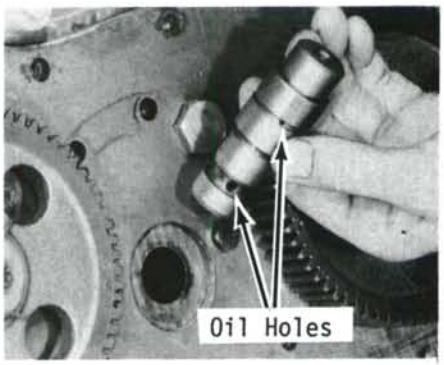


Fig. 86—When installing idler shaft, be sure oil holes are positioned downward toward the crankshaft.

Models 1594-1690

95. Timing gears on the six-cylinder engine used in these models consist of crankshaft gear (11—Fig. 89), camshaft gear (4), fuel injection pump drive gear (14) and idler gear (12).

To remove timing gears, first remove timing gear cover as outlined in paragraph 91. Rotate crankshaft until No. 1 piston is at "TDC" on compression stroke. Remove idler gear with shims (10), retainer plate (9) and tab washer (8). Remove nut retaining injection pump drive gear, then use a suitable puller to remove gear from tapered shaft. Remove lock wire and loosen bolt retaining camshaft gear. Use a suitable puller to pull gear free, then remove retaining bolt and gear.

If crankshaft gear is to be renewed, it will be necessary to first remove engine assembly as outlined in paragraph 76. With engine removed, remove camshaft retaining plate, idler gear shaft, fuel injection pump and power steering pump. Remove timing gear housing. Use a suitable puller, such as tool No. DB-960604, to remove the crankshaft gear.

If timing gear housing was removed, remove oil supply restrictor (Fig. 90) for timing gears from front of cylinder block. Clean restrictor and oil passage with compressed air, then reinstall restrictor. Inspect all gears for excessive wear and damage. Backlash between gears should be 0.10-0.15 mm (0.004-0.006 inch). Crankshaft gear to oil pump idler gear backlash should be 0.13-0.20 mm (0.005-0.008 inch).

Idler shaft (15—Fig. 89) diameter should be 76.14-76.16 mm (2.997-2.998 inches). Inner diameter of idler gear bushing (13) should be 76.20-76.24 mm (3.000-3.001 inches). Desired shaft to bushing operating clearance is 0.04-0.10 mm (0.001-0.004 inch).

To reassemble, reverse the disassembly procedure while noting the following special instructions. Tighten camshaft retaining plate bolts to 34 N·m (25 ft.-lbs.) torque. Tighten camshaft gear retaining bolt to 54 N·m (40 ft.-lbs.) torque and secure with a new lock wire. Tighten injection pump gear retaining nut to 88 N·m (65 ft.-lbs.)

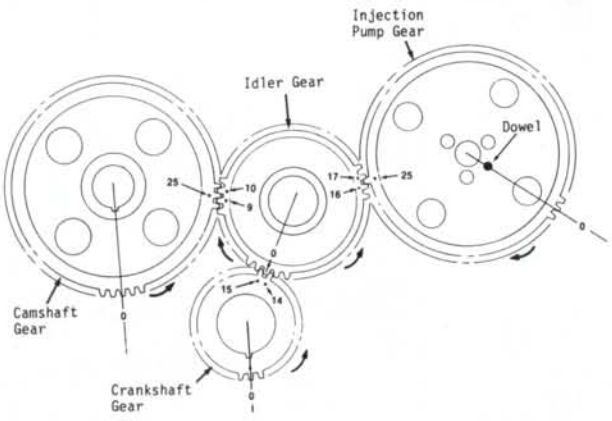


Fig. 87—View showing timing gear marks in proper meshed position on four-cylinder engines. Numbers on the gears indicate tooth numbers (counting from tooth number 0) to be aligned if timing marks are not present.

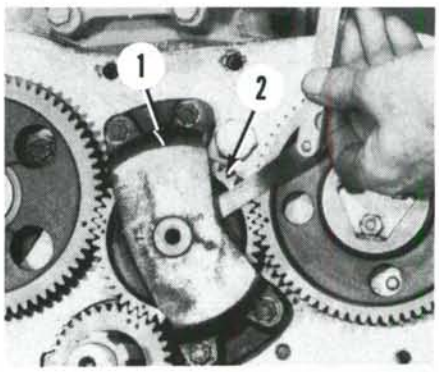


Fig. 88—Check clearance between idler gear (2) and support bracket (1) using a feeler gage. Add or remove bracket mounting shims to adjust clearance.

torque and secure with tab washer. Lubricate idler gear bushing with oil, then install gear, aligning timing marks on installed gears with marks on idler gear as shown in Fig. 91.

Install idler gear retaining plate (9—Fig. 89) with shims (10) which were removed during disassembly. Install special tab washer in position as shown in Fig. 92. Tighten retaining bolts to 20 N·m (15 ft.-lbs.) torque, then check clearance between idler gear and retainer plate with a feeler gage. End clearance should be 0.05-0.10 mm (0.002-0.004 inch). Adjust by adding or removing shims (10—Fig. 89) as necessary. When clearance is correct, bend tab washer against bolt heads to secure.

VALVE TAPPETS

All Models

96. 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 15.824-15.850 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

Models 1190-1194

97. Camshaft may be removed without removing engine assembly by removing timing gear cover as outlined in paragraph 89. 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 fuel injection pump as outlined in paragraph 136. Pull injection pump and oil pump drive assembly from cylinder block. Remove fuel transfer pump and pump push rod. Remove tappet chamber cover plates from side of cylinder block. Lift each tappet and retain in raised position by placing a 12 mm (½ inch) diameter "O" ring around each tappet. Remove camshaft gear and camshaft locating plate, then withdraw camshaft from 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.

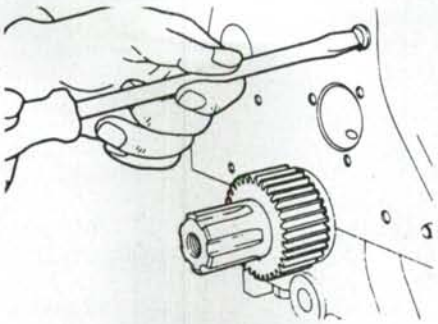


Fig. 90—View showing removal of oil supply restrictor for timing gears. Clean with compressed air, then reinstall.

Camshaft specifications are as follows:

Front Journal	
Diameter	60.261-60.287 mm (2.3725-2.3735 in.)
No. 2 Journal	
Diameter	47.516-47.549 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 (1.7475-1.7488 in.)
Camshaft End Play	0.05-0.15 mm (0.002-0.006 in.)

Inspect camshaft lobes and surface of tappets for wear or pitting. If camshaft is renewed, it is recommended that tappets be renewed also.

Install camshaft in cylinder block, then install locating plate. Check camshaft end play. If end play is not within range of 0.05-0.15 mm (0.002-0.006 inch), renew parts as necessary. Install camshaft gear, aligning timing marks as shown in Fig. 84. Tighten camshaft gear cap screw to 54 N·m (40 ft.-lbs.) torque. Complete reassembly by reversing disassembly procedure. Install and time injection pump as outlined in paragraph 136.

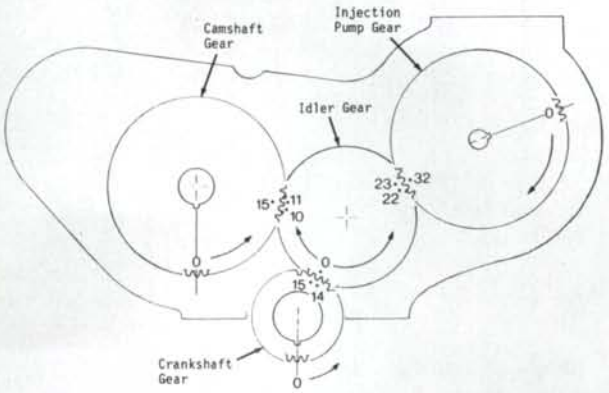


Fig. 91—Timing gears are properly timed when timing marks are aligned as shown for six-cylinder engines. Numbers on the gears indicate tooth numbers (counting from tooth number 0) to be aligned if timing marks are not present.

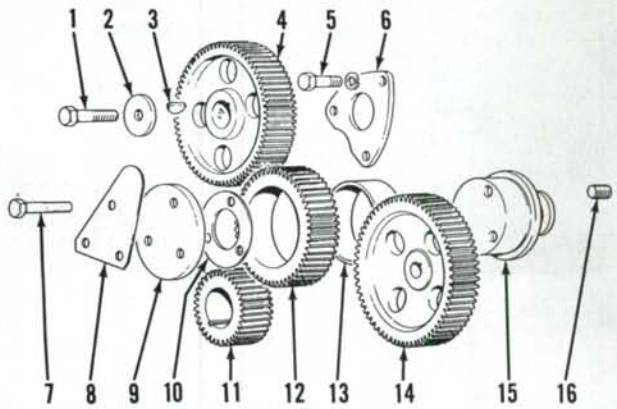


Fig. 89—View showing timing gears and related parts used on six-cylinder engines.

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

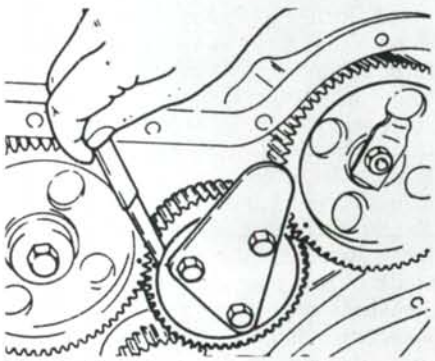


Fig. 92—View showing proper position of special tab washer on idler gear. Use a feeler gage to check clearance between gear and retaining plate. Adjust by removing or installing shims.

Models 1290-1294-1390-1394-1490-1494

98. Camshaft may be removed without removing engine by first removing timing gear cover as outlined in paragraph 90. Remove rocker arm cover, rocker arm assembly and push rods from cylinder head. Disconnect tachometer drive cable. Remove fuel transfer pump and push rods from cylinder block. Drain engine oil and remove oil pan. Remove oil pump locating screw from side of cylinder block, disconnect oil pressure line from pump and remove oil pump. Remove tappet chamber covers from side of cylinder block. Pull each tappet up and retain in raised position by placing a 12 mm (½ inch) diameter "O" ring around each tappet. Remove camshaft gear and camshaft locating plate. Pull camshaft from cylinder block.

Camshaft specifications are as follows:

Front Journal Diameter	47.50-47.55 mm (1.870-1.872 in.)
No. 2 Journal Diameter	46.35-46.41 mm (1.825-1.827 in.)
No. 3 Journal Diameter	45.97-46.00 mm (1.810-1.811 in.)
No. 4 Journal Diameter	45.97-46.00 mm (1.810-1.811 in.)
No. 5 Journal Diameter	44.78-44.83 mm (1.763-1.765 in.)
No. 6 Journal Diameter	44.37-44.42 mm (1.747-1.749 in.)
Retainer Plate Thickness	6.10-6.22 mm (0.240-0.245 in.)
Camshaft End Play	0.25-0.50 mm (0.010-0.020 in.)

Renew camshaft if bearing journal measurements are more than 0.025 mm (0.001 inch) below minimum dimensions. Inspect camshaft lobes and surface of tappets for wear or pitting and renew if necessary.

Install camshaft in cylinder block. Install locating plate and tighten retaining bolts to 34 N·m (25 ft.-lbs.) torque. Check camshaft end play which should be 0.25-0.50 mm (0.010-0.020 inch). Renew locator plate and/or camshaft if end play is excessive. Install camshaft gear, aligning timing marks as shown in Fig. 87. Tighten gear retaining bolt to 54 N·m (40 ft.-lbs.) torque and secure with a new lock wire. Complete reassembly by reversing disassembly procedure.

Models 1594-1690

99. Camshaft can be removed without removing engine assembly by removing timing gear cover as outlined in paragraph 91. Remove camshaft gear and camshaft locating plate. Remove rocker arm cover, rocker arm assembly and push rods. Remove tappet chamber covers from right side of cylinder block. Lift each tappet and retain in raised position by placing a 12 mm (½ inch) diameter "O" ring around each tappet. Remove fuel transfer pump and plunger from cylinder block. Disconnect tachometer drive cable, remove set screw in side of block retaining tachometer drive assembly and remove drive unit from block. Withdraw camshaft from cylinder block.

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.)
No. 3 Journal Diameter	46.37-46.40 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 Play	0.06-0.24 mm (0.002-0.009 in.)

Inspect camshaft lobes and surface of tappets for wear or pitting and renew if necessary.

Lubricate camshaft, then install in cylinder block. Install locating plate and tighten retaining bolts to 34 N·m (25 ft.-lbs.) torque. Check camshaft end play which should be within range of 0.06-0.24 mm (0.002-0.009 inch). Tighten camshaft gear retaining bolt to 54 N·m (40 ft.-lbs.) torque and secure with a new lock wire. Make certain timing marks are aligned as shown in Fig. 91. Complete reassembly by reversing the removal procedure.

CAMSHAFT REAR SEAL

All Models

100. 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 217 or 218. Remove clutch assembly, flywheel and starter support plate. Remove "O" ring.

Reassemble by reversing disassembly procedure.

CONNECTING ROD AND PISTON ASSEMBLY

All Models

101. Connecting rod and piston assemblies are removed from above after removing cylinder head, oil pan and oil pump assembly. Be sure to remove carbon and ring ridge (if present) from top of cylinder prior to piston removal; otherwise, damage to piston may occur during removal.

Note identification numbers stamped on camshaft side of connecting rod and cap before removing caps. If numbers are not present on connecting rod and cap, mark them prior to removal to ensure proper reassembly. Rod cap and connecting rod have been machined as an assembly and cap must be mated with original connecting rod from which it was removed. Keep connecting rod bearings matched with connecting rods during removal so they can be installed in original positions if being reused.

Install piston and rod assemblies with valve recesses in piston and numbered side of rod and cap toward camshaft side of engine. Be sure tangs on bearings properly engage notches in rod and cap. Install rod cap making sure identification numbers on rod and cap are aligned. Install new retaining nuts and tighten evenly to 68 N·m (50 ft.-lbs.) torque.

PISTON PINS AND BUSHINGS

All Models

102. Piston pins float in renewable bushings which are press fitted in bore of connecting rod. Pins are a transition fit in piston bores and are retained by a snap ring at each end.

To remove pin from piston, remove snap rings and tap pin from piston. If pin is tight, immerse piston in hot water until pin slides easily from piston bore. Measure piston pin diameter and diameter of piston bores. Renew piston if pin to piston bore clearance exceeds 0.05 mm (0.002 inch).

Inside diameter of bushing in connecting rod should be 31.76-31.78 mm (1.250-1.251 inches). Outside diameter of piston pin should be 31.74-31.75 mm (1.2495-1.250 inches). If bushing is ex-

cessively worn or out-of-round, renew bushing. Align oil holes in bushing and rod as bushing is pressed into bore. Ream new bushing to provide 0.02 mm (0.001 inch) clearance for pin being used.

When installing piston pin, heating piston in hot water to expand piston bores will make pin installation easier. Be sure valve recesses in top of piston are on same side as identification numbers on connecting rod, then secure pin with snap rings.

CONNECTING RODS AND BEARINGS

All Models

103. Precision, insert type connecting rod bearings are used on all models. Bearings are renewable from below after removing oil pan, oil pump and connecting rod caps.

Recommended bearing oil clearance is 0.05-0.10 mm (0.002-0.004 inch). Bearings are available in undersizes as well as standard size.

Lubricate bearings during assembly and make certain tangs of bearings properly engage notches in connecting rod and cap. Be sure identification numbers on rod and cap are in register. Tighten cap retaining nuts to 68 N·m (50 ft.-lbs.) torque on all models.

PISTONS AND PISTON RINGS

All Models

104. Pistons are of aluminum alloy and have a combustion chamber machined in their crown 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 diameter is measured at bottom of skirt at right angle to piston pin hole. Check piston ring groove wear by placing new ring in piston groove, then measure side clearance between ring and land with a feeler gage. Renew piston if side clearance is excessive. Check piston ring end gap by pushing ring squarely into cylinder bore, then measure end gap with a feeler gage.

Piston specifications for all models are as follows:

Piston Skirt Diameter . . . 99.87 mm (3.932 in.)

Ring End Gap,
All Rings . . . . . 0.28-0.40 mm (0.011-0.016 in.)

Ring Side Clearance—
Models 1190-1194
Compression Rings . . 0.06-0.09 mm (0.0025-0.0035 in.)
Oil Control Ring . . 0.05-0.07 mm (0.002-0.003 in.)
Models 1290-1294-1390-1594-1690
Compression Rings . . 0.05-0.10 mm (0.002-0.004 in.)
Oil Control Ring . . 0.02-0.20 mm (0.001-0.008 in.)
Models 1394-1490-1494
Compression Rings . . 0.05-0.10 mm (0.002-0.004 in.)
Oil Control Ring . . 0.04-0.09 mm (0.0015-0.0035 in.)

Clean oil holes in piston using a small drill or wire When reinstalling piston, be sure valve recesses in top of piston are on same side as identification numbers on connecting rod. Install rings so end gaps are staggered 120° from each other. Lubricate piston and rings with clean engine oil before reinstalling in cylinder.

CYLINDERS

All Models

105. Some models are equipped with dry, interference fit cylinder liners, while on other models, pistons run directly against cylinder block bores. Standard cylinder bore for all models is 100.045-100.066 mm (3.9388-3.9396 inches).

If cylinder bore wear exceeds 0.25 mm (0.010 inch) or if any bore is out-of-round or tapered more than 0.13 mm (0.005 inch), cylinder block or cylinder liners should be rebored and appropriate oversize pistons installed. All cylinders must be rebored to the same size.

Cylinder liners are available and can be used on models not originally equipped with liners when cylinder bores are worn beyond maximum oversize or when cylinder bore is damaged. To install liner, cylinder must first be bored to provide an interference fit for liner of 0.08-0.11 mm (0.003-0.004 inch). Liners may be bored oversize in same manner as original cylinder bore.

CRANKSHAFT AND MAIN BEARINGS

Models 1190-1194

106. REMOVE. To remove crankshaft, first remove engine assembly as outlined in paragraph 75. Remove timing gear cover, timing gears and engine front plate. Remove cylinder head, oil pump, clutch assembly, flywheel and starter support plate. Remove connecting rod caps and bearings, then remove piston and rod assemblies.

NOTE: Keep connecting rod caps with their mated connecting rods and identified with cylinder number so they can be reinstalled in original positions.

Remove rear oil seal retainer plate from rear of cylinder block. Mark positions of main bearing caps, then remove caps and bearings. Lift crankshaft from cylinder block.

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

107. INSPECTION. Clean and inspect crankshaft carefully for wear, scoring or other damage. Main journal standard diameter is 63.474-63.487 mm (2.4990-2.4995 inches). Rod journal standard diameter is 60.274-60.287 mm (2.3730-2.3735 inches). Maximum taperer out-of-round permitted is 0.013 mm (0.0005 inch). Maximum journal wear permitted before reconditioning is required is 0.13 mm (0.005 inch) for main and rod journals. When crankshaft journals are machined, original fillet radius of 3.8-4.1 mm (0.150-0.160 inch) must be maintained. Main and rod bearings are available in 0.25, 0.51 and 0.76 mm (0.010, 0.020 and 0.030 inch) undersizes.

Crankshaft balance weights must be removed before regrinding crankshaft journals. Scribe identification marks on weights and crankshaft so weights can be reinstalled in their original positions. Use new bolts and tab washers when reinstalling weights, and tighten bolts to 54 N·m (40 ft.-lbs.) torque. Make certain there is no gap between mating surfaces of weights and crankshaft.

108. REINSTALL. Main and rod bearing clearance should be 0.05-0.10 mm (0.002-0.004 inch). Use "Plastigage" to accurately check clearance.

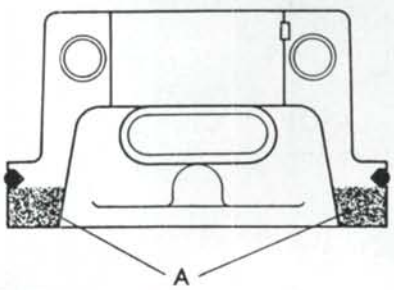


Fig. 93—When installing front main bearing cap on three-cylinder engines, apply light coat of RTV silicone sealer to mounting surface of cap indicated by shaded area "A".

Use suitable lubricant on all bearings during installation. Apply a thin film of RTV silicone sealer to mounting surface of front main bearing cap as shown in Fig. 93. Install rear oil seal and retainer as outlined in paragraph 115. Be sure thrust washers are installed on number three main bearing. Tighten main bearing cap retaining bolts to 163 N·m (120 ft.-lbs.) torque. Install new connecting rod cap locknuts and tighten to 68 N.m (50 ft.-lbs.) torque.

Crankshaft end play should be 0.05-0.25 mm (0.002-0.010 inch). End play is controlled by thrust washers at number three main bearing. Thrust washers are available in standard size and 0.13 and 0.51 mm (0.005 and 0.020 inch) oversizes.

Models 1290-1294-1390-1394-1490-1494

109. REMOVE. To remove crankshaft, first remove engine as outlined in paragraph 76. Remove cylinder head, timing gear cover, timing gears, engine front plate with steering pump and fuel injection pump, clutch, flywheel and starter support plate. Remove oil pump locating screw from side of cylinder block, disconnect pressure line from pump and withdraw oil pump assembly. Mark connecting rod bearing caps so they can be reinstalled in their original positions, remove bearing caps, then push connecting rods away from crankshaft. Mark positions of main bearing caps, then remove caps. Lift crankshaft from cylinder block.

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

110. INSPECTION. Clean and inspect crankshaft carefully. Journals must be smooth and free of scoring. Using a micrometer, measure main and rod journals to determine if they are excessively worn, tapered or out-of-round. Maximum taper or out-of-round permitted is 0.013 mm (0.0005 inch). Crankshaft standard specifications are as follows:

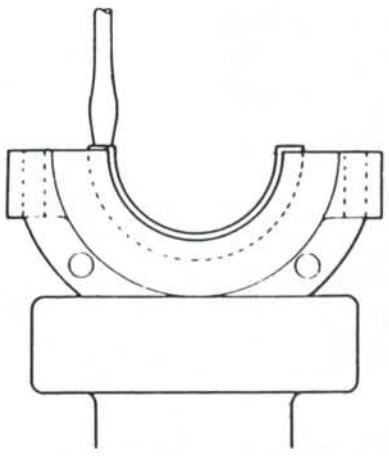


Fig. 94—When renewing packing in crankshaft rear seal retainer, use a blunt tool to tamp packing ends below face of retainer.

Models 1290-1294-1390

Main Journal
Diameter . . . . . 63.474-63.487 mm (2.4990-2.4995 in.)
Main Bearing
Clearance . . . . . .0.05-0.10 mm (0.002-0.004 in.)
Rod Journal
Diameter . . . . . 60.27-60.29 mm (2.3730-2.3735 in.)
Rod Bearing
Clearance . . . . . .0.05-0.10 mm (0.002-0.004 in.)

Models 1394-1490-1494

Main Journal
Diameter . . . . . 66.650-66.662 mm (2.6240-2.6245 in.)
Main Bearing
Clearance . . . . . .0.05-0.10 mm (0.002-0.004 in.)
Rod Journal
Diameter . . . . . 63.449-63.462 mm (2.4980-2.4985 in.)
Rod Bearing
Clearance . . . . . .0.05-0.10 mm (0.002-0.004 in.)

If crankshaft journals are worn, scored or damaged, crankshaft must be reground to appropriate undersize. When journals are machined, original fillet radius of 3.8-4.0 mm (0.150-0.160 inch) must be maintained.

111. REINSTALL. To check main and rod bearing clearance, make sure journals and bearings are clean and dry. Use "Plastigage" on each bearing to accurately check clearance.

Use suitable lubricant on all bearings during final assembly. Be sure thrust washers are installed with steel back side against cylinder block and bearing cap. On Models 1290, 1294, 1390, tighten main bearing cap retaining bolts to 217 N·m (160 ft.-lbs.) torque. On Models 1394, 1490 and 1494, tighten center main bearing cap bolts to 298 N·m (220 ft.-lbs.) torque and remainder of main bearing cap bolts to 217 N·m (160 ft.-lbs.) torque. On all models, install rear oil seal and retainer as outlined in paragraph 115. Install new connecting rod cap locknuts and tighten to 68 N·m (50 ft.-lbs.) torque.

Crankshaft end play should be 0.05-0.25 mm (0.002-0.004 inch). End play is controlled by thrust washers at center main bearing. Thrust washers are available in standard size and oversizes of 0.13 and 0.51 mm (0.005 and 0.020 inch).

Complete installation by reversing the removal procedure.

Models 1594-1690

112. REMOVE. To remove crankshaft, first remove engine assembly as outlined in paragraph 76. Remove cylinder heads, timing gear cover, engine oil pump, clutch and flywheel. Remove front oil seal retainer from lower part of timing gear housing. Remove rear oil seal retainer using two bolts in threaded holes in retainer to push retainer off crankshaft flange. Remove connecting rod bearing caps and push connecting rods away from crankshaft. Mark position of main bearing caps to ensure correct reassembly, then remove caps. Lift crankshaft from cylinder block.

If main bearings, thrust washers or rod bearings are to be reused, they must be reinstalled in their original positions.

113. INSPECTION. Clean and inspect crankshaft carefully. Journals must be smooth and free of scoring. Using a micrometer, measure rod and main journals to determine if they are excessively worn, tapered or out-of-round. Maximum taper or out-of-round permitted is 0.013 mm (0.0005 inch). Main journal standard diameter is 69.84-69.85 mm (2.7495-2.7500 inches). Rod journal standard diameter is 60.27-60.28 mm (2.3728-2.3732 inches). Maximum allowable runout, measured at center journal, is 0.02 mm (0.001 inch). Bearings are available in 0.25, 0.51 and 0.76 mm (0.010, 0.020 and 0.030 inch) oversizes as well as standard size.

When regrinding crankshaft, journal fillet radius of 3.8-4.0 mm (0.150-0.160 inch) and flange fillet radius of 6.35 mm (0.250 inch) must be maintained.

114. REINSTALL. Bearing clearance should be 0.05-0.10 mm (0.002-0.004 inch) for both main and rod bearings. Be sure journals and bearings are clean and dry and use "Plastigage" on each bearing to accurately measure clearance.

Use suitable lubricant on all bearings during final assembly. Install thrust washers at each side of center main bearing making sure grooved side of washers face the crankshaft. Tighten main bearing cap retaining bolts to 217 N·m (160 ft.-lbs.) torque. Install new connecting rod cap locknuts and tighten to 68 N·m (50 ft.-lbs.) torque.

Crankshaft end play is determined by thickness of thrust washers installed at center main bearing. 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). Thrust washers are available in 0.13 and 0.51 mm (0.005 and 0.020 inch) oversizes.

Install rear oil seal and retainer as outlined in paragraph 116. Apply sealant to threads of flywheel mounting bolts, then tighten to 108 N·m (80 ft.-lbs.) torque. Complete installation by reversing the removal procedure.

CRANKSHAFT REAR OIL SEAL

Models 1190-1194-1290-1294-1390-1394-1490-1494

115. To renew rear oil seal, first remove old packing and clean grooves of retainers. Push new packing into groove of retainer using a smooth, round bar. Begin at the center and work outward to each end. Use a blunt tool to push protruding ends of packing below the joint face of retainer as shown in Fig. 94.

NOTE: Do not cut off ends of packing. The packings are made to correct length and leakage will occur if length is decreased.

Use a sharp knife or razor blade to trim loose fibers at ends of packings (Fig. 95). Repeat the procedure for the other half of retainer.

Position retainer halves on the crankshaft and tighten socket head screws to draw retainer halves together and seat the packings. Remove retainer assembly. Install gaskets on retainer halves using a light coat of gasket sealer on both sides of gaskets. Position upper retainer on cylinder block, but do not tighten mounting bolts. Apply small amount of gasket maker on mating faces of lower retainer half as shown in Fig. 96. Position lower retainer on cylinder block, but do not tighten mounting bolts.

Install socket head screws and tighten evenly to 20 N·m (15 ft.-lbs.) torque, then loosen each screw one half turn. Tighten retainer mounting bolts to 20 N·m (15 ft.-lbs.) torque, then retighten socket head screws to 20 N·m (15 ft.-lbs.) torque. Loosen the retainer mounting bolts, wait about 30 seconds, then retighten to 20 N·m (15 ft.-lbs.) torque.

Models 1594-1690

116. Press new oil seal into seal housing using special tool (DB-1163) with seal lip facing away from tool. Lubricate seal lip and crankshaft flange, then install seal and housing over end of crankshaft. Align bolt holes, install mounting bolts and tighten evenly.

ENGINE OIL FILTER

All Models

117. The engine oil filter is located on left side of cylinder block on all models. 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. Refer to CONDENSED SERVICE DATA section for crankcase oil capacity specifications.

OIL PAN

All Models

118. 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.

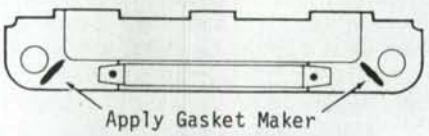


Fig. 96—Apply a small amount of Loctite 515 gasket maker on mating surfaces of lower seal retainer half in areas indicated.

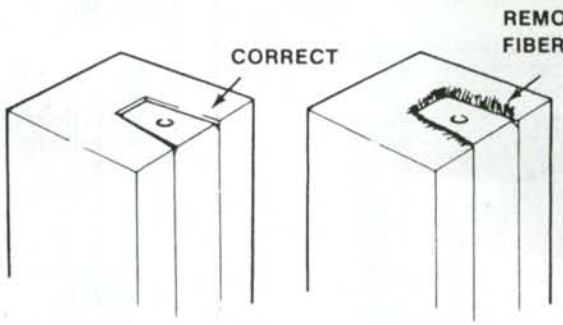


Fig. 95—Remove loose fibers from ends of crankshaft rear seal packing using a sharp knife or razor blade. DO NOT cut off ends of packing.

ENGINE OIL PUMP

Models 1190-1194

119. REMOVE AND REINSTALL. To remove oil pump, drain engine oil and remove oil pan. Disconnect and remove oil pressure tube. Remove pump locating screw from right side of cylinder block. Withdraw oil pump assembly from cylinder block being careful not to lose thrust spring from counterbore in top end of pump shaft.

NOTE: Injection pump drive shaft may fall out as oil pump is removed. Use caution to avoid damage to injection pump drive shaft. The injection pump must be removed to reinstall drive shaft.

Reinstall oil pump making certain thrust spring is located in top of oil pump shaft. Install injection pump drive shaft, if removed, with chamfer end up and install injection pump as outlined in paragraph 136. Install oil pan and tighten bolts to 27 N·m (20 ft.-lbs.) torque.

120. OVERHAUL. Disassembly of pump is obvious after examination of unit and reference to Fig. 97. When removing pressure regulator adjusting screw (10), count number of turns required to remove screw. The screw can then be reinstalled to original pressure setting.

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

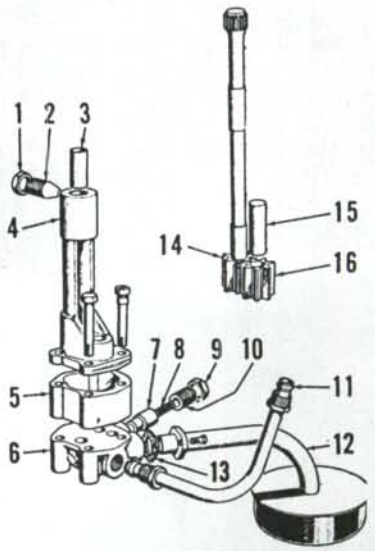


Fig. 97—Exploded view of oil pump used on three-cylinder engine showing component parts and their relative positions.

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

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. 97) is 12.458-12.509 mm (0.4905-0.4925 inch). Gear width must be 30.112-30.137 mm (1.1855-1.1865 inches) and gear housing depth must be 30.162-30.200 mm (1.1875-1.1890 inches).

Assemble drive shaft and driven gear (14—Fig. 97) in bracket (4). Install idler shaft (15) and idler gear (16). Use a dial indicator to measure backlash between pump gears. Backlash must be 0.51-0.66 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. 98. Install pump cover (6—Fig. 97) and tighten retaining bolts to 10 N·m (7 ft.-lbs.) torque. Remove cover (6) and check clearance. 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	41.27 mm (1.625 in.)
Test Length	33.33 mm (1.312 in.)
Test Pressure	20 N (4.5 lbs.)

Install relief valve plunger (7—Fig. 97), spring (8) and adjusting screw (10). Turn adjusting screw into cover (6) the same number of turns as noted at removal. If necessary, 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). One full turn of adjusting screw will result in a 41 kPa (6 psi) change in pressure. Tighten locknut (9) securely.

Models 1290-1294-1390-1394-1490-1494

121. REMOVE AND REINSTALL. To remove oil pump, first drain engine oil and remove oil pan. Disconnect and remove oil pressure tube. Remove pump locating screw from side of cylinder block, then withdraw oil pump.

To reinstall oil pump, reverse the removal procedure. Install oil pan and tighten mounting bolts to 27 N·m (20 ft.-lbs.) torque.

122. OVERHAUL. Disassembly of oil pump is obvious after examination of unit and reference to Fig. 99. Use a suitable puller to remove spiral gear (4) and driven gear (9) from drive shaft (6). Note number of turns required to remove relief valve adjusting screw (15) so it can be reinstalled to original setting.

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

To reassemble, press idler shaft (8—Fig. 99) 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 play. Use a feeler gage between face of spiral gear shoulder and top edge of bracket (7) to measure end play. Install bolts and pump body (11). Using a feeler gage inserted between mating gear teeth, measure backlash. Backlash should be 0.51-0.66 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 0.025-0.050 mm (0.001-0.002 inch). Place "Plastigage" on face of pump gears as shown in Fig. 98. Install pump cover (12) and tighten bolts to 12-15 N·m (9-11 ft.-lbs.) torque. Remove cover (12) and check clearance. 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.

Install relief valve plunger (13—Fig. 99), spring (14) and adjusting screw (15). Turn 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 below flange for pickup screen mounting bolt.

Models 1594-1690

123. REMOVE AND REINSTALL. To remove oil pump, it is necessary to first remove engine assembly as outlined in paragraph 76. Remove suction filter (28 or 30—Fig. 100), suction pipe and pressure pipe (7). Remove pump retaining bolts and withdraw oil pump.

Reinstall by reversing removal procedure. Tighten pump mounting bolts to 20 N·m (15 ft.-lbs.) torque.

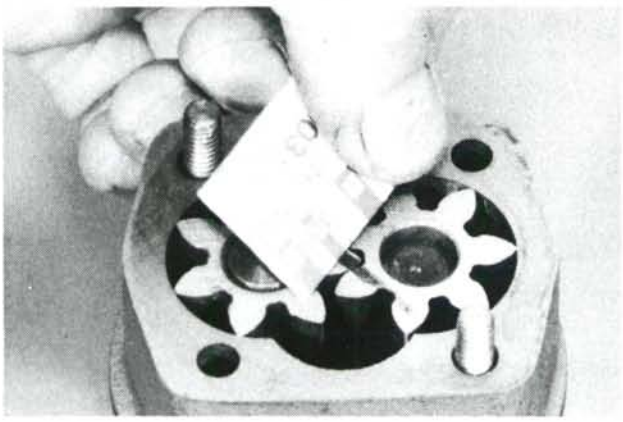


Fig. 98—View showing proper positioning of "Plastigage" when checking end clearance of oil pump rotors. Clearance must be within range of 0.025-0.089 mm (0.001-0.0035 inch).

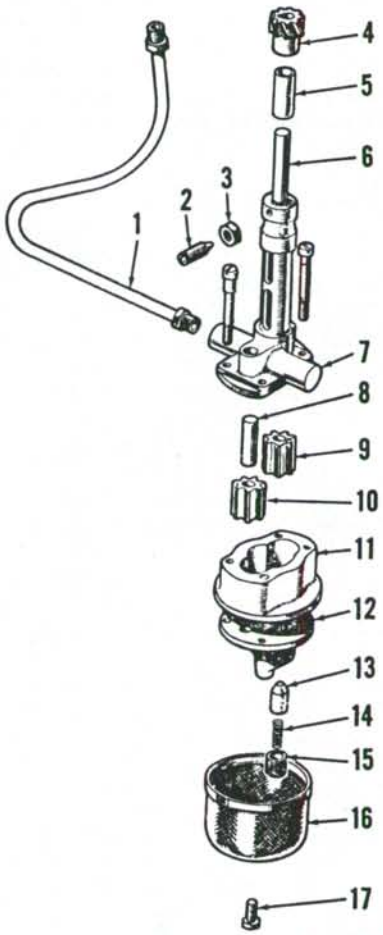


Fig. 99—Exploded view of oil pump used on four-cylinder engine showing component parts and their relative positions.

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. Suction screen
17. Screen retaining cap screw

124. OVERHAUL. Disassembly of pump is obvious after examination of unit and reference to Fig. 100.

Check all gears, bushings, shafts and housing wear surfaces for scoring, damage or excessive wear and renew as needed. Oil pump specifications are as follows:

Idler gear shaft diameter, gear end	25.35-25.37 mm (0.998-0.999 in.)
Idler gear bore	25.40-25.43 mm (1.000-1.001 in.)
Idler gear to shaft clearance	0.02-0.08 mm (0.001-0.003 in.)
Idler shaft end play	0.05-0.15 mm (0.002-0.006 in.)
Idler gear to oil pump gear backlash	0.18-0.27 mm (0.007-0.011 in.)
Housing depth	20.65-20.67 mm (0.813-0.814 in.)
Drive rotor bushing bores installed	15.62-15.64 mm (0.615-0.616 in.)
Drive rotor shaft diameter	15.545-15.59 mm (0.612-0.614 in.)
Rotor shaft to bushing clearance	0.03-0.08 mm (0.001-0.003 in.)
Rotor width	20.59-20.61 mm (0.810-0.811 in.)
Rotor end play	0.025-0.08 mm (0.001-0.003 in.)
Rotor teeth backlash	0.40-0.50 mm (0.016-0.020 in.)
Rotor teeth to body clearance	0.08-0.13 mm (0.003-0.005 in.)

Lubricate all parts with oil during assembly. Tighten pump body throughbolts to 20 N·m (15 ft.-lbs.) torque. Install pump drive gear using a new locknut.

When assembling pressure relief valve, turn the adjusting screw in until end of screw protrudes 9.92 mm (0.390 inch) from housing (A—Fig. 101). Install locknut and tighten securely.

Engine oil pressure should be approximately 205 kPa (30 psi) at 700 rpm and 275-345 kPa (40-50 psi) at 1800 rpm with engine at operating temperature.

FLYWHEEL

All Models

125. To remove flywheel, first separate tractor between engine and transmission as outlined in appropriate paragraph 217 or 218. Remove clutch assembly and flywheel.

Starter ring gear is installed from front side of flywheel. Heat new gear until gear will slip onto flywheel, but do not heat to more than 225°C (420°F). Be sure gear is seated squarely against shoulder of flywheel.

Inspect pilot bearing for roughness and wear and renew if necessary.

On Models 1594 and 1690, apply sealant to threads of flywheel mounting bolts and tighten bolts to 108 N·m (80 ft.-lbs.) torque. On all other models, install mounting bolts dry and tighten to 68 N·m (50 ft.-lbs.) torque.

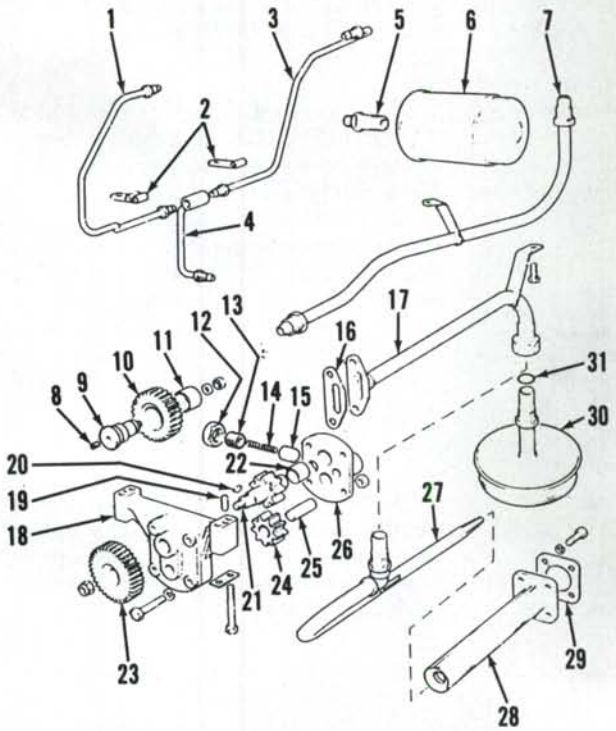


Fig. 100—Exploded view of oil pump used on six-cylinder engine showing component parts and their relative positions.

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. Driven 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

TURBOCHARGER

A Holset 3501259 or Schwitzer L 185221 turbocharger is used on Model 1490. A Schwitzer 310335 turbocharger is used on Models 1394 and 1494.

All Models So Equipped

126. 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.

Prime the turbocharger as follows: With fuel shut-off control in "STOP" position, crank engine with starter until engine oil pressure light goes out. Do not operate starter motor longer than 30 seconds without interruption to avoid overheating. Start engine and operate at 1000 rpm for about two minutes to ensure proper lubrication before increasing speed.

127. INSPECTION. Always determine cause of turbocharger failure before installing new 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 overextended service intervals. Shaft end play must be within

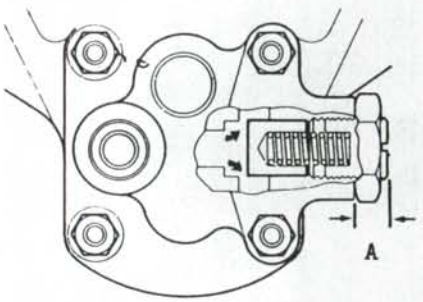


Fig. 101—On six-cylinder engine oil pump, turn relief valve adjusting screw in until end of screw is 9.92 mm (0.390 inch) from pump body as shown at (A).

range of 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 result of overfueling, overloading 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 overextended 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.

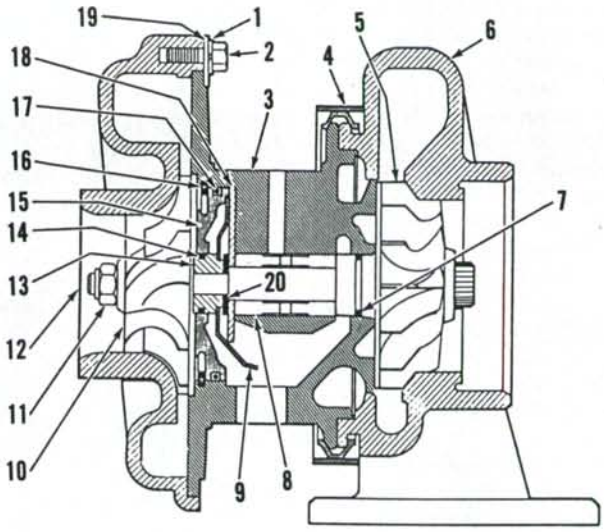


Fig. 103—Sectional view of Schwitzer turbocharger showing component parts and their relative positions.

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

128. OVERHAUL HOLSET TURBOCHARGER. Remove turbocharger unit as outlined in paragraph 126. Mark compressor cover, center housing, turbine housing and clamp positions for reassembly. Remove clamp (6—Fig. 102) 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.

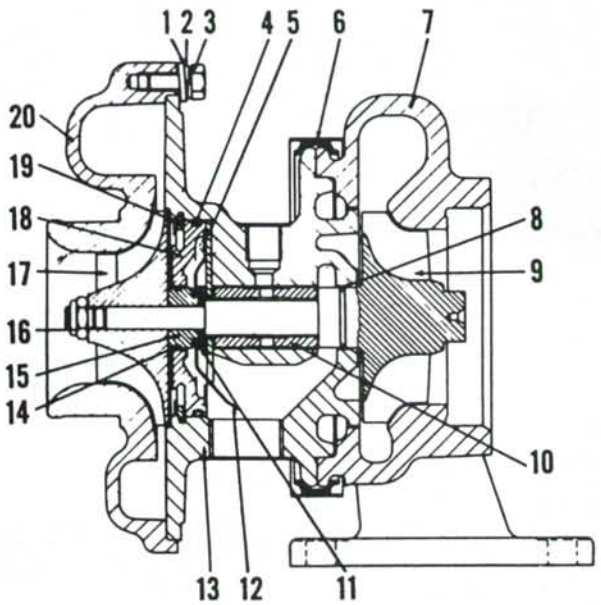


Fig. 102—Sectional view of Holset turbocharger showing component parts and their relative positions.

1. Washer
2. Lockwasher
3. Special screw
4. "O" ring
5. Thrust plate
6. "V" clamp
7. Turbine housing
8. Seal 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

Inspect all parts and renew as needed. See paragraph 127. **NEVER** attempt to straighten any bent parts.

Use care to not overexpand ring (8—Fig. 102) 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 (160 in.-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 (120 in.-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 (60 in.-lbs.) torque.

129. OVERHAUL SCHWITZER TURBOCHARGER. Remove turbocharger as outlined in paragraph 126. Mark compressor cover, bearing housing and turbine housing for reassembly. Clamp turbocharger mounting flange (exhaust inlet) in vise and remove cap screws (2—Fig. 103), 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. 103) 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 127. **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 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 (160 in.-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 (120 in.-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 (60 in.-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 system, maintenance of absolute cleanliness is of the utmost importance. Of equal importance is avoidance of nicks or burrs on any working parts.

FUEL FILTERS

All Models

130. 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. 104) 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. 104) 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 131.

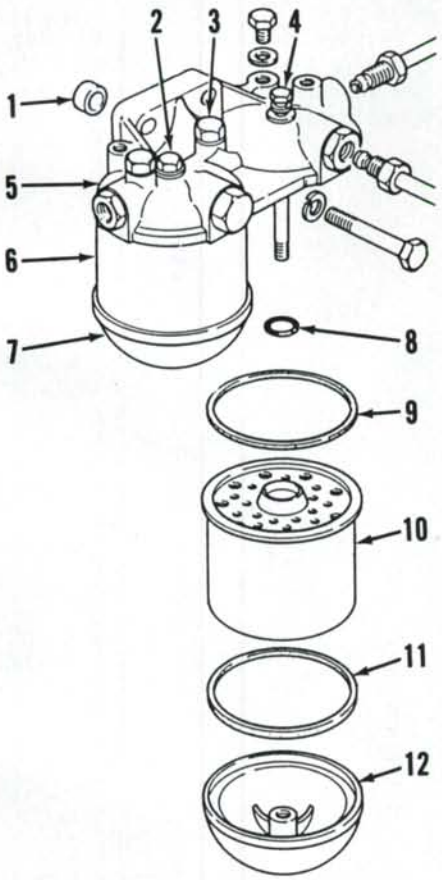


Fig. 104—View of typical fuel filter arrangement used on all models.

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

131. BLEEDING SYSTEM. Make sure fuel tank contains at least 10 L (2½ gallons) of fuel. Loosen filter bleed screw (1—Fig. 105 or 106), then operate primer pump lever (3) until air-free fuel flows from bleeder screw. Note that it may be necessary to rotate crankshaft to reposition primer pump actuating cam in order to manually operate primer pump. Tighten filter bleed screw and loosen injection pump bleed screws (2). Actuate primer pump lever until air-free fuel flows from bleed screws, then retighten bleed screws.

If engine fails to start at this point, loosen high pressure fuel line connections at injectors. Place fuel shut-off control in "RUN" position and move throttle to full speed position. Crank engine with starter until fuel is discharged from injection lines. Tighten fuel line connections, then start engine.

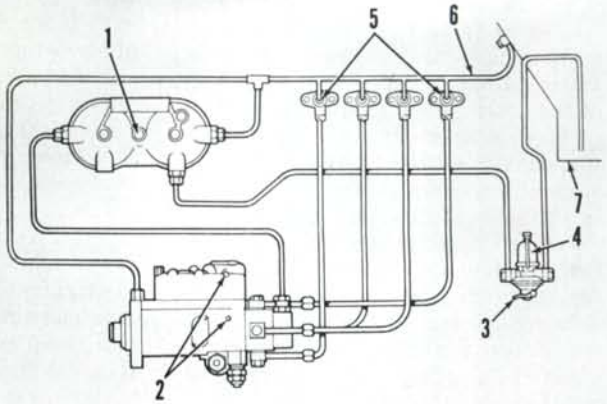


Fig. 105—View of fuel system used on four-cylinder engines. Three-cylinder engine system is similar except injection pump is mounted vertically.

1. Filter bleed screw
2. Injection pump bleed screws
3. Primer pump lever
4. Sediment bowl
5. Injectors
6. Fuel return line
7. Fuel tank

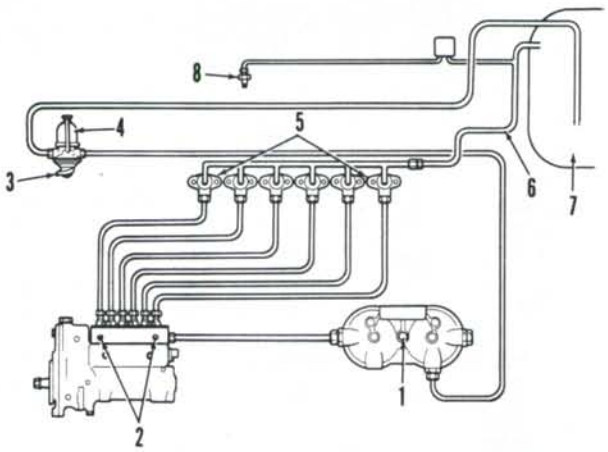


Fig. 106—View showing typical fuel system for six-cylinder engine. Refer to Fig. 105 legend except for thermostart unit (8).

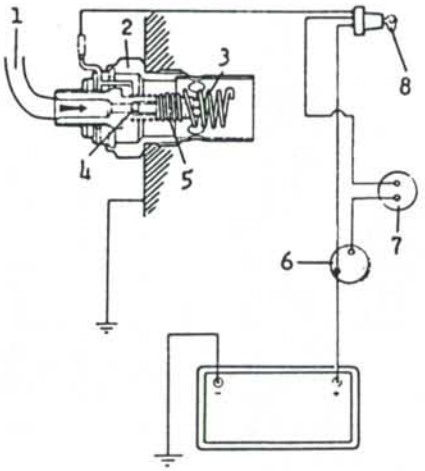


Fig. 107—Diagram of typical thermostart unit showing component parts and their relative positions.

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

THERMOSTART SYSTEM

All Models

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

System consists of a fuel reservoir connected to fuel return line, thermostart unit located in intake manifold and a switch which is an integral part of the starter switch. See Fig. 107.

When starter key (8—Fig. 107) 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 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 ether 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.

133. 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 while 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 SUPPLY PUMP

All Models

134. Fuel supply (transfer) pump is actuated by a lobe on engine camshaft via a short push rod running in a bore in cylinder block. Pump service consists of renewing diaphragm (6—Fig. 108).

Before disassembling pump, scribe alignment marks on pump cover (5) and body (7) to ensure proper reassembly. Push down on diaphragm (6) and rotate 90 degrees in either direction to remove diaphragm.

When reassembling, lift priming lever to compress spring as cover screws are tightened. Be sure marks made during disassembly are aligned.

Tighten pump mounting bolts to 20 N·m (15 ft.-lbs.) torque. Bleed air from system as outlined in paragraph 131.

FUEL INJECTION PUMP

Models 1190-1194

135. PUMP TIMING. Provided injection pump drive gear to camshaft timing (paragraph 93) 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. 109. If pump drive gear has been removed, refer to paragraph 137.

Refer to table in Fig. 115 for injection pump timing specifications in degrees and corresponding piston travel before top dead center.

136. REMOVE AND REINSTALL INJECTION PUMP. Disconnect throttle and fuel shut-off controls. Thoroughly clean pump, lines and surrounding area. Remove fuel injector 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 in top end of oil pump shaft. Insert splined drive shaft in drive gear with chamfered end up. Install injec-

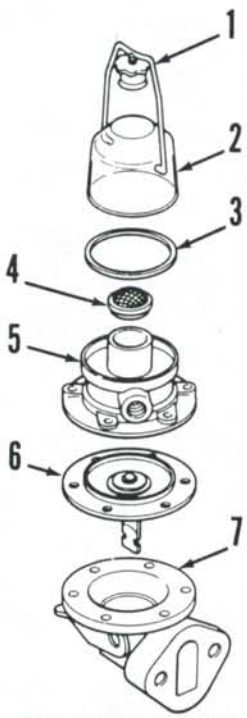


Fig. 108—Exploded view of fuel transfer pump used on all models.

1. Bowl clamp
2. Bowl
3. Gasket
4. Filter screen
5. Cover
6. Diaphragm
7. Pump body

tion pump aligning timing marks as shown in Fig. 109, and tighten pump retaining nuts. Reconnect fuel lines leaving injector line connections loose at injectors. Install throttle and stop controls, then bleed air from system as outlined in paragraph 131.

137. INJECTION PUMP DRIVE GEAR. To remove drive gear (10—Fig. 110) and housing assembly, first remove injection pump, splined drive shaft and drive shaft thrust spring as outlined in paragraph 136. Lift gear and housing assembly from cylinder block.

If drive gear (14) on camshaft is to be renewed, refer to paragraph 97.

To remove drive gear from housing, remove snap ring (6—Fig. 110) 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. 110) first, then install snap ring (8) with chamfered edge downward. See Fig. 111. Press new needle roller bearing (9—Fig. 110) 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. 110) into housing assembly and install snap ring (6) with chamfered edge downward. See Fig. 112.

To install gear and housing assembly, first turn crankshaft so No. 1 piston is at TDC on compression stroke. Install gear and housing with master spline at "4 o'clock" position (A—Fig. 113). As gear meshes with drive gear on camshaft, master spline should move to position (B) between "6 o'clock" and "7 o'clock".

With injection pump drive gear properly meshed with camshaft gear, reinstall splined drive shaft and injection pump as outlined in paragraph 136.

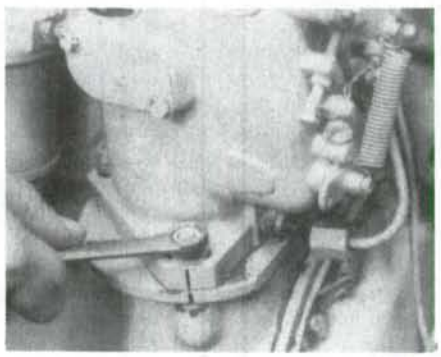


Fig. 109—View showing timing mark alignment on fuel injection pump for 1190 and 1194 models.

Models 1290-1294-1390-1394-1490-1494

138. PUMP TIMING. Injection pump drive gear is timed to pump shaft by a dowel pin. Providing mesh position of engine timing gears is correct (paragraph 94), injection pump is properly timed when timing marks on pump flange and engine front plate are aligned as shown in Fig. 114.

If pump timing mark accuracy is in doubt, injection timing should be checked using static timing specifications and corresponding piston travel before top dead center (BTDC) specifications listed in table shown in Fig. 115.

139. REMOVE AND REINSTALL INJECTION PUMP. Clean timing gear cover, injection pump, fuel lines and surrounding area. Drain coolant from radiator, then remove lower radiator hose Remove pump drive gear cover plate from timing gear cover. Rotate crankshaft until single timing mark on injection pump drive gear is aligned with double timing marks on idler gear. Bend tab washer and remove pump gear retaining bolts. Disconnect throttle and fuel shut-off controls from pump. Disconnect injector lines, fuel supply line and fuel return line from injection pump. Cap all openings. Remove pump mounting bolts and withdraw pump. The pump drive gear will remain in the timing gear cover.

NOTE: Once injection pump is removed, do not turn crankshaft as damage to gears or timing gear cover could result.

To reinstall injection pump, first make certain idler gear and pump drive gear timing marks are still correctly aligned. Install pump, aligning slot in pump shaft with dowel in gear. Align marks on pump flange and engine front plate (Fig. 114), then tighten pump

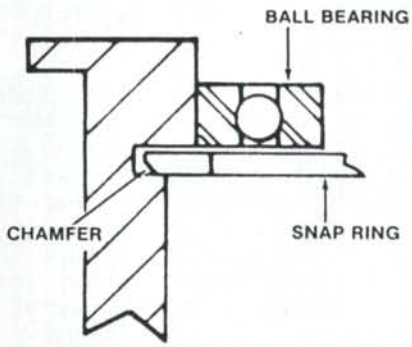


Fig. 111—View showing proper installation of snap ring retaining ball bearing in injection pump drive housing used on three-cylinder engines.

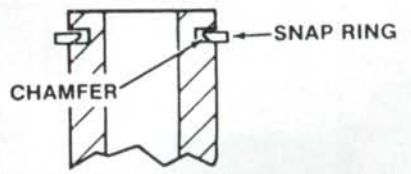


Fig. 112—When reinstalling drive gear in injection pump drive housing, install snap ring with chamfered edge downward.

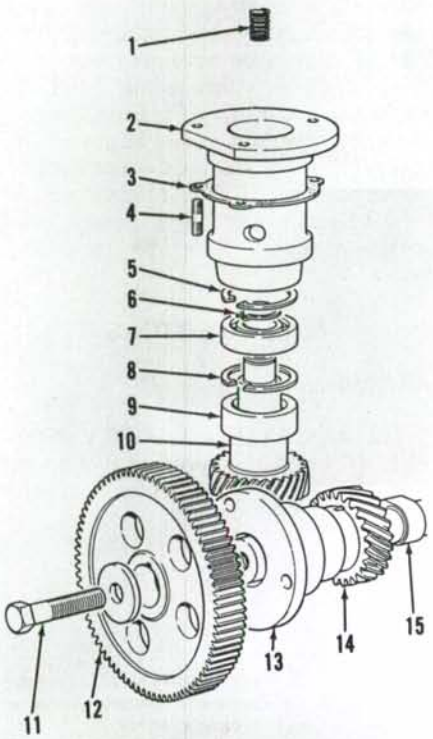


Fig. 110—Exploded view showing three-cylinder diesel fuel injection pump drive assembly and related parts.

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

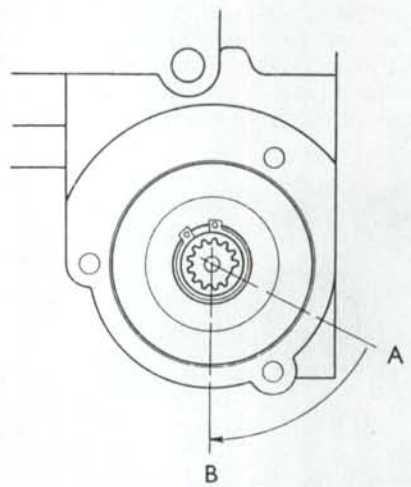


Fig. 113—View showing "4 o'clock" position (A) and "6 o'clock" assembly position (B) used in injection pump drive gear installation on Models 1190 and 1194. Refer to text.

mounting bolts to 20 N·m (15 ft.-lbs.) torque. Tighten gear retaining bolts to 27 N·m (20 ft.-lbs.) torque and bend tab washer to secure. Complete installation by reversing removal procedure. Bleed air from system as outlined in paragraph 131.

Models 1594-1690

140. PUMP LUBRICATION. The inline injection pump used on these models contains an oil reservoir for lubrication of pump rotating parts. The oil must be drained and renewed after every 100 hours of operation when engine oil is changed. Recommended oil is same grade and viscosity as used in engine. Add oil through fill plug (Fig. 116) until it flows from level plug opening.

141. PUMP TIMING. Pump drive gear is keyed to injection pump shaft. Providing mesh position of engine timing gears is correct, injection pump is properly timed when marks on pump and timing gear case are aligned in similar manner as marks in Fig. 114.

Refer to table in Fig. 115 for pump static timing specifications in crankshaft degrees and corresponding piston travel before top dead center.

TRACTOR MODEL	STATIC TIMING BTDC	PISTON TRAVEL BTDC
1190 and 1194	16°	2.832 mm (0.1115 in.)
1290 Prior to P.I.N. 11052369	17°	2.771 mm (0.1091 in.)
1290 P.I.N. 11052369 and After, 1294 and 1390	17°	3.195 mm (0.1258 in.)
1490 Prior to P.I.N. 11414528	10°	3.980 mm (0.1567 in.)
1490 P.I.N. 11414528 and After, 1394 and 1494	20°	4.850 mm (0.1910 in.)
1594 and 1690	25°	6.817 mm (0.2684 in.)

Fig. 115—Injection pump timing specification table.

142. REMOVE AND REINSTALL INJECTION PUMP. Turn crankshaft 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 lines, supply lines and return lines. Cap all openings. Remove pump retaining nuts and remove pump.

NOTE: Do not turn crankshaft after removing injection pump.

To reinstall pump, first make certain idler gear and pump drive gear are positioned as marked at disassembly. Install pump aligning key in pump shaft with slot in gear. Align timing marks on pump flange and timing gear case, then tighten pump retaining nuts. Tighten drive gear retaining nut to 61 N·m (45 ft.-lbs.) torque and bend tab washer to secure nut. Complete installation by reversing removal procedure. Bleed air from system as outlined in paragraph 131. Check lubricating oil level in pump and fill to proper level with engine oil. Refer to paragraph 140.

FUEL INJECTORS

All Models

143. LOCATING FAULTY NOZZLE. If rough or uneven engine operation or misfiring indicates a faulty injector, check for defective unit as follows: Run engine at speed that defect is most noticeable, then loosen high pressure fuel line connection at each injector in turn and note any change in engine operation. The faulty unit is the one that least affects running of the engine.

If a faulty injector is found and considerable time has elapsed since injectors have been serviced, it is recommended that all injectors be removed and serviced.

144. 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, then remove injectors. Remove sealing washers.

Clean nozzle recesses in cylinder head using care not to damage seating surfaces. Renew sealing washer, coat injector body and nozzle retaining cap with heat resistant antiseize compound and insert carefully into cylinder head. Tighten nozzle holder stud nuts evenly to 20 N·m (15 ft.-lbs.) torque. Reinstall all fuel lines, but leave high pressure line connections loose at injectors. With fuel shut-off control in RUN position, crank engine with starter until fuel is discharged from injector lines. Tighten fuel line connections and start engine.

145. NOZZLE TESTING. A complete job of testing and adjusting fuel injectors requires use of special test equipment. Use only clean approved testing oil in tester tank. The nozzle should be checked for opening pressure, seat leakage, back leakage and spray pattern.

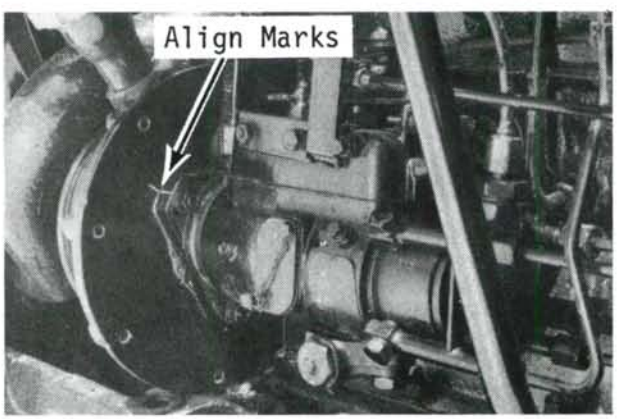


Fig. 114—On four-cylinder engines, injection pump is properly timed to engine when marks on pump flange and engine front plate are aligned.

CAUTION: Fuel leaves nozzle tip with sufficient force to penetrate the skin. Keep unprotected parts of body clear of nozzle tip when testing.

146. OPENING PRESSURE. Connect injector to tester and operate lever several times to purge air from nozzle and to make sure nozzle valve is not stuck. Operate tester lever slowly and observe pressure at which injection spray occurs. Opening pressure for a new injector should be 18750 kPa (2720 psi). Opening pressure for a used injector should be 17650 kPa (2560 psi). Maximum allowable pressure variation between injectors is 690 kPa (100 psi).

To adjust nozzle opening pressure, remove top cap nut (1—Fig. 117) and turn adjusting screw (3) until specified opening pressure is obtained.

NOTE: When adjusting an overhauled injector with a new pressure spring (5), set pressure to new injector specifications to allow for initial pressure loss as spring takes a set.

147. SEAT LEAKAGE. Wipe nozzle tip dry, then operate tester lever slowly to maintain pressure at 1000 kPa (145 psi) below nozzle opening pressure. If fuel appears on nozzle tip within a period of five seconds, nozzle is leaking and must be overhauled or renewed.

148. BACK LEAKAGE. Operate tester lever slowly until pressure reading is slightly below opening pressure. Release tester lever and note time taken as pressure falls from 14755 kPa (2140 psi) to 9860 kPa (1430 psi). The time must be between 6 and 25 seconds. Note that a leaking tester will show up in this test as excessively fast leakback. If all nozzles fail to pass this test, tester rather than nozzles should be suspected.

149. SPRAY PATTERN. Operate tester lever several times at approximately one stroke per second and observe spray pattern. Four finely atomized, equally spaced and shaped sprays should emerge from nozzle tip. If pattern is uneven, ragged or a solid spray, overhaul or renew nozzle.

150. 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. Soak injectors in approved carbon cleaning solvent, if necessary, to loosen hard carbon deposits. Rinse injectors in clean diesel fuel after cleaning with solvent. Never use steel wire brush, emery cloth or hard or sharp tools to clean injectors.

To disassemble injector, clamp body in holding fixture or soft jawed vise with only enough pressure to keep injector from slipping. Remove cap (1—Fig. 117) and washer (2). Some 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 from retaining cap and needle (9) from nozzle. Place in approved cleaning solvent. Remove adjusting screw (3), using care not to lose washer (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

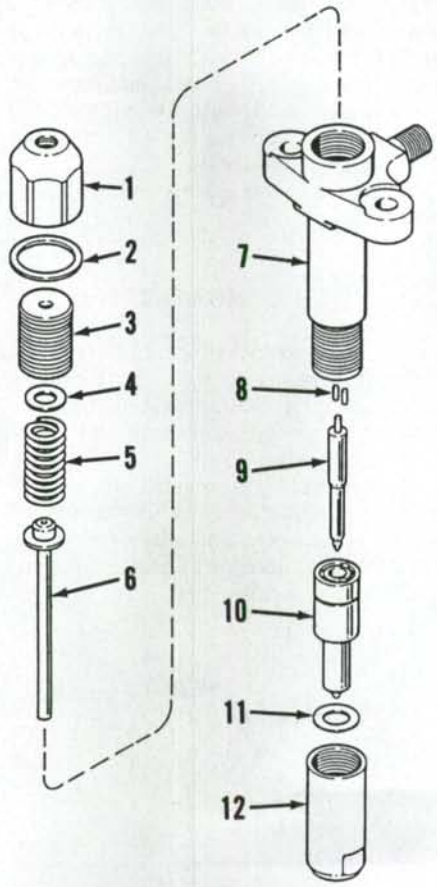


Fig. 117—Exploded view of typical fuel injector used on all models.

1. Cap nut
2. Copper washer
3. Adjusting screw
4. Washer
5. Spring
6. Spindle
7. Body
8. Dowels
9. Needle
10. Nozzle
11. Washer
12. Nozzle retaining cap

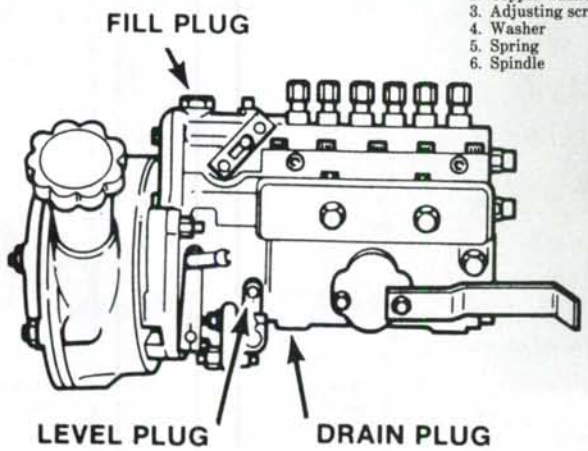


Fig. 116—View showing location of filler plug, oil level plug and drain plug on inline injection pump used on six-cylinder engines.

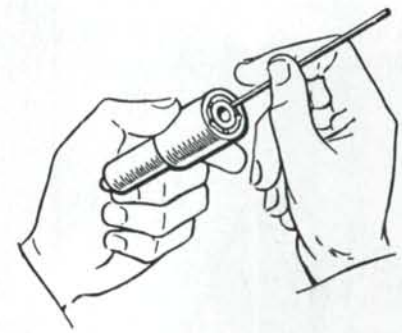


Fig. 118—Clean small feed channel bores with drill or wire as shown. These bores are rarely choked and insertion of drill or wire by hand will be sufficient.

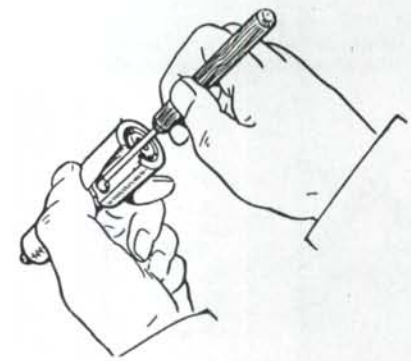


Fig. 119—Insert special groove scraper until hooked nose of scraper enters fuel gallery. Press scraper hard against side of gallery and rotate nozzle to clear any carbon deposit from this area.

heat discoloration. Clean small feed channel bores using a small wire as shown in Fig. 118. 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. 119. While pressing seat scraper against needle seat, rotate scraper and clean carbon off seat as shown in Fig. 120. Remove carbon from dome cavity with dome cavity cleaner as shown in Fig. 121. 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 as removal is often impossible. Clean orifices as shown in Fig. 122.

Clean all parts using clean diesel fuel and install needle (9—Fig. 117) into nozzle (10). Needle should slide freely by its own weight to bottom of nozzle body. If needle sticks, reclean or renew nozzle valve assembly.

Place washer (11), if so equipped, on nozzle. Position nozzle on injector body (7) engaging dowels (8) in holes in nozzle. Install retaining cap (12) and tighten securely. Place spindle (6) in injector body and install spring (5), washer (4) and adjusting screw (3).

Connect injector to tester and set opening pressure and check operation as outlined in NOZZLE TESTING paragraphs.

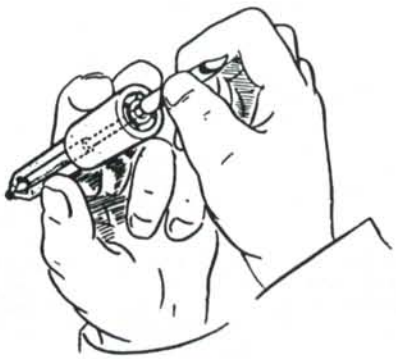


Fig. 120—Use a seat scraper to clean all carbon from needle seat in tip of nozzle by rotating scraper while pressing it against seat.

Fig. 121—Remove any carbon from dome (tip) cavity with dome cavity cleaner as shown.

COOLING SYSTEM

RADIATOR

All Models

151. REMOVE AND REINSTALL. Drain radiator and remove complete engine cover assembly, 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. Some models 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

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

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

Fig. 122—Use a pin vise and proper size cleaning wire to probe all carbon from the four injection spray holes in each nozzle tip.

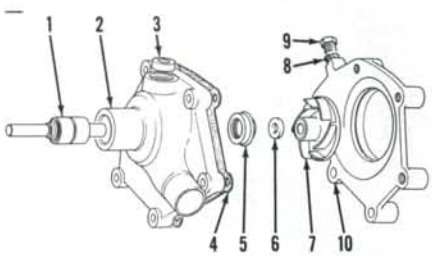


Fig. 123—Exploded view of typical water pump showing component parts and their relative positions. Pump body design varies, but basic assembly is the same.

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

Standard thermostat should begin to open at 79°-83°C (174°-181°F) and should be fully open at 93°-96°C (199°-205°F).

WATER PUMP

All Models

153. 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. On Models 1594 and 1690, tighten pump mounting bolts to 20 N·m (15 ft.-lbs.) torque. On all other models, tighten pump and fan mounting bolts to 34 N·m (25 ft.-lbs.) torque.

154. OVERHAUL. To disassemble water pump, first note position of pump shaft in pulley for proper reassembly. Using a suitable puller or press, remove pulley from pump shaft. Separate impeller housing (10—Fig. 123) from pump body (2). Press bearing and shaft assembly (1) forward out of impeller (7) and pump body. Remove seal ring (6) and seal (5) from pump body.

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

To reassemble, press bearing and shaft assembly into body from the front with smaller diameter end of shaft entering housing first. Press against outer race only of bearing until end of bearing is flush with outer face of housing as shown in Fig. 124. Support impeller end of shaft, then press pulley onto shaft to same position noted during disassembly. Install new seal (5—Fig. 123)

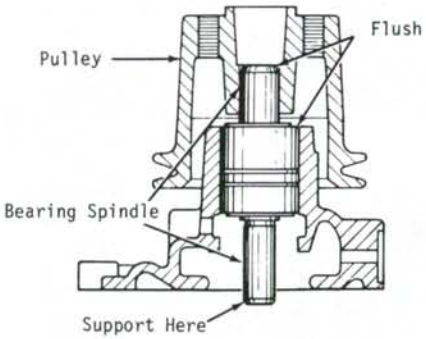


Fig. 124—Outer end of pump shaft bearing should be flush with face of water pump body. Pulley installation shown is for all models except 1594 and 1690.

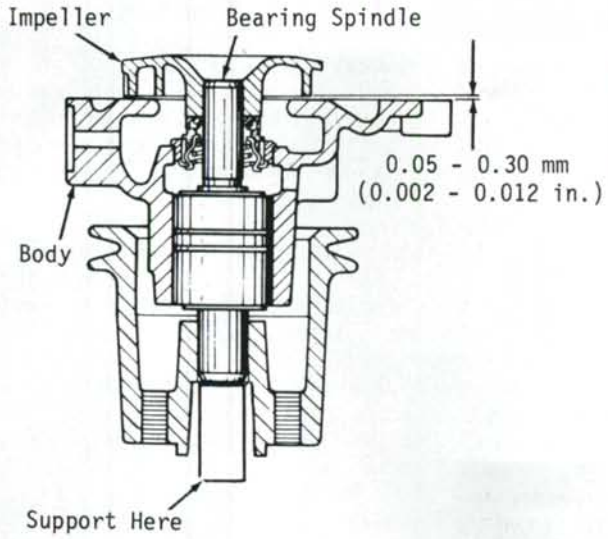


Fig. 125—Support pulley end of shaft, then press impeller onto shaft until desired clearance between impeller and body is obtained.

and seal ring (6) with smooth sealing surfaces facing together. Support pump shaft at pulley end (Fig. 125), then press impeller onto shaft until clearance between body and impeller is 0.05-0.30 mm (0.002-0.012 inch). Rotate pulley to assure smooth operation. Install body on impeller housing.

ELECTRICAL SYSTEM

BATTERY

All Models

155. 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 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, it should be recharged to rated level using an external battery charger. Failure to do so can cause alternator to overheat resulting in premature failure of alternator, regulator or both.

156. 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 an ammeter lead to negative battery post and the other lead to negative cable end. Make sure all electrical systems are off. Any reading on ammeter indicates current leakage. Check for lights, radio or accessories being on, or shorted electrical wiring or components.

CHARGING SYSTEM

All Models

157. TESTING. Prior to beginning test, be sure battery is fully charged, all connections are clean and tight and alternator 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 158.

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 158.

158. 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

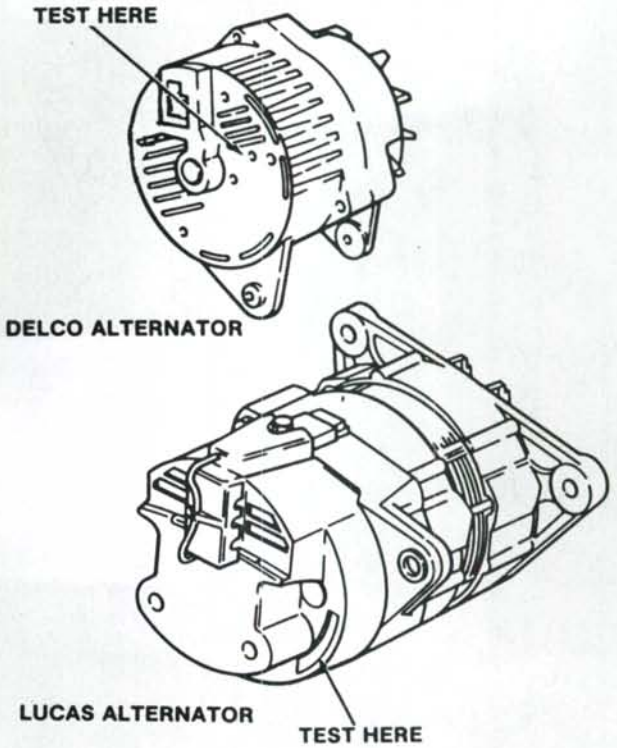


Fig. 126—View showing test hole location for bypassing voltage regulator. Refer to paragraph 160.

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 159. 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 159.

159. ALTERNATOR VOLTAGE OUTPUT TEST. Make certain all wiring connections are in place, then connect voltmeter positive lead to **BAT** terminal of alternator 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, bypass regulator and check as outlined in paragraph 160. Voltage in excess of 15 volts indicates either a grounded brush inside alternator or faulty voltage regulator. Repair as necessary.

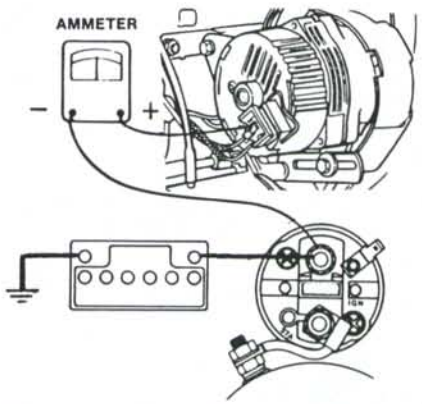


Fig. 127—View showing proper installation of ammeter for performing amperage output test. Refer to paragraph 161.

160. VOLTAGE REGULATOR BYPASS TEST. With voltmeter connected as outlined in paragraph 159, 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. 126. If voltage before bypassing regulator was not between 13 and 15 volts, but is between 13 and 15 volts while regulator is being bypassed, renew voltage regulator. If voltage fails to be between 13 and 15 volts while bypassing regulator, remove alternator and overhaul as outlined in paragraphs for appropriate model.

161. ALTERNATOR AMPERAGE OUTPUT TEST. Disconnect brown wires from alternator and connect ammeter in alternator output circuit as shown in Fig. 127. Start and run engine at full rated speed. Turn on all lights and accessories, then check ammeter reading.

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

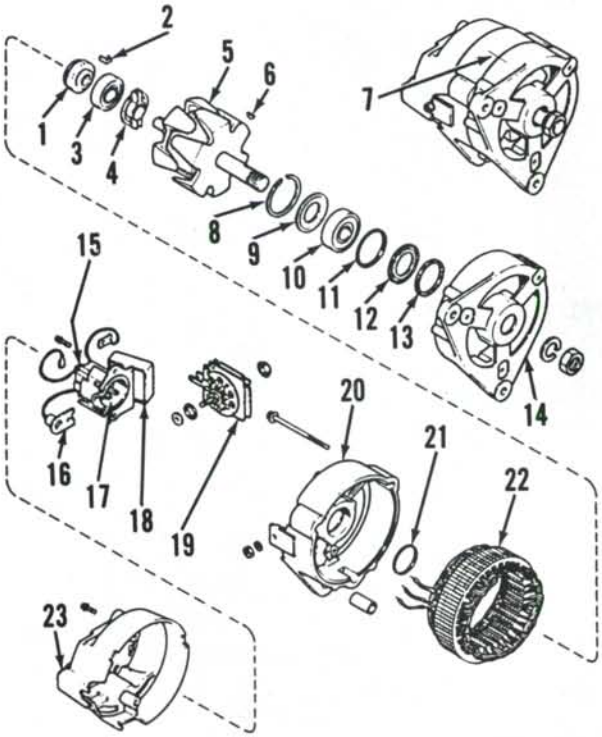


Fig. 128—Exploded view of standard-duty Lucas alternator showing component parts and their relative positions.

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 assy.
20. Housing
21. Pressure ring
22. Stator
23. Cover

ALTERNATOR

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

Both Lucas and AC Delco alternators used have nonadjustable internal type voltage regulators.

Lucas Standard Duty Alternator

162. DISASSEMBLY. Scribe locating marks on alternator housings (7—Fig. 128), then 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, then 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).

163. 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.

164. ROTOR WINDING TESTS. Check rotor winding continuity and resistance simultaneously by connecting a battery operated ohmmeter (Fig. 129) 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. 130. If test light comes on, rotor should be renewed.

165. STATOR WINDING TESTS. Short circuiting between windings is

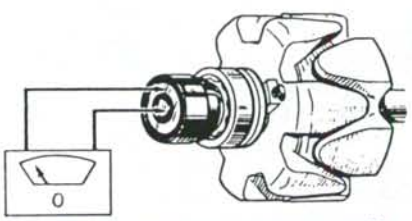


Fig. 129—View showing proper connection of ohmmeter to slip ring for resistance check. Refer to paragraph 164.

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. 131. 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. 132. If test light comes on, stator is short circuited and must be renewed.

166. 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 liqht. 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. 133. 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.

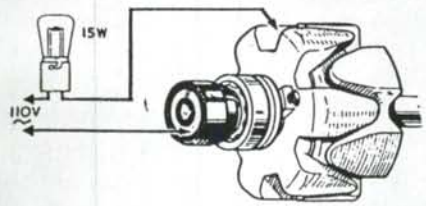


Fig. 130—Check rotor winding for short circuit to body using test light as outlined in paragraph 164.

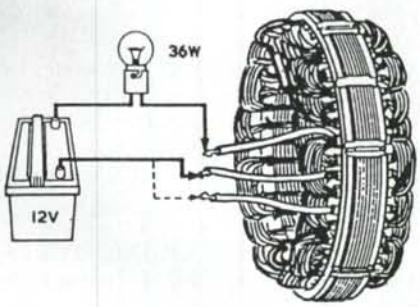


Fig. 131—Continuity check of stator winding using 30 watt test light. Refer to paragraph 165.

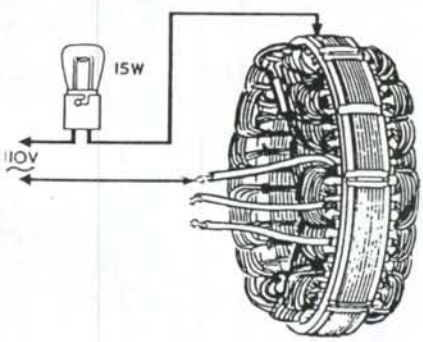


Fig. 132—When using 15 watt test light to check insulation of stator winding, connect one lead to stator body and remaining lead to 110 volt power source. Connect 110 volt lead to each stator lead separately. Refer to paragraph 165.

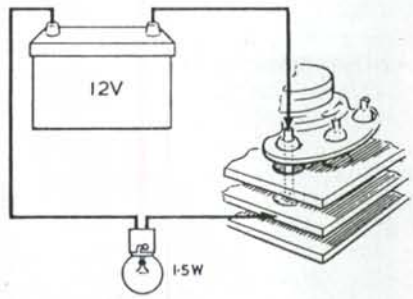


Fig. 133—To check diode in rectifier, connect test light as shown and refer to paragraph 166.

167. REASSEMBLY. Note that 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 realign scribe marks when joining housing halves.

Lucas Heavy-Duty Alternator

168. DISASSEMBLY. Scribe locating marks on alternator housings, then remove cover (3—Fig. 134). 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

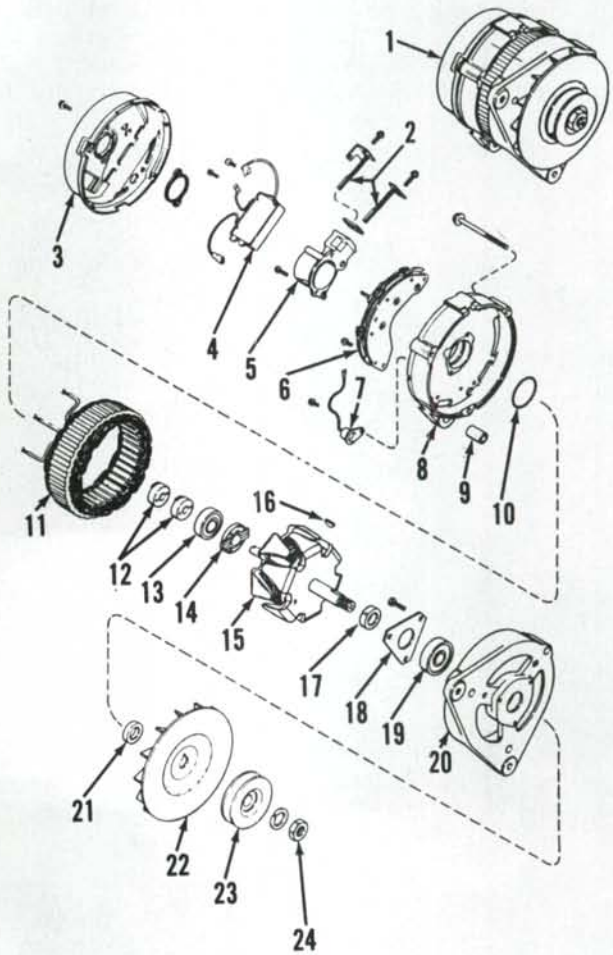


Fig. 134—Exploded view of heavy-duty Lucas alternator used on models having cab or high electrical requirements.

1. Alternator assy
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 rings
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

bearing (13) and seal (14). Remove stator (11) from rear housing (8).

169. 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.) 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.

170. 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.

171. STATOR WINDING TESTS. Test stator windings as outlined in paragraph 165.

172. DIODE TESTS. Note that rectifier assembly construction is different, but basic testing procedures are the same as for standard duty Lucas alternators. Locate individual diode leads and test rectifier assembly and surge

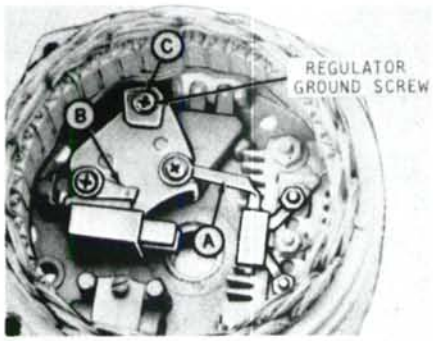


Fig. 136—Screws at "A" and "B" connections must use insulating washers. Screw at "C" is a ground connection.

(isolation) protection diodes as outlined in paragraph 166.

173. REASSEMBLY. Note that 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 realign scribe marks when joining housing halves.

Delco Alternator

174. DISASSEMBLY. Scribe alignment marks across alternator housings to ensure proper reassembly. Remove housing retaining bolts, then separate drive end housing (2—Fig. 135) and rotor (6) from rear housing (10). Remove retaining nut, pulley and fan from rotor shaft and withdraw rotor from housing. Remove retainer plate (4) and bearing (3). Note location of insulating washers under screws at "A" and "B" connections (Fig. 136) at brush holder, then remove retaining screws and nuts. Remove diode trio (8—Fig. 135), brush holder (11), regulator (12) and rectifier assembly (9). Press needle bearing (13) inward to remove from housing.

175. 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 0.05 mm (0.002 inch) or if surface is scored, surfaces may be trued on a lathe. Finish with 400 grit (nonmetallic) sandpaper or polishing cloth until scratches or machine marks are removed.

176. 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.

177. STATOR WINDING TESTS. Test stator as outlined in paragraph 165.

178. DIODE TESTS. To test diode trio (8—Fig. 135), connect a battery operated ohmmeter lead to diode trio at "D", Fig. 137 and remaining lead to

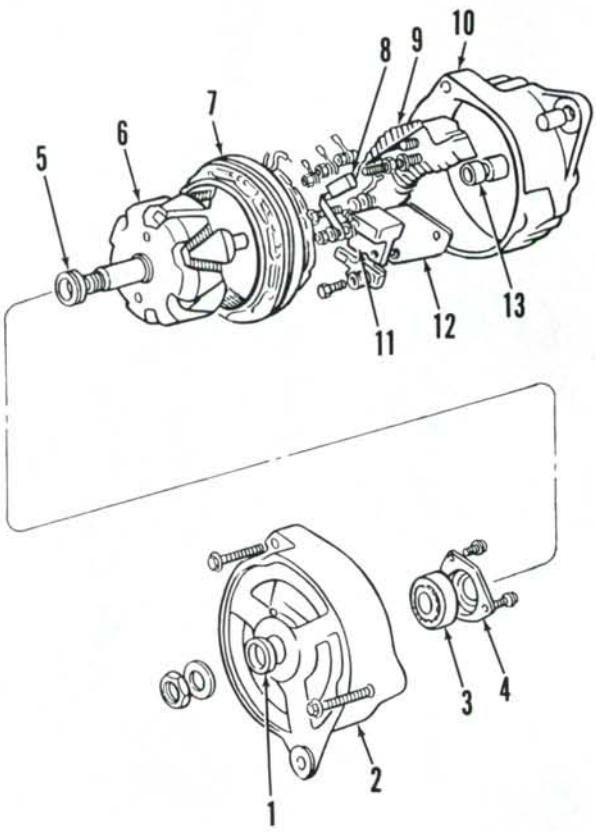


Fig. 135—Exploded view of Delco alternator used on some tractors.

1. Spacer
2. Housing
3. Bearing
4. Retainer plate
5. Spacer
6. Rotor
7. Stator
8. Diode trio
9. Rectifier bridge assy.
10. Housing
11. Brush holder
12. Regulator
13. Bearing

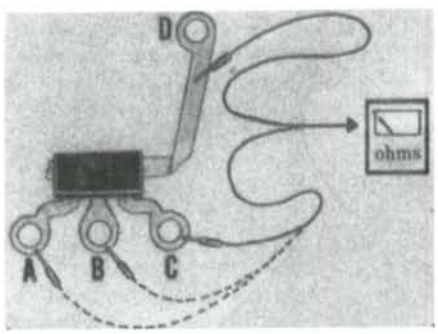


Fig. 137—Connect ohmmeter as shown to test diode trio as outlined in paragraph 178.

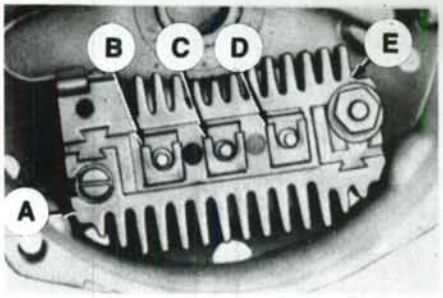


Fig. 138—Rectifier bridge has a grounded mounting screw "A" and an insulated screw "E" which is connected to output terminal. "B", "C" and "D" are individual diode leads.

"A", "B" and "C" in succession, noting ohmmeter reading at each connection. Reverse ohmmeter connections 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 diode trio assembly.

The rectifier bridge (Fig. 138) has a grounded heat sink (A) and an insulated heat sink (E) that is connected to output terminal. To check rectifier, connect ohmmeter to grounded heat sink (A) and flat metal strip (B). Then, reverse ohmmeter lead connections and note meter readings. If both readings are the same, rectifier bridge is defective. Repeat this test between points A-C, A-D, B-E, C-E and D-E.

179. REASSEMBLY. Note position of insulated washers (Fig. 136) when reassembling. If needle bearing (13—Fig. 135) is being renewed, press new bearing into housing from the outside until bearing is flush with outside of end frame. Push brushes against spring pressure, then insert a plastic pin or toothpick through holes in brush holder and end frame to hold brushes in retracted position. Be sure to align scribe marks when assembling housings. Make certain that pin retaining the brushes is removed after housings are assembled.

STARTING MOTOR

With the exception of 1390 models, Lucas starting motors are used on all tractors. A Bosch starting motor is used on 1390 models.

Lucas Starter

180. DISASSEMBLY. To disassemble Lucas starter, first remove solenoid assembly and copper link connecting solenoid to starter. Remove throughbolts (30—Fig. 139) 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 (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.

181. 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 nonconductive emery cloth. Do not undercut insulators between commutator segments.

182. ARMATURE INSULATION TEST. Armature insulation may be tested by using a 110 volt, 15 watt AC current test light connected as shown in Fig. 140. 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.

183. FIELD COIL TEST. Field coil insulation may be tested using a 110 volt, 15 watt, AC current test light connected as shown in Fig. 141. 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. 139) and field housing (18). Repair or renew as necessary.

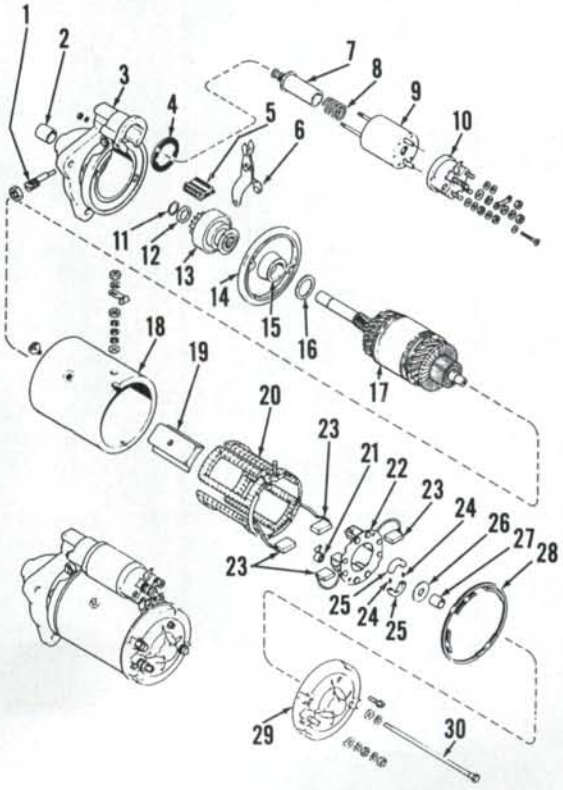


Fig. 139—Exploded view of typical Lucas starter assembly. Note that construction may vary slightly according to model, but basic design remains the same.

1. Pivot bolt
2. Bushing
3. Drive end housing
4. Gasket
5. Grommet
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

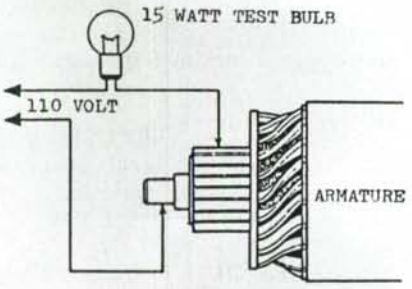


Fig. 140—When checking insulation, each commutator segment must be checked separately. Refer to paragraph 182.

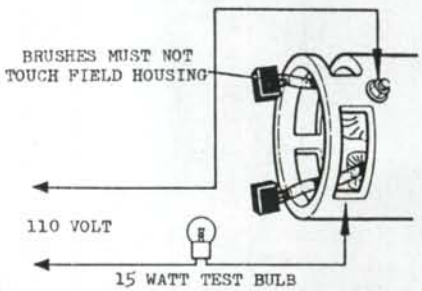


Fig. 141—Brushes must not touch housing and insulation at terminals must be good when checking field coils. Refer to paragraph 183.

184. 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. 142 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.

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

Armature end play must be 0.13-0.63 mm (0.005-0.025 inch) and is controlled by thickness of shims (16—Fig. 139) 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. 143) to remove any free play. Measure with a feeler gage as shown in Fig. 143. Turn pivot bolt (1—Fig. 139) to adjust clearance and when set, lock pivot bolt in place with locknut. Standard-duty starter pinion clearance must be 0.13-0.38 mm (0.005-0.015 inch) and heavy-duty starter pinion clearance is 0.13-1.14 mm (0.005-0.045 inch).

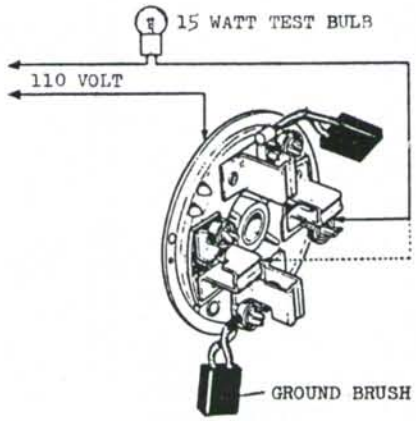


Fig. 142—Check both insulated brush holders as outlined in paragraph 184.

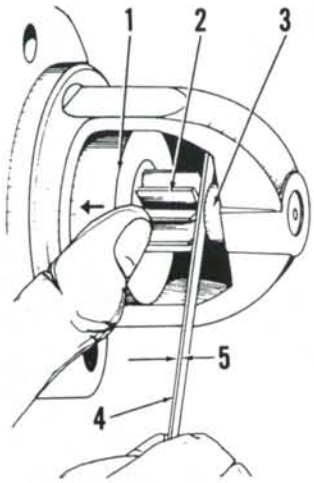


Fig. 143—Measure pinion clearance with a feeler gage as shown. Refer to paragraph 185 for specifications.

1. Starter drive clutch
2. Starter drive
3. Thrust collar
4. Feeler gage
5. Clearance

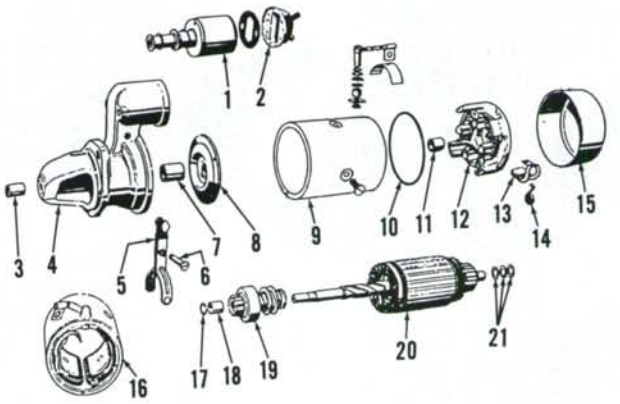


Fig. 144—Exploded view of Bosch starter showing component parts and their relative positions.

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. Bushing
12. Brush holder
13. Brush
14. Brush spring
15. End cover
16. Field coil
17. Snap ring
18. Bushing
19. Starter drive
20. Armature
21. Shims

Bosch Starter

186. **DISASSEMBLY.** Remove solenoid assembly (1—Fig. 144 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 thickness 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.

187. ARMATURE. Inspect armature commutator for wear, roughness or pitting. Light sanding with nonconductive emery cloth to clean and smooth surface is permissible. Check insulation as outlined in paragraph 182.

188. FIELD COIL. Inspect field coil for overheating and burnt insulating wrap. Test as outlined in paragraph 183.

189. INSULATED BRUSH BOX TEST. Locate the two insulated brush boxes on brush holder assembly and test as outlined in paragraph 184.

190. **REASSEMBLY.** Reassemble by reversing disassembly procedure. Install shims (21—Fig. 144) to original thickness noted during disassembly.

SOLENOID

All Models

191. 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

192. 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 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

193. FUSES. Fuses are installed in 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.

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

ACCESSORY SYSTEMS

All Models

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

195. 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 check wiring as outlined in paragraph 192.

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

196. GAGES AND WARNING SYSTEMS. Gage and warning systems consist of three basic components, which are the gage or warning light, sending unit or activating switch and necessary wiring to connect all components.

197. 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. 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.

198. AIR FILTER WARNING LIGHT. The air filter warning light is normally off. When on, it indicates need to service engine air filter. To test bulb and wiring, remove yellow/white wire from air filter vacuum switch (1690 models have two switches) and ground wire to engine. Light should come on.

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 filter. If light stays on, renew vacuum switch.

199. TRANSMISSION FILTER WARNING LIGHT. Some tractors are equipped with a transmission filter warning light which is normally off with engine running. If light is on, remove the black/light green wire from transmission filter 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 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.

200. 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.

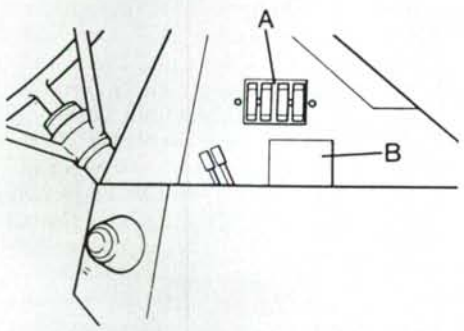


Fig. 145—Fuse holder (A) and cover (B) are located on right side of instrument panel on some models. Replace fuses with specified size and amperage fuse only.

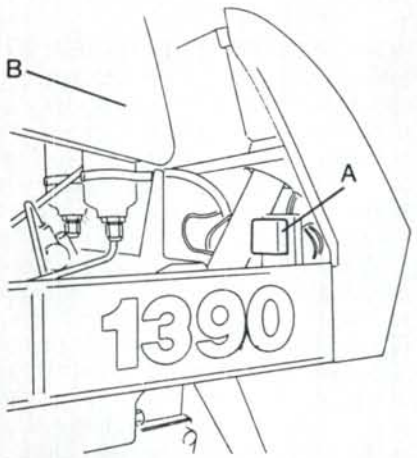


Fig. 146—Engine cover (B) must be raised to gain access to fuse holder (A) on models not equipped with cab.

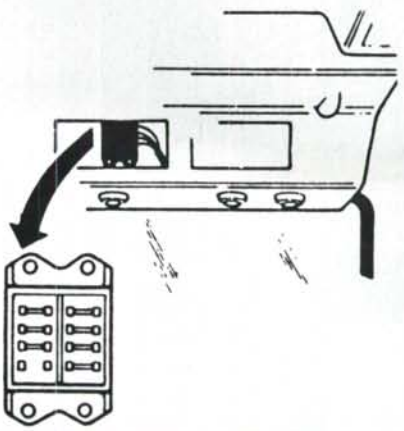


Fig. 147—On models equipped with cab, fuse holder is located on right-hand side of roof panel.

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.

201. ALTERNATOR WARNING LIGHT. Normal alternator warning light operation, testing and repair procedures are outlined in paragraphs 157 and 158.

202. FUEL LEVEL GAGE. If fuel gage reading is inaccurate, remove tank sending unit and connect the two ohmmeter leads to sender 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.

203. WINDSHIELD WIPER. Normal operation of windshield wiper on cab equipped models is with key on, wiper should operate when wiper switch is moved to LO and HI positions. 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.

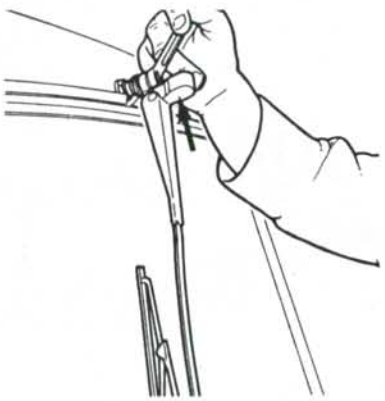


Fig. 148—To remove wiper arm, pull top of arm forward as shown and remove nut retaining arm to motor shaft. Remove wiper arm complete with wiper blade.

If wiper motor operates but does not return to park position, use voltmeter and with wiper switch in **OFF** position 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.

204. R&R WIPER MOTOR. To remove wiper motor, first move top of arm forward (Fig. 148) 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.

205. 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 resister block and with blower switch on, check voltage at resister block terminal where blue wire from blower switch "B" terminal is connected. If voltage is present, check for voltage at resister block terminal where red and green wires are connected. If no voltage is present at blue wires terminal, check wire between blower switch and resister block. If voltage is to resister block but fails to pass through resister, renew resister block.

If voltage passes through resister 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.

206. HEATER AND AIR CONDITIONING. Heater and air conditioner blower motor testing procedures are the same as outlined in paragraph 205. 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 ensure 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 indicates a very low refrigerant level. Oil streaks or dark spots on inside of sight glass indicate no refrigerant in system. See Fig. 149.

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. 149.

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.

207. 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,

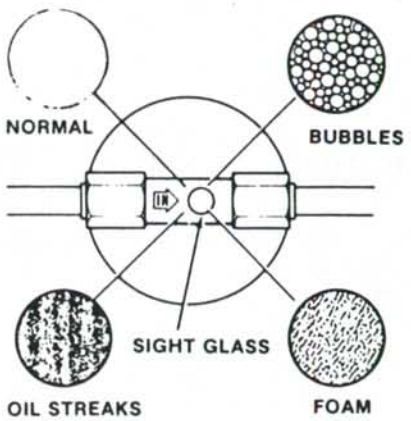


Fig. 149—Appearance of refrigerant in sight glass indicates condition of refrigerant charge in air conditioning system.

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 to bypass switch. If compressor clutch engages, check system pressure or renew high pressure switch as necessary.

If clutch still fails to engage, disconnect light blue wires from low pressure switch located at receiver dryer and install jumper wire to bypass low pressure switch. 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. 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

ADJUSTMENT

Models 1190-1194-1290-1294-1390 With Continuous Clutch

208. Clutch pedal free travel should be 25 mm (1 inch) as shown in Fig. 150. Adjust jam nuts (1) as necessary to obtain recommended free travel.

Models 1190-1194-1290-1294-1390-1394 (Without Cab) With Independent Pto Clutch

209. Adjust transmission clutch pedal free travel to 25 mm (1 inch) by turning adjusting screw (T—Fig. 151) as necessary.

Adjust pto clutch lever screw (P) to provide 38 mm (1½ inches) lever free travel measured as shown in Fig. 151.

Models 1194-1290-1390 (With Cab) With Independent Pto Clutch

210. These models use a foot operated master cylinder and a slave cylinder to hydraulically actuate transmission clutch release mechanism. The pto clutch release linkage is actuated mechanically by a hand lever and cable assembly.

Check transmission clutch linkage to make certain there is clearance of approximately 2 mm (5/64 inch) between adjusting screw (4—Fig. 152) and slave cylinder push rod (2). To adjust, turn screw clockwise until there is no free movement, then turn screw counterclockwise 1½ to 2 turns and tighten locknut.

On all models, there should be free movement of 3-5 mm (⅛-¼ inch) at pto clutch cross-shaft lever (1—Fig. 153) when clutch is in engaged position. To adjust, loosen locknut (5) and turn cable adjuster (4) as necessary to provide free movement. After making adjustment, be certain pto clutch is com-

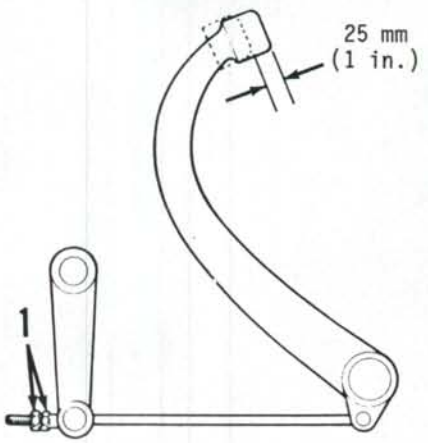


Fig. 150—On tractors with continuous type clutch, adjust jam nuts (1) to provide 25 mm (1 inch) pedal free play measured at top of pedal. Refer to paragraph 208.

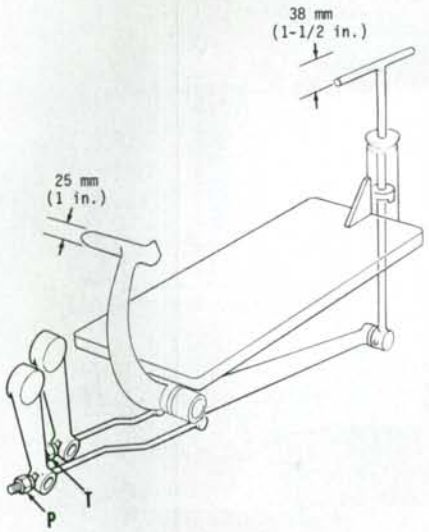


Fig. 151—On tractors (without cab) equipped with independent type clutch, adjust nut (T) to provide 25 mm (1 inch) clutch foot pedal free movement. Adjust nut (P) to provide 38 mm (1½ inches) pto clutch lever free movement. Refer to paragraph 209.

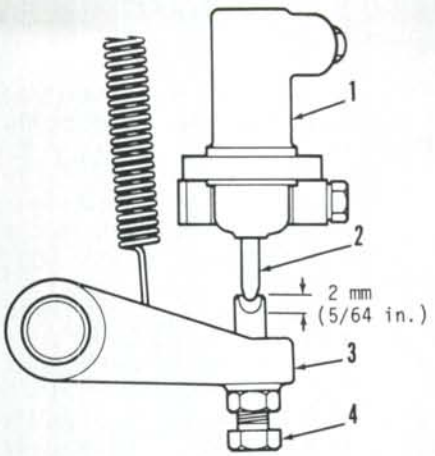


Fig. 152—On 1194, 1290 and 1390 tractors equipped with a cab and independent clutch, clearance of 2 mm (5/64 inch) should be maintained between slave cylinder push rod (2) and adjusting screw (4). Refer to Fig. 153 for pto clutch linkage adjustment.

1. Clutch slave cylinder
2. Push rod
3. Locknut
4. Adjusting screw

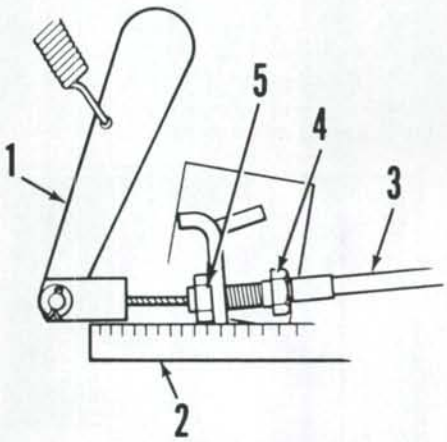


Fig. 153—On 1194, 1290 and 1390 tractors equipped with independent type clutch, adjust clutch cable to provide 3-5 mm (⅛-¼ inch) free movement of clutch cross-shaft lever.

1. Cross-shaft lever
2. Ruler
3. Pto clutch cable
4. Adjuster
5. Locknut

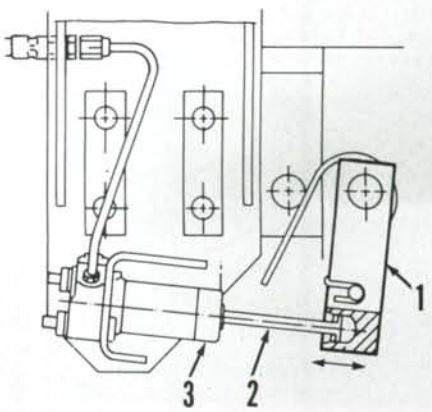


Fig. 154—View of clutch slave cylinder and release lever used on Models 1294, 1394, 1494 and 1594 equipped with a cab and independent type clutch. No adjustment is required on these models. Refer to Fig. 155 for pto clutch linkage adjustment.

1. Transmission clutch release lever
2. Push rod
3. Slave cylinder

pletely disengaged when hand lever is pulled fully up.

Models 1294-1394-1494-1594 (With Cab) With Independent Pto Clutch

211. These models use hydraulically actuated transmission clutch release mechanism and mechanical pto clutch release linkage.

No adjustment of transmission clutch is required. However, after every 400 hours of operation, clutch wear should be checked as follows: Push operating lever (1—Fig. 154) counterclockwise by hand until release plate contacts clutch release bearing. Then move operating lever clockwise as far as possible and note amount of lever movement. If movement is 1.5 mm (1/16 inch) or less, clutch plate is excessively worn and should be renewed as soon as possible. After performing this check, push clutch pedal to the floor several times and make sure clutch operates correctly before starting the engine.

Pto clutch cable (Fig. 155) should be adjusted to provide some free movement at end of cross-shaft lever when clutch is engaged. Turn cable yoke clockwise to decrease free movement and counterclockwise to increase free movement. Clutch must be completely disengaged when hand lever is pulled fully up.

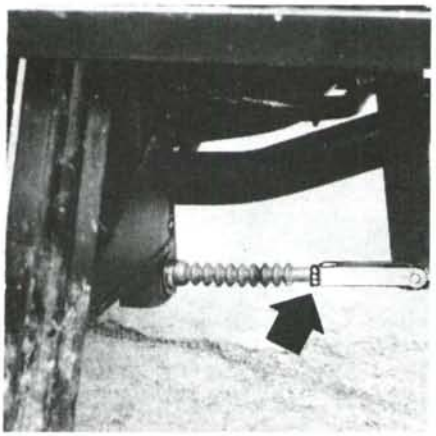


Fig. 155—Adjust pto clutch cable yoke to provide free movement at end of cross-shaft lever when clutch hand lever is in engaged position.

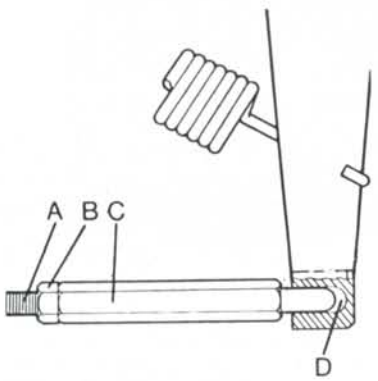


Fig. 156—View showing transmission clutch adjustment linkage for 1490 low profile tractors.
A. Push rod
B. Locknut
C. Adjusting sleeve
D. Free movement of 4 mm (5/32 inch)

Low Profile Model 1490

212. Transmission clutch free travel should be 4 mm (5/32 inch) measured at "D" (Fig. 156) between adjusting sleeve (C) and cross-shaft lever. Loosen locknut (B) and turn adjusting sleeve (C) on slave cylinder push rod (A) as necessary.

To adjust pto clutch, move hand lever to disengaged position. Check angle between centerline of crank lever and cable as shown in Fig. 157. The angle must be 90° and is adjusted by turning cable adjuster sleeve (B). Measure free movement of pto clutch hand lever. If necessary, adjust control rod nuts (D and E) to obtain lever free movement of 63 mm (2½ inches).

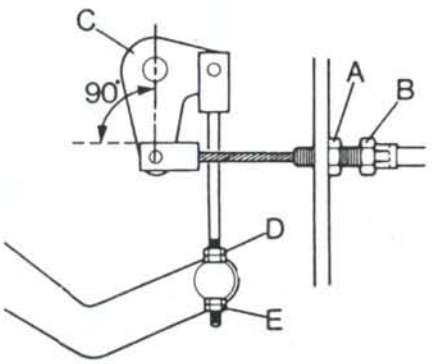


Fig. 157—View showing pto linkage adjustment for 1490 low profile tractors.
A. Locknut
B. Cable adjusting sleeve
C. Crank lever
D. Locknut
E. Locknut

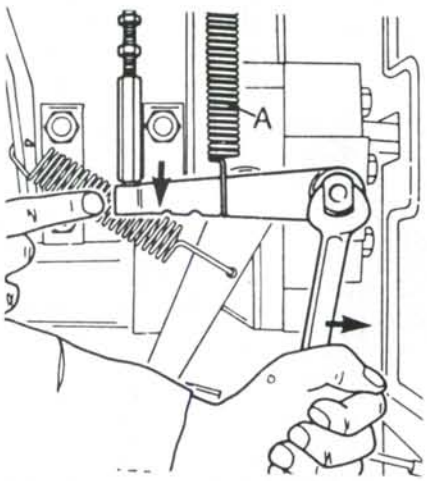


Fig. 158—Use a wrench to move transmission clutch cross-shaft lever until release bearing is against thrust plate when adjusting clutch free travel on 1490 and 1690 models equipped with high platform or cab.

NOTE: Do not operate tractor if free movement is less than 45 mm (1¾ inches.

Models 1490-1690 With High Platform or Cab

213. Transmission clutch linkage should be checked and adjusted after every 60 hours of operation. Move cross-shaft lever away from slave cylinder push rod (Fig. 158) until release bearing is against release lever plate and note amount of lever movement. Clearance (free movement) between cross-shaft lever and end of push rod adjusting sleeve should be 4 mm (5/32 inch). If necessary, loosen locknut (B—Fig. 159) and turn adjusting sleeve (C) until correct clearance is obtained.

To adjust pto clutch linkage, place pto clutch hand lever in engaged position. Loosen locknut (A—Fig. 160) and turn cable adjuster (B) to provide 3-5 mm (1/8-1/4 inch) free movement at end of pto clutch cross-shaft lever.

BLEEDING AIR FROM CLUTCH HYDRAULIC SYSTEM

All Models So Equipped

214. The clutch hydraulic system is filled at the factory with Agricastrol FBS fluid. It is recommended that fluid be changed every two years. Refill system with Agricastrol FBS fluid or equivalent. Do not mix different types of fluid when adding fluid to system.

To bleed system, clean a pressure oil can and fill can with specified fluid. Connect oil can to air screw (C—Fig. 161) on clutch slave cylinder (D) using a flexible hose (B). Remove reservoir filler cap and loosen air screw. Operate pressure oil can to push fluid into reservoir. When fluid entering reservoir is free of air bubbles, tighten air screw.

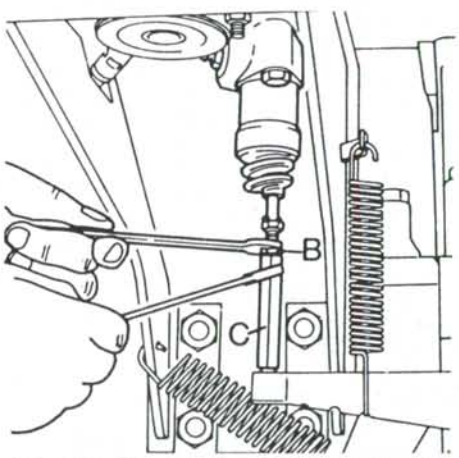


Fig. 159—View showing adjusting sleeve (C) and locknut (B) on 1490 and 1690 models.

Add fluid to reservoir to correct level as necessary.

CLUTCH MASTER CYLINDER

All Models So Equipped

215. Overhaul kits are available for clutch master cylinder and slave cylinder.

After repairing or renewing master cylinder, adjust as follows: With pedal against return stop screw, adjust clevis until pin (C—Fig. 162) will fit easily into clevis and clutch pedal with push rod (A) lightly contacting master cylinder piston. Be sure piston is not being pushed into cylinder when making this adjustment.

TRACTOR SPLIT

216. To remove engine clutch assembly, it is first necessary to separate (split) tractor between transmission and engine as outlined in the following paragraphs.

Models 1190-1194-1290-1294-1390-1394

217. To split tractor, remove muffler and air intake pipe. Open engine hood, remove two upper bolts from hood rear supports and push hood forward. Remove retaining screws from rear of side panels. Disconnect battery cables. On models with top mounted fuel tank, drain fuel, disconnect necessary wire and fuel lines, remove tank mounting bolts and remove fuel tank. On models with side mounted fuel tanks, disconnect fuel tank filler tube, air vent hose and fuel supply and return lines. On Model 1190 with manual steering, disconnect drag link. On models with power steering, disconnect hydraulic lines at the steering valve and cap openings. Remove steering pipe at upper left-hand side of console.

On all models, disconnect engine wiring harness and wires to starter motor. Remove starter motor mounting bolts and remove starter. Disconnect tachometer drive cable. Remove engine speed control foot pedal. Disconnect transmission and pto clutch linkage. Disconnect hydraulic brake lines and clutch lines (if so equipped) as necessary. Disconnect engine stop and throttle control linkage.

On models equipped with a cab, disconnect heater hoses and air conditioner hoses. On models equipped with front-wheel drive, remove drive shaft to front axle. On models with front mounted hydraulic pump, drain oil from transmission. Disconnect hydraulic pump inlet pipe and outlet pipe.

On all models, remove clutch housing cover mounting bolts. Remove lower bolts securing rear frame to center frame. (These bolts can be difficult to remove after installing splitting tools.) Support front and rear sections of tractor using suitable splitting stands such as Case special tools CAS-10506-1, CAS-10506-2 and CAS-10100. Drive wooden wedges between front axle and frame to prevent tipping. Engage pto to prevent selector gear from moving out of position. Remove remaining front to rear frame mounting bolts. Move sections apart about 25 mm (1 inch), then remove wedge, shims and clutch cover.

On Models 1290, 1294, 1390 and 1394 with independent type clutch, remove left-hand trunnion pin from pto clutch release fork. Remove cotter pin from right-hand trunnion.

On all models, make certain all necessary parts are disconnected and are not binding, then move tractor sections apart.

To reconnect tractor, reverse the splitting procedure while noting the following special instructions: Installation of two guide studs in rear frame will aid in aligning front and rear sections. When properly aligned and shafts properly engaged in clutch disc splines, it should be possible to push the two sections together without using excessive force. Do not use bolts to pull the sections together. Install wedge and original shim between transmission housing and clutch cover. Tighten clutch cover mounting bolts to 40 N·m (30 ft.-lbs.) torque. Tighten front to rear frame mounting bolts to 68-81 N·m (50-60 ft.-lbs.) torque.

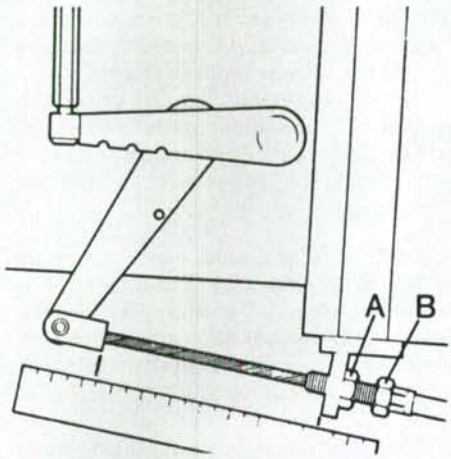


Fig. 160—Adjust pto clutch by turning cable adjuster (B) until cross-shaft lever free movement is 3-5 mm (⅛-¼ inch).

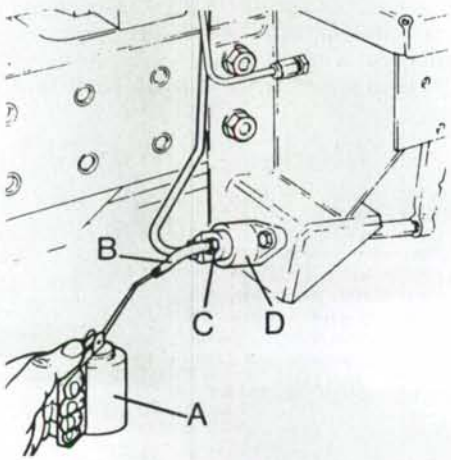


Fig. 161—Use pressure oil can (A) connected to air screw (C) on slave cylinder (D) by flexible tube (B) to bleed air from clutch hydraulic system.

Models 1490-1494-1594-1690

218. To split tractor, remove muffler and air intake precleaner. Open hood and move forward until locked in position. Disconnect battery cables. Drain oil from transmission.

If equipped with cab, drain cooling system and disconnect heater hoses. Disconnect air conditioner hoses if so equipped.

Disconnect engine stop control and throttle control linkage. Disconnect and remove steering pipe on left-hand side of console. Disconnect power steering lines. Disconnect engine wiring harness and wires to starter motor. Remove starter motor mounting bolts and remove starter. Disconnect hydraulic pump inlet and outlet lines. Disconnect fuel supply and return lines, fuel tank filler hose and air vent hose. Disconnect tachometer drive cable. Remove steps and foot plates on models so equipped. Disconnect clutch control linkage, clutch hydraulic pipes and brake hydraulic pipes as necessary.

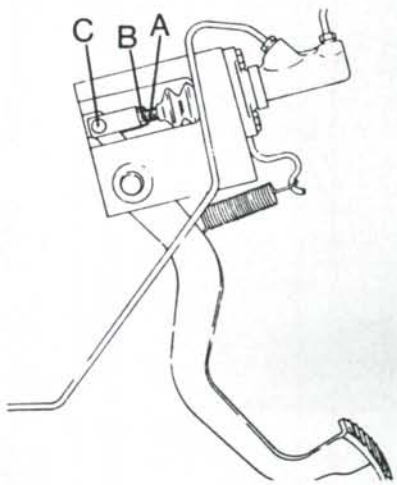


Fig. 162—Remove pin (C) from rod (A) and loosen locknut (B), and adjust master cylinder as outlined in paragraph 215.

On models equipped with front-wheel drive, remove drive shaft to front axle.

On all models, support front and rear of tractor with stands suitable for splitting tractor. Drive wooden wedges between front axle and frame to prevent tipping. Remove clutch cover mounting bolts and front to rear frame mounting bolts.

NOTE: Engage pto to keep pto selector gear in position during tractor separation.

Move front and rear sections apart carefully making sure all components are disconnected as necessary.

To reconnect tractor, reverse the splitting procedure while noting the following special instructions: Installation of two guide studs in rear frame will aid in aligning front and rear sections. Be sure studs are positioned so they can be removed after tractor is reconnected. When front and rear sections are properly aligned and shafts properly engaged in clutch disc splines, the two sections should go together easily. Do not use bolts to pull the sections together.

R&R AND OVERHAUL CLUTCH

Borg And Beck Continuous Type Clutch Assembly

219. Before removing clutch, mark pressure plate to flywheel position for reassembly. Place an 11 mm (7/16 inch) nut under each release lever to relieve spring tension as clutch mounting bolts are removed. Remove pressure plate assembly and outer clutch disc from flywheel. Identify flywheel side of clutch discs (if not already marked) to assure correct reassembly. Make alignment marks on separator plate and flywheel for reassembly, then remove separator plate and inner disc. Remove the three springs from flywheel.

Scribe alignment marks on clutch pressure plate, inner cover and outer cover and release levers to pressure plate lugs for reassembly in original positions.

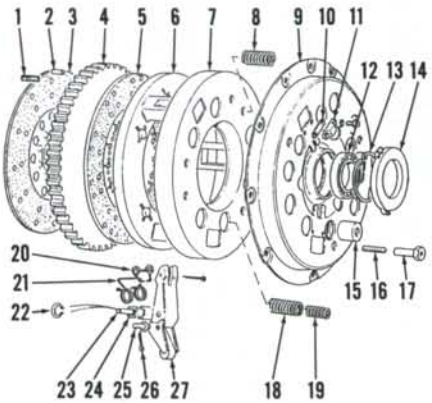


Fig. 163—Exploded view of Borg and Beck continuous type clutch showing component parts and their relative positions.

1. Flywheel spring
2. Dowel
3. Driven plate, pto
4. Separator plate
5. Drive plate, transmission
6. Pressure plate
7. Inner cover
8. Thrust spring, pto
9. Outer cover
10. Shim
11. Adjusting pad
12. Bearing
13. Snap ring
14. Release lever plate
15. Spring cover
16. Adjusting screw
17. Locknut
18. Thrust spring, transmission outer
19. Thrust spring, transmission inner
20. Retainer spring
21. Spring, antirattle
22. Retainer ring
23. Pin
24. Needle roller bearing
25. Pin, release lever
26. Cotter pin
27. Release lever

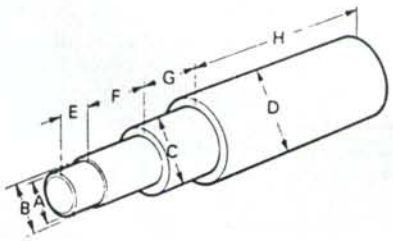


Fig. 164—When installing Borg and Beck continuous type clutch, use a pilot shaft made to dimensions shown.

A. 22.20 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. 38.10 mm (1.5 in.)
G. 44.45 mm (1.750 in.)
H. 127 mm (5.0 in.)

NOTE: Use of special clutch fixture kit (CAS-1217, CAS-1218 and CAS-1224 is recommended for proper disassembly, reassembly and adjustment of clutch unit. The following overhaul procedure is for use with these special tools.

Remove release lever actuating plate (14—Fig. 163). Remove the three adjusting screws (16). Place three Code 14 spacers (from clutch tool kit) on 912917 base plate. Position pressure plate on base plate so pressure plate rests on top of spacers. Install a 912724 spacer under and a stud through each mounting hole in clutch cover. Thread studs into base plate, install flat washers and nuts on studs and tighten nuts evenly until clutch cover contacts spacers. Release the large release lever springs (21) from clutch cover tabs. Remove pivot pins (25) and release levers (27). Remove springs (20 and 21), pivot pin (23) and needle bearing (24) from release levers.

Loosen stud nuts evenly until clutch spring tension is relieved, then separate pressure plate components. Remove snap ring (13) and tap bearing (12) from outer cover.

Check release levers for wear on tips of fulcrum points and renew as needed. Check all clutch springs and renew if distorted, discolored or weak.

Inspect pressure plate for cracks, scoring or discoloration. Light scores may be removed by resurfacing, however maximum amount of material removed must not exceed 0.38 mm (0.015 inch).

If separator plate shows wear only on transmission side, further use may be obtained by reversing the plate. If plate is badly scored or cracked, it may be resurfaced providing amount of material removed does not exceed 0.76 mm (0.030 inch) total for both sides. Plate thickness when new is 17.78-17.90 mm (0.700-0.705 inch). Make certain separator plate is a free sliding fit in flywheel teeth. A tight plate can cause pto clutch slippage. A very loose plate may rattle when clutch pedal is depressed, however separator plate rattle does not affect clutch operation.

Install pressure plate into inner and outer covers and check side clearance between the three pressure plate lugs and their respective slots in covers. Side clearance should be 0.15-0.30 mm (0.006-0.012 inch). If slots are excessively worn, renew covers.

Inspect clutch release bearing and renew if excessively worn or damaged.

To reassemble, position pressure plate on 912917 base plate so the Code 14 spacers are located below the release lever lugs. Place clutch inner cover (7)

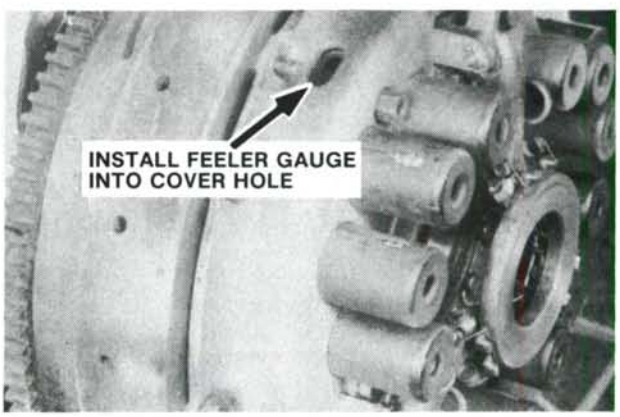


Fig. 165—On Borg and Beck continuous type clutch, insert feeler gage through holes in clutch cover to check clearance between adjusting screws and pressure plate.

over pressure plate aligning marks made during disassembly. Install springs on inner cover, then place outer cover over the springs and onto the studs and spacers aligning match marks on covers. Tighten stud nuts evenly until outer cover contacts the spacers. Assemble release levers and install in their original positions on pressure plate.

Using clutch actuating tool or other suitable means, actuate release levers several times to be certain clutch springs are properly seated. Install 912723 adapter in center hole of base plate. Assemble 961845 guide pin into adapter and position Code 8 spacer on guide pin with recess side down. Install 961880 stud, 920203 gage and 961879 nut on the guide pin. Hold gage down firmly, then check clearance between each release lever and the gage. The levers must just touch gage or be within 0.05 mm (0.002 inch) of gage. To adjust clearance, add or remove shims (10—Fig. 163) under roller pads (11). A variation of 0.025 mm (0.001 inch) in shim thickness will change release lever height approximately 0.114 mm (0.0045 inch). Adjust all levers to as near equal height as possible. Remove lever adjusting gage.

Reconnect release lever springs (21) in tabs of outer cover. Install adjusting screws (16), but do not adjust at this time. Place 11 mm (7/16 inch) nuts under each release lever, then remove nuts from base plate studs. Remove clutch assembly from base plate. Install release lever actuating plate (14).

To reinstall clutch, place springs (1) in flywheel, then install inner disc with large hub towards flywheel. Install separator plate aligning marks on plate and flywheel made during removal. Install outer disc with side stamped "Flywheel Side" facing flywheel. Install pressure plate assembly aligning match marks made during removal. Use a suitable pilot tool (Fig. 164) to align inner and outer discs, then tighten clutch mounting bolts evenly to 68 N·m (50 ft.-lbs.) torque.

Using a feeler gage through holes in cover (Fig. 165), check clearance between end of adjusting screws and the pressure plate. Clearance should be 1.77 mm (0.070 inch). Adjust the screws as required, then secure with locknuts.

Borg and Beck Independent Type Clutch Assembly

220. Before removing clutch, mark pressure plate to flywheel position for reassembly. Install retainers made from stiff wire over pto clutch release levers to retain pressure of clutch springs. Remove bolts securing clutch assembly to flywheel, then remove clutch being careful not to drop inner clutch disc.

NOTE: To properly service dual clutch unit, use of special clutch kit (CAS-1217, CAS-1218 and CAS-1224) is recommended. The following overhaul procedure is for use with these special tools.

Install nine special long studs into appropriate holes in 912917 base plate. Place three Code 3 spacers on base plate, then install clutch assembly onto base plate and studs and arrange spacers so they are located below pto release lever lugs of pressure plate. Install flat washers and nuts on studs and tighten nuts evenly until clutch is seated on base plate.

NOTE: Mark positions of the following components so they can be reinstalled in their original positions if reused: Pressure plates (2 and 20—Fig. 166) and covers (6 and 23), pressure plate lugs and release levers (28) and outer cover and release levers (18).

Install release lever actuator into base plate, depress pto release levers and remove release lever retainer wires installed during removal. Remove actuator from base plate. Remove release lever pivot pins and remove levers from cover. Remove six bolts retaining clutch cover (23) to separator housing (6). Unscrew stud nuts evenly to relieve spring tension, then separate clutch components.

Inspect all parts for excessive wear or other damage. Friction surfaces of clutch cover and separator housing should be smooth and free of cracks. Surfaces may be reground providing amount of material removed does not exceed 0.38 mm (0.015 inch). Check separator housing bearing (7) for smooth operation and renew if necessary.

Renew pressure springs if rusted, distorted or weak. Renew insulating washers (4) if damaged. Loose washers should be held in place in housing with suitable adhesive.

Inspect release levers and pivot pins for wear or damage and renew as needed. Renew release lever plates (30 and 31) if excessively worn.

To reassemble, install pto pressure plate (2) on base plate and position three Code 3 spacers under plate at release lever lugs. Assemble pto springs and separator housing on pressure plate. Place three Code 13 spacers on friction surface of separator housing, then install transmission pressure plate (20), aligning assembly marks and positioning spacers under release lever lugs. Assemble springs and outer cover on pressure plate. Install flat washers and nuts on studs and tighten until clutch is bottomed on base plate. Install six bolts retaining cover to separator housing. Install release levers and lever plates.

Install short adapter and release lever actuator into base plate. Actuate release levers about a dozen times to ensure components are properly seated, then remove actuator. Thread guide pin into adapter, then place Code 16X spacer on guide pin with recessed side towards adapter. Install short gage on guide pin, then adjust screws (26) on transmission clutch release levers until lever plate just touches gage all the way around. Tighten locknuts to secure adjustment.

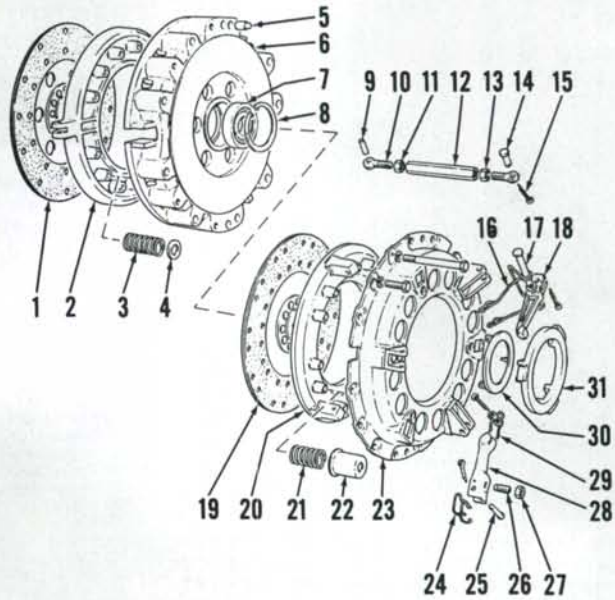


Fig. 166—Exploded view of Borg and Beck independent type clutch used on 1290 and 1390 models and early 1294 and 1394 models with independent pto.

1. Pto plate
2. Pto pressure plate
3. Thrust spring, pto
4. Insulating washer
5. Dowel
6. Separator housing
7. Bearing
8. Snap ring
9. Pin
10. Eye-bolt
11. Locknut
12. Turnbuckle
13. Locknut
14. Pin
15. Cotter pin
16. Spring, antirattle
17. Pin
18. Release lever, pto
19. Transmission plate
20. Transmission pressure plate
21. Thrust spring
22. Cup, spring
23. Cover
24. Spring, antirattle
25. Pin
26. Adjusting screw
27. Locknut
28. Release lever, transmission
29. Spring clip
30. Release levers plate
31. Release levers plate

Remove short adapter from base plate and install long adapter. Install release lever actuator and depress pto release levers about a dozen times to ensure parts are properly seated. Remove actuator and install guide pin in adapter. Install Code 16X spacer with recessed side facing down. Install long adjusting gage on guide, then adjust pto release levers (18) until lever plate just touches gage all the way around. Remove gage, spacer and guide pin.

Remove pto release lever plate and pto release lever pivot pins. Swing release levers outward clear of clutch. Install three stiff wire retainers over transmission release levers to retain clutch spring tension. Remove cover retaining bolts, then loosen stud nuts evenly and lift clutch cover from separator housing. Remove spacers and install transmission clutch disc on separator housing with side marked "Flywheel" towards housing. Reinstall cover assembly. Use a pilot tool (Fig. 167) or a clutch drive shaft to align clutch disc with separator housing bearing, then install nuts and washers on three studs and tighten evenly to clamp cover to base plate. Install the six cover retaining bolts. Remove wire retainers from transmission clutch levers.

Reinstall pto clutch release levers, pivot pins and lever plate. Secure pto levers with stiff wire retainers used during removal, then loosen the three stud nuts and lift clutch assembly from base plate.

To reinstall, install inner disc with longer hub side towards flywheel. Position clutch assembly in flywheel aligning match marks made during removal. Use a suitable pilot shaft to align clutch discs, then tighten clutch mounting bolts evenly. Remove pilot tool from clutch.

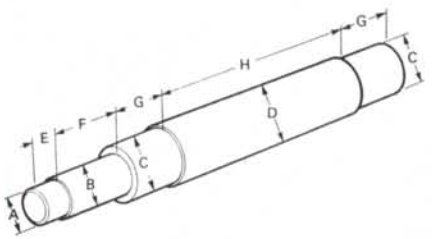


Fig. 167—When installing Borg and Beck independent type clutch, use a pilot shaft made to dimensions shown to align clutch discs.

A. 22.20 mm (0.874 in.)
B. 23.24 mm (0.915 in.)
C. 34.90 mm (1.374 in.)
D. 36.07 mm (1.420 in.)
E. 19 mm (0.750 in.)
F. 57 mm (2.250 in.)
G. 38 mm (1.500 in.)
H. 152 mm (6 in.)

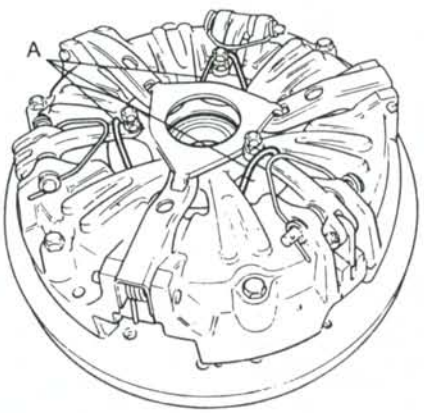


Fig. 168—Use retainers (A) made from stiff wire to hold pto clutch release levers down during removal and installation of clutch. Do not use soft wire or welding rod as they will not retain pressure of clutch springs.

Laycock Clutch Assembly

221. Before removing clutch, mark position of clutch cover to flywheel so unit can be reinstalled in its original position. Install retainers (A—Fig. 168) made from stiff wire over pto clutch release levers to retain pressure of clutch springs. Loosen clutch mounting bolts evenly, then remove clutch assembly from flywheel.

NOTE: To properly service dual clutch unit, it is recommended that special clutch kit (CAS-1217, CAS-1224, CAS-1240, CAS-1610 and CAS-1611) be used to disassemble, reassemble and adjust clutch.

To disassemble clutch, place three Code 33 spacers on base plate to align with pto release lever lugs of pressure plate and place six spacers DB 8832/2 over holes in base plate which will align with clutch cover bolt holes. Install center post adapter DB 8832/1 in base plate, then install locating sleeve DB 1176 on center post. Small OD of locating sleeve is up on 1490 and 1494 models and down on 1594 and 1690 models. Install six cover mounting bolts with flat washers through cover and spacers and tighten evenly. Remove retainer clips from pto release levers.

NOTE: Mark all parts before disassembling clutch so parts can be assembled in original positions if reused.

Remove pto release lever pivot pins, then move release levers (20—Fig. 169) outward from clutch cover. Remove pivot pins and springs from transmission release levers (15), then remove levers and roller (16). Remove centering sleeve. Loosen cover retaining bolts evenly, then remove clutch cover (6) and separate clutch components.

Inspect release levers and pivot pins for wear or damage and renew if necessary.

Inspect friction surfaces of pressure plates and cover for distortion, heat cracks, scoring or other damage. Friction surfaces can be machined, but do not remove more than 0.50 mm (0.020 inch) of material from each plate. The combined total amount of material removed from all three of the surfaces must not exceed 1.0 mm (0.040 inch). Thickness of pto pressure plate (2) when new is 28.63 mm (1.127 inches) and thickness of transmission pressure plate (4) when new is 23.77 mm (0.936 inch). Depth of clutch cover (6) when new is 72.82 mm (2.867 inches).

Renew clutch pressure springs that are rusted, distorted or weak.

To reassemble, arrange the three Code 33 spacers and the six DB 8832/2 spacers on base plate. Position pto pressure plate on base plate so Code 33 spacers are aligned with release lever lugs. Install new fiber washers (11) on pressure plate. Place the pressure springs (10) and Belleville spring (3) in position on pto pressure plate. Be sure outer

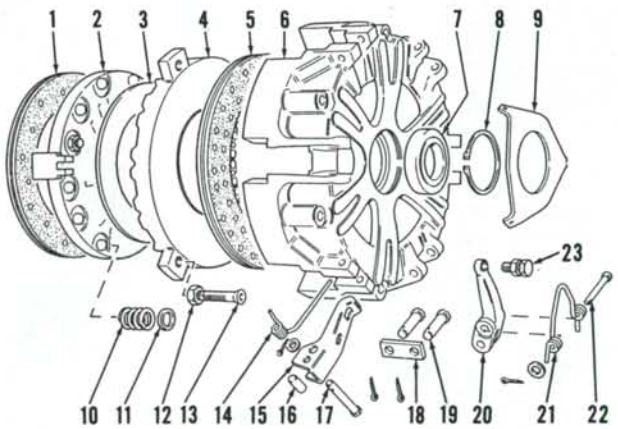


Fig. 169—Exploded view of Laycock double disc clutch showing component parts and their relative positions.

1. Disc, pto
2. Pressure plate, pto
3. Belleville spring
4. Pressure plate, transmission
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, antirattle
15. Release lever, transmission
16. Roller
17. Pin
18. Link
19. Pin
20. Release lever, pto
21. Spring, antirattle
22. Pivot pin
23. Adjusting bolt

edge of Belleville spring is higher than inner edge. Align assembly marks and position pressure plate (4) with new fiber washers on top of pressure springs. Install transmission clutch disc (5) with hub facing downward. Align assembly marks and install clutch cover (6). Install center post adapter 961845 and centering sleeve DB 1176. The small OD of sleeve must be up on 1490 and 1494 models and down on 1594 and 1690 models. Install six cover mounting bolts and tighten until pto release levers can be connected to cover.

NOTE: Make sure pressure plate lugs are free in slots of clutch cover and Belleville spring is properly seated when tightening bolts.

Install adjuster screws in transmission pressure plate, but do not tighten. Install transmission release levers, rollers and thrust plate. Assemble lever springs (14) to transmission release levers with longer leg of spring through thrust plate (9) lug. Tighten six cover bolts until cover is seated, then remove centering sleeve and post.

To set height of transmission release levers, first install center post adapter DB 8832/1 (7—Fig. 170) and release lever actuator in base plate. Actuate transmission release levers about a dozen times to make sure all parts are properly seated. Remove actuator and install center post 981845 into adapter. Install Code 4 spacer (6), extra spacer DB 1248 (5) on 1594 and 1690 models and setting gage (4). Adjust each adjuster bolt (1) until setting gage just contacts thrust plate (3) all the way around. Remove gage and spacers, install lever actuator and actuate release levers several times. Reinstall spacers and gage and recheck lever adjustment. Readjust if necessary. Remove gage and spacers.

To adjust pto release lever height, install center post adapter DB 8832/4 and lever actuator with adapter plate 920204. Actuate pto release levers about a dozen times to be sure all parts are properly seated. Remove actuator and install center post 961845 into center adapter (1—Fig. 171). Install Code 4 spacer (2) and setting gage (3). Hold gage against spacer, then adjust each pto release lever adjusting screw (4) until screws just contact gage. Remove gage and spacer and install lever actuator and adapter plate. Actuate release levers several times, then recheck lever height and readjust if necessary. Remove gage, spacer, center post and adapter.

Install wire retainers over pto levers to hold pressure springs in compressed position. Remove six cover bolts and lift clutch unit from base plate.

Use a suitable pilot tool such as one shown in Fig. 172 or 172A to align clutch discs. Be sure inner disc is positioned so large part of hub is towards flywheel. Align assembly marks on clutch cover and flywheel, then install six mounting bolts and tighten evenly. Remove pilot tool from clutch, and remove wire retainers from pto release levers.

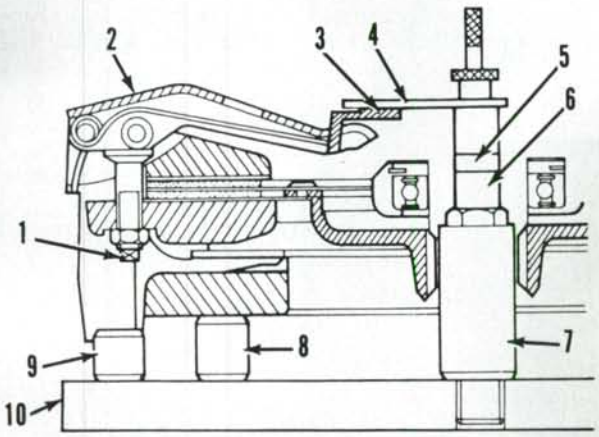


Fig. 170—Adjust height of transmission levers using tools shown. Extra spacer DB1248 (5) is used only on 1594 and 1690 models.

1. Adjusting bolt
2. Transmission release lever
3. Thrust plate
4. Setting gage
5. Spacer DB1248
6. Code 4 spacer
7. Adapter DB8832/1
8. Code 33 spacers
9. Spacers DB8832/2
10. Base plate

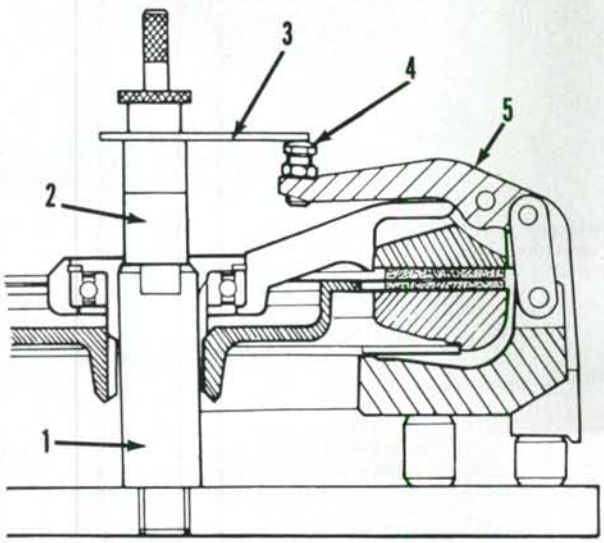


Fig. 171—Adjust pto release lever adjusting screws (4) until they just touch setting gage (3).

1. Adapter DB8832/4
2. Code 4 spacer
3. Setting gage
4. Adjusting screw
5. Pto release lever

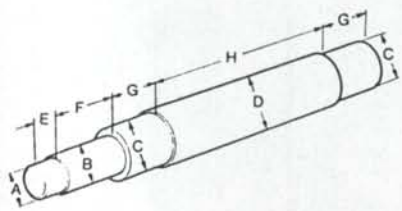


Fig. 172—When installing Laycock clutch in all models except 1594 and 1690, use a pilot shaft made to dimensions shown.

A. 22.20 mm (0.874 in.)
B. 23.16 mm (0.912 in.)
C. 38.10 mm (1.50 in.)
D. 44.93 mm (1.769 in.)
E. 19.05 mm (0.75 in.)
F. 57.15 mm (2.25 in.)
G. 38.10 mm (1.50 in.)
H. 152.4 mm (6.0 in.)

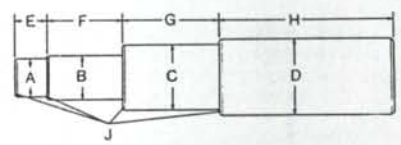


Fig. 172A—Use a pilot shaft made to dimensions shown when installing Laycock clutch assembly on 1594 and 1690 models.

A. 22.20 mm (0.874 in.)
B. 25.55-26.65 mm (1.006-1.010 in.)
C. 40.51-40.58 mm (1.595-1.598 in.)
D. 44.85-44.90 mm (1.766-1.768 in.)
E. 19 mm (0.750 in.)
F. 44.5 mm (1.750 in.)
G. 57.15 mm (2.250 in.)
H. 101.6 mm (4 in.)
J. 45° by 1.5 mm ($\frac{1}{16}$ in.)

SYNCHROMESH 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 and second to third and a down shift on the move from third to second by depressing foot clutch and shifting.

SHIFT LEVERS

All Models

222. Transmission or range selector lever (Fig. 173) assemblies may be removed as separate units from transmission top cover. Models equipped with platform or cab vary in construction, however basic design is similar to 1190, 1194, 1290, 1294 and 1390 models shown in Fig. 173.

Shift rods are carried in transmission assembly end plates. Refer to transmission overhaul procedure for removal and disassembly of shift rods and forks.

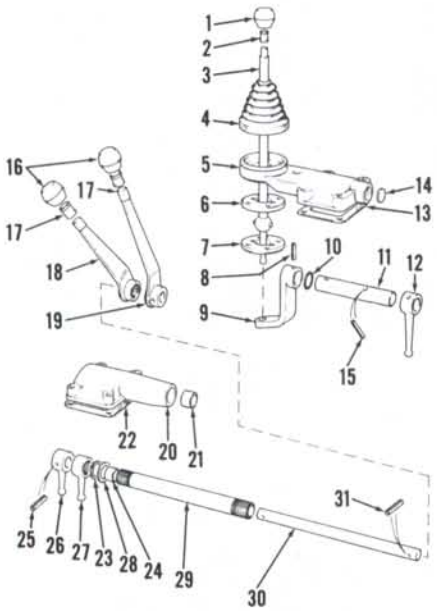


Fig. 173—Exploded view of range and transmission shift selector levers for tractors without cabs equipped with synchromesh transmission. Models with cabs are similar.

1. Knob
2. Retaining ring
3. Lever
4. Boot
5. Housing
6. Ball housing
7. Ball housing
8. Roll pin
9. Selector shaft arm
10. Oil seal
11. Selector shaft
12. Selector lever
13. Gasket
14. Core plug
15. Roll pin
16. Knob
17. Retainer ring
18. Lever
19. Lever
20. Housing
21. Bushing
22. Gasket
23. Snap ring
24. Bushing
25. Roll pin
26. Selector lever
27. Selector lever
28. Washer
29. Selector tube
30. Selector shaft
31. Roll pin

REMOVE AND REINSTALL TRANSMISSION

Models 1190-1194-1290-1294-1390

223. REMOVE. If equipped with platform or cab, remove as outlined in paragraph 348 or 349. Remove muffler, air intake precleaner, engine hood and side covers. Remove hand and foot operated throttle control rods and engine stop cable. Disconnect fuel lines, necessary power steering lines, tachometer drive cable and all necessary electrical connections, then remove fuel tank (without cab) and instrument panel.

Drain oil from transmission. Remove remote valve couplers and support bracket. Disconnect remote valve hoses and remove remote valve assembly. Disconnect draft sensing cable at hitch upper link connection. Remove drawbar mounting bolts and lower drawbar assembly to the ground.

On Models 1190, 1194, 1290 and 1294, remove vacuum switch from bottom of pto housing.

On all models, attach a hoist to pto housing. Remove housing retaining bolts and install a guide stud on each side of housing. Slide housing rearward on studs and remove pto unit from tractor. Withdraw pto clutch shaft from rear of tractor.

On 1190, 1194, 1290 and 1294 tractors, remove hydraulic pump, pressure line retaining bracket and pump support plate from rear of tractor.

On all models, support each side of tractor with suitable stands. Raise rear of tractor and position a suitable support stand under center of rear frame. Remove left and right wheels and final drive assemblies as outlined in paragraph 279. Remove right-hand brake assembly, right-hand seal, differential lock sleeve and spring. Remove transmission dipstick and transmission range and gear selector lever assemblies from transmission cover. Remove mounting bolts from transmission cover and rear axle case. Remove wedge and shim from front of transmission cover. Lift transmission cover from housing.

Support axle housing with a hoist. Disconnect differential lock linkage and hand brake linkage. Remove axle housing mounting bolts, then remove housing from main frame.

Remove lubrication line from transmission. Remove mounting bolts from clutch shaft bearing carrier. Remove transmission mounting bolts and bushings. Remove transmission rearward from main frame (Fig. 175).

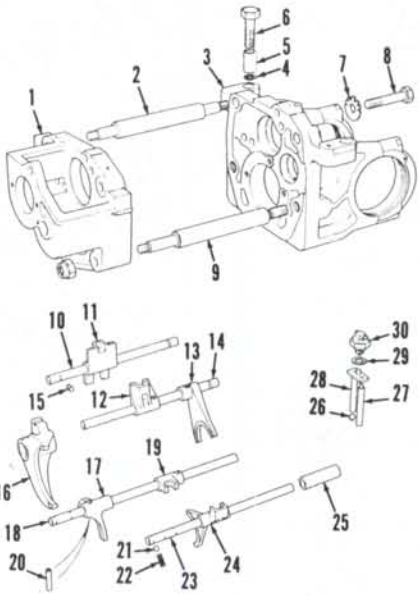


Fig. 174—Exploded view showing end plates, shift rods and shift forks used on 1190, 1194, 1290, 1294 and 1390 models.

1. Front end plate
2. Top spacer bar
3. Rear end plate
4. Shim
5. Bushing
6. Mounting bolts
7. Tab washer
8. Differential cap bolt
9. Bottom spacer bar
10. 2nd & 3rd shift rod
11. 2nd & 3rd selector
12. 1st & reverse selector
13. 1st & reverse shift fork
14. 1st & reverse shift rod
15. Gear lock
16. 2nd & 3rd shift fork
17. Shift fork, slow/normal
18. Slow/normal shift rod
19. Selector
20. Roll pin
21. Detent ball
22. Detent spring
23. Range shift rod
24. Shifter fork, Hi-Lo
25. Sleeve
26. Steel ball
27. Plunger
28. Plunger
29. Shim
30. Safety start switch

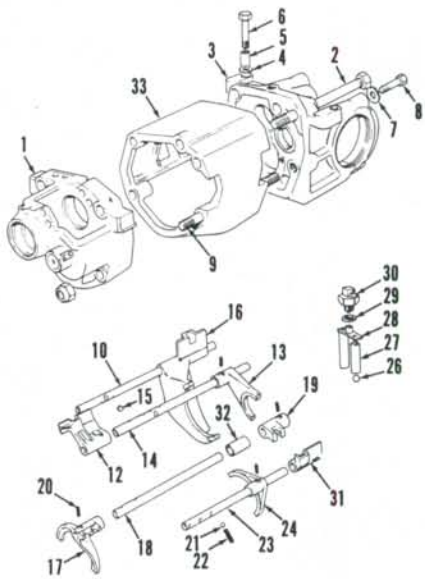


Fig. 174A—Exploded view of end plates, shift rods and shift forks used on 1394, 1490, 1494, 1594 and 1690 models. Refer to Fig. 174 for legend except for the following:

31. Hi-Lo selector jaw
32. Sleeve
33. Spacer

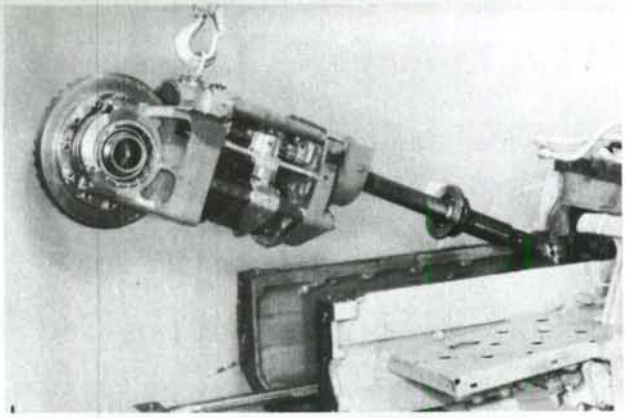


Fig. 175—Attach a hoist to transmission as shown and remove unit rearward from main frame.

224. REINSTALL. Using a hoist, install transmission assembly in main frame (Fig. 175). Install mounting bolts and bushings. Tighten bolts to 163 N·m (120 ft.-lbs.) torque, then measure clearance between bolt heads and end plate using a feeler gage as shown in Fig. 176. Clearance should be 0.08-0.50 mm (0.003-0.020 inch). If clearance is not within this range, add or remove shims (4—Fig. 174) below bushing (5). Tighten clutch shaft bearing retainer mounting bolts to 23-27 N·m (17-20 ft.-lbs.).

Apply gasket sealer to front mating surface of rear axle housing, then install axle housing assembly. Tighten ½ inch mounting bolts to 110-130 N·m (80-95 ft.-lbs.) torque and ⅝ inch mounting bolts to 205-245 N·m (150-180 ft.-lbs.) torque. Connect differential lock linkage.

Apply gasket sealer to upper surface of rear axle housing. Install transmission lubrication tube. Install transmission cover and drive the wedge and shim into gap at front of cover. Tapered side of wedge must be against clutch housing. Tighten ½ inch diameter rear mounting bolts to 110-130 N·m (80-95 ft.-lbs.) torque and ⅝ inch diameter rear mounting bolts to 205-245 N·m (150-180 ft.-lbs.) torque. Tighten side and front mounting bolts to 110-130 N·m (80-95 ft.-lbs.) torque. Install gear selector housings and tighten mounting bolts to 23-27 N·m (17-20 ft.-lbs.) torque.

Install spring for differential lock in right side axle opening and install differential locking sleeve using special tool CAS-1633. Use wire to hold differential lock linkage in engaged position until final drive is installed. Install axle housing seals and brake shoes. Install final drive assemblies and tighten mounting bolts to 68 N·m (50 ft.-lbs.) torque. Install wheels and tighten nuts to 190 N·m (140 ft.-lbs.) torque. Remove support stands. Connect brake lines and parking brake linkage.

On Models 1190, 1194, 1290 and 1294, install hydraulic pump support plate, pressure tube retainer bracket and hydraulic pump. Tighten pump mounting bolts to 47-57 N·m (35-40 ft.-lbs.) torque.

On all models, install pto drive shaft. Using a hoist, install pto assembly. Put pto in gear and turn output shaft to engage splines of drive shaft and teeth of hydraulic pump gear. Remove guide studs, install mounting bolts and tighten to 102 N·m (75 ft.-lbs.) torque.

Complete installation by reversing removal procedure. Install a new transmission filter and fill transmission with oil.

Models 1394-1490-1494-1594-1690

225. REMOVE. Remove platform or cab as outlined in paragraph 348 or 349 if so equipped. Drain oil from transmission and final drive units. Raise rear of tractor and install suitable support stands under center of rear main frame and at each side of front frame rails.

Disconnect battery ground cable and rear wiring harness connector. On left-hand side, remove brake cables from hand lever, remove knobs from dump valve lever (if so equipped) and three-way valve lever and remove axle cover mounting bolts. On right-hand side, disconnect hydraulic control lever assembly and remove axle cover mounting bolts. Unbolt and remove fenders, axle cover and seat as one unit.

Disconnect and remove drawbar assembly and hitch lift arms, leveling levers and lower links. Remove external hydraulic filter. Disconnect hydraulic hoses and lines from remote valve, then remove remote valve and couplers. Disconnect cable from draft sensing unit. Use a hoist to support pto assembly. Remove pto housing mounting bolts and install two guide studs. Remove pto unit and withdraw pto drive shaft.

Disconnect brake lines and cap openings. Push differential lock pedal down and secure with wire to hold it in engaged position. Support final drive with suitable hoist and lifting bracket, remove mounting bolts and remove final drive assembly. Repeat for opposite side.

On 1490 and 1494 models, push differential lock sleeve in and down to disengage from selector fork, then remove sleeve and spring.

On 1594 and 1690 models, release differential lock pedal. Pull sleeve and spring away from differential and put a piece of flat metal between spring and differential to hold spring clear while removing axle housing.

On all models, support axle housing with a hoist and sling, remove mounting bolts and remove axle housing from main frame.

Remove gear selector assemblies from transmission cover. Remove cover mounting bolts and lift out wedge and shims from front of transmission cover. Lift cover from rear main frame.

Attach a lifting eye to transmission rear end frame, then use a hoist to support transmission unit. Remove snap ring from groove in clutch shaft and slide coupling forward. On models equipped with David Brown front drive axle, remove bolt from drive shaft cou-

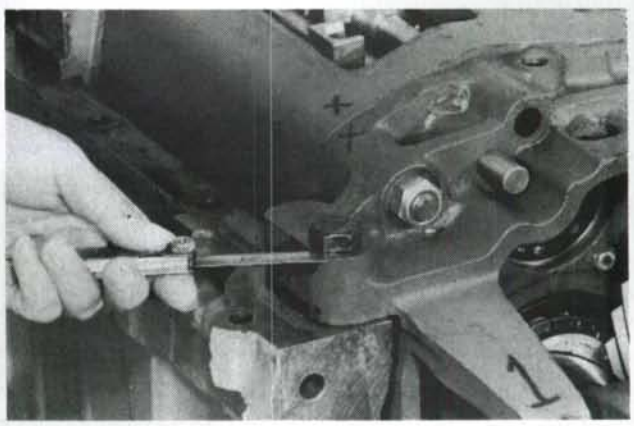


Fig. 176—Measure clearance between head of mounting bolts and transmission housing. Clearance is determined by thickness of shims installed beneath mounting bolt bushings.

pler and move coupler rearward. On all models, remove transmission mounting bolts and bushings. Move transmission rearward to disengage drive couplers, then lift transmission unit from frame. Retain any shims used with clutch shaft coupler.

226. REINSTALL. Clean all foreign material from housing mounting surfaces. Install front drive axle coupler (if so equipped) on pinion shaft. Install original shims onto transmission input shaft and position coupler on clutch shaft. Install transmission into main frame and slide it forward into couplers. Install transmission mounting bolts without the bushings (5—Fig. 174A).

Be sure both lugs of transmission front housing contact the frame. If lugs are not flat on frame, loosen the four transmission housing nuts and push housing down against frame. Tighten nuts to 95 N·m (70 ft.-lbs.) torque when lugs are flat on frame.

Remove transmission mounting bolts, reinstall bolts with bushings and tighten to 163 N·m (120 ft.-lbs.) torque. Use a feeler gage to check clearance between bolt heads and housing lugs as shown in Fig. 176. Clearance should be 0.08-0.50 mm (0.003-0.020 inch). If necessary, install shims (4—Fig. 174A) below bushings (5) to obtain desired clearance.

Measure clearance between clutch shaft coupler (Fig. 177) and snap ring. Clearance should be 0.2-1.0 mm (0.008-0.040 inch). Add or remove shims on transmission input gear to obtain correct clearance.

On models equipped with David Brown front drive axle, install bolt and locknut in transfer gearbox coupler.

On models equipped with Carraro front drive axle, measure clearance between transfer gearbox shaft (Fig. 178) and pinion shaft coupler. If clearance exceeds 0.30 mm (0.012 inch), unseat snap ring that holds coupler adjusting screw. Turn adjusting screw to move coupler until desired clearance is obtained, then reinstall snap ring over adjusting screw.

On all models, install transmission cover, wedge and shims, but do not tighten mounting bolts.

On 1594 and 1690 models, position differential lock sleeve in right-hand side of rear axle housing. Groove in sleeve must be aligned with differential lock selector fork.

On all models, install rear axle housing onto transmission housing making certain that lubrication supply tube in axle housing is connected with transmission lubrication tube. On 1594 and 1690 models, be sure small diameter lubrication tube in rear axle housing is installed into hole in lubrication flange for pto shaft.

On 1394, 1490 and 1494 models, install differential lock return spring into axle housing through right-hand axle hole. Use special tool CAS-1633, or other suitable tool, to insert differential lock sleeve into axle housing. Push sleeve in and down to engage selector fork with groove in sleeve. Push sleeve in until it engages internal splines of differential carrier, then wire differential lock linkage in engaged position.

On 1594 and 1690 models, install differential lock spring into differential and differential lock sleeve. Insert special tool CAS-1633, or other suitable tool, into axle housing and engage tool with splines of lock sleeve. Be sure groove in sleeve is engaged with selector fork, then lift sleeve and turn to engage sleeve with differential lock ring gear. Use wire to fasten differential lock linkage in engaged position.

On all models, tighten ½ inch axle housing mounting torque bolts to 110-130 N·m (80-95 ft.-lbs.) torque and ⅝ inch mounting bolts to 205-245 N·m (150-180 ft.-lbs.) torque. Tighten transmission cover mounting bolts to 110-130 N·m (80-95 ft.-lbs.) torque.

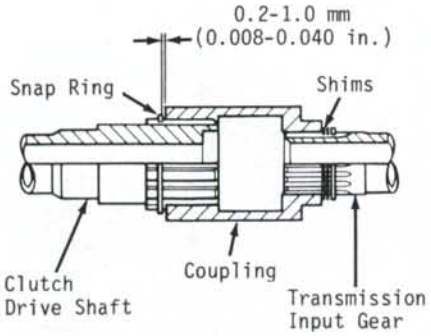


Fig. 177—Clearance between transmission clutch shaft coupler and snap ring should be 0.2-1.0 mm (0.008-0.040 inch). Add or subtract shims to adjust.

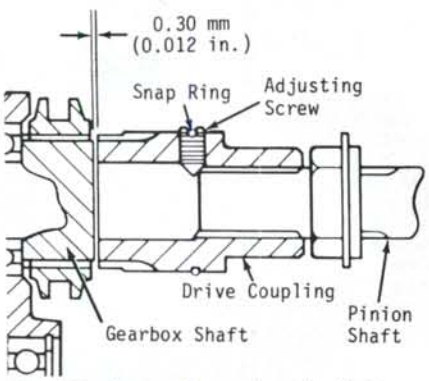


Fig. 178—On models equipped with Carraro front drive axle, clearance between transfer gearbox shaft and pinion shaft coupler must not exceed 0.30 mm (0.012 inch).

Install final drive assemblies as outlined in paragraph 279. Install pto drive shaft and pto assembly. Pto unit should slide easily into position. Do not use mounting bolts to pull pto into position as damage to engine crankshaft thrust surfaces could result.

Complete installation by reversing the removal procedure.

TRANSMISSION OVERHAUL

Models 1190-1194-1290-1294

227. It is recommended that transmission be mounted in a suitable support stand to aid in handling unit during overhaul procedure.

Remove mounting bolts from input shaft rear bearinq carrier (3—Fig. 179) and remove input shaft (1) assembly. Remove snap ring securing input shaft front bearing carrier, then slide carrier from shaft. Remove "O" ring and oil seal from front bearing carrier. Remove seal (8) and "O" ring (7) from input gear (5). Remove snap rings (2 and 6) and remove input gear and rear bearing carrier with bearing from input shaft.

Drive roll pins from shift forks. Cover detent holes in end housing to prevent detent balls and springs from flying out as shift rails are removed. Keep each shift rail assembly together as they are removed.

Use a wooden wedge to lock differential assembly, then remove pinion shaft nut (31).

NOTE: Pinion shaft nut has left-hand threads.

Remove four nuts from housing spacer rods, then withdraw front end housing (49). Remove high/low slow gear (9). Remove idler shaft retainer plate (50), then remove idler shaft (61) and idler gear (65). Remove remaining bearing cups from end housing as necessary.

Remove neutral start plungers (27 and 28—Fig. 174) and detent balls (26) from rear housing. Remove first and reverse shift rod assembly and second and third shift rod assembly. Remove countershaft assembly (69—Fig. 179) and rear input shaft (17) assembly.

Press front bearing (12) off rear input shaft (17). Remove spacer (13), snap ring (14) and range pinion gear (15). Press reverse idler gear carrier (18), idler gear (20) and bearing (23) together off rear input shaft. Use care not to lose dowel pin (21). Remove bushings (10 and 19) from input shaft and reverse idler gear if necessary.

Remove first and reverse gear shift fork from pinion shaft assembly. Remove spacer (35), shims (36), spacer

(37), washer (51) and third gear (52) from pinion shaft (59). Remove the six bearing pads (38), then lift synchronizer (40) with shift fork off shaft. Remove front and rear synchronizer gears, second gear (41) and the six bearing pads (55). Remove splined washer (42) and split retainer ring (43). Remove first and reverse gear (56). Remove pinion shaft retainer plate (57) and shims (44). Remove pinion shaft (59) and press bearing (58) off shaft.

228. 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 synchronizer pads (38 and 55—Fig. 179). Slight radial clearance (looseness) in synchronizer is normal and the pads should slide easily into their grooves without binding. No attempt should be made to disassemble synchronizer assembly as individual service parts are not available.

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. 180. Shift rail grooves should have straight 60 degree sides and balls must be smooth with no pits, rust or flat spots. If necessary, grind bottom of 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 housings, center housing, or pinion shaft bearings are renewed, pinion shaft protrusion must be set as outlined in paragraph 273 before transmission reassembly.

229. REASSEMBLY. If pinion shaft protrusion must be set, refer to paragraph 273.

230. PINION SHAFT ASSEMBLY. With pinion shaft (59—Fig. 179), 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 spacer (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, then 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 splined 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).

231. REAR INPUT SHAFT ASSEMBLY. Press bushing (10—Fig. 179) 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. Heat rear bearing to 120°C (250°F) maximum, then install onto shaft.

Install high/low range gear (15) with larger diameter gear on shaft first. Install snap ring (14) and spacer (13). Heat front bearing (12) to 120°C (250°F) maximum, then install onto shaft.

Install input shaft assembly in position on rear housing (28) minus shims

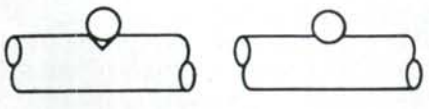


Fig. 180—Shift rod grooves must have straight 60° sides and allow a small clearance under detent balls.

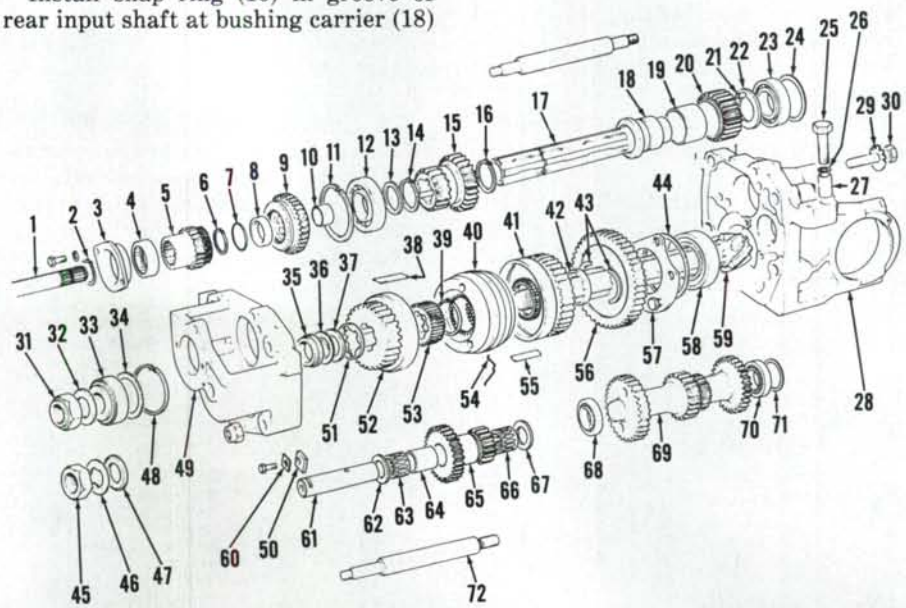


Fig. 179—Exploded view of 12-speed synchromesh transmission used on 1190, 1194, 1290, 1294 and 1390 models.

1. Front input shaft
2. Snap ring
3. Rear bearing carrier
4. Bearing
5. Input gear
6. Snap ring
7. "O" ring
8. Seal
9. High/low slow gear
10. Bushing
11. Snap ring
12. Bearing
13. Spacer
14. Snap ring
15. Range pinion
16. Snap ring
17. Rear input shaft
18. Gear carrier
19. Bushing
20. Reverse idler gear
21. Dowel pin
22. Washer
23. Bearing
24. Shim
25. Mounting bolt
26. Shim
27. Bushing
28. Rear end housing
29. Tab washer
30. Bolt
31. Locknut
32. Washer
33. Bearing
34. Shim
35. Spacer
36. Spacer
37. Spacer
38. Bearing pad
39. Snap ring
40. Synchronizer
41. Second gear
42. Splined washer
43. Split rings
44. Shim
45. Locknut (used with front drive)
46. Tab washer (used with front drive)
47. Washer (used with front drive)
48. Snap ring
49. Front end housing
50. Locating plate
51. Splined washer
52. Third gear
53. Front synchronizer gear
54. Synchronizer spring
55. Bearing pad
56. First/reverse gear
57. Retainer plate
58. Bearing
59. Pinion shaft
60. Tab washer
61. Idler shaft
62. Thrust washer
63. Bearing
64. Spacer
65. Idler gear
66. Bearing
67. Thrust washer
68. Bearing
69. Countershaft assy.
70. Bearing
71. Shim
72. Spacer bar

(24). Install front housing (49) and tighten spacer bar nuts to 95 N·m (70 ft.-lbs.) torque. Mount dial indicator on front housing so probe touches end of rear input shaft. Move shaft up and down and measure end play. Correct end play is 0.05-0.43 mm (0.002-0.017 inch). Remove front housing and the rear input shaft assembly. Assemble and install shims (24) as necessary in rear housing bearing bore to obtain correct end play. Reinstall rear input shaft assembly.

232. COUNTERSHAFT ASSEMBLY. Heat bearings (68 and 70—Fig. 179) to 120°C (250°F) maximum before installing on countershaft (69). Install bearing cup in rear housing without shims (71). Position countershaft in rear end housing, install front housing and tighten spacer bar nuts to 95 N·m (70 ft.-lbs.) torque.

Mount a dial indicator on rear housing so probe contacts face of rear gear of countershaft. Move shaft up and down and measure end play. Specified end play is 0.05-0.10 mm (0.002-0.004 inch). Remove front end housing, countershaft and rear bearing cup. Install shims (71) as necessary to provide desired end play, then reinstall bearing cup and countershaft.

Install first/reverse and second/third shift rail assemblies.

233. FRONT HOUSING ASSEMBLY. Install bearings (63 and 66—Fig. 179) and spacer (64) into range idler gear (65). Bearing cages should be slightly below end surface of range idler gear when installed. Install idler gear assembly with a thrust washer (62 and 67) at each end. Install idler shaft (61) and secure with locating plate (50) and mounting bolt. Position high/low slow gear (9) in front housing with shift fork groove up. Install front housing assembly onto transmission making certain rear input shaft goes through high/low slow gear. Install new spacer rod nuts and tighten to 95 N·m (70 ft.-lbs.) torque.

234. PINION SHAFT END PLAY. Install original shim pack (36—Fig. 179) removed during disassembly plus an additional 0.25 mm (0.010 inch) thick shim. Install shoulder washer (35) with flat side against shims. Install bearing cone, washer and nut on pinion shaft and tighten nut to 270 N·m (200 ft.-lbs.) torque. Position a dial indicator on front housing so probe contacts end of pinion shaft. Move pinion shaft up and down and measure end play. Remove nut and bearing, then reduce shim thickness as necessary to provide zero end play to 0.05 mm (0.002 inch) preload. Reassemble using a new nut and tighten nut to 270 N·m (200 ft.-lbs.) torque.

235. FRONT INPUT SHAFT ASSEMBLY. Install new needle bearing (10—Fig. 181), if removed, into retainer (9) using special tool CAS-1015 or other suitable tool. Install oil seal (5) in support sleeve (2) and place "O" ring (1) on sleeve. Place input gear (12) onto shaft (4) and install snap ring (13). Install new "O" ring (14) and oil seal (15) into input gear. Install snap ring (11) against input gear. Slide rear bearing carrier assembly (9) onto input shaft. Install front carrier bearing (7) and retaining rings onto shaft. Lubricate support sleeve seal, then slide sleeve over the shaft and onto front bearing. Install snap ring (3) in support sleeve.

236. SHIFT RODS AND DETENT ASSEMBLY. To facilitate installation of detent balls and springs, fabricate an installation tool as shown in Fig. 182.

Install detent ball and spring for first/reverse shift rod using tool as shown in Fig. 183. Push detent ball down with tool while moving shift rod into rod bore as shown.

Install shift interlock plug by placing in position through second/third gear shift rod bore. With interlock plug in position, install detent ball and spring and second/third shift rod.

Install remaining shift rods, forks, detent springs and balls in similar manner. Install roll pins in shift forks and rods. Install neutral start switch balls, rods, plate and switch.

Install input shaft assembly and tighten rear bearing retainer mounting 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.

Fig. 181—Exploded view of front input shaft assembly used on Models 1190, 1194, 1290, 1294 and 1390.
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

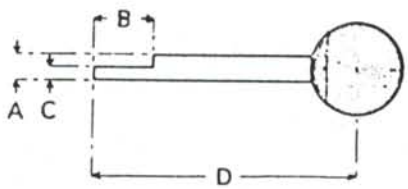


Fig. 182—As an aid for installing detent balls and springs, fabricate a tool using the following dimensions.
A. 9.5 mm (0.375 in.)
B. 15.8 mm (0.625 in.)
C. 4.8 mm (0.187 in.)
D. 150 mm (6.0 in.)

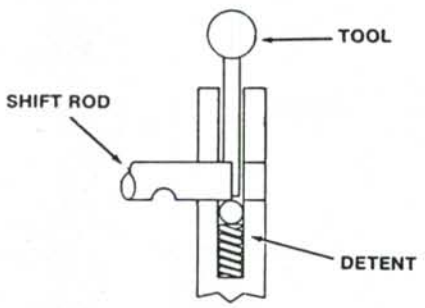


Fig. 183—When installing shift rods and detents, use tool as shown to push detent ball and spring down while moving shift rod in. Remove tool and push shift rod completely into rod bore.

Models 1394 (Prior to P.I.N. 11139846)-1490-1494 (Prior to P.I.N. 1194089)

237. DISASSEMBLY. Place transmission in a suitable transmission support stand, then remove roll pins from slow/normal shift fork (74—Fig. 184) 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) has left-hand threads, remove nut (27), washer (28) and bearing cone (29) from pinion shaft (54). Remove stud bolt nuts, then separate and support front end housing (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 housing (31) off transmission center housing (56). Remove slow/normal sliding gear (10) from inside front end housing.

Remove roll pin (60) and remove idler shaft (59). Remove snap ring (1) from input gear (8) and snap ring (2) from front end housing (31). Carefully remove input gear assembly out of front end housing. 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 housing. Remove remaining bearing cups, spacer, bearings and snap rings as necessary.

Remove stud bolts. Remove center housing (56) by rotating center housing towards countershaft to gain clearance, then lift housing over shaft and gear assemblies.

Remove countershaft (69) from rear end housinq (42). Remove retaining bolt (23), remove high/low shift fork from sliding gear (16), and remove input shaft assembly (17) from rear end housing. 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 and spacer (13) off input shaft (17). Remove snap ring (14) and high/low sliding gear (16). Remove bushing (15) from inside input shaft.

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 gear 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 rearward from housing.

238. INSPECTION. Clean and inspect all parts. Examine bearings and bushings for wear or damage and renew as necessary. If gear teeth show excessive wear or irrregular wear pattern, gear should be renewed along with its mating gear.

Examine synchronizer friction surfaces and the synchronizer pads (35 and 51—Fig. 184) for wear. Slight looseness of pads in synchronizer is normal and the pads should slide easily into their grooves with no binding. No attempt should be made to disassemble synchronizer assembly as individual service parts are not available.

Examine fit of detent balls in grooves of shifter rails (Fig. 180). Shift rail grooves should have straight 60 degree sides and detent ball must not contact bottom of groove.

Check all thrust washers and spacers for excessive wear or damage and renew as necessary.

239. REASSEMBLY. If pinion shaft, bearings, end housings or center housing are renewed, pinion shaft protrusion must be set as outlined in paragraph 273 before reassembling transmission.

240. INPUT SHAFT ASSEMBLY. Install new bushing (15—Fig. 184) into front end of input shaft (17). Place high/low sliding gear (16) on input shaft with larger diameter gear toward rear end of shaft. Heat front bearing (12) to 120°C (250°F) maximum, then install snap ring (14), spacer (13) and bearing on shaft. Note that bearing must be installed with side stamped with bearing numbers towards front end of shaft. Press new bushing (19) into reverse idler gear (20), then install gear onto input shaft with beveled edge of gear teeth towards front of shaft. Install thrust washer (24) with flat side towards idler gear. Heat rear bearing (25) to 120°F (250°F) maximum, then install bearing and snap ring (26).

Position shaft assembly on rear housing and install retaining washer (21), tab washer (22) and bolt (23). Tighten bolt to 11 N·m (8 ft.-lbs.) torque, then bend tab washer against bolt head.

241. PINION SHAFT ASSEMBLY. Install pinion shaft and rear bearing

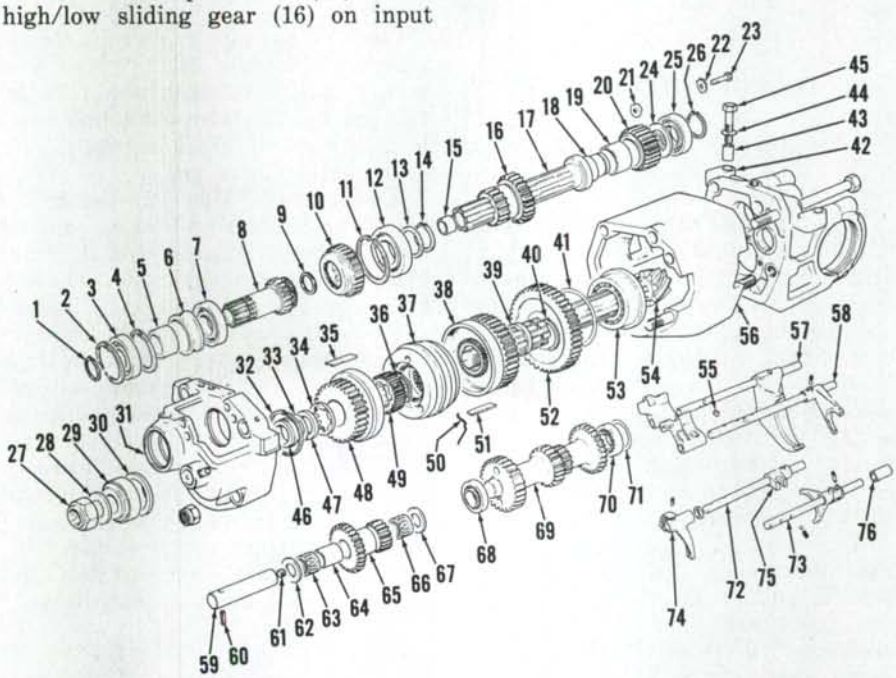


Fig. 184—Exploded view of 12-speed syncromesh transmission used on early 1394 (prior to P.I.N. 11139846), early 1494 (prior to P.I.N. 11194089) and all 1490 models.

1. Snap ring
2. Snap ring
3. Bearing
4. Snap ring
5. Inner spacer
6. Outer spacer
7. Bearing
8. Input gear
9. Sealing ring
10. Slow/normal sliding gear
11. Snap ring
12. Bearing
13. Spacer
14. Snap ring
15. Bushing
16. High/low sliding gear
17. Input shaft
18. Bushing surface
19. Bushing
20. Reverse idler gear
21. Retaining washer
22. Tab washer
23. Bolt
24. Thrust washer
25. Bearing
26. Snap ring
27. Locknut
28. Washer
29. Bearing
30. Spacer
31. Front end housing
32. Snap ring
33. Shims
34. Thrust washer
35. Bearing pad
36. Snap ring
37. Synchronizer
38. Second gear
39. Retaining washer
40. Split rings
41. Shim
42. Rear end housing
43. Bushing
44. Shim
45. Mounting bolt
46. Shoulder spacer
47. Washer
48. Third gear
49. Front synchronizer gear
50. Synchronizer spring
51. Bearing pad
52. First/reverse sliding gear
53. Bearing
54. Pinion shaft
55. Shift interlock
56. Center housing
57. Second/third shift rod
58. First/reverse shift rod
59. Idler shaft
60. Roll pin
61. Plug
62. Thrust washer
63. Bearing
64. Spacer
65. Idler gear
66. Bearing
67. Thrust washer
68. Bearing
69. Countershaft
70. Bearing
71. Shim
72. Slow/normal shift rod
73. High/low shift rod
74. Shift fork
75. Selector jaw
76. Sleeve

into rear housing. Position first/reverse shift fork into slot in sliding gear (52—Fig. 184), then install gear over pinion shaft. Make certain shift rod enters hole nearest input shaft retaining washer. Install split rings (40) and retaining washer (39). Install second gear (38) with synchronizer ring towards front end of shaft. Lightly coat bearing pads (51) with grease, then install pads in pinion shaft splines under second gear. Install rear synchronizer gear so end of gear with alignment marks is towards second gear. Install snap ring (36), align marks of rear synchronizer gear with marks on front synchronizer gear and install front gear (49) with slotted end of gear towards front of shaft. Install synchronizer (37). Install third gear (48) with synchronizer ring towards synchronizer. Apply small amount of grease to bearing pads (35), then install pads behind third gear. Install thrust washer (34) and flat spacer (47). Do not install shims (33) or shoulder spacer (46) at this time.

242. COUNTERSHAFT ASSEMBLY. Heat front and rear bearings (68 and 70—Fig. 184) to 120°C (250°F) maximum, then install on countershaft (69).

To adjust end play, remove a shim 0.25 mm (0.010 inch) in thickness from original shim pack (71). Install remainder of shims and bearing cup in rear housing. Install front bearing cup in bore of front housing. Position countershaft on rear housing, install center housing, stud bolts and front housing and tighten stud bolt nuts to 95 N·m (70 ft.-lbs.) torque. Mount a dial indicator so probe contacts rear gear of countershaft. Move shaft up and down and measure end play. Disassemble housings and countershaft. Remove rear bearing cup and shims. Subtract 0.076 mm (0.003 inch) from end play measurement. The result is thickness of shims that must be added to original shim pack to obtain specified end play of 0.076 mm (0.003 inch). Install required thickness of shims and reinstall bearing cup. Position countershaft on rear housing.

243. CENTER AND FRONT HOUSING ASSEMBLIES. To install center housing (56—Fig. 184), place second/third gear selector fork into groove on synchronizer (37). Put high/low selector fork into groove on sliding gear (16). Install center housing turning the housing to clear countershaft gears. Apply Loctite 242 to stud bolt threads, then install stud bolts into rear housing and tighten to 122 N·m (90 ft.-lbs.) torque.

Heat bearing (7—Fig. 184) to 120°C (250°F) maximum, then install on input gear (8). Be sure side of bearing stamped with bearing numbers is towards splined end of gear. Install inner spacer (5) on input gear. Install snap ring (4), bearing (3) and snap ring (2) in front housing (31). Install outer spacer (6) and outer bearing race for roller bearing in front housing.

Assemble bearings (63 and 66) and spacer (64) in range idler gear (65). Use a depth micrometer to measure distance needle bearing cage is below face of idler gear. The distance must be 0.25-1.27 mm (0.010-0.050 inch). If distance is not within the specified range, check for worn needle bearings. Renew spacer if spacer length is less than 42.545 mm (1.675 inches).

Install assembled range idler gear and thrust washer (62 and 67) in front housing with larger gear towards front of the housing. Install input gear assembly in front housing and install snap ring.

Clean oil passage in idler gear shaft (59), apply Loctite 242 to threads of plug (61) and install plug in shaft. Align roll pin hole in idler shaft and front housing, install shaft through idler gear and install roll pin.

Assemble snap ring (32), spacer (30) and pinion shaft front bearing cup into bore in front housing. Install front housing assembly and support housing approximately 40 mm (1½ inches) above center housing. Place slow/normal sliding gear (10) on rear input shaft (17) with selector fork groove towards input gear. Remove spacers, then lower front housing until first/reverse shift rod (58) enters hole in front housing. Install detent ball and spring using tool shown in Fig. 182 and 183 while joining front housing and center housing. Install new locknuts on housing studs and tighten to 95 N·m (70 ft.-lbs.) torque.

244. SHIFT RODS AND DETENTS. Install high/low shift rod (73—Fig. 184) and spacer (76). Install detent spring and ball using tool shown in Fig. 182 and 183. Install roll pin in shift fork.

Install slow/normal shift rod (72—Fig. 184), shift fork (74), spacer and selector jaw (75). Install detent spring and ball using assembly tool, then install roll pins in 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.

245. PINION SHAFT BEARING PRELOAD. Install original shims (33—Fig. 184) removed during disassembly plus an additional 0.25 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 that nut has left-hand threads and tighten to 270 N·m (200 ft.-lbs.) torque. Mark differential bearing caps and remove differential assembly if not already removed. 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) 0.05 mm (0.002 inch) greater than amount of measured end play to obtain specified bearing preload of 0.05 mm (0.002 inch). Reinstall spacer, bearing, washer and nut. Tighten nut to 270 N·m (200 ft.-lbs.) torque.

Reinstall differential assembly and adjust backlash as outlined in paragraph 274.

Shift transmission and range section through all gears and check to be certain all gears and detents work properly.

Models 1394 (P.I.N. 11139846 and After)-1494 (P.I.N. 11194089 and After)-1594-1690

246. DISASSEMBLY. Place transmission in a suitable transmission support stand. Drive roll pins from slow/normal shift rod (84—Fig. 185), 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), 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), shift fork, selector jaw, detent ball and spring and shift interlock plug (68).

Note that pinion nut (39) has left-hand threads, then 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 nuts from stud bolts and raise front end housing (43) approximately 40 mm (1.5 inches). Use blocks

to support front end housing 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 housing (43).

Remove roll pin (72) and idler shaft (71). Remove thrust washers (74 and 79) and idler gear (77).

To disassemble input gear (8), remove snap ring (3). Press bearings (4 and 7) and spacers (5 and 6) off input gear (8).

Remove remaining bearing cups, snap rings and spacers from front end housing.

Remove stud bolts and rotate center housing (53) toward countershaft (81) to gain gear clearance and remove center housing. Remove countershaft (81) and press bearings (80 and 82) off as necessary.

Remove retaining bolts (56) and high/low shift fork from sliding collar (20). Remove input shaft (31) 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) and the six bearing pads (30). Remove splined washer (25) and snap ring (26) on 1690 models. On all other models, remove spacer (86) and shims (87). On all models, remove bushing (27) from input shaft if necessary.

Remove second/third shift fork from synchronizer. Remove spacer (58), 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, rear bearing and shims from rear end housing.

247. INSPECTION. Clean and inspect all parts. Examine bearings and bushings for wear or damage and renew as necessary. If gear teeth show excessive wear or irregular wear pattern, gear should be renewed along with its mating gear.

Examine synchronizer friction surfaces and the synchronizer pads (47 and 63—Fig. 185) for wear. Pads should slide easily into their grooves with no binding, but should not be excessively loose. No attempt should be made to disassemble synchronizer assembly as individual service parts are not available.

Check detent balls and shift rail grooves for wear. There should be a small clearance between ball and bottom of groove.

Check all thrust washers and spacers for excessive wear and renew as necessary.

248. REASSEMBLY. If pinion shaft, pinion shaft bearings or transmission housings are renewed, the pinion shaft protrusion must be set as outlined in paragraph 273 before reassembling transmission.

If countershaft (81—Fig. 185), bearings (80 and 82) or transmission housings are renewed, shaft end play must be set as follows: Remove bearing cup from rear housing and subtract 0.20 mm (0.008 inch) thickness shims from original shim pack. Reinstall bearing cup with shims and assemble countershaft, center housing (53) and front end housing (43). Tighten stud nuts to 95 N·m (70 ft.-lbs.) torque. Rotate shaft to be sure bearings are properly seated.

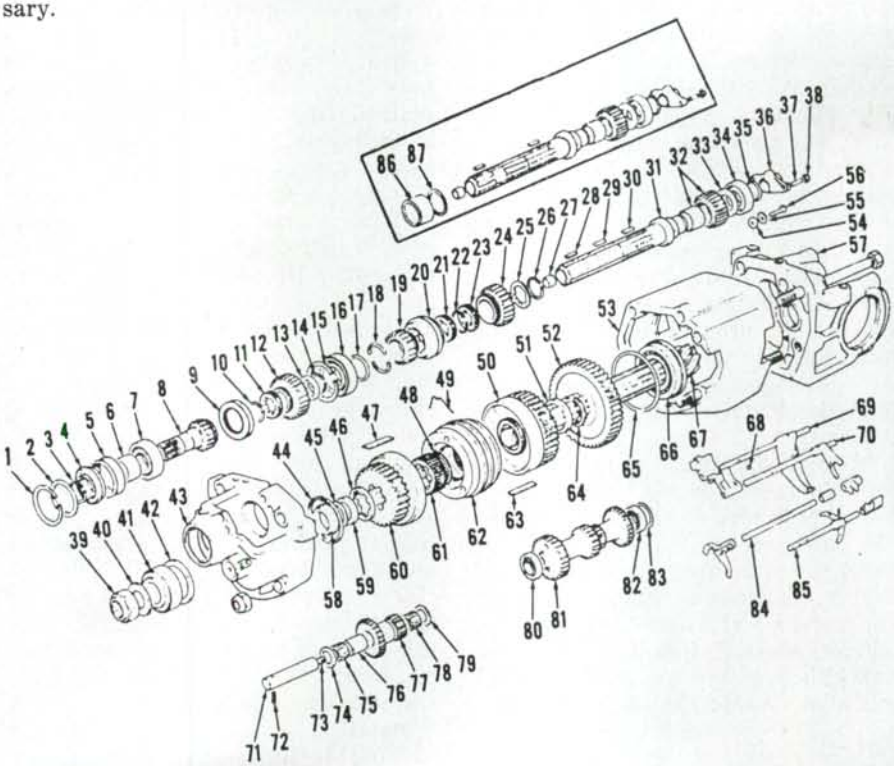


Fig. 185—Exploded view of 12-speed syncromesh transmission used on Model 1690. Transmission used on late 1394 and 1494 models and all 1594 models is similar except that a spacer and shims (inset) are used in place of washer (25) and snap ring (26) to locate components on input shaft (31).

1. Snap ring.
2. Shim
3. Snap ring
4. Bearing
5. Outer spacer
6. Inner spacer
7. Bearing
8. Input gear
9. Sliding collar
10. Snap ring
11. Collar gear
12. Slow range gear
13. Thrust washer
14. Snap ring
15. Snap ring
16. Bearing
17. Retaining collar
18. Split rings
19. Low range gear
20. Sliding collar
21. Front sliding collar gear
22. Snap ring
23. Rear sliding collar gear
24. High range gear
25. Splined washer
26. Snap ring
27. Bushing
28. Bearing pad
29. Bearing pad
30. Bearing pad
31. Input shaft
32. Reverse idler gear & bushing
33. Spacer
34. Bearing
35. Snap ring
36. Lubrication bracket
37. Stud
38. Nut
39. Locknut
40. Washer
41. Bearing
42. Spacer
43. Front end housing
44. Snap ring
45. Shim
46. Splined washer
47. Bearing pad
48. Snap ring
49. Centralizer spring
50. Second gear
51. Retaining washer
52. First/reverse sliding gear
53. Center housing
54. Retaining washer
55. Tab washer
56. Bolt
57. Rear end housing
58. Shoulder washer
59. Spacer
60. Third gear
61. Front synchronizer gear
62. Synchronizer
63. Bearing pad
64. Split rings
65. Shim
66. Bearing
67. Pinion shaft
68. Shift interlock plug
69. Second/third shift rod
70. First/reverse shift rod
71. Idler shaft
72. Roll pin
73. Plug
74. Thrust washer
75. Bearing
76. Spacer
77. Idler gear
78. Bearing
79. Thrust washer
80. Bearing
81. Intermediate shaft
82. Bearing
83. Shim
84. Slow/normal shift rod
85. High/low shift rod
86. Spacer
87. Shim

Position a dial indicator so probe contacts face of rear gear, then move shaft up and down and measure end play. Correct end play is 0.05-0.10 mm (0.002-0.004 inch). Remove countershaft and rear bearing cup and install shims (83) as necessary to provide correct end play.

249. PINION SHAFT ASSEMBLY. Install input shaft rear bearing (34—Fig. 185) in rear housing (57) and hold in place with retaining washer (54), tab washer (55) and bolt (56).

Assemble pinion shaft (67) and rear bearing (66) into position in rear housing. Install center housing (53) so front face of housing is even with ends of bottom studs. Place first/reverse sliding gear (52) on shaft with selector fork groove towards rear housing. Install washer (51) with recessed side towards gear (52). Slide second gear (50) onto shaft, put a small amount of grease on bearing pads (63) and install pads into splines between shaft and gear. Position rear synchronizer gear (not shown) with thin part of teeth towards front of pinion shaft. Slide snap ring (48) onto shaft but not into groove. Install front synchronizer gear (61) with thin part of teeth towards the rear, aligning mark on side of gear with mark on side of rear gear. Install synchronizer (62) over the gears.

Install second/third shift rod assembly (69) into groove of synchronizer. Install first/reverse shift rod assembly (70) into groove of sliding gear (52). Enter end of first/reverse shift rod into hole in rear housing, then move center housing (56) and shift rod rearward together about 50 mm (2 inches). Position split ring (64) into groove in shaft and slide washer (51) over split ring.

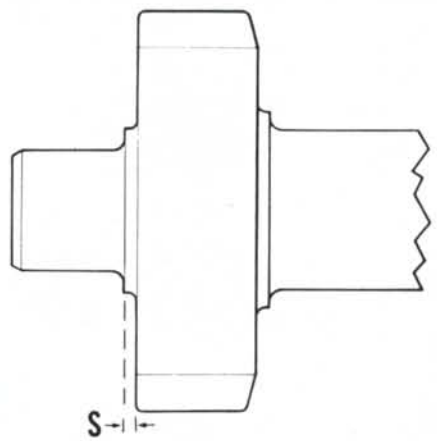


Fig. 186—When adjusting countershaft end play, measure width of shoulder (S) on front of countershaft to determine if adjusting shims should be installed at front or rear of shaft. Refer to paragraph 251.

Push all parts rearward until snap ring (48) is seated in shaft groove.

Install third gear (60), put a small amount of grease on bearing pads (47) and insert pads into splines between gear and shaft. Install splined washer (46) and spacer (59).

250. INPUT SHAFT ASSEMBLY. Assemble components onto input shaft (31—Fig. 185) in reverse order of removal while observing the following special instructions.

On Models 1394, 1494 and 1594, shims (87) are installed as necessary to remove all end play of components on the shaft. On Model 1690, components are located on shaft by snap ring (26); there is no provision for adjustment of end play.

Rear sliding collar gears (21 and 23) have lubrication slots and a punch marked tooth for alignment on one side of each gear. Install rear gear (23) so slotted side is facing high range gear (24) and punch marked tooth is aligned with input shaft spline that has a hole in it. 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 tooth with punch marked tooth of rear gear (23). The sliding gear splines will engage sliding collar splines when correctly installed.

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. Install split ring (18), retaining collar (17) and bearing (16). Be sure bearing is installed with side stamped with bearing number facing front end of shaft. Bearing must seat against retaining collar.

Install reverse idler gear (32) with bushing on input shaft making sure side with beveled gear teeth is towards front of shaft. Install thrust washer (33) with flat side against reverse idler gear.

Drive input shaft into rear bearing (34) and end housing (57) until snap ring (35) can be installed. Install lubrication bracket (36), but do not tighten mounting bolts at this time.

250A. COUNTERSHAFT ASSEMBLY. To adjust countershaft end play, first measure width of shoulder (S—Fig. 186) on front of countershaft. If shoulder width is 1.5-1.73 mm (0.060-0.068 inch), shims (83—Fig. 185) should be installed in front end housing. If shoulder width is 3.33-3.58 mm (0.131-0.141 inch), shims should be installed in rear end housing.

Assemble countershaft, center housing and front housing. Tighten stud nuts to 95 N·m (70 ft.-lbs.) torque. Turn countershaft in both directions to seat bearings. Mount a dial indicator so probe is against end of countershaft, then move shaft up and down and measure end play. Correct end play is 0.05-0.10 mm (0.002-0.004 inch).

Remove countershaft from gearbox. Remove bearing cup from front or rear end housing and install shims as required between the bearing cup and end housing to provide specified end play. Reinstall bearing cup and countershaft.

Place second/third gear shift fork in synchronizer groove. Place high/low shift fork in groove on high/low sliding gear. Reinstall center housing.

251. FRONT END HOUSING ASSEMBLY. Install bearings (75 and 78—Fig. 185) and spacer (76) into idler gear (77). Both bearings should be 0.25-1.3 mm (0.010-0.050 inch) below outer surfaces of idler gear when installed. Install idler shaft assembly and thrust washers in front end housing (43) with large gear towards the front. Push idler shaft (71) into idler gear aligning spring pin holes in shaft and front housing. Install spring pin (72).

Install detent springs and balls for first/reverse and second/third into end housing. Install front end housing onto the bottom studs. Assemble splined washer (13) and slow range gear (12) onto input shaft with smaller gear teeth towards the front. Lubricate and install the six bearing pads (28) between shaft splines and range gear. Install sliding collar gear (11) and sliding collar (9).

Insert first/reverse shift rod into front end housing using tool shown in Fig. 183 to depress detent ball and spring. Insert second/third shift rod into front housing using tool to depress detent ball and spring. Install high/low shift rod using tool to install detent ball and spring. Install roll pins in shift forks.

Install snap ring (10—Fig. 185) on front of input shaft (31). Align input shaft, countershaft and pinion shaft with end housing, then position front end housing down against center housing. Tighten end housing retaining nuts to 95 N·m (70 ft.-lbs.) torque.

Install slow/normal shift fork into groove of sliding collar (9). Push shift rod rearward through shift fork and selector jaw, align pin holes and install spring pins. Install safety start switch balls and plungers.

Install bearing (7) on input gear (8) with thick edge of outer race facing away from gear. Install spacers (6 and 5). Install outer bearing (4) so snap ring groove on outer race is towards front

splined end of input gear. Install snap ring (3). Align gap in teeth of input gear with tooth of idler gear, then push input gear assembly into front housing until spacer (2) and snap ring (1) can be installed.

252. PINION SHAFT BEARING PRELOAD. Install spacer (59—Fig. 185) and all shims (45) removed during disassembly plus an additional 0.25 mm (0.010 inch) thick shim. Install shoulder washer (58) with flat side against shims. Install bearing cone (41), washer (40) and nut (39). Tighten nut to 270 N·m (200 ft.-lbs.) torque. Mount a dial indicator so probe contacts end of pinion shaft and measure shaft end play.

Remove nut, washer, bearing and shoulder washer. Remove thickness of shims (45) equal to measured end play plus an additional 0.05 mm (0.002 inch). This will provide recommended preload of 0.05 mm (0.002 inch). Reinstall spacer, bearing, washer and nut and tighten nut to 270 N·m (200 ft.-lbs.) torque.

Shift transmission and range section through all gears and check to be certain all gears and detents work properly.

POWER SHIFT TRANSMISSION

253. Power shift transmission is available on 1394, 1490, 1494, 1594 and 1690 models. The transmission consists of a three forward, one reverse mechanical gear section coupled with a four-speed, hydraulic power shift section providing twelve forward and four reverse speed selections.

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. Gear (range) speeds are selected manually and transmission clutch must be used.

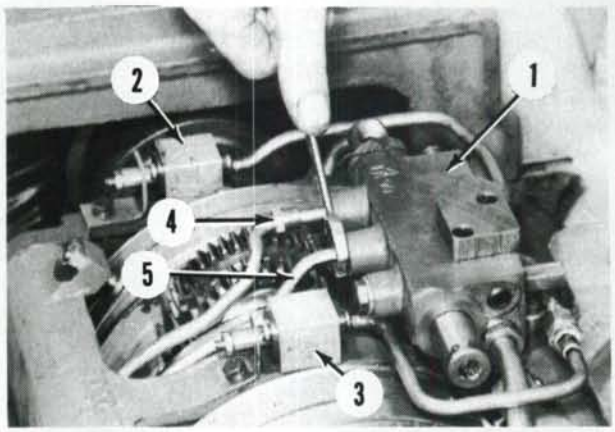


Fig. 187—Identify power shift front sequence valve (2) and rear sequence valve (3) prior to removal as valves are not interchangeable. Flow restrictors are located in front and rear planetary brake pressure lines (4 and 5).

POWER SHIFT CONTROL VALVE

All Power Shift Models

254. Power shift control valve spool and body (8—Fig. 188) are serviced as an assembly only. However, relief valve spring (2) and spool (3) are available separately.

To remove control valve, first remove platform or cab, if so equipped, as outlined in paragraph 348 or 349. Remove fuel tanks. Disconnect wiring harness to rear of tractor and disconnect neutral start switch wires. Remove range and power shift selector assemblies from transmission cover. Disconnect hydraulic lines and control linkage from remote valve. Remove mounting bolts and remove remote valve assembly. Remove transmission cover mounting bolts and remove wedge and shim from front of cover. Use a hoist to lift transmission cover from main frame.

Disconnect hydraulic lines from control valve (1—Fig. 187). Mark sequence valves (2 and 3) so they can be reinstalled in their original positions, then remove both valves. Remove control valve mounting bolts and remove valve assembly.

To disassemble valve for inspection, remove seal wire from relief valve adjusting screw (1—Fig. 188). Remove adjusting screw while noting number of turns required to remove screw for use

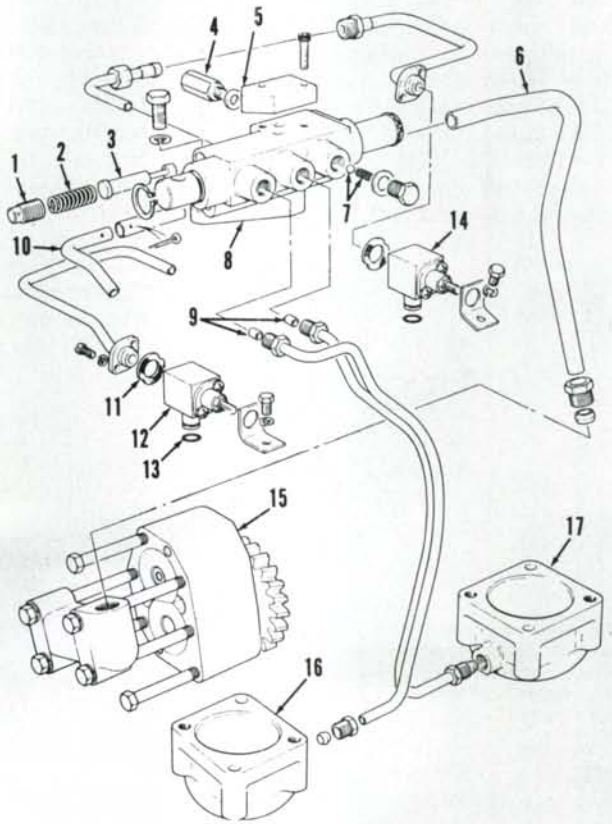


Fig. 188—Partially exploded view of power shift control valve, sequence valves and related oil lines.

1. Adjusting screw
2. Spring
3. Relief valve plunger
4. Plug
5. Restrictor plate
6. Oil supply pipe
7. Detent spring & ball
8. Control valve body & spool
9. Restrictors
10. Lubrication tube
11. Sealing washer
12. Sequence valve, front
13. "O" ring
14. Sequence valve, rear
15. Power shift hydraulic pump
16. Planetary brake cylinder, front
17. Planetary brake cylinder, rear

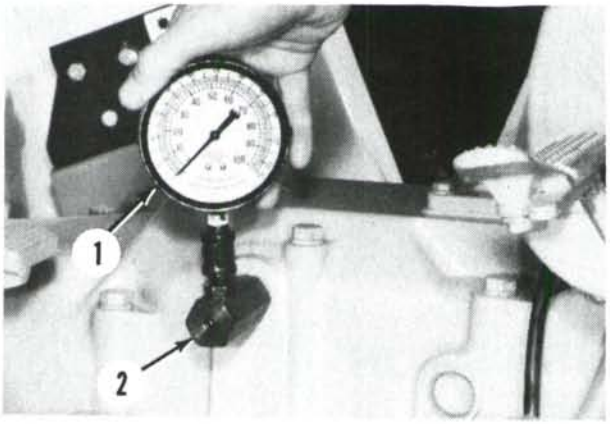


Fig. 189—Install pressure gage (1) using special adapter CAS-1242 (2) in control valve test port to check control valve relief pressure.

in reassembly. Remove spring (2) and relief valve spool (3). Remove plug and detent spring and ball (7). Remove snap ring from valve spool, then withdraw spool from valve body. Remove test port plug (4) and restrictor plate (5).

Inspect all parts for wear or scoring. Be sure control valve spool and bore are free of scoring or other damage.

Reassemble valve by reversing disassembly procedure. Lubricate all parts during reassembly.

255. SETTING CONTROL VALVE PRESSURE. Reinstall control valve and tighten mounting bolts to 34 N·m (25 ft.-lbs.) torque. Install front and rear sequence valves. Move control valve spool fully forward and remove plug (4—Fig. 188) from control valve test port. Install transmission cover and remote valve assembly. Do not install power shift selector lever at this time. Remove test port plug from right side of transmission cover. Install special adapter CAS-1242 (2—Fig. 189) and a 0-1000 kPa (0-150 psi) pressure gage (1) through opening in cover and into control valve test port.

Use a remote fuel supply to operate tractor. Start engine and run to bring transmission fluid temperature to approximately 45°C (115°F). Transmission housing must be warm to the touch. With engine running at 1500 rpm, pressure reading should be 350-560 kPa (77-81 psi) for 1394, 1490 and 1494 models, or 600-625 kPa (87-91 psi) for 1594 and 1690 models. To adjust pressure, insert a screwdriver through power shift selector opening in transmission cover and turn relief valve adjusting screw clockwise to increase pressure or counterclockwise to reduce pressure.

Stop engine and remove manifold and gage. Remove remote valve and transmission cover. Install plug in control valve test port and install a lock wire in relief valve adjusting screw to secure adjustment.

Reassemble tractor by reversing disassembly procedure while noting the following special instructions. Tighten remote valve mounting bolts to 47-57 N·m (35-40 ft.-lbs.) torque. Tighten transmission cover ½ inch mounting bolts to 102-122 N·m (75-90 ft.-lbs.) torque and ⅝ inch mounting bolts to 165-200 N·m (120-130 ft.-lbs.) torque. Tighten range and power shift selector housing mounting bolts to 23-28 N·m (17-20 ft.-lbs.) torque.

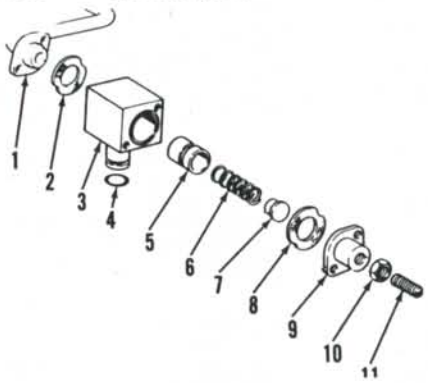


Fig. 190—Exploded view of power shift sequence valve. Adjustment screw (11) setting should not be changed unless valve pressure is to be reset as outlined in paragraph 256.

1. Pressure line
2. Gasket
3. Valve body
4. "O" ring
5. Piston
6. Spring
7. Spring seat
8. Gasket
9. End cap
10. Locknut
11. Adjusting screw

SEQUENCE VALVES

All Power Shift Models

256. The sequence valves (2 and 3—Fig. 187) control release timing of front and rear planetary clutch units. Front and rear sequence valves are mechanically identical, however, they have different pressure settings. Therefore, be sure valves are properly marked before removal so they can be reinstalled in their original positions. Front sequence valve controls release of front planetary clutch, while rear sequence valve controls release of rear planetary clutch.

To remove sequence valves, it is first necessary to remove transmission cover as outlined in paragraph 254. Sequence valves are serviced as a complete assembly only, but valves may be disassembled for cleaning and inspection. It is recommended adjustment screw setting not be disturbed during disassembly.

All new sequence valves obtained through parts are adjusted at factory to rear sequence valve pressure setting (which is lower than front setting). If a new sequence valve is to be installed in front position, increase factory setting by turning adjusting screw clockwise two full turns.

Pressure setting of sequence valves can be checked and adjusted using a suitable hand pressure pump and a 0-400 kPa (0-60 psi) pressure gage. Remove hydraulic pressure line from valve, block orifice in piston with tape and reinstall pressure pipe. Connect sequence valve to hand pressure pump and pressure gage. Operate hand pump slowly and note pressure reading at point pressure makes a rapid drop indicating valve opened. Adjust screw (11—Fig. 190) until pressure release point is 210-220 kPa (32-33 psi). If valve is to be installed in rear position, tighten jam nut to secure adjusting screw at this setting. If valve is to be installed in front position, turn screw clockwise an

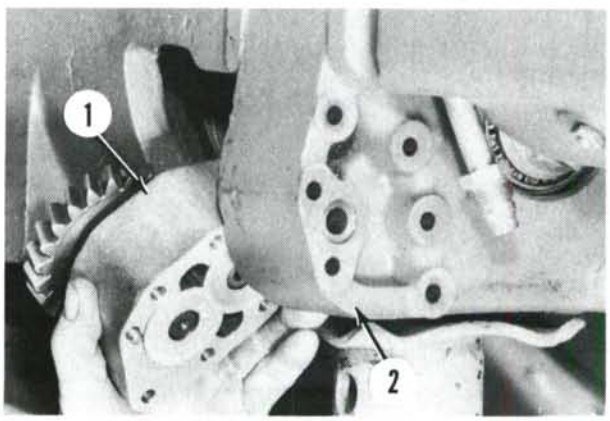


Fig. 191—Power shift hydraulic pump (1) is mounted on lower right corner of range gearbox cover (2). Hydraulic manifold mounts on front side of the cover.

additional two turns and secure with jam nut. Remove tape from piston orifice, reassemble valve and install in proper position.

POWER SHIFT HYDRAULIC PUMP

All Power Shift Models

257. The power shift hydraulic pump is mounted on lower right-hand corner of range gearbox front cover (Fig. 191). The pump is gear driven from reverse gear of range transmission.

To remove pump, first separate power shift transmission from main frame as outlined in paragraph 258. Remove manifold and pump mounting bolts, then remove pump assembly from rear side of housing.

Use a suitable puller to remove pump drive gear. Remove Woodruff key, then separate pump rotor assembly from pump body (Fig. 192).

Inspect all parts for wear or damage. Pump rotors and bearings are serviced as a complete set. Renew all "O" rings.

When reassembling, make sure sides of bearings with oil grooves are against gears. Lubricate all parts with clean oil during assembly. Install drive gear using a new locknut and tighten nut to 73-86 N·m (54-64 ft.-lbs.) torque.

Reinstall pump and manifold using new "O" rings in oil ports. Tighten mounting bolts to 23-27 N·m (17-20 ft.-lbs.) torque.

REMOVE AND REINSTALL TRANSMISSION

All Power Shift Models

258. REMOVE. To remove power shift unit, first remove platform or cab as outlined in paragraph 348 or 349. Remove fuel tanks. Drain oil from transmission and remove filter housing cover and filter assembly from bottom of transmission housing. Attach support stands on each side of tractor. Disconnect battery ground cable, rear wiring harness and neutral start switch wires.

Remove range and power shift selector assemblies and transmission dipstick from transmission cover. Remove cover mounting bolts, then drive wedge and shims from between front of cover and clutch housing. Disconnect all hoses, supply lines and control linkage from remote valve. Remove remote valve mounting bolts and remove valve. Use a hoist to remove transmission cover.

Disconnect all oil lines from power shift control valve (1—Fig. 187). Mark sequence valves (2 and 3) so they can be reinstalled in their original positions, then remove front and rear sequence valves. Remove power shift control valve.

Remove rear lubrication line from top of transmission. Remove transmission mounting bolts and bushings.

Disconnect both hydraulic lines at unions on right side of main frame. Remove hydraulic oil filter assembly from right side of main frame. Disconnect draft sensor cable at hitch upper link connection. Remove remote hoses and mounting bracket. Remove drawbar and drawbar support.

Remove a mounting bolt from each side of pto housing and install two guide studs. Support pto housing with a hoist, remove remainder of mounting bolts and remove pto unit. Withdraw the pto drive shaft.

Fabricate a connector plate using dimensions shown in Fig. 193. Mount plate between range gearbox and rear axle housing as shown in Fig. 194 to prevent housings from separating during removal of power shift unit

Connect a hoist and chain to upper front corner bolts of power shift unit. Remove bolts connecting rear axle housing to main frame. Separate power shift unit from main frame. Support rear of tractor with a stand under range gearbox. Use a hoist (Fig. 195) with a suitable lifting sling or chain to support power shift unit, then remove stud nuts and separate power shift unit from range gearbox.

259. REINSTALL. Use a hoist to position power shift unit on mounting studs. Tighten stud nuts to 100 N·m (75 ft.-lbs.) torque. Apply Loctite 504 Gasket Eliminator to end of main frame. Roll rear section of tractor forward engaging transmission input shaft in splines of clutch. Tighten housing retaining nuts and bolts to 100 N·m (75 ft.-lbs.) torque. Install transmission mounting bolts and bushings and tighten to 165 N·m (120 ft.-lbs.) torque. Remove connecting plate (Fig. 194).

Install pto drive shaft and pto unit. Engage pto and turn output shaft to engage drive shaft splines with pto sliding gear. Tighten housing mounting

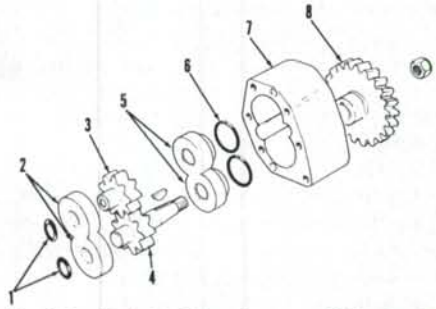


Fig. 192—Exploded view of power shift hydraulic pump.

1. "O" rings
2. Bushings
3. Idler gear
4. Driven gear
5. Bushings
6. "O" rings
7. Pump body
8. Drive gear

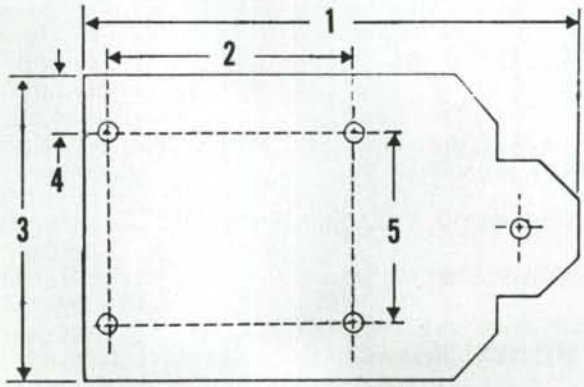


Fig. 193—A connector plate must be fabricated from 6 mm (¼ inch) thick steel plate to dimensions shown and used when splitting tractors equipped with power shift transmission.

1. 305 mm (12 in.)
2. 149.2 mm (5⅞ in.)
3. 190 mm (7½ in.)
4. 35 mm (1⅜ in.)
5. 139.7 mm (5½ in.)

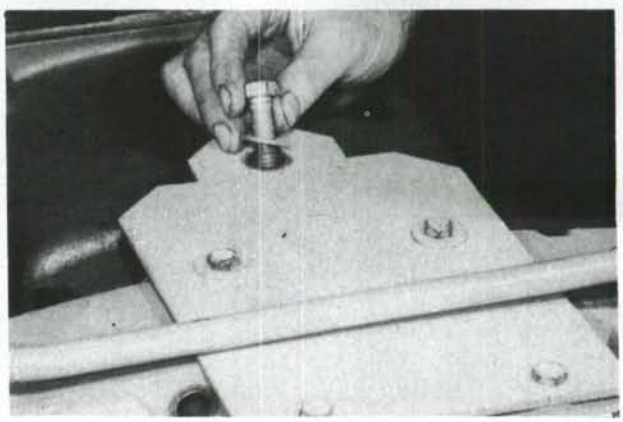


Fig. 194—Mount connector plate between top of range gearbox and rear axle housing to prevent housings from separating during removal of power shift unit.

bolts to 75-85 N·m (54-64 ft.-lbs.) torque.

Install drawbar support and drawbar. Connect draft sensing cable. Install hydraulic filter assembly and tighten mounting bolts to 47-57 N·m (35-40 ft.-lbs.) torque. Install filter supply line using a new "O" ring and tighten retaining bolts to 47-57 N·m (35-40 ft.-lbs.) torque. Connect hydraulic lines along right side of main frame and install lubrication line on top of range gearbox.

Install power shift control valve and tighten mounting bolts to 47-57 N·m (35-40 ft.-lbs.) torque. Install front and rear sequence valves and reconnect hydraulic lines. Make sure flow restrictors are located in front and rear planetary brake pressure lines (4 and 5—Fig. 187) at control valve (1).

Install transmission cover leaving mounting bolts loosely installed. Install remote valve using new "O" rings and tighten mounting bolts to 47-57 N·m (35-40 ft.-lbs.) torque. Connect remote valve hydraulic lines and control linkage.

Install wedge and shim in front of transmission cover. Tighten the ½ inch rear cover mounting bolts and all side and front mounting bolts to 110-130 N·m (80-95 ft.-lbs.) torque. Tighten the two ⅝ inch rear bolts to 205-245 N·m (150-180 ft.-lbs.) torque. Install power shift and range shift selector assemblies and tighten mounting bolts to 23-28 N·m (17-20 ft.-lbs.) torque.

Reconnect wiring harness and neutral start switch wires. Install a new transmission oil filter and tighten filter cover mounting bolts to 23-28 N·m (17-20 ft.-lbs.) torque.

Complete installation by reversing removal procedure.

OVERHAUL TRANSMISSION

All Power Shift Models

260. REMOVE PLANETARY ASSEMBLIES. Remove support sleeve (20—Fig. 196) and front cover (23). Disconnect brake line from front planetary brake cylinder (35) and remove cylinder. Loosen front brake band locating screws and remove brake band adjusting nuts (6 and 37). Remove sleeve (39), spring (40) and seat (41). Withdraw input shaft (1), then remove brake band (42) and lift front planetary unit from center housing. Remove hydraulic line for planetary brake cylinder from center carrier. Remove spacer plate (17) and sprag clutch (18).

Turn center housing over, then remove rear brake band and rear planetary assembly (Fig. 197) from housing in same manner as front unit. Unbolt and remove bearing carrier (46—Fig. 196) from center housing. Remove spacer (20—Fig. 197), sprag clutch (21) and carrier (42) from rear end housing (43) if necessary.

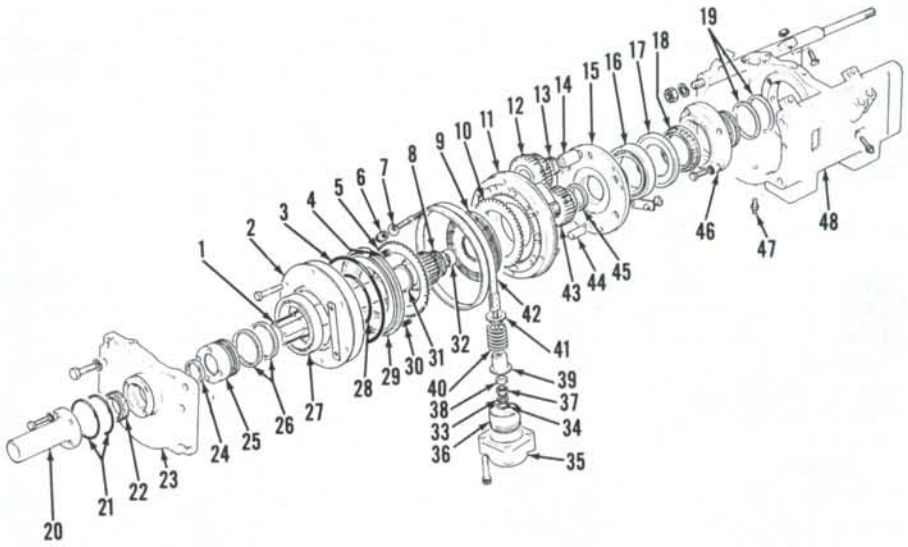


Fig. 196—Exploded view of front planetary assembly of power shift transmission. See Fig. 197 for view of rear planetary assembly.

1. Input shaft
2. Clutch cylinder
3. "O" ring
4. Spring, inner
5. Clutch plate, steel
6. Locknut
7. Conical washer
8. Seal
9. Clutch plate, bronze
10. Backing plate
11. Carrier & cylinder
12. Planet gear
13. Needle roller bearing
14. Bearing pin
15. End cover
16. Bearing
17. Spacer plate
18. Sprag clutch
19. Sealing rings
20. Support tube
21. "O" rings
22. Seal
23. Front cover
24. Bushing
25. Support sleeve
26. Sealing rings
27. Bearing
28. "O" ring
29. Piston
30. Spring, outer
31. Thrust washer
32. Bushing
33. Washer
34. Snap ring
35. Cylinder
36. Piston
37. Locknut
38. Spherical washer
39. Sleeve
40. Spring
41. Seat
42. Brake band
43. Sun gear
44. Dowel
45. Thrust washer
46. Bearing carrier
47. Locating screw
48. Center carrier

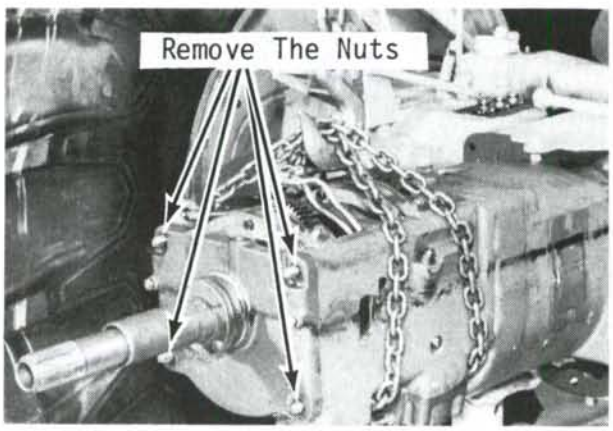


Fig. 195—Use a hoist and chain to support power shift unit as shown when removing and installing unit from range gearbox.

261. FRONT PLANETARY OVERHAUL. Mark clutch cylinder (2—Fig. 196), carrier (11) and end cover (15) so they can be reassembled in their original positions. Remove mounting bolts, then separate clutch cylinder from planetary carrier. Remove piston (29) from cylinder and remove and discard "O" rings (3 and 28). Remove inner and outer springs (4 and 30). Remove clutch plates (5, 9 and 10) keeping plates together for use in reassembly.

NOTE: Clutch plates are a matched set and are not available separately.

Remove retaining bolts and separate end cover (15) from carrier (11). Mark position of planetary gears (12) and gear pins (14) for proper reassembly, then remove from end cover.

Clutch plates must be free of cracks, distortion or excessive wear. Renew plates as necessary. Inspect springs (4 and 30) and renew if distorted or weak. Check thrust washer, bearings and planetary gears for wear or damage and renew as necessary.

Lubricate "O" rings (3 and 28) and install on piston (29). Carefully install

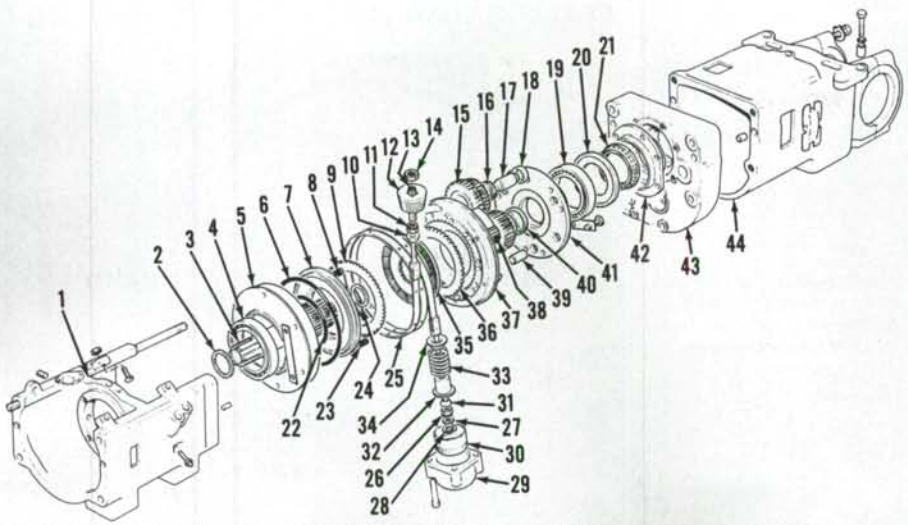


Fig. 197—Exploded view of rear planetary assembly of power shift transmission. See Fig. 196 for view of front planetary assembly.

1. Center carrier
2. Thrust washer
3. Rear input shaft
4. Bearing
5. Carrier & cylinder
6. "O" ring
7. Piston
8. Spring inner
9. Clutch plate, steel
10. Conical washer
11. Locknut
12. Taper plug
13. Stop screw
14. Locknut
15. Planet gear
16. Needle roller bearing
17. Bearing pin
18. Spacer
19. Bearing
20. Spacer plate
21. Sprag clutch
22. "O" ring
23. Spring, outer
24. Thrust washer
25. Brake band
26. Locknut
27. Washer
28. Snap ring
29. Cylinder
30. Piston
31. Spherical washer
32. Sleeve
33. Spring
34. Seat
35. Clutch plate, bronze
36. Backing plate
37. Carrier & cylinder
38. Sun gear
39. Dowel pin
40. Thrust washer
41. End cover
42. Carrier
43. End housing
44. Case

piston into cylinder. Position inner springs in clutch piston and hold in place with petroleum jelly or grease.

Install planetary gear pins, bearings and gears in their original positions with gear timing marks pointing toward center of carrier. See Fig. 198. Install sun gear aligning timing marks as shown. Install thrust washer (45—Fig. 196), with oil groove facing up, into end cover (15). Install end cover over planetary gears aligning marks made during disassembly. Tighten mounting bolts to 40 N·m (30 ft.-lbs.) torque and secure with locking plates.

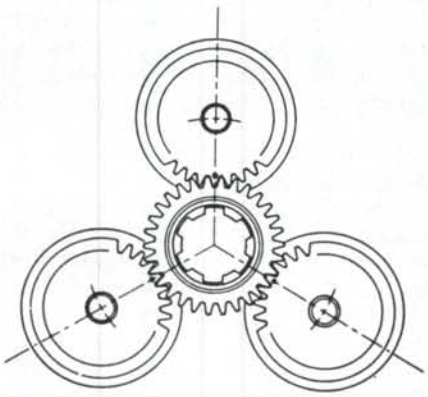


Fig. 198—Planet gears must be timed as shown with punch marked tooth of each gear pointing towards center of sun gear.

Assemble thick clutch backing plate (10), slotted bronze clutch plate (9), thin steel spacer plate (5), remaining slotted bronze plate (9) and thin steel plate (5) onto clutch carrier (11). Install outer springs in carrier. Install clutch cylinder (2) with piston and inner springs onto carrier aligning marks made during disassembly. Tighten mounting bolts to 27 N·m (20 ft.-lbs.) torque and secure with locking plates.

262. REAR PLANETARY OVERHAUL. Mark clutch cylinder (5—Fig. 197), carrier (37) and end cover (41) so they can be reassembled in their original positions. Remove clutch cylinder mounting bolts and separate planetary halves. Remove inner and outer springs (8 and 23). Remove piston (7) from cylinder and remove and discard "O" rings (6 and 22).

Lift input shaft (3) and clutch plates (9, 35 and 36) from carrier keeping plates together for reassembly.

NOTE: Clutch plates are a matched set and are not available separately.

Remove mounting bolts and separate end cover (41) from carrier. Mark position of planetary gears (15), bearing pins (17) and dowels (39) for reassembly, then remove sun gear and planetary gears. Remove thrust washer (40) from sun gear. Use a suitable puller to remove bearings (4 and 19).

Clutch plates must be free of cracks, distortion or excessive wear. Renew springs (8 and 23) if distorted or weak. Inspect thrust washers, bearings, bear-

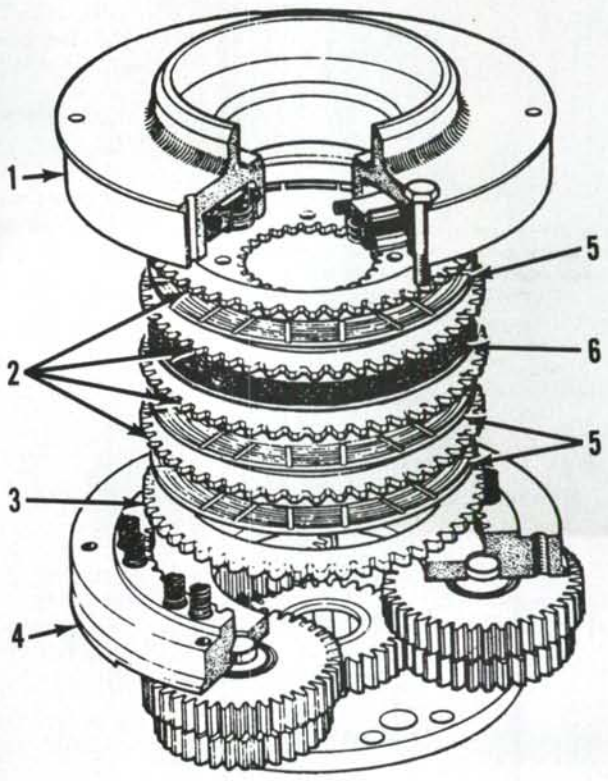


Fig. 199—Install backing plate, grooved bronze clutch plates, smooth bronze clutch plate and thin steel clutch plates for rear planetary clutch in sequence shown.

1. Cylinder assy.
2. Thin steel clutch plates
3. Backing plate
4. Carrier
5. Grooved bronze clutch plates
6. Smooth bronze clutch plate

ing pins and planetary gears for excessive wear or damage and renew if necessary.

Install new bearing (4—Fig. 197) on clutch cylinder (5). Lubricate "O" rings (6 and 22) and install on piston, then carefully install piston into cylinder. Install inner springs (8) and apply grease to hold springs in position during assembly.

Install bearing pins (17) in carrier (37) making sure they are in their original positions. Assemble a short bearing (16), thrust washer (18) with oil groove facing away from short bearing and a long bearing onto bearing pins. Install planetary gears on their original pins with gear timing marks pointing toward center of carrier. See Fig. 198. Place thrust washer in sun gear counterbore with oil groove side of washer facing up. Install sun gear with thrust washer towards carrier aligning timing marks as shown in Fig. 198. Install new bearing (19—Fig. 197), if removed, on end cover (41) and position thrust washer (40) in cover. Position end cover over planetary gears aligning assembly marks made during disassembly. Tighten mounting bolts to 40 N·m (30 ft.-lbs.) torque and secure with locking plates.

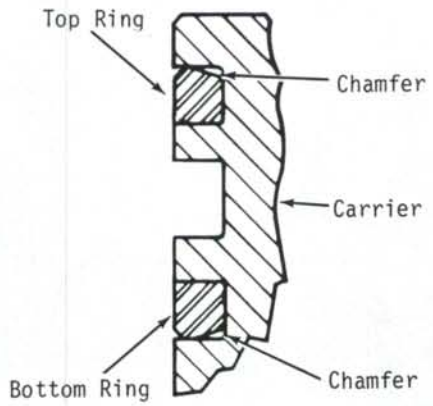


Fig. 200—Sealing rings must be installed in center carrier with inside chamfer up on top ring and inside chamfer down on bottom ring. Ring gaps must be 180° from each other.

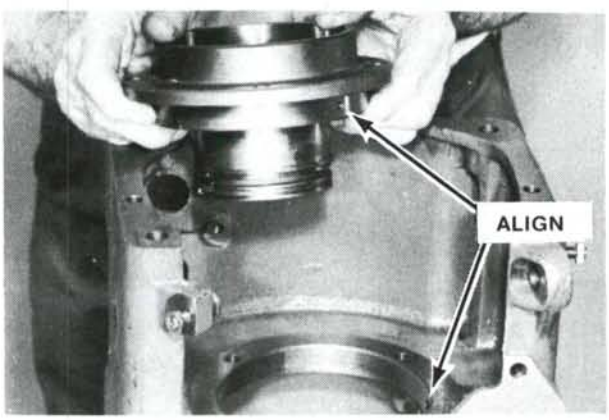


Fig. 201—Align lubrication holes in bearing carrier and center carrier as shown during installation. Tighten retaining bolts to 40 N·m (30 ft.-lbs.) torque.

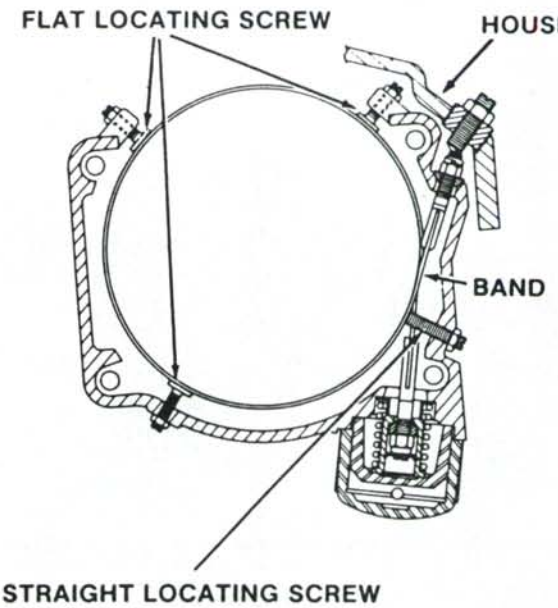


Fig. 202—View of rear planetary brake band and housing showing location of the four locating screws.

Install input shaft (3) into planetary assembly. Install thick backing plate (3—Fig. 199) into carrier (4). There are four thin steel clutch plates (2), three grooved bronze clutch plates (5) and one smooth bronze clutch plate (6). To assemble plates in carrier, place one grooved bronze plate on top of backing plate, then one thin steel plate, another grooved bronze plate, a thin steel plate, then the smooth bronze plate, a thin steel plate, a grooved bronze plate and remaining thin steel plate last.

Install outer clutch springs (23—Fig. 197). Align assembly marks and install cylinder (5) on carrier. Tighten mounting bolts to 27 N·m (20 ft.-lbs.) torque, then bend corners of locking plates against bolt heads.

263. CENTER CARRIER AND FRONT COVER. Inspect sealing rings (19—Fig. 196) in bearing carrier (46) and renew as necessary.

Position thrust washer in carrier counterbore with oil groove facing up. Install sealing rings in carrier grooves with chamfered side up on top ring and down on bottom ring as shown in Fig. 200. Stagger ring end gaps 180° from each other.

When reinstalling carrier in center housing, make certain lubrication holes are in alignment as shown in Fig. 201. Tighten carrier mounting bolts to 40 N·m (30 ft.-lbs.) torque. Lubricate seal rings with transmission fluid prior to reassembly.

Renew thrust washer (31—Fig. 196), bushing (32) and oil seal (8) in front input shaft (1) if necessary. Be sure to install thrust washer with oil groove side towards gear.

Pry oil seal (22—Fig. 196) from front cover (23). Remove seal rings (26) from front support sleeve (25). Remove sleeve mounting bolts and remove sleeve from front cover if renewal of bushing (24) is necessary.

Install new bushing (24) flush with inner face of support sleeve (25). Apply gasket sealer to mounting surface of sleeve, then install and tighten bolts to 20 N·m (15 ft.-lbs.) torque. Install sleeve sealing rings (26) with chamfered side up on top ring and chamfered side down on bottom ring as shown in Fig. 200. Install new front oil seal (22—Fig. 196) with lip facing inward.

264. REINSTALL PLANETARY ASSEMBLIES. Be sure brake band locating screws are in place in center housing. See Fig. 202 and 203. Install rear brake band in housing, then position rear planetary in center carrier.

Install sprag clutch (Fig. 204) into center bearing carrier with wide edge facing inward. Position spacer over sprag clutch. Install front planetary brake hydraulic line. Install front planetary unit into carrier rotating unit

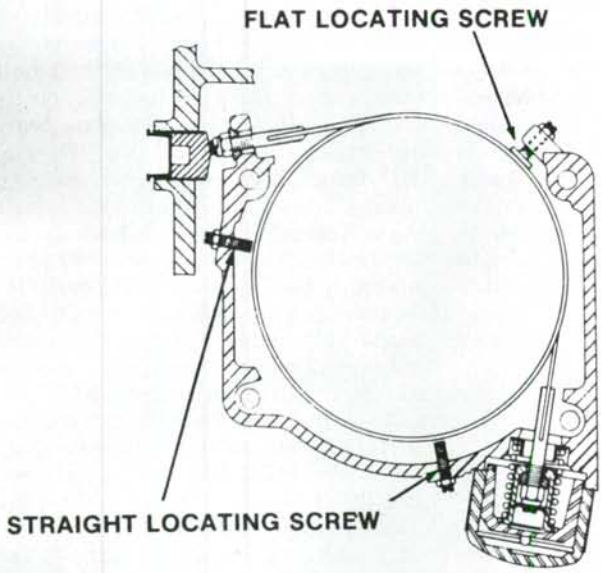


Fig. 203—View of front planetary brake band and housing showing correct position of the three locating screws.

clockwise during installation. Install front brake band.

Install front cover and tighten mounting bolts to 20 N·m (15 ft.-lbs.) torque. Install new "O" rings (21—Fig. 196) on support sleeve (25) and tube (20). Position support tube (20) on front cover so oil hole in tube is towards bottom of power shift housing and tighten mounting bolts to 12 N·m (9 ft.-lbs.) torque.

Install brake band springs and adjusting nuts. Tighten adjusting nut on spring end of band until spring length is 33.33 mm (1 5/16 inches) if new bands were installed, or 35 mm (1 3/8 inches) if old bands are being reused. Install brake piston and cylinder and tighten mounting bolts to 23-28 N·m (17-20 ft.-lbs.) torque. Connect brake hydraulic lines. Turn brake band locating screws clockwise until they contact brake bands, then turn rear band locating screws counterclockwise ½ turn and turn front band locating screws counterclockwise ¾ turn. Tighten locknuts to secure locating screw adjustment.

Final planetary brake band adjustment must be made with tractor running as outlined in paragraph 265.

265. PLANETARY BRAKE BAND ADJUSTMENT. Planetary brake bands provide braking on overrun, 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.

Transmission fluid must be at normal operating temperature. Remove plugs from right side of transmission cover. Remove test port plug from power shift control valve and install gage manifold (CAS-1242) with a 0-700 kPa (0-100 psi) gage in control valve test port. See Fig. 205.

266. FRONT BRAKE BAND. Start engine, put range selector in neutral and put power shift in fourth. Adjust engine speed until pressure gage reads 515 kPa (75 psi). Tighten brake band adjusting nut (3—Fig. 205) until engine speed drops 25 rpm. Depress clutch pedal, then loosen adjusting nut four turns.

Apply sealer to threads of plug which covers adjusting nut. Install plug and tighten until it contacts end of brake band, then loosen plug ¼ turn.

267. REAR BRAKE BAND. Remove jam nut, adjusting screw (1—Fig. 206) and plug (2) from left side of transmission cover to gain access to rear brake band adjusting nut. Start engine, put range selector in neutral and put power shift in fourth. Increase engine speed until pressure gage (1—Fig. 205) reading reaches 515 kPa (75 psi). Turn brake band adjusting nut clockwise until engine speed drops 25 rpm. Depress clutch pedal, then turn adjusting nut counterclockwise four turns.

Apply sealer to threads of plug, then install plug. Install adjusting screw in plug and tighten screw until it contacts end of brake band, then loosen ½ turn. Tighten jam nut.

Remove pressure gage and manifold. Install test port plug into control valve. Install plugs in transmission cover.

RANGE GEARBOX

All Power Shift Models

268. DISASSEMBLY. Power shift transmission incorporates a three-speed range gearbox located directly behind the power shift unit. Except for removal of bevel pinion shaft (19—Fig.

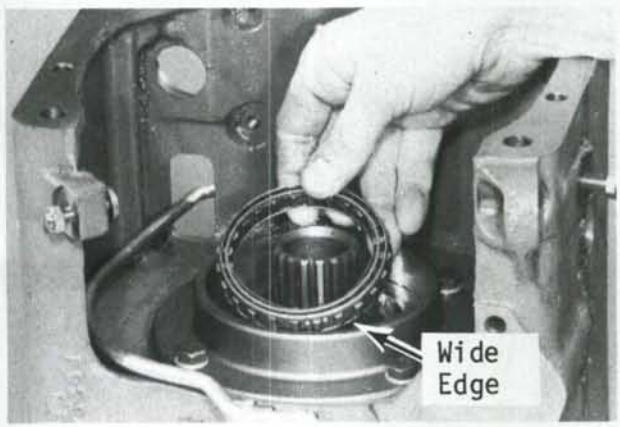


Fig. 204—Install sprag clutch into carrier housing with wide edge facing inward as shown.

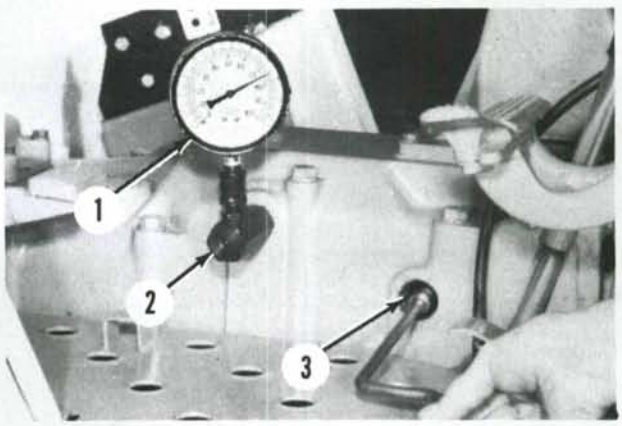


Fig. 205—View showing installation of pressure gage (1) using adapter CAS-1242 (2) in control valve test port for adjusting planetary brake bands. Adjustment screw (3) for front brake band is shown.

207), range gearbox components can be serviced after splitting the tractor and removing power shift unit as outlined in paragraph 258. If removal of pinion shaft is required, range gearbox must be removed from tractor as follows:

Remove platform or cab (if so equipped) as outlined in paragraph 348 or 349. Remove fuel tanks. Support tractor with suitable stands, then remove rear wheels and final drive assemblies as outlined in paragraph 279. Remove differential lock sleeve and spring from right side of rear axle housing. Remove transmission cover and remote valve assembly. Remove pto assembly and pto drive shaft. Support rear axle housing with a hoist, remove mounting bolts securing axle housing to main frame and remove axle housing. Remove transmission mounting bolts and bushings. Attach lifting chain and hoist to transmission, then move transmission rearward from main frame. Mount transmission on a stand if available.

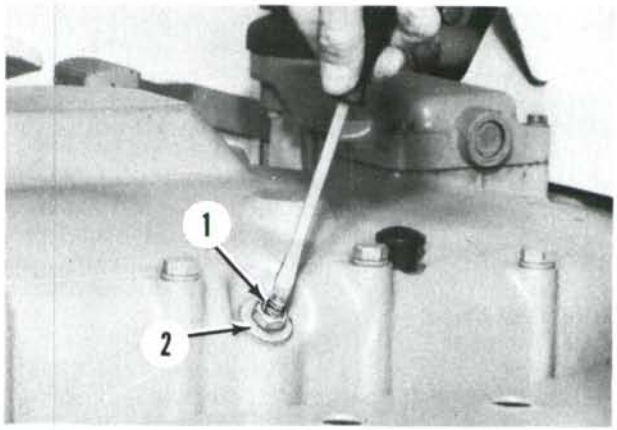


Fig. 206—Remove adjusting screw (1) and plug (2) from left-hand side of transmission cover to gain access to rear planetary brake band adjusting nut.

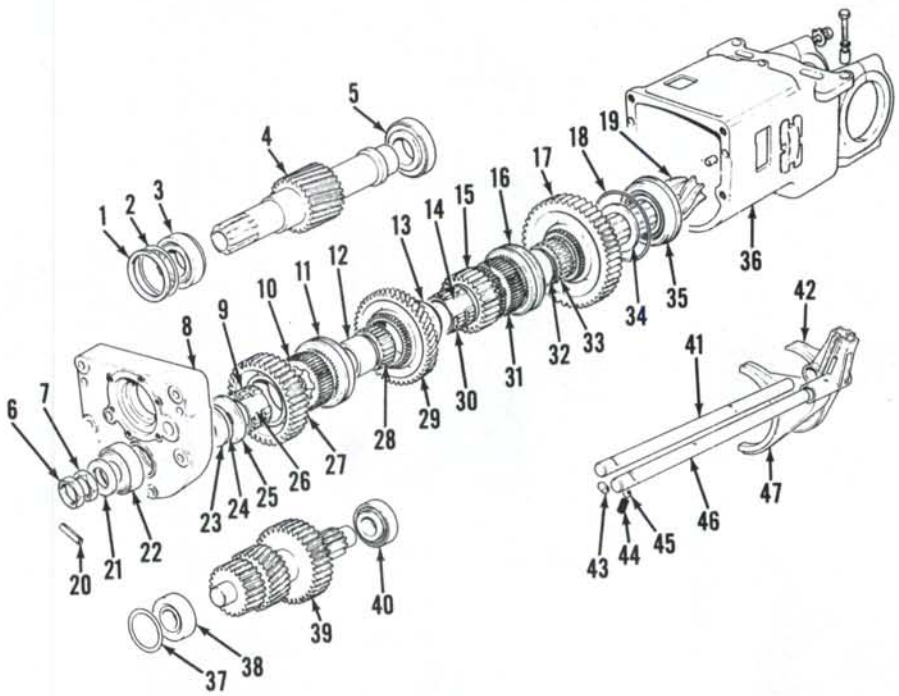


Fig. 207—Exploded view of power shift range transmission showing component parts and their relative positions.

1. Spacer
2. Shim
3. Bearing
4. Input shaft
5. Bearing
6. Slotted nut
7. Nut
8. End plate
9. Needle roller bearings
10. Sliding collar gear
11. Sliding collar
12. Bearing inner race
13. Thrust washer
14. Bearing inner race
15. Third range gear
16. Sliding collar
17. First range gear
18. Shim
19. Pinion shaft
20. Roll pin
21. Washer
22. Bearing
23. Thrust washer
24. Shim
25. Spacer
26. Bearing inner race
27. Second range gear
28. Needle roller bearing
29. Reverse range gear
30. Needle roller bearing
31. Sliding collar gear
32. Bearing inner race
33. Needle roller bearing
34. Thrust washer
35. Bearing
36. Range housing
37. Shim
38. Bearing
39. Idler shaft
40. Bearing
41. Second/reverse range shift rod
42. Second/reverse shift fork
43. Shift interlock plug
44. Detent spring
45. Detent ball
46. First/third range shift rod
47. First/third shift fork

Remove nuts from transmission studs, then separate power shift unit from range gearbox. Remove spacer and sprag clutch from end plate bearing retainer. Drive roll pin (20—Fig. 207) from pinion shaft (19). Remove locking nuts (6 and 7) noting that shaft has left-hand threads. Remove spacer (21) and bearing (22). Remove end cover mounting bolts, then lift end cover (8) from range housing (36). Remove thrust washer (23), shims (24), spacer (25), second gear (27), needle roller bearings (9) and race (26) from pinion shaft. Remove second/reverse shift rod and collar (11) as an assembly. Remove gear (10), bearing (28) and race (12), reverse gear (29), thrust washer (13), third gear (15), bearings (30) and race (14), first/third shift rail assembly with collar (16) and sliding collar inner gear (31). Withdraw input shaft assembly (4) and idler shaft assembly (39). Remove first gear (17), bearing (33) and race (32) and thrust washer (34).

Mark differential carrier bearing caps to ensure correct reassembly, then remove caps and differential assembly. Remove pinion shaft (19) and rear bearing (35) rearward from range housing.

Remove neutral start switch, rods and balls from housing. Remove shift interlock plug (43), detent ball (45) and spring (44).

269. REASSEMBLY. Inspect all gears, thrust washers and bearings for excessive wear or damage and renew as necessary. If renewal of input shaft (4—Fig. 207) or idler gear (39) or their bearings is required, shaft end play must be set as outlined in following paragraph before reassembling transmission. If renewal of pinion shaft (19) or rear bearing is necessary, pinion shaft protrusion must be set as outlined in paragraph 273 before proceeding with reassembly.

270. IDLER SHAFT AND INPUT SHAFT END PLAY. Heat bearings to 120°C (250°F) maximum before installing on the shafts. Install spacer (1—Fig. 207) and front bearing cups minus shims (2 and 37) into front end housing. Position idler shaft and input shaft assemblies into housing and install front housing. Remove the four housing mounting studs, if not already removed, and install four bolts in place of the studs. Tighten bolts to 95 N·m (70 ft.-lbs.) torque and rotate shafts to be sure bearings are seated.

Mount a dial indicator so probe contacts end of idler shaft through hole in front housing. Move shaft up and down and measure end play.

Mount dial indicator so probe con-

tacts end of input shaft. Move shaft up and down and measure end play.

Remove front end housing and remove front bearing cups using a suitable puller. Install shims (2 and 37) in front housing as necessary to obtain 0.05-0.10 mm (0.002-0.004 inch) end play for each shaft. Reinstall bearing cups in front housing making sure they are properly seated. Remove idler shaft and input shaft from range housing.

271. PINION SHAFT ASSEMBLY. With pinion shaft protrusion set and pinion shaft installed in housing, reassemble range transmission as follows: Install thrust washer (34—Fig. 207) on pinion shaft with oil grooves facing away from rear bearing. Install first gear (17), bearing (33) and race (32). Position idler shaft and input shaft assemblies in housing. Position shift interlock plug (43) in housing bore so it is between shift rod holes in range housing. Install gear (31) on pinion shaft. Install sliding collar (16) and first/third shift rail assembly. Use tool shown in Fig. 182 to depress detent ball and spring as shift rail is inserted into housing bore.

Install third gear (15—Fig. 207), bearings (30) and race (14). Install thrust washer (13) with oil grooves facing away from third gear. Install reverse gear (29), bearing (28) and race (12). Install sliding collar gear (10), sliding collar (11) and second/reverse shift rail assembly. Use special tool to depress detent ball and spring as shift rail is pushed into housing bore. Install second gear (27), bearing (9) and race (26). Install spacer (25) with larger outside diameter against second gear.

Install shims (24) removed during disassembly plus an additional 0.25 mm (0.010 inch) thickness of shims to assure pinion shaft end play. Install thrust washer (23) with flat side of washer against shims. Install end housing (8) with front bearing cup and tighten mounting bolts to 40 N·m (30 ft.-lbs.) torque. Install pinion shaft bearing (22), washer (21) and nut (7). Tighten nut to 271 N·m (200 ft.-lbs.) torque. Mount a dial indicator so probe contacts end of pinion shaft and measure shaft end play. Remove pinion shaft bearing retaining nut and front housing. Subtract shims from shim pack (24) equal to measured end play plus an additional 0.05 mm (0.002 inch) to provide bearing setting within specified range of zero end play to 0.05 mm (0.002 inch) preload.

With correct thickness shims installed, reinstall front housing, bearing, washer and retaining nut. Tighten nut to 271 N·m (200 ft.-lbs.) torque. Install locknut (6) and tighten to 271 N·m (200 ft.-lbs.) torque, then back nut off to first slot and install roll pin (20).

Apply Loctite 270 to threads of studs, install studs and tighten to 95 N·m (70 ft.-lbs.) torque. Complete installation by reversing the removal procedure.

MAIN DRIVE BEVEL GEARS AND DIFFERENTIAL

R&R DIFFERENTIAL ASSEMBLY

All Models

272. To remove differential assembly, it is first necessary to remove synchromesh transmission assembly as outlined in appropriate paragraph 223 or 225, or remove power shift and range gearbox assembly as outlined in paragraph 268. Be sure to mark differential bearing caps before removal as they must be reinstalled in their original positions.

To remove bevel pinion shaft, it is necessary to disassemble synchromesh transmission or range gearbox of power shift transmission. Refer to appropriate paragraphs in transmission section for model being serviced.

Note that pinion shaft gear and bevel ring gear are available as a matched set only. When renewing bevel ring gear and pinion, the pinion shaft protrusion, differential carrier bearing adjustment and bevel gear backlash must be reset. Refer to the following appropriate paragraphs.

PINION SHAFT PROTRUSION

All Models

273. While construction of synchromesh transmission and power shift range gearbox are different, method for determining correct pinion shaft protrusion is the same. Pinion shaft protrusion must be set whenever pinion shaft, rear bearing or transmission housing is renewed.

Install pinion shaft rear bearing cup without shims into rear housing. Position pinion shaft in housing, then assemble front housing and tighten mounting nuts on synchromesh transmission to 95 N·m (70 ft.-lbs.) torque, or mounting bolts on power shift transmission to 110-130 N·m (80-95 ft.-lbs.) torque. On all models, install pinion shaft front bearing and retaining nut and tighten nut while turning shaft until all free play is removed.

Install special pinion setting tool (CAS-1234) in the differential support bracket and secure with carrier bearing end caps (Fig. 208). Assemble correct thickness spacer (7) on tool for model being serviced as recommended by tool manufacturer. Adjust tool until tip of probe lightly contacts surface of bearing inner race. Use a feeler gage to measure gap between the spacer and shaft as shown in Fig. 209.

Note pinion shaft protrusion correction number (3—Fig. 208) etched on end of pinion gear. The number will be preceded by either a plus (+) or minus (−) mark. Shaft will be marked "OK" if no correction is needed. The correction number indicates thousandths of an inch (example: −7 equals −0.007 inch).

A constant dimension of 0.030 inch (0.762 mm) is used along with correction number and feeler gage measurement to set pinion shaft protrusion. Substitute appropriate dimensions in the following example to determine shim thickness needed at pinion shaft rear bearing to provide correct shaft protrusion.

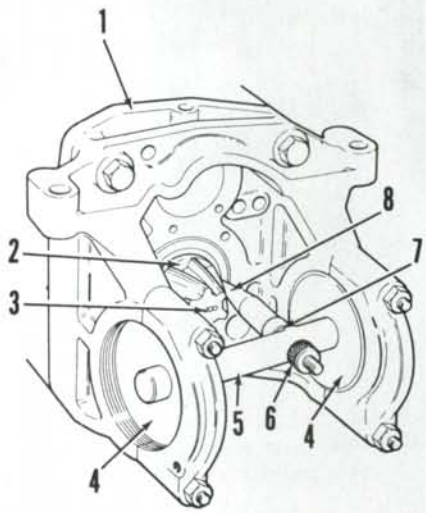


Fig. 208—Use pinion setting gage (CAS-1234) to adjust pinion shaft protrusion on all models.

1. Rear housing
2. Pinion shaft
3. Correction number
4. Discs
5. Shaft
6. Nut
7. Spacer
8. Probe

Constant dimension	0.030 in. (0.762 mm)
Add or subtract correction number (+ or −) . . .	−0.007 in. (0.178 mm)
Result is correct setting dimension "A" .	0.023 in. (0.584 mm)
Measured gap . .	0.058 in. (1.473 mm)
Minus result "A"	−0.023 in. (0.584 mm)
Result is shim thickness needed	0.035 in. (0.889 mm)

If an "OK" correction mark is shown on pinion gear, subtract the constant dimension from the gap measurement. The result is shim thickness needed for correct shaft protrusion.

Disassemble end cover and pinion shaft from transmission housing. Remove pinion shaft rear bearing cup and install required shims. Recheck pinion shaft setting after installing shims.

DIFFERENTIAL CARRIER BEARINGS AND BEVEL GEAR BACKLASH ADJUSTMENT

All Models

274. Pinion shaft protrusion must be properly adjusted as outlined in paragraph 273 before adjusting carrier bearings and bevel gear backlash.

Install differential and ring gear assembly into carrier. Install bearing caps making sure identification marks on caps and carrier match. Install bearing adjusting rings and tighten bearing cap bolts.

NOTE: Make certain there is clearance between ring gear and pinion gear teeth and that adjusting ring nuts can be turned after tightening bearing cap bolts.

Turn the adjuster rings to move ring gear as far away from the pinion gear as possible. Insert a screwdriver into opening in differential case as shown in Fig. 210. Turn the adjuster rings so the weight of the screwdriver will not turn the differential assembly, then turn adjuster rings until weight of screwdriver just begins to rotate differential Tap differential carrier bearing caps with a soft hammer to seat bearings, then recheck bearing setting. This bearing setting must be maintained while adjusting ring gear to pinion gear backlash.

To adjust bevel gear backlash, first put alignment marks on bearing caps and one of the tangs of each adjuster ring. Use the marks to ensure adjuster rings are turned an equal amount. Mount a dial indicator on housing with probe at a 90° angle to a tooth of ring gear as shown in Fig. 211. While holding pinion shaft, rotate ring gear in each direction and measure backlash. Specified backlash is 0.18-0.23 mm (0.007-0.009 inch) for all models. Turn both adjuster rings an equal amount to move ring gear sideways until backlash is within recommended range. Check backlash at three different locations around ring gear.

When adjustment is correct, install lockplates in adjuster ring slots. Tighten bearing cap bolts to 165 N·m (120 ft.-lbs.) torque.

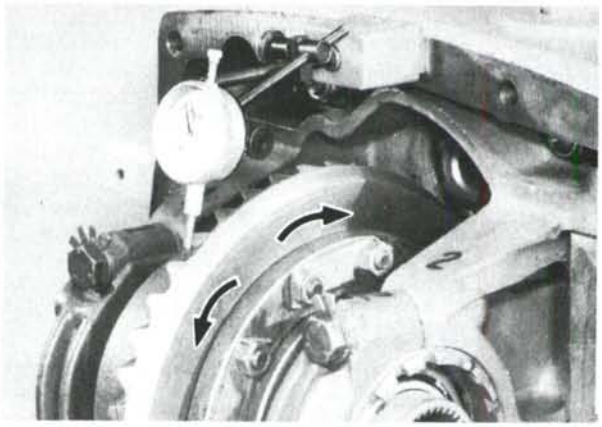


Fig. 211—Mount a dial indicator so probe contacts ring gear tooth as shown to measure bevel gear backlash.

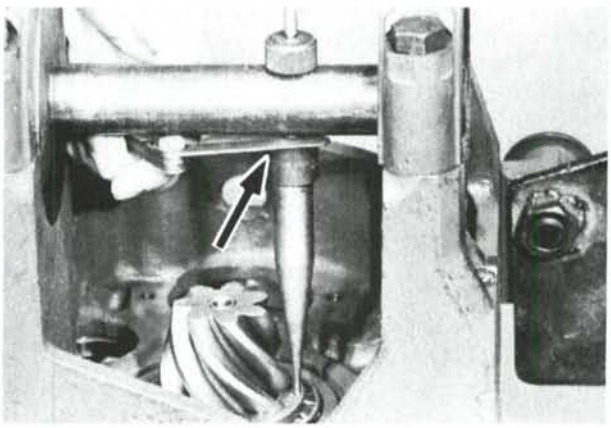


Fig. 209—Use a feeler gage to measure gap between spacer and shaft.

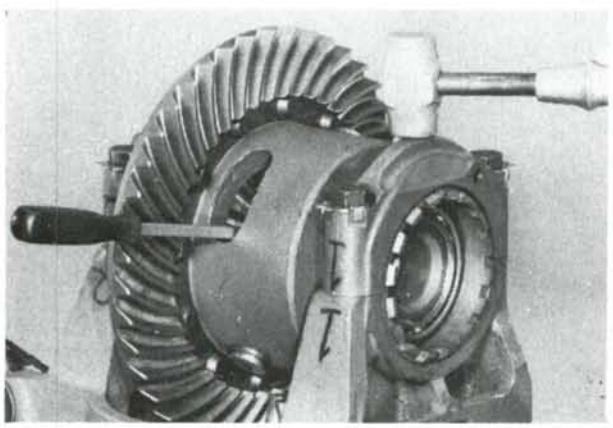


Fig. 210—Place a screwdriver into a slot in differential case and rotate ring gear so screwdriver is in a horizontal position. Tap bearing caps with a soft hammer to seat bearing. Refer to paragraph 274 for bearing adjustment procedure.

DIFFERENTIAL OVERHAUL

All Models Except 1594-1690

275. Mark end plate (3—Fig. 212), differential case (9) and ring gear (14) so parts can be reinstalled in their original positions. Remove carrier bearings (2) if necessary. Remove end plate mounting bolts, then remove end plate (3) using a slide hammer puller if removal is difficult. Remove snap ring (12) from pinion shaft (11). On Models 1394, 1490 and 1494, drive pinion shaft inward until dowel retainer (10) can be removed. On all models, remove pinion shaft, pinion gears (7) and axle gears (5). Unbolt and remove ring gear (14) from case if necessary.

Inspect all gears for wear, chips or other damage. Ring gear (14) and pinion gear (13) are a matched set and must be renewed as an assembly. Thrust washer (8) and pinion gear bushings (6), if so equipped, must be smooth and free of scores or excessive wear. Renew parts as needed.

Lubricate running surfaces of pinion gears and axle gears with multipurpose grease during reassembly. Install end plate making sure previously made match marks are aligned. Tighten ring gear mounting bolts evenly using a diagonal tightening sequence. Final torque should be 40 N·m (30 ft.-lbs.) torque on Models 1190, 1194, 1290, 1294 and 1390, or 68 N·m (50 ft.-lbs.) torque on Models 1394, 1490 and 1494. Bend lockplates to secure all nuts after tightening. Heat carrier bearings to 120°C (250°F), then install bearings.

Models 1594-1690

276. Mark positions of outer carrier half (3—Fig. 213), inner carrier half (9), pinion gear cross (6), ring gear (10) and end plate (12) for reassembly. Unbolt and remove outer carrier (3). Remove axle gear (5), pinion cross (6) and pinion gears (8), inner cage (9), ring gear (10) and remaining axle gear. Remove snap ring (16) and differential lock gear (15). Remove carrier bearings (2 and 13) if necessary.

Inspect all gears for wear, chips or other damage. Bevel ring gear (10) and pinion gear (11) must be renewed as a matched set. Thrust washers and mating surfaces must be smooth and free of scores or excessive wear.

When installing new carrier bearings, heat bearings to 120°C (250°F) maximum and install with wide edge of outer race facing outward. Lubricate thrust washers, pinion gears and axle gears with multipurpose grease during assembly. Align previously made match marks when assembling carrier cases and pinion gear cross. Tighten ring gear and carrier retaining bolts evenly to 100 N·m (75 ft.-lbs.) torque and secure with lockplates. Install differential lock gear (15) with side of gear with recessed inner teeth towards carrier bearing.

DIFFERENTIAL LOCK

All Models

277. Depressing differential lock foot pedal causes sleeve (12—Fig. 214) on 1594 and 1690 models, or sleeve (13) on all other models to engage gear (1594 and 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.

Locking sleeve (12 or 13) and release spring (11) may be removed after removal of right final drive assembly as outlined in paragraph 279. Differential

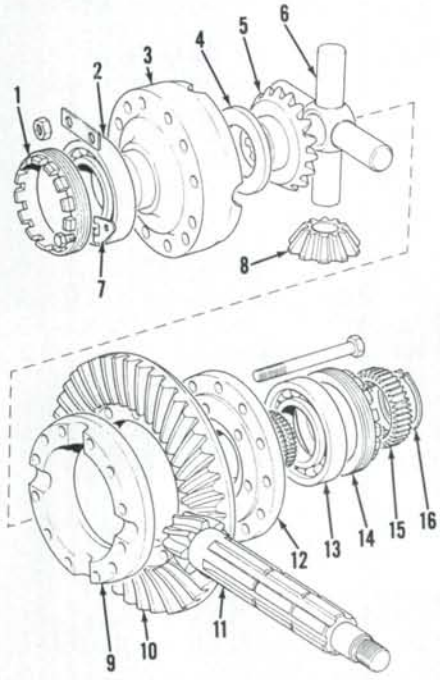


Fig. 213—Exploded view of four pinion gear differential assembly used on Models 1594 and 1690.

1. Adjuster ring nut
2. Bearing
3. Outer carrier half
4. Thrust washer
5. Axle gear
6. Pinion gear cross
7. Lockplate
8. Pinion gear
9. Inner carrier half
10. Bevel ring gear
11. Bevel pinion gear
12. End plate
13. Bearing
14. Adjuster ring nut
15. Gear
16. Snap ring

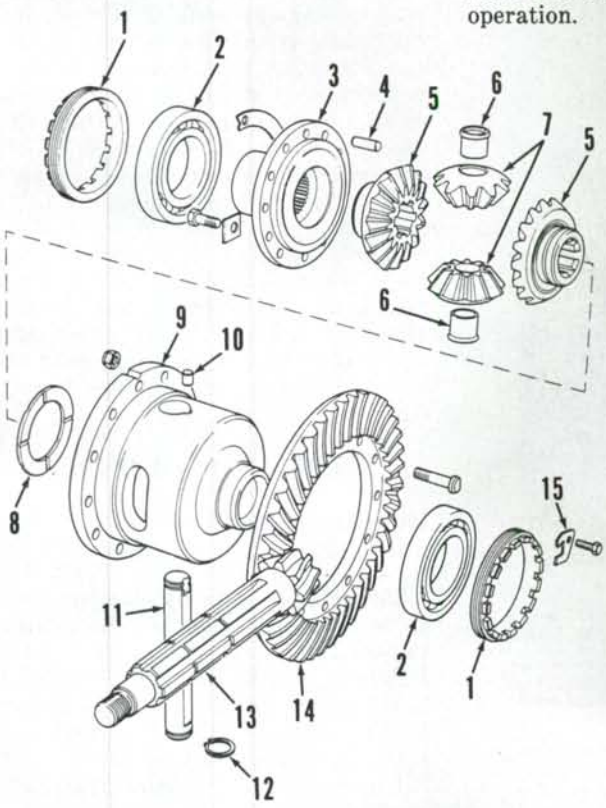


Fig. 212—Exploded view of typical two pinion gear differential used on all models except 1594 and 1690. Note that thrust washers (8) and bushings (6) are not used on some models.

1. Adjuster ring nut
2. Bearing
3. End plate
4. Dowel pin
5. Axle gears
6. Bushing
7. Pinion gears
8. Thrust washer
9. Carrier
10. Dowel
11. Pinion shaft
12. Snap ring
13. Bevel pinion gear
14. Bevel ring gear

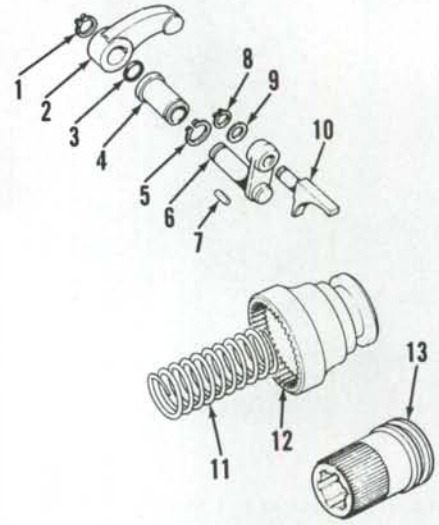


Fig. 214—Exploded view of typical differential lock component parts. Note that pedal and linkage arrangement varies from model to model. Sleeve (12) is used on 1594 and 1690 models, while all other models use sleeve (13).

1. Snap ring
2. Lever
3. "O" ring
4. Bushing
5. Snap ring
6. Shaft
7. Key
8. Snap ring
9. Washer
10. Fork
11. Spring
12. Sleeve
13. Sleeve

engagement gear (1594 and 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).

To reassemble, reverse disassembly procedure. Note that a special tool (CAS-1633) is available to aid installation of locking sleeve and spring. Install spring in differential carrier. Place sleeve on end of special tool, then push sleeve and spring in until sleeve splines engage differential splines and fork (10) is in groove of sleeve. Wire operating lever (2) in engaged position to hold sleeve and spring in place during remainder of reassembly.

FINAL DRIVE

Final drive assembly consists of axle shaft, bull gear, stub axle and housing. Stub axle, bearings and bull gear can be serviced without removing final drive housing. However, if axle shaft is to be serviced, final drive assembly must be removed.

LUBRICATION

All Models

278. Lubricating oil for final drive gears is contained separately in each final drive housing. It is recommended that oil be changed at 800 hour intervals. Capacity for each final drive is approximately 2.3 L (2.5 quarts) for 1190, 1194, 1290, 1294, 1390 and 1394 models, 6.8 L (7 quarts) for 1490 and 1494 models and 7.5 L (8 quarts) for 1594 and 1690 models. Recommended oil is Case ETHB Fluid or equivalent.

Breather assemblies are located in final drive covers on Models 1190, 1194, 1290, 1294, 1390 and 1394. On all other models, breathers are located in brake housings. Breathers must be open and free of obstruction or gear motion will cause pressure buildup in final drive housing forcing fluid past axle shaft seals.

A grease fitting is located in rear axle seal housing. A lubricant passage leads to axle 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.

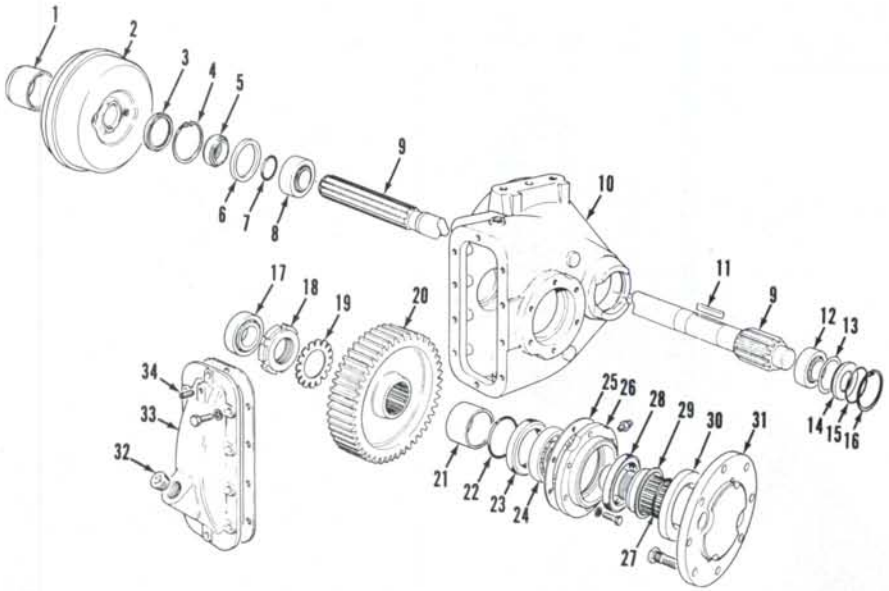


Fig. 215—Exploded view of final drive assembly used on 1190, 1194, 1290, 1294, 1390 and 1394 models.

1. Sleeve
2. Brake drum
3. Oil seal
4. Snap ring
5. Collar
6. Spacer
7. "O" ring
8. Bearing
9. Axle shaft
10. Final drive housing
11. Key
12. Bearing
13. Shim
14. End cover
15. "O" ring
16. Snap ring
17. Bearing
18. Nut
19. Tab washer
20. Bull gear
21. Sleeve
22. "O" ring
23. Oil seal
24. Bearing
25. Shim
26. Seal housing
27. "O" ring
28. Oil seal
29. Sleeve
30. Dust shield
31. Stub axle
32. Fill plug
33. Cover
34. Breather

R&R FINAL DRIVE

All Models

279. Raise rear of tractor and support with suitable stands. Drain oil from final drive housing. Remove wheel and tire. Disconnect hitch stabilizer bar from final drive housing. If equipped with cab or platform, remove rear support bracket bolts, then lift and support cab or platform so there is a small clearance between support bracket and final drive housing.

On models equipped with drum brakes, loosen brake adjustment so brake drum will not drag on brake shoes during removal. On models equipped with disc brakes, disconnect and remove brake line from brake cylinder. Disconnect hand brake linkage from final drive housing.

On all models, wire differential lock pedal in engaged position if removing right-hand final drive to keep locking sleeve and spring in correct position. Support final drive housing with a hoist, remove housing mounting nuts and remove final drive assembly.

To reinstall, reverse the removal procedure. Tighten housing mounting bolts to 102 N·m (75 ft.-lbs.) torque on Models 1190, 1194, 1290, 1294, 1390 and 1394 and tighten to 135 N·m (100 ft.-lbs.) torque on all other models. Install wheel and tire and tighten wheel nuts to 200 N·m (150 ft.-lbs.) torque on all models. Bleed and adjust brakes as necessary.

OVERHAUL FINAL DRIVE

Models 1190-1194-1290-1294-1390-1394

280. DISASSEMBLY. Remove final drive cover (33—Fig. 215). Bend back tab washer (19) from nut, then use a suitable spanner wrench (CAS-1666 for 1190 and 1194, or CAS-1210 for all other models) to loosen nut (18) on stub axle shaft (31) Place a suitable block under bull gear (20) to prevent gear from fall-

ing when stub axle is removed. Use two bolts with washers and nuts as jack screws through openings in stub axle flange as shown in Fig. 216 to pull stub shaft from housing. Remove bull gear, inner bearing (17—Fig. 215) and sleeve (21). Remove oil seal housing (26) and shims (25). Use a puller to remove outer bearing (24). Use a driver to remove inner seal (23) from final drive housing and outer seal (28) from seal housing.

To remove axle shaft (9—Fig. 215), the final drive housing must be removed. Remove snap ring (16), then press axle shaft out of housing towards wheel side. Remove end cover (14), shims (13) and outer bearing cup. Remove collar (1) and brake drum (2). Remove inner bearing cup, spacer (6), snap ring (4) and oil seal (3) from housing. Remove keys (11), collar (5) and bearing cones from axle shaft.

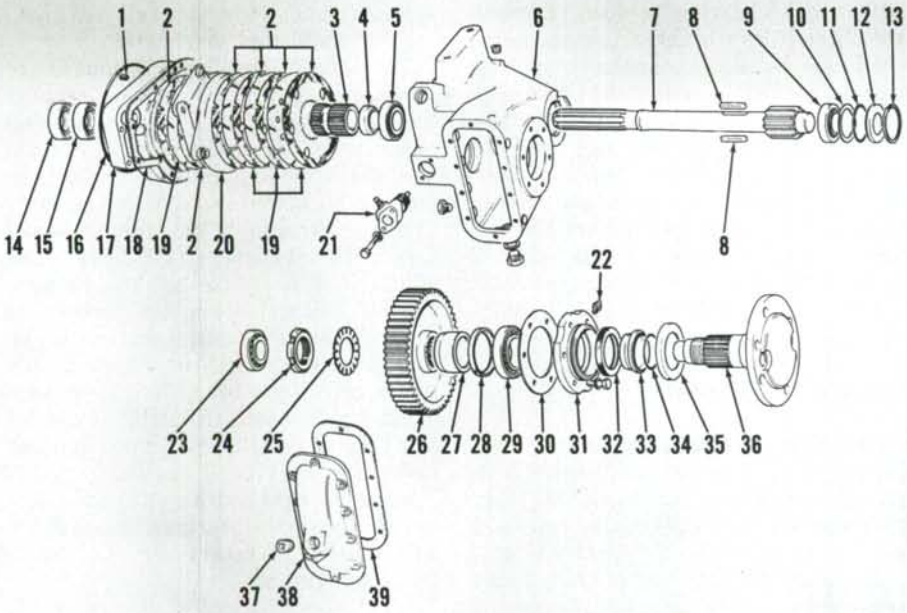


Fig. 217—Exploded view of Model 1490 final drive assembly. Final drive used on Model 1494 is similar.

1. Breather
2. Rotating discs
3. Brake hub
4. Spacer
5. Bearing
6. Final drive housing
7. Axle shaft
8. Keys
9. Bearing
10. Shims
11. "O" ring
12. End cover
13. Snap ring
14. Outer seal
15. Inner seal
16. "O" ring
17. Brake cover
18. Gasket
19. Stationary discs
20. Actuator assy.
21. Brake cylinder
22. Grease fitting
23. Bearing
24. Nut
25. Tab washer
26. Bull gear
27. Spacer
28. Seal
29. Bearing
30. Shim
31. Seal housing
32. Seal
33. Sleeve
34. "O" ring
35. Dust shield
36. Stub axle
37. Filler plug
38. Final drive cover
39. Gasket

281. REASSEMBLY. Renew worn or damaged parts as necessary. Renew all oil seals and "O" rings. Lubricate seals and "O" rings with small amount of grease during assembly.

Heat bearing cones to 120°C (250°F) maximum before installing on axle shaft. Press collar (5—Fig. 215), "O" ring end first, onto axle until collar seats against bearing. Install keys (11) in axle shaft. Assemble inner bearing cup, spacer (6), snap ring (4) and seal (3) into housing. Lip of seal must be towards snap ring. Place axle into housing from wheel side and install outer bearing cup.

Place final drive housing in a press and place a support under outer end of axle shaft. Position brake drum (2) on axle shaft aligning keys with keyways, then use a suitable steel tube to press drum onto axle until seated against collar. Apply hydraulic sealant to inside of collar (1), then use the steel tube to press collar onto axle until seated against drum.

Install end cover (14) without shims (13) and "O" ring (16). Mount a dial indicator so probe is against brake drum. Rotate shaft to be sure bearings are properly seated, then measure shaft end play. Add 0.076 mm (0.003 inch) to end play measurement to determine thickness of shims (13) required to provide bearing preload of 0.076 mm (0.003 inch). Remove cover (14) and install correct amount of shims and a new "O" ring (15). Reinstall cover and snap ring.

Install "O" ring (27), dust shield (30) and sleeve (29) on stub axle. Install seal (28) in housing (26) with lip of seal towards outside of housing. Lubricate seal with grease, then position seal housing on stub axle. Position outer bearing cup in seal housing counterbore. Heat bearing cone to 120°C (250°F), then install on stub axle. Install sleeve (21) with chamfered end away from bearing.

Install inner bearing cup and inner oil seal (23) in final drive housing with lip of seal towards inside of housing. Drive seal in until face of seal is 25 mm (1 inch) from outer surface of housing. Position inner bearing cone and bull gear in housing. Support bull gear with a block while installing stub axle assembly into housing. Install tab washer and slotted nut (18) as stub axle is installed, but do not tighten nut.

Install three equally spaced bolts in oil seal housing, but do not tighten. Be sure grease fitting in seal housing is towards rear of final drive housing. Tighten bull gear nut (18) securely using a suitable spanner wrench. Secure nut with tab washer. Tighten the three bolts in seal housing evenly until all end play is removed from stub axle shaft. Tap end of shaft with a soft hammer to make sure bearings are properly seated as bolts are tightened. Measure gap between oil seal housing and final drive housing at three different locations using a feeler gage and average the measurements. Subtract 0.13 mm (0.005 inch) from the average measured gap; the result is thickness of shims (25) needed to provide desired 0.13 mm

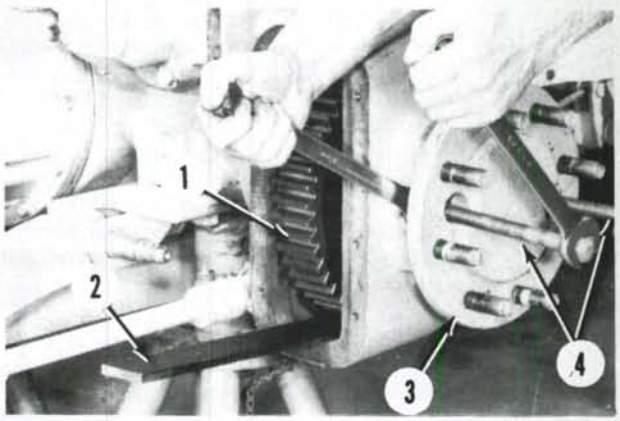


Fig. 216—Use two jack screws (4) with flat washers and nuts through holes in stub axle flange to pull stub axle shaft from housing.

1. Bull gear
2. Support bar
3. Stub axle
4. Jack screws

(0.005 inch) bearing preload. Remove the three bolts and install shims. Reinstall seal housing mounting bolts and tighten to 68 N·m (50 ft.-lbs.) torque.

Lubricate with multipurpose grease at grease fitting in oil seal housing until grease is visible at inner oil seal lip. Install housing cover (33) and tighten mounting bolts to 35 N·m (25 ft.-lbs.) torque. Be sure breather (34) is clean. Refill final drive housing with 2.3 L (2.5 quarts) of Case ETHB Fluid or equivalent.

Models 1490-1494

282. DISASSEMBLY. It is not necessary to remove cab or platform to service final drives. Stub axle (36—Fig. 217) and bull gear (26) can be removed without removing final drive housing.

Raise and support rear of tractor and remove rear wheel and tire. Drain oil from final drive housing and remove cover (38). Bend tab washer (25) away from slotted nut (24), then use spanner wrench (CAS-1210) to loosen nut. Remove oil seal housing (31) retaining bolts. Pull stub axle partially out and remove split shims (30), inner bearing (23), nut (24) and tab washer (25). Support bull gear (26) to prevent it from falling, then withdraw stub axle and remove bull gear Remove inner oil seal (28) and inner bearing cup from housing. Remove spacer (27) from stub axle and use a puller to remove oil seal housing (31) and outer bearing (29).

To remove axle shaft (7), final drive housing must first be removed as outlined in paragraph 279. Remove parking brake lever and brake cover (17) from final drive housing. Remove brake discs and brake actuator assembly as outlined in paragraph 290. Install brake hub puller adapter (CAS-1644-3) or similar tool on brake hub (3). Be sure side of adapter with counterbore is towards shorter hub splines. Use brake hub puller (CAS-1211) or other suitable puller to remove brake hub from axle shaft. Remove snap ring (13) retaining shaft end cover (12). Push axle shaft out towards wheel side of housing.

Remove brake hub keys (8) and spacer (4), then press bearings (5 and 9) off axle shaft if necessary. Drive oil seals from brake cover.

283. REASSEMBLY. Heat bearing cones to 120°C (250°F) maximum before installing onto axle shaft (7—Fig. 217). Install spacer (4) with chamfered side towards bearing. Install inner bearing cup in housing, then install axle shaft assembly. Install outer bearing cup and end cover (12) without shims (10) and "O" ring (11). Make sure all parts are properly seated, then use a dial indicator to measure axle shaft end play. Remove snap ring and end cover. Install shim (10) thickness equal to measured end play plus an additional 0.08 mm (0.003 inch) to provide correct bearing preload. Install new "O" ring (11), end cover and snap ring.

Install keys in axle shaft making certain they are bottomed in shaft keyways. Heat brake hub (3) to 200°C (400°F) maximum, then install hub on axle shaft with longer splines toward final drive housing. Be sure hub bottoms against spacer.

Install brake discs and brake actuator assembly as outlined in paragraph 290. Install inner oil seal (15) in brake cover (17) with seal lip facing inward. Push seal in until flush with end of bore. Install outer oil seal (14) with seal lip towards outside of cover. Push seal in until flush with outer surface of cover. Fill space between seals with grease. Install brake cover being careful not to damage seals. Install new parking brake shaft oil seal and dust shield in brake cover. Tighten cover mounting bolts to 135 N·m (100 ft.-lbs.) torque.

Renew "O" ring (16) on axle housing flange, then install final drive housing and tighten mounting bolts to 135 N·m (100 ft.-lbs.) torque.

Assemble "O" ring (34), dust shield (35) and oil seal sleeve (33) on stub axle. Install oil seal in seal housing and lubricate seal lips with grease. Position seal housing on stub shaft and install outer bearing cup in seal housing counterbore. Heat outer bearing cone to 120°C (250°F) maximum, then install on stub shaft. Lubricate bearing with lithium base grease. Install spacer (27) with beveled end facing away from bearing. Install inner bearing cup and inner oil seal (28) in final drive housing. Be sure seal lip faces inward and seal is even with inner surface of housing. Lubricate seal lip with grease.

Position inner bearing cone and bull gear in housing making sure side of gear with lugs on the hub is towards inner bearing. Insert stub axle into housing and bull gear putting tab washer and nut on shaft as shaft is installed. Hand tighten nut. Position oil seal housing (31) so grease fitting is towards rear of final drive housing, then install three bolts equally spaced around seal housing and tighten finger tight. Tighten slotted nut (24) securely using a suitable spanner wrench such as CAS-1210. Hit stub axle flange with a hammer while tightening to make certain bearings seat properly.

NOTE: Nut (24) must be very tight or early failure of bearings and gears will result.

Tighten three oil seal housing bolts evenly until inner bearing cone seats against stub axle shoulder. Use a feeler

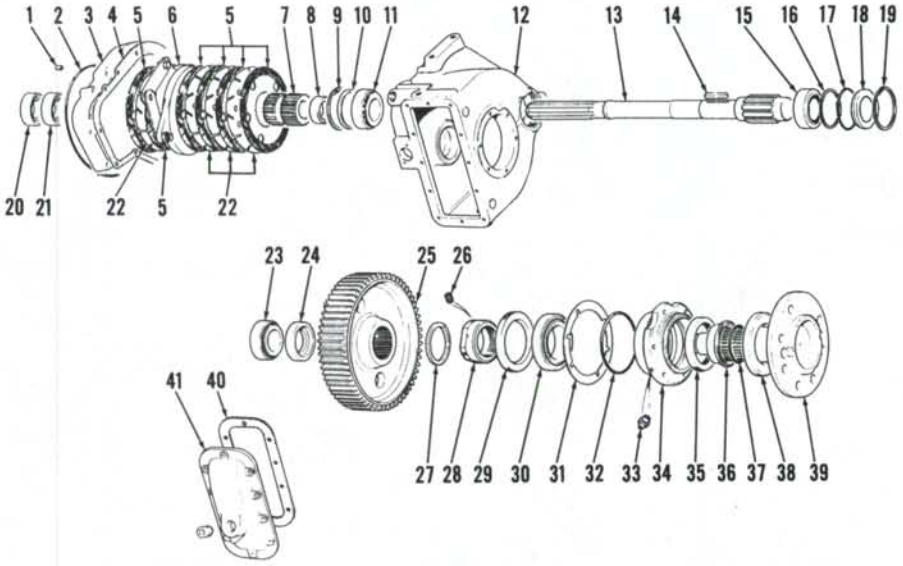


Fig. 218—Exploded view of Model 1594 and 1690 final drive showing component parts and their relative positions.

1. Breather
2. "O" ring
3. Brake cover
4. Gasket
5. Rotating discs
6. Actuator assy.
7. Brake hub
8. Spacer
9. Snap ring
10. Spacer
11. Bearing
12. Final drive housing
13. Axle shaft
14. Key
15. Bearing
16. Shim
17. "O" ring
18. End cover
19. Snap ring
20. Outer seal
21. Inner seal
22. Stationary disc
23. Bearing
24. Spacer
25. Bull gear
26. Lock screw
27. Spacer
28. Nut
29. Seal
30. Bearing
31. Shim
32. "O" ring
33. Grease fitting
34. Seal housing
35. Seal
36. Sleeve
37. "O" ring
38. Dust shield
39. Stub axle
40. Gasket
41. Final drive cover

gage to measure gap between seal housing and final drive housing. Subtract 0.15 mm (0.006 inch) from gap measurement; the result is thickness of shims (30) needed to provide correct bearing preload. Remove the three bolts and install correct thickness shims. Install seal housing mounting bolts and tighten to 68 N·m (50 ft.-lbs.) torque. Bend tab washer (25) to secure nut (24).

Install housing cover (38) and tighten mounting bolts to 40 N·m (30 ft.-lbs.) torque. Refill housing with 6.8 L (7 quarts) of Case ETHB Fluid or equivalent. Lubricate outer bearing at grease fitting (22) with lithium base grease.

Models 1594-1690

284. DISASSEMBLY. It is not necessary to remove cab or platform to service final drives. Stub axle (39—Fig. 218) and bull gear (25) can be removed without removing final drive housing.

Raise and support tractor, then remove tire and wheel. Drain oil from final drive housing. Remove housing cover (41). Place a support under bull gear (25) to prevent it from falling when stub shaft (39) is removed. Remove mounting bolts from oil seal housing (34). Pull stub axle shaft from housing and remove bull gear, spacers (24 and 27) and inner bearing (23). Retain shims (31) for use in reassembly.

Remove set screw (26) from ring nut (28). Secure stub shaft in a vise, then use special wrench (CAS-1241) to remove nut. Press stub shaft out of oil seal housing.

To remove axle shaft (13), final drive housing must be removed as outlined in paragraph 279. Remove parking brake lever and brake cover (3) from final drive housing. Remove brake slave cylinder. Remove remainder of brake discs and actuating components as outlined in paragraph 290. Remove snap ring (19) retaining shaft end cover (18), then tap inner end of axle shaft to remove end cover. Remove shims (16), "O" ring (17) and outer bearing cup. Remove axle shaft assembly from housing. Press axle shaft out of brake hub (7). Remove two keys (14) and spacer (8). Press bearing cones from shaft if necessary.

285. REASSEMBLY. Heat axle shaft bearings (11 and 15—Fig. 218) to 120°C (250°F) maximum before installing on shaft. Install spacer (8) and keys (14) making sure keys are bottomed in keyways. Heat brake hub (7) to 200°C (400°F) maximum, then install on axle shaft with longer splines toward bearing cone.

Install axle shaft assembly into final drive housing. Install outer bearing cup, end cover (18) and snap ring (19). Do not install shims (16) or "O" ring (17) at this time. Rotate shaft to seat bearings, then use a dial indicator to measure shaft end play. Select shim pack thickness that is equal to measured end play plus 0.13 mm (0.005 inch) to provide correct bearing preload. Remove end cover and install shims (16) and a new "O" ring (17). Reinstall end cover and snap ring.

Install brake discs and actuator as outlined in paragraph 290. Install brake cover (3) with new shims and tighten mounting bolts to 102 N·m (75 ft.-lbs.) torque. Install new "O" ring (2) on axle housing, then install final drive housing and tighten retaining nuts to 102 N·m (75 ft.-lbs.) torque.

Install outer oil seal (35) into seal housing (34) with seal lip facing outward. Place bearing cone (30) in seal housing, then install inner oil seal (29) with lip of seal facing away from bearing. Secure stub axle in a vise and assemble "O" ring (37), dust shield (38) and sleeve (36) over the shaft. Apply grease to oil seals and stub axle shaft, then position seal housing assembly over the axle shaft. Install ring nut (28) on axle shaft and use special wrench (CAS-1241) to tighten nut securely so bearing is seated against sleeve.

NOTE: Nut (28) must be very tight or early failure of bearings and gears will result.

Apply Loctite 271 to threads of set screw (26), then install screw into one of the holes in nut that is opposite a spline groove in axle shaft. Head of set screw must be approximately 0.8 mm (1/32 inch) below surface of nut when properly installed.

Install "O" ring (32) on seal housing and lubricate with grease. Install original spacer (27) onto stub shaft. Install inner bearing cup and cone and bull gear into final drive housing. Partially install stub shaft assembly through housing and bull gear. Install spacer (24) on stub shaft making sure side with larger inside diameter is towards bull gear.

Install three bolts, equally spaced, in oil seal housing. Tighten bolts evenly until all end play in stub axle is removed. Measure the gap between oil seal housing and final drive housing using a feeler gage. Select thickness of shims (31) 0.13 mm (0.005 inch) less than measured gap to provide correct bearing preload. Remove three bolts and install shims. Install mounting bolts and tighten to 68 N·m (50 ft.-lbs.) torque.

Mount a dial indicator so probe is against side of bull gear and measure side to side movement of gear. If movement is not within range of 0.10-0.66 mm (0.004-0.026 inch), replace spacer (27) between ring nut and bull gear with a different thickness spacer as necessary.

Apply grease at oil seal housing fitting (33) until grease is visible at inner oil seal. Install housing cover (41) and tighten mounting bolts to 40 N·m (30 ft.-lbs.) torque. Refill final drive housing with Case ETHB Fluid or equivalent. Capacity is approximately 7.5 L (8 quarts). Install wheel and tire and tighten wheel nuts to 200 N·m (150 ft.-lbs.) torque. Bleed and adjust brakes as outlined in BRAKES section.

BRAKES

ADJUSTMENT

Models 1190-1194-1290-1294-1390-1394 (Without Cab)

286. Align left and right brake pedal height, if necessary, by adjusting screws (6—Fig. 219). Tighten locknuts to secure adjustment.

To adjust brakes, raise tractor until both rear wheels are off the ground. Connect pedals with the lock, depress pedals about 40 mm (1½ inches) and pull hand brake lever up to hold pedals in this position. Loosen locknut and turn adjusting nut (3—Fig. 219) on one brake rod until wheel is locked, then loosen nut until it is just possible to turn wheel by hand. Tighten locknut. Repeat procedure for the other brake. Release hand brake and check for satisfactory operation.

Models 1194-1294-1394 (With Cab)

287. To adjust brakes, first raise tractor so rear wheels are off the

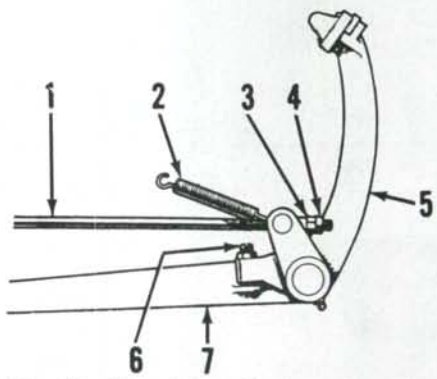


Fig. 219—View of typical brake pedal used on models equipped with mechanical drum brakes.

1. Brake rod
2. Spring
3. Adjusting nut
4. Locknut
5. Brake pedal
6. Adjusting screw
7. Park brake lever

ground. Loosen locknut (Fig. 220) on brake adjuster and turn adjusting bolt clockwise until wheel cannot be turned by hand. Then, turn adjusting bolt counterclockwise until wheel just begins to turn freely by hand. Tighten locknut. Repeat operation for brake on opposite side.

Models 1490-1494-1594-1690

288. To adjust brakes, first raise tractor so rear wheels are off the ground. Remove brake adjustment hole plug from top of final drive housing (Fig. 221). With brakes released, turn brake adjusting nut clockwise until wheel cannot be turned by hand. Turn adjusting nut counterclockwise 2½ turns. Be sure wheel turns freely, then reinstall plug. Repeat procedure for the brake on opposite side.

BRAKE SHOES AND DRUMS

Models 1190-1194-1290-1294-1390-1394

289. Brake shoes and drum can be removed after first removing final drive housing as outlined in paragraph 279. Use a suitable puller such as CAS-1211 to remove brake drum from axle shaft.

Brake shoes and lining (2—Fig. 222) are available as an assembly or linings can be renewed separately. Inspect brake camshaft (5) and bushings (8) for excessive wear and renew as necessary.

To install brake drum, first remove axle shaft end cover (14—Fig. 215) and shims (13) from final drive housing. Place final drive assembly in a press and support bearing end of axle shaft. Align keyways of drum with shaft keys, then press drum onto axle until seated against collar (5). Apply hydraulic sealant to inside diameter of brake drum sleeve (1), then press sleeve onto axle shaft until it bottoms against brake drum. Install shims, "O" ring, end cover and snap ring.

Reinstall brake shoes and final drive housing by reversing removal procedure. Adjust brakes as previously outlined.

BRAKE DISCS AND ACTUATING ASSEMBLY

Models 1490-1494-1594-1690

290. To remove brake discs, final drive housing must first be removed as outlined in paragraph 279. Remove parking brake lever (1—Fig. 223) and brake cover (7). Remove wheel cylinder (18). Remove adjusting hole plug (16), then remove adjuster nut (23) and spacer (22). Remove snap ring from pivot pin (8), push pivot pin out of adjuster rod (20) and actuator links (9), then remove adjuster rod and bellcrank assembly (24). Remove brake discs from

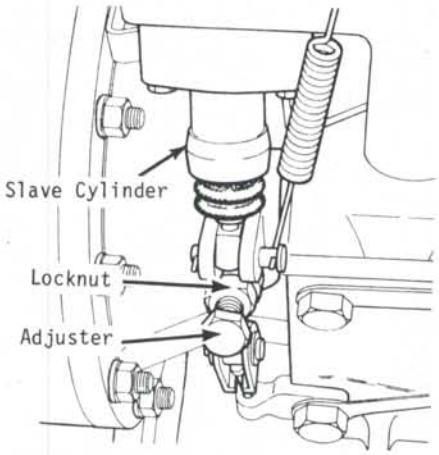


Fig. 220—View of brake adjuster bolt on 1194, 1294 and 1394 models equipped with a cab.

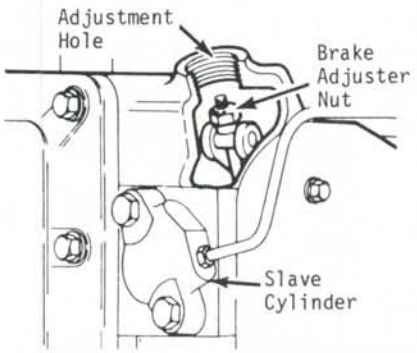


Fig. 221—On Models 1490, 1494, 1594 and 1690, remove plug from adjustment hole in final drive housing for access to brake adjuster nut.

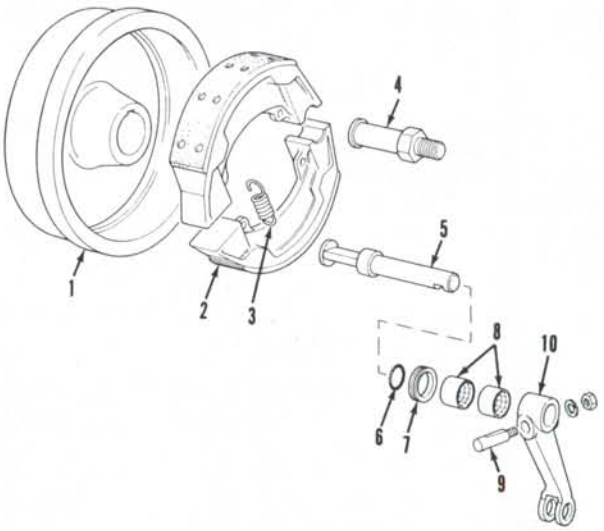


Fig. 222—Exploded view of brake shoes and drum used on models without cab. A hydraulic slave cylinder is used to actuate brake camshaft (4) on cab equipped models.

1. Brake drum
2. Brake shoe
3. Return spring
4. Pivot pin
5. Brake camshaft
6. "O" ring
7. Dust seal
8. Bushings
9. Lockpin
10. Camshaft lever

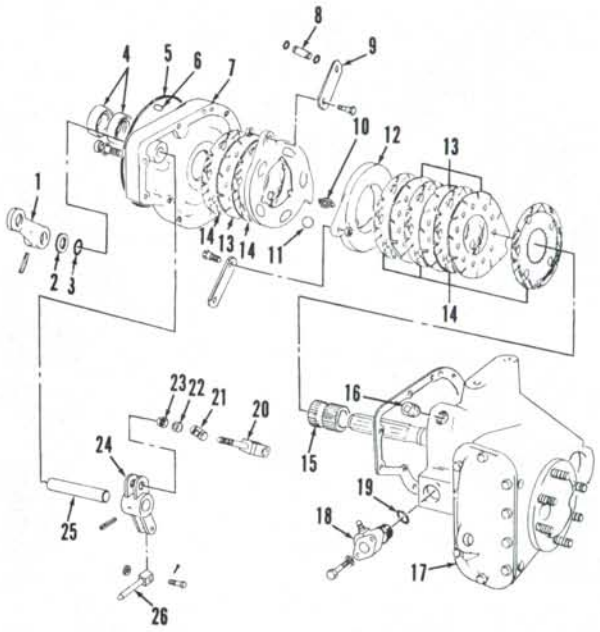


Fig. 223—Exploded view of disc brake components used on 1490, 1494, 1594 and 1690 models.

1. Parking brake lever
2. Dust shield
3. Oil seal
4. Oil seals
5. "O" ring
6. Breather
7. Brake cover
8. Pivot pin
9. Actuator link
10. Return spring
11. Steel ball
12. Actuator plate
13. Stationary discs
14. Rotating discs
15. Brake hub
16. Adjuster hole plug
17. Final drive housing
18. Brake cylinder
19. "O" ring
20. Adjuster rod
21. Adjuster pin
22. Spacer
23. Adjuster nut
24. Bellcrank
25. Pivot shaft
26. Wheel cylinder rod

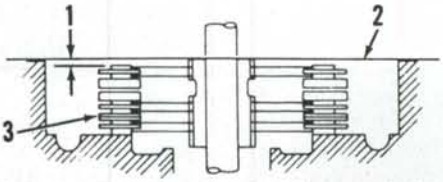


Fig. 224—Place a straightedge (2) across brake cover mounting surface and measure gap (1) between straightedge and top brake disc. Install extra stationary plate at location (3) only if necessary to bring disc height within specifications.

top of actuator, remove actuator plates (12) and remove remainder of brake discs.

Use a suitable puller, such as CAS-1211, to remove brake hub (15) from axle shaft if necessary. Disconnect actuator springs (10) and separate actuator plates (12). Remove seals from brake cover (7).

Inspect steel balls (11) and actuator plate ramps for wear or damage. Check friction surfaces of brake cover, actuator and final drive housing for excessive wear and renew as necessary. Measure thickness of stationary discs (13) and renew if less than 1.9 mm (0.075 inch) thick. Check condition of rotating discs (14) and renew all discs if one or more is worn to the point that grooves are almost gone.

If brake hub (15) was removed, heat hub to 200°C (400°F) maximum before installing on axle shaft. Be sure longer splines are toward final drive housing and hub is seated against axle shaft spacer. Assemble actuator assembly making sure links (9) and bolt head are installed on inside surface of actuator plates (12).

When installing brake discs, begin with a rotating disc (14) and alternately install stationary discs (13) and rotating discs until there are four rotating discs and three stationary discs assembled on hub. The last disc must be a rotating disc. Install actuator assembly, then install a rotating disc, stationary disc and remaining rotating disc.

Place a straightedge across surface of final drive housing and use a feeler gage to measure clearance between straightedge and friction surface of top disc (Fig. 224). Clearance must be within range of 0.43-3.12 mm (0.017-0.123 inch). If clearance exceeds 3.12 mm (0.123 inch), an extra stationary disc may be installed at location (3).

NOTE: Use this method only when new discs fail to bring clearance within specifications. Do not use extra stationary disc to compensate for excessively worn discs. Minimum clearance must still be 0.43 mm (0.017 inch).

When assembling bellcrank and shaft for right-hand brake, position bellcrank as shown in Fig. 225 and install end of shaft with the hole farthest from the end into bellcrank hub. Position bellcrank for left-hand brake as shown in Fig. 225A and install end of shaft with hole farthest from the end into bellcrank hub.

Install bellcrank assembly and adjuster rod into final drive housing. Be sure flat side of adjuster rod pin (21—Fig. 223) faces away from brake discs. Install wheel cylinder (18) making sure air bleed valve points away from final drive housing.

Renew brake cover seals (4). Lip of inner seal must face towards inner surface of cover and lip of outer seal must face towards outer surface of cover. Lubricate seal lips with grease. Tighten brake cover mounting bolts to 135 N·m (100 ft.-lbs.) torque.

Reinstall final drive as outlined in paragraph 279. Adjust brakes as outlined in paragraph 288 and bleed air from brakes as outlined in paragraph 292.

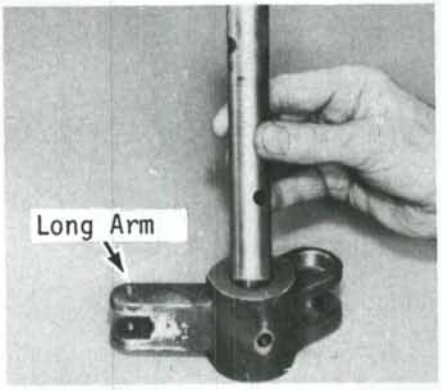


Fig. 225—To assemble bellcrank and pivot shaft for right-hand brake, position long arm of bellcrank as shown and install end of shaft with hole farthest from the end into bellcrank hub.

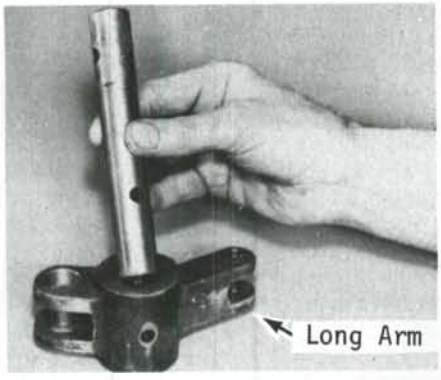


Fig. 225A—To assemble bellcrank and shaft for left-hand brake, position long arm of bellcrank as shown and install end of shaft with hole farthest from the end into bellcrank hub.

BRAKE HYDRAULIC SYSTEM

The brake hydraulic system used on some models consists of a reservoir, left and right brake master cylinders, balance valve and left and right wheel cylinders. Brake fluid reservoir is located under steering console cover.

All Models So Equipped

291. BRAKE FLUID. The brake hydraulic system is filled at the factory with Agricastrol FBS fluid. It is recommended that fluid be changed every two years. Refill system with Agricastrol FBS fluid or equivalent. Do not substitute automotive type brake fluid. Do not mix different types of fluid when adding fluid to system.

292. BLEED BRAKE SYSTEM. Check brake fluid level in reservoir and fill to maximum level with specified fluid. Disengage pedal lock so pedals can be operated individually. Connect a flexible tube over slave cylinder bleeder valve on side being bled and place other end of tube in a suitable container. Pump pedal on side being bled until resistance is felt. While applying pres-

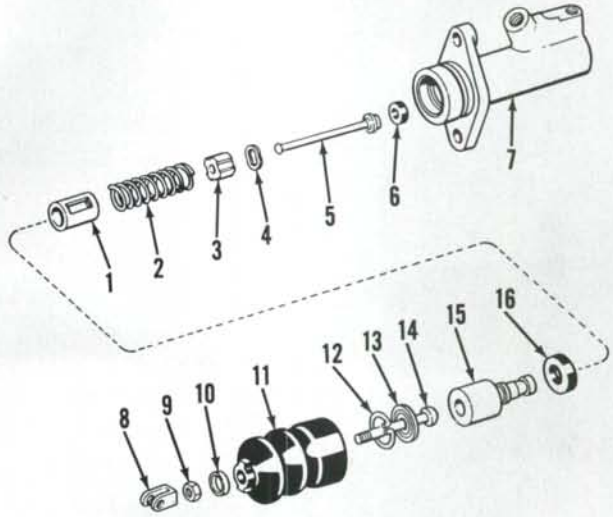


Fig. 226—Exploded view of brake master cylinder showing component parts and their relative positions. A separate master cylinder is used for each brake.

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

sure on pedal, loosen bleeder valve fitting to allow air to escape. When foot pedal contacts platform, tighten bleeder fitting. Repeat procedure until fluid from bleeder valve is free of air. Be sure to check reservoir fluid level frequently during bleeding operation.

Repeat procedure for brake on other side.

293. MASTER CYLINDERS. Left and right brake master cylinders are identical. A seal kit is available for servicing the master cylinders.

To remove master cylinders, first remove console cover and instrument cluster from steering console. Disconnect hydraulic lines, remove support bracket mounting bolts and remove master cylinders, brake pedals and support bracket as an assembly. Remove individual master cylinders from support bracket.

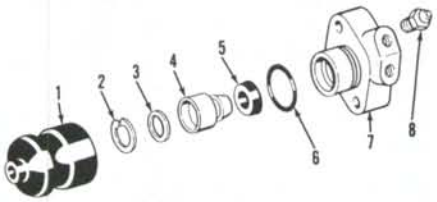


Fig. 227—Exploded view of wheel cylinder showing component parts and their relative positions.

1. Rubber boot
2. Snap ring
3. Washer
4. Piston
5. Seal
6. "O" ring
7. Wheel cylinder
8. Bleeder valve

Remove yoke (8—Fig. 226) and locknut (9). Cut and remove retainer (10) and withdraw rubber boot (11). Remove snap ring (12), then remove actuating rod (14), piston assembly (15) and spring assembly (2) from cylinder body. Use a small screwdriver to release retainer (1), then separate piston and spring assembly. Disconnect return spring rod (5) from retainer (1) and disassemble spring assembly.

To reassemble, reverse the disassembly procedure while noting the following special instructions: Install new seal (16) on piston with flat side towards piston. Lubricate piston with clean brake fluid prior to installing piston in cylinder. Apply lubricant that comes with repair kit to actuating rod (14) and washer (13).

Reinstall master cylinder on support bracket. With actuating rod pulled all the way out and foot pedal raised against stop plate, adjust yoke until pin can be inserted through hole in foot pedal and yoke. Tighten locknut against yoke. Install pedal and master cylinder assembly, then bleed air from system as outlined in paragraph 292.

294. BALANCE VALVE. No repair parts are available for the balance valve. The valve must be renewed as a complete unit if defective.

To check balance valve, disengage brake pedal latch so pedals can be operated individually. Using both feet, push down equally on both pedals until resistance is felt. Apply additional pressure to right pedal, the left pedal should then come back a small amount. Repeat procedure applying more pressure to left pedal and note that right pedal should move back a small amount. If this does not occur, renew balance valve.

295. WHEEL CYLINDERS. Left and right wheel cylinders are identical. Seal kit is available for cylinder overhaul.

With wheel cylinder removed, remove rubber boot (1—Fig. 227), snap ring (2), washer (3) and piston (4). Remove seal (5) from piston and remove "O" ring (6) from cylinder.

Install new seal with flat side towards piston. Lubricate piston with clean brake fluid prior to reassembly.

Reinstall wheel cylinder and tighten mounting cap screws to 23-28 N·m (17-21 ft.-lbs.) torque. Bleed air from system as outlined in paragraph 292.

POWER TAKE-OFF

REMOVE AND REINSTALL

All Models

296. To remove pto unit, first drain oil from transmission housing. Remove hitch lower links and drawbar support. Remove hitch upper draft arm. Disconnect control cable from upper link draft sensing unit. Remove hydraulic couplers and support bracket. Remove external hydraulic filter on models so equipped. Remove vacuum switch from bottom of pto housing on models so equipped. Engage the pto on reversible shaft models, then disconnect selector lever.

On all models, remove a mounting bolt from both sides of pto housing and install guide studs in their place. Support pto assembly with a suitable hoist, remove remaining mounting bolts and remove pto assembly from rear axle case.

Reinstall pto by reversing the removal procedure. Turn pto output shaft by hand to align drive shaft splines as unit is moved into position. Tighten mounting bolts to 100 N·m (75 ft.-lbs.) torque.

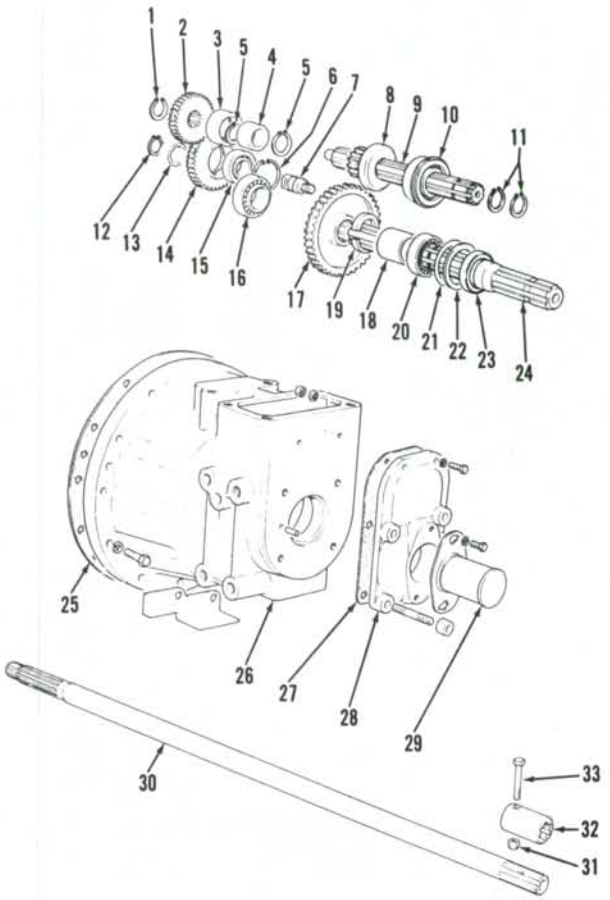


Fig. 228—Exploded view of single speed (540 rpm) pto assembly used on some Models 1190, 1194, 1290 and 1294.

1. Snap ring
2. Drive gear
3. Needle bearing
4. Inner race
5. Snap ring
6. Snap ring
7. Idler shaft
8. Sliding gear
9. Input shaft
10. Bearing
11. Snap rings
12. Snap ring
13. Shim
14. Idler gear
15. Bearing
16. Bearing
17. Output gear
18. Spacer
19. Split ring
20. Bearing
21. Shim
22. Spacer
23. Seal
24. Output shaft
25. Gasket
26. Housing
27. Gasket
28. End plate
29. Cover
30. Shaft
31. Nut
32. Coupler
33. Bolt

OUTPUT SHAFT OIL SEAL

All Models

297. Output shaft oil seal (23—Fig. 228) may be renewed on single speed and multispeed models without removing and disassembling pto housing. Remove end plate (28) and renew oil seal. Lip of seal must face inward.

Reversible shaft pto requires removal and disassembly of pto assembly for seal renewal.

OVERHAUL PTO ASSEMBLY

Models 1190-1194-1290-1294

298. DISASSEMBLY. Single speed pto assembly is shown in Fig. 228 and multispeed pto assembly is shown in Fig. 229. Note that sliding gears (8) are different and spacer (18—Fig. 228) is replaced by gear (18—Fig. 229) on multispeed units. Service procedures are the same for either assembly.

With pto removed as outlined in paragraph 296, remove draft sensor housing and metal gasket from top of pto housing. Remove safety shields and end plate (28). Remove spacer (22) and shims (21) from output shaft. Remove snap ring (1) and drive gear (2) from input shaft (9). Remove snap ring (12), shims (13) and idler gear (14).

Lightly wedge a tapered punch into end of shift rod retainer pin (8—Fig. 230), then withdraw pin from top of pto housing. Remove shift rod (7), spacer (6) and shift fork (12). Drive out roll pin (2) and remove shift lever (1) and arm (5).

Remove input shaft rear snap ring (11—Fig. 228 or 229), then drive input shaft (9) forward out of rear bearing. Remove inner snap ring (11) and sliding gear (8), then withdraw input shaft from housing. Drive output shaft (24) rearward out of front bearing and remove shaft and gears from housing.

Inspect all gears and shafts for wear or damage. Note that idler shaft (7) is staked and has locking compound applied to the threads. Do not remove shaft unless renewal is required. Inspect all bearings and renew as necessary.

299. REASSEMBLY. Install new "O" ring (4—Fig. 230) in housing shift arm bore. Assemble shift arm (5) and shift lever (1) using shims (3) as necessary to provide 0.13-0.25 mm (0.005-0.010 inch) end play.

If idler shaft (7—Fig. 228 or 229) is being renewed, apply Loctite 271 to threads of shaft. Install shaft and tighten to 95-108 N·m (70-80 ft.-lbs.) torque, then stake shaft threads inside the housing in three locations.

Heat output shaft rear bearing cone (20) to 120°C (250°F) maximum before installing on output shaft. Install spacer (18) or gear, as equipped, and split rings (19). Use grease to hold split rings in place. Lubricate front bearing cone (16) and install in front bearing cup. Position output gear (17) in housing so counterbore in hub faces rearward. Install output shaft through output gear and into front bearing making sure split retainers fit inside counterbore of output gear hub. Tap shaft forward until seated in front bearing. Install rear bearing cup.

Heat needle bearing inner race (4) to 120°C (250°F) maximum before installing on input shaft (9). Install front needle bearing (3) into housing bore with numbered side of bearing facing outward. Insert input shaft into housing installing sliding gear (8) and inner snap ring (11) as shaft is installed. Position rear bearing (10) in housing bore. Use two "C" clamps or other suitable means to hold rear bearing in place, then drive input shaft into the bearing until rear snap ring (11) can be installed.

To reassemble shift fork (12—Fig. 230), insert a 13 mm (½ inch) x 30 mm (1¼ inches) dowel into shift rod hole in fork. Assemble detent ball spring and plug in fork and tighten plug until outer end is even with chamfer in shift fork. Install fork on sliding gear, install spacer (6), then push shift rod (7) into fork until it moves dowel out of fork and detent ball engages with shift rod. Install special pin (8) into housing and shift rod making sure end of pin with the hole faces upward.

Install idler gear (14—Fig. 228 or 229) with bearing on idler shaft. Install snap ring (12) without shims (13). Using a dial indicator, measure idler gear end play. Remove snap ring and install a shim pack equal to measured end play minus 0.10 mm (0.004 inch) to provide

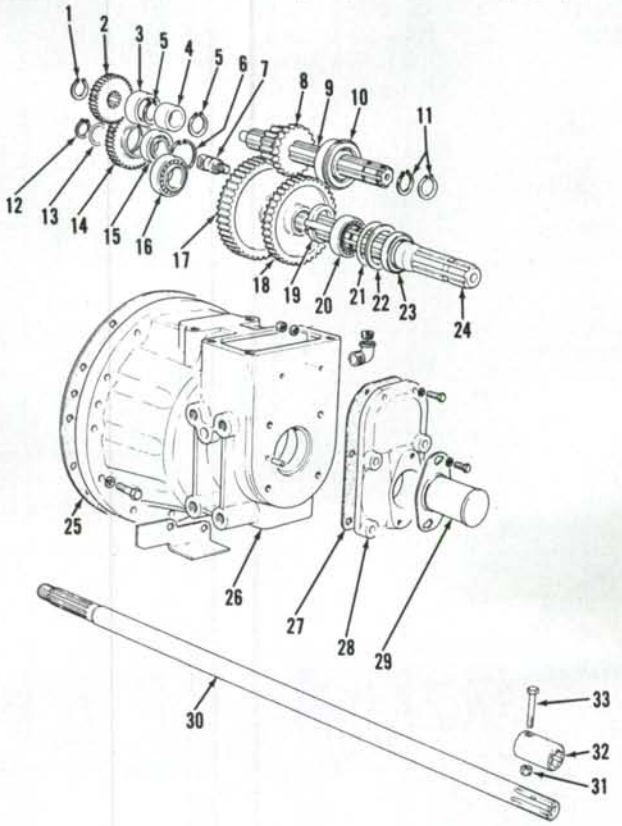


Fig. 229—Exploded view of multispeed pto assembly used on some Models 1190, 1194, 1290 and 1294. Pto unit is identical to single speed pto (Fig. 228) except for speed change gear (8) and high range output gear (17).

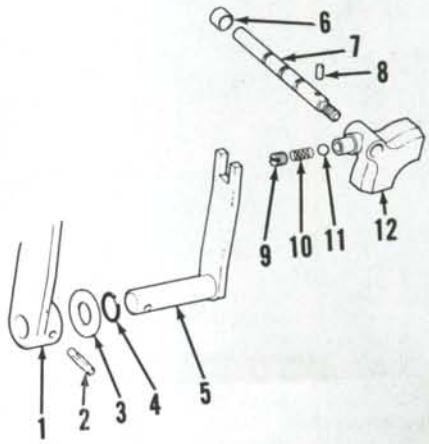


Fig. 230—Exploded view of typical pto shift linkage. Some models use a retainer plate to secure shift rod (7) in place of pin (8).

1. Engagement lever
2. Roll pin
3. Shim
4. "O" ring
5. Shaft & lever
6. Spacer
7. Shift rod
8. Special pin
9. Screw
10. Detent spring
11. Ball
12. Shift fork

recommended end play. Reinstall snap ring. Install drive gear (2) and snap ring (1) on input shaft (9).

Assemble shims (21) removed during disassembly plus an additional 0.50 mm (0.020 inch) shim on output shaft (24). Install spacer (22), gasket (27) and end plate (28) without oil seal (23). Tighten end plate mounting nuts evenly while turning output shaft by hand until resistance to shaft rotation is felt. Use a feeler gage to measure gap between end plate and housing. Remove end plate, spacer and shims. Subtract shims equal to measured gap dimension plus 0.05-0.10 mm (0.002-0.004 inch) from the previously installed shim pack to provide desired 0.05-0.10 mm (0.002-0.004 inch) shaft end play. Install new oil seal in end plate with lip facing inward. Lubricate seal lip, then reinstall shim pack, spacer and end plate. Tighten end plate mounting nuts to 68 N·m (50 ft.-lbs.) torque.

Install metal gasket and draft sensor housing on top of pto housing. Tighten draft housing bolts to 110-130 N·m (80-95 ft.-lbs.) torque. Reinstall pto assembly as outlined in paragraph 296.

Models 1390-1394-1490-1494 With Single Speed or Multispeed Pto

300. DISASSEMBLY. Single speed and multispeed pto assemblies are similar and service procedures are the same. Input shaft (8—Fig. 231) and output gear (13) are different in single speed assemblies.

With pto removed as outlined in paragraph 296, remove draft sensor housing and metal gasket from top of pto housing. Remove safety shields and end plate (18). Retain shims (10 and 15) for use in reassembly. 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 (12) rearward out of housing, then remove output gear (13).

Inspect all bearings, gears and shafts for wear or damage and renew as necessary.

301. REASSEMBLY. Reassemble pto by reversing disassembly procedure while noting the following special instructions. If input shaft, output shaft or bearings are renewed, check and adjust shaft end play as follows:

With shafts and bearings in place, install gasket (17—Fig. 231) and end cover (18) without shims (10 and 15) and oil seal (16). Use a dial indicator to measure end play of input and output shafts. Remove end plate. Assemble shim pack (10 and 15) for each shaft equal to measured shaft end play less 0.05-0.10 mm (0.002-0.004 inch) to provide specified 0.05-0.10 mm (0.002-0.004 inch) shaft end play. Install a new oil seal in end plate. Lubricate lip of seal, then reinstall gasket and end plate with correct thickness shim packs.

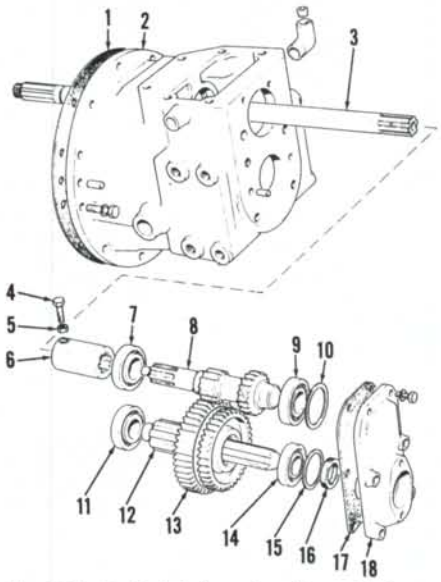


Fig. 231—Exploded view of multispeed pto assembly used on some 1390, 1394, 1490 and 1494 models. Single speed pto unit is similar except for shaft (8) and gear (13). Service procedure is the same.

1. Gasket
2. Housing
3. Shaft
4. Bolt
5. Nut
6. Coupler
7. Bearing
8. Input shaft
9. Bearing
10. Shim
11. Bearing
12. Output shaft
13. Output gears
14. Bearing
15. Shim
16. Seal
17. Gasket
18. End plate

Models 1390-1394-1490-1494-1594-1690 With Reversible Shaft Pto

302. DISASSEMBLY. With pto assembly removed as outlined in paragraph 296, remove shields and pto reversible shaft (6—Fig. 232). Remove end plate mounting bolts, then lift end plate (5) with output shaft assembly from pto housing. Remove input shaft (11) from the housing.

Bend tab washer (13) away from output shaft bolts, then remove the three bolts and washers. Use a puller under gear (18) to remove front bearing (16). Remove gear (18), thrust bearing (19), high speed output shaft (30), bearings (27) and spacer (26). Use a puller to remove low output gear (20). Remove split rings (21), then tap low speed shaft (25) out of bearing (22).

Remove snap ring which retains shift fork on shift rod, then withdraw shift fork and sliding gear. Remove retainer plate and shift rod. Drive pin from shift selector lever, then remove shift arm, washers and "O" ring from housing.

302A. REASSEMBLY. To reassemble speed selector components, reverse the disassembly procedure. If necessary, add washers to provide 0.13-0.25 mm (0.005-0.010 inch) end play of shift selector arm.

Install new bearings on input shaft (11—Fig. 232) if necessary. Assemble output shaft assembly by reversing disassembly procedure. Tighten the three retainer bolts in end of shaft to 27 N·m (20 ft.-lbs.) torque, then bend tab washer against bolt heads.

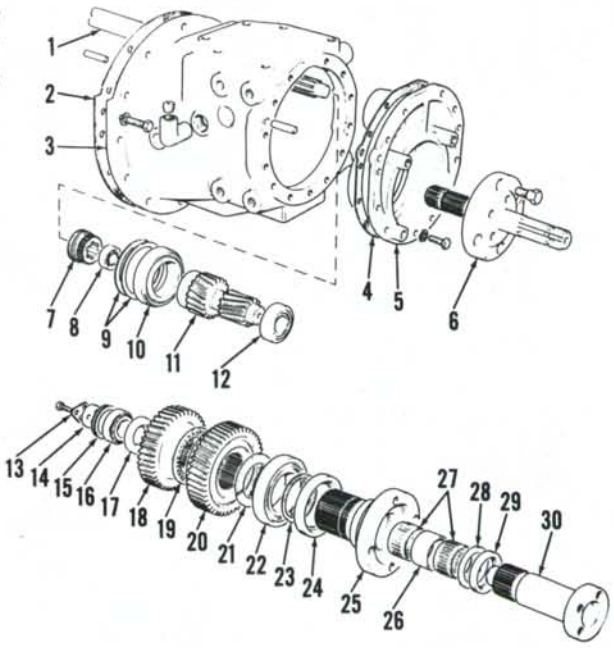


Fig. 232—Exploded view of reversible shaft pto assembly used on some 1390, 1394, 1490, 1494, 1594 and 1690 models.

1. Shaft
2. Gasket
3. Housing
4. Gasket
5. End plate
6. Reversible shaft
7. Sliding gear
8. Bearing
9. Shims
10. Bearing
11. Input shaft
12. Bearing
13. Tab washer
14. Bearing retainer
15. Shims
16. Bearing
17. Special washer
18. Output gear (high)
19. Thrust bearing
20. Output gear (low)
21. Split ring
22. Bearing
23. Special washer
24. Seal
25. Output shaft (low)
26. Spacer
27. Bearings
28. Plate
29. Seal
30. Output shaft (high)

Note that adjustment of input shaft and output shaft end play must be made when bearings, gears or shafts are renewed. To set end play, remove bearing cups and shims (9 and 15—Fig. 232) from front of pto housing. Reinstall bearing cups without shims, then position input shaft assembly and output shaft assembly into housing. Tighten end plate mounting bolts to 27 N·m (20 ft.-lbs.) torque. Install reversible shaft (6) with 540 rpm end (six splines) outward and tighten shaft mounting bolts securely. Rotate output shaft to make sure bearings are seated. Using a dial indicator, measure and record end play of output shaft and input shaft. To provide correct end play of 0.05-0.10 mm (0.002-0.004 inch) for each shaft, assembly shim pack (9 and 15) thicknesses equal to measured end play minus 0.05-0.10 mm (0.002-0.004 inch). Use thick shims when possible rather than several thin shims. Remove output shaft, input shaft and front bearing cups. Install shims, then reassemble pto. Tighten end cover bolts to 27 N·m (20 ft.-lbs.) torque and reversible shaft mounting bolts to 122 N·m (90 ft.-lbs.) torque.

HYDRAULIC SYSTEM

The hydraulic system is basically the same on all models. However, hydraulic pump type and location will vary according to model. On Models 1190, 1194, 1290 and 1294, hydraulic pump is mounted internally in pto housing and driven by a gear on pto input shaft. All other models have either a single pump or tandem pumps mounted externally in front of radiator and driven by a drive shaft coupled to engine crankshaft front pulley.

OPERATING PRINCIPLES

Models With Rear Mounted Pump

303. Hydraulic pump is mounted to back of rear axle housing between axle and pto housings. Pump is driven by a gear on pto input shaft, and is operating only when pto clutch is engaged.

Pump lifts oil from transmission reservoir through a full flow filter (7—Fig. 233). A pressure relief valve (9), located on top of pump, controls system pressure. Oil is pumped through a pipe to distribution block (4) located on top of rear axle case on right-hand side of tractor. Oil is directed first to remote valve (3), if so equipped, then to selectamatic valve (5).

Movement of remote valve lever forward or backward from neutral position directs all the oil flow through the remote valve to external equipment. When lever is in neutral position, all the oil flow is directed to selectamatic valve.

Oil flow is routed from selectamatic valve to three-way valve (10), if so equipped, and hitch rockshaft cylinder (13). If equipped with a three-way valve, oil flow can be used to operate rockshaft and external equipment at the same time when control lever is in "L/1" position. Remaining lever positions provide rockshaft only or external operation only.

Remaining oil flow is used to supply lubrication to upper bearings of transmission.

Models With Front Mounted Single Pump

304. Hydraulic pump (9—Fig. 234) 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. Pressure oil then flows through external filter (5) to distribution block (4) and remote valve (2).

When remote valve control lever is in neutral position, oil flow is directed to selectamatic valve (6). The selectamatic valve will direct oil flow to rockshaft cylinder (15) and three-way valve (14). The oil flow can be used to operate rockshaft and external equipment at the same time when control lever is in "L/1" position. Remaining lever positions provide rockshaft operation only or external operation only.

When remote valve lever is moved from neutral position, oil flow is cut off from selectamatic valve and all oil is directed instead to operate external equipment.

Return oil is used to lubricate transmission bearings. An oil cooler (12) is used on models equipped with power shift transmission.

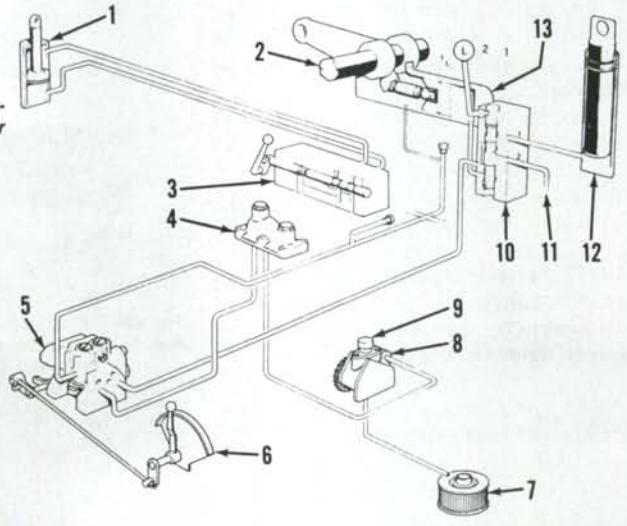


Fig. 233—Schematic of hydraulic system with rear mounted hydraulic pump.

1. External double acting cylinder
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

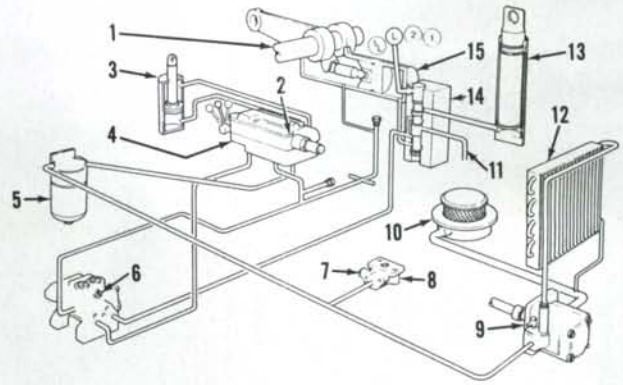


Fig. 234—Schematic of hydraulic system with single front mounted hydraulic pump.

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. Pressure 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

Models With Front Mounted Tandem Pumps

305. This system is similar to single pump system except that two pumps are coupled together as a single unit and may be used separately or together according to position of combining valve (16—Fig. 235).

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 (5) or distribution block (4), and no oil goes to rockshaft cylinder (15).

When combining valve is set for separate pump operation, one pump supplies oil to rockshaft cylinder and remaining pump supplies oil to remote valve. Rockshaft can be used at the same time as external equipment.

Each pump has a separate pressure relief valve (8).

HYDRAULIC FILTERS AND FLUID

Models 1190-1194-1290-1294

306. These models have a metal screen (2—Fig. 236) equipped with a magnet (7) and a renewable paper filter (5) on suction side of pump. Filter assembly is located in housing (9) which is bolted to bottom of transmission housing.

Filter element (5) should be renewed after every 400 hours of operation and hydraulic fluid should be renewed every 800 hours. Capacity is approximately 27.5 L (29 quarts).

NOTE: Remove drain plug (3) and drain fluid from transmssion before removing filter housing (9). Be sure to drain fluid into clean container if fluid will be reinstalled.

Clean metal screen and remove metal particles, if present, from magnet (7). Install filter and screen using new "O" ring (6) and gasket (8). Tighten housing retaining bolts to 23-27 N·m (17-20 ft.-lbs.) torque.

If reusing fluid, reinstall all but about the last 4 L (1 gallon) which should contain any foreign material that settled to bottom of container. Add new Case TFD Fluid, Hy-Tran Plus or equivalent fluid to bring fluid level to correct operating level. Bleed air from system as outlined in paragraph 308.

Models 1390-1394-1490-1494-1594-1690

307. Filtering system on these models consists of fine metal filter element (2—Fig. 237) on suction side of pump and a renewable filter element (12—Fig. 238) on pressure side. Suction filter is located on underside of transmission housing. On models equipped with power shift transmission, the power shift pump inlet filter (9—Fig. 237) is also located in suction filter housing. Pressure filter element (12—Fig. 238) is located in a canister mounted on right-hand rear axle housing.

Pressure filter element should be renewed after every 400 hours of operation. Transmission/hydraulic fluid should be drained and renewed after every 800 hours of operation. Suction filter screen and power shift pump inlet screen should be removed and cleaned at same time hydraulic fluid is drained and renewed.

On all models use new "O" rings and gaskets when reinstalling filter assemblies. Tighten suction filter housing retaining bolts to 27 N·m (20 ft.-lbs.) torque and tighten pressure filter canister to 34 N·m (25 ft.-lbs.) torque.

If reusing fluid, reinstall all but the last 4 L (1 gallon) which should contain any foreign material that settled to bottom of container. Add new Case PTF fluid, HY-Tran Plus or equivalent fluid to bring fluid level to correct operating level. Bleed air from system as outlined in paragraph 308.

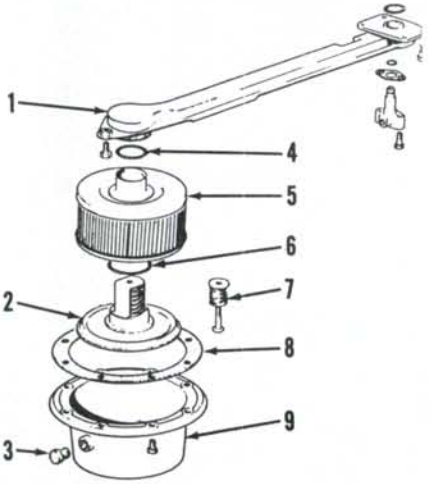


Fig. 236—Exploded view of hydraulic pump suction filter assembly used on 1190, 1194, 1290 and 1294 models.

1. Suction pipe
2. Metal screen
3. Drain plug
4. "O" ring
5. Filter
6. "O" ring
7. Magnet
8. Gasket
9. Filter housing

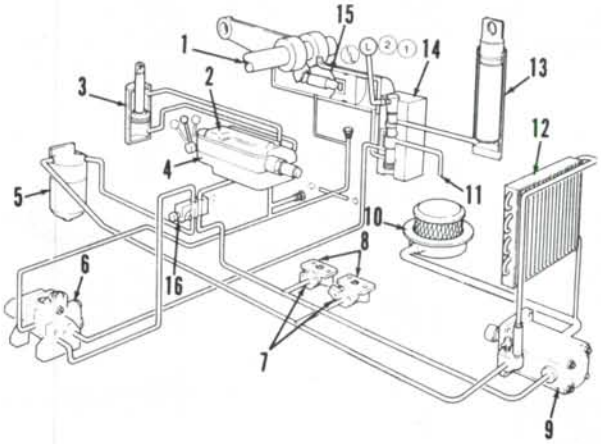


Fig. 235—Schematic of hydraulic system with tandem front mounted hydraulic pumps. Refer to legend for Fig. 234 except for combining valve (16).

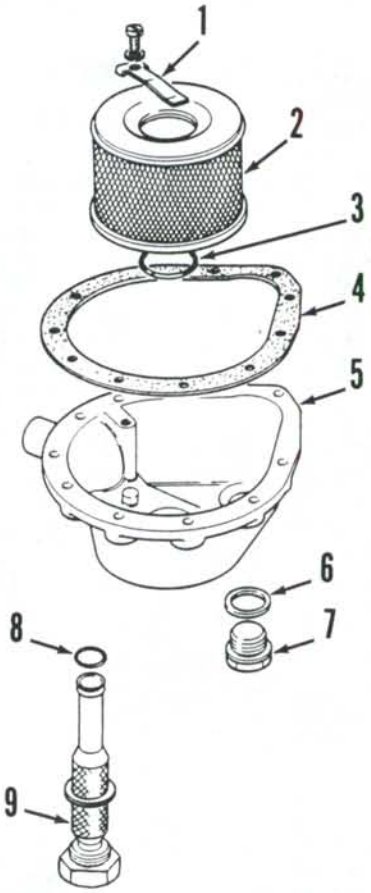


Fig. 237—Exploded view of hydraulic suction filter assembly used on Models 1494 and 1594. Models 1390, 1394, 1490 and 1690 are similar. Filter screen (9) is used on power shift models only.

1. Retainer
2. Filter element
3. "O" ring
4. Gasket
5. Housing
6. Sealing washer
7. Drain plug
8. "O" ring
9. Filter screen

BLEEDING AIR FROM HYDRAULIC SYSTEM

All Models

308. When oil has been drained from hydraulic system, use the following procedure to ensure all air is removed from the system. Make sure system is refilled to correct operating level. Move selectamatic control to "DRAFT" position and push quadrant lever fully forward to "LOWER" position.

On all models equipped with a dump valve, except 1594 and 1690, remove dump valve (1—Fig. 239) and plate (2) from top of selectamatic valve. Reinstall dump valve and open valve by pulling knob up. Turn plugs for bypass and hold valves, located under plate (2), until bleed hole in side of each plug is clear of the bore. With engine stop control in "STOP" position, crank engine with starter motor until air-free oil flows from plugs. Tighten plugs and reinstall cover.

Disconnect outlet pipe from remote valve (if so equipped). Move operating lever forward from neutral position, then operate starter until oil is free of air. Reconnect outlet pipe. Disconnect pipe from number 1 (top) port of three-way valve (if so equipped). Put operating lever in "1" position, then operate starter until all air is forced out. Reconnect pipe.

On all models except 1594 and 1690, move three-way valve lever to "L" position and turn air bleed fitting (1—Fig. 240) on rockshaft cylinder counterclockwise. Operate starter until air-free oil flows from bleeder, then retighten bleed screw. On Models 1594 and 1690, open dump valve and operate starter to remove air from rockshaft cylinder.

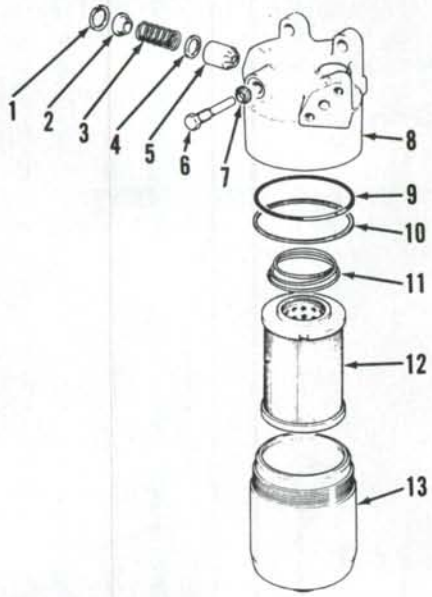


Fig. 238—Exploded view of hydraulic system pressure filter used on some models.

1. Snap ring
2. Retainer
3. Spring
4. Washer
5. Plunger
6. Set screw
7. Sealing washer
8. Filter head
9. Sealing ring
10. Backup ring
11. Spring
12. Filter element
13. Filter canister

TROUBLESHOOTING

All Models

309. When troubleshooting 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 good condition. Refer to following list of malfunctions and possible causes as an aid in locating source of trouble.

A. FAILURE TO LIFT. Could be caused by:
1. Low oil level, air in system or suction filter plugged.
2. Pressure relief valve opening too soon.
3. Spool valve seized.
4. Bypass valve or hold valve not seating.
5. Nonreturn valve seat loose.
6. Leakage from rockshaft cylinder or dump valve.
7. Worn or damaged hydraulic pump.

B. FAILURE TO HOLD LOAD. Could be caused by:
1. Hold valve sealing washer defective.
2. Faulty hold relief valve.
3. Hold valve plunger seized.
4. Faulty rockshaft piston seals.
5. Faulty nonreturn valve.

C. FAILURE TO LOWER. Could be caused by:
1. Rockshaft lock pin (if so equipped) engaged.
2. Lowering control valve in "closed" position.
3. Rockshaft seized.

D. LOWERS SLOWLY. Could be caused by:
1. Lowering control valve misadjusted.
2. Spool valve misadjusted.
3. Hold valve seized.
4. Flow control valve plunger seized.

E. INCORRECT DEPTH CONTROL. Could be caused by:
1. Loose control lever pivot.
2. Sensing cable incorrectly adjusted or seized.
3. Sensing valve seized.
4. Selectamatic valve plungers sticking.

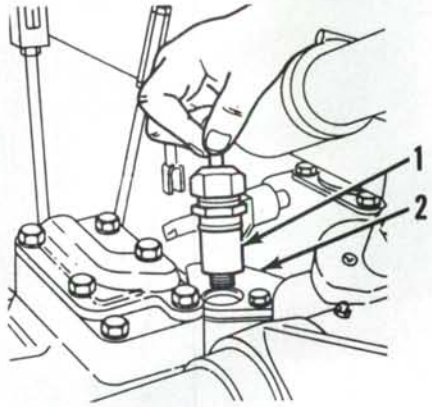


Fig. 239—On models equipped with a dump valve (except 1594 and 1690), dump valve (1) and plate (2) must be removed from top of selectamatic valve to gain access to bleed points. Refer to paragraph 308.

HYDRAULIC SYSTEM PRESSURE CHECK

Models 1190-1194-1290-1294

310. If tractor is equipped with remote valve, connect a 0-20000 kPa (0-3000 psi) pressure gage to remote outlet port. Operate engine at idle speed, then actuate remote valve to direct oil to gage and note pressure reading.

If tractor is not equipped with remote valve, remove connector plate (1—Fig. 241) from top of rear axle housing and install special plug (2), part number K961977, in the rear tube as shown. Remove rear plug from connector plate and install a 0-20000 kPa (0-3000 psi) pressure gage in the opening. Reinstall distribution block. Operate engine at idle speed and note pressure reading.

Minimum allowable pressure is 13800 kPa (2000 psi) with oil at normal operating temperature.

Models 1390-1394-1490-1494-1594-1690

311. If tractor is equipped with remote outlet, connect a 0-20000 kPa (0-3000 psi) pressure gage to remove

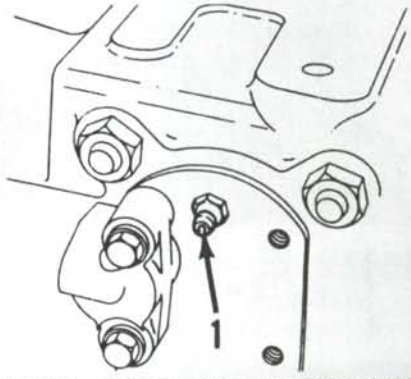


Fig. 240—On all models except 1594 and 1690, air bleed fitting (1) is located on rockshaft cylinder.

outlet port. Operate engine at idle speed, then actuate remote valve to direct oil flow to gage and note pressure reading.

If tractor is not equipped with remote outlet, remove cover from distribution block and install adapter plate (2—Fig. 242), part number K962234, in its place. Install a 0-20000 kPa (0-3000 psi) pressure gage in adapter plate port. Operate engine at idle speed and note gage reading.

On all models, minimum allowable pressure is 13800 kPa (2000 psi) with oil at normal operating temperature.

HYDRAULIC SYSTEM ADJUSTMENTS

All Models Except 1594

312. ROCKSHAFT CAM ADJUSTMENT. Hold lift linkage control lever in SELECT postion, then select POSITION CONTROL on selector dial. Move linkage control lever to RAISE position. Lift the lower links by hand to fully raised position, then engage lift latch if so equipped. If not equipped with lift latch, lower the linkage 40 mm (1½ inches), measured at outer end of lower link, and support in this position with a suitable stand. Remove cover from rear of right-hand rockshaft bracket. Loosen the two nuts (3—Fig. 243), insert a punch (2) into hole in rockshaft cam (4) and turn cam until roller (1) is seated in notch. Tighten the two nuts to secure adjustment.

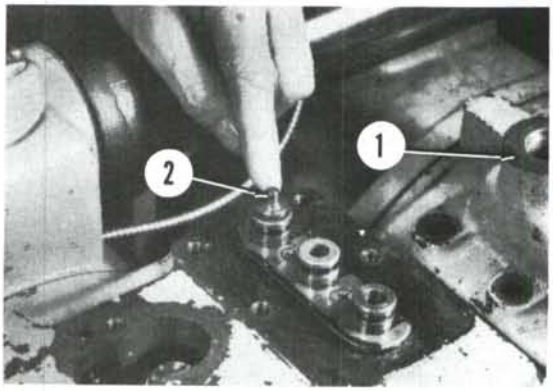


Fig. 241—To check system pressure on models with rear mounted pump and not equipped with a remote valve, remove connector plate (1) and install special plug (2) as shown. Reinstall connector plate and install a 0-20000 kPa (0-3000 psi) gage in plate test port.

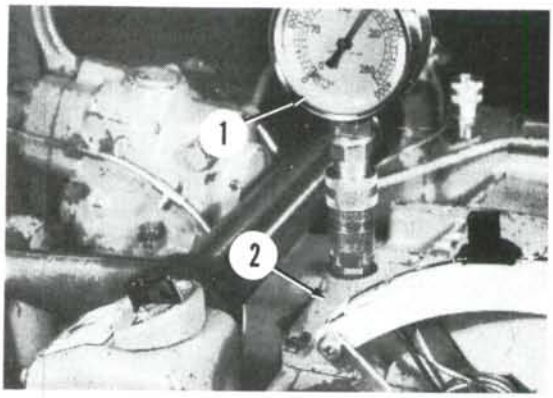


Fig. 242—To check system pressure on models with front mounted pump and not equipped with remote valve, remove cover from distribution block and install adapter plate (2) part no. K962234. Install 0-20000 kPa (0-3000 psi) pressure gage in adapter plate test port.

313. CONNECTING LINK ADJUSTMENT. Move selector dial to POSITION control setting. Remove cover (4—Fig. 244) from control housing on tractors equipped with cab or platform. (Control housing (1) is located on right-hand side of rear axle housing.) On models without cab or platform, remove plug (4—Fig. 245) from control housing cover. On all models, turn nut (2—Fig. 244 or 245) counterclockwise until it is even with end of connecting link (3). Remove cover from rear of right-hand rockshaft bracket. Move linkage control lever rearward to SELECT position and hold in this position. Raise lift arms by hand until roller (1—Fig. 243) is seated in notch in cam (4). Support lift arms in this position with a suitable stand. Place a 0.05 mm (0.002 inch) feeler gage between rocker lever (2—Fig. 246) and push rod (1). Then turn connecting link locknut (2—Fig. 244 or 245) clockwise until feeler gage is snug but can be moved between rocker lever and push rod.

Install covers and remove stands supporting lift arms.

314. CONTROL LEVER FRICTION DISC ADJUSTMENT. If lift linkage control lever moves from a set position, tighten nuts (4—Fig. 247) to

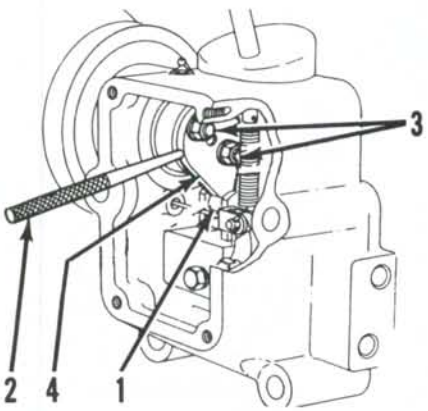


Fig. 243—View showing adjustment of rockshaft cam. Refer to paragraph 312.

1. Roller
2. Punch
3. Nuts
4. Rockshaft cam

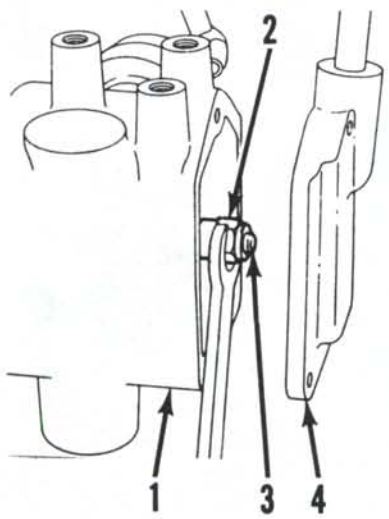


Fig. 244—View showing location of locknut used to adjust connecting link on cab or platform equipped models.

1. Control housing
2. Locknut
3. Connecting link
4. Cover

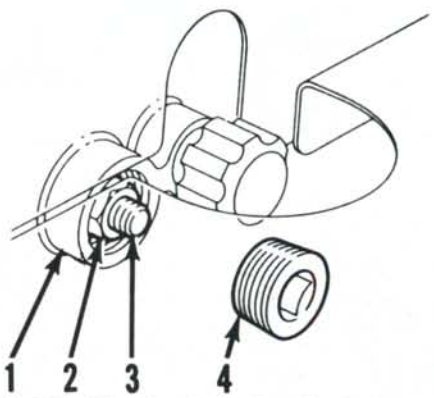


Fig. 245—View showing location of locknut used to adjust connecting link on low profile models.

1. Control housing cover
2. Locknut
3. Connecting link
4. Plug

increase friction disc (3) pressure. If control lever is difficult to move, loosen nuts. Be sure nuts are not too tight that lever fails to move from SELECT position when released.

315. SPRING CARRIER ADJUSTMENT. Start engine and run at 1800 rpm. Move selector dial to POSITION control setting. Hold linkage control lever in SELECT position until linkage is at full height and pump relief valve opens. Slowly move control lever forward until relief valve closes but lift arms do not lower. Hold control lever in this position. Loosen the two bolts (7—Fig. 247) and move spring carrier (9) until it contacts lever stop (10). Tighten the two bolts to secure adjustment.

316. LIFT LINKAGE CONTROL LEVER ADJUSTMENT. Place selector dial in POSITION control setting. Move linkage control lever forward until it is 3 mm (⅛ inch) from end of quadrant slot. Loosen jam nuts (2—Fig. 248) and turn adjuster (1) until friction lever (5) contacts pin (6). Tighten jam nuts securely against adjuster (1).

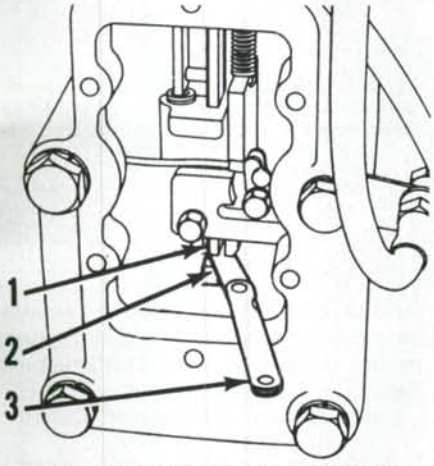


Fig. 246—Insert 0.05 mm (0.002 inch) feeler gage (3) between push rod (1) and rocker lever (2), then turn connecting link adjusting nut until feeler gage is snug but can still be moved.

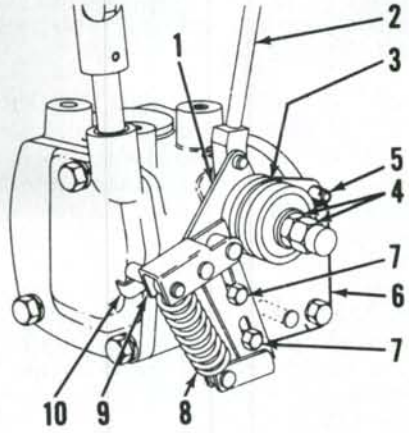


Fig. 247—View of control lever linkage friction adjustment and spring carrier adjustment points.

1. Friction lever
2. Control rod
3. Friction discs
4. Jam nuts
5. Pin
6. Plate
7. Bolts
8. Spring
9. Spring carrier
10. Friction lever stop

317. SELECT STOP ADJUSTMENT. Place selector dial in POSITION control setting. Loosen nut (2—Fig. 249) and move stop assembly (3) to bottom of slot. Move linkage control lever (1) rearward until friction lever pin (5—Fig. 247) contacts plate (6). Move stop until it just contacts linkage control lever, then tighten nut to retain stop in this position.

318. DRAFT SENSING CABLE. Remove upper link from draft sensing unit. Install weights on lower links only. Move selector dial to DRAFT control setting. Turn jam nut (4—Fig. 250) clockwise and adjuster (5) counterclockwise until inner cable is free at bracket (2). Move linkage control lever rearward until SELECT position spring tension is felt. Start engine and allow lift linkage to raise to its highest position, then stop engine. Turn cable adjuster clockwise until linkage just starts to lower. Then turn cable adjuster counterclockwise 5¼ revolutions, hold adjuster in this position and tighten jam nut against bracket (3) to secure adjustment.

Lower the linkage and remove weights.

Model 1594

319. SENSING CONTROL ADJUSTMENT. To adjust draft sensing control linkage, first move sensing control lever fully forward to minimum draft position. Move lift linkage control lever rearward to SELECT position and lock in place. Be sure friction lever on side of control housing (located on right-hand side of axle housing) contacts the stop. Make certain spring carrier on side of control housing is clear of friction lever. If tractor is equipped with tandem hydraulic pumps, move

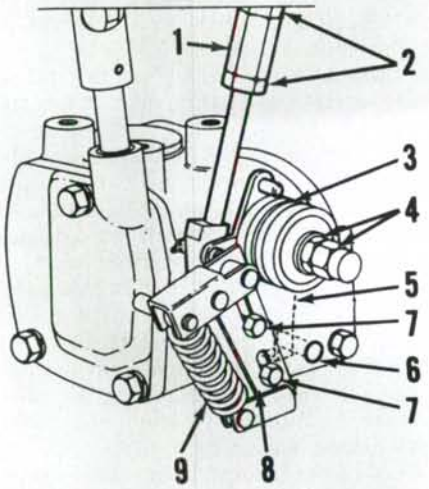


Fig. 248—View of linkage control lever connecting rod adjustment point.

1. Adjuster
2. Jam nuts
3. Friction discs
4. Jam nuts
5. Friction lever
6. Pin
7. Bolts
8. Spring carrier
9. Spring

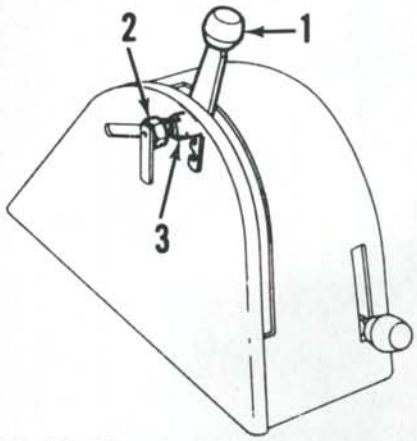


Fig. 249—View of typical quadrant control lever (1) and stop (2).

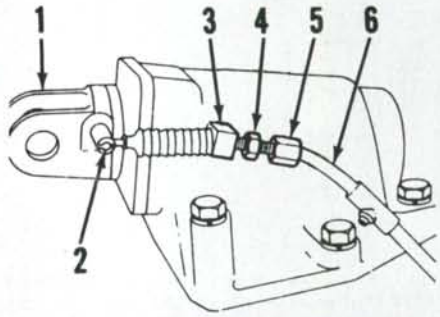


Fig. 250—View of sensing cable and its adjustment points.

1. Yoke shaft
2. Cable bracket
3. Cable support
4. Jam nut
5. Adjuster
6. Cable & housing

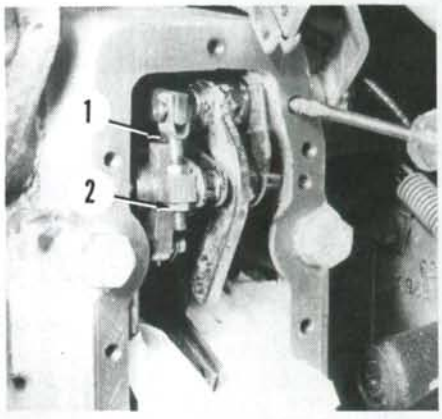


Fig. 251—Remove cover from rear of right-hand rockshaft bracket to gain access to draft link adjuster (1) and adjusting nuts (2) on Model 1594.

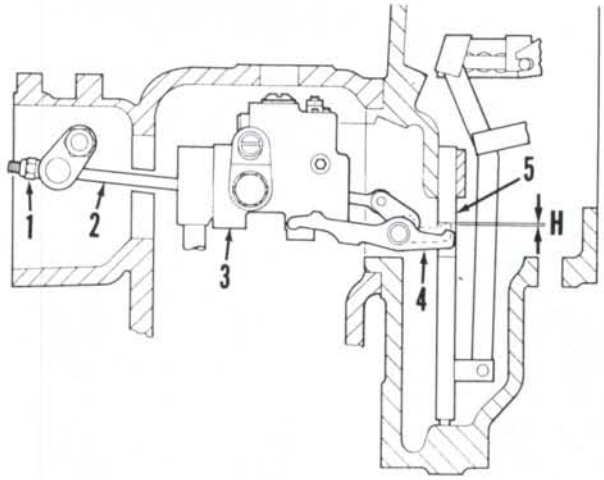


Fig. 252—Adjust control rod nut (1) to provide 2 mm (0.080 inch) gap (H) between rocker lever and sliding bar. Refer to paragraph 319.

1. Nut
2. Control rod
3. Selectamatic valve
4. Rocker lever
5. Sliding bar

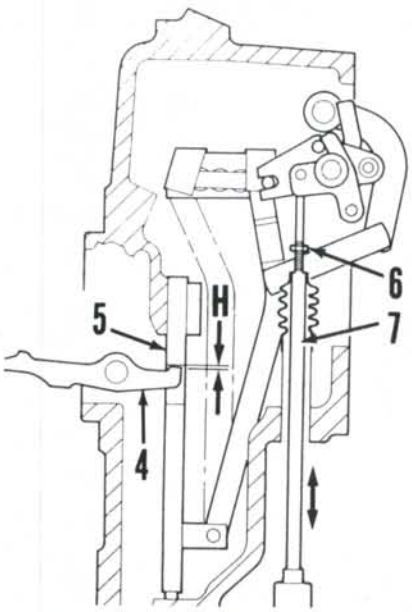


Fig. 253—Adjust draft transfer rod on Model 1594 to provide 2 mm (0.080 inch) gap (H) between rocker lever and sliding bar. Refer to paragraph 319.

4. Rocker lever
5. Sliding bar
6. Locknut
7. Transfer rod

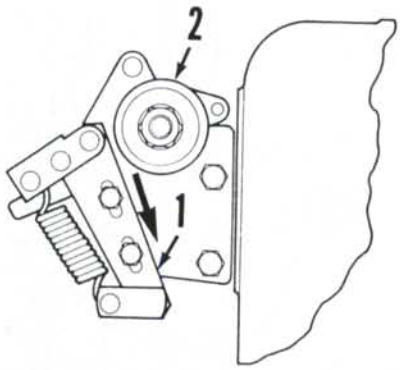


Fig. 254—View of control linkage spring carrier (1) and friction lever (2). Refer to text for adjustment procedure.

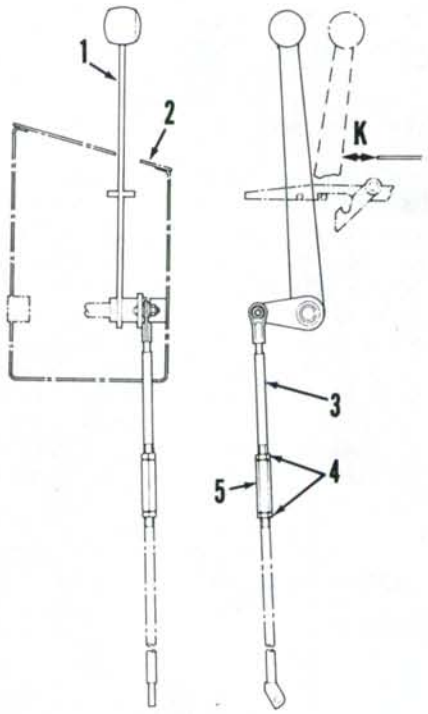


Fig. 255—With quadrant control lever moved rearward to full lift position, distance (K) between lever and end of quadrant slot should be 36 mm (1-7/16 inches).

1. Linkage control lever
2. Quadrant housing
3. Control rod
4. Jam nuts
5. Adjuster

combining valve lever forward to direct oil to lift linkage.

Raise lift arms by hand and support in fully raised position with stands. Remove cover from rear of right-hand rockshaft housing. Loosen lower nut (2—Fig. 251) on draft link adjuster (1) until nut is even with end of adjuster rod. Remove cover from control housing on right side of axle housing. Turn adjusting nut (1—Fig. 252) on end of control rod (2) clockwise to increase clearance between rocker lever (4) and sliding bar (5), then turn nut (1) counterclockwise until there is a 2 mm (0.080 inch) gap (H) between lever and bar. Insert feeler gage through rear opening in rockshaft bracket to measure gap.

Move sensing control lever fully rearward to full draft position. Loosen locknut (6—Fig. 253) on transfer rod (7), then adjust rod so there is a 2 mm (0.080 inch) gap (H) between rocker lever (4) and sliding bar (5). Tighten locknut.

Move sensing lever fully forward to minimum draft position, remove stands and lower lift arms. Place cover over rockshaft bracket opening to prevent oil from coming out. Start engine and, if necessary, hold linkage control lever in SELECT position until all air is removed from system.

Loosen the two bolts retaining spring carrier (1—Fig. 254) on side of control housing. Move linkage control lever rearward until lift linkage is fully raised and pressure relief valve opens. Then move spring carrier in direction of arrow (Fig. 254), which rotates friction lever (2), until pressure relief valve closes. Hold spring carrier in this position and tighten retaining bolts. To check setting, move control lever to SELECT position; relief valve must open. Release control lever; it must return to full lift position and relief valve must close.

Lower the linkage, then raise linkage to full lift position. Move sensing control lever rearward to full draft position. Turn lower nut (2—Fig. 251) on draft link adjuster (1) clockwise until pressure relief valve just closes, then tighten upper locknut. Move sensing lever from full draft to minimum draft several times. The lift linkage must not lower and relief valve must not open.

Reinstall covers using new gaskets.

320. LIFT LINKAGE CONTROL LEVER ADJUSTMENT. Move control lever rearward to full lift position. Distance (K—Fig. 255) between rear edge of control lever (1) and end of quadrant slot should be 36 mm (1 7/16 inches). To adjust, loosen locknuts (4) and turn control rod adjuster (5) as necessary.

321. DRAFT SENSING LEVER ADJUSTMENT. Draft control lever adjustment can only be done accurately with control cable removed. Adjust ball joint at control lever end to 12.5 mm (½ inch) dimension as shown in Fig. 256. Adjust ball joint at other end of cable so overall length of cable is 992.5-997.5 mm (39⅛ to 39¼ inches) between centers of ball joints. Install cable assembly in cable brackets. Threads of cable housing should be centered in upper bracket (2).

Connect cable upper ball joint to control lever (1), then move control lever so it is aligned with center square on quadrant decal. Move control arm (6) by hand until detent mechanism in

rockshaft bracket engages center detent. Move lower cable bracket (5) at slotted hole until retaining bolt slides freely through lower ball joint and control arm (6). If additional adjustment is required for proper alignment, adjust upper bracket locknuts (3) as necessary.

HYDRAULIC PUMP

Models 1190-1194-1290-1294

322. R&R AND OVERHAUL. Hydraulic pump is located internally in pto housing at rear of tractor. To remove pump, drain oil from transmission and remove pto housing as outlined in paragraph 296. Disconnect inlet pipe from pump, remove pump mounting bolts and stud nut and remove pump.

Scribe an alignment mark across mounting plate (13—Fig. 257), pump body (12) and end plate (5) to aid in reassembly. Remove gear retaining nut, then remove gear using a suitable puller. Remove drive gear key. Remove nuts and bolts from pump body, then remove end plate (5). Use a felt tip pen or other suitable means to scribe alignment mark across face of pump body (12) and bearing (7). Remove pump body, bearing and pump rotors. Put an alignment mark on flange of bearing (10) and plate (13). Remove seal rings (6 and 11). Remove relief valve assembly (15).

Carefully clean and inspect all parts. Inspect pump body bore for wear. It is normal for rotors to cut a light track on inlet side of body as the bearings wear. If wear marks are deep, renew pump assembly. Do not install new bearings in a worn pump body. Check bearing bores and faces of bearings for scoring and wear. Assemble bearings and rotors into pump body and front plate as shown in Fig. 258. Measure distance (X) from face of pump body to surface of top bearing. If distance is not within range of 0.1-0.2 mm (0.004-0.008 inch), renew bearings. Be sure bearings slide freely into body bore. Inspect rotors for scoring, wear or damage to teeth and journals.

When reassembling, renew sealing rings in end cover and front plate. Install new seal (4—Fig. 257) into end plate (5) with seal lip facing outward. Lubricate seal lip with oil. Lubricate bearings and rotors with clean hydraulic oil and reinstall in their original positions. Note that "Y" shaped groove in bearings goes towards the rotors and inlet side of pump body. Install end plates aligning marks made during disassembly. Tighten retaining nuts to 60 N·m (45 ft.-lbs.) torque. Be sure rotors turn with a light drag with no tight or rough spots.

To reinstall pump, reverse the removal procedure. Bleed air from system as outlined in paragraph 308.

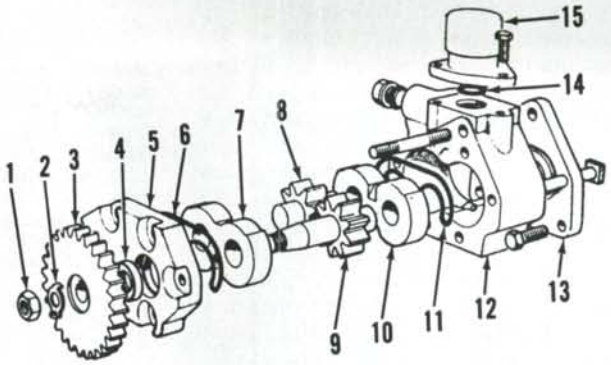


Fig. 257—Exploded view of rear mounted hydraulic pump used on 1190, 1194, 1290 and 1294 models.

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

Models 1390-1394-1490-1494-1594-1690

323. R&R AND OVERHAUL. Hydraulic pump or pumps are located at front of tractor just forward of radiator. To remove, raise hood and remove side panels. Disconnect and remove battery. On power shift models, disconnect oil cooler line. On all models, disconnect pump inlet and outlet pipes. Remove pump mounting bolts, then pull pump forward off drive shaft and remove from tractor.

Disassembly of Dowty, Plessey or Sundstrand single and tandem pumps is similar and the same procedure can be followed for all pumps. Refer to appropriate Fig. 259 or 260 for exploded view of pumps.

Use a suitable marking pen to scribe alignment marks on pump body and end plates as an aid to reassembly. Remove drive coupler from pump shaft using a suitable puller.

NOTE: Do not attempt to remove coupler wth a hammer or pry bar as damage to pump could result.

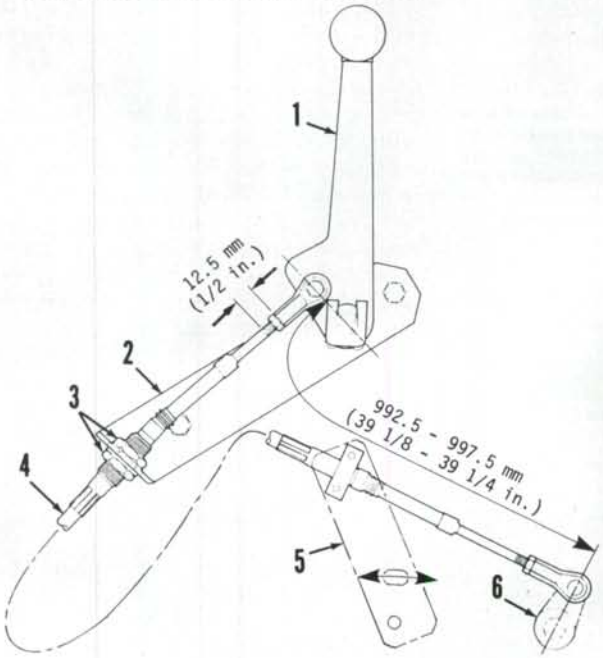


Fig. 256—View of draft control lever adjustment points on Model 1594.

1. Control lever
2. Upper bracket
3. Jam nuts
4. Cable
5. Lower bracket
6. Draft control arm

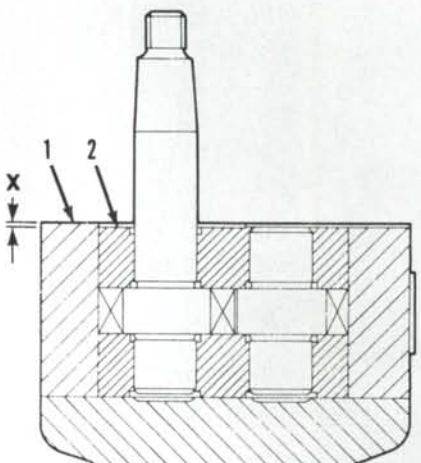


Fig. 258—Measure clearance (X) between surface of pump body (1) and bearings (2). Renew bearings if clearance exceeds 0.2 mm (0.008 inch).

Remove pump through-bolts and separate end plates from pump body. Tap end plates with a soft mallet if difficult to remove. Do not attempt to pry apart. Make alignment marks on bearings and inlet side of pump body to ensure correct reassembly. Remove bearings and rotors from pump body. Remove seal rings and oil seal from end plates.

Inspect pump body bore for wear. It is normal for rotors to cut a light track on inlet side of pump body as bearings wear. If wear marks are deep, renew pump assembly. Do not install new bearings in a worn pump body. Check bearing bores and faces of bearings for scoring and wear. Assemble bearings and rotors into pump body and end plate as shown in Fig. 258. Measure distance (X) from face of pump body to surface of top bearing. If distance is not within range of 0.1-0.2 mm (0.004-0.008 inch), renew bearings. Be sure bearings slide freely into body bore. Inspect rotors for scoring, wear or damage to teeth and journals.

Lubricate all parts with hydraulic oil during assembly. Install bearings and rotors into pump body aligning marks made during disassembly. Install new seal rings. Install new oil seal into end plate with seal lip facing outward. Install end plates and through-bolts. Tighten nuts to 48 N·m (35 ft.-lbs.) torque on Dowty pump. On all other pumps, tighten nuts to 60 N·m (45 ft.-lbs.) torque. Be sure rotors turn with a light drag with no tight or rough spots.

Reinstall pump by reversing removal procedure. Bleed hydraulic system as outlined in paragraph 308.

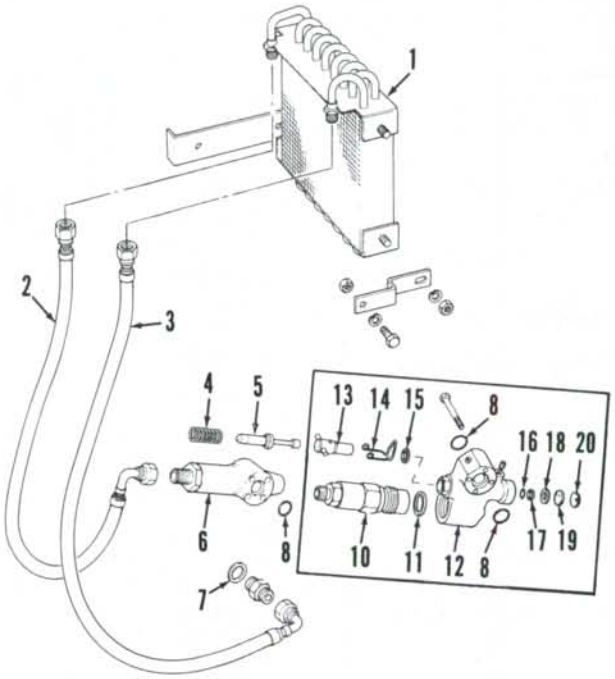


Fig. 261—A hydraulic oil cooler (1) is used on models equipped with power shift transmission. Early style cooler control valve used a manually operated valve (13) and an automatic flow valve (10) to control flow of oil to cooler. Late models are equipped with automatic flow control valve (6) only.

1. Oil cooler
2. Inlet hose
3. Outlet hose
4. Spring
5. Plunger
6. Flow control valve (late models)
7. Sealing washer
8. "O" ring
10. Flow control valve (early models)
11. Aluminum washer
12. Valve body
13. Control valve knob
14. Spring clip
15. Wiper ring
16. "O" ring
17. Backup ring
18. Washer
19. Felt breather
20. Plug

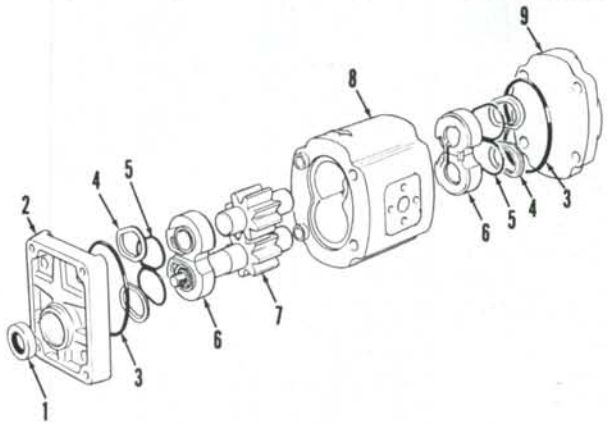


Fig. 259—Exploded view of Dowty front mounted single pump used on some models.

1. Oil seal
2. Mounting flange
3. "O" ring
4. Backup rings
5. Seal rings
6. Bearings
7. Rotors
8. Pump body
9. End cover

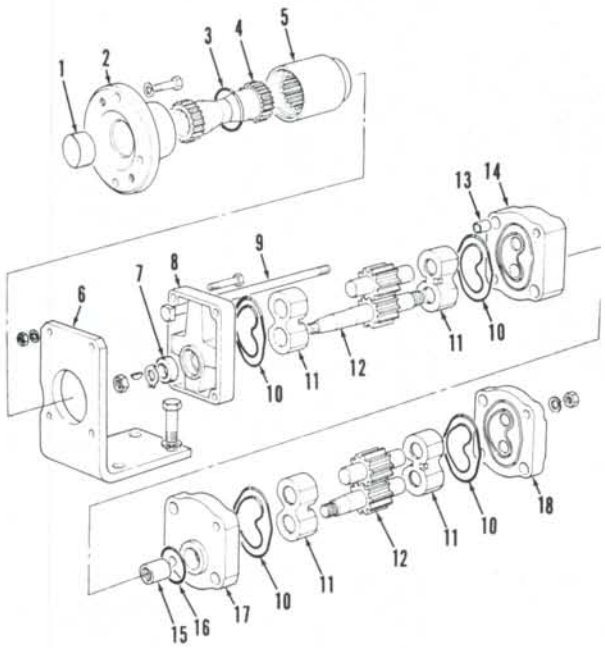


Fig. 260—Exploded view of Plessey or Sundstrand front mounted tandem pumps used on some models. Pump drive coupling may be different on some models.

1. Rubber disc
2. Crankshaft coupling
3. "O" ring
4. Drive shaft
5. Pump coupling
6. Mounting bracket
7. Oil seal
8. Mounting flange
9. Through-bolts
10. Seal rings
11. Bearings
12. Rotor
13. Dowel
14. End plate
15. Coupling
16. "O" ring
17. End plate
18. End plate

HYDRAULIC OIL COOLER

Power Shift Models

324. Power shift models are equipped with a hydraulic oil cooler mounted in front of radiator. The cooler is located in the hydraulic system between hydraulic pump and the external pressure filter. Early models are equipped with a control valve (13—Fig. 261) which must be manually opened and closed and a flow valve (10) which automatically opens and closes in response to system pressure to protect cooler against excessively high pressure. Late models use only the automatic flow valve (6) to control oil flow through cooler.

OIL COOLER CONTROL AND FLOW VALVES

Power Shift Models

325. Hydraulic oil cooler flow and control valve assembly (Fig. 261) is mounted on the side of hydraulic pump just below radiator. The valve is con-

nected to oil cooler by a hose. Note that manual control valve has been eliminated on late models.

On early models, pulling control valve spool knob (13) out closes oil passage to flow valve and oil cooler. Pushing valve in opens oil passage and directs oil flow to flow valve assembly. On late models without manual control valve, oil passage to flow valve assembly is open all the time.

On all models, a spring (4) in flow valve holds plunger (5) off its seat when system pressure is less than 5500 kPa (800 psi). This allows a portion of pump output to flow through cooler to inlet side of pump. When system pressure exceeds 5500 kPa (800 psi), oil pressure overcomes spring pressure on plunger and seats plunger. No oil will flow through cooler, thus protecting it from excessive pressure.

A seal kit is available for servicing early style valves. There are no individual parts available for late style valve. Valves may be disassembled for inspection, however complete valve assembly must be renewed if internal parts are worn or damaged.

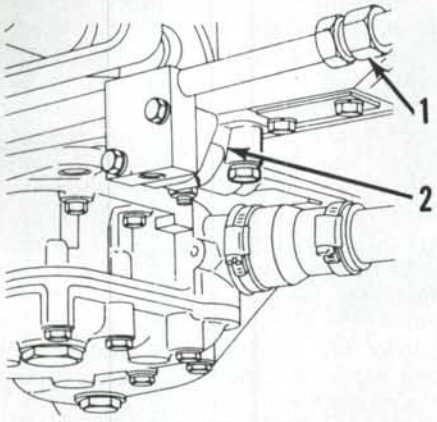


Fig. 262—On models with front mounted pump, system relief valve (2) and air relief valve are located in pump outlet pipe (1) between pump and external oil filter.

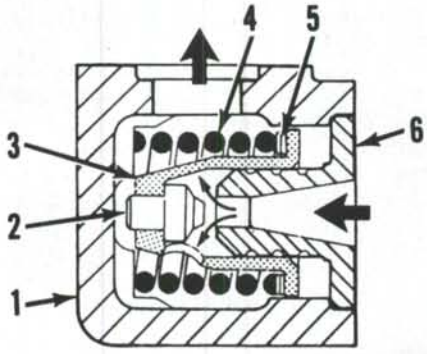


Fig. 263—Sectional view of hydraulic oil pressure relief valve.

1. Body
2. Plunger
3. Cap
4. Spring
5. Shims
6. Seat

SYSTEM PRESSURE RELIEF VALVE

All Models

326. The relief valve is mounted on top of hydraulic pump on Models 1190, 1194, 1290 and 1294. Refer to paragraph 322 for pump removal procedure. On Models 1390, 1394, 1490, 1494, 1594 and 1690, relief valve (2—Fig. 262) is connected in the hydraulic pump outlet pipe (1) between the pump and external oil filter. Drain transmission oil before removing valve.

On all models, relief valve may be disassembled for cleaning and inspection only as individual parts are not available to service the valve. Relief valve opening pressure is set by thickness of shims (5—Fig. 263), however valve is serviced as a preset assembly only. Relief valve minimum opening pressure is 13800 kPa (2000 psi). Refer to appropriate paragraph 310 or 311 for testing procedure.

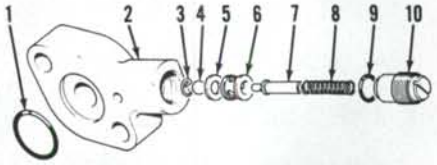


Fig. 264—Exploded view of air relief valve used on models equipped with front mounted hydraulic pump.

1. "O" ring
2. Body
3. Retainer
4. Steel ball
5. Special washer
6. Seat
7. Plunger
8. Spring
9. "O" ring
10. Plug

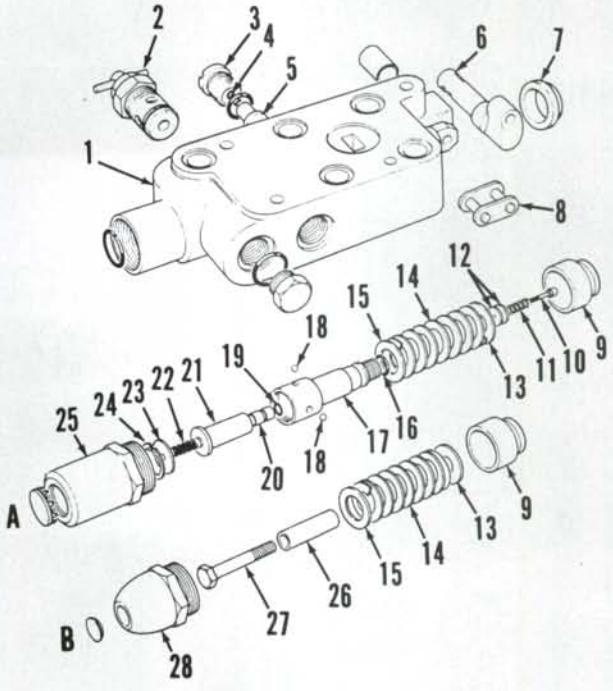


Fig. 265—Exploded view of double acting remote valve assembly. Valve may be detented for raise and lower positions (A) or spring centered without detents (B).

1. Valve body
2. Double to single acting plug
3. Plug
4. Spring
5. Nonreturn valve plunger
6. Actuating lever
7. Seal
8. Link
9. Bushing
10. Spool plunger
11. Spring
12. Shims
13. Washer
14. Centering spring
15. Washer
16. "O" ring
17. Detent retainer
18. Detent balls
19. "O" ring
20. Detent release piston
21. Detent plunger
22. Spring
23. Washer
24. Snap ring
25. End cap
26. Spacer
27. Bolt
28. End cap

AIR RELIEF VALVE

Models 1390-1394-1490-1494-1594-1690

327. Air relief valve is mounted to the side of oil pressure relief valve (2—Fig. 262) on models equipped with front mounted hydraulic pump. The valve is used to bleed air automatically from hydraulic system.

All parts (Fig. 264) are available separately for servicing valve.

Be sure small hole in valve body and mounting gasket are aligned when reinstalling valve. Tighten mounting bolts to 35 N·m (25 ft.-lbs.) torque.

REMOTE VALVE

All Models So Equipped

328. R&R AND OVERHAUL. The remote valve is mounted on top, right-hand side of rear axle housing. One or more valves may be bolted together at this location to provide multiple remote hydraulic outlets. Valve may be detented for raise and lower positions, detented with a float position or spring centered without detents.

To remove valve, first disconnect control linkage. Remove remote coupler hoses. Disconnect all hydraulic lines from valve. Remove mounting bolts and remove valve assembly.

To disassemble, remove retaining bolts and separate remote valve from combining valve or distribution block. Remove plug (3—Fig. 265), spring (4) and nonreturn valve plunger (5). Disconnect link (8) and remove actuating

lever and shaft (6). Remove plug from end cap (25), loosen end cap, then disengage snap ring (24) from detent retainer (17) to release detent spring tension. Remove spool end cap (25) being careful not to lose detent balls (18). Remove washer (23), spring (22) and detent plunger (21). Withdraw control spool from valve body. Unscrew detent retainer (17) from spool, then separate spool plunger (10), spring (11), shims (12) and detent release piston (20) from spool and detent retainer. Remove bushing (9), "O" ring and seal (7) from valve body. Remove and discard all "O" rings.

Inspect parts for wear or damage and renew as necessary. Valve spool and body are available as complete unit only. Renew all "O" rings.

Lubricate all parts with clean hydraulic oil during assembly. When assembling detent mechanism, install spool plunger (10) and spring (11) into end of spool. Install detent release piston (20) and shims (12) into detent retainer (17). Install retainer with centering spring (11) and washers onto spool and tighten securely. Install detent release plunger (21), spring (22) and washer (23) into detent retainer. Push washer into detent retainer until snap ring (24) can be installed in retainer groove. Use grease to position detent balls in detent retainer holes. Hold detent balls in place with one hand while pushing end cap (25) down over the balls and detent retainer. Reinstall control spool in valve body and tighten end cap securely. Complete reassembly by reversing disassembly procedure.

Tighten valve mounting bolts to 34 N·m (25 ft.-lbs.) torque.

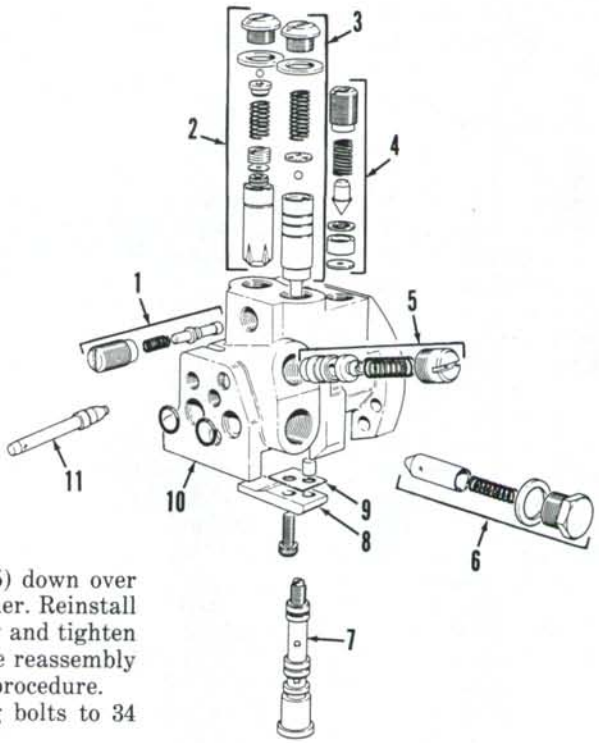


Fig. 267—Exploded view of selectamatic control valve assembly.
1. Sensing valve
2. Bypass valve
3. Hold valve
4. Relief valve
5. Rate of lowering valve
6. Nonreturn valve
7. Spool valve
8. Rocker lever plate
9. Shims
10. Selectamatic valve body
11. Rate of lowering needle valve

COMBINING VALVE

All Models So Equipped

329. R&R AND OVERHAUL. Combining valve is used on tractors equipped with tandem hydraulic pumps to either combine or separate oil flow from the pumps. When flow is separated, one pump supplies rockshaft cylinder and the other pump supplies remote valve. This allows simultaneous operation of lift linkage and remote valve. When output of pumps is combined, all oil is directed to remote valve only. Rockshaft cylinder cannot be operated when pump output is combined.

Combining valve is mounted on top of rear axle housing beneath the remote valve. Remove valves as outlined in paragraph 328. Remove retaining bolts and separate remote valve from combining valve.

Remove control lever (if so equipped) and spacer (12—Fig. 266). Pull control spool from valve body. Remove end cap (7) and breather (8).

Inspect spool and valve body bore for scoring or wear. Spool and valve body must be renewed as an assembly. Renew all "O" rings.

Lubricate all parts with clean hydraulic oil during assembly. Apply Loctite 270 to threads of control spool extension. Reassemble by reversing disassembly procedure. Tighten valve retaining bolts evenly to 34 N·m (25 ft.-lbs.) torque.

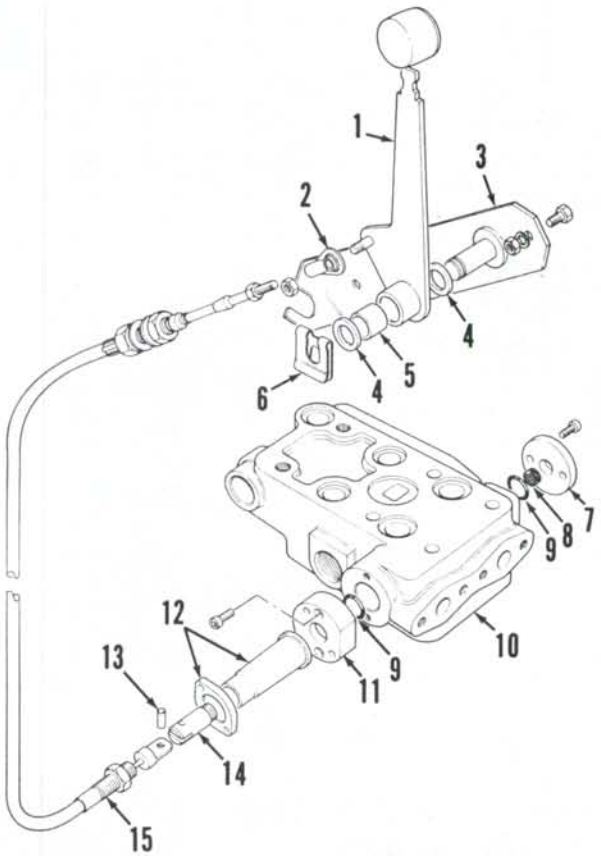


Fig. 266—Combining valve (10) is used on models equipped with tandem hydraulic pumps to either combine or separate oil flow from the pumps. Control cable (14) is used on models equipped with a cab.
1. Control lever
2. Ball joint
3. Support bracket
4. Spacers
5. Bushing
6. Retaining clip
7. End plate
8. Breather
9. "O" rings
10. Valve assy.
11. Spacer
12. Cable sleeve
13. Pin
14. Valve spool extension
15. Cable & housing

SELECTAMATIC VALVE

All Models

330. R&R AND OVERHAUL. The selectamatic valve assembly is located

inside rear axle housing, mounted on right-hand rockshaft bracket. It consists of seven different valves in one body which are used to control and regulate various hydraulic functions associated with operation of hitch lift linkage.

To remove valve, first clean area around rear axle and rockshaft housings. Remove controls, covers and rockshaft. If equipped with dump valve located over hold valve, remove dump valve. Remove right-hand rockshaft bracket. Unbolt and remove valve assembly from rockshaft bracket. If valve is tight on dowels, tap with a rubber mallet to loosen valve. Do not pry apart.

If complete disassembly of valve is necessary, keep components of each valve together. Do not mix parts from one valve to another. Position valve in a vise, then loosen all the valve plugs. Remove rocker lever plate (8—Fig. 267) and shims (9).

331. BYPASS VALVE. The bypass valve (2—Fig. 267) controls flow of hydraulic fluid from pump, directing flow to rockshaft cylinder when controls are in "RAISE" position. When rockshaft controls are in "NEUTRAL", bypass valve opens and directs oil to lubrication circuit.

To disassemble, remove plug over bypass valve and remove ball, retainer and spring. Use a wood or plastic dowel to remove bypass valve plunger. Remove plug, restrictor washer and filter (if so equipped) from plunger.

Lubricate parts with clean hydraulic oil when reassembling. Be sure plunger slides freely in bore. Install a new plug sealing washer and tighten plug securely.

332. HOLD VALVE. The hold valve (3—Fig. 267) is used as a check valve to retain fluid in rockshaft cylinder until necessary to lower lift linkage. When valve opens, fluid in rockshaft cylinder is allowed to return to sump.

To disassemble, remove plug and spring. Use a wood or plastic dowel to remove plunger. Remove retaining washer and ball from plunger.

Lubricate plunger with hydraulic oil when reassembling. Be sure plunger slides freely in valve bore. Install new sealing washer on plug and tighten plug securely.

333. HOLD RELIEF VALVE. The hold relief valve (4—Fig. 267) protects rockshaft cylinder and selectamatic valve from shock pressure created when transporting heavy implements over rough ground.

Remove plug, spring, poppet and shims. Use a hooked wire to remove valve seat and washer.

Inspect valve poppet and seat for wear or damage. Relief valve assembly is serviced as a complete unit.

When assembling valve, be sure original shims are reinstalled.

334. SPOOL VALVE. The spool valve (7—Fig. 267) is actuated by quadrant lever. The valve controls operation of bypass and hold valves to raise or lower lift linkage according to quadrant lever position.

To disassemble, remove nuts from end of spool. Withdraw spool and spring from valve body.

Inspect spool and valve body bore for scoring or wear and renew as necessary.

Lubricate spool with clean hydraulic oil during assembly. Make certain spool slides freely in valve bore. Install nuts on spool, but do not tighten. Final adjustment of spool valve is covered in paragraph 335.

335. SELECTAMATIC CONTROL SPOOL ADJUSTMENT. Place valve assembly in a vise and mount a dial indicator so probe contacts valve spool end as shown in Fig. 268. Push spool (3) into valve body against spring pressure until it stops, set dial indicator to zero, then 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 valve spool. If movement is greater than given dimension, tighten adjusting nuts (5). If movement is less, loosen nuts. Repeat procedure until movement is no more than 0.025 mm (0.001 inch) greater than given dimension. Valve movement must never be less than given dimension etched on spool.

336. NONRETURN VALVE. The nonreturn valve (6—Fig. 267) prevents oil in rockshaft cylinder from returning to selectamatic valve oil inlet passage when hold valve is closed and bypass valve is open. When bypass valve is closed (quadrant lever in "RAISE" position), nonreturn valve plunger is pushed open by oil flow to rockshaft cylinder.

To disassemble, remove plug, spring and plunger.

Be sure plunger slides freely in valve body bore. Lubricate with hydraulic oil when reassembling.

337. SENSING VALVE. The sensing valve (1—Fig. 267) is used to open or close bypass valve quickly in response to small movements of spool valve. This provides quick response to height and load changes to lift linkage.

To disassemble, remove plug, spring and plunger.

Lubricate with hydraulic oil during assembly. Be sure spool slides freely in valve body bore.

338. RATE OF LOWERING VALVE. The rate of lowering valve (5—Fig. 267) is a flow control valve which regulates flow of oil returning from rockshaft cylinder to sump. Rate (time required) to lower lift linkage can be controlled regardless of implement weight by manually adjusting the rate of lowering needle valve (11).

To disassemble, remove plug, spring and plunger.

Examine plunger for scoring or wear. Be sure plunger slides freely in body bore. Lubricate with hydraulic oil during reassembly.

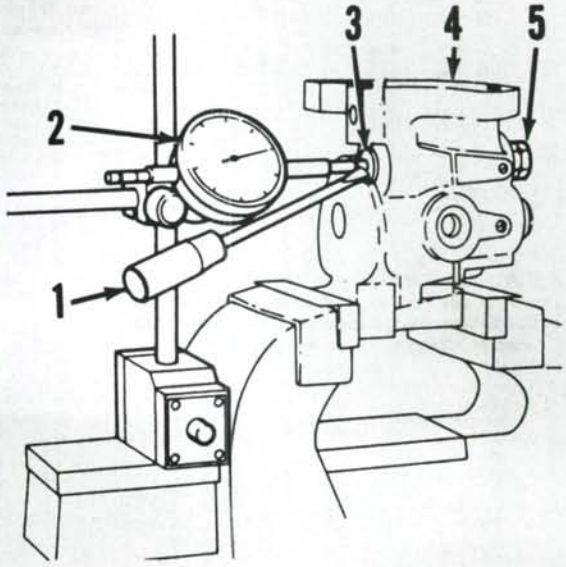


Fig. 268—Use a dial indicator to measure spool movement when adjusting selectamatic control valve spool.
1. Screwdriver
2. Dial indicator
3. Spool
4. Selectamatic valve
5. Adjustment nuts

DUMP VALVE

All Models

339. The dump valve is installed in hydraulic system to enable rapid lowering of lift linkage under no load or light load conditions.

The dump valve (Fig. 269) is located on top of selectamatic hold valve on all models except 1594 and 1690. When dump valve is pushed down, the hold valve works normally. When valve is pulled up, spring tension is released from hold valve. Oil pressure in rockshaft cylinder will push hold valve plunger off its seat allowing lift linkage to lower rapidly.

On Models 1594 and 1690, dump valve (Fig. 270) is mounted on front of rockshaft cylinder. When valve is pushed down, dump port is closed and system operates normally. When valve is pulled up, oil from rockshaft cylinder flows through dump port to sump bypassing selectamatic valve. Lift linkage will then lower rapidly.

Disassembly of valve is obvious after referring to appropriate Fig. 269 or 270 and examination of unit. Be sure to renew "O" rings and backup rings. Lubricate parts with hydraulic oil during assembly.

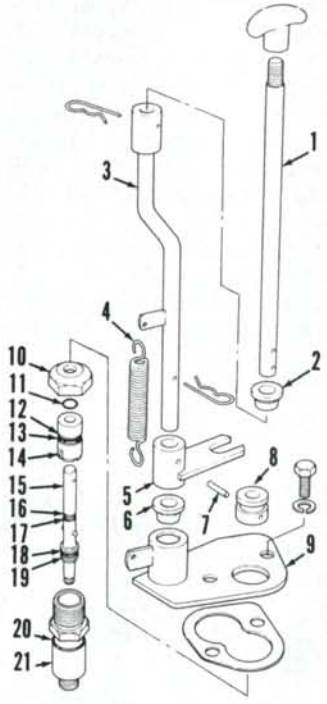


Fig. 269—Exploded view of typical dump valve assembly used on all models except 1594 and 1690. Control linkage shown is for cab equipped tractor. Control linkage will vary between models.

1. Upper control rod
2. Bushing
3. Lower control rod
4. Return spring
5. Control arm
6. Bushing
7. Pin
8. Valve collar
9. Cover plate
10. Nut
11. Seal ring
12. Backup ring
13. "O" ring
14. Bushing
15. Plunger
16. Backup ring
17. "O" ring
18. "O" ring
19. Backup ring
20. Seal ring
21. Valve body

THREE-WAY VALVE

All Models So Equipped

340. The three-way valve (Fig. 271) is mounted on end of rockshaft cylinder and is used to control flow of oil to either rockshaft cylinder or to single acting remote cylinder. The valve control lever can be moved to four different positions: 1, 2, L and L/l.

When lever is in position "1" or "2", oil flow is directed out upper or lower valve port to actuate remote cylinder. Lift linkage will not operate as no oil flows to rockshaft cylinder.

When valve control lever is in "L" position, oil is directed to rockshaft cylinder and quadrant lever will actuate lift linkage. Any equipment attached to three-way valve remote ports will stay in position.

When control lever is moved to "L/l" position, oil will be directed to number "1" outlet port and to rockshaft cylinder. The quadrant lever will actuate lift linkage and any equipment connected to number "1" outlet simultaneously.

Valve spool (17—Fig. 271) and body (8) are serviced as a complete unit only. Make certain breather (11) is clean and not damaged. Renew "O" rings and lubricate all parts with hydraulic oil during assembly.

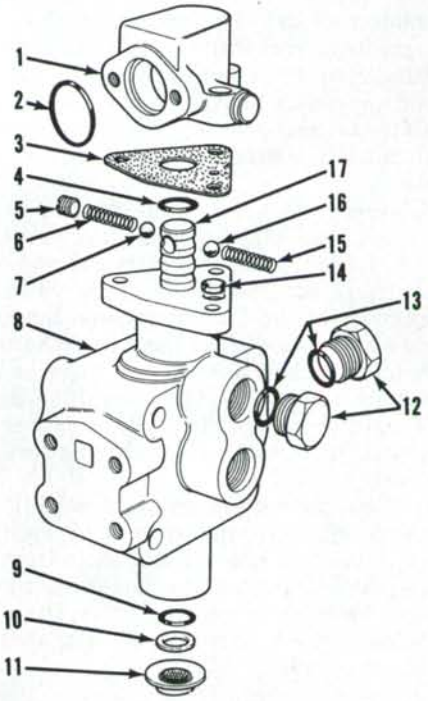
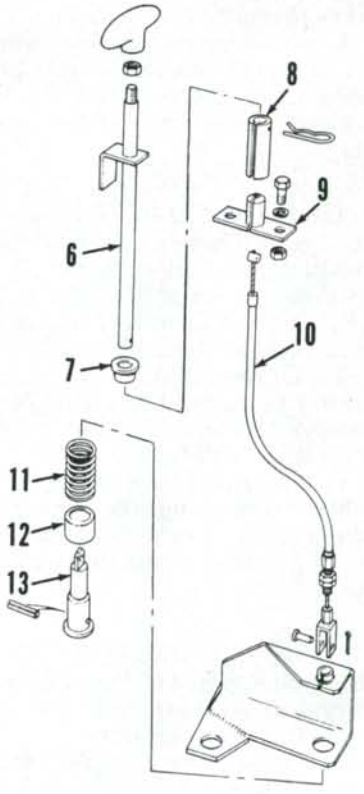


Fig. 271—Exploded view of three-way valve showing component parts and their related positions.

1. Cover
2. "O" ring
3. Gasket
4. "O" ring
5. Plug
6. Spring
7. Ball
8. Valve body
9. "O" ring
10. Backup ring
11. Breather
12. Plugs
13. "O" rings
14. Breather pad
15. Spring
16. Steel ball
17. Spool

Fig. 270—Exploded view of typical dump valve assembly and control linkage used on 1594 and 1690 models. Control linkage components 6 through 13 are used on tractors with cab.

1. Bushing
2. Support bracket
3. Return spring
4. Cap
5. Control rod
6. Control rod
7. Bushing
8. Connector
9. Cable support bracket
10. Control cable
11. Return spring
12. Cap
13. Extension
14. Backup ring
15. "O" ring
16. Valve plunger
17. Seal ring
18. "O" ring
19. Backup ring
20. "O" ring
21. Valve body



ROCKSHAFT, CYLINDER AND CONTROL LINKAGE

All Models Except 1594 and 1690

341. OVERHAUL ROCKSHAFT AND CYLINDER. Rockshaft piston can be removed without removing rockshaft cylinder from axle housing. Support lift linkage in fully raised position. Remove rockshaft cylinder rear cover (22—Fig. 272). Drive pin (12) from connecting rod (11) and remove rod. Remove three-way valve or connector from front of cylinder, then insert small diameter rod through oil supply hole to push piston (10) out of cylinder.

Inspect piston and cylinder for scoring or excessive wear. Cylinder can be honed oversize for installation of 0.50 mm (0.020 inch) oversize piston if necessary.

Lubricate all parts with hydraulic oil during assembly When renewing rockshaft bushings, be sure holes in bushings are aligned with grease fitting holes in cover.

Models 1594-1690

342. OVERHAUL ROCKSHAFT AND CYLINDER. To disassemble, disconnect hydraulic lines and dump valve control linkage. Remove throughbolts, then withdraw end cover (20—Fig. 273), housing (18), cylinder sleeve (13) and piston (10). Remove cover (5) from rockshaft bracket (6). Disconnect lift links from rockshaft (3) and remove rockshaft.

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

Lubricate all parts with hydraulic fluid during assembly.

Models So Equipped

343. SELECTOR DIAL MECHANISM. The selector dial mechanism is used to change the controls for selectamatic valve. Quadrant lever must be held in SELECT position when changing position of selector dial.

When selector dial is positioned in DRAFT control, selectamatic spool valve is actuated by movement of draft sensing cable and linkage. This provides correct depth control of implement to maintain desired draft load.

Moving selector dial to POSITION control will move draft control linkage away from selectamatic spool valve. The spool valve will now be controlled only by quadrant lever to provide lift linkage height control.

To disassemble, remove draft sensing cable, disconnect control linkage, remove rockshaft assembly and right-hand rockshaft bracket. Remove guide bracket (23—Fig. 274), push rods (31) and cam (28), then unbolt and remove control valve assembly from rockshaft bracket.

Remove snap ring (8) and connecting rod (9) from rocker shaft (12). Drive the pin (14) from selector fork (15). Remove threaded plug from side of rockshaft housing, then tap selector shaft (7) out of housing and remove selector fork, detent ball and spring. Remove shaft locating screw (11), then slide rocker lever (17) from shaft and remove rocker shaft (12). Remove pin (35) and pull selector control (1) from selector rod (4). Remove rod, dial (34) and "O" ring (2).

If rockshaft bushing (21) is worn, renew making certain grease fitting holes are aligned and split in bushing is to rear side of housing.

Reassemble by reversing the disassembly procedure. Adjust linkage as outlined in paragraph 313.

All Models Except 1594

344. DRAFT SENSING UNIT. Tractor may be equipped with a single

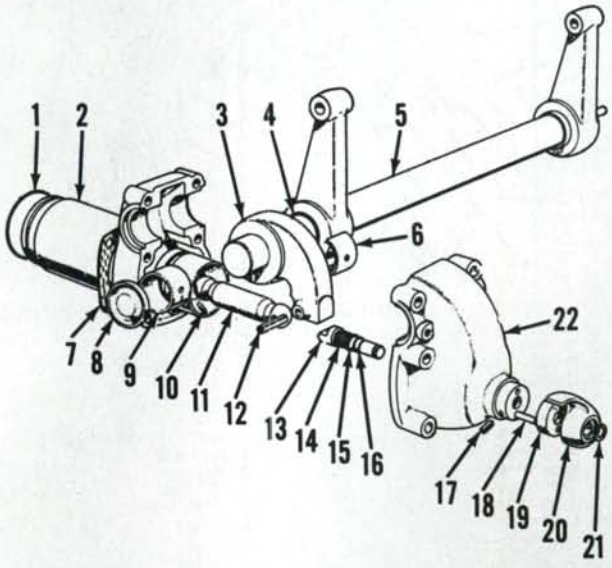


Fig. 272—Exploded view of rockshaft cylinder and rockshaft used on 1190, 1290, 1390 and 1490 models. Lift latch mechanism was used on early production tractors. Models 1194, 1294, 1394 and 1494 are similar.

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

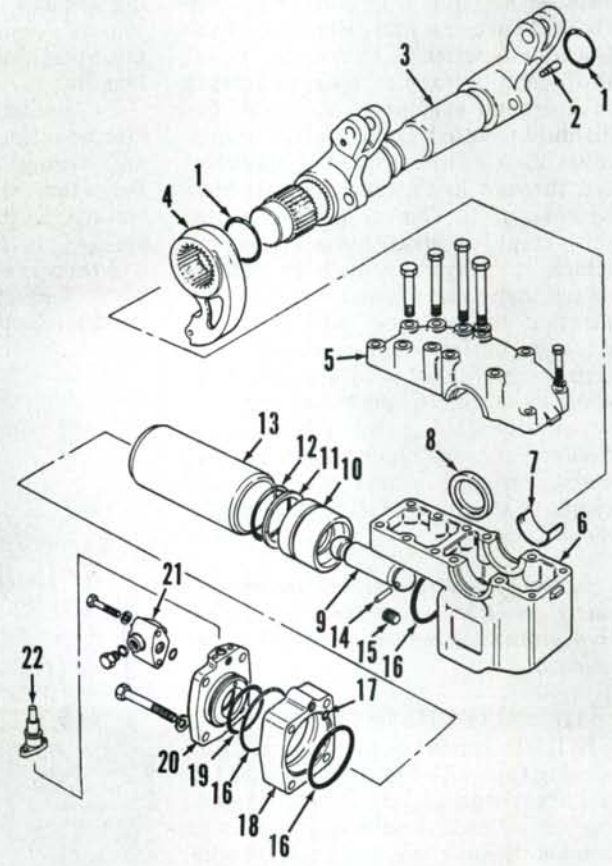


Fig. 273—Exploded view of rockshaft cylinder and rockshaft used on Models 1594 and 1690.

1. "O" ring
2. Pin
3. Rockshaft
4. Rockshaft arm
5. Cover
6. Rockshaft bracket
7. Bushing
8. Seal
9. Rod
10. Piston
11. Backup ring
12. "O" ring
13. Cylinder sleeve
14. Pin
15. Restrictor plug
16. "O" rings
17. "O" ring
18. Cylinder housing
19. "O" ring
20. End cover
21. Connector
22. Dump valve

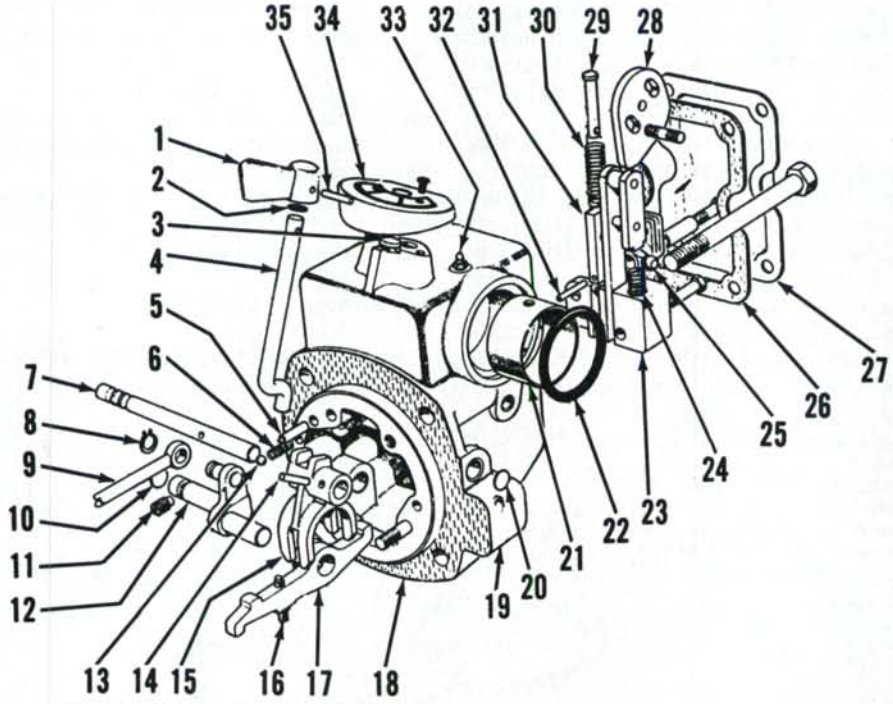


Fig. 274—Exploded view of selector dial mechanism and control used on some models.

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 support R.H.
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

rate sensing unit (Fig. 275) or a selective rate sensing unit (Fig. 276). Sensing unit function is to maintain a set draft load by varying operating depth of a ground engaging implement. Resistance created from pulling implement through the ground is transmitted through hitch upper link to draft sensing unit. This resistance causes movement of draft sensing spring which is relayed through linkage to selectamatic valve control spool. Movement of control spool will cause lift linkage to raise, lower or stay in position in accordance with amount of resistance causing spring movement.

Selective sensing units provide selection of light, medium or heavy sensing spring strength which offers greater range of sensitivity for varying implement sizes.

NOTE: If sensing unit is not working correctly, check for seized sensing cable before proceeding with sensing unit disassembly.

345. SINGLE RATE SENSING UNIT. To remove, disconnect draft sensing cable (3—Fig. 275). Remove top link from sensing unit. Remove mounting bolts from hydraulic remote coupler bracket. Remove mounting bolts retaining sensing unit to pto housing, then remove sensing unit. Note positions of mounting bolts as they are different lengths.

To disassemble, remove end plate (13) mounting bolts and withdraw shaft and spring assembly from housing. Drive out retaining pin (5), then separate collar (6), thrust washer (9) and spring (10). Secure sleeve (11) in a vise and turn shaft counterclockwise to remove. Note that shaft will be tight as Loctite is applied to threads on assembly.

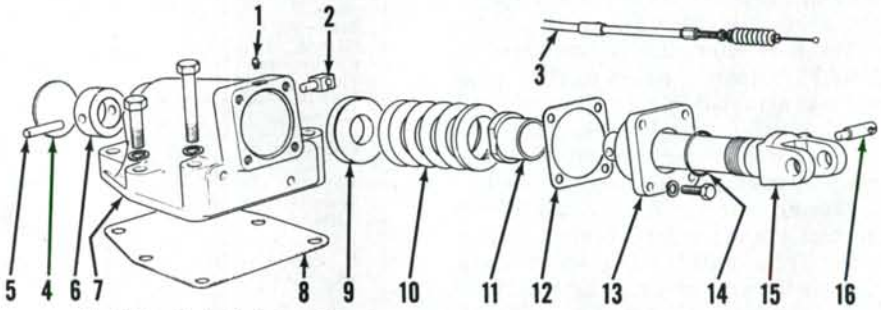


Fig. 275—Exploded view of single rate draft sensing unit used on some models.

1. Grease fitting
2. Cable support
3. Sensing cable
4. Expansion plug
5. Pin
6. Collar
7. Housing
8. Plate
9. Thrust washer
10. Spring
11. Sleeve
12. Shim
13. End plate
14. "O" ring
15. Yoke shaft
16. Cable support

Renew "O" ring (14) in end plate. Apply Loctite 270 to threads of shaft before installing sleeve (11). Note that spring end play on assembled shaft must be 0.25 mm (0.010 inch). End play is adjusted by changing thickness of thrust washer (9).

Reinstall shaft and spring assembly using original shim pack (12). Check end play of shaft assembly as end plate mounting bolts are tightened to a torque of 42 N·m (30 ft.-lbs.) torque. Shaft end play must be 0.25 mm (0.010 inch) with bolts fully tightened. Increase or decrease thickness of shims (12) to obtain correct end play.

Install sensing unit and tighten mounting bolts to 105 N·m (77 ft.-lbs.) torque. Adjust draft sensing cable as outlined in paragraph 318.

346. SELECTIVE DRAFT SENSING UNIT. To remove, clean area and disconnect draft sensing cable. Remove top link from sensing unit. Remove mounting bolts and lift unit from tractor.

To disassemble, remove plug (4—Fig. 276) from top of housing and move selector lever (11) so it points towards top of housing. Remove end plate (30) mounting bolts, then pull shaft assembly out of housing. Drive pin (17) out of collar (18), then slide parts off shaft. Secure sleeve (28) in a vise, then turn shaft counterclockwise. Note that shaft will be tight as Loctite is applied to threads on assembly.

Remove plug (1), spring (2) and detent plunger (3) from housing. Drive pin out of pinion (7), unscrew bushing (9) and remove selector shaft (8) and pinion.

Inspect all parts for wear or damage and renew as necessary. Install a new wiper seal (31) in end plate.

Before reassembling, position springs (21 and 25) with original shims (22 and 24) onto carrier (23) and make certain end of each spring protrudes 0.13-0.25 mm (0.005-0.010 inch) beyond

ends of carrier. If necessary, adjust by varying thickness of appropriate shims (22 or 24) until spring protrusion is within specified range.

Apply Loctite 270 to threads of shaft before installing sleeve (28). Assemble components onto shaft (thrust washer, shims and spring with larger center diameter go on first). Install pin (17) into appropriate holes in collar (18) so springs are not compressed. Spring carrier (23) should have 0.30 mm (0.012 inch) end play. If correct end play cannot be obtained by installing pin in different holes in collar, install thrust washer (20) of different thickness. Be sure pin protrudes an equal amount on each side of collar.

Install selector shaft, pinion and detent assembly into housing. Apply grease to ends of pin (17) and grooves in housing, then install shaft assembly (without shims) into housing engaging pin in housing grooves. Pin must slide freely in grooves; use a file or emery cloth to smooth ends of pin if necessary. Push shaft assembly towards housing and use a feeler gage to measure gap between housing and end plate (30). Remove shaft and install shims (29) of same thickness as gap measurement.

Position selector lever so it points towards top of housing. Install shaft assembly with correct shims making certain teeth of pinion are centered in teeth of spring carrier (23). Tighten end plate mounting bolts evenly to 42 N·m (30 ft.-lbs.) torque. Move selector lever to all three positions to check operation.

Reinstall unit and adjust sensing cable as outlined in paragraph 318.

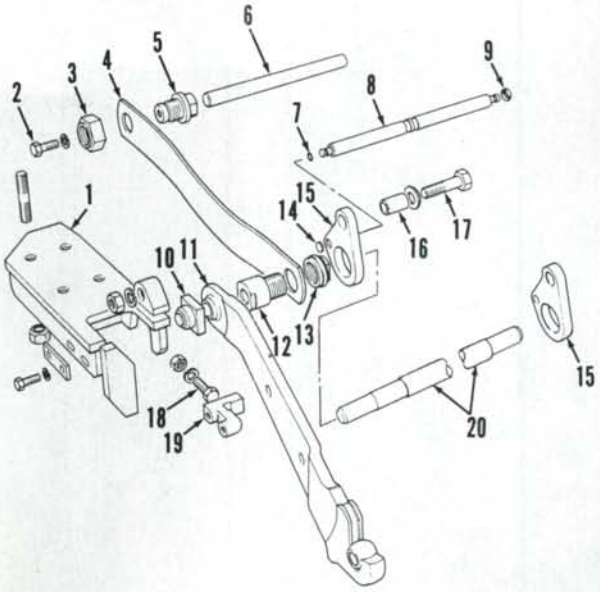


Fig. 277—Exploded view of draft control lower link sensing components used on Model 1594.

1. Hitch bracket
2. Bolt
3. Nut
4. Sensing spring
5. Bearing
6. Anchor shaft
7. "O" ring
8. Actuator shaft
9. Washer
10. Cap
11. Lower link
12. Sleeve
13. Nut
14. Plug
15. Swing link
16. Pivot bushing
17. Bolt
18. Adjuster bolt
19. Thrust block
20. Cross-shaft

Model 1594

347. LOWER LINK SENSING. On Model 1594, draft sensing is provided by two leaf springs (4—Fig. 277) attached to lower link cross-shaft (20). When operating a ground engaging implement, the springs flex in relation to draft load being applied to lower links. This flexing motion is transferred through connecting linkage to selectamatic valve control spool. Movement of spool will cause lift linkage to raise, lower or stay in position in accordance with load being applied to springs.

To remove sensing springs, disconnect stabilizer bars (if so equipped) and lift rods from lower links (11). Turn adjuster bolts (18), located just forward of front ends of lower links, clockwise one turn. Remove thrust blocks (19). Remove caps (10) and lower links (11) from cross-shaft (20). Remove cover over fuel tank connecting pipe. Remove drawbar support or pickup hitch. Remove retaining bolts (17) from rear end of springs, push out bushings (16) and lower rear end of springs to the ground. Remove bolts (2) from ends of anchor shaft (6). Push front ends of springs and bearings (5) inward to clear fuel tank support brackets, then lower spring assembly from tractor.

Pull actuator shaft (8) out of swing links (15). Remove nuts (3) and sleeves (12) from front and rear ends of springs, then separate springs from shafts.

To disassemble transfer shaft (26—Fig. 278), disconnect transfer rod fork (30) from lever (27). Remove retaining nut from right-hand end of shaft, then remove lever (27) and key. Remove bearing retaining screw (25) from center support under pto housing. Using a hammer and punch, tap against right-hand end of shaft to remove shaft, left-hand bearing assembly and fork (21) as a unit. Remove bearings (23) and seals (22).

To reassemble transfer shaft, reverse the disassembly procedure. Lubricate bearings with grease during assembly. Tighten fork retaining nuts to 102 N·m (75 ft.-lbs.) torque

To reassemble sensing springs, first install swing links (15—Fig. 277) on cross-shaft making sure plugs (14) are toward the outside. Install front bearings (5), rear nuts (13) and springs (4). Tighten front nut (3) to 257 N·m (190 ft.-lbs.) torque and tighten rear sleeve (12) to 380 N·m (280 ft.-lbs.) torque. Install actuating shaft (8) with new seals.

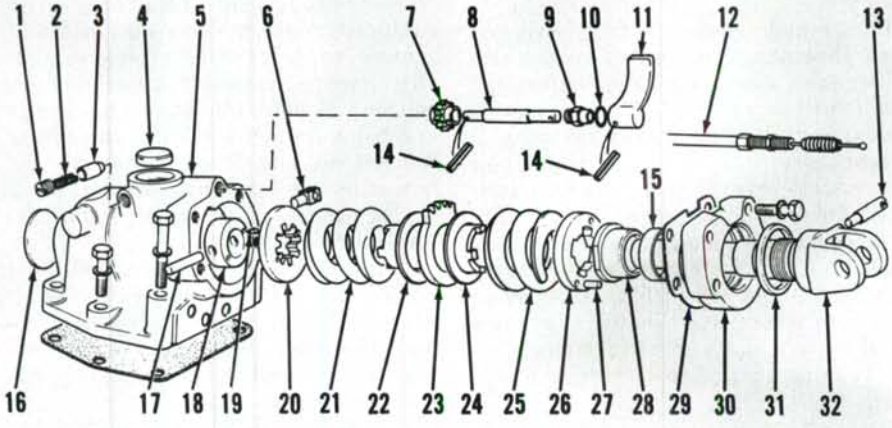


Fig. 276—Exploded view of selective rate draft sensing unit used on some models.

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. Pins
15. Bushing
16. Expansion plug
17. Pin
18. Collar
19. Stepped dowel
20. Thrust washer
21. Spring
22. Shim
23. Spring support
24. Shim
25. Spring
26. Thrust washer
27. Dowel
28. Sleeve
29. Shim
30. End plate
31. Seal
32. Yoke shaft

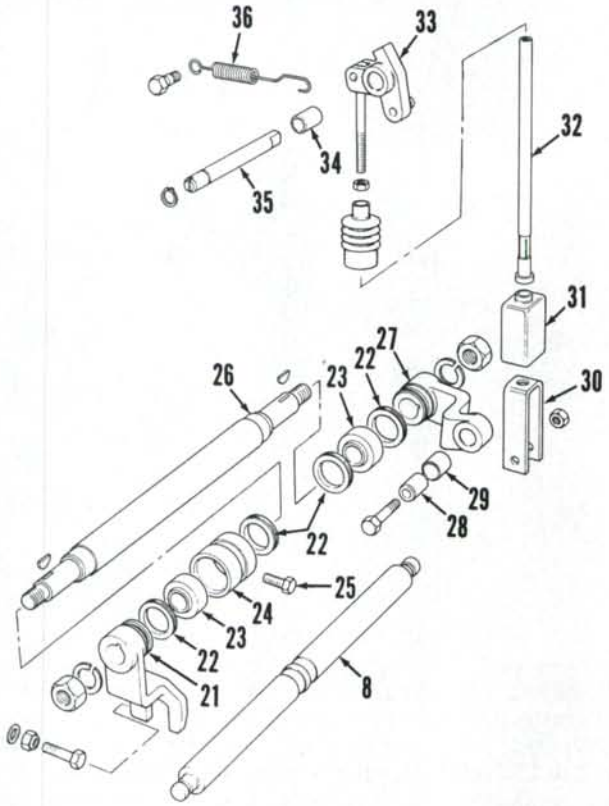


Fig. 278—Exploded view of draft sensing transfer linkage used on Model 1594.

8. Actuator shaft
21. Transfer shaft fork
22. Seal
23. Bearing
24. Bushing
25. Set screw
26. Transfer shaft
27. Transfer shaft lever
28. Spacer
29. Bushing
30. Fork
31. Cover
32. Transfer rod
33. Transfer lever
34. Bushing
35. Pivot shaft
36. Return spring

Install front end of sensing spring assembly into place first and tighten retaining bolts to 102-122 N·m (75-90 ft.-lbs.) torque. Lift rear end of springs into position making sure actuator shaft (8) engages fork (21—Fig. 278) of transfer shaft. Install pivot bushings (16—Fig. 277) and retaining bolts (17). Tighten nuts to 244-298 N·m (180-220 ft.-lbs.) torque. Install lower links (11) and caps (10). Install thrust blocks (19), but do not tighten mounting bolts. Turn adjusting bolts (18) counterclockwise until all clearance is removed between thrust blocks and end caps, then turn the bolts an additional ½ turn and tighten locknuts. Tighten thrust block mounting bolts to 102-122 N·m (75-90 ft.-lbs.) torque. Complete assembly, then adjust linkage as outlined in paragraph 319.

PLATFORM AND FENDERS

All Models So Equipped

348. Platform, fenders and seat can be removed as an entire unit as necessary to perform certain service procedures. To remove platform as an assembly, first raise the hood and disconnect negative battery cable. Remove the two bolts at lower front side of fenders on each side and the three step mounting bolts located under step plate on each side. Remove quadrant lever cover and disconnect control lever linkage. Remove remote valve cover, remove remote lever mounting bolts, disconnect linkage and remove remote valve levers. Disconnect pto control linkage and disconnect wires to pto vacuum sensing switch (if so equipped). Remove rate of lower control knob. Disconnect all necessary electrical wiring and the wiring harness to rear of tractor. Remove harness from mounting clips. Remove nuts from platform mounting studs. Attach a hoist to platform and raise platform about 300 mm (12 inches). Disconnect wires to neutral start switch, then raise and remove platform and fenders.

To reinstall, reverse the removal procedure.

CAB

All Models So Equipped

349. To remove cab, first raise the hood and disconnect battery ground cable. Drain engine coolant and discharge air conditioning system (if so equipped).

CAUTION: Refrigerant in air conditioning system is under pressure. Use proper procedure and wear eye and hand protection when servicing system.

Disconnect air conditioning high pressure and low pressure hoses. Disconnect heater hoses and power steering lines. Disconnect fuel pump supply line, fuel return line and fuel tank ventilation line. Disconnect tachometer cable from engine. Disconnect foot throttle and hand throttle linkage. Disconnect and remove fuel shut-off rod. Disconnect clutch hydraulic line at cab mounting bracket. Disconnect all necessary electrical wiring and wiring harnesses. Remove bolts from frame brace at front of cab just behind engine and remove brace. Remove transmission shift lever. Disconnect pto control cable and remove yoke from cable. Disconnect brake hydraulic lines and parking brake cables. Remove hitch level adjusting rod and hitch lock lever rod (if so equipped). Remove the four bolts from shift levers. Disconnect hitch dial selector rod, dump valve rod, remote valve control linkage, hitch control rod, rate of lowering rod, differential lock lever and pto linkage rod. Disconnect front-wheel drive control linkage (if so equipped). Move cab floor mat back and remove cover over fuel tank sender. Disconnect fuel sender wires. Remove cab step. Remove all cab retaining nuts and bolts. Attach a suitable cab lifting bracket to cab, then raise cab off mounting brackets and disconnect main wiring harness. Remove cab from tractor.

Reinstall by reversing removal procedure. Be sure to connect main wiring harness before cab is lowered onto mounting brackets. Tighten cab mounting nuts and bolts to 163 N·m (120 ft.-lbs.) torque.