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IMPLEMENT & TRACTOR

publication

T&T SHOP SERVICE

OLIVER

SHOP MANUAL

OLIVER SERIES
1600 1650

COCKSHUTT SERIES
1600 1650

MANUAL NO. 0-17 PRICE, $3.50

TECHNICAL PUBLICATIONS, INCORPORATED
(*A Subsidiary of* IMPLEMENT & TRACTOR)
KANSAS CITY, MISSOURI 64105

Information and Instructions

This individual Shop Manual is one unit of the I&T SHOP SERVICE described elsewhere on this page. Contained in it are the necessary specifications and the brief but terse procedural data needed by a mechanic when repairing a tractor on which he has had no previous actual experience.

The material is arranged in a systematic order beginning with an index which is followed immediately by a Table of Condensed Service Specifications. These specifications include dimensions, fits, clearances and timing instructons, as well as liquid capacities of the transmission, final drive, crankcase and cooling system. Next in order of arrangement is the procedures section.

In the procedures section, the order of presentation starts with the front axle system and steering and proceeds toward the rear axle. The last portion of the procedures section is devoted to the belt pulley, power take-off and power lift systems. Interspersed where needed in this section are additional tabular specifications pertaining to wear limits, torquing, etc.

HOW TO USE THE INDEX

Suppose you want to know the procedure to R&R (remove and reinstall) the engine camshaft. Your first step is to look in the index under the main heading of ENGINE until you find the entry "Camshaft." Now read to the right where under the column covering the tractor you are repairing, you will find a number which indicates the beginning paragraph pertaining to the camshaft. To locate this wanted paragraph in the manual, turn the pages until the running index appearing on the top outside corner of each page contains the number you are seeking. In this paragraph you will find the information concerning the removal of the camshaft.

The Complete SHOP SERVICE Contains:

A. Heavy, expanding Shop Manual binder.
B. Shop Manuals for each make of tractor.
C. Three-ring Flat Rate Manual binder.
D. Flat Rate Manuals for each make of tractor.
E. Service Supplements.

Additional copies of this manual are available to subscribers of the I&T SHOP SERVICE.

I&T SHOP SERVICE

Published by

TECHNICAL PUBLICATIONS, INCORPORATED

(A Subsidiary of IMPLEMENT & TRACTOR)

Affiliated with Howard W. Sams & Co., Inc.

1014 WYANDOTTE STREET

KANSAS CITY, MISSOURI, 64105

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SHOP MANUAL

OLIVER

MODELS 1600, 1650

Also Covers COCKSHUTT

MODELS 1600, 1650

SERIAL NUMBER LOCATION

Tractor serial number plate is located on the rear side of the instrument panel support. Engine serial number is stamped on right front flange of engine directly below the generator or alternator.

BUILT IN THESE VERSIONS

Rowcrop, Industrial, Wheatland and Utility. Rowcrop tractors are available in single front wheel, dual wheel tricycle and adjustable axle versions, while Industrial, Wheatland and Utility models are available with non-adjustable front axles only.

Printed in U. S. A.

INDEX (By Starting Paragraph)

CONDENSED SERVICE DATA

GENERAL	Model 1600	Model 1650
Engine Make	Own	Own
Engine Model	1600	1650
Cylinders, Number of	6	6
Cylinder Bore, Non-Diesel—Inches	3½(1), 3⅝	3¾
Cylinder Bore, Diesel—Inches	3¾	3⅞
Stroke—Inches	4	4
Displacement, Non-Diesel—Cubic Inches	231(1), 248	265
Displacement, Diesel—Cubic Inches	265	283
Compression Ratio, Gasoline	8.5	8.5
Compression Ratio, LP-Gas	9.0	9.0
Compression Ratio, Diesel	16.0	16.0
Pistons Removed From	Above	Above
Main Bearings, Number of	4	4(2)
Cylinder Sleeves, Type	Wet	Wet
Forward Speeds, Number of	6	6
Battery Terminal Grounded	Positive	Negative

(1) Prior to Tractor Serial No. 137613.
(2) Series 1650 diesel engine has 7 main bearings.

TUNE-UP		
Firing Order	1-5-3-6-2-4	1-5-3-6-2-4
Valve Tappet Gap, Non-Diesel, Intake	0.013-0.015	0.013-0.015
Valve Tappet Gap, Diesel, Intake	0.009-0.011	0.017-0.019
Valve Tappet Gap, Non-Diesel, Exhaust	0.022-0.024	0.023-0.025
Valve Tappet Gap, Diesel, Exhaust	0.015-0.017	0.027-0.029
Valve Face Angle, Degrees	44½	44½
Valve Seat Angle, Degrees	45	45
Ignition Distributor Make	D-R	Holley
Ignition Distributor Model	1112632	D-2563AA
Generator & Regulator Make	D-R	D-R
Generator Model	1100419	1100725(3)
Regulator Model	1118997	1119517
Starting Motor Make	D-R	D-R
Starting Motor Model, Non-Diesel	1107682	1107358
Starting Motor Model, Diesel	1113098	1113098
Ignition Distributor Contact Gap	0.016	0.025
Ignition Distributor Timing, Gasoline	——— See Par. 145 ———	
Ignition Distributor Timing, LP-Gas	5° BTDC	TDC
Injection Pump Make	Roosa-Master	Roosa-Master
Injection Pump Model	See Par. 122	DGBFC-629-1DH
Injection Pump Timing	7° BTDC	2° BTDC
Injector Make	CAV	CAV
Carburetor Make, Gasoline	M-S	M-S
Carburetor Make, LP-Gas	Zenith or Bosch	Bosch-Ensign
Carburetor Model, Gasoline	See Par. 89	TSX-807
Carburetor Model, LP-Gas	PC2J10 or CBX	CBX
Engine Low Idle RPM, Gasoline	300	450
Engine Low Idle RPM, LP-Gas	500	450
Engine Low Idle RPM, Diesel	675	650
Engine High Idle RPM, Non-Diesel	2100	2450
Engine High Idle RPM, Diesel	2100	2450
Engine Rated RPM	1900	2200
Belt Pulley RPM, High Idle	1302	1208
[illegible] RPM, Rated Engine	1188	1085
[illegible] (540 pto)	652	612

TUNE-UP (Contd.)	Model 1600	Model 1650
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PTO RPM, Rated Engine (540 pto)	581	550
PTO RPM, Rated Engine (1000 pto)	1008	994

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Crankpin Diameter, Diesel	2.4365-2.4375	2.4365-2.4375
Rod Length, Center to Center	6.749-6.750	6.749-6.750
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Camshaft Journal Diameter, Others	1.7485-1.7495	See Par. 74
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Rod Bearings Clearance, Diesel	0.0005-0.0015	0.0005-0.0015
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FRONT SYSTEM (AXLE TYPE)

AXLE MAIN MEMBER AND PIVOT PIN

Rowcrop Models

1. Rowcrop tractors may be equipped with an adjustable front axle as shown in Fig. O1. The main (center) member (16 or 16A) is carried on a pin which is retained in the front support (bolster) by a pin.

To remove the front axle, stay rod (26) and wheels as an assembly, support front of tractor, then unbolt stay rod support (32) from front main frame. Disconnect inner ends of the tie rods from steering arm. Slide front axle from pivot pin on manual steering models, or, on power steering equipped models, remove pivot pin and lift front of tractor and remove the axle assembly. Remove nut (27) from rear end of stay rod and withdraw stay rod support (32). Bushings (31) and (17 or 17A) should be reamed, if necessary, to provide 0.001-0.002 diametral clearance for the pins.

Utility Models

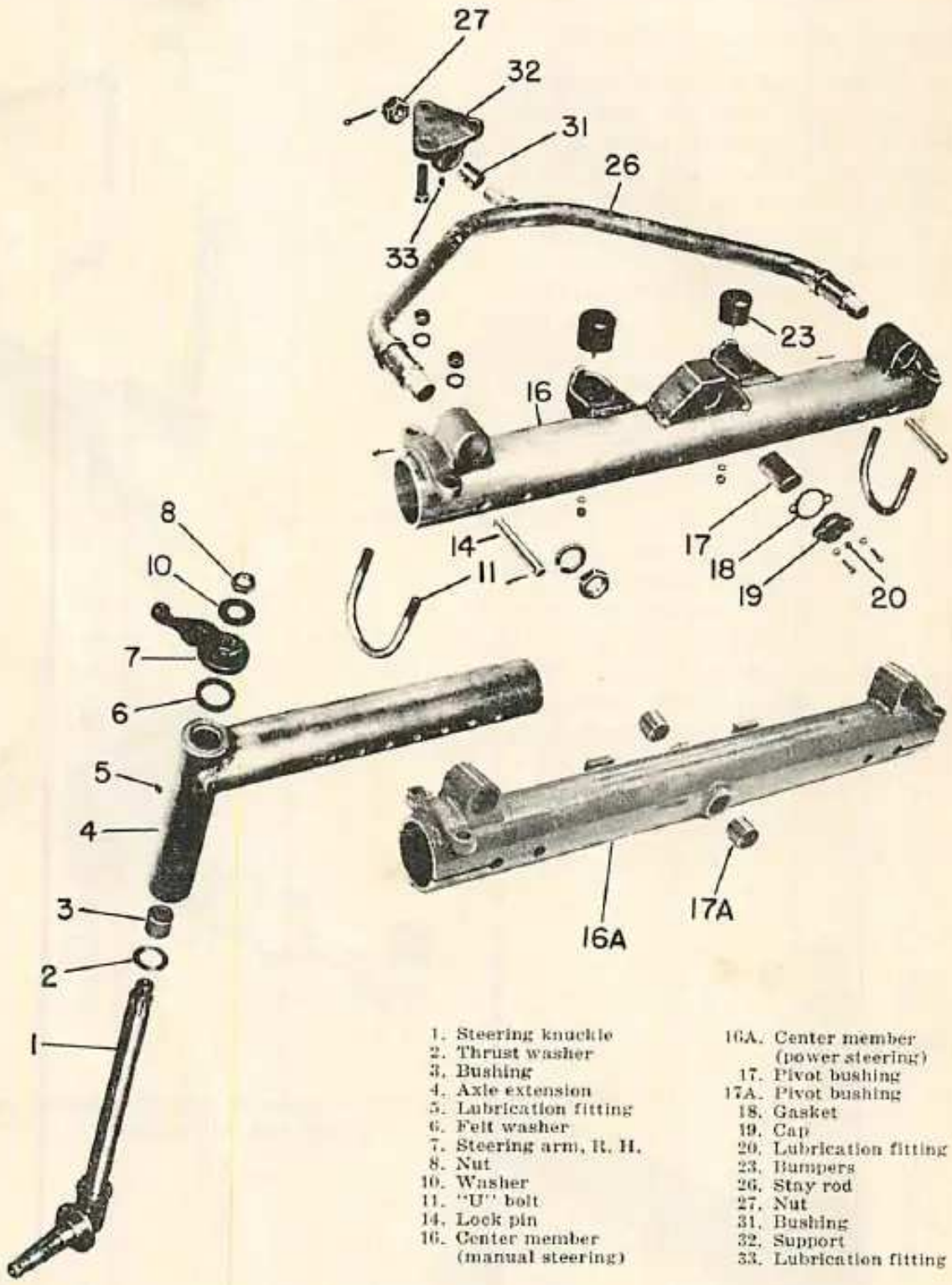
2. On Utility models, the pivot pin is an integral part of the axle main member (16—Fig. 02). Bushing (24) in rear carrier (20) and bushing (not shown) in front carrier for pivot pin are pre-sized and should not require reaming if carefully installed.

To remove front axle as an assembly, support front end of tractor, disconnect tie rods from center steering arm and remove thrust washer (17) from front end of pivot pin. Support axle, remove pivot pin rear carrier (20) and slide axle back out of front carrier. Remove bushings from front and rear carriers and install new bushings with suitable driver. Be sure that grease hole in each bushing is aligned with lubrication fitting.

Wheatland and Industrial Models

3. The Wheatland and Industrial model tractors are fitted with a non-adjustable, live spindle axle as shown in Fig. 03. Note: Industrial axle is shown, but Wheatland axle differs only in that the axle is arched.

To remove axle, stay rod (21) and wheels as an assembly, support front end of tractor, remove stay rod ball socket cap from support (28) and disconnect tie rods from center steering arm. Remove pin which retains axle pivot pin in front bolster, drive out pivot pin and remove front axle assembly. Bushing (20) should be reamed, if necessary, to provide 0.001-0.002 clearance for pin.



1. Steering knuckle
2. Thrust washer
3. Bushing
4. Axle extension
5. Lubrication fitting
6. Felt washer
7. Steering arm, R. H.
8. Nut
10. Washer
11. "U" bolt
14. Lock pin
16. Center member (manual steering)
16A. Center member (power steering)
17. Pivot bushing
17A. Pivot bushing
18. Gasket
19. Cap
20. Lubrication fitting
23. Bumpers
26. Stay rod
27. Nut
31. Bushing
32. Support
33. Lubrication fitting

Fig. O1 — Exploded view of Rowcrop adjustable front axle assembly. Models equipped with manual steering use center (main) member (16); those equipped with power steering use center member (16A). Narrow tread power steering models use center member similar to (16A), but shorter than standard part.

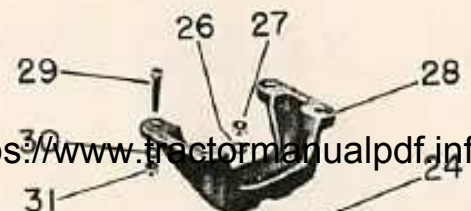
TIE RODS AND TOE-IN

All Axle Type

4. Tie rod ends are of the non-adjustable automotive type and are serviced by either renewing the end assembly or the complete tie rod assembly.

Toe-in for all axle type model[s] $\frac{3}{16}$-inch. Obtain correct toe-in by ing length of [tie rod] amount.

STEERING KNUCKLES AND BUSHINGS

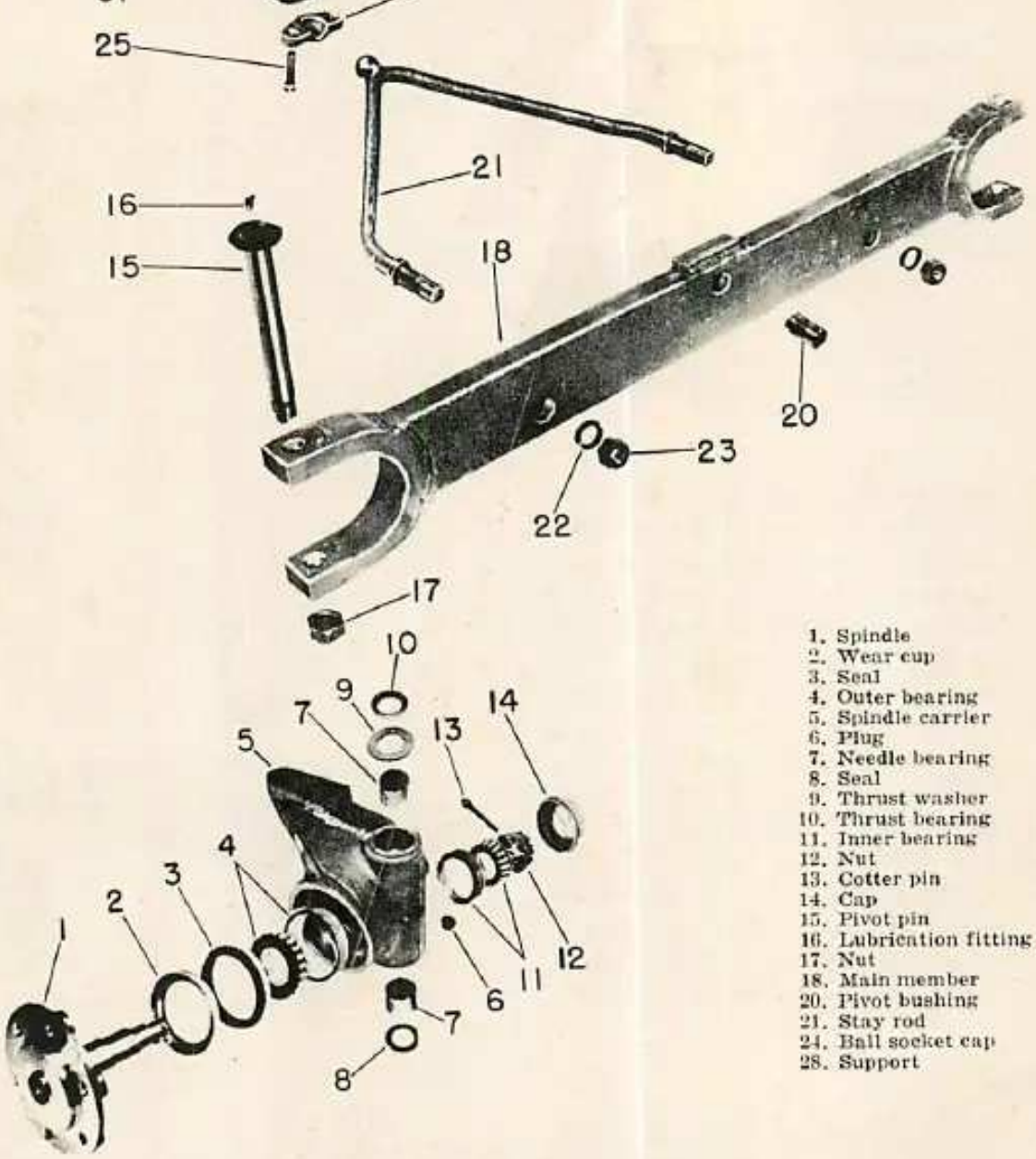


Rowcrop and Utility Models

5. To remove the steering knuckles (1—Fig. O1 or Fig. O2) and renew bushings (3), support front end of tractor and remove tire and wheel assembly. Straighten tab of washer (10) and remove nut (8). Remove steering arm (7) from knuckle and withdraw knuckle from axle extension.

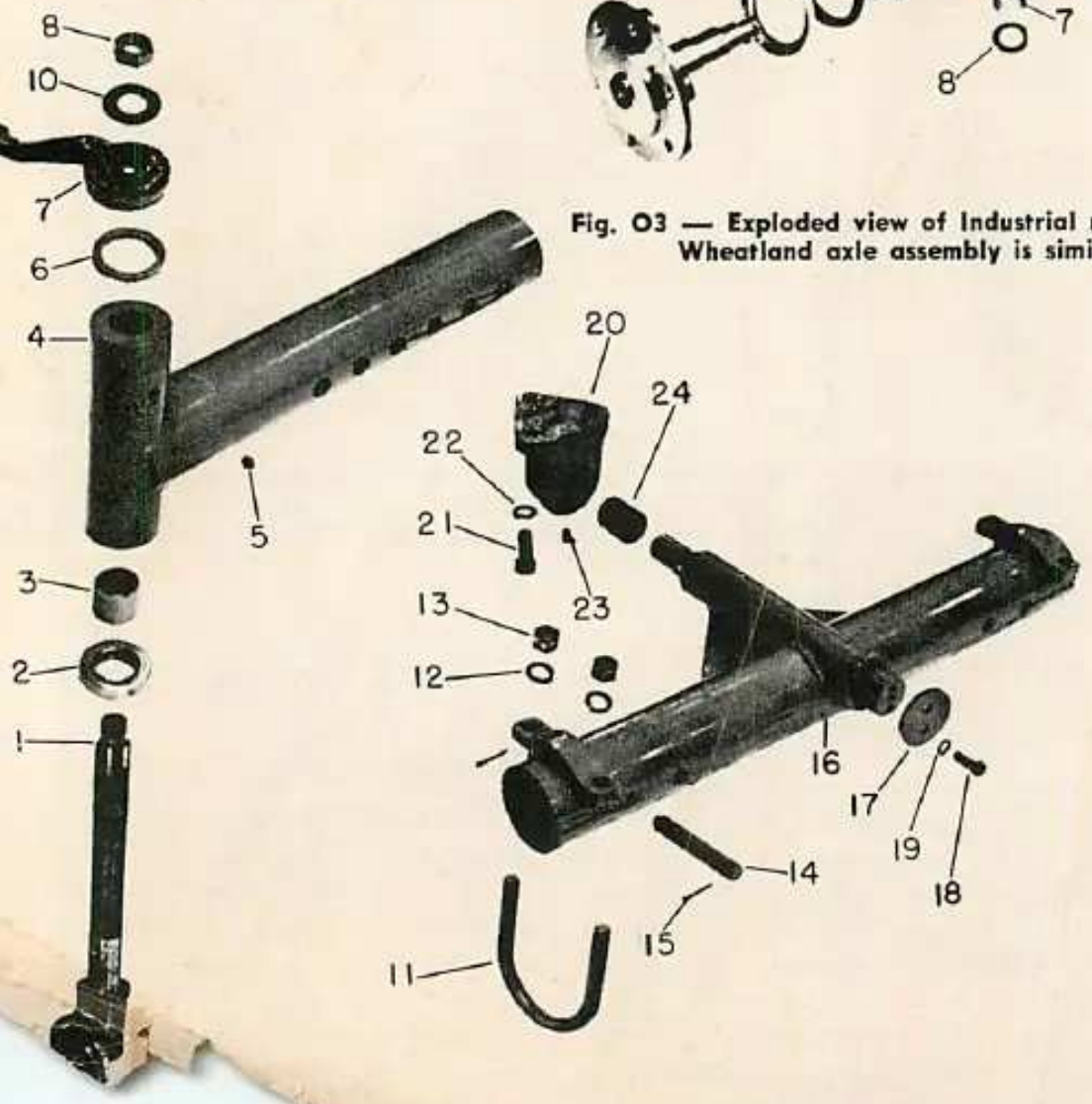
Drive the bushings (3) from axle extension and install new bushings flush with bore. Bushings are pre-sized and reaming should not be necessary if bushings are installed with suitable driver.

A thrust washer (2—Fig. O1) is used between knuckle and axle extension on Rowcrop models; Utility models are fitted with a thrust bearing (2—Fig. O2). Install thrust bearing on steering knuckle with washer side down. Install thrust washer on Rowcrop knuckle with either side up. Insert knuckle into axle extension, install new felt (6) and install steering arm (7) extending to rear and at approximately 90° to wheel spindle.



1. Spindle
2. Wear cup
3. Seal
4. Outer bearing
5. Spindle carrier
6. Plug
7. Needle bearing
8. Seal
9. Thrust washer
10. Thrust bearing
11. Inner bearing
12. Nut
13. Cotter pin
14. Cap
15. Pivot pin
16. Lubrication fitting
17. Nut
18. Main member
20. Pivot bushing
21. Stay rod
24. Ball socket cap
28. Support

Fig. O3 — Exploded view of Industrial non-adjustable, live (rotating) spindle front axle. Wheatland axle assembly is similar except main member (18) is arched.



2 — Exploded view of Utility front axle assembly.

LIVE SPINDLES AND SPINDLE CARRIERS

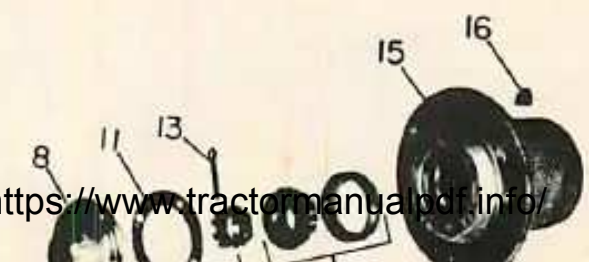
Wheatland and Industrial Models

6. **SPINDLES.** Front wheels on Wheatland and Industrial models are attached to live (rotating) spindles (1—Fig. O3) which are carried in tapered roller bearings mounted in the spindle carriers (5). Spindles can be removed by removing the cap (14) from inner side of spindle carrier and removing the cotter pin (13) and slotted nut (12) from inner end of

1. Steering knuckle
2. Thrust bearing
3. Bushings
4. Axle extension, R. H.
5. Lubrication fitting
6. Felt washer
7. Steering arm, R. H.
8. Nut
10. Washer
11. "U" bolt
14. Lock pin
16. Center (main) member
17. Thrust washer
20. Support
24. Bushing

spindle. Refer to paragraph 8 for bearing and seal service information.

7. **SPINDLE CARRIERS.** To renew the spindle carrier pivot pin (15—Fig. O3) and/or pivot pin needle bearing (7), first remove wheel and dis-



pin can be installed. Bearing adjustment is *correct when* torque of 20 inch-pounds is required to rotate wheel. Renew gasket (11—Fig. O4) when installing cap on Rowcrop or Utility model hub.

connect tie rod outer end from carrier. Remove nut (17) from bottom end of pivot pin and drive the pin up out of axle (18) and carrier. Drive bearings (7) from carrier and install new bearings by driving or pressing on lettered side of cage only. To renew carrier, remove spindle as outlined in paragraph 6. When reassembling, renew seal (8) and, if damaged, renew thrust bearing (10) and washer (9). Refer to paragraph 8 for wheel bearing and seal information.

WHEEL BEARINGS AND SEAL

All Models

8. Refer to Fig. O4 for exploded view of Rowcrop and Utility model front wheel bearing and seal installation and to Fig. O3 (items 1 through 14) for Wheatland and Industrial models.

To install new seal (3—Fig. O3, or 18—Fig. O4), first apply thin coat of gasket sealer to outer metal rim of seal. On Rowcrop or Utility model, install seal in wheel hub (15—Fig. O4) with Oliver ST-97 or ST-145 Seal Driver and ST-125 Mandrel or equivalent tool. On Wheatland or Industrial model, install seal in spindle carrier (5—Fig. O3) with Oliver ST-123 or ST-146 Seal Driver and ST-125 Mandrel or equivalent tool. Apply thin coat of gasket sealer to inside of seal wearing cup (19—Fig. O4, or 2—Fig. O3) and install wearing cup on spindle using Oliver ST-98 Driver on Rowcrop or Utility model, or ST-124 Driver on Wheatland or Industrial model. Face of cup must be smooth and flat after installation.

When reassembling, wheel hub or spindle carrier and bearings should be packed with ½-pound of lithium or calcium base multi-purpose grease. Threads of plug (16—Fig. O4) in wheel hub or (6—Fig. O3) in spindle carrier should be coated with gasket sealer or white lead if plug has been removed.

To adjust wheel bearings, tighten nut until definite drag is felt when rotating wheel, then back nut off to remove preload. Continue to tighten and loosen nut until a point is located where torque required to tighten nut definitely increases, then tighten nut from this point to where cotter

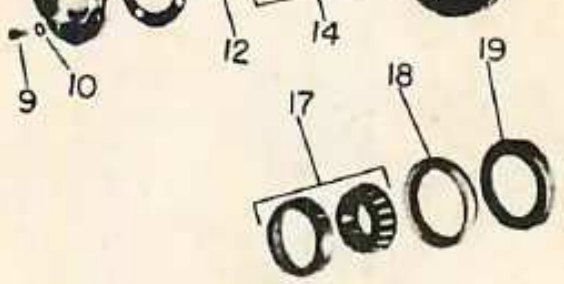


Fig. O4 — Exploded view of front wheel hub, bearing and seal assembly used on Rowcrop and Utility models.

8. Hub cap
9. Capscrews
11. Gasket
12. Nut
13. Cotter pin
14. Outer bearing
15. Hub
16. Plug
17. Inner bearing
18. Seal
19. Wear cup

MANUAL STEERING GEAR

Models So Equipped

9. **R&R STEERING GEAR UNIT.** Disconnect tie rods from steering gear arm. Loosen steering shaft support bearing at clutch housing and disconnect universal joint from steering gear wormshaft. Support front end of tractor and unbolt stay rod support on Rowcrop models, remove stay rod ball socket cap on Wheatland or Industrial models, or on Utility models, unbolt rear pivot pin bracket. Remove capscrews that retain front axle bolster (support) or carrier to tractor main frame, raise front of tractor and roll complete front axle assembly away from tractor. Remove steering arm from steering gear sector shaft and remove steering gear unit from front bolster or carrier.

NOTE: When gear unit is removed from front bolster or carrier, do not turn wormshaft hard against stop in either direction as damage to ball guides could result.

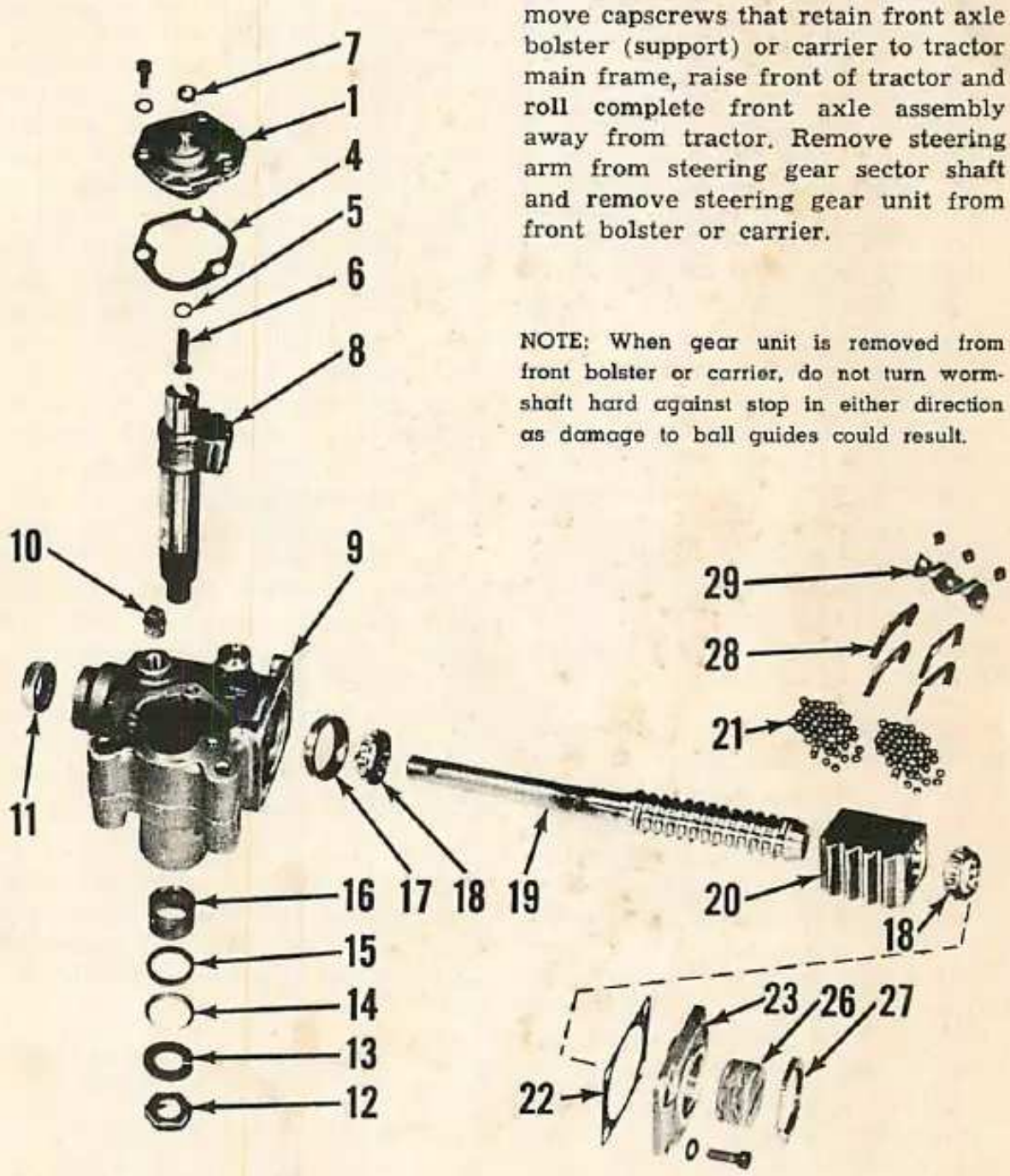
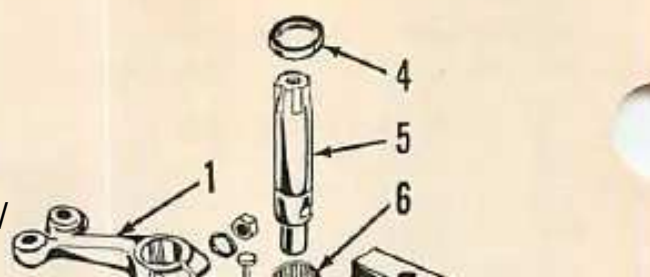


Fig. O5 — Exploded view of Saginaw steering gear assembly used on manual steering models.

1. Cover
4. Gasket
5. Shim
6. Lash adjuster
7. Jam nut
8. Pitman shaft (sector gear)
9. Housing
10. Plug
11. Seal
12. Nut
13. Lock washer
14. Packing retainer
15. Packing
16. Bushing
17. Bearing cup
18. Bearing cone
19. Steering shaft
20. Ball nut
21. Steel balls (106)
22. Gasket
23. End cover
26. Bearing adjuster
27. Lock nut
28. Ball guides
29. Guide retainer

10. **WORMSHAFT ADJUSTMENT.** Remove steering gear unit as outlined in paragraph 9. Loosen lash adjusting screw (6—Fig. O5) several turns to relieve any load that may be imposed by the meshing of sector and worm gears. Loosen lock nut (27) and turn adjuster (26) inward until 8-12 in.-



lbs. torque is required to rotate the worm shaft. Tighten lock nut and recheck. Adjust sector mesh as outlined in paragraph 11.

11. **SECTOR MESH (BACKLASH) ADJUSTMENT.** This adjustment is controlled by lash adjuster screw (6); however, before making any adjustment, make sure that the wormshaft adjustment is correct as specified in paragraph 10.

Disconnect tie-rods from sector shaft arm. Loosen lock nut (7). Locate mid-position of steering gear sector by rotating wormshaft from full right to full left, counting the total number of turns; then, rotate wormshaft back exactly half way to the center or mid-position. With steering gear sector in its mid-position of travel, rotate lash adjuster (6) in a clockwise direction until 16 to 20 inch-pounds of torque is required to turn wormshaft through mid-position of gear travel. Tighten lash adjuster locknut.

Note: Backlash adjusting screw (6) should have from zero to 0.002 end play in gear. If end play exceeds 0.002 it will prevent correct adjustment of backlash; in which case, sector cover (1) should be removed and a shim (5) of correct thickness be installed at head of adjuster screw to remove the excess backlash. Shims are available in a kit of four shims, 0.063, 0.065, 0.067 and 0.069 thick.

12. **OVERHAUL GEAR ASSEMBLY.** To disassemble steering gear unit, remove assembly as outlined in paragraph 9; then, proceed as follows: Remove pitman arm. Remove cap screws from sector cover (1) and withdraw sector and cover as a unit from housing. Remove worm (screw) shaft cover (23) and withdraw wormshaft through this opening. Wormshaft bearing cup (17) and/or oil seal (11) can be renewed at this time.

Ball nut (20) should move along grooves in wormshaft smoothly and with minimum end play. If worm shows signs of wear, scoring or other derangement, it is advisable to renew the worm and nut as a unit. To disassemble nut (20) from worm (screw) shaft (19), remove ball retainer clamp (29), ball return guides (28), balls and worm nut.

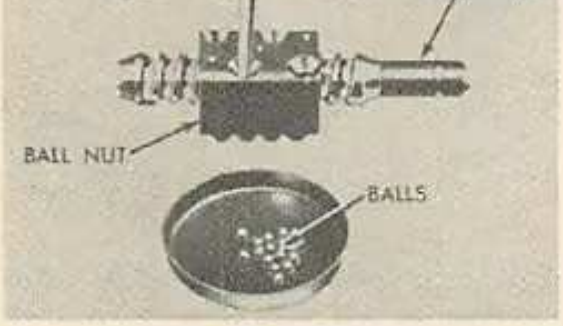


Fig. O6 — Using punch to align ball nut with wormgear and to fill ball circuit.

To reassemble ball nut, place nut over middle section of worm as shown in Fig. O6. Drop bearing balls into one retainer hole in nut and rotate wormshaft slowly to carry balls away from hole. Continue inserting balls in each circuit until circuit is full to bottom of both holes. If end of worm is reached while inserting balls and rotating worm in nut, hold the balls in position with a clean blunt rod as shown in Fig. O6 while shaft is rotated in an opposite direction for a few turns. Remove the rod and drop the remaining balls in the circuit. Make certain that no balls are outside regular ball circuits. If balls remain in groove between two circuits or at ends, they cannot circulate and will cause gear failure. Next, lay one-half of each split guide (28—Fig. O5) on the bench and place 13 balls in each. Place the other halves of each retainer over the balls. While holding the halves together, plug their ends with heavy grease to prevent the balls from dropping out; then, insert complete retainer units in worm nut and install guide clamp.

Sector shaft large bushing (16—Fig. O5) has an inside diameter of 1.375. Other sector shaft bushing has an inside diameter of 1.0625. I&T suggested clearance of shaft in bushings is 0.0015-0.003.

Note: Sector cover (1) and its bushing are not available separately.

Select and insert a shim (5) on sector mesh adjusting screw (6) to provide zero to 0.002 end play, before reinstalling sector and shaft in gear housing. Adjust worm (screw) shaft bearings and sector mesh as outlined in paragraphs 10 and 11. Fill unit with No. 1 grade multi-purpose lithium or calcium base grease.

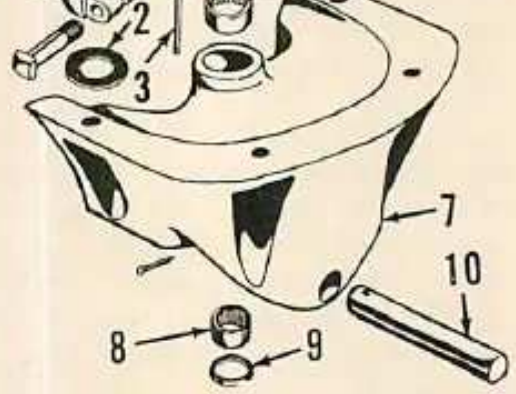


Fig. O7—Exploded view of Industrial front bolster for power steering equipped model. While shape of bolster or carrier differs for other models, operating parts remain basically the same for all axle type models with power steering.

1. Steering arm
2. Thrust washer
3. Retaining pin
4. Seal
5. Pitman shaft
6. Bearing
7. Bolster
8. Bearing
9. Seal
10. Pivot pin

FRONT BOLSTER (SUPPORT) OR CARRIER

All Models

13. **R&R AND OVERHAUL.** On models equipped with manual steering, remove steering gear assembly as outlined in paragraph 9, then remove bolster or carrier from axle assembly. Front bushing for pivot pin is renewable in carrier on Utility models. Bushing is pre-sized and should not require reaming if carefully installed.

On models equipped with power steering, remove the power steering cylinder as outlined in paragraph 57 and the front axle assembly as outlined in paragraph 1, 2 or 3. Then, unbolt and remove bolster or carrier from tractor main frame. Remove clamp bolt from steering arm and remove steering arm (1—Fig. O7), shaft (5) and thrust washer (2) from bolster or carrier. Oil seals (4 and 9) and needle bearings (6 and 8) can now be removed. When installing new needle bearings, drive or press on lettered end of bearing cage only. Oil hole in each bearing cage must align with lubrication fitting when bearing is installed. Press small bearing (8) in from top until flush with boss. Press large bearing (6) in from top until top of bearing is $\frac{3}{16}$-inch below flush with boss. Drive lower seal (9)

in from bottom with lip out (towards bottom of bolster or carrier). Place thrust washer (2) against lower bearing boss and insert steering arm, with offset downward, between thrust washer and upper bearing boss. Insert shaft through bearings, arm and washer and install clamp bolt. Then

install upper seal (4) over shaft with lip outward (up) and drive seal into housing. Thoroughly lubricate shaft bearings with pressure type grease gun.

FRONT SYSTEM (Tricycle Type)

ADJUSTMENTS

Models With Manual Steering

14. AXLE POST OR WHEEL FORK BEARINGS. On dual wheel tricycle models, adjust axle post (28—Fig. O8) to 0.006 or less end play by adding or removing shims (20) located between sector gear (8) hub and eccentric bushing (10). Bend washer (19) against flat of nut (9) when adjustment is correct. Access to shims is by removing front support as outlined in paragraph 20, or by removing radiator as outlined in paragraph 138, and then removing gear cover (13), nut (9) and sector gear.

On single front wheel models, adjust wheel fork (3—Fig. O9) to 0.006 or less end play by tightening or loosening nut (22). Stake nut to slot in fork after correct adjustment is obtained. Access to nut is by removing front support as outlined in paragraph 20, or by removing the radiator as outlined in paragraph 138, and then removing cover (6), from gear housing (26).

15. WORMSHAFT. Wormshaft bearings should be adjusted with the sector gear (8—Fig. O8, or 24—Fig. O9) removed.

To adjust wormshaft bearings, add or remove shims (7—Fig. O8 or 21—Fig. O9) located between bearing retainer (2—Fig. O8 or 16—Fig. O9) and the column or gear housing to eliminate all wormshaft end play but permitting wormshaft to rotate without binding. When wormshaft bearings are properly adjusted, 30 inch-pounds torque should be required to rotate the wormshaft (including seal drag). Shims are available in thicknesses of 0.002, 0.004 and 0.0156.

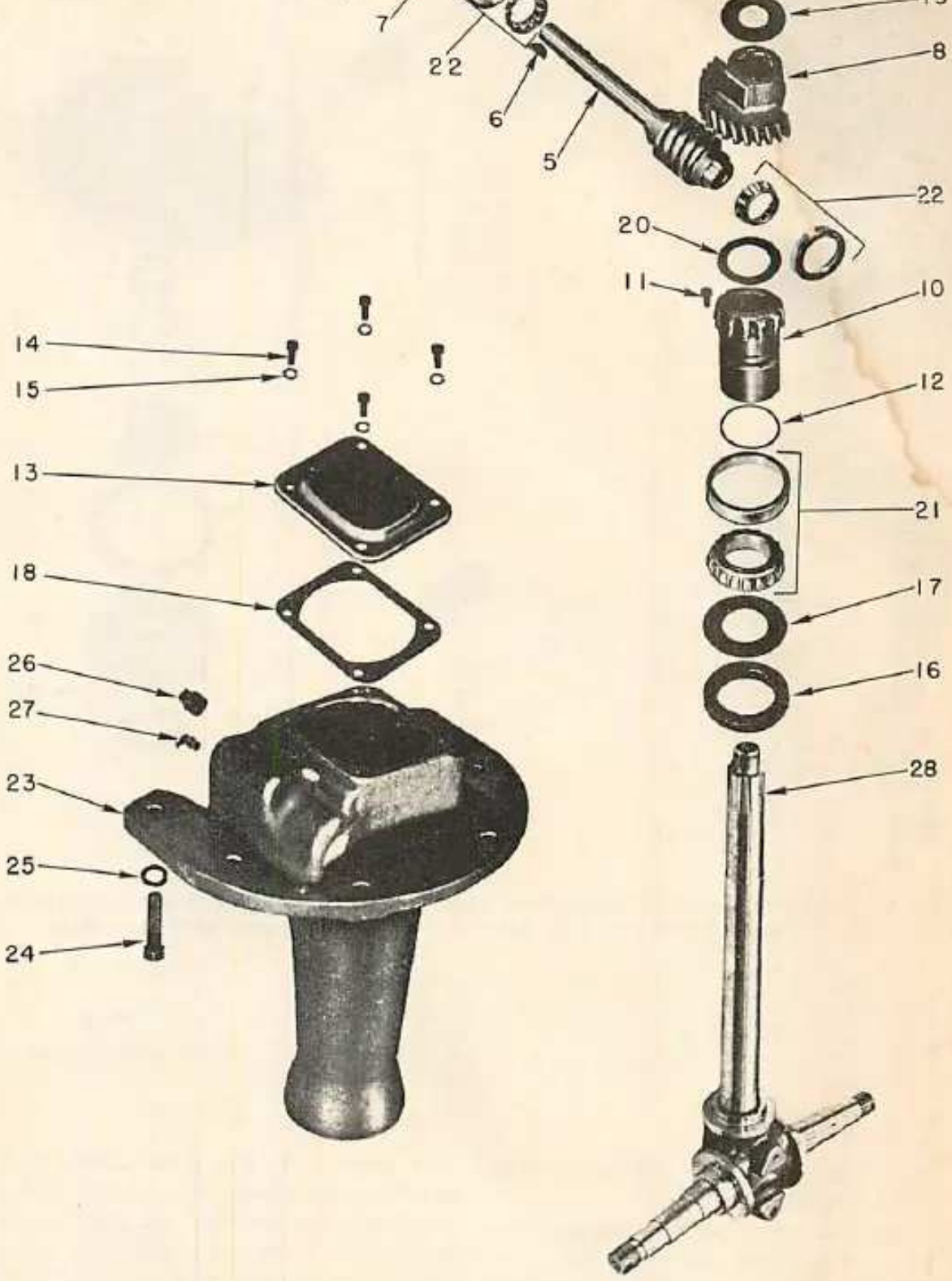
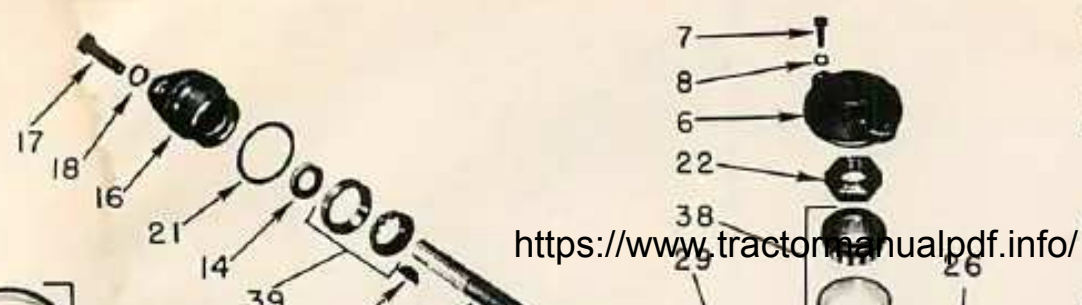


Fig. O8 — Exploded view of dual wheel tricycle front support and related parts as used on manual steering models. Refer to Fig. O12 for front support for power steering models.

1. Oil seal
2. Bearing cover
5. Steering worm
6. Woodruff key
7. Shims
8. Steering sector
9. Nut
10. Eccentric bushing
11. Cap screw
12. "O" ring
13. Gear housing cover
16. Felt
17. Felt retainer
18. Gasket
19. Washer
20. Shims
21. Tapered roller bearing
22. Worm shaft bearings
23. Steering column (front support)
26. Plug
28. Axle and post

16. **GEAR MESH.** On dual wheel tricycle models, remove cover (13—Fig. O8) and turn wormshaft so that sector gear (8) is in mid-position. Remove lock screw (11) from eccentric bushing (10) and rotate bushing in bore until all backlash between sector gear and wormshaft gear is removed. Temporarily lock bushing in this position and turn wormshaft in each direction to each sector stop position; if no binding condition is noted, tighten lock screw securely. If binding occurs, rotate bushing slightly to



adjustment is correct when approximately 20 inch-pounds torque is required to rotate front wheel. Reinstall cap with new gasket (11).

All Single Front Wheel Models

19. **WHEEL BEARING ADJUST-**

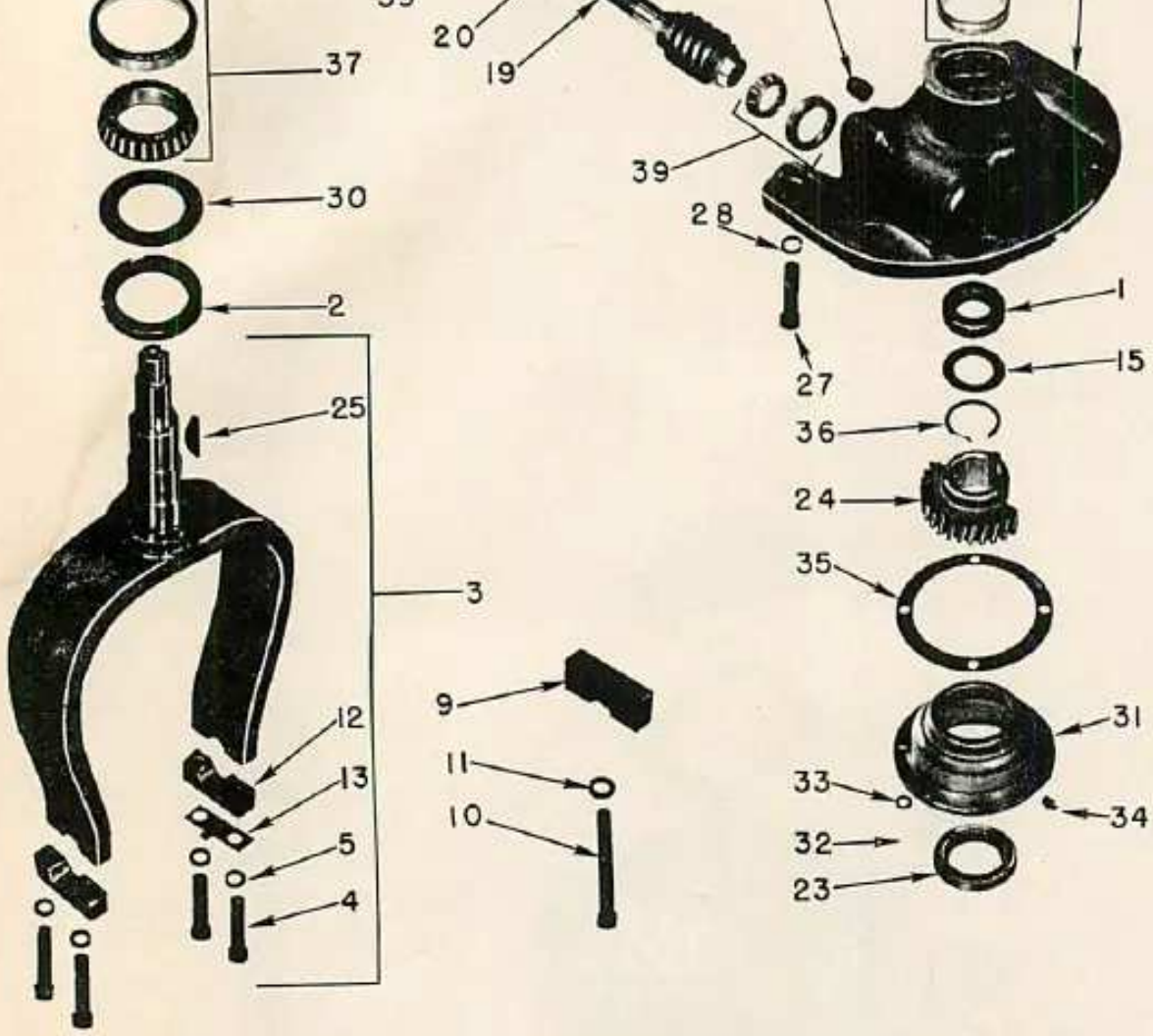


Fig. O9 — Exploded view of single wheel front support (gear housing) and related parts used on manual steering models. Refer to Fig. O13 for power steering models.

1. Felt washer
2. Felt washer
3. Fork assembly
6. Bearing cap
9. Adapter (7.50-16 tire)
12. Bearing cap
14. Seal
15. Felt retainer
16. Bearing cover
19. Worm shaft
20. Woodruff key
21. Shims
22. Nut
23. Oil seal
24. Sector gear
25. Woodruff key
26. Gear housing
29. Plug
30. Felt retainer
31. Bearing cage
35. Gasket
36. Snap ring
37. Lower bearing
38. Upper bearing
39. Wormshaft bearings

just remove binding condition and lock bushing in position.

On single front wheel models, rotate bearing cage (31—Fig. O9) to a bolting position providing minimum backlash between sector gear (24) and wormshaft without causing any binding condition when wormshaft is rotated throughout range of travel.

Models With Power Steering

17. **AXLE POST OR WHEEL FORK BEARINGS.** To adjust the dual front wheel axle post or single front wheel fork bearings, the power steering cylinder must first be removed as outlined in paragraph 57. If unit has been disassembled, be sure that bearing cups and cone and roller assemblies are fully seated, then adjust nut (5—Fig. O12 or 14—Fig. O13) so that axle post or wheel fork turns freely in the bearings, but without end play. After bearings are correctly adjusted, stake nut to slot in axle post or wheel fork shaft.

All Dual Wheel Tricycle Models

18. **WHEEL BEARING ADJUSTMENT.** Refer to Fig. O10 for exploded view of wheel hub and related parts. Remove cap (8) and cotter pin (13), then tighten nut until a definite drag is felt when rotating wheel. Back nut off to remove preload, then continue to tighten and loosen nut until a definite point is located where torque required to tighten nut definitely increases, then tighten nut to where cotter pin can be installed. Bearing

MENT. To adjust the single front wheel bearings, the wheel assembly must be mounted in the wheel fork and the axle spindle retaining caps tightened, but with the nut lock (13—Fig. O9 and 8—Fig. O13) removed. Then, tighten the bearing nut (31—Fig. O11) until a definite drag is felt when rotating wheel. Back nut off to remove preload, then continue to tighten and loosen nut until a definite point is located where torque required to tighten nut definitely increases, then tighten nut to where finger on nut lock will enter a slot in nut when the nut lock is installed on spindle cap retaining screws.

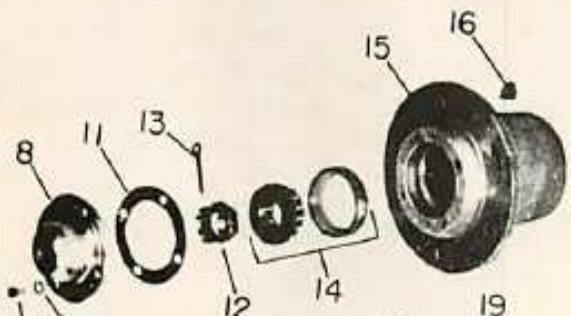
OVERHAUL FRONT ASSEMBLY

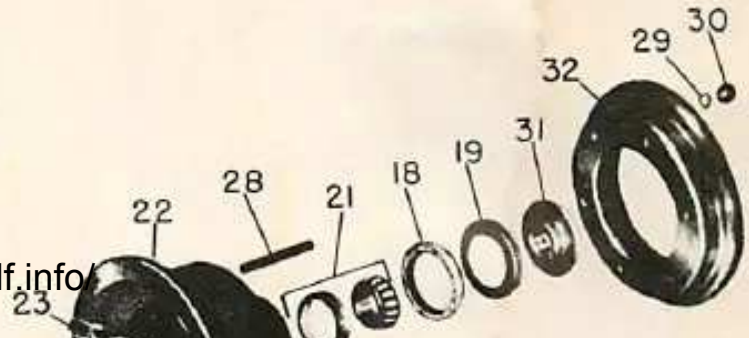
All Models

20. **R&R FRONT ASSEMBLY AS A UNIT.** On power steering equipped models, first remove the power steering cylinder as outlined in paragraph 57. On manual steering models, remove the dirt guard bolted to rear of column, housing or support. Loosen steering shaft support bearing at clutch housing and disconnect universal joint from steering gear wormshaft. Then, on all models, support front of tractor and remove capscrews retaining column, gear housing or support to tractor main frame. Raise front end of tractor and remove the assembly.

Dual Wheel Tricycle With Manual Steering

21. **OVERHAUL FRONT ASSEMBLY.** Remove assembly from tractor as outlined in paragraph 20 and remove wheels from hubs. Refer to Fig. O8 for exploded view of unit. Remove plug (26) and drain lubricating oil from gear unit. Remove cover (13), straighten tab of washer (19) and remove nut (9). Bump or pull axle post (28) out of column (23). Remove lower bearing cone, felt retainer (17) and felt washer (16) from axle post. Withdraw sector gear (8), remove shims (20), eccentric bushing (10) and "O" ring (12) from cover (13) opening. Remove lower bearing





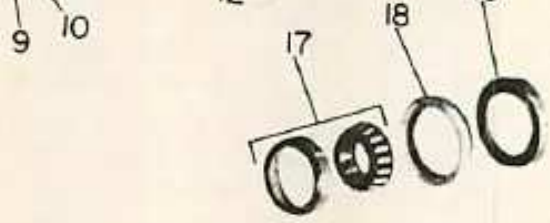


Fig. O10 — Exploded view of front wheel hub, bearing and seal assembly used on dual wheel tricycle models.

8. Hub cap
9. Cap screws
11. Gasket
12. Nut
13. Cotter pin
14. Outer bearing
15. Hub
16. Plug
17. Inner bearing
18. Seal
19. Wear cup

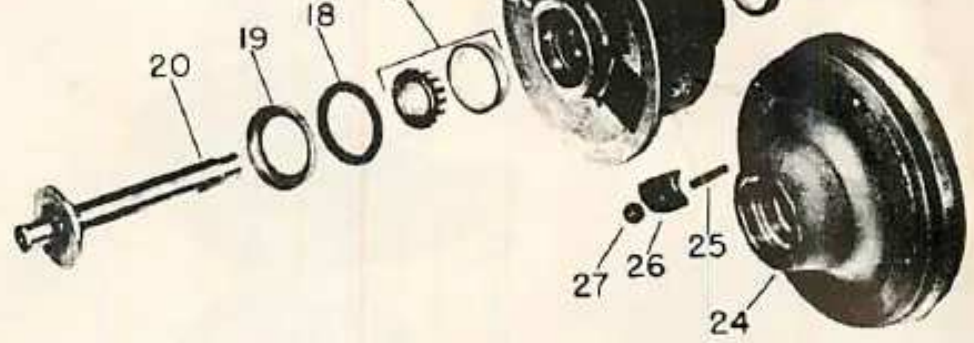


Fig. O11 — Exploded view of wheel, bearing, seal and axle shaft assembly used on single wheel tricycle models. Wheel disc (24) is for optional 7.50-16 tire and rim, and requires use of adapters (9—Fig. O9).

18. Seals
19. Wear cups
20. Axle spindle
21. Bearing assemblies
22. Wheel
23. Plug
24. Wheel disc (7.50-16 rim)
26. Rim clamps
31. Nut
32. Flange

cup from bottom of column. Remove wormshaft bearing retainer (2), shims (7) and wormshaft (5) with bearings (22) and seal (1) from rear of column.

Carefully inspect all parts and renew any that are excessively worn, scored or damaged. Reassemble unit using new seal (1), "O" ring (12), gasket (18) and felt (16) as follows:

Install seal (1) in retainer (2) with lip of seal inward (to front). Install wormshaft (5), bearings (22) and retainer (2) in column with correct thickness of shims (7) for bearing adjustment as outlined in paragraph 15.

Place new "O" ring (12) on eccentric bushing (10), lubricate "O" ring and install bushing in bore of column. Pack tapered roller bearing cone with No. 1 multi-purpose grease and install felt (16), retainer (17) and bearing cone on axle post being sure cone is firmly seated. Install bearing cup in bottom of column being sure cup is firmly seated and pack cavity between bearing cup and eccentric bushing with ½-lb. of No. 1 multi-purpose grease. Install axle post in column taking care not to dislodge eccentric bushing. Install sector gear (8), washer (19) and nut (9) with correct number of shims (20) for proper axle post adjustment as outlined in paragraph 14. Adjust gear mesh as outlined in paragraph 16. Fill gear unit to level of plug (26) with SAE 80 multi-purpose gear lubricant conforming to military specification MIL-L-2105. Install cover (13) with new gasket (18).

Single Wheel Tricycle With Manual Steering

22. **OVERHAUL FRONT ASSEMBLY.** Remove assembly as outlined in paragraph 20. Refer to Fig. O9 for exploded view of unit. Remove plug (29) and drain lubricant from gear housing (26). Remove cap (6) and unstake and remove nut (22) from wheel fork shaft (3). Push fork shaft out of bearing (38) and gear housing. Remove snap ring (36), sector gear (24), Woodruff key (25), and bearing cage (31) from fork shaft. Remove seal (23) and bearing cup from cage. Remove bearing cone, felt retainer (30) and felt (2) from fork shaft. Remove upper bearing (38), felt retainer (15) and felt (1) from gear housing. Remove retainer (16), shims (21) and wormshaft and bearings (19 and 39) from gear housing. Remove seal (14) from retainer.

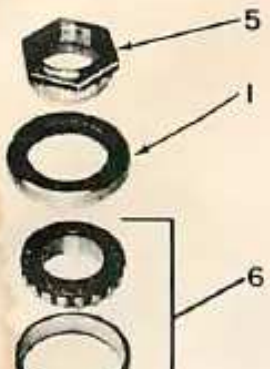
Carefully inspect all parts and renew any that are excessively worn, scored or damaged. Reassemble unit using new seals (14 and 23), felts (1 and 2) and gasket (35) as follows:

Install seal (14) in retainer (16) with lip of seal inward (to front). Install wormshaft (19), bearings (39) and retainer (16) in gear housing with correct thickness of shims (21) for proper bearing adjustment as outlined in paragraph 15.

Drive cup of upper bearing (38) into gear housing (26) until firmly seated and install new felt (1) and felt retainer (15). Drive cup of lower bearing (37) into bearing cage (31) until firmly seated and install new felt (2) and felt retainer (30) on fork shaft. Pack cone and roller assemblies of bearings (37 and 38) with No. 1 multi-purpose grease and drive cone of lower bearing (37) onto fork shaft until firmly seated. Drive seal (23) into bearing cage (31) with lip up (away from bearing cup). Place bearing cage on fork shaft and gasket (35) on cage. Install Woodruff key (25), sector gear (24) and snap ring (36) on fork shaft. Place gear housing over fork shaft and install cone and roller of upper bearing (38) and nut (22) and adjust nut as outlined in paragraph 14. Adjust gear mesh as outlined in paragraph 16 and install bearing cage retaining capscrews. Install cover (6). Fill gear housing to level of plug (29) with SAE 80 multi-purpose gear lubricant conforming to military specification MIL-L-2105.

Dual Wheel Tricycle With Power Steering

23. **OVERHAUL FRONT ASSEMBLY.** Remove assembly from tractor as outlined in paragraph 20. Refer to Fig. O12 for exploded view of unit. Unstake and remove nut (5), then bump or push axle post (11) from upper bearing (6) and column (7). Remove cone and roller assembly of lower bearing (6), felt retainer (3) and felt (2) from axle post. Remove seal (1), bearing assembly (6) and grease retainer (4) from upper bore



assembly. Install seal (1) with lip up (away from bearing), lubricate seal contact surface of nut (5) and install nut for proper bearing adjustment as outlined in paragraph 17.

Single Wheel Tricycle With Power Steering

24. **OVERHAUL FRONT ASSEM-**

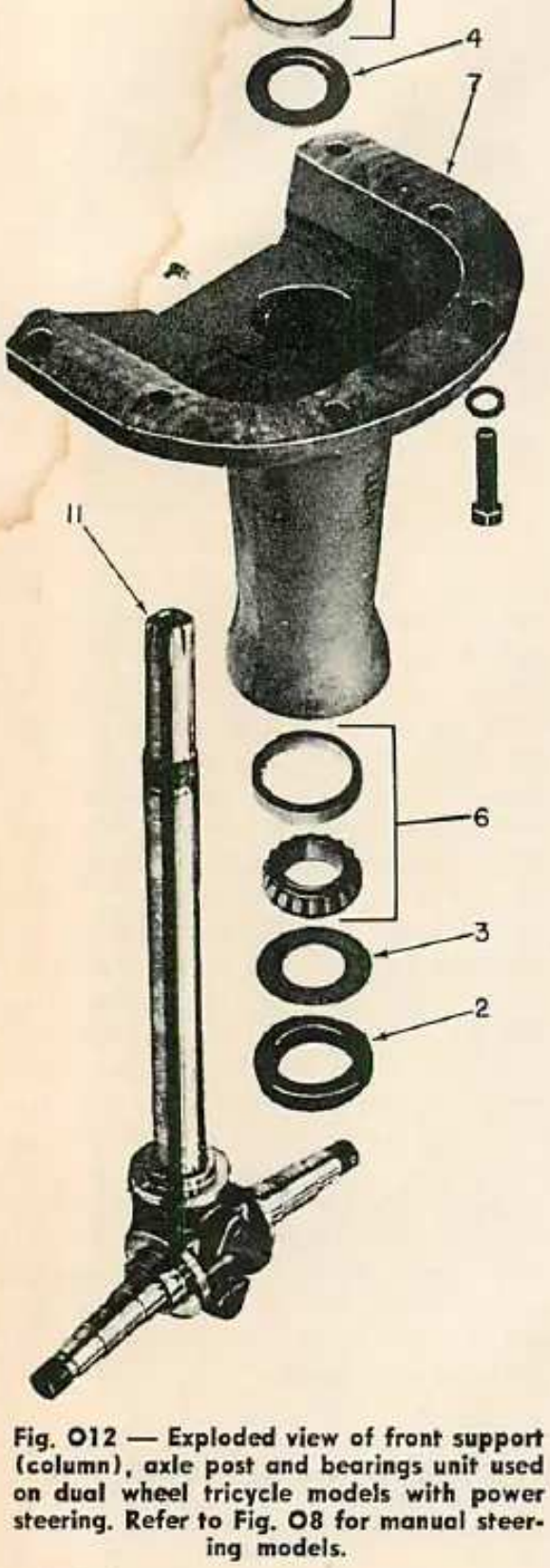


Fig. O12 — Exploded view of front support (column), axle post and bearings unit used on dual wheel tricycle models with power steering. Refer to Fig. O8 for manual steering models.

1. Seal
2. Felt
3. Felt retainer
4. Grease retainer
5. Nut
6. Bearing assemblies
7. Pedestal (column)
11. Axle post

of column and drive cup of lower bearing (6) from bottom of bore.

Carefully inspect all parts and renew any that are excessively worn, scored or damaged. Reassemble unit using new seal (1), felt (2) and grease retainer (4) as follows:

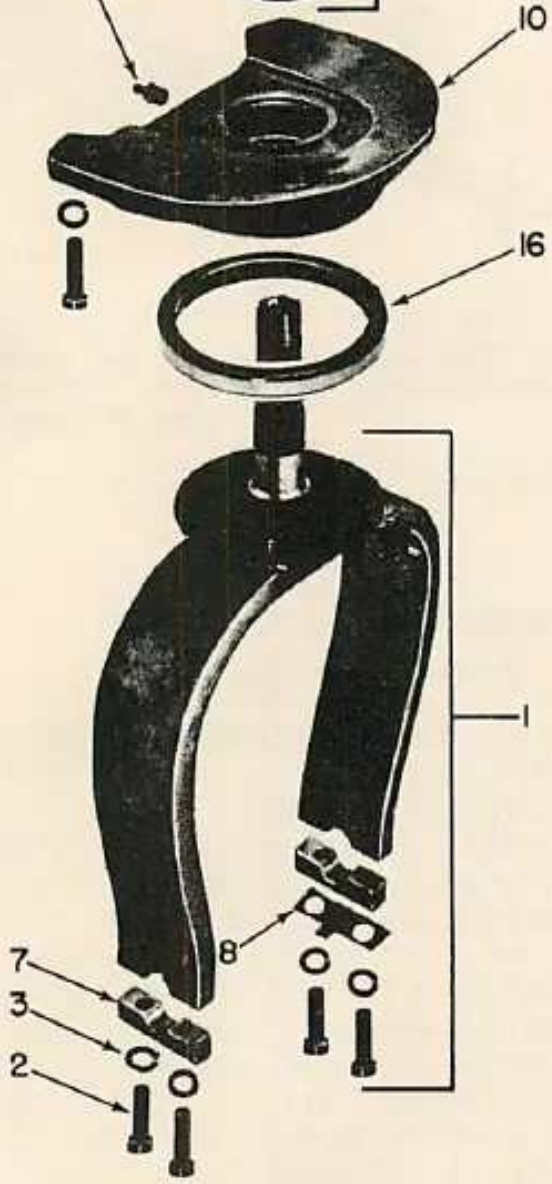


Fig. O13 — Exploded view of single front wheel front support (carrier) and related parts used on power steering models. Refer to Fig. O9 for manual steering models, and for 7.50-16 tire adapter.

1. Fork assembly
7. Cap
9. Seal
10. Carrier
14. Nut
15. Upper bearing
16. Lower bearing

Install grease retainer (4) with ridge upward and drive upper bearing cup in firmly against retainer. Drive lower bearing cup in firmly against shoulder in bottom of bore. Pack cone and roller assemblies of both bearings with No. 1 multi-purpose grease and pack ½-pound of same type grease in cavity above lower bearing cup in column. Install new felt (2) and retainer (3) on axle post, then drive cone and roller of lower bearing firmly against shoulder of axle post. Insert axle post in column and install upper bearing cone and roller

BLY. Remove assembly from tractor as outlined in paragraph 20. Refer to Fig. O13 for exploded view of unit. Unstake and remove nut (14); then, press or bump fork shaft from carrier (10). Remove seal (9) and upper bearing assembly (15) from carrier and thrust bearing (16) from fork.

Carefully inspect all parts and renew any that are excessively worn, scored or damaged. Reassemble unit using new seal (9) as follows:

Drive cup of upper bearing into carrier until firmly seated. Pack upper bearing cone and roller assembly and lower thrust bearing assembly with No. 1 multi-purpose grease. Thrust bearing should be a hand push fit on shoulder of wheel fork; dress shoulder with file or stone to remove burrs if bearing fits tightly. Place carrier (10) over fork shaft and thrust bearing and install cone and roller assembly of upper bearing. Install seal (9) with lip upward (away from bearing), lubricate seal contact surface of nut (14) and install nut for proper bearing adjustment as outlined in paragraph 17.

WHEEL BEARINGS AND SEAL UNITS

All Dual Wheel Tricycle Models

25. **RENEW WHEEL BEARINGS AND/OR SEALS.** Refer to Fig. 010 for exploded view of hub, bearing and seal unit used on dual wheel tricycle models.

To install new seal (18), first apply a thin coat of gasket sealer to outer metal rim of seal, then install seal in hub with Oliver ST-97 or ST-145 Seal Driver and ST-125 Mandrel or equivalent tools.

To install new seal wear cup on axle post spindle, first apply a thin coat of gasket sealer to inner surface of wear cup, then install cup on spindle (not in hub) with Oliver ST-98 Wearing Cup Driver or equivalent tool. Face of cup must be smooth and flat after installation.

When reassembling, bearing cone and roller assemblies and each hub should be packed with ½-lb. of No. 1

multi-purpose grease. Threads of plug (16) should be sealed with white lead or gasket sealer. Adjust wheel bearings as outlined in paragraph 18.

All Single Wheel Tricycle

26. **RENEW WHEEL BEARINGS AND/OR SEALS.** Refer to Fig. 011 for exploded view of wheel and

To install new seals (18), first apply a thin coat of gasket sealer to outside metal rim of seals, then install seal in wheel using Oliver ST-97 or ST-145 Driver and ST-125 Mandrel or equivalent tools.

Before installing new seal wearing cups (19) on axle spindle (20) or nut (31), apply a thin coat of gasket sealer to inner surface of the cups. Install wearing cup on nut (31)

Driver or equivalent tool. Install wearing cup on spindle by carefully driving cup in place with soft wood block. Face of cup must be smooth and flat after installation.

When reassembling, bearing cone and roller assemblies and hub of wheel should be packed with one pound of No. 1 multi-purpose grease. Adjust wheel bearings as outlined in paragraph 19 when reinstalling wheel

bearings unit.

with Oliver ST-98 Wearing Cup

assembly in wheel fork.

FRONT SYSTEM (Four-Wheel Drive)

Series 1600 and 1650 tractors are available with a front drive axle which is driven from the transmission bevel pinion shaft via a transfer case and a drive shaft fitted with two universal joints. A shifting mechanism in the transfer case allows connecting or disconnecting power to the front drive axle.

All four-wheel drive tractors are equipped with power steering. All models are equipped with a Saginaw Hydramotor steering unit. Refer to POWER STEERING section for information on the Saginaw Hydramotor and the two steering cylinders.

FRONT AXLE AND CARRIER

All Models So Equipped

27. **R&R AXLE ASSEMBLY.** The complete front axle assembly can be removed from tractor as follows: Disconnect drive shaft from companion flange of differential pinion shaft. Disconnect both power steering cylinders from axle and spindle supports and lay cylinders on top of axle carrier. Remove bolts retaining axle to axle carrier, then raise tractor and roll the complete axle and wheels unit forward and away from tractor.

Note: A rolling floor jack can be placed under differential pinion shaft to keep axle from rotating as tractor is lifted from axle.

If necessary, wheels and tie-rod can now be removed and procedure for doing so is obvious.

Reinstall axle by reversing the removal procedure and be sure piston rod ends of steering cylinders are attached to steering spindle supports. Tighten the cylinder attaching bolt lock nuts until they just contact the mounting flanges. Further tightening may distort mounting flanges and cause cylinder to bind.

28. **R&R AXLE CARRIER.** To remove axle carrier, first remove the front axle as outlined in paragraph 27, then, secure steering cylinders to tractor frame. Place a rolling floor jack under axle carrier and take weight of carrier. Remove pivot pin retaining capscrews, slide pivot pins from pivot supports and lower the axle carrier from tractor. If necessary, pivot supports can be removed from tractor frame.

Bushings in axle carrier can now be renewed. Bushings are pre-sized and should not require reaming if carefully installed.

29. **OVERHAUL FRONT AXLE.** Overhaul of the front drive axle assembly will be discussed as four operations; the planet spider assembly, the hub assembly, the spindle support assembly and the differential and carrier assembly. All operations except the differential and carrier overhaul can be accomplished without removing the front drive axle from tractor. Both outer ends of axle are identical, hence, only one outer end will be discussed.

30. PLANET SPIDER. To overhaul the planet spider assembly, support outer end of axle and remove the tire and rim. Remove relief valve from center of planet spider, remove plug from wheel hub and drain oil from planet spider. Remove capscrews that retain planet spider to wheel hub and the two puller hole capscrews. Use two of the removed retaining capscrews in the puller holes to remove planet spider assembly from wheel hub.

With unit removed, remove the three pinion shaft lock pins by driving them toward center of unit as shown in Fig. 014. Remove pinion shafts and expansion plugs by driving pinion shafts toward outside of planet spider. Remove planet pinions, rollers (34 in each pinion) and thrust washers. Discard the expansion plugs. Refer to Fig. 015.

Fig. O14 — Remove pinion shaft pins by driving them inward.

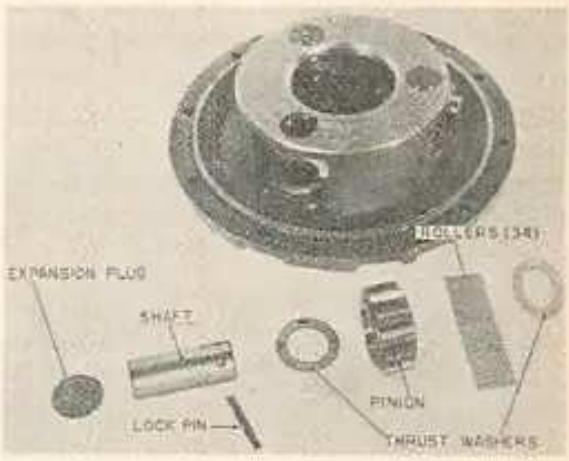


Fig. O15 — View showing one pinion assembly removed from spider.

Clean and inspect all parts and renew as necessary. Pay particular attention to the pinion rollers and thrust washers.

31. When reassembling, use heavy grease to hold rollers in inner bore of pinions. Be sure tangs of thrust washers are in the slots provided for them and that holes in pinion shaft and mounting boss are aligned

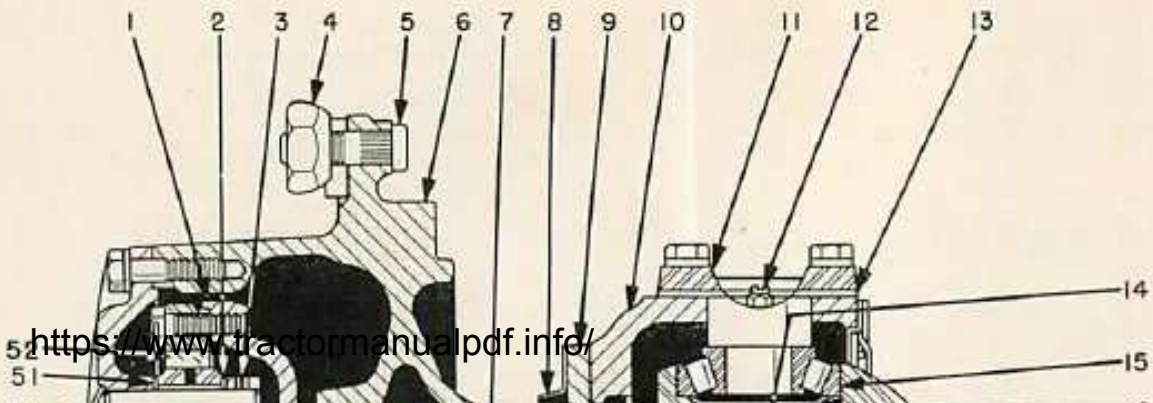


Fig. O16 — Sun gear can be removed from outer end of axle shaft after snap ring is removed. Note method of safety wiring the internal gear capscrews.

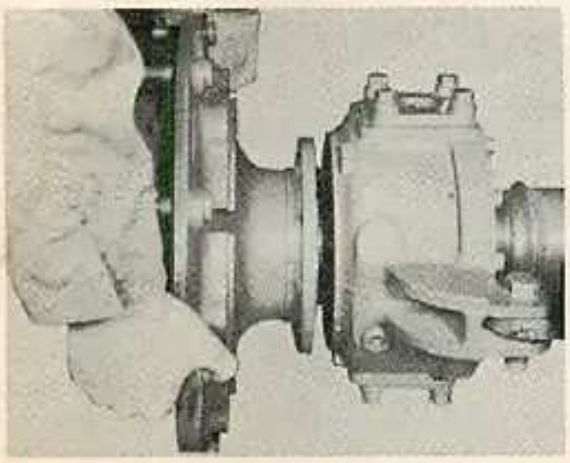


Fig. O17 — Removing wheel hub assembly from spindle support.

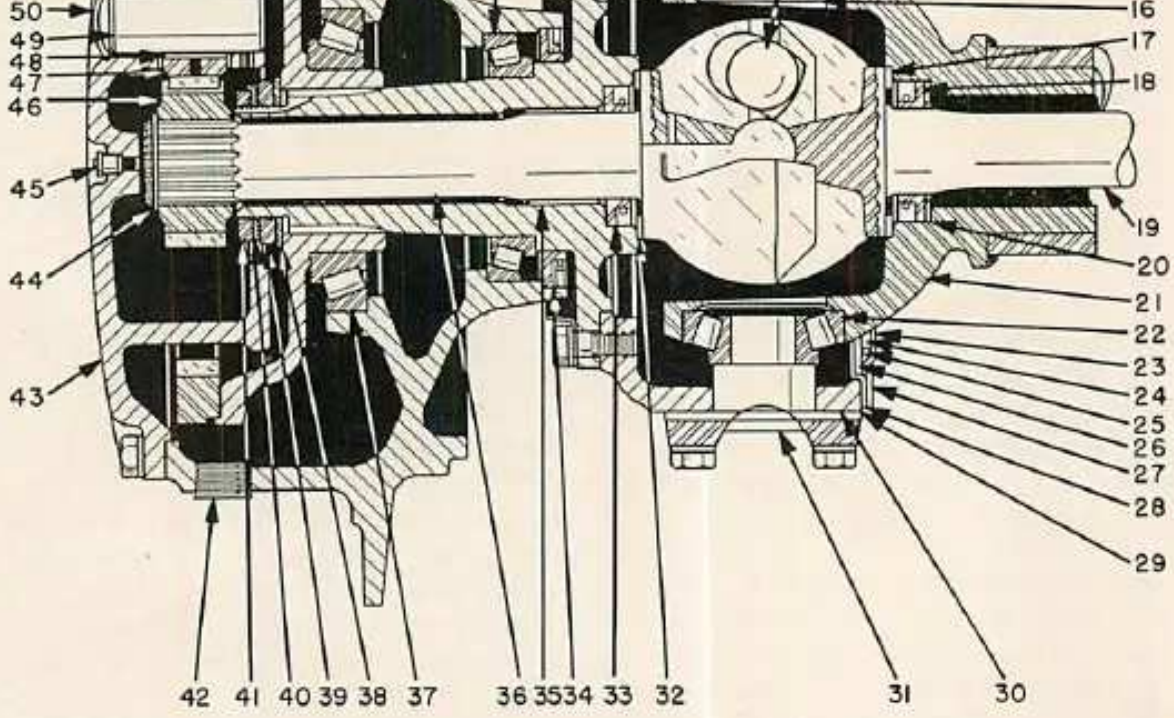


Fig. O18 — Cross-sectional view showing components of front drive axle outer end.

1. Internal gear hub
2. Thrust washer
3. Pinion shaft lock pin
6. Wheel hub
7. Hub inner bearing
8. Dirt shield
9. Spindle
10. Spindle support
11. Upper trunnion
12. Grease fitting
13. Shims
14. Universal joint
15. Upper trunnion bearing
16. Grease retainer
17. Thrust washer
18. Oil seal
19. Axle shaft (inner)
20. Washer
21. Axle housing
22. Lower trunnion bearing
23. Dust seal retainer
24. Dust seal
25. Spring
26. Felt seal
28. Seal retainer
29. Gasket
30. Shims
31. Lower trunnion
32. Thrust washer
33. Oil seal
34. Oil seal
35. Bushing
36. Axle shaft (outer)
37. Hub outer bearing
38. Thrust washer
39. Inner nut
40. Lock washer
41. Outer nut
42. Filler hole plug
43. Planet spider
44. Snap ring
45. Relief valve
46. Sun gear
47. Pinion
48. Pinion rollers
50. Expansion plug
51. Thrust washer
52. Internal gear

before pinion shafts are final positioned. Coat mating surfaces of planet spider and wheel hub with No. 2 Permatex or equivalent sealer and install planet spider in wheel hub. Tighten retaining capscrews to a torque of 52-57 Ft.-Lbs.

32. HUB ASSEMBLY. To overhaul the wheel hub assembly, first remove planet spider assembly as outlined in paragraph 30. With planet spider removed, remove snap ring and sun gear from outer end of axle shaft. See Fig. O16. If necessary, the internal gear can be removed at this time by clipping the lock wires and removing retaining capscrews. Straighten tabs of spindle nut lockwasher, then use OTC tool JD-4 or equivalent and remove spindle outer nut and lockwasher. Now loosen but **do not** remove the spindle inner nut. Unbolt spindle from spindle support and remove wheel hub assembly as shown in Fig. O17.

Place hub assembly on bench with spindle nut on top side and block up assembly so spindle will be free to drop several inches. Remove the spindle inner nut, then place a wood block over end of spindle and bump spindle from internal gear hub. Lift internal gear hub and bearing from wheel hub and be careful not to allow bearing to drop from hub of internal gear hub. Complete removal of spindle from wheel hub. All bearings and seals, thrust washers and dirt shield can now be removed and renewed if necessary. Bushing and oil seal in inner bore of spindle (items 33 and 35—Fig. O18) can also be renewed at this time.

33. Use Fig. O18 as a reference and reassemble wheel hub unit as follows: Install bearing cups (7 and 37) in hub with smallest diameters toward inside of hub. Place inner bearing in inner bearing cup, then install oil seal (34) with lip facing bearing. Bump seal into bore until it bottoms. Place dirt shield (8) on hub so flat side is toward flange of spindle, then using caution not to damage seal, install spindle in wheel hub. Hold spindle in that position and turn unit over so threaded end of spindle shaft is on top. Place outer bearing over end of spindle and push bearing down into cup. Start bearing hub of internal gear hub (1) into outer bearing cone and, if necessary, tap gear lightly with a soft faced hammer to position. Install thrust washer (38) and spindle inner nut (39) and tighten nut finger tight. Coat mating surfaces of spindle and spindle support with No. 2 Permatex or equivalent sealer and install dirt shield and spindle on spindle support. Tighten retaining capscrews to a torque of 80-88 Ft.-Lbs.

Adjust inner nut as required until a pull of 33-38 pounds on a spring scale attached to a wheel stud is required to keep hub in motion. See Fig. O19. Install lockwasher (40—Fig. O18) and outer nut (41). Tighten outer nut and recheck hub rolling torque. When adjustment is correct,

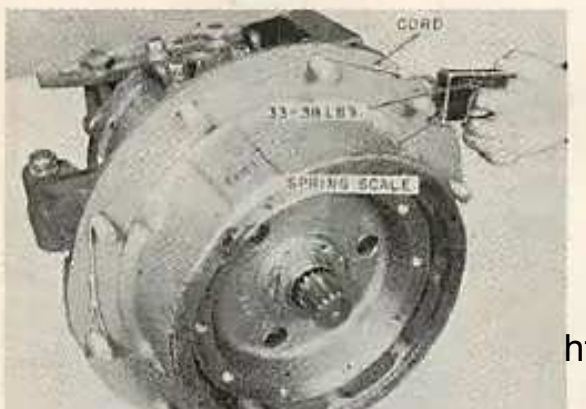


Fig. O19 — Use method shown to check wheel hub bearing preload.

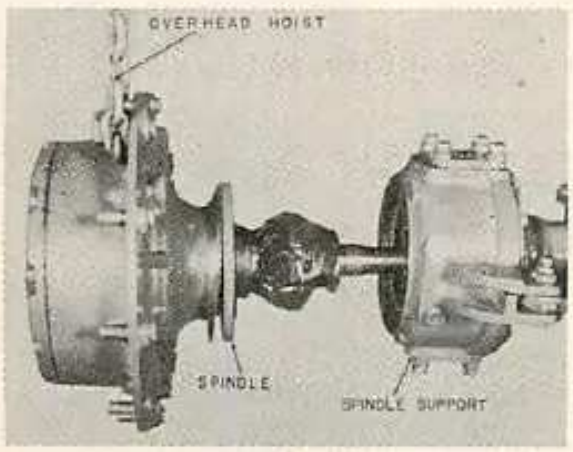


Fig. O20 — Planet spider, wheel hub and axle shaft assembly can be removed as shown.

bend tabs on lockwasher to secure both nuts. Install sun gear (46) and snap ring (44) on outer end of axle shaft. If internal gear (52) was removed, install gear so smallest outside diameter is in counterbore of internal gear hub. After retaining capscrews are tightened, secure in pairs with safety wire as shown in Fig. 016. Coat mating surfaces of wheel hub and planet spider with No. 2 Permatex or equivalent sealer and install planet spider. Tighten retaining capscrews to a torque of 52-57 Ft.-Lbs. Install the puller hole capscrews and the tire and rim.

34. SPINDLE SUPPORT. The spindle support can be serviced after planet spider and wheel hub assembly are removed as outlined in paragraphs 30 and 32. However, if service is required only on the spindle support, the planet spider, wheel hub and axle shaft can be removed as a unit as follows:

Raise outer end of axle and remove tire and rim. Attach hoist to wheel stud, then unbolt spindle from spin-

Fig. O21 — Axle outer end seals and retainers are removed from spindle support as shown.

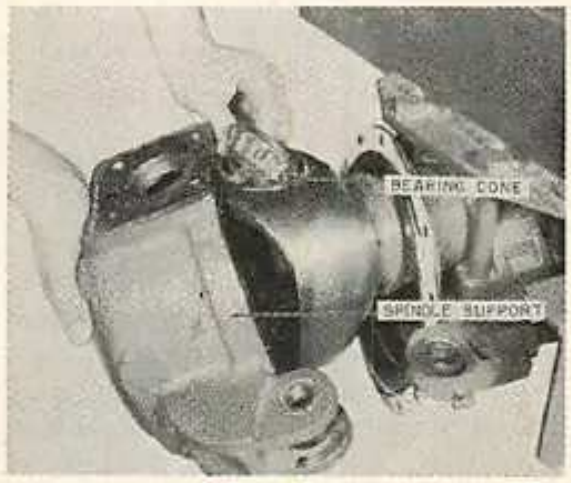


Fig. O22 — Remove spindle support from outer end of axle housing as shown.

dle support and pull complete hub assembly and axle shaft from outer end of axle. Refer to Fig. 020. **Do not** allow weight of assembly to be supported by axle shaft or damage to oil seal in axle housing outer end will result.

With the complete hub assembly and axle shaft removed, disconnect tie-rod and power steering cylinder from spindle support. Remove the capscrews from the two-piece retainer ring on inner side of spindle support and separate the retainers, seals and gasket from spindle support as shown in Fig. 021.

Note: At this time, it is desirable to remove the grease from cavity formed by spindle support and outer end of axle housing.

Remove upper trunnion, pull top of spindle support outward and remove spindle support from outer end of axle housing as shown in Fig. 022. Keep shims present under top trunnion tied to the trunnion for use dur-

Fig. O23 — Use a spring scale in tie-rod stud hole to check trunnion bearing adjustment.

ing reassembly. Remove upper trunnion bearing from axle housing. Remove lower trunnion, shims and bearing from spindle support. Both trunnion bearing cups and upper trunnion bearing grease retainer can now be removed if necessary. If necessary to remove axle shaft thrust washer, oil seal and oil seal washer from axle outer end, a slide hammer and puller attachment can be used. Seals (Fig. 021) on outer end of axle housing can also be removed at this time.

Clean and inspect all parts and renew as necessary. It is recommended that new seals be used during reassembly.

35. To reassemble spindle support, proceed as follows: Install axle shaft seal washer and oil seal with lip toward inside and be sure oil seal is bottomed. Install axle shaft thrust washer. Install seal components over outer end of axle housing in the following order: Inner seal retainer with step toward inside of tractor; dust seal spring, rubber dust seal and felt grease seal and be sure bevel in inside diameter of both seals is toward bell of axle outer end; outer seal retainer with step toward outside of tractor and gasket. Install grease retainer (cup side up) and upper bearing cup (smallest I.D. down) in the upper trunnion bearing bore. Bolt lower trunion to spindle support using original shims and tighten cap screws to a torque of 80-88 Ft.-Lbs. Place lower trunnion bearing over lower trunnion. Install lower trunnion bearing cup in outer end of axle housing with smallest I.D. of cup up. Place upper trunnion bearing in the upper trunnion bearing cup, then while tipping upper side of spindle support slightly outward, position spindle support over outer end of axle housing and install

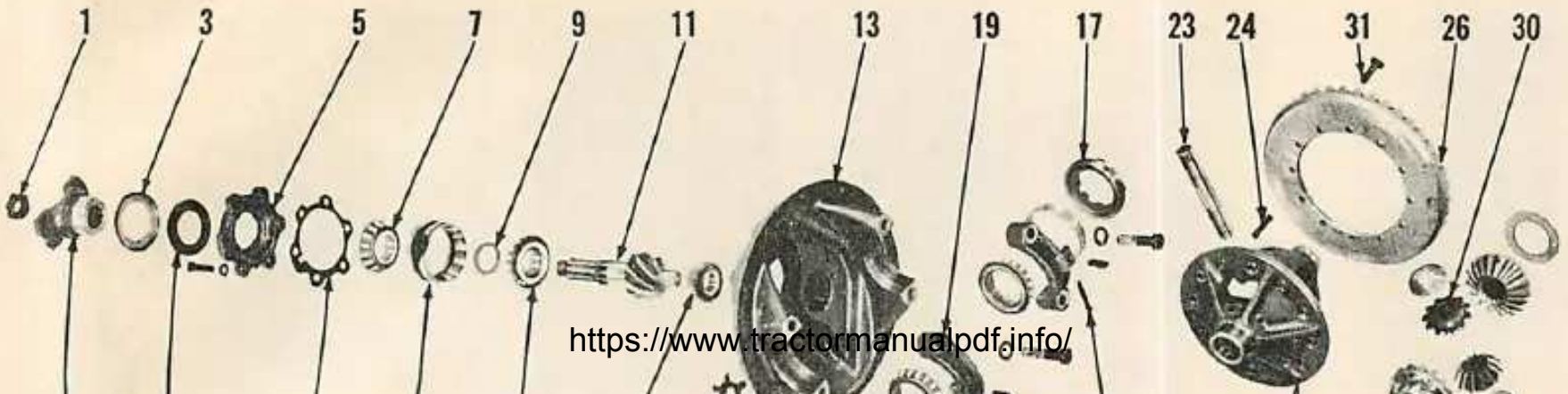


Fig. O24 — Exploded view of the differential and carrier assembly used in front drive axle of all four-wheel drive models.

1. Nut
2. Companion flange
3. Dirt shield
4. Oil seal
5. Bearing retainer
6. Gasket
7. Bearing cone
8. Bearing cup
9. Spacer and shim kit
10. Bearing cone
11. Pinion shaft
12. Pilot bearing
13. Carrier
14. Locking washer
15. Thrust screw
16. Lock nut
17. Adjusting nut
18. Bearing cup
19. Bearing cap
20. Bearing cone
21. Lock pin
22. Cotter pin
23. Pinion pin (shaft)
24. Lock pin
25. Differential case
26. Bevel ring gear
27. Thrust washer
28. Side gear
29. Thrust washer
30. Pinion gear

upper trunnion with original shim pack. Tighten trunnion retaining capscrews to a torque of 80-88 Ft.-Lbs.

Before attaching tie-rod, power steering cylinder or seal assembly to spindle support, check adjustment of trunnion bearings as follows: Connect a spring pull scale to tie-rod hole of spindle support and check pull required to rotate the spindle support. Refer to Fig. 023. Adjustment is correct when 12 to 18 pounds pull is required. To adjust bearings, vary number of shims located under the trunnions as required to obtain proper adjustment keeping the total thickness of shims under the top trunnion and lower trunnion as equal as possible. Shims are available in thicknesses of 0.003, 0.005 and 0.010.

Use grease to hold seal retainer gasket in place, then install seal assembly on spindle support, being sure that the split ends of outer seal assembly do not align. Attach tie-rod and tighten tie-rod stud nut to a torque of 200 Ft.-Lbs. Attach power steering cylinder and tighten attaching bolt lock nut until it just contacts mounting flange.

Place approximately four pounds of grease in the cavity of spindle support and pack universal joint of axle shaft. Coat mating surfaces of spindle and spindle support with No. 2 Permatex or equivalent sealer and install the planet spider, wheel hub and axle assembly on the spindle support. Tighten attaching capscrews to a torque of 80-88 Ft.-Lbs. Then, install tire and rim.

DIFFERENTIAL AND CARRIER

36. **REMOVE AND REINSTALL.** To remove the differential and carrier assembly, raise front of tractor, block axle carrier to prevent front axle assembly from rocking and remove tires and rims. Drain differential housing. Disconnect power steering cylinders and lay them on top side of axle carrier. Disconnect drive shaft from companion flange of differential pinion shaft.

Attach hoist to one of the wheel studs and take up slack of hoist. Unbolt spindle from spindle support and pull complete assembly from outer end of axle housing. Refer to Fig. 020. Remove opposite assembly in like manner.

Note: Do not allow weight of hub assembly to be supported by axle shaft or damage to oil seal in axle housing outer end will result.

Place a rolling floor jack under front axle, unbolt axle from axle carrier and lower the axle from tractor. Position axle on supports with differential pinion shaft up and secure assembly in this position with blocks. Disconnect one end of tie-rod and swing it out of way. Remove capscrews retaining differential carrier to axle housing and remove the assembly from housing.

Reinstall by reversing removal procedure and coat carrier retaining capscrews and mating surfaces of carrier and axle housing with No. 2 Permatex or equivalent sealer. Tighten capscrews to a torque of 37-41 Ft.-Lbs. Tighten tie-rod stud nut to a torque of 200 Ft.-Lbs. When joining spindle to spindle support, coat mating surfaces with No. 2 Permatex or equivalent sealer and tighten retaining capscrews to a torque of 80-88 Ft.-Lbs. Piston rod end of power steering cylinders are attached to spindle supports. Tighten cylinder attaching bolt lock nuts until they just contact mounting flanges.

37. **OVERHAUL.** With differential and carrier removed as outlined in paragraph 36, disassemble unit as follows: Straighten tab of locking washer (14—Fig. 024) and remove lock nut, locking washer and thrust screw (15). Punch mark carrier bearing caps (19) so they can be reinstalled in original position, then remove cotter pins and the adjusting nut lock pins (21). Cut lock wires and remove the carrier bearing caps. Lift differential from carrier and keep bearing cups (18) identified with their bearing cones (20). Bearing cones can now be removed from differential case if necessary. Unbolt and remove bevel ring gear from differential case if necessary to renew gear. Drive pinion pin (shaft) lock pin (24) out of differential case and remove pinion pin (23), pinions (30), side gears (28) and thrust washers (27 and 29) from differential case.

Remove cotter pin and nut (1) from pinion shaft (11), then using a puller, remove the companion flange (2) and dust shield. Remove pinion shaft

bearing retainer (5) and press pinion shaft and bearing from carrier. Use a split bearing puller to support pinion bearing cup (8) on edge nearest pinion shaft gear and press pinion shaft from rear bearing and bearing cup. Remove spacer (9) and any shims which may be present from pinion shaft. Remove front bearing and inner (pilot) bearing (12) in a similar manner.

Clean and inspect all parts. Pay A spacer and shim kit is available under Oliver part number 155 342-A.

With pinion shaft assembled and correct rolling torque (bearing adjustment) obtained, press pinion shaft assembly into carrier, install bearing retainer and tighten capscrews to a torque of 25 Ft.-Lbs. Install cotter pin to lock the nut in place .

40. Reassemble differential case assembly as follows: Place side gears,

TRANSFER DRIVE

All Models So Equipped

41. **R&R AND OVERHAUL.** To remove the transfer drive assembly, it will be necessary to split the tractor front main frame from the rear main frame. If tractor is equipped with Hydra-Power, Creeper or Reverse-O-Torc Drive, it will also be necessary to remove the engine and drive unit

particular attention to bearings, bearing cups and thrust washers. If any of the differential side gears or pinions are damaged or excessively worn, renew all gears and thrust washers. Pinion shaft and bevel ring gears are available in a matched set only.

38. The differential and carrier unit is assembled as follows: Place inner (pilot) bearing on inner end of pinion shaft and stake in four places. Use a piece of pipe the size of inner pinion shaft bearing race to press forward bearing cone (10) onto shaft with taper facing threaded end of pinion shaft. Place bearing spacer and any shims which were present during disassembly over pinion shaft, then position the bearing cup over forward bearing. Press the rear pinion shaft bearing (7) on shaft with taper away from threaded end of pinion shaft. Check and, if necessary, renew the dust shield (3) on companion flange. Position companion flange so it will not obstruct cotter pin hole in end of pinion shaft, slide bearing retainer oil seal on its land on companion flange, then press companion flange on pinion shaft. Install retaining nut, clamp companion flange in a vise and tighten nut to a torque of 300 Ft.-Lbs.

Note: Pressure of oil seal will generally hold bearing retainer away from bearing. If it does not do so, tie retainer to companion flange.

39. With pinion shaft assembled as outlined above, clamp the bearing cup in a soft jawed vise just tight enough to prevent rotation, then using an inch-pound torque wrench on companion flange retaining nut, check torque required to rotate pinion shaft. Pinion shaft bearing adjustment is correct if 13 to 23 inch-pounds is required to rotate shaft. If rolling torque is not as specified, disassemble the pinion shaft assembly and vary thickness of spacer and/or shims as required to obtain proper rolling torque.

ential case and install pinion pin (shaft). Secure pinion pin with lock pin and, if lock pin is straight type, stake pin in position. It is not necessary to stake the spring type lock pin. If bevel ring gear was removed, reinstall with bolt heads on ring gear side of assembly and tighten the nuts to a torque of 78-86 Ft.-Lbs. Press bearings on differential case with tapers facing away from case. Place bearing cups over differential bearings and place differential assembly in carrier. Position bearing adjusting nuts in carrier and install the carrier bearing caps. Tighten the bearing cap screws until caps are snug but be sure threads of caps and adjusting nuts are in register. Maintain some clearance between gear teeth and tighten adjusting nuts until bearing cups are seated and all end play of differential is eliminated. Mount a dial indicator and shift differential assembly as required to obtain a backlash of 0.008-0.011 between bevel pinion shaft and bevel ring gear. Differential is shifted by loosening one adjusting nut and tightening the opposite nut an equal amount. Note: Mesh position of the bevel pinion shaft is not adjustable.

With gear backlash adjusted, tighten the bearing cap retaining capscrews to a torque of 65 Ft.-Lbs. and secure with lock wire. Install adjusting nut lock pins and cotter pins.

Note: If lock pins will not enter slots of adjusting nuts after backlash adjustment has been made, tighten rather than loosen the adjusting nut, or nuts. Recheck gear backlash.

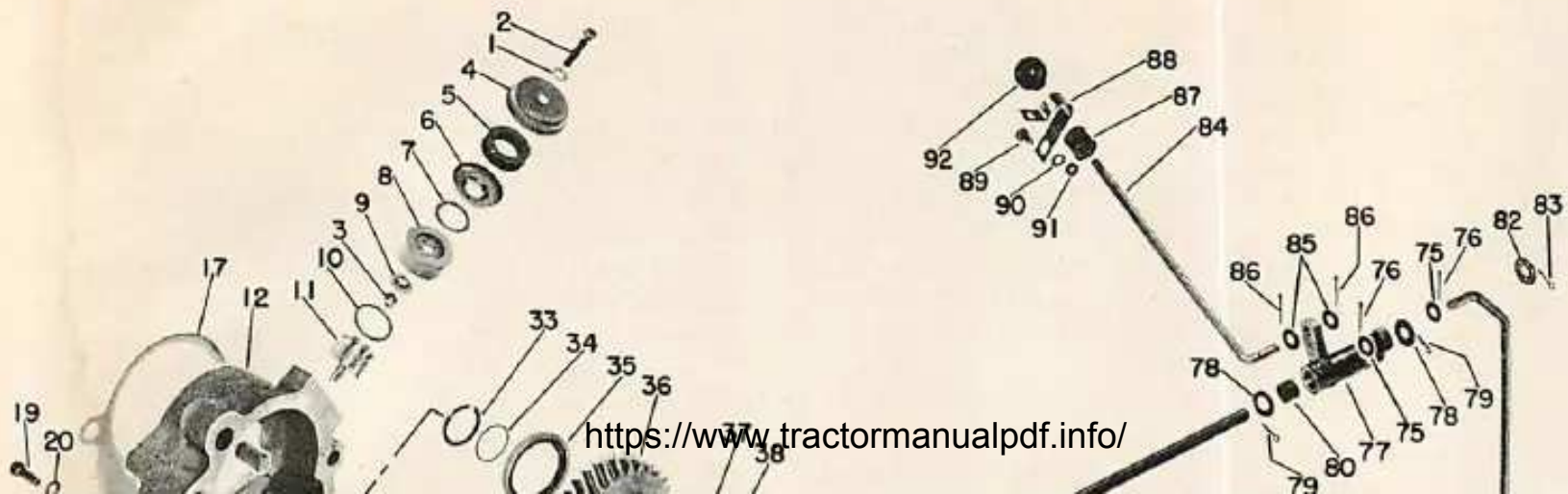
Install thrust screw and turn screw in until it contacts back side of bevel ring gear, then back screw out ¼ to ½ turn. Apply sealer to threads of thrust screw at surface of carrier, then while holding screw from turning, install locking washer and nut. Secure nut by bending one tang of locking washer over nut and another tang over boss of carrier.

before tractor can be split.

42. To split tractor equipped with Hydra-Power, Creeper or Reverse-O-Torc Drive, first remove engine and drive unit as outlined in paragraph 60, then proceed as follows: Disconnect speedometer drive cable from adapter. Disconnect shifting rod from transfer drive shifter arm and pull it from front main frame. Disconnect drive shaft from companion flange of transfer drive output shaft. Unclip and disconnect power steering oil lines. Disconnect safety starting switch wires. Disconnect rear light wires and remove clips. On non-diesel models, unhook governor control bellcrank spring. Support tractor front frame in manner which will prevent tipping, then support rear frame with rolling floor jack. Remove front frame to rear frame retaining cap screws and separate tractor.

43. To split direct drive models, proceed as follows: Remove PTO drive shaft as outlined in paragraph 221 on Series 1600 or 226 on Series 1650, or remove the hydraulic pump drive shaft as outlined in paragraph 248, if so equipped. Remove coupling chain from clutch shaft to transmission shaft. Disconnect shifting rod from transfer drive and pull it from hole in front main frame. Disconnect drive shaft from companion flange of transfer drive output shaft. Unclip and disconnect power steering lines. Disconnect rear light wires and remove clips. On non-diesel models, unhook governor control bellcrank spring. Support tractor front frame in a manner which will prevent tipping, then support rear frame with a rolling floor jack. Remove front frame to rear frame retaining capscrews and separate tractor.

44. With tractor split as outlined in paragraph 42 or 43, drain transmission and transfer housings, refer to Fig. O25 and proceed as follows: Place transmission and transfer drive in



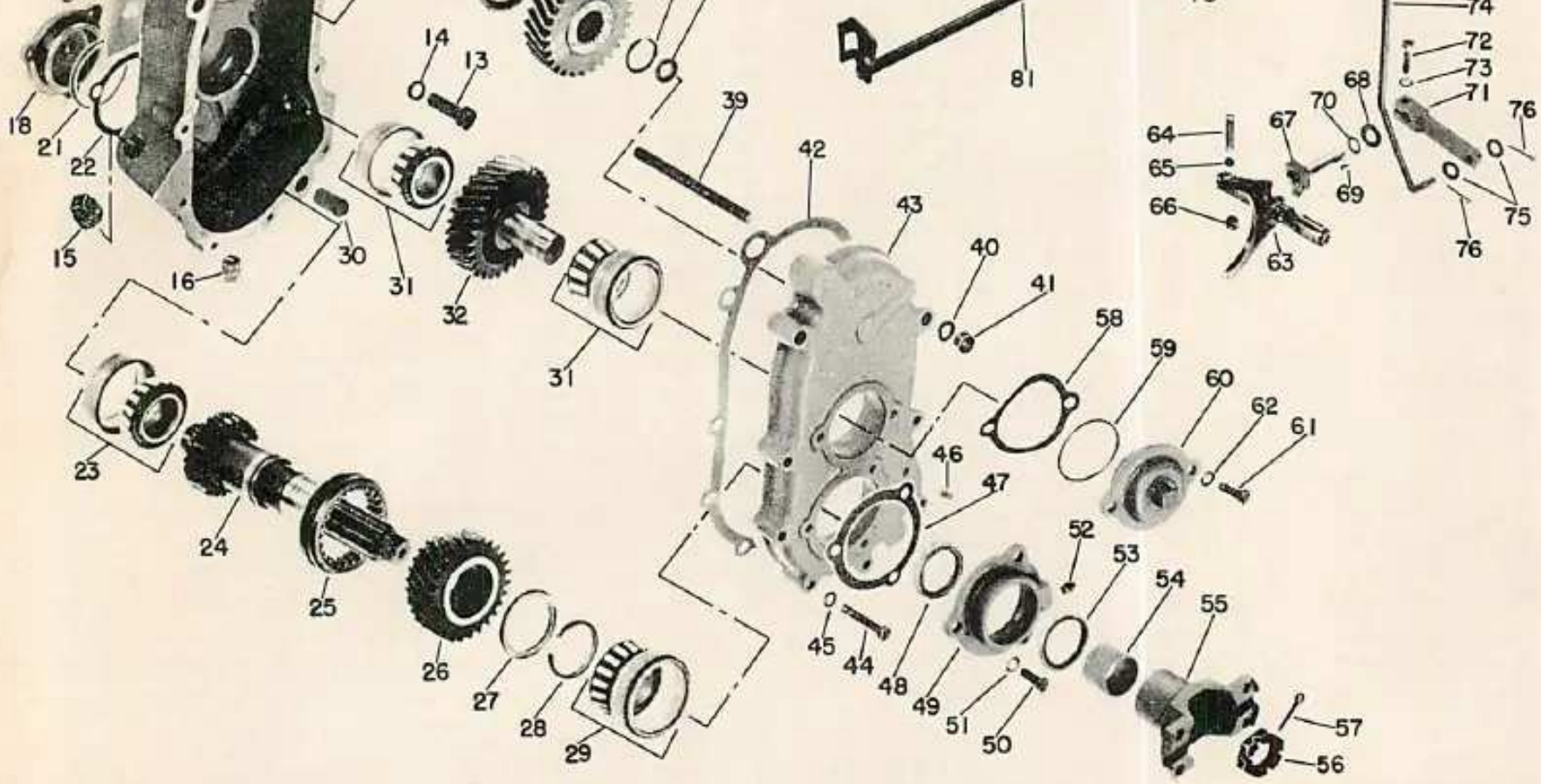


Fig. O25 — Exploded view of the four-wheel drive transfer case and shift linkage. Breather filter element (5) should be renewed yearly or after each 1000 hours of operation. Maintain oil level at plug (15) opening; drain plug is (16).

5. Breather element
7. Gasket
9. Baffle
10. "O" ring
12. Case
15. Filler plug
16. Drain plug
17. Gasket
18. Bearing retainer
21. "O" ring
22. Shim (0.004, 0.0075, 0.015)
23. Bearing
24. Shaft
25. Coupling
26. Gear (27 teeth)
27. Washer
28. Snap ring
29. Bearing
30. Dowels
31. Bearing
32. Idler gear
33. Snap ring
34. "O" ring
35. Oil seal
36. Gear
37. Snap ring
38. Seal
39. Stud bolt
42. Gasket
43. Cover
47. Gasket
48. Seal
49. Retainer
53. Seal
54. Spacer
55. Companion flange
56. Castellated nut
58. Shims (0.004, 0.0075, 0.015)
59. "O" ring
60. Retainer
63. Shift fork & rod
64. Detent spring
65. Detent ball
66. Plug
67. Actuator
69. Woodruff key
70. Seal
71. Arm
74. Shift rod
77. Pivot
80. Bushings
81. Rod
84. Rod
92. Knob

gear and to unscrew nut (56) and remove companion flange and spacer from transfer drive output shaft. Disconnect oil line from transfer drive case, then unbolt transfer drive cover (43) from case and remove cover along with idler gear (32), output gear (26) and shaft (24). Remove shifter coupling (25) from fork if necessary. Remove snap ring (37) and gear (36) from forward end of transmission bevel pinion shaft; discard snap ring. Unbolt and remove transfer case (12) from tractor rear frame. Shifter fork (63) and actuator (67) can be removed after shifter arm (71) and Woodruff key (69) are removed. Any further disassembly required will be evident. Save shims (22 and 58) located under bearing retainers (18 and 60) for reassembly.

45. Clean and inspect all parts and renew as necessary. New seals, "O" rings and gaskets should be used during assembly. The unit should be partially reassembled and the end play of idler and output shafts checked and adjusted before unit is installed on tractor rear main frame.

Install idler shaft rear bearing cup in transfer drive case and install output shaft rear bearing cup in shaft rear bearing retainer. Be sure both bearing cups are firmly seated and install output shaft rear bearing retainer (18) along with original shim pack (22). Install output shaft front bearing retainer (49) and idler shaft front bearing retainer (60) with original shim pack. Be sure both bearing cups are against the bearing retainers. Install dowels (30) in transfer case if removed. Place output shaft and idler shaft assemblies in the transfer drive case cover, then using a new gasket (42), secure cover to case. Use dial indicator to check end play of both shafts; end play should be 0.001-0.003 and is adjusted by varying number of shims under the bearing retainers. If shims are added, be sure bearing cups are seated against retainers before rechecking shaft end play.

With shaft bearings (end play) adjusted, remove cover, shafts and bearing retainers. Renew the "O" rings (21 and 59) on bearing retainers and install new oil seals as follows: Bevel pinion shaft oil seal (35) in case with lip rearward. Bevel pinion shaft seal (38) in cover with lip forward. Shift fork actuator seal (70) with lip inward. Install wide seal (48) at rear with lip facing rearward and the narrow oil seal (53) at front with lip facing forward in the output shaft front bearing retainer.

Coat all seals and "O" rings with grease prior to installation and fill cavity between the two seals in output shaft front bearing retainer with grease.

Reassemble unit by reversing the disassembly procedure. Renew the "O" ring on bevel pinion shaft front bearing retainer and install case with new gasket (17). Use a new snap ring (37) and "O" ring (34) when installing drive gear (36) on transmission bevel pinion shaft. Use heavy grease on sliding coupling (25) to hold it in position in shifter fork. When installing companion flange (55), be sure not to obstruct cotter pin hole.

DRIVE SHAFT

All Models So Equipped

46. The front axle drive shaft is of conventional design. Removal and overhaul procedure is evident after examination of unit. Spider and bearing assemblies are available as units only. All other parts are available separately.

When installing drive shaft, yoke end is installed to rear.

POWER STEERING

All Models So Equipped

47. All models having power steering utilize a Saginaw Steering Gear Hydramotor unit which, in direct relationship to turning the steering wheel, directs pressurized fluid in metered amounts to actuate the front wheel steering cylinder. (Two steering cylinders are used on four-wheel drive models.)

On models not equipped with a hydraulic lift system, pressure for the power steering system is supplied by a belt driven gear type pump mounted at front end of engine, and a separate power steering fluid reservoir is mounted on top of engine.

On models equipped with a hydraulic lift system, hydraulic fluid is utilized as the power steering fluid and pressure for the power steering system is supplied by the hydraulic pump via a flow divider valve mounted on the hydraulic lift housing.

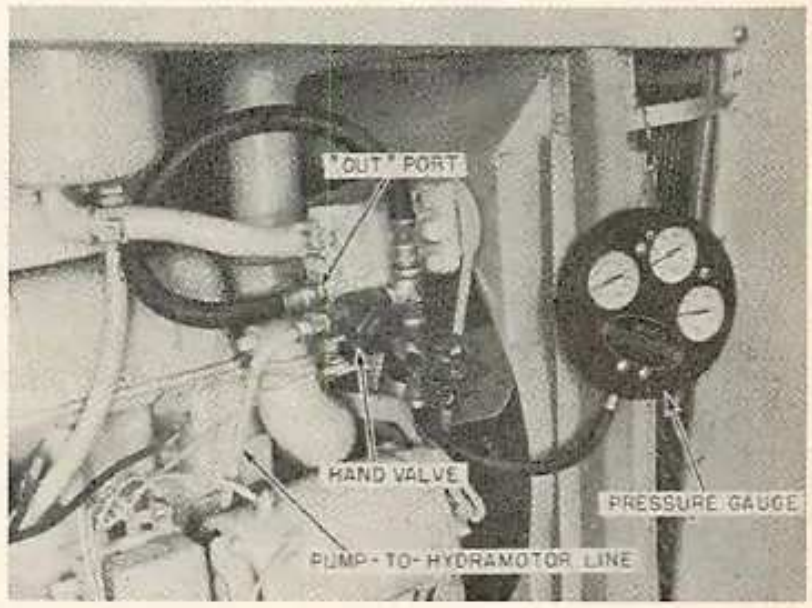


Fig. O26 — View showing test gage and shut-off valve installed in pump to hydramotor pressure line. Note that gage is installed between pump and shut-off valve.

LUBRICATION (FLUID) AND BLEEDING

All Models

48. On models not equipped with a hydraulic system, power steering fluid reservoir is located on a bracket attached to engine rocker arm cover retaining bolts and reservoir filler pipe extends through opening in engine hood. Maintain fluid level at "FULL" mark on dipstick attached to reservoir filler cap. Recommended power steering fluid is SAE 10W Supplement 1 motor oil or "Type A" automatic transmission fluid.

On models with hydraulic lift system, refer to paragraph 233.

Steering system is self-bleeding and any air trapped in lines, cylinder or Hydramotor should be eliminated by turning steering wheel to move steering cylinder, or cylinders, through full range of travel several times in each direction.

SYSTEM PRESSURE TEST

All Models

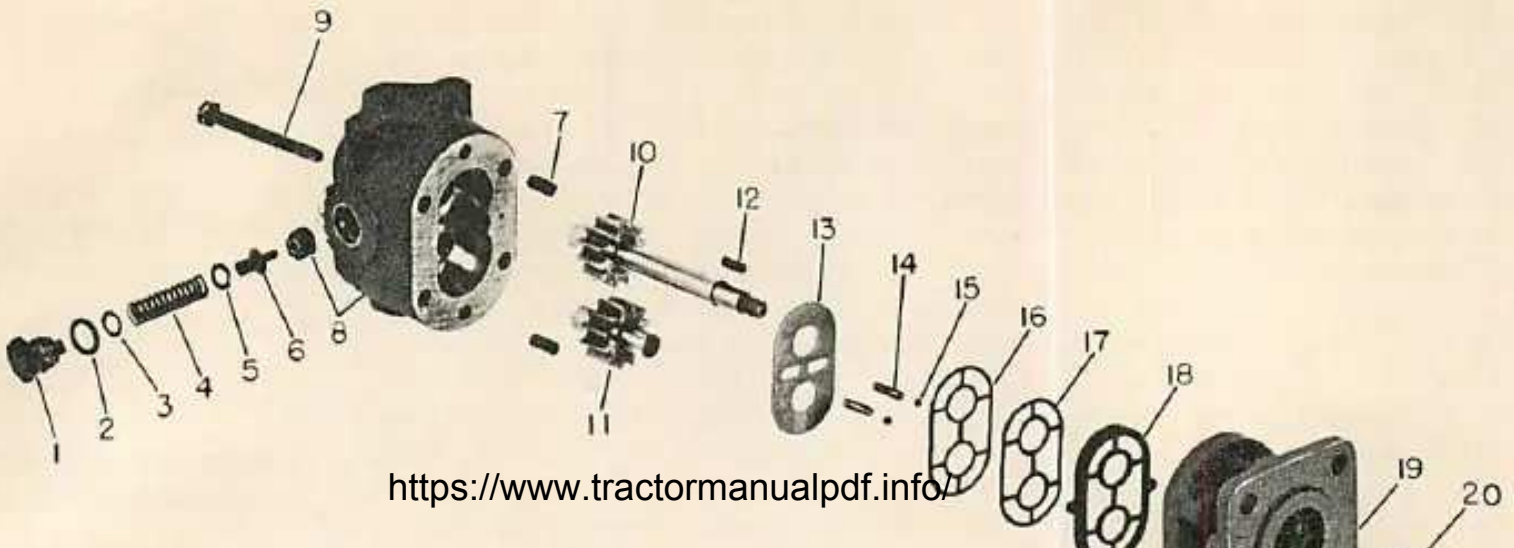
49. On models with hydraulic lift system, refer to paragraph 243. On models without a hydraulic lift system, proceed as follows:

Install a pressure gage (2000 psi capacity) as shown in Fig. O26. With power steering fluid at operating temperature and the test gage valve open, turn steering wheel in either direction until the steering cylinder, or cylinders, are at extreme end of travel and hold the steering wheel in this position only long enough to observe pressure gage reading.

Maximum allowable pump relief pressure is either 1200 psi or 1600 psi, depending on whether tractor is equipped with early type single vane Hydramotor as shown in Fig. O29, or late type dual vane Hydramotor as shown in Fig. O37. The late type dual vane Hydramotor is factory installed on all 1650 models and 1600 models after approximate serial No. 141 288-000, and may be installed on 1600 models prior to serial No. 141 288-000 as a field installation.

Factory setting for power steering pump relief valve pressure was 1000-1100 psi prior to tractor serial No. 147 695-000 and 1500-1600 psi after this serial number on 1600 model tractors; factory setting for all 1650 model tractors is 1500-1600 psi. To improve steering performance, it is recommended that the pump relief pressure be increased to 1200 psi for tractors equipped with early type Hydramotor, and to 1500-1600 for all tractors equipped with late type Hydramotor. CAUTION: Do not adjust pump relief pressure to above 1200 psi if tractor is equipped with Hydra-

1. Plug
2. "O" ring
3. Thin shims
4. Spring
5. Thick shim
6. Valve poppet
7. Pins
8. Rear plate & valve seat assy.
9. Capscrews
10. Drive shaft & gear assy.
11. Idler gear & shaft assy.
12. Key
13. Diaphragm
14. Springs
15. Check valve balls
16. Backup gasket
17. Protector gasket
18. Diaphragm seal
19. Front plate



20. Shaft seal

Fig. O27 — Exploded view of power steering pump used on all models not equipped with hydraulic lift system. Pressure relief is adjusted by varying number of thin shims (3); a thick shim (5) is located between spring (4) and valve poppet (6).

motor having separate steel pivot bracket as shown in Fig. O29, or to above 1600 psi on tractors equipped with late type Hydramotor as shown in Fig. O37.

If pressure is less than specified, check pump by closing the shut-off valve (see Fig. O26) only long enough to obtain a reading. If pressure is now approximately that specified, the pump can be considered satisfactory and the trouble is located in the power steering unit. If pump relief pressure remains the same as when checked with shut-off valve open, readjust pump relief pressure as follows:

Remove plug (1—Fig. O27) from pump and add or remove thin shims (3) to effect minor change in pump relief pressure; adding or removing one shim should change relief pressure approximately 75 psi. To change pump relief pressure from the 1000-1100 psi range to the higher 1500-1600 psi setting, a conversion package is available. The package includes six adjusting shims (3), a heavier relief valve spring (4), a different spacer shim (5), a heavy duty pump drive belt and a plug sealing "O" ring (2).

If pump relief pressure cannot be satisfactorily increased by adding shims, remove and overhaul the pump assembly as outlined in paragraph 50.

PUMP

Models Without Hydraulic Lift

50. **R&R AND OVERHAUL.** Remove hood right panel, disconnect pump to reservoir hose to drain reservoir and disconnect Hydramotor pressure tube at pump. Unbolt pump and mounting bracket from support and remove assembly from tractor.

Prior to disassembly, thoroughly clean exterior of pump and scribe assembly marks across mounting bracket, front plate (19—Fig. O27) and back plate (8). Remove pulley retaining nut, pulley and key (12) from pump drive shaft and remove mounting bracket from front plate. Remove back plate retaining cap-screws (9) and bump end of drive shaft against wood block to separate the back plate from the front plate. Remove gear and shaft assemblies (10 and 11), diaphragm (13), gaskets (16 and 17), diaphragm seal (18), check springs (14) and check balls (15) from front plate. Using suitable tool, remove drive shaft seal (20). Remove plug (1) and relief valve components (2, 3, 4, 5 & 6) from back plate.

Thoroughly clean, dry and inspect all parts. Drive shaft and gear assembly (10) or idler gear and shaft assembly (11) should be renewed if shaft bearing diameter measures less than 0.4360, or gear width measures less than 0.566. (Gears are not renewable separately from shafts, although one gear and shaft assembly may be renewed without renewing the other.) Remove minor burrs from gear teeth with fine emery cloth.

Renew back plate if gear pocket diameter exceeds 1.1695, or wear at bottom of gear pocket is more than 0.001. Renew the back plate and/or front plate if bushing inside diameter is more than 0.4375. Back plate and relief valve seat (8) are available as an assembly only; renew back plate if seat is excessively worn or damaged. Relief valve components (items 1 through 6) are available as a repair kit which includes pins (7), or are available separately.

Fig. O28 — Install diaphragm with bronze side up and grooves towards low pressure side of pump as shown.

Reassemble as follows: Using a dull pointed tool, tuck diaphragm seal (18) into grooves in front plate with open part of "V" sections down. Drop the steel balls (15) into their bores and insert springs (14) on top of balls. Install protector gasket (17) and backup gasket (16) into diaphragm seal and install diaphragm over backup gasket with bronze face up and grooves toward low pressure side of pump as shown in Fig. O28. Install gear and shaft assemblies (10 and 11 —Fig. O27) in bores of front plate. Apply thin coat of heavy grease to milled faces of rear plate and front plate and install rear plate to front plate with previously affixed scribe marks aligned. Install retaining cap-screws and tighten to torque of 7-10

Ft.-Lbs. Lubricate lip of seal (20), work seal over the drive shaft with lip inward and then drive the seal into front plate with suitable tools. Install relief valve poppet (6), thick shim (5), spring (4) and plug (1) with new "O" ring (2) and same number of thin (adjusting) shims as were removed. Install mounting bracket to front plate with previously affixed scribe marks aligned, then install key, pulley and pulley retaining nut.

Reinstall pump on tractor with test

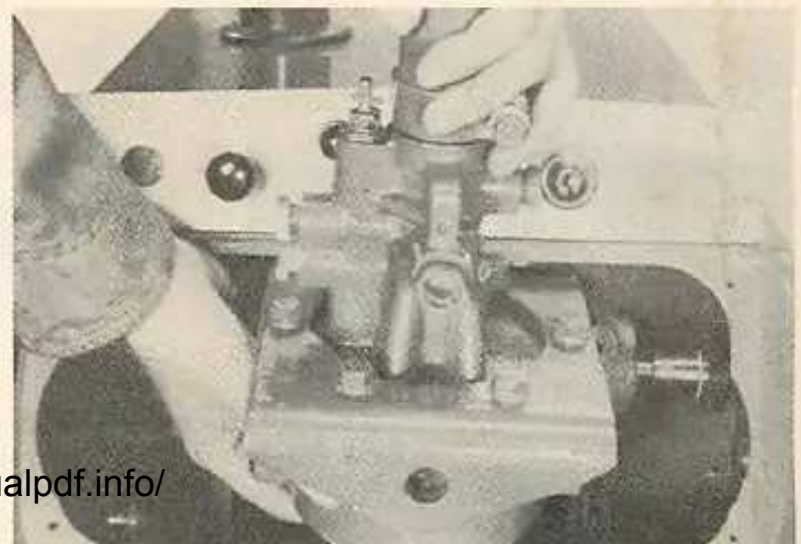


Fig. O30 — Removing early production type Hydramotor unit out through instrument panel opening.

gage and shut-off valve installed as shown in Fig. O26, fill reservoir with proper fluid and, if necessary, adjust pump relief pressure as outlined in paragraph 49.

HYDRAMOTOR STEERING UNIT

Except for production changes, the Hydramotor steering units used on all tractor models are alike. Early production Hydramotor steering units were fitted with a separate steel pivot (mounting) plate and have a maximum working pressure of 1200 psi. Late production units have pivot holes in the unit cover casting and have a maximum working pressure of 1600 psi. Service on both the early and late production units is similar; any differences will be noted in the following text.

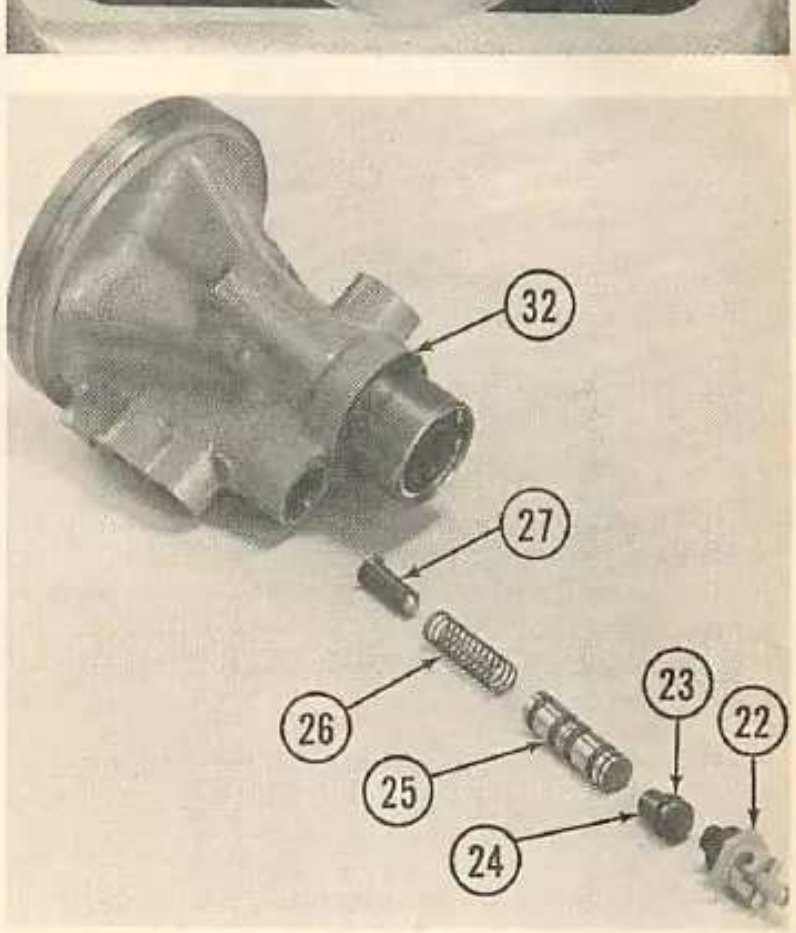


Fig. O31—Exploded view of Hydramotor housing and blocking valve components. Blocking valve can be removed without disassembling Hydramotor steering unit.

22. Lockout
23. "O" ring
24. Plug
25. Valve spool
26. Spring
27. Spring & guide assy.
32. Housing

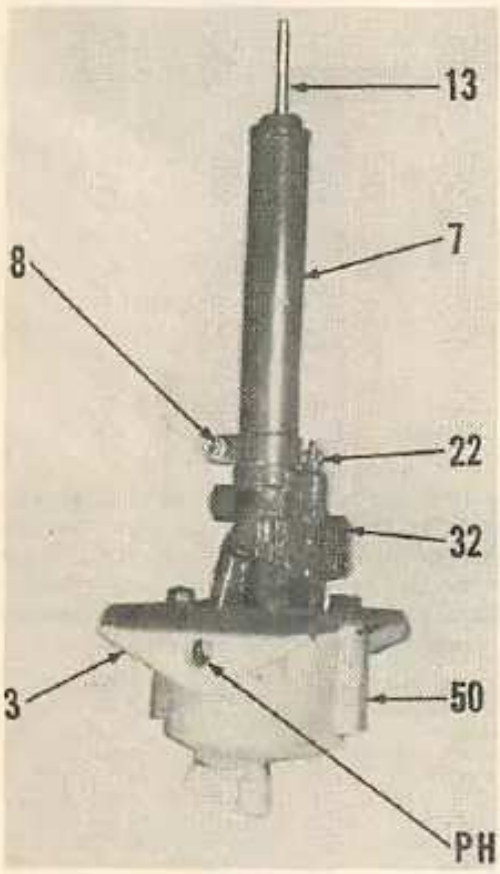


Fig. O29 — View of early production Hydramotor steering unit removed from tractor. Pivot holes (PH) for unit are in separate steel bracket (3), while pivot holes for late production units are in the cover (50) casting; see (PH—Fig. O37).

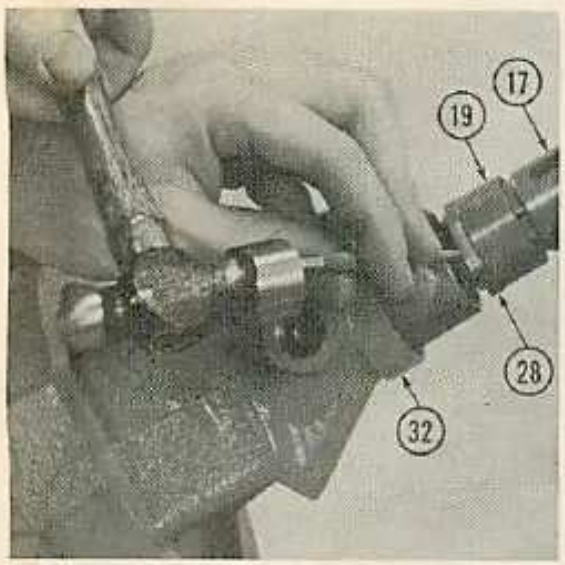
PH. Pivot holes
3. Pivot bracket
7. Column jacket
8. Jacket clamp
13. Adjuster bolt
22. Blocking valve lockout
32. Housing
50. Cover

All Models

51. **R&R HYDRAMOTOR STEERING UNIT.** First, disconnect the battery ground strap, then proceed as follows: Remove emblem from steering wheel adjuster lock knob, unscrew jam nut and the lock knob from adjuster bolt, remove flat washer from bolt and then pull steering wheel and inner shaft from steering column. Remove control panel hood and the instrument panel retaining screws; then, disconnect tachourmeter cable, snap-out the instrument panel lights, disconnect wiring from gages and remove the instrument panel. Loosen the outer nuts on steering column clamp and remove instrument panel slot "door" from column. Tag the four Hydramotor hoses for ease in reconnecting same, then disconnect hoses from unit and immediately cap all openings.

On late production units, loosen pivot pin lock nuts and unscrew the pivot pins until clear of the Hydramotor cover casting. Then, lift the unit out from opening in instrument panel support.

On early production units, drive the spring (roll) pin from governor control shaft arm, remove control shaft nut from steering unit R. H. support and pull control shaft from arm and the L. H. steering unit support. Be careful not to lose bushing from L. H. support as shaft is withdrawn. Loosen lock nuts on pivot pins and unscrew the pins until they are clear of the Hydramotor pivot bracket. Lift Hydramotor, turn it ¼-turn counter-clockwise, slip pivot bracket over front of the instrument panel opening and lift unit up out of opening as shown in Fig. O30.



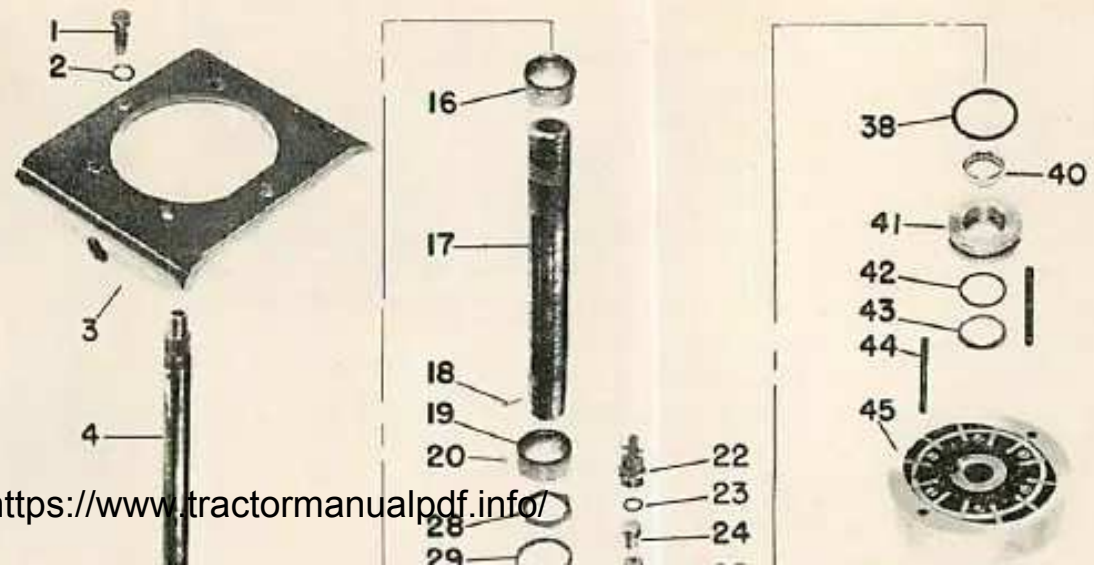


Fig. O32 — After installing steering shaft on Hydramotor stub shaft, stake hex nut to slot in steering shaft (17) with center punch.

17. Outer shaft
19. Tapered collar
28. Hex nut
32. Housing

Reverse removal procedures to reinstall either the early or late production unit. On models without hydraulic system, refill power steering reservoir as outlined in paragraph 48.

52. **R&R BLOCKING SPOOL VALVE.** The blocking spool valve and related parts can be removed and reinstalled after the Hydramotor steering unit has been removed as outlined in paragraph 51. Refer to Fig. O31 and proceed as follows:

Remove the lockout adjuster nut (22). Plug (24) and spool valve (25) may now be removed by pushing the plug into bore against spring pressure with screwdriver or other tool, then quickly releasing the plug to allow spring to pop it out of the bore. Remove plug and, if spool sticks in bore, invert the unit and tap housing (32) with soft faced mallet to jar spool out. Invert unit and allow spring (26) and the spring and guide assembly (27) to drop from bore.

If spool (25) is excessively worn or badly nicked, it should be renewed. A brightly polished wear pattern is normal. Spool should slide and rotate freely in bore.

To reassemble, install parts in bore of housing (32) as shown in exploded view, renewing the "O" ring (23) on plug (24) and tightening adjuster nut to a torque of 10-15 Ft.-Lbs.

53. **R&R STEERING COLUMN JACKET AND SHAFT ASSEMBLIES.** With Hydramotor unit removed as outlined in paragraph 51, proceed as follows:

Loosen clamp (8—Fig. O33) and pull column jacket assembly (7) from control valve housing (32). Hold steering shaft with large screwdriver inserted through slot in outer shaft (pull adjuster bolt up out of way) and unscrew the hex nut (28) until it nearly contacts control valve housing. Drive the tapered collar (19) towards nut until collar is loose, then turn collar until hole in collar is over locking ball hole in outer shaft (17),

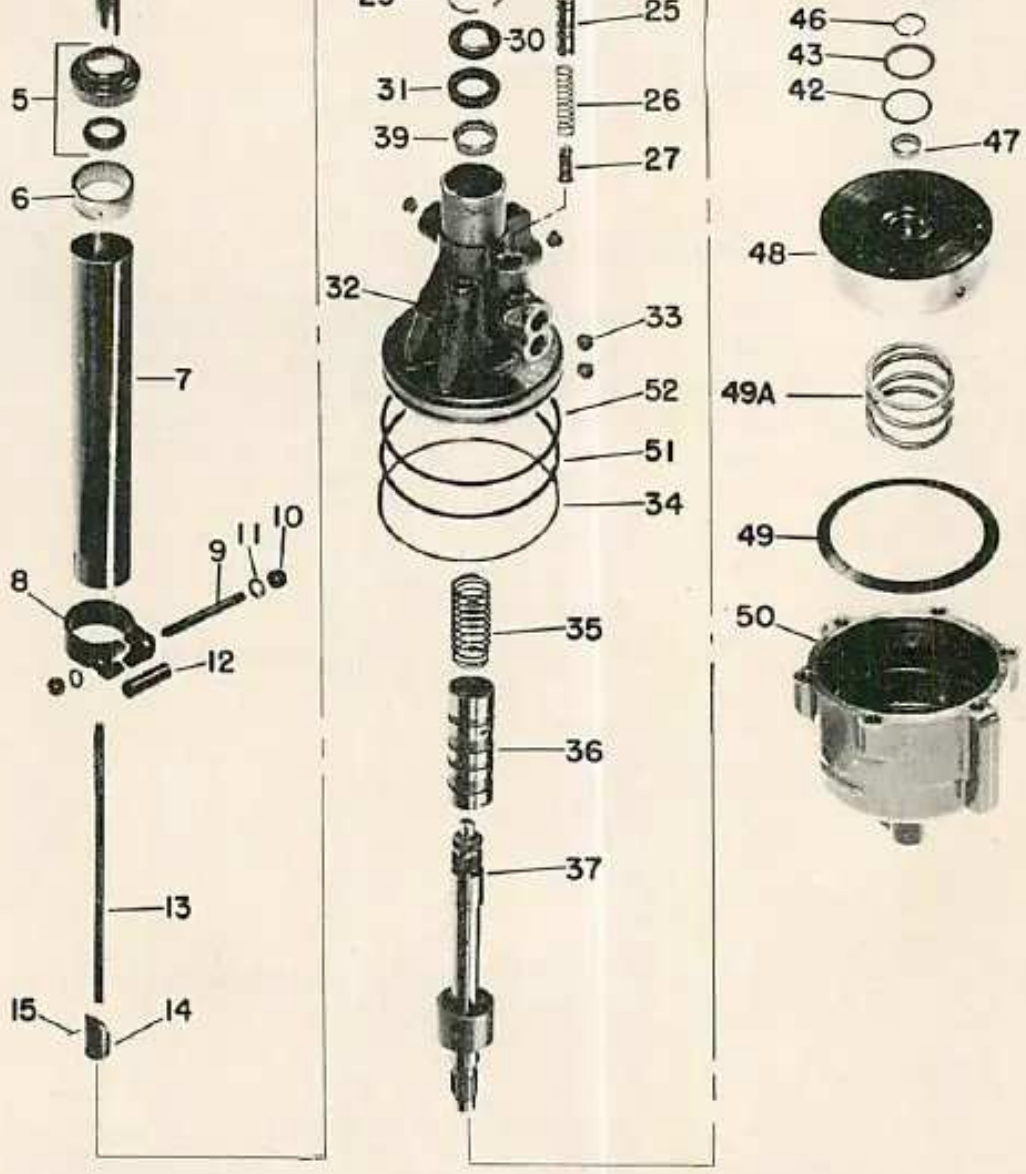


Fig. O33 — Exploded view of composite early and late production Hydramotor steering unit. On early production units, cover (50) is retained to housing (32) by pivot bracket (3) and capscrews (1); "O" ring (51) is located in groove of housing and a Belleville washer (49) pressure plate spring is used. On late production models, cover is retained to housing by snap ring (52); "O" ring (51) and backup ring (34) are located in groove in I.D. of cover and a coil type pressure plate spring (49A) is used.

3. Pivot bracket
4. Inner shaft
5. Dust cap & scraper
6. Needle bearing (not serviced)
7. Column jacket
8. Jacket clamp
12. Spacer
13. Adjuster bolt
14. Adjuster nut
15. Pin
16. Bearing race (not serviced)
17. Outer shaft
18. Pin
19. Tapered collar
20. Locking ball
22. Lockout assembly
23. "O" ring
24. Plug
25. Valve spool
26. Spring
27. Spring & guide assy.
28. Hex nut
29. Snap ring
30. Dust seal
31. Oil seal
32. Housing
33. Connector seats
34. Backup ring
35. Spring
36. Valve spool
37. Stub shaft assembly
38. "O" ring
39. Needle bearing
40. Needle bearing
41. Bearing support
42. "O" rings
43. Teflon seals
44. Dowel pins
45. Pump ring & rotor assy.
46. Snap ring
47. Needle bearing
48. Pressure plate
49. Spring (early production)
49A. Spring (late production)
50. Cover (early production shown)

then shake the ball (20) out of hole. The outer shaft, tapered collar, hex nut and adjusting bolt (13) with nut (14) can then be removed from the stub shaft (37).

If necessary to disassemble the steering shaft or column jacket assemblies, procedure for doing so is obvious. When installing new needle bearing (6), drive or press on lettered side of bearing cage only. Bearing race (16) is used on early production units only. Reassemble the unit before reinstalling on stub shaft as follows:

Engage splines of outer shaft on splines of stub shaft being sure that locking ball hole in outer shaft is away from flat on stub shaft. Align hole in tapered collar, hole in stub shaft and groove around the stub shaft, then drop locking ball in hole and groove and turn tapered collar ¼-turn. Tighten the hex nut to a torque of 20-30 Ft.-Lbs. and stake nut into slot in outer shaft as shown in Fig. O32.

Early Production Hydramotor Units

54. **R&R PIVOT (MOUNTING) BRACKET.** The pivot bracket (3—Fig. O33) retains cover (50) to control valve housing on early production Hydramotor units. With unit removed from tractor as outlined in paragraph 51, the pivot bracket can be removed as follows: Loosen capscrews (1) retaining pivot plate to cover and remove all the capscrews except the one where interference with control valve housing is encountered. Bump pivot plate loose and rotate the control valve housing within the cover so that remaining capscrew can be removed. Then remove the pivot plate. For further service, clamp the Hydramotor unit in vise as shown in Fig. O37 and refer to paragraph 56.

Reinstall pivot plate by reversing removal procedure. Tighten the plate retaining capscrews to a torque of 45-60 Ft.-Lbs.

Late Production Hydramotor Units

55. **R&R COVER RETAINING SNAP RING.** On late production units, a snap ring (52—Fig. O34) is used to retain cover (50) to control valve housing (32). To remove the snap ring, first remove unit from tractor as outlined in paragraph 51, then proceed as follows: If end gap of snap ring is not near hole in cover as shown, bump the snap ring into this position with hammer and punch. Insert a pin or punch into hole and drive pin or punch inward to dislodge snap ring end from groove. With the pin or punch under the snap ring, use screwdrivers to pry ring from cover. After removing the snap ring, place Hydramotor unit in vise as shown in Fig. O37 and refer to paragraph 56 for further service procedure.

Fig. O34—To remove cover (50) retaining snap ring (52) on late production units, drive pin or punch through hole in cover (dotted lines) to disengage snap ring in groove. Housing is (32).

Fig. O35 — In event coil pressure plate spring does not push cover from housing, tap around edge of cover with soft faced mallet.

NOTE: Usually, spring (49A—Fig. O33) will push control valve housing from cover. However, if burrs or binding condition exists, it may be necessary to bump cover loose by tapping around edge of cover with mallet as shown in Fig. O35.

Fig. O36 — To reinstall cover retaining snap ring (52), place unit in arbor press and push housing (32) into cover (50) with sleeve as shown.

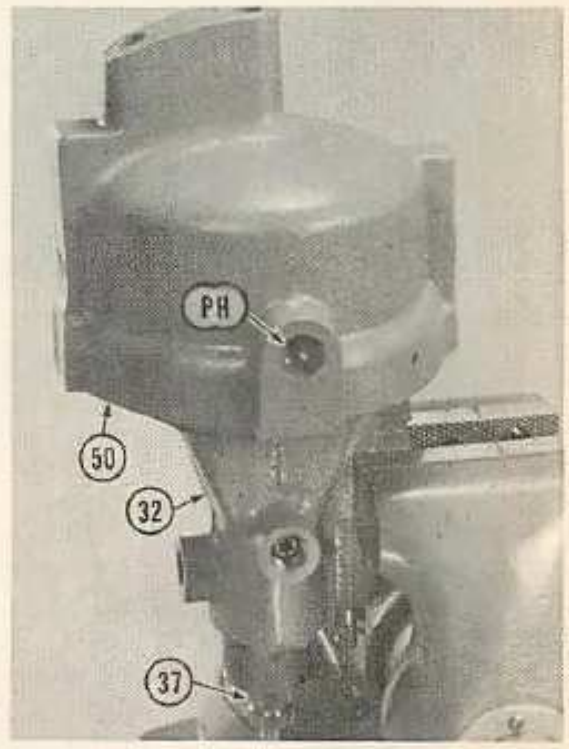


Fig. O37 — Late production Hydramotor mounted in vise for overhaul. Note pivot hole (PH) in cover (50).

PH. Pivot holes
32. Housing
37. Stub shaft
50. Cover

To reinstall the cover retaining snap ring, control valve housing must be held in cover against pressure from spring (49A—Fig. O33). It is recommended that the unit be placed in an arbor press and the housing be pushed into cover by a sleeve as shown in Fig. O36. CAUTION: **Do not** push against end of stub shaft (37—Fig. O37). Place snap ring over housing before placing unit in press. Carefully

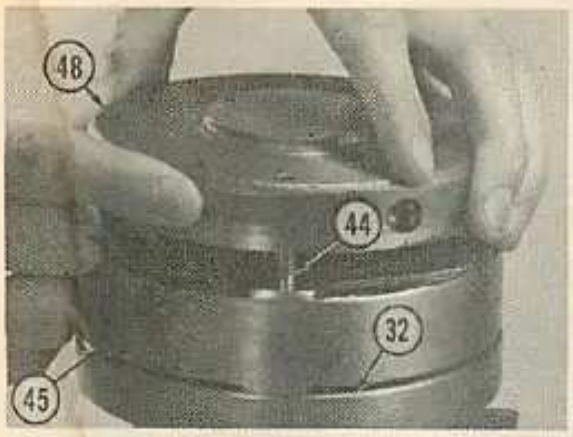


Fig. O38 — Removing pressure plate (48) from dowel pins (44).

32. Housing
44. Dowel pins
45. Pump ring & rotor assy.
48. Pressure plate

Fig. O40 — Lifting the pump ring and rotor

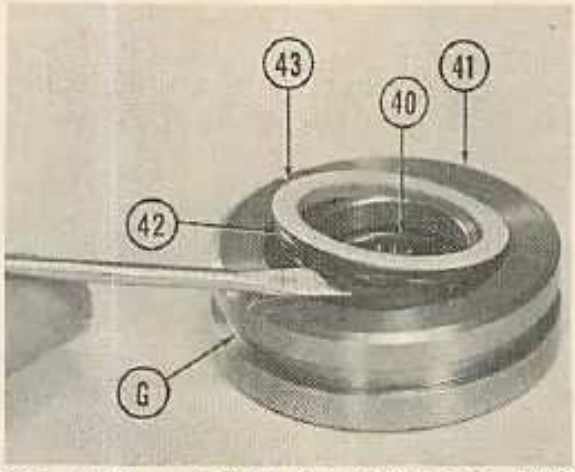


Fig. O42 — Lifting the Teflon seal (43) and "O" ring (42) from bearing support (41). Needle bearing (40) is serviced separately. Install new "O" ring in groove (G)

Fig. O40 — Lifting the pump ring and rotor assembly (45) from stub shaft (37) and housing (32). Bearing support is (41).

before installing bearing support. Identical seals (42 and 43) are used in pressure plate.

Fig. O39 — Removing dowel pins (44) from pump ring and rotor assembly (45) and housing (32). Discard snap ring (46) after it is removed from stub shaft (37) and install new snap ring on reassembly.

apply pressure on housing with sleeve until flange on housing is below snap ring groove in cover. Note that lug on housing must enter slot in cover. If housing binds in cover, do not apply heavy pressure; remove unit from press and bump cover loose with mallet as shown in Fig. O35. When housing has been pushed sufficiently far into cover, install snap ring in groove with end gap near hole in cover as shown in Fig. O34.

All Models

56. **OVERHAUL HYDRAMOTOR STEERING UNIT.** With steering shaft and column unit removed as in paragraph 53 and the pivot bracket or cover retaining snap ring removed as outlined in paragraph 54 or 55, proceed as follows:

Remove cover (50—Fig. O37) by pulling upward with twisting motion. Remove the pressure plate spring,

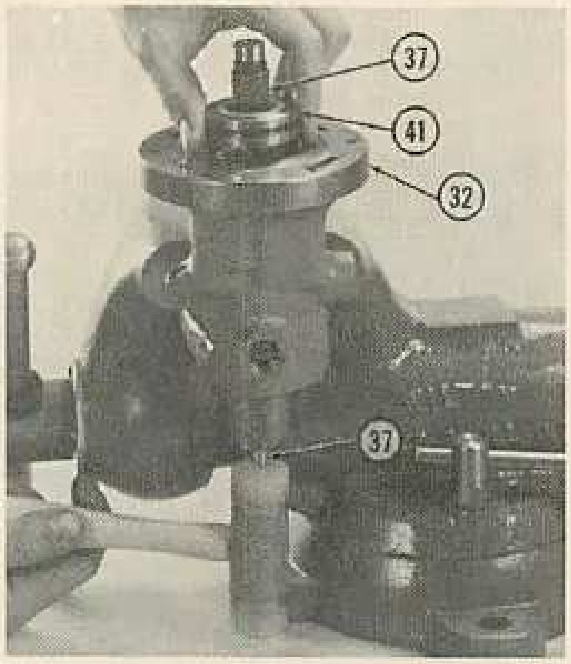


Fig. O41 — Tap on end of stub shaft (37) with soft faced mallet to bump bearing support (41) out of housing.

then lift off pressure plate as in Fig. O38. Remove dowel pins as in Fig. O39, then remove snap ring (46) from stub shaft (37) with suitable snap ring pliers and screwdriver; discard snap ring. Pull pump ring and rotor assembly (45) up off of stub shaft as shown in Fig. O40. Tap end of stub shaft with soft faced mallet as shown in Fig. O41 until bearing support (41) can be removed, then carefully remove actuator assembly from housing as shown in Fig. O43. Note: It is recommended that the actuator assembly not be disassembled as it is a factory balanced unit and serviced as an assembly only.

Housing (32—Fig. O33), blocking valve spool (25) and actuator assembly, which includes spring (35), spool (36) and stub shaft assembly (37) are serviced as a matched set only. If these parts are otherwise serviceable,

Fig. O43 — Removing the actuator assembly (stub shaft and control valve spool) from housing. Be careful not to cock spool in bore of housing.

needle bearing (39), seals (30 and 31), connector seats (33) and blocking valve components except the valve spool (25) may be renewed as necessary. Install new needle bearing (39) by pressing on lettered side of bearing cage only until bearing cage is flush with counterbore. Connectors (33) may be removed by threading inside diameter with tap as shown in Fig. O44, then removing connector with puller bolt. Refer to paragraph 52 for information on blocking valve unit.

Needle bearings (40 and 47—Fig. O33) in bearing support (41) and pressure plate (48) may be renewed if support and/or plate are otherwise serviceable. Install new bearings by pressing on lettered side of bearing cage only.

Rotor, ring, vanes and vane springs are serviced as a complete assembly (45) only; however, the unit may be

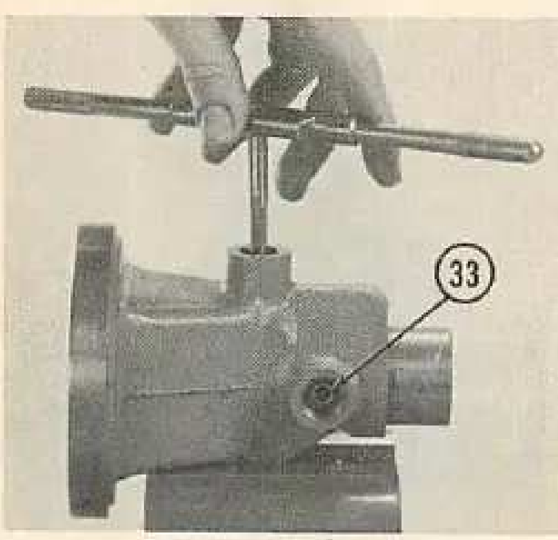


Fig. O44 — To remove connector seats (33), thread inside diameter with tap as

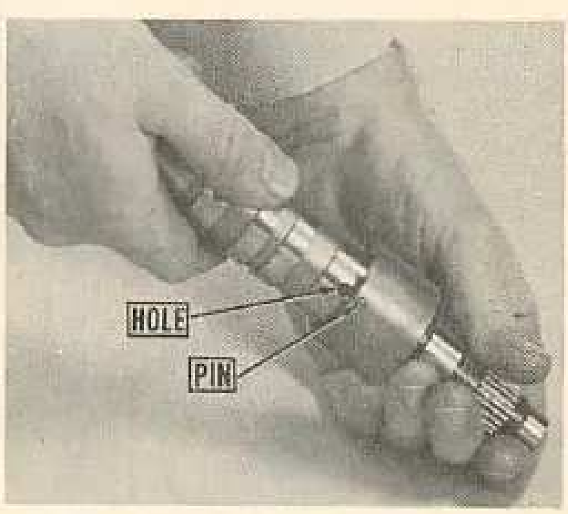
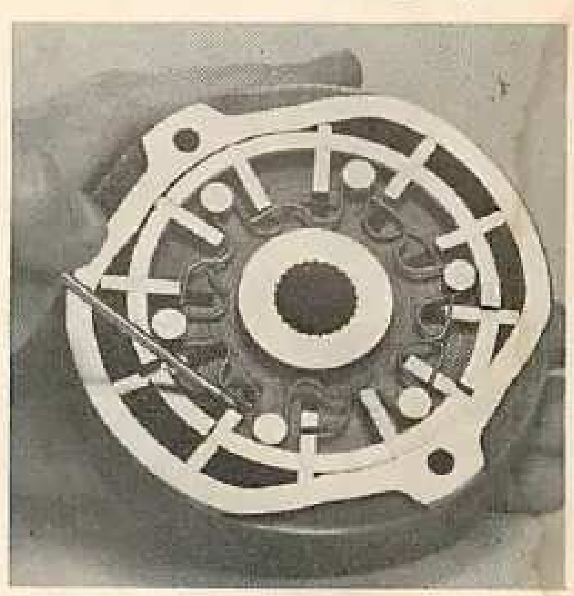


Fig. O45 — Pin in actuator sleeve must be engaged in hole in end of spool valve before actuator assembly is installed. If spool can-



shown, then use puller bolts to remove seals.

not be pulled out of sleeve, pin is engaged.

Fig. O47 — Be sure all vane springs are engaged behind the rotor vanes. Springs can be pried into place with screwdriver as shown.

disassembled for cleaning and inspection. Reassemble by placing rotor in ring on flat surface. Insert vanes (rounded side out) in rotor slots aligned with large diameter of ring, turn rotor ¼-turn and insert remaining vanes. Hook the vane springs behind each vane with screwdriver as shown in Fig. O47; be sure that vane springs are in proper place on both sides of rotor.

To reassemble Hydramotor unit, place housing, with needle bearing, seals and snap ring installed, in a vise with flat (bottom) side up. Check to be sure that pin in actuator is engaged in valve spool; if spool can be pulled away from actuator as shown in Fig. O45, push spool back into actuator and be sure that the pin is engaged into hole in spool. Then, carefully insert actuator assembly into bore of housing. Place bearing support assembly on stub shaft and carefully push the assembly in flush with housing as shown in Fig. O46. Place the pump ring and rotor assembly on stub shaft and housing; on late production units, chamfered outer edge of pump ring must be away from housing (up). Install a new rotor retaining ring and insert the dowel pins through ring into housing. Stick the "O" ring and Teflon seals (See Fig. O42) into pressure plate with heavy grease, then install pressure plate over stub shaft, pump ring and rotor assembly and the dowel pins. Place pressure plate spring on pressure plate. Note: On early production units a Belleville washer type spring is used; cup side of spring must be away from pressure plate. A coil spring is used on all late production units. On early production units, install new sealing "O" ring in groove on outside diameter of housing. On late production units, install new "O" ring and backup ring in groove in cover (refer to Fig. O48). Then, install cover over the assembled steering unit and install pivot bracket on early production units as in paragraph 54, or cover retaining snap ring on late production units as in paragraph 55.

Fig. O46 — When pushing bearing support (41) for stub shaft (37) into housing (32), take care not to damage sealing "O" ring.

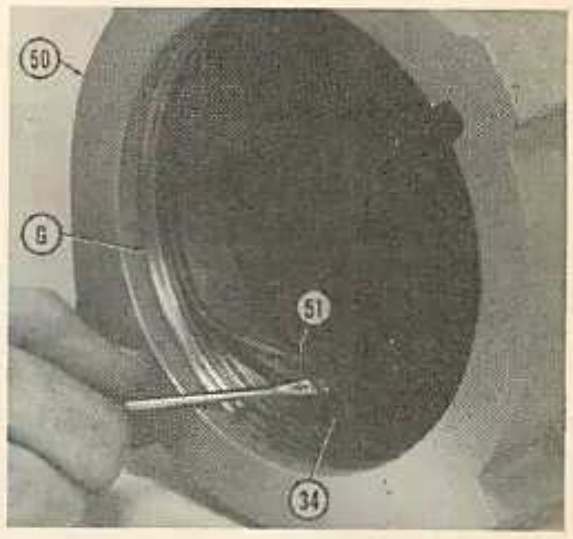


Fig. O48 — On late production units "O" ring (51) and backup ring (34) are installed in cover (50); be sure backup ring is to outside (open side of cover). Groove (G) is for cover retaining snap ring.

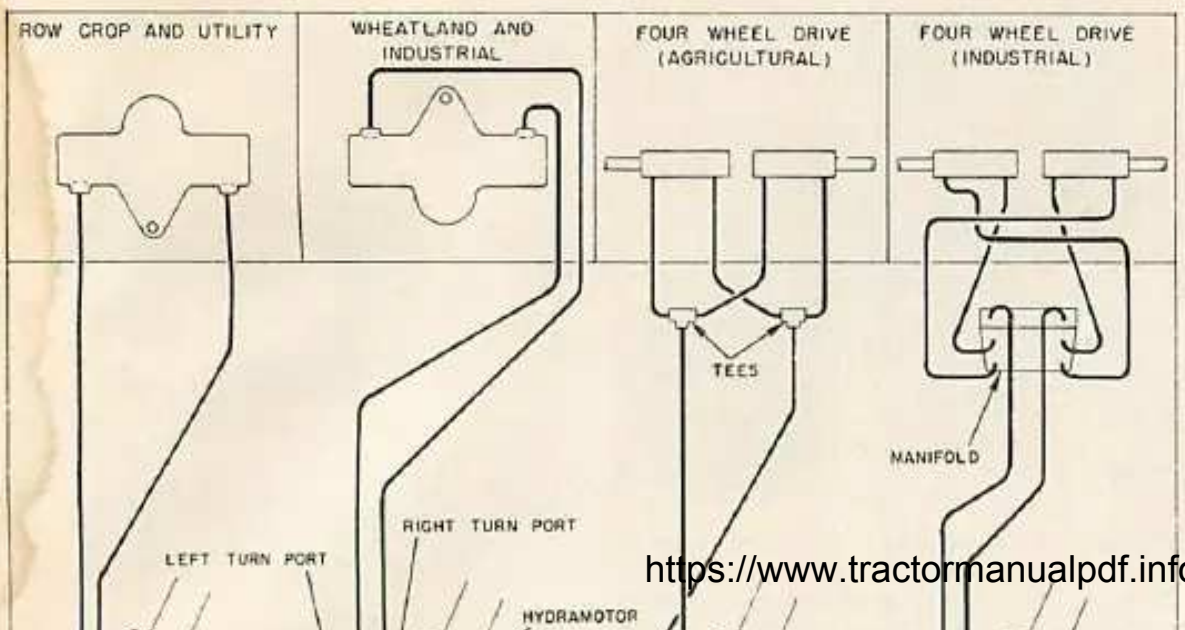
POWER STEERING CYLINDER

All Models Except Four Wheel Drive

57. **R&R POWER STEERING CYLINDER.** On Row Crop and Utility models equipped with oil cooler, disconnect oil cooler clamps from their supports and remove grille from main frame. Then, on all models, remove radiator as outlined in paragraph 138. Loosen power steering line clamps at side of engine, disconnect lines from power steering cylinder and immediately cap all openings. Refer to Fig. O52; remove plug (4) from cap (1) and remove cap from power steering cylinder. Pry plug (7) from pinion (11). Pull pinion from splines of front assembly shaft by turning puller bolt (9) counter-clockwise.

On Row Crop and Utility models, lift cylinder upward to disengage stud in cylinder from torque link, turn cylinder counter-clockwise on front assembly shaft and push cylinder downward to free pinion from shaft. Withdraw pinion from cylinder, then remove cylinder from front end of main frame.

On Wheatland and Industrial models, remove nut and washer from tapered stud at end of torque link and drive the stud upward out of main frame and the link. Then remove the



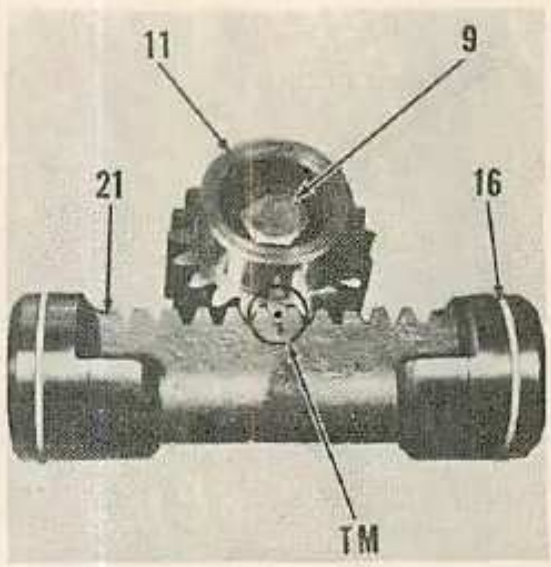


Fig. O51 — View of pinion (11) and piston

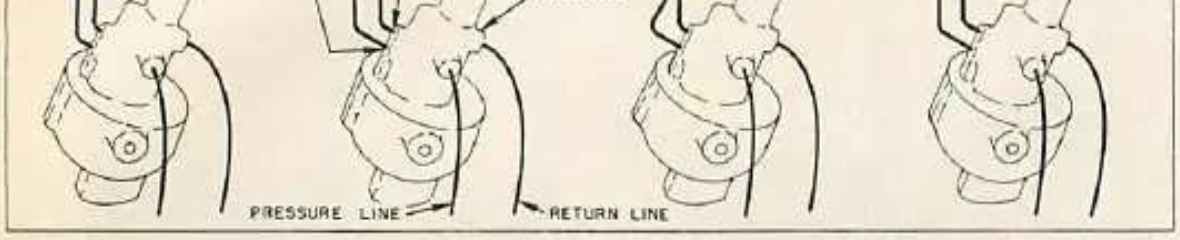


Fig. O49 — Schematic views showing Hydramotor and steering cylinder lines for the different front axle types.

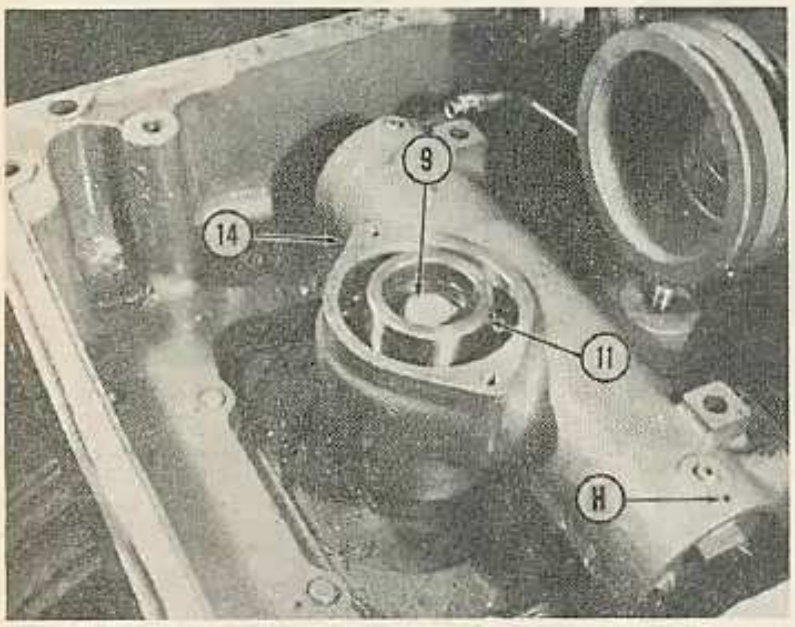


Fig. O50 — View showing power steering cylinder on Row Crop and Utility models with cylinder cap and pinion plug removed. On Wheatland and Industrial models, cylinder is mounted to front side of front assembly shaft instead of to rear as shown.

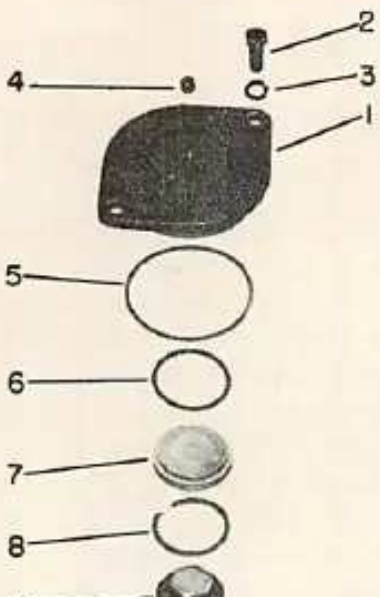
H. Hole for removing snap ring
9. Puller bolt
11. Pinion
14. Cylinder

power steering cylinder, with pinion installed, from front end of main frame.

Reverse removal procedures to reinstall cylinder. Punch mark on tooth of pinion (11) must be aligned with center tooth groove in piston as shown in Fig. O51. Tighten the puller bolt to a torque of 200 Ft.-Lbs., and tighten the nuts on torque link and tapered stud securely. Install plug (7—Fig. O52) with new "O" ring (6). Fill cavity around pinion with proper power steering fluid (see paragraph 48) before reinstalling cap (1) with new "O" ring (5).

58. **OVERHAUL POWER STEERING CYLINDER.** After removing the cylinder assembly as outlined in paragraph 57, proceed as follows: On Wheatland and Industrial models, remove pinion (11—Fig. O52). Remove snap ring (8), puller bolt (9) and washer (10). To remove end plug retaining snap ring (24), insert pin or punch in hole (H—Fig. O50) and push snap ring from groove in cylinder. Grasp one of the lugs on end plug with vise-grip pliers and, with a twisting motion, pull end plug from cylinder. Remove plug sealing "O" ring (22—Fig. O52) from end of cylinder and remove the piston (21). Remove the Teflon seals (16) and "O" rings (17) from groove at each end of piston and remove pinion sealing quad ring (12) from bottom of cylinder. If necessary to remove the check valve assembly (18, 19 and 20) from either end of cylinder, insert punch in hole from inner side of piston head and drive valve ball, spring and spring pin from piston. If the hydraulic line connector seats (13) are damaged, they may be removed in a manner similar to that shown in Fig. 044. Carefully clean and inspect all parts and renew any that are excessively worn, deeply scored or damaged beyond further use.

Reassemble cylinder, using all new sealing rings as follows: Insert check ball (20) into bore in end of piston (21), insert spring (19) with small end next to ball and drive the retaining spring pin (18) in flush with end of piston. Install "O" ring (17) in bottom of groove in end of piston, then install Teflon ring (16) on top of the "O" ring. Lubricate piston and install in bore of cylinder. Install "O" ring (22) in groove in open end of cylinder, lubricate and install end plug (23) and install plug retaining snap ring (24). Install quad ring (12) in bottom of pinion bore in cylinder casting and lubricate ring and bore. Install pinion (11), and washer (10), puller bolt (9) and retaining snap ring (8) in top of pinion. On Wheatland and Industrial models, insert pinion in cylinder with timing marks on pinion and piston aligned as shown in Fig. O51. Reinstall cylinder as outlined in paragraph 57.



POWER STEERING CYLINDERS

Four Wheel Drive Models

59. **R&R AND OVERHAUL.** To remove either power steering cylinder, disconnect the hoses, cap all openings, then remove the bolts from cylinder end assemblies and remove the cylinder from tractor. Loosen the lock nut on rod end of assembly and the clamp on cylinder end, then remove the end assemblies. Bushings in either end assembly may be renewed if worn or damaged.

Before reinstalling cylinder, install the end assemblies and, with cylinder rod fully retracted, adjust position of end assemblies so that center-to-center measurement of the mounting holes is 18½ inches. Then, tighten the lock nut and clamp to secure end assemblies in this position and install cylinder on tractor. Refer to Fig. O49 for line connection diagram.

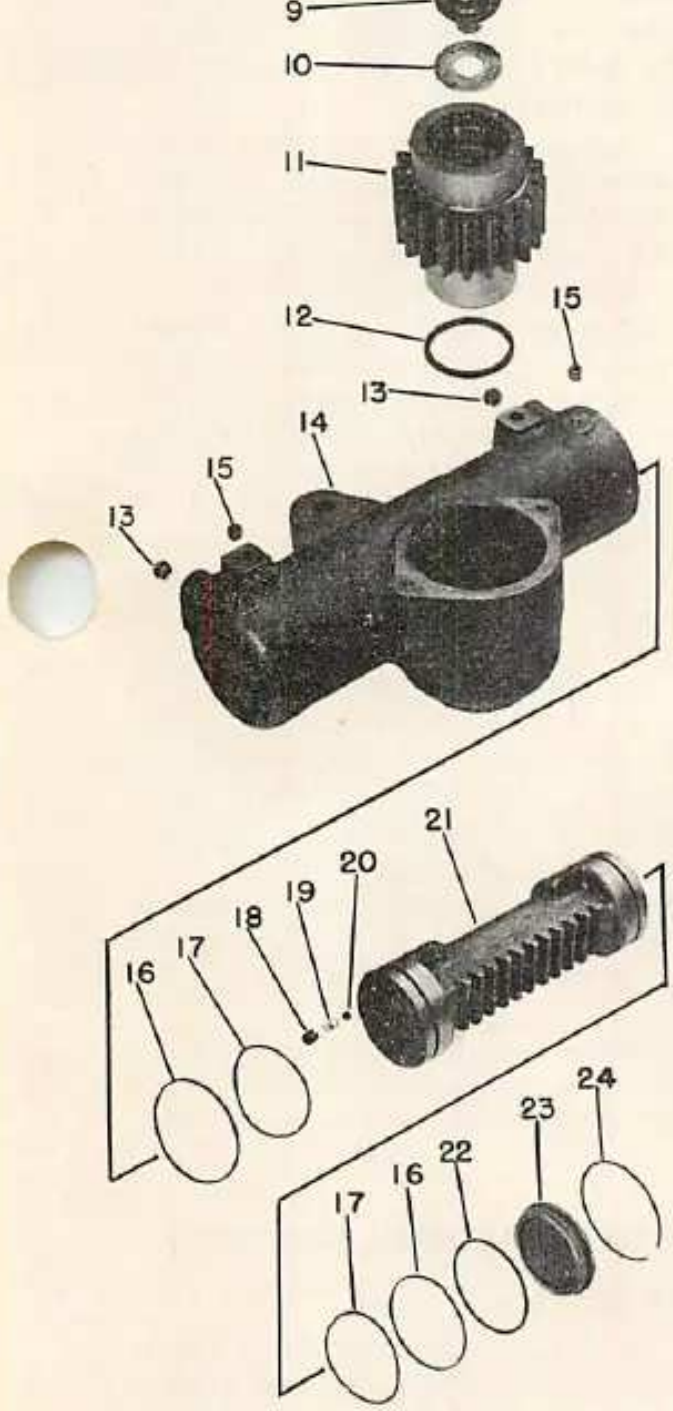


Fig. O52 — Exploded view of power steering cylinder assembly used on all models except those equipped with four wheel drive.

1. Cap
4. Plug
5. "O" ring
6. "O" ring
7. Plug
8. Snap ring
9. Puller bolt
10. Washer
11. Pinion
12. Quad ring
13. Connectors
14. Cylinder
15. Plugs
16. Teflon rings
17. "O" rings
18. Spring pins
19. Springs
20. Check valves
21. Piston
22. "O" ring
23. End plug
24. Snap ring

To disassemble cylinder, refer to Fig. O53 and proceed as follows: Remove end plate (19), push bearing (14) into cylinder to expose snap ring (18) and remove the snap ring. Pull the piston rod (6), bearing and piston (10) from cylinder as an assembly. Hold rod from turning at flat near outer end, then remove cotter pin and piston retaining nut (7). Slide piston and bearing from inner end of rod. Remove the sealing rings and wiper from piston and bearing. Clean and carefully inspect all parts and renew any that are excessively worn, scored or damaged.

Reassemble, using all new seals, as follows: Install "O" ring (15) and backup ring (16) in bore of bearing with backup ring at outer side of "O" ring. Install wiper (17) with lip outward, lubricate bore of bearing and install bearing on piston rod with "O" ring groove on outer diameter of bearing towards small (inner) end of rod. Install new "O" ring (13) on bearing. Install new "O" rings (11) in bottom of grooves on piston and install the Teflon rings (12) on top of the "O" rings. Install piston, washer (9) and nut (10) on piston rod and tighten nut securely. Note: If nut threads onto piston rod too far and slots in nut will not engage cotter pin, remove the nut and add washers (9) as necessary. Install cotter pin (8), lubricate piston and cylinder bore and carefully insert piston and bearing into bore but avoid damaging sealing rings on snap ring groove. Using a dull tool, compress the sealing rings as they pass hole for hydraulic fitting in cylinder tube. Push bearing far enough into bore to install snap ring (18), bump bearing out against snap ring with piston and install plate (19).

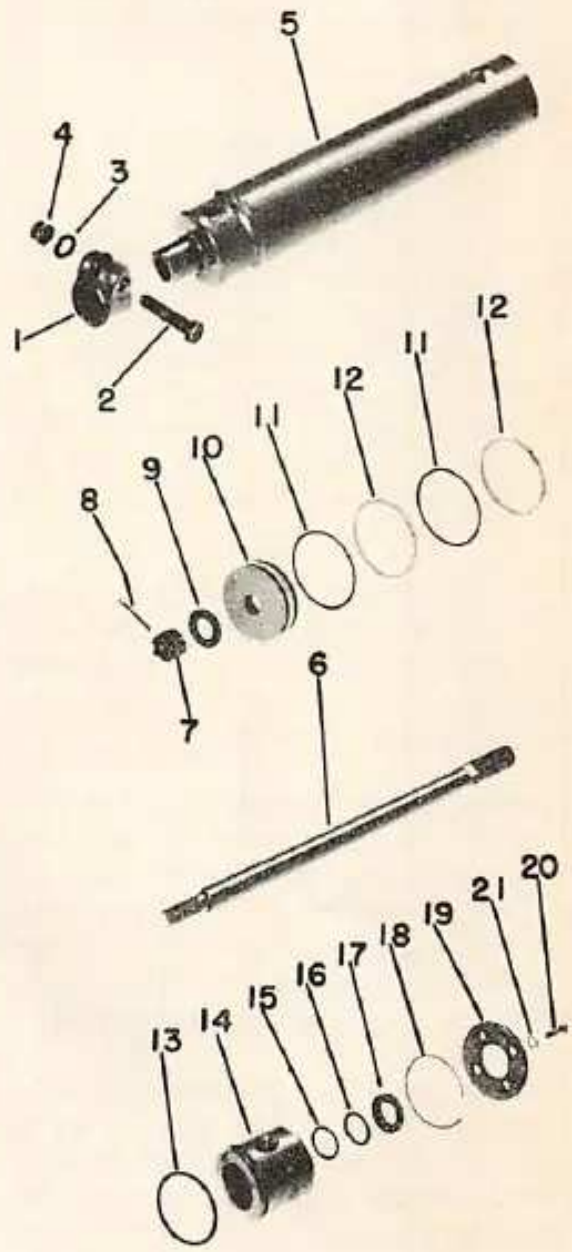


Fig. O53 — Exploded view of power steering cylinder used on four wheel drive models. Refer to Fig. O49 for schematic view of cylinder line connections.

1. Clamp
5. Cylinder barrel
6. Piston rod
7. Slotted nut
9. Washer
10. Piston
11. "O" rings
12. Teflon rings
13. "O" rings
14. Bearing
15. "O" ring
16. Backup ring
17. Wiper
18. Snap ring
19. Retainer plate

ENGINE AND COMPONENTS

Oliver 1600 and 1650 Series tractors are fitted with six cylinder engines. Early 1600 non-diesel engines have a bore and stroke of 3.500 x 4.000 inches and displacement of 231 cubic inches. Late 1600 non-diesel engines have a bore and stroke of 3.625 x 4.000 inches and displacement of 248 cubic inches. Series 1650 non-diesel engines have a bore and stroke of 3.750 x 4.000 inches and a displacement of 265 cubic inches. Series 1600 diesel engines have a bore and stroke of 3.750 x 4.000 inches and displacement of 265 cubic inches. Series 1650 diesel engines have a bore and stroke of 3.875 x

diesel models, disconnect fuel return line. Unhook fuel gage wire and remove fuel tank. Disconnect wiring from engine accessories. Disconnect or remove the diesel fuel injection pump control rod and stop wire or the governor (throttle) rod and choke wire.

On manual steering models, disconnect steering shaft support bearing from bracket at clutch housing.

On models equipped with Reverse-O-Matic Drive, disconnect the oil cooler lines at drive unit.

Remove upper radiator hose, air cleaner and air cleaner hose. On models with Hydra-Power Drive, disconnect Hydra-Power coolant hose at front of cylinder head and from bracket on rocker arm cover. Disconnect or remove breather tube from rocker arm cover. On diesel models, disconnect wiring from manifold heater solenoid. On non-diesel models, remove ignition coil, disconnect spark plug wires and remove the carburetor, intake manifold and exhaust manifold as an assembly. On diesel models,

4.000 inches and a displacement of 283 cubic inches. Series 1600 and 1650 non-diesel engines and 1600 diesel engines have a four-main bearing crankshaft; Series 1650 diesel engines have a seven-main bearing crankshaft.

R&R ENGINE ASSEMBLY

On direct drive models, the engine clutch can be removed without removing engine from tractor, or the engine and clutch assembly may be removed as a unit. On models equipped with Hydra-Power, Creeper or Reverse-O-Torc Drive, the engine and drive unit must be removed as an assembly, then the drive unit removed from engine for service of either the engine or drive unit and/or clutch.

60. To remove engine and clutch, Hydra-Power Drive, Creeper Drive or Reverse-O-Torc Drive as a unit, first disconnect battery ground strap, then proceed as follows:

Drain cooling system, and if engine is to be disassembled, drain oil pan. On models equipped with Reverse-O-Torc Drive, drain the drive unit. On models equipped with either Hydra-Power or Creeper Drive, drain drive unit if unit is to be disassembled.

If so equipped, remove the PTO drive shaft and clutch unit on Series 1600 as outlined in paragraph 221, remove Series 1650 PTO drive shaft as outlined in paragraph 226, or remove hydraulic pump drive shaft as outlined in paragraph 248.

Remove both hood side panels and hood. Remove fan assembly from water pump and set fan in radiator shroud. Disconnect the radiator hoses and if tractor is equipped with Hydra-Power, Creeper or Reverse-O-Torc Drive, remove the radiator and fan from tractor. Shut-off the fuel supply valve, disconnect fuel line and, on

On power steering models not equipped with hydraulic lift, disconnect Hydramotor lines from power steering pump and reservoir.

On direct drive models, remove drive shaft shield, disconnect coupling chain, disengage snap ring from groove in shaft at front of coupling, slide snap ring and front coupling half forward, then remove rear coupling half from between transmission and rear end of drive shaft. Front half of coupling can then be removed from drive shaft.

On Hydra-Power, Creeper or Reverse-O-Torc Drive, remove chain coupling from between drive unit and transmission.

On Series 1650 models, remove the dry type air cleaner from top of engine. Remove other engine accessories as indicated by service to be performed on engine or drive unit.

Attach lifting hooks to the lift bolts on engine head and attach hoist to lift hooks. Remove the four bolts retaining engine to main frame and lift engine and clutch or drive unit from tractor. NOTE: The left front and right rear engine retaining bolts are dowel bolts and must be reinstalled in same position from which they were removed.

To reinstall engine, reverse removal procedure. Bleed the diesel fuel system as outlined in paragraph 113.

R&R CYLINDER HEAD

All Models

61. To remove cylinder head, first remove both hood side panels and engine hood, drain the cooling system, then proceed as follows:

On power steering models not equipped with hydraulic lift, drain the power steering reservoir, remove Hydramotor to pump and reservoir hoses and remove the pump and reservoir assemblies from engine.

disconnect injector pressure lines and the fuel return lines; immediately cap all openings.

Remove rocker arm cover and disconnect rocker arm shaft oil line. Remove rocker arm shaft assembly from cylinder head, then remove cylinder head from engine.

62. When reinstalling cylinder head, refer to Fig. O56 for location of oil screw on non-diesel models, or to Fig. O57 on Series 1600 diesel models. Tighten cylinder head cap screws in sequence shown in Fig. O56 for all non-diesel engines, in sequence shown in Fig. O57 for Series 1600 diesel engines, or in sequence shown in Fig. O55 for Series 1650 diesel engines.

On all Series 1600 models, and on Series 1650 non-diesel models, tighten the oil screw to a torque of 96-100 Ft.-Lbs., and tighten all other cylinder head capscrews on these models to a torque of 112-117 Ft.-Lbs.

On Series 1650 diesel models, tighten all cylinder head retaining capscrews to a torque of 129-133 Ft.-Lbs.

Rocker arm shaft bracket nuts and manifold nuts on all models should be tightened to a torque of 25-27 Ft.-Lbs.

VALVES, GUIDES AND SEATS

All Models

63. Intake and exhaust valves on all models have a face angle of 44½° and a seat angle of 45°. Desired seat width is 0.080-0.090. Seats may be narrowed by using 20 and 60 degree stones.

Exhaust valve seat inserts are standard equipment on all non-diesel engines and intake valve seat inserts are standard equipment on Series 1600 diesel engines. Series 1650 diesel engines have both intake and exhaust valve seat inserts. Inserts are installed with a 0.002-0.0035 interference fit.

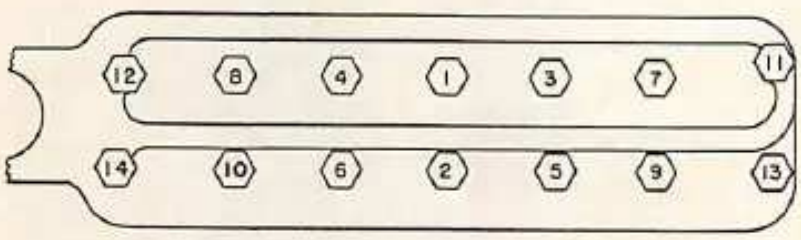
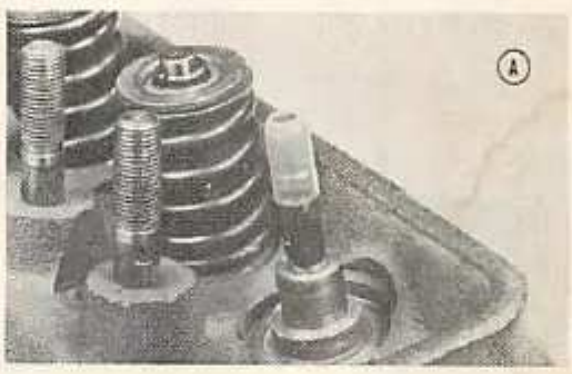


Fig. O55 — Cylinder head tightening sequence for Series 1650 diesel engines only. Tighten all capscrews to a torque of 129-133 Ft.-Lbs.



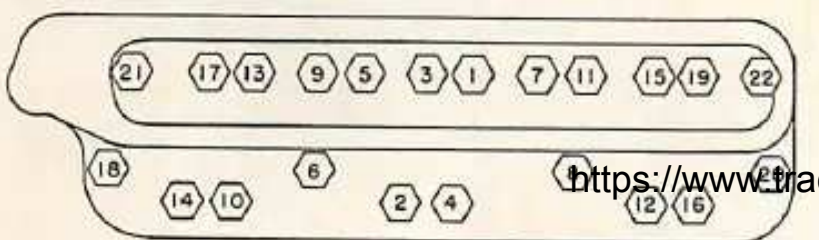


Fig. O56 — Cylinder head capscrew tightening sequence for Series 1600 and Series 1650 non-diesel engines. Tighten the oil can screw (22) to a torque of 96-100 Ft.-Lbs. and tighten all other cap-

screws to a torque of 112-117 Ft.-Lbs.

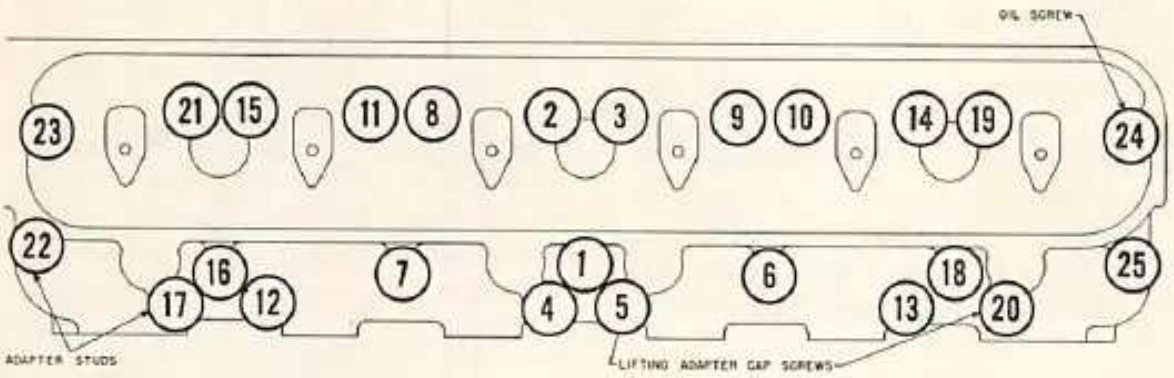


Fig. O57 — Cylinder head capscrew tightening sequence for Series 1600 diesel engines. Tighten the oil capscrew (24) to a torque of 96-100 Ft.-Lbs. and all other capscrews to a torque of 112-117 Ft.-Lbs.

Early production non-diesel intake valves were provided with neoprene oil guards to prevent oil from passing into the combustion chamber via the valve stems. Late production non-diesel valve guides are fitted with Perfect Circle valve stem seals. Install new oil guards or valve stem seals each time the valves are reseated. Refer to Fig. O58 for Perfect Circle seal installation procedure. Early production valve guides can be fitted with Perfect Circle seals after machining the guide with proper tools. Refer to paragraph 64 for proper valve guide height.

Adjust valve tappet gap cold to the following values:

Intake, All Non-Diesel	0.013-0.015
Intake, Series 1600 Diesel	0.009-0.011
Intake, Series 1650 Diesel	0.017-0.019
Exhaust, Series 1600 Non-Diesel	0.022-0.024
Exhaust, Series 1650 Non-Diesel	0.023-0.025
Exhaust, Series 1600 Diesel	0.015-0.017
Exhaust, Series 1650 Diesel	0.027-0.029

64. Intake and exhaust valve guides are not interchangeable. Intake guides for all non-diesel engines are $2\frac{25}{32}$ inches in length ($2\frac{5}{8}$ inches when equipped with Perfect Circle seals), Series 1600 diesel intake guides are $3\frac{3}{16}$ inches in length and Series 1650 diesel intake guides are $2\frac{1}{4}$ inches long. Non-diesel exhaust guides are $2\frac{5}{8}$ inches in length, Series 1600 diesel exhaust guides are $2\frac{5}{16}$ inches long and Series 1650 exhaust guides are $2\frac{5}{8}$ inches long.

When properly installed, valve guide height above machined top surface of cylinder is as follows: Non-diesel intake (without Perfect Circle seal), $\frac{15}{16}$-inch; non-diesel intake with Perfect Circle seal (not including seal), $\frac{25}{32}$-inch; diesel intake and non-diesel exhaust, $\frac{15}{16}$-inch; Series 1600 diesel exhaust, $1\frac{3}{16}$ inches; and Series 1650 diesel exhaust valve guides, $\frac{15}{16}$-inch.

New guides have an inside diameter of 0.374-0.375. Maximum allowable inside diameter (wear limit) is 0.377 for intake valve guides and 0.378 for exhaust valve guides.

Fig. O58 — Views A through E illustrate method of installing Perfect Circle valve stem seals on models so equipped. Photos courtesy of Perfect Circle Corporation.

VALVE ROTATORS

All Models

65. Exhaust valves of gasoline engines *and both* intake and exhaust valves of diesel engines are equipped with positive type valve rotators. These rotators cannot be serviced but should be observed while engine is running to be sure each valve equipped with rotator turns slightly each time the valve is opened. Renew the rotator of any valve that does not turn.

VALVE SPRINGS

hood side panels and hood. On Series 1650 models, remove the dry type air cleaner. On power steering models not equipped with hydraulic lift, remove the power steering reservoir. Disconnect or remove the rocker arm breather and, on non-diesel models, remove the ignition coil. Remove rocker arm cover and disconnect the oil line. Then, unbolt and remove rocker arm shaft assembly.

Disassembly of rocker arm shaft assembly is obvious. Note that rocker arms are right and left hand assemblies and that offset valve contact ends [illegible] kets.

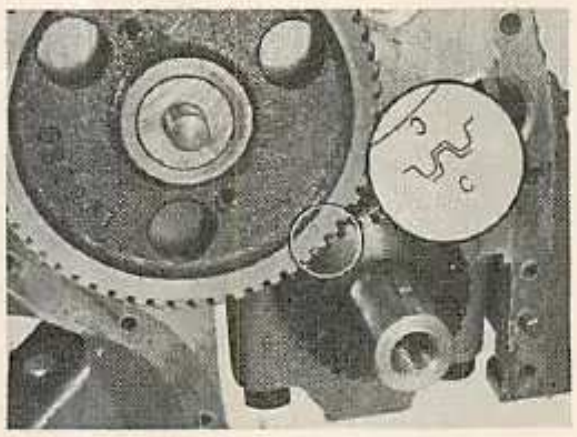


Fig. O59 — Valves are properly timed on all models when "C" marked tooth on crankshaft gear is meshed with "C" marked tooth groove on camshaft gear as shown.

All Models

66. Valve springs of three different free lengths are used. Usage and test specifications are as follows:

106 573-A — Used as intake valve spring on all non-diesel engines and as exhaust valve spring on LP-Gas and Series 1600 diesel engines.

Free length.....2.562
Lbs. pressure @ 1.906 in.....55-63
Lbs. pressure @ 1.506 in.....91-99

107 625-A — Used as intake valve spring on all diesel engines and as exhaust valve spring on Series 1600 gasoline and Series 1650 diesel engines.

Free length.....2.667
Lbs. pressure @ 1.750 in.....53-61
Lbs. pressure @ 1.350 in.....86-94

159 026-A — Used as exhaust valve spring on Series 1650 gasoline engine.

Free length.....2.440
Lbs. pressure @ 1.750 in.....53-61
Lbs. pressure @ 1.350 in.....86-94

VALVE LIFTERS (CAM) FOLLOWERS

All Models

67. The mushroom type valve lifters operate directly in machined bores of cylinder block. Valve lifters are supplied only in standard size of 0.6240-0.6245 and should have an operating clearance of 0.0005-0.002 in their bores. Renew valve lifters if their diameter is less than 0.619. If valve lifter bore exceeds 0.631, renew cylinder block.

Valve lifters can be removed from cylinder block after removing camshaft as outlined in paragraph 74.

VALVE ROCKER ARMS AND SHAFTS

All Models

68. The rocker arm shaft assembly can be removed as follows: Remove

Rocker arm shaft diameter, new, is 0.742-0.743; renew shaft if worn to 0.740 or less. Inside diameter of rocker arm bushing is 0.7445-0.7455 new. Desired operating clearance is 0.0015-0.0035; if clearance exceeds 0.005, renew rocker arm assembly as bushings are not available separately from rocker arms. Rocker arm contact radius can be refaced providing the radius is maintained within 0.485-0.515 on non-diesels and 0.360-0.390 on diesels, and face is kept parallel with rocker arm shaft.

The hollow rocker arm shaft is fitted with a sealing plug in each end and a restrictor plug near mid-length of shaft bore. The plugs are serviced separately from shaft and should be renewed if removed to clean the shaft bore. Also, location of the restrictor plug should be checked if the rear rocker arms are receiving more lubricating oil than the front plugs. Install new restrictor plug to a depth of 13½ inches from rear end of shaft. Install new sealing plugs cup side out with cup edge flush with end of shaft.

Rocker arm shaft spring free length should be 2½ inches and spring should exert 10 pounds pressure when compressed to a length of ⅝-inch.

When reinstalling rocker arm shaft assembly, tighten bracket retaining nuts to a torque of 25-27 Ft.-Lbs.

VALVE TIMING

All Models

69. Valves are correctly timed when the mark "C" on camshaft gear is aligned with identical mark on crankshaft gear as shown in Fig. 059.

TIMING GEAR COVER

All Models

70. To remove timing gear cover, proceed as follows: Remove hood side panels and engine hood. Drain cooling system and remove radiator hose. Remove fan blades, set blades in radiator shroud and remove the radiator with the fan blade assembly. Remove water pump, generator or alternator and fan belt. On Row Crop or Utility models with power steering, remove the grille and the power steering cylinder. On non-diesel engines, disconnect governor linkage and remove the governor. Remove capscrew from crankshaft pulley and using suitable pullers attached to capscrews threaded into the pulley, remove pulley from crankshaft. Drain and remove the oil pan. Remove timing gear cover retaining capscrews and remove cover from engine. Front oil seal can now be renewed as outlined in paragraph 81.

TIMING GEARS

All Models

71. Desired camshaft gear to crankshaft gear backlash is 0.003-0.005; camshaft and crankshaft gears should be renewed if backlash exceeds 0.007.

To renew the camshaft gear, follow procedure outlined in paragraph 74 for renewing camshaft. Crankshaft gear can be renewed without removing crankshaft as follows: Pull gear from shaft by using suitable puller attached to capscrews threaded into the gear; a suitable centering adapter should be used to prevent damage to front end of shaft. Press new gear onto shaft with a length of 2-inch pipe, suitable spacers and a ¾-inch, 16 thread puller bolt threaded into front end of crankshaft. Be sure that gear is installed with "C" timing mark to front and that the timing gears are properly meshed as outlined in paragraph 69. On diesel models, retime fuel injection pump drive gear as outlined in paragraph 122A. If the crankshaft is removed and crankshaft

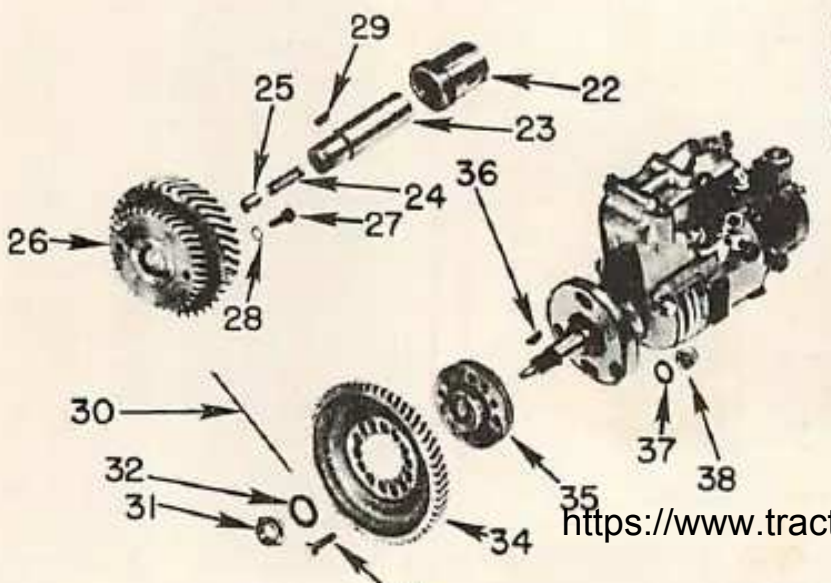


Fig. O60—Exploded view of diesel fuel injection pump idler and drive gears. Matched set of idler gears (26) are fastened together by two capscrews (27).

22. Idler bushing
23. Idler shaft
24. Plunger spring
25. Thrust plunger
26. Idler gears
27. Capscrews (2)
28. Lockwashers (2)
29. Woodruff key
30. Locking wire
31. Nut
32. Lockwasher
33. Capscrews (2)
34. Drive gear
35. Gear hub
36. Woodruff key
37. Washer
38. Nuts

DIESEL INJECTION PUMP IDLER GEARS

All Diesel Models

73. After removing timing gear cover as outlined in paragraph 70 and the injection pump drive gear and shaft unit as in paragraph 72, the idler gear and shaft assembly can be withdrawn from bushing and sleeve assembly in front face of cylinder block.

Desired idler gear to crankshaft gear backlash is 0.003-0.005; if backlash exceeds 0.007, the idler gear assembly, crankshaft gear and cam-

gear is being installed in a press, support crankshaft at front throw to avoid springing the shaft.

Note: A timing gear lubrication tube is installed in front face of cylinder block. If necessary to renew the lubrication tube, be sure hole in side of tube is toward the camshaft gear.

DIESEL INJECTION PUMP DRIVE GEAR

All Diesel Models

72. The diesel injection pump drive gear and shaft unit can be withdrawn from the fuel injection pump after removing the timing gear cover as outlined in paragraph 70, or after removing the cover plate from front of timing gear cover; refer to paragraph 124.

Before removing drive gear and shaft unit, shut off the fuel supply valve and remove timing window from injection pump. Turn engine in normal direction of rotation until timing marks of the injection pump cam and governor weight retainer are both visible in timing window and the 7° BTDC timing mark (Series 1600 models) or 2° BTDC timing mark (Series 1650 models) on engine flywheel is aligned with timing pointer. Refer to paragraph 122A. Then, remove gear and shaft unit taking care not to lose the thrust button or spring from front end of shaft.

Cut the locking wire and remove the two cap screws retaining drive gear to gear hub and remove gear from hub. Clamp the tang end of drive shaft in a soft jawed vise and remove the hub retaining nut, hub and drive key. Remove the two cup type shaft seals.

Install two new seals on drive shaft with lip of each seal pointing away from other seal. Use of Roosa-Master No. 13369 seal installation tool is recommended. Clamp tang of drive shaft in soft jawed vise and install drive key, hub and retaining nut. Tighten the nut to a torque of 35-40 Ft.-Lbs. Lubricate seals and bore of pump with Lubriplate or equivalent grease. Be sure that engine is still positioned on 7° BTDC (Series 1600) or 2° BTDC (Series 1650). Insert drive shaft into pump bore with offset dimple in end of tang aligned with similar offset mark in drive slot of pump rotor. Carefully work lip of rear seal into bore of pump body with a small dull pointed tool. Note: If lip of seal is rolled back when shaft is inserted, remove the shaft and renew the seal. With shaft tang engaged in pump rotor, align pump timing marks and insert small screwdriver tip in notch below timing marks to keep rotor from turning. Place drive gear on hub with teeth meshed into idler gear teeth and move gear counter-clockwise as far as possible to eliminate backlash. Insert gear retaining screws in the two holes of gear and hub that are most nearly aligned, tighten the screws securely and install locking wire. Insert spring and thrust button in front end of shaft and install timing gear cover or gear cover plate to timing gear cover.

Check pump timing by turning engine two turns to where proper degree mark on flywheel is aligned with pointer and No. 1 cylinder is on top dead center. If pump timing marks are not exactly aligned, loosen the pump mounting bolts and turn pump body as required to align the marks. Tighten the pump mounting bolts securely while holding pump in proper position.

shaft timing gears should be renewed.

Desired idler gear shaft to bushing clearance is 0.0015-0.003; if clearance exceeds 0.005, the shaft and/or sleeve and bushings assembly should be renewed. Shaft diameter, new, is 0.999-1.000. A thrust button and spring in front end of idler shaft controls idler gear end play.

The idler gear assembly is keyed and press fitted to the idler shaft. The sleeve and bushing assembly is pressed into front of cylinder block and can be removed with OTC 927 Puller and OTC 933 Extractor or similar tools. Install new sleeve and bushing assembly with suitable driver so that oil holes in sleeve and crankcase bore are aligned and flange on sleeve is tight against crankcase.

Thrust button spring should exert 6½-8½ pounds pressure when compressed to a length of $\frac{11}{32}$-inch. Renew thrust button if scored or excessively worn.

CAMSHAFT

All Models

74. To remove camshaft, first remove hood side panels and hood, grille and radiator and remove timing gear cover as outlined in paragraph 70. Remove ignition distributor and fuel pump on non-diesel engines. On all engines remove rocker arm cover, rocker arm assembly, push rods, oil pan and oil pump. If engine has been removed from tractor, turn the engine upside down so that cam lifters will fall away from camshaft. With engine in tractor, push cam lifters up away from camshaft and if they do not stick in their bores, support them in some way. Withdraw camshaft and gear from front of cylinder block. Camshaft gear can be removed in press or by using suitable pullers attached to ⅜-16 capscrews threaded into front of gear.

On Series 1600 diesel and all non-diesel engines, front camshaft journal is supported in a renewable bushing and the three rear journals rotate in unbushed bores in cylinder block. On Series 1650 diesel, camshaft is supported in four renewable bushings. Maximum allowable bushing inside diameter (wear limit) is 1.7560. Install new bushings with closely piloted driver such as OTC T-812 Driver and mandrel. Bushings are pre-sized and reaming should not be necessary if they are carefully installed. Note: On non-diesels and Series 1600 diesel models, cylinder block bores can be line bored to

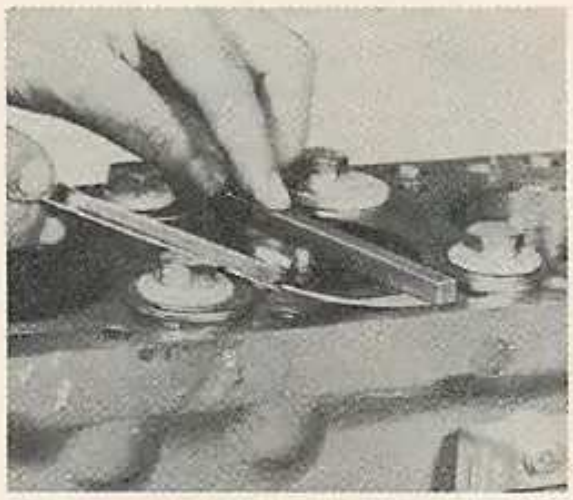


Fig. O61 — Checking sleeve protrusion above machined surface of cylinder block. Note that sleeve is clamped in place by short capscrews and spacer washers.

To install sleeve, proceed as follows: Coat new packing rings with Lubriplate or multi-purpose grease, install the rings in clean grooves at bottom of sleeve and run a small round rod or punch around the sleeve under the rings several times to eliminate any twist in the rings and to seat rings evenly in the grooves. Be sure bores in cylinder block, especially the taper at upper edge of lower bore, are clean and smooth. Then, insert sleeve into bore and push into place by hand. Do not force the sleeve into place; if excessive pressure is required, it indicates the sealing rings have been distorted. Remove sleeve,

1.8745-1.8755 and bushings be installed for the three rear camshaft journals if necessary.

Camshaft journal diameter, new, is 1.749-1.750 for the front journal and 1.7485-1.7495 for the three rear journals. Desired journal to bushing or bore clearance is 0.0015-0.003; maximum allowable clearance is 0.005.

Camshaft end play is controlled by a spring loaded thrust button. Thrust spring free length should be $1\frac{3}{16}$ inches and spring should exert 15½ to 18½ pounds pressure when compressed to a length of $\frac{13}{32}$-inch.

Before installing camshaft, press gear onto shaft making sure that side of gear with "C" timing mark is to front. Thrust spring and button can be inserted in camshaft after shaft is installed in cylinder block.

ROD AND PISTON UNITS

All Models

75. Connecting rod and piston units are removed from above after removing cylinder head and oil pan. Before removing connecting rod caps, note if cylinder number is stamped on camshaft side of rod and cap; if not, stamp the cylinder number into each rod and cap prior to removing rod and piston assembly.

Tighten connecting rod bolt nuts to a torque of 46-50 Ft.-Lbs. on non-diesel engines, to a torque of 56-60 Ft.-Lbs. on Series 1600 diesel engines and to a torque of 56-58 Ft.-Lbs. on Series 1650 diesel engines.

PISTONS, RINGS AND SLEEVES

All Models

76. **PISTONS AND SLEEVES.** All engines are fitted with wet type sleeves which are sealed at bottom end with two packing rings and at top end by the cylinder head gasket. Sleeves can be pulled from cylinder block using an OTC 938 puller and proper size sleeve attachment. Sleeve bore diameter (new) is as follows:

Series 1600 non-diesel (early)	3.500-3.5015
Late production	3.6251-3.6266
Series 1600 diesel	3.750-3.7515
Series 1650 non-diesel	3.750-3.7515
Series 1650 diesel	3.875-3.8765

Sleeves and pistons are available in a package containing a sleeve, piston, piston pin, pin retaining rings, piston ring set and sleeve packing rings for one cylinder only. Sleeves and pistons are not available separately. Install new sleeve and piston packages if sleeve taper exceeds 0.004, sleeve out-of-round condition exceeds 0.002 or if ring end gap, measured at top of ring travel with new compression ring, is excessive. Also, install new sleeve and piston package if side clearance of new compression ring in top ring groove exceeds 0.006, or if piston and/or sleeve is scored, cracked or otherwise damaged.

Prior to installing sleeves, check sleeve standout or protrusion above machined surface of cylinder block as follows: Thoroughly clean the sleeve and sleeve bore in cylinder block, then insert sleeve in bore **without** sealing rings. Clamp sleeve in bore with short cap screws and flat washers. Check sleeve protrusion with straight edge and feeler gage; if protrusion is less than 0.001, a shim must be installed between flange of sleeve and bottom of counterbore in cylinder block. If the protrusion is more than 0.004, clean the sleeve flange and cylinder block counterbore more thoroughly. See Fig. 061.

Note: On Series 1650 diesel models, sleeve protrusion does not include sleeve "fire wall"; measure sleeve protrusion outside of firewall on these models.

When installing new pistons in new sleeves, piston skirt to cylinder wall clearance should be checked as follows: After installing sleeves in cylinder block, insert piston (without rings) in sleeve with a ½-inch wide feeler gage of specified thickness inserted between cylinder wall and piston skirt at right angle to piston pin. Piston skirt clearance is correct if 3 to 6 pounds pull (3-5 pounds pull on Series 1650 diesel) on a pull scale is required to withdraw the feeler gage. Specified feeler gage thickness is as follows:

Series 1600 non-diesel	0.0025
Series 1650 non-diesel	0.003
Series 1600 diesel	0.003
Series 1650 diesel	0.004

77. **PISTON RINGS.** Non-diesel pistons are fitted with two compression rings and one oil control ring. Three compression rings and one oil control ring are used on diesel pistons. Oil control ring on non-diesel engines and in diesel re-ring sets is of the flexible expander type with two steel rails.

Refer to the following specifications when checking piston rings:

Compression Ring Width:

All non-diesel	0.0925-0.0935
Series 1600 diesel	0.1235-0.1240
Series 1650 diesel	0.0930-0.0935

Oil Ring Width:

Series 1600 diesel	0.1860-0.1870
Series 1650 diesel	0.1860-0.1865

Ring End Gap:

Compression rings (all models)	0.010-0.020
Oil ring (diesel)	0.010-0.018
Maximum allowable (all)	0.045

Steel Oil Ring Rail End Gap:

All models so equipped	0.015-0.055

Ring Side Clearance:

Top ring,	
all non-diesel	0.0025-0.0045
Series 1600 diesel	0.0020-0.0035
Series 1650 diesel	0.0025-0.0040
2nd ring,	
all non-diesel	0.0020-0.0040
Series 1600 diesel	0.0015-0.0030
Series 1650 diesel	0.0020-0.0035
3rd ring,	
Series 1600 diesel	0.0015-0.0030
Series 1650 diesel	0.0020-0.0035
Oil ring,	
Series 1600 diesel	0.0010-0.0030
Series 1650 diesel	0.0015-0.0030
Maximum allowable side clearance, all rings (except flexible oil	

in rod and cap on the same side of the assembly. Note: Factory installed connecting rods and caps are not numbered; cylinder numbers should be stamped on camshaft side of rod and cap prior to removing cap, if necessary.

Connecting rod length, center-to-center, is 6.747-6.750 on non-diesel models and 6.749-6.750 on diesel models. Series 1600 diesel connecting rods are offset 0.120-0.130; connecting rods on all other models have no offset.

Bearing inserts are available in

non-diesel or Series 1600 diesel engine.

To remove the crankshaft, first remove engine as outlined in paragraph 60. Remove from engine, as so equipped, the Reverse-O-Torc Drive, Hydra-Power Drive and clutch, Creeper Drive and clutch or the direct drive clutch housing and clutch. Then, remove flywheel, oil pan and oil pump, rear oil seal retainer and timing gear cover. On diesel models, remove the fuel injection pump idler gear, injection pump drive gear and shaft, then unbolt fuel injection pump from engine front plate and remove the plate from front of cyl-

rings), all models.....0.006

PISTON PINS AND BUSHINGS

All Models

78. The full floating type piston pins are retained in piston bosses by snap rings. Piston pins are available for service in oversizes of 0.005 and 0.010 as well as the standard size 1.2494-1.2497.

Connecting rods are fitted with two split type steel backed bronze bushings in each rod. Bushings are available for service and when being installed, the notch in inner side of each bushing must be aligned with oil hole in rod and outer side of each bushing flush with rod. After bushings are installed, hone the bushings to provide a thumb press fit of pin in bushings at room temperature with surfaces dry. With pin and bushings lubricated, pin should just fall through bushings from its own weight. Desired pin to bushing clearance is 0.0004-0.0009, with maximum allowable clearance of 0.0019.

When installing oversize piston pins, the piston bosses must be honed to provide a 0.0002-0.0004 clearance for pin. Maximum allowable pin to piston bore clearance is 0.0008.

CONNECTING RODS AND BEARINGS

All Models

79. Connecting rod bearings are of the non-adjustable precision insert type and can be renewed after removing oil pan and connecting rod caps. When installing new bearing inserts, make certain that tangs on inserts fit into slots in connecting rod and cap and that the cap is installed with slots undersizes of 0.003 and 0.020 as well as standard size.

Check the crankpin and bearing inserts against the following values:

Crankpin dia., all
- Non-diesel 2.249-2.250
- Diesel 2.4365-2.4375

Rod bearing running clearance,
- all models 0.0005-0.0015

Maximum running clearance,
- all models 0.0025

Connecting rod side play,
- all models 0.0075-0.0135

Connecting rod bolt torque, Ft.-Lbs.:
- Non-diesel models 46-50
- Series 1600 diesel.....56-60
- Series 1650 diesel.....56-58

CRANKSHAFT AND BEARINGS

All Models

80. Crankshaft in the Series 1650 diesel engine is supported in seven main bearings. In all other models, crankshaft is supported in four main bearings. Bearings are of the non-adjustable precision insert type. Crankshaft end play is controlled by the flanged number five main bearing inserts on Series 1650 diesel crankshaft and by the flanged number three main bearing inserts on other models. Excessive crankshaft end play can be corrected by renewing the crankshaft and/or main bearings, or by regrinding the crankshaft main bearing thrust journal diameter to 0.020 undersize and 0.017 overwidth, then installing the 0.020 undersize, 0.017 overwidth bearing inserts available.

Note: The 0.020 undersize main bearing thrust journal inserts for Series 1600 engines were of standard width. However, the 0.020 undersize, 0.017 overwidth thrust journal inserts for Series 1650 non-diesel models can be installed in either the Series 1600 inder block. Remove the connecting rod and main bearing caps and lift crankshaft from engine. Remove crankshaft timing gear as outlined in paragraph 71, if necessary.

Refer to the following specifications for checking the crankshaft and main bearings:

Desired crankshaft end play:
- Series 1650 diesel.....0.0045-0.0095
- All other models.....0.0045-0.0085

Maximum allowable crankshaft end play:
- Series 1650 diesel.....0.011
- All other models.....0.010

Crankshaft thrust journal standard width:
- Series 1650 diesel.....1.5025-1.5045
- All other models.....1.7525-1.7545

Thrust bearing insert width (standard and 0.003 undersize):
- Series 1650 diesel.....1.4950-1.4980
- All other models.....1.7460-1.7480

Thrust bearing insert width (0.020 undersize):
- Series 1650 diesel.....1.5120-1.5150
- All other models.....1.7630-1.7650

Crankshaft main journal standard diameter:
- All models 2.6240-2.6250

Crankshaft crankpin standard diameter:
- Non-diesel 2.2490-2.2500
- Diesel 2.4365-2.4375

Main bearing running clearance:
- Series 1650 diesel,
  - Desired 0.0015-0.0045
  - Maximum allowable 0.0055
- All other models,
  - Desired 0.0005-0.00035
  - Maximum allowable 0.0045

Journal out-of-round or taper, maximum:
- All models 0.0003

Flywheel mounting flange runout, maximum:
- All models 0.001

Main bearing bolt torque, Ft.-Lbs.:
- Series 1650 diesel.....129-133
- All other models.....108-112

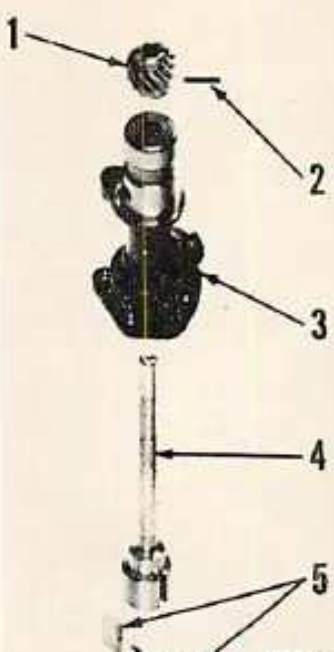
CRANKSHAFT OIL SEALS

All Models

81. **FRONT OIL SEAL.** After removing the timing gear cover as outlined in paragraph 70, the crankshaft front oil seal can be removed from the crankshaft. Install a new sealing gasket on the crankshaft, place new seal on shaft with sealing face out and place a second sealing gasket on shaft in front of the oil seal. Check condition of the seal contact surface on timing gear cover before reinstalling the cover. Note: On early production, a gasket was fitted between the oil seal and crankshaft timing gear only. However, install a new

On direct drive models, remove the engine clutch as outlined in paragraph 151, then proceed as follows: Remove cap screws retaining PTO drive hub and flywheel to engine crankshaft. Using two of the capscrews as puller bolts, remove drive hub from the flywheel and two dowel pins. Then remove flywheel from the dowel pins and crankshaft flange.

To install a new flywheel ring gear, heat gear evenly to a temperature of 400°F. to 450°F. and install gear with beveled end of teeth toward front of flywheel. If necessary to renew the timing tape, thoroughly clean flywheel, peel backing from tape and apply tape to flywheel with edge of



gasket at both front and rear of the oil seal when servicing these engines.

82. **REAR OIL SEAL.** On direct drive models, the crankshaft rear oil seal can be renewed without removing the engine from tractor.

To renew the crankshaft rear oil seal, remove the flywheel as outlined in paragraph 83 and drain and remove the oil pan. Remove the oil seal retainer capscrews and carefully pry retainer loose from the locating dowels and gasket seal. Carefully press new seal into retainer with lip forward. Reinstall retainer with new gasket, tighten the retaining capscrews and then install oil pan with new gasket.

Note: If the oil seal retainer is warped or otherwise damaged, the seal and retainer should be renewed as a unit. Late production retainers are ribbed to prevent warpage and if an early production retainer without reinforcing ribs is encountered, it is recommended that the late type ribbed retainer and seal assembly be installed.

FLYWHEEL

All Models

83. On models equipped with Reverse-O-Torc drive, remove engine from tractor as outlined in paragraph 60, remove converter housing and torque converter as in paragraph 182. The flywheel can then be unbolted and removed from the crankshaft flange and dowel pins.

On models equipped with Creeper Drive or Hydra-Power Drive, remove engine from tractor as outlined in paragraph 60 and remove the drive unit as outlined in paragraph 155 or 172. Then remove clutch unit and flywheel following same general procedure as outlined for direct drive models.

tape even with edge of flywheel and the TDC marks on flywheel and tape aligned.

When installing flywheel, and PTO drive hub if so equipped, tighten the retaining cap screws to a torque of 66-69 Ft.-Lbs. After flywheel is installed, check flywheel runout which should not exceed 0.005.

OIL PUMP

All Models Except Series 1650 Diesel

84. All models except the Series 1650 diesel are fitted with a vane type oil pump as shown in the exploded view in Fig. O62. To remove the pump, drain and remove oil pan. After removing the one retaining cap screw, pump can be withdrawn from bottom of engine crankcase.

Pump vanes (5) and spring (6) can be removed after removing cover (7). To remove shaft (4), place assembly marks on gear (1) and shaft, then remove the pin (2) and press or pull gear from shaft. Clean all parts and inspect for wear. Although all parts are available separately, a new pump assembly should be installed if both the pump body and shaft are worn excessively.

If new shaft or gear is being installed, press gear on shaft to a position so that shaft end play is $\frac{1}{32}$-inch, drill a hole through gear and shaft with a No. 13 drill and install pin. If reinstalling original gear and shaft, press gear onto shaft with previously affixed assembly marks aligned and so that pin can be installed in the hole through gear and shaft. Also see Fig. 063.

85. When installing pump assembly on diesel engines, remove the tachourmeter drive unit if so equipped. After installing the oil pump, insert

Fig. O62 — Exploded view of vane type oil pump used in all models except Series 1650 diesel.

1. Drive gear
2. Pin
3. Pump body
4. Pump shaft
5. Vanes
6. Spring
7. Pump cover
8. Cotter pin
9. Floating screen

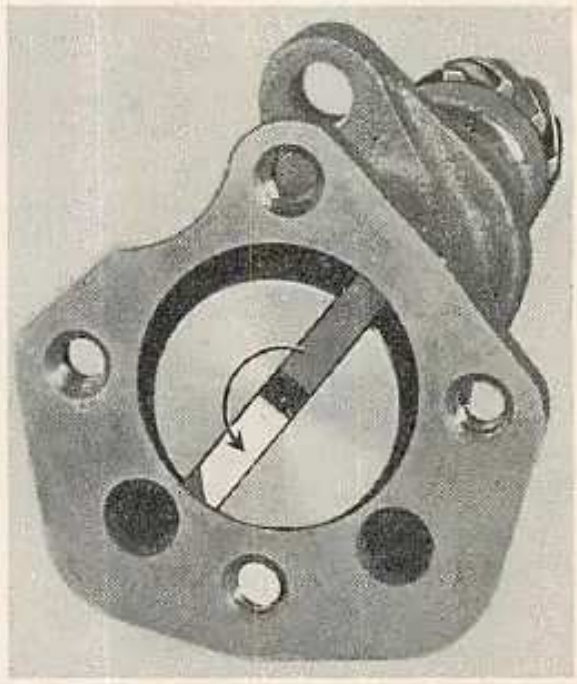


Fig. O63 — When installing pump vanes, be sure beveled edges are placed as shown.

tachourmeter drive shaft into slot in pump drive gear. Then, reinstall tachourmeter drive housing and retaining clamps.

86. On non-diesel models, remove the ignition distributor and turn the engine to where the No. 1 piston is at TDC on compression stroke. Then, install oil pump with slot in drive gear positioned as shown in Fig. O64. Reinstall and time ignition distributor as outlined in paragraph 145.

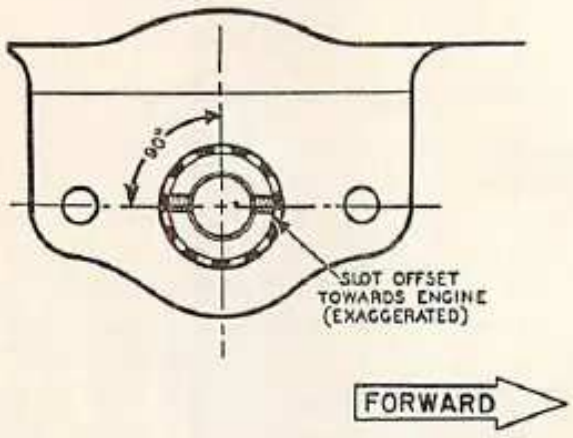


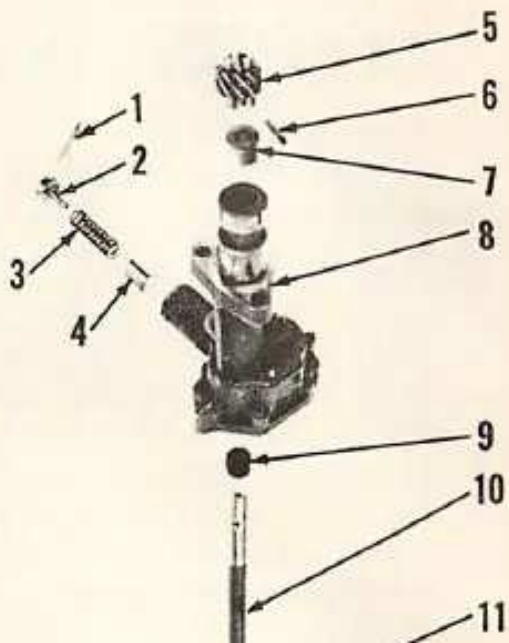
Fig. O64 — When installing oil pump in non-diesel models, slot in drive gear must be timed. Refer to text.

adjusting screw in same number of turns required to remove screw and to a position where the previously affixed marks are aligned, then install cotter pin (1). Note: If new screw is being installed, or original position of screw is not known, reinstall screw flush with pump body, then turn screw in to first position that cotter pin can be installed.

Install the oil pump as outlined in paragraph 85 or 86.

MAIN OIL GALLERY PRESSURE RELIEF VALVE

All Models



Series 1650 Diesel

87. A gear type oil pump as shown in the exploded view in Fig. O65 is used on the Series 1650 diesel engine. To remove pump, drain oil pan, remove the pan and the two pump retaining capscrews and withdraw pump from bottom of engine crankcase.

Place alignment marks on adjusting screw (2) and pump body (8) prior to removing screw, then count the number of turns required to remove the screw and record for proper reassembly. Also, place assembly marks on the drive gear (5) and shaft (10) in the event that the original gear and shaft may be reinstalled.

Refer to the following specifications when overhauling pump:

Relief valve setting.....42 psi.
Relief valve spring
free length .....2 11/16 inch
Relief valve plunger
diameter 0.745-0.747
Idler gear to shaft
clearance, desired 0.0035-0.0045
Maximum allowable 0.006
Drive shaft to bushing clearance,
Upper bushing, desired.0.0005-0.003
Maximum allowable 0.0045
Lower bushing,
desired 0.0035-0.0045
Maximum allowable 0.006
Drive gear to body
clearance 0.004-0.008

If installing new upper drive shaft bushing (7), be sure oil hole in bushing is aligned with hole in pump body (8). If installing new drive gear (5) and shaft (10), press gear onto shaft so that drive gear to body clearance is 0.004-0.008, drill a 3/16-inch hole through gear and shaft and install pin (6).

When installing relief valve, thread

88. Oil pressure on all models is controlled by a spring loaded poppet type relief valve in the main oil gallery as shown in Fig. O66. To check engine oil pressure, remove the oil pressure warning sender switch from engine and install a master oil pressure gage. With engine at normal operating temperature, oil pressure should be as follows:

Series 1600, All Models:
Pressure @ 400
engine RPM .....5-10 psi
Pressure @ 2000
engine RPM .....25-30 psi

Series 1650, Non-Diesel Models:
Pressure at slow
idle speed .....5 psi
Pressure @ 2200
engine RPM .....20-40 psi

Series 1650 Diesel Models:
Pressure at slow
idle speed .....10 psi
Pressure @ 2200
engine RPM .....25-42 psi

If pressure is not as specified, the gallery oil pressure relief valve should be removed, cleaned and inspected. The 0.497-0.498 diameter plunger should slide freely in bore of cylinder block. Check the spring against the following specifications:

Series 1650 Diesel Models:
Spring free length.....1⅜-inches
Pressure @ 1 in. length.5½-6½ lbs.

All Models Except Series 1650 Diesel:
Spring free length.....2 inches
Pressure @ 1 inch length....10 lbs.

On Series 1650 diesel models, a 42 psi safety relief valve is incorporated in the gear type oil pump. If, after reinstalling the main gallery relief valve on these models, pressure is still not as specified, a faulty or sticking pump relief valve should be suspected.

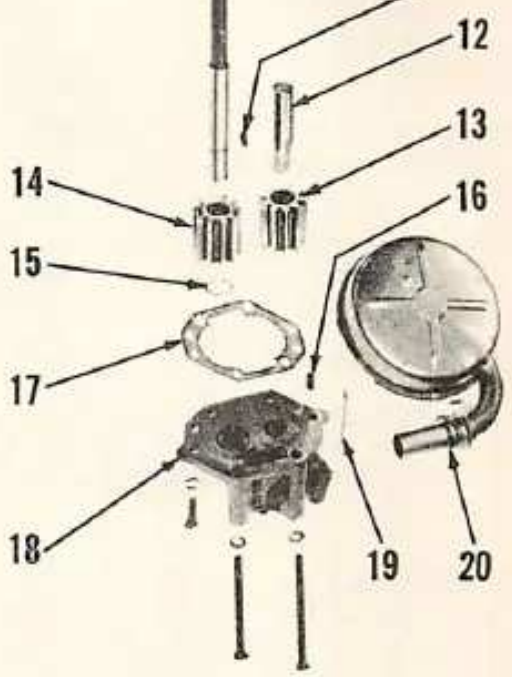


Fig. O65 — Exploded view of gear type oil pump used on Series 1650 diesel engines. Engine oil pressure is controlled by main gallery relief valve shown in Fig. O66. Pump relief valve (items 1 through 4) is set at 42 psi by adjusting screw (2).

1. Cotter pin
2. Adjusting screw
3. Spring
4. Plunger
5. Drive gear
6. Pin
7. Upper bushing
8. Pump body
9. Lower bushing
10. Drive shaft
11. Woodruff key
12. Idler shaft
13. Idler gear
14. Driven gear
15. Snap ring
16. Dowel pins (2)
17. Gasket
18. Pump cover
19. Cotter pin
20. Floating screen

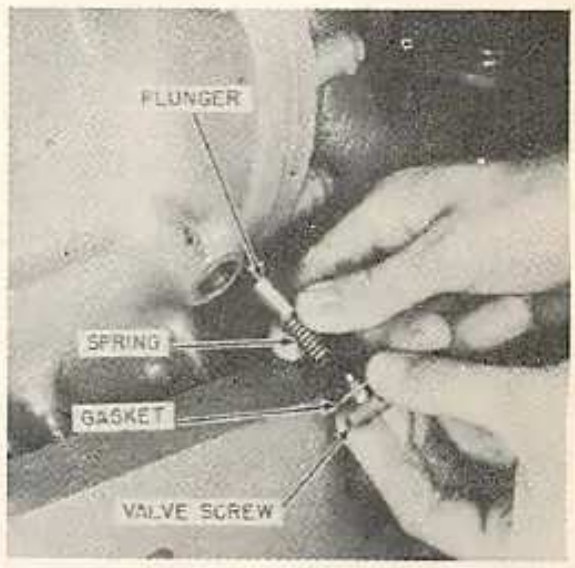


Fig. O66 — View showing main oil gallery relief valve.

CARBURETOR (Except L-P Gas)

All Gasoline Models

89. Series 1600 and Series 1650 gasoline engines are equipped with Marvel-Schebler Model TSX carburetors as follows: Early production Series 1600 (231 cu. in. displacement), TSX-868; late production Series 1600 (248 cu. in. displacement), TSX-880; and Series 1650, TSX-807.

With carburetor throttle body inverted, float level should be ¼-inch above gasket (5/32-inch above machined surface) on all models. Repair data follows:

Model TSX-868:
Repair kit 286-1418
Gasket set 16-594
Inlet needle and seat.....233-543-or 233-608
Idle jet 49-203
Nozzle 47-796
Power jet 49-216
Economizer jet 49-264

Model TSX-880:

FILTER

Models With Zenith System

91. The LP-Gas filter, located at left side of battery tray, is fitted with a renewable element and should be cleaned monthly as follows: Turn off the vapor and liquid withdrawal valves, remove plug from bottom of filter bowl and allow any accumulations to drain. Slowly open the vapor valve and blow out any accumulations which remain.

Every year, unscrew the filter bowl and renew the element and gasket.

VAPORIZER

Model TSX-807:

Repair kit	286-1318
Gasket set	16-594
Inlet needle and seat	233-581
Idle jet	49-203
Nozzle	47-416
Power jet	49-479
Economizer jet	49-145
Repair kit	286-1437
Gasket set	16-594
Inlet needle and seat	233-543 or 233-608
Idle jet	49-203
Nozzle	47-A96
Power jet	49-369
Economizer jet	49-264

L-P GAS SYSTEM (Zenith)

Early production Series 1600 LP-Gas models were equipped with a Zenith vaporizer and primary regulator unit and a Zenith pressure regulating carburetor. For American Bosch-Ensign LP-Gas equipment used on late production Series 1600 and Series 1650 LP-Gas models, refer to paragraph 98.

ADJUSTMENTS

Models With Zenith System

90. Initial adjustments on the carburetor are 2 to 3 turns open for the idle mixture screw and 1 to 2 turns open for the main fuel adjusting screw.

Start engine and bring to operating temperature. Adjust throttle stop screw to obtain an engine low idle speed of 475-525 rpm. Turn the idle mixture screw in or out as required until engine runs smoothly. Correct adjustment should be obtained with idle mixture screw open approximately 2⅜ turns. Recheck engine low idle rpm.

Place load on engine and run at high idle (2200 rpm). Turn the main adjusting needle inward until engine starts to lose power, then turn needle out until full power is restored. Repeat this operation until a definite setting is obtained. Correct setting should be obtained when the needle is 1¾ turns open for tractors using commercial propane; 1½ turns open for tractors using 50 percent propane and 50 percent butane and 1¼ turns open for tractors using 20 percent propane and 80 percent butane.

If stationary loading of engine is not possible, make adjustments then operate tractor under drawbar load. Refer to Fig. O67.

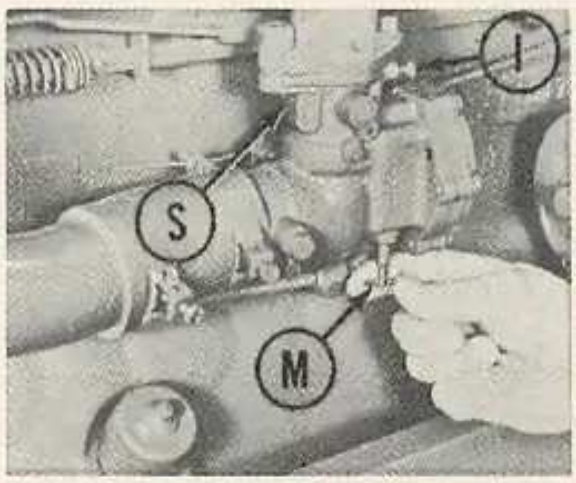


Fig. O67 — Points of adjustment for the Zenith LP-Gas pressure regulating carburetor.

I. Idle mixture screw
M. Main fuel needle
S. Throttle stop screw

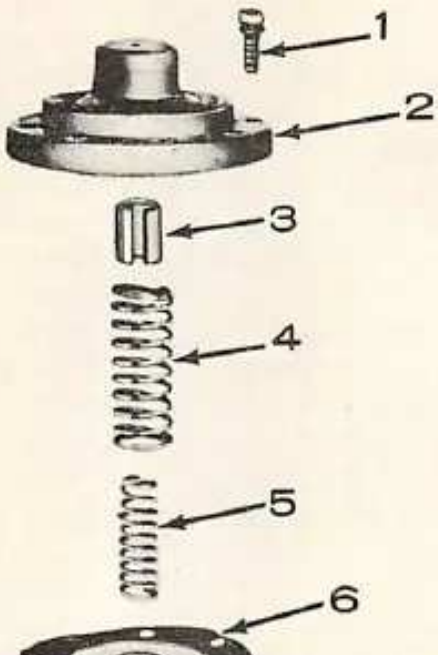
Models With Zenith System

92. The vaporizer used on LP-Gas models of the early Series 1600 tractors is a Zenith model number A962A-1.

93. **R&R AND OVERHAUL.** Before disconnecting any lines, be sure that all fuel is out of the lines, vaporizer, regulator and carburetor by closing the tank withdrawal valves and allowing the engine to run until it stops. Turn off ignition switch, then drain cooling system and remove hood and side panels. Disconnect and remove air cleaner and bracket assembly. Disconnect fuel lines from vaporizer, then remove the retaining cap screw at bottom of vaporizer housing and withdraw vaporizer assembly.

Refer to Fig. O68 and proceed as follows: Remove the four cap screws and separate vaporizer coil and mounting plate assembly (18) from vaporizer body (14). Discard all three "O" rings. Remove any alternate four of the diaphragm cover screws and install in their place four aligning studs (Zenith No. C161-195, or equivalent). Maintain pressure on the diaphragm, remove the remaining four cap screws, then carefully release the pressure on diaphragm cover and remove cover (2), diaphragm springs (4 and 5) and vibration dampener (3). Remove studs; then remove diaphragm (6), baffle plate (7), baffle plate gasket (8) and fuel valve cap (9) as shown in Fig. O69. Use a 1-inch socket wrench and remove valve seat (10—Fig. O68), fuel valve (12) and spring (13) as shown in Fig. O70.

Clean all parts in a grease solvent, however, DO NOT use carburetor cleaning solvents for cleaning any of the parts as carburetor cleaners will destroy the impregnation used in the casting and the coating on the coil. Inspect all parts for undue wear or other damage and renew as necessary.



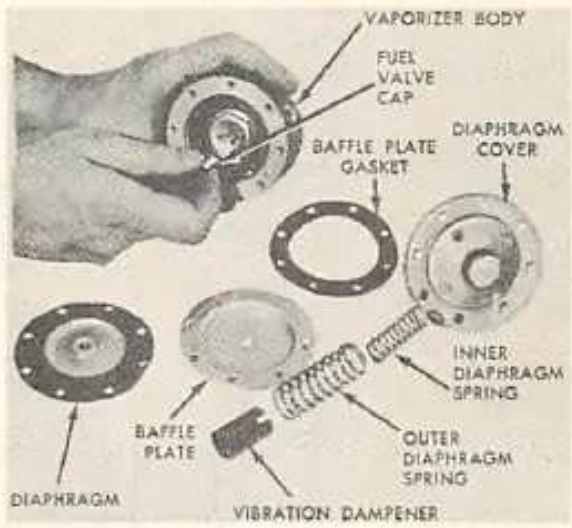


Fig. O69 — Partially disassembled view of vaporizer assembly. Note fuel valve cap.

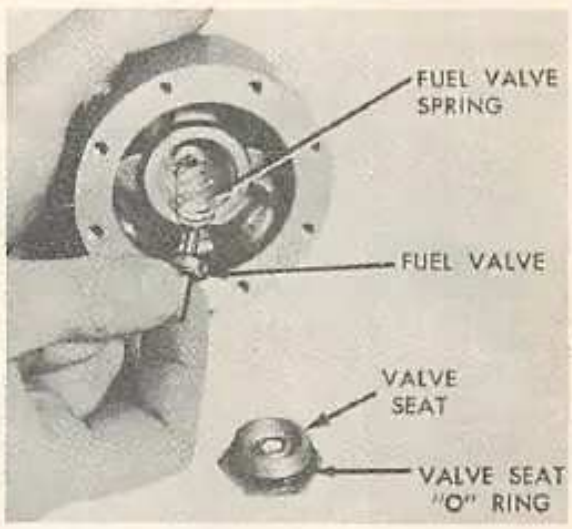


Fig. O70 — View showing fuel valve being removed from body.

94. To reassemble, proceed as fol-

a pressure of 9 to 11 psi and the read-

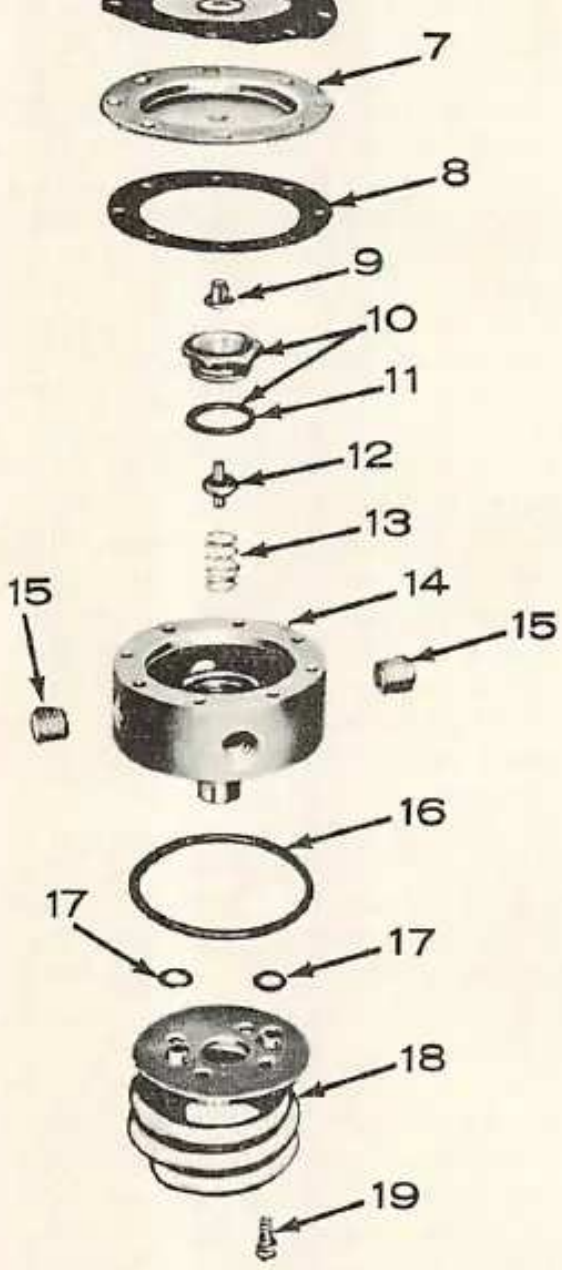


Fig. O68 — Exploded view of Zenith LP-Gas vaporizer assembly.

2. Diaphragm cover
3. Vibration dampener
4. Outer spring
5. Inner spring
6. Diaphragm
7. Baffle plate
8. Gasket
9. Fuel valve cap
10. Valve seat
11. "O" ring
12. Fuel valve
13. Valve spring
14. Body
15. Allen plug
16. "O" ring
17. "O" ring
18. Coil & mounting plate

low: Place fuel valve spring (13—Fig. O68) over boss in center of vaporizer housing (14), then place fuel valve (12) on spring with shortest stem toward housing. Be sure spring is resting on machined shoulder of fuel valve, then with new "O" ring on valve seat (10), install valve seat in vaporizer body and tighten. Place fuel valve cap (9) over the protruding fuel valve stem. Reinstall the aligning studs in four alternate holes in top of vaporizer body, then install new baffle plate gasket (8), baffle plate (7), with recessed side toward body, and diaphragm (6), with flanged disc away from body. Be sure fuel valve cap enters center hole of baffle plate. Place vibration dampener (3) inside the outer diaphragm spring (4). Place inner diaphragm spring (5) over center of diaphragm plate, then install outer spring over the inner spring. Place diaphragm cover (2) over aligning studs and depress cover until cap screws can be installed in the remaining four holes. Continue to depress the diaphragm cover and seat the cap screws lightly. Remove the aligning studs and install the remaining four cap screws. Tighten all the cap screws evenly and to a moderate tightness. Install a new "O" ring (16) on vaporizer body and two new "O" rings (17) on ends of vaporizer coil. Align mounting holes and install coil and mounting plate assembly (18) to vaporizer body.

95. **PRESSURE AND LEAKAGE TESTS.** To conduct pressure and leakage tests, proceed as follows: Install a pressure gage capable of registering at least 30 psi in the vaporizer outlet as shown in Fig. O71. Connect the vaporizer inlet to a source of compressed air, loosen the previously installed gage until leakage occurs, then retighten gage. Gage should register ing should remain steady. If gage reading creeps up, it indicates a leaking fuel valve or fuel valve seat. If a leak is indicated, correct it by cleaning and/or renewing valve parts as necessary.

To check for leakage, use a bubble solution and proceed as follows:

Cover vent hole in diaphragm cover. If bubble forms, the diaphragm is leaking. Renew diaphragm and recheck.

Check around the diaphragm cover. If bubbles form, renew baffle plate gasket and recheck.

Check pipe plugs and if bubbles form, remove plugs; then reinstall them using a pipe plug compound and recheck.

Check the vaporizer coil mounting plate and if bubbles form, remove the vaporizer coil and mounting plate and renew "O" rings; then recheck.

PRESSURE REGULATING CARBURETOR

Models With Zenith System

96. **OPERATION.** The Zenith PC2 J 10 pressure regulating carburetor serves both as a secondary regulator and carburetor. See Fig. O72 for a cross-sectional view of the carburetor.

The fuel valve seat (2) is adjustable so that the relationship of the diaphragm lever (9) and the diaphragm flange can be varied to meet the specifications for the particular engine operation. The fuel valve seat (2) is locked in position in the carburetor body by means of the lock screw and plug.

Fuel enters the carburetor at the

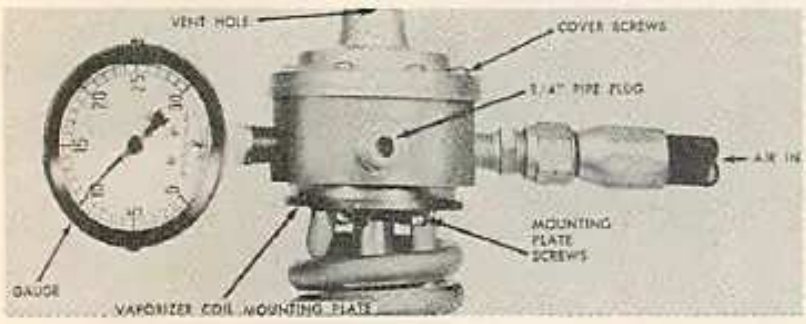
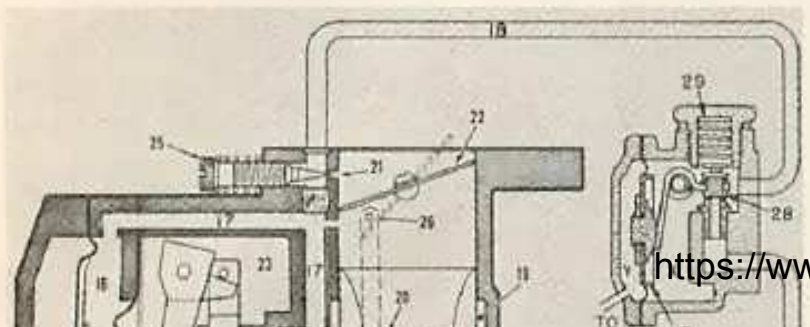
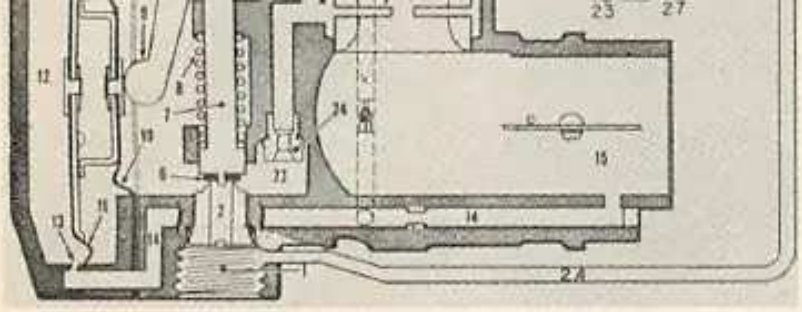


Fig. O71 — To test vaporizer assembly, install pressure gage and line as shown. Refer to text for procedure.



1. Fuel inlet
2. Fuel valve seat
7. Fuel valve
8. Fuel valve spring
9. Diaphragm lever
10. Inner diaphragm
11. Outer diaphragm
12. Outer diaphragm chamber
14. Air passage
15. Air intake

fuel inlet (1) from the primary regulator at a pressure of 9-11 psi; but is prevented entering the carburetor by the neoprene seal (6) on the regulating (fuel) valve (7). When the engine is not running, pressures are equal in all parts of the carburetor and no fuel can flow. When the engine choke is closed and the engine turned over with the starter, a partial vacuum is built up in the carburetor air horn beyond the choke fly and transmitted to the chamber (16) between the two diaphragms by means of passage (17). The greater pressure in chamber (12) causes the large diaphragm (11) to move inward, acting through the spacer on diaphragm (10), moving the lever arms (9) to overcome the pres-



16. Inner diaphram chamber
17. Idle fuel passage
19. Annulus
20. Venturi
21. Idle needle seat
22. Throttle disc
23. Pressure chamber
24. Main jet
25. Idle needle
26. Economizer orifice
27. Idle diaphragm
28. Idle mixture valve
29. Spring

Fig. O72—Cross-sectional schematic view of Zenith LP-Gas pressure regulating carburetor.

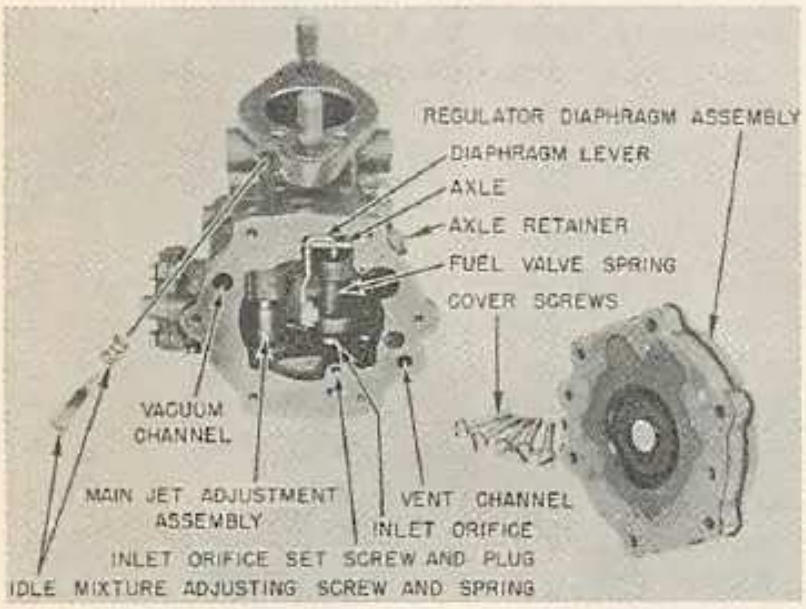


Fig. O73 — Zenith LP-Gas pressure regulating carburetor shown with diaphragm assembly removed.

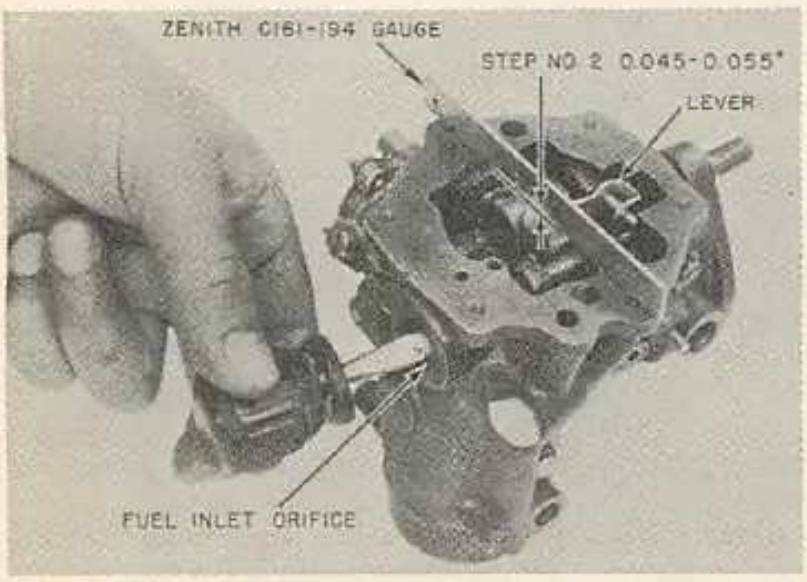


Fig. O74 — When adjusting diaphragm lever, use step number two of Zenith gage number C161-194 as shown.

sure of spring (8) and raise the fuel valve (7) off its seat admitting fuel to the pressure chamber (23). Fuel continues to enter the pressure chamber until pressure in chamber (23), combined with the pressure of spring (8), overcomes the pressure of diaphragm (11) and closes the fuel valve (7). In engine idle operation, throttle valve (22) is closed, causing a high vacuum above the throttle valve, and fuel flows from the pressure chamber through orifice (18) past idle needle (25) to provide fuel for engine idle. At full throttle operation, the restriction of the venturi (20) causes a pressure drop at this point, drawing fuel into the carburetor and mixing it with air at the venturi. At part throttle operation, the action of the throttle valve (22) causes a decrease of pressure at orifice (26) which is transmitted through a drilled passage to passage (14) causing a slight lowering of pressure in chamber (12) back of diaphragm (11), resulting in a progressively leaner fuel mixture at part throttle operation.

97. **R&R AND OVERHAUL.** To remove the carburetor, first close both withdrawal valves and exhaust the fuel in the regulator and lines by allowing the engine to run until it stops. Turn off the ignition switch, disconnect the choke and throttle linkage, air cleaner hose and the fuel inlet line. Unbolt and remove the carburetor assembly. Remove the six screws, securing the diaphragms to the carburetor and remove the diaphragms as shown in Fig. O73. Remove the fuel inlet fitting from the bottom of the carburetor and the inlet valve seat set screw and plug; then remove the inlet valve seat while holding the valve off its seat with the diaphragm lever.

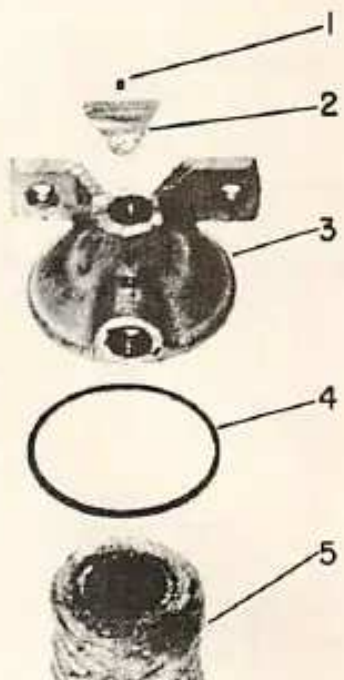
Remove the diaphragm lever shaft plug in the side of the carburetor body and remove the shaft, lever and fuel valve assembly. Remove the main and idle needle valves and the main valve body using Zenith tool No. C161-193, or equivalent. Remove the throttle and choke flys and shafts, and the venturi by removing the venturi locking screw in the side of the carburetor body.

Clean all parts, with the exception of the diaphragms and fuel valve seal, in a suitable solvent and examine for wear or damage. Examine the diaphragm for cracks, pin holes or deterioration and renew if necessary. Reassemble the carburetor by reversing the disassembly procedure using

While holding the fuel valve open, install the fuel valve seat and adjust same until fuel valve lever just touches the land of step number three of Zenith gage C161-194 as shown in Fig. O74. Retain fuel valve in this position by installing plug and set screw.

Note: If Zenith gage is not available, the distance between machined surface of body and tip of lever is $\frac{3}{32}$-inch.

When reinstalling the diaphragm, [illegible] make sure that the parts are arranged so



ing the disassembly procedure using new gaskets and a new fuel valve seal.

that the diaphragm passages are aligned with the passages in the carburetor body.

LP-GAS SYSTEM (Bosch-Ensign)

Late production Series 1600 and Series 1650 tractors are available with an LP-Gas system manufactured by the Ensign Products Section, American Bosch Arma Corporation. Like other LP-Gas systems, this system is designed to operate with the fuel tank not more than 80% filled.

The Bosch-Ensign Series CBX carburetors and Series RDG Regulator have three points of mixture adjustment, plus an idle stop screw. Application and repair data follows:

Bosch-Ensign Carburetor Part No.:

Series 1600 ..... CBX125A5525A
Series 1650 ..... CBX150A5530A-2

Carburetor Repair Kit Part No.:

All Models KT46115

Bosch-Ensign Regulator Part No.:

All Models RDG100A1

Regulator Repair Kit Part No.:

All Models KT46150

ADJUSTMENTS

Models With Bosch-Ensign System

98. **INITIAL ADJUSTMENTS.** After overhauling or installing new carburetor or regulator, make the following initial adjustments: Open idle screw on regulator 1½ turns. Open starting adjustment screw on carburetor 1 turn. Open load adjustment screw on carburetor 7½ to 8 turns. Close choke and open throttle halfway to start engine.

99. **STARTING SCREW ADJUSTMENT.** After engine has been started and is at normal operating temperature, fully open throttle while leaving choke closed. Adjust starting screw to give highest engine speed, then turn screw out slightly until engine speed just starts to drop and tighten lock nut. Return throttle to slow idle position and open choke.

100. **IDLE STOP SCREW.** Adjust idle stop screw on carburetor throttle to obtain an engine slow idle speed of 450 RPM.

101. **IDLE MIXTURE SCREW.** Adjust idle mixture screw on regulator to obtain best engine idle performance when engine is at operating temperature. Readjust idle stop screw if necessary.

102. **LOAD SCREW ADJUSTMENT (WITH ANALYZER).** Be sure to follow the gas analyzer operating instructions and set load screw to give a reading of 12.8 on gasoline scale or 14.3 on LP-Gas scale with engine at normal operating temperature and normal operating temperature and running at high idle speed. Recheck idle mixture and stop screw adjustment.

103. **LOAD SCREW ADJUSTMENT (WITHOUT ANALYZER).** With engine running at full throttle and at normal operating temperature, apply load until governor opens carburetor throttle wide open. Find adjustment point where engine speed begins to drop from mixture being too rich, then too lean. Set adjustment midway between these two points and tighten jam nut. Recheck idle mixture and stop screw adjustment .

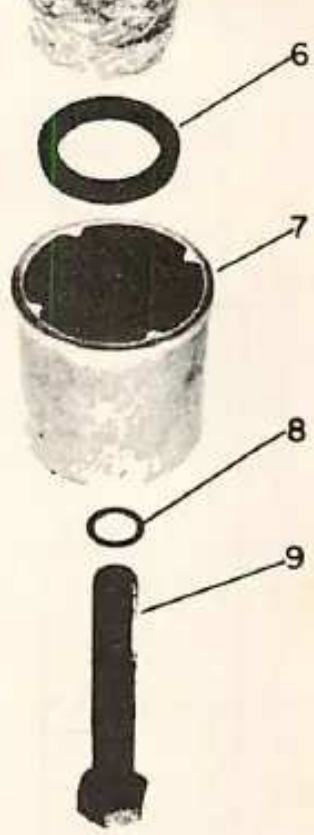
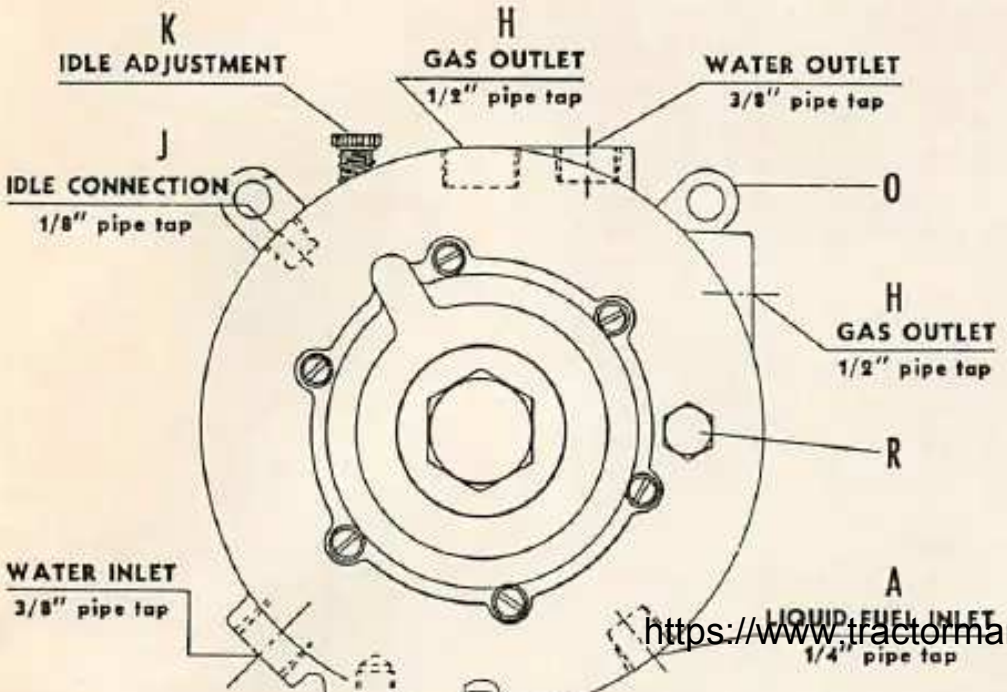
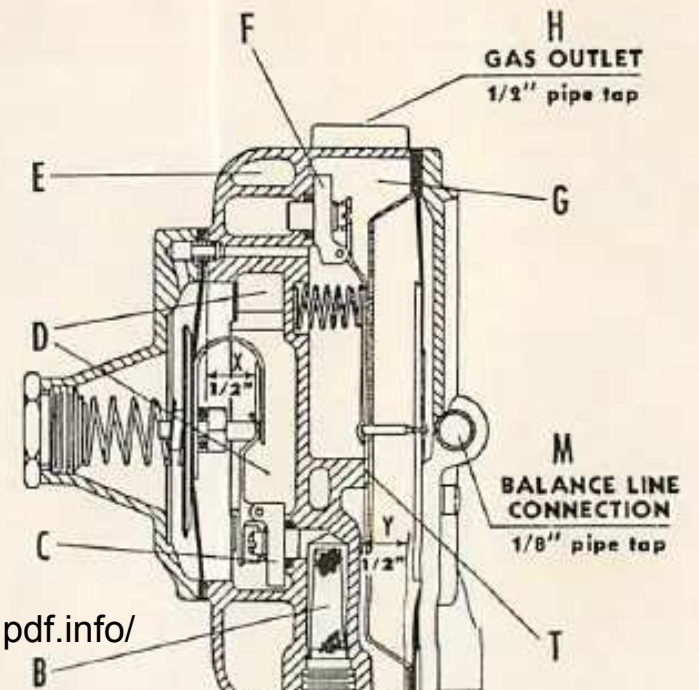


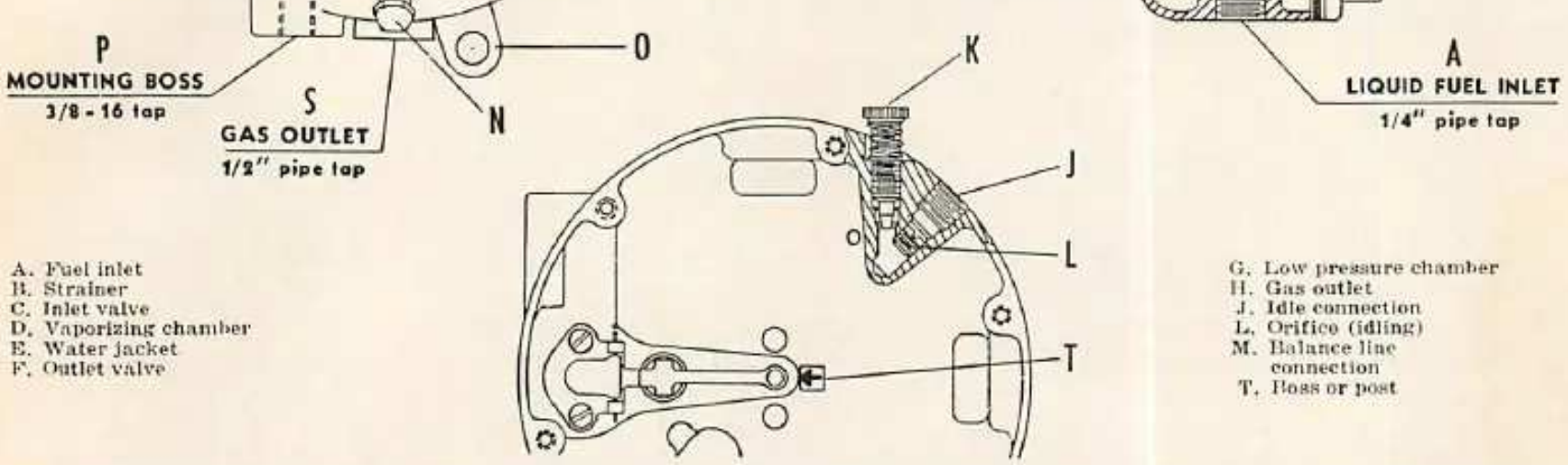
Fig. O75 — Exploded view of the Bosch-Ensign FLP25B1 fuel filter used on late Series 1600 and Series 1650 LP-Gas equipped models.

1. Screw
2. Nameplate
3. Cover
4. Gasket
5. Element
6. Magnet
7. Housing
8. Gasket
9. Bolt

104. **LOAD SCREW ADJUSTMENT. (WITHOUT ANALYZER OR LOAD).** Make idle adjustment carefully as outlined in paragraph 101. With engine running at high idle speed and at normal operating temperature, adjust load screw to give maximum engine RPM; then, slowly turn load screw in until engine speed begins to fall. Set load screw midway between these two positions.







A. Fuel inlet
B. Strainer
C. Inlet valve
D. Vaporizing chamber
E. Water jacket
F. Outlet valve

G. Low pressure chamber
H. Gas outlet
J. Idle connection
L. Orifice (idling)
M. Balance line connection
T. Boss or post

Fig. O76 — Views showing construction and adjustment points of Bosch-Ensign regulator similar to that used on late Series 1600 and Series 1650 tractors. For exploded view of regulator, refer to Fig. O77.

FILTER

Models With Bosch-Ensign System

105. The Bosch-Ensign filter (See Fig. O75) is equipped with a felt filtering element and a magnetic ring. When servicing the LP-system or on major engine overhauls, it is advisable to remove the filter housing and clean or renew the filtering element. CAUTION: Shut off both liquid and vapor valves at fuel tank and run engine until fuel is exhausted before attempting to remove the filter housing.

REGULATOR

Models With Bosch-Ensign System

The Bosch-Ensign Series RDG regulator combines a heat exchanger to vaporize liquid LP-Gas with a two stage regulator to reduce fuel pressure to slightly below atmospheric. The primary regulator reduces the fuel from tank pressure to approximately 4 psi as it enters the final regulator. Heat for vaporizing the liquid fuel is obtained from coolant from the tractor cooling system. Refer to Fig. 076 for cross-sectional views of regulator and principles of operation.

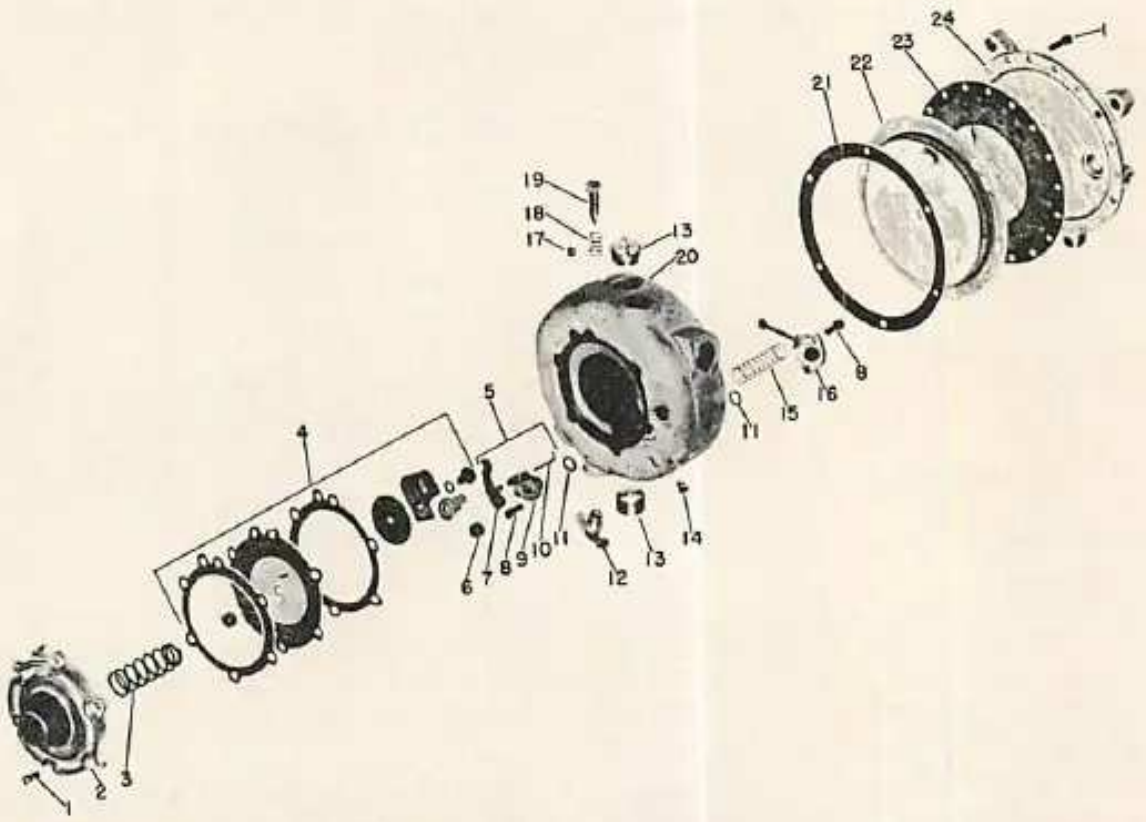


Fig. O77 — Exploded view of the Bosch-Ensign regulator used on Series 1650 and late Series 1600 tractors. Refer to Fig. O76 for views showing construction and adjustment points.

1. Screws
2. Cover
3. Spring
4. Diaphragm assy.
5. Valve assembly
6. Plug
7. Lever
8. Screw & washer
9. Valve body
10. Pin
11. "O" ring
12. Drain cock
13. Plug
14. Strainer
15. Spring
16. Valve assy.
17. Screw
18. Spring
19. Idle adj. screw
20. Regulator body
21. Gasket
22. Plate
23. Diaphragm
24. Cover plate

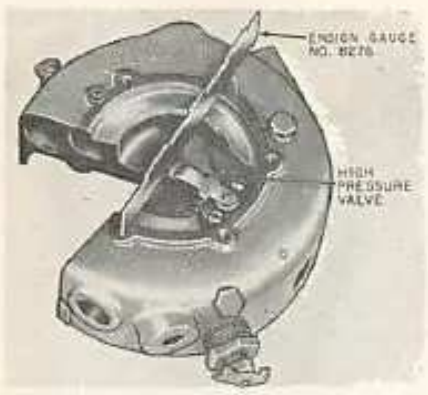
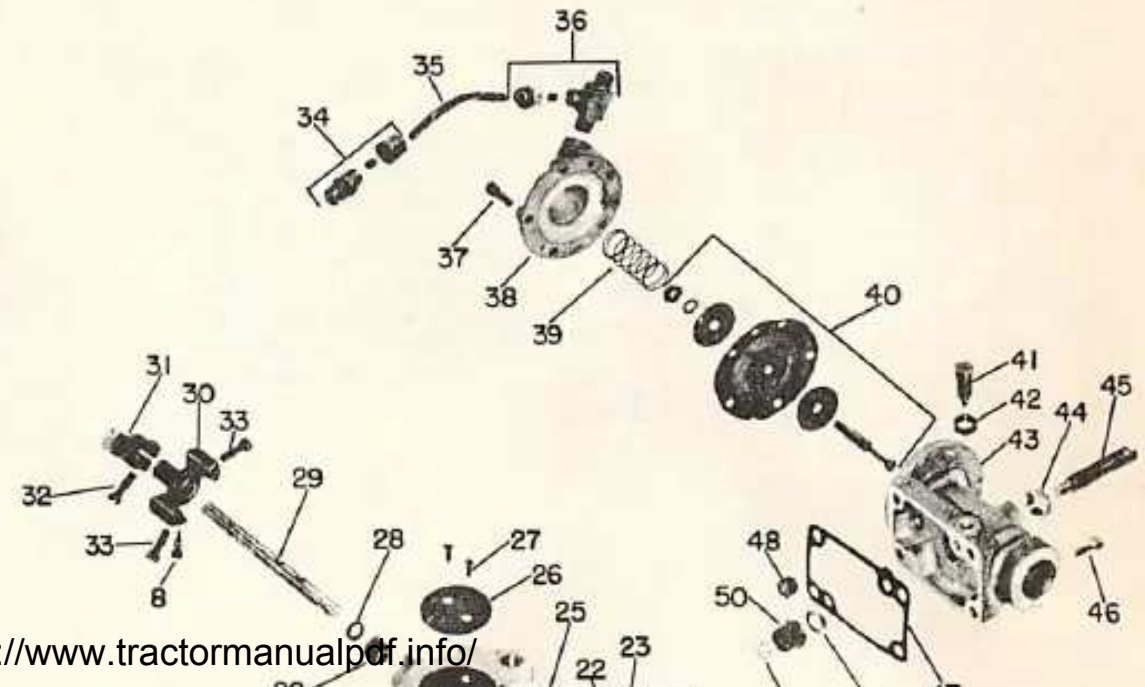


Fig. O78 — Using Ensign gage 8276 to set the fuel inlet valve lever to dimension "X" as indicated in Fig. O76.



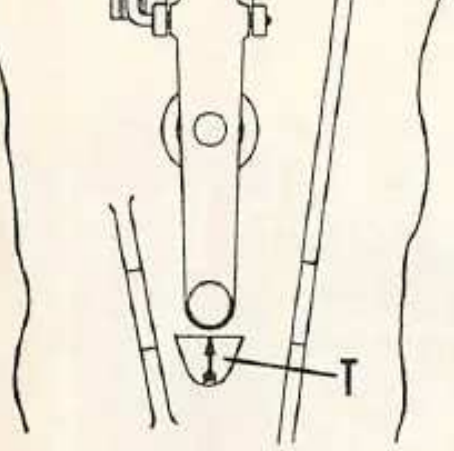


Fig. O79 — Location of post or boss with stamped arrow for the purpose of setting the fuel inlet valve lever.

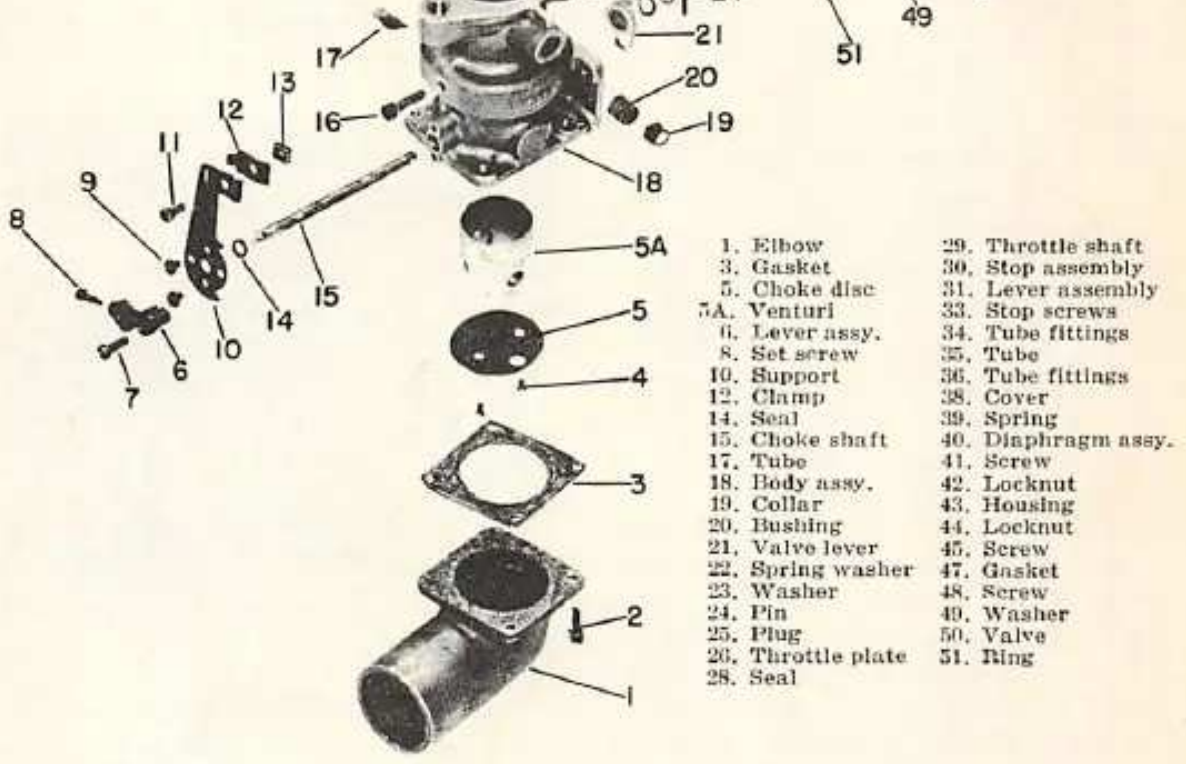


Fig. O80 — Exploded view of the Bosch-Ensign LP-Gas carburetor used on Series 1650 and late Series 1600 tractors.

106. **R&R REGULATOR.** Shut off both the liquid and vapor withdrawal valves at fuel tank and run engine until fuel in system is exhausted. Drain engine cooling system. Remove water connections to engine cooling system. Disconnect fuel and balance lines and remove regulator from tractor. Reverse removal procedure to reinstall regulator.

107. **OVERHAUL REGULATOR.** Refer to exploded view of regulator in Fig. O77. Disassemble the regulator and clean parts with solvent and dry with air hose. Inspect and renew valve seats, valves, diaphragms and springs as necessary. Parts are available separately or in a repair kit.

After inlet valve (primarily regulator valve) assembly is installed, open and close valve several times; then, check distance from face of housing to bottom of groove in inlet valve lever (See Fig. O78 and dimension "X" in Fig. O76). Bend inlet valve lever as necessary so that this measurement is exactly ½-inch.

When installing outlet valve (final regulator valve) assembly, align center of valve lever with arrow on boss (See Fig. O79) and, after operating valve several times, bend valve lever as necessary so that lever is flush with top of boss.

108. **TROUBLE SHOOTING REGULATOR PROBLEMS.** Generally, difficulties encountered with regulator are due to leakage of gas past valves. Trouble will generally show up as excessive fuel consumption, decrease in power, inability to properly adjust fuel mixtures and/or loss of gas through carburetor when engine is not running. To test regulator, remove plug (R—Fig. 076) and install a 0-10 psi gage in opening. If gage pressure gradually builds up after engine is stopped, inlet valve is leaking and same should be cleaned or renewed. Remove fuel hose from regulator to carburetor. Soap bubble should hold over fuel opening at regulator. If not, fuel outlet valve or low pressure diaphragm is leaking. Clean or renew valve and check diaphragm.

CARBURETOR

Models With Bosch-Ensign System

The Bosch-Ensign Series CBX carburetor is equipped with starting and load adjustment screws and with an economizer unit that richens the fuel mixture under load conditions. See Fig. 080 for exploded view of carburetor. Idle fuel mixture adjustment is provided on the regulator.

109. **OVERHAUL CARBURETOR.** Refer to Fig. 080. Repair parts are available separately, also a repair kit is available for the carburetor. Other

than renewing throttle shaft and throttle shaft bushings, carburetor servicing generally concerns renewal of economizer diaphragm (40) and making sure that starting valve (21) is working properly. Check to see that economizer diaphragm will hold vacuum. Inspect starting valve for proper position when choke is closed. Valve should fit tightly against carburetor body and completely cover main fuel opening in carburetor body when choke is closed. Refer to Fig. 080A for assembly of fuel adjusting screw.

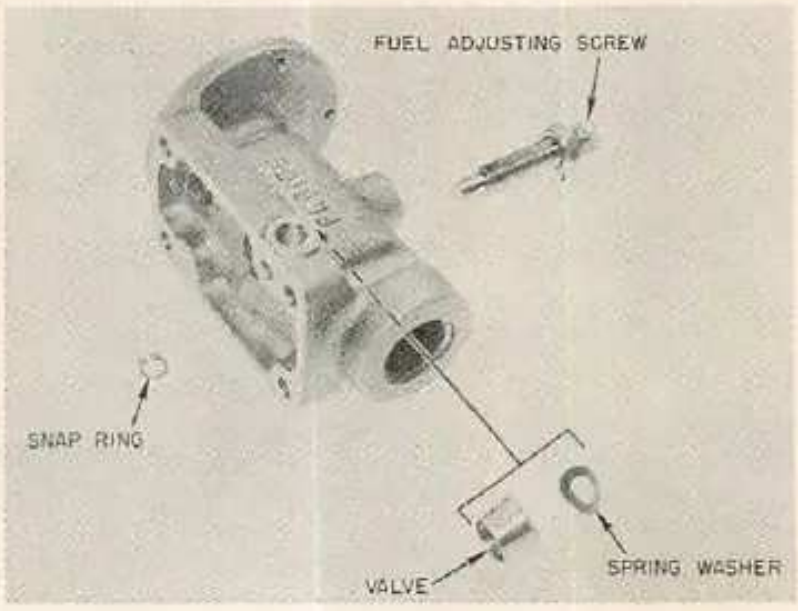


Fig. O80A — To assemble fuel adjusting valve, insert valve through fuel inlet opening, screw the adjusting screw inward through valve and secure valve on screw with snap ring. Cup of spring washer is towards valve.

DIESEL FUEL SYSTEM

DIESEL FUEL SYSTEM

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

Probably the most important precaution that servicing personnel can impart to owners of diesel powered tractors is to urge them to use an approved fuel that is absolutely clean and free from foreign material. Extra precaution should be taken to make certain that no water enters the fuel storage tanks. This last precaution is based on the fact that all diesel fuels contain some sulfur. When water is mixed with sulfur, an acid is formed which will quickly erode the closely fitting parts of the injection pump and fuel injection nozzles.

TROUBLE SHOOTING

110. If the engine will not start or does not run properly, refer to the following for possible cause of trouble:

111. **ENGINE WILL NOT START.** If the engine will not start, possible cause of trouble are as follows:

Fuel tank empty
Fuel supply valve closed
Engine stop control applied or improperly adjusted
Water in fuel
Inferior fuel
Clogged fuel filter
Air traps in system
Low cranking speed
Pump installed out of time
Pump shaft broken (pump seized)
Faulty or worn fuel injection pump
Faulty injector nozzles
Low engine compression

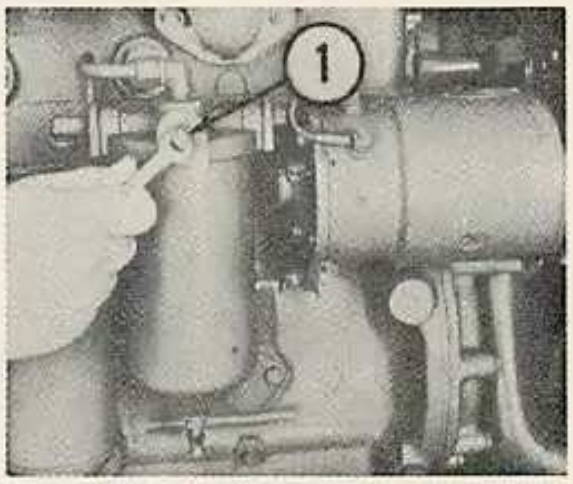


Fig. O81 — Remove plug (1) to purge air from primary fuel filter.

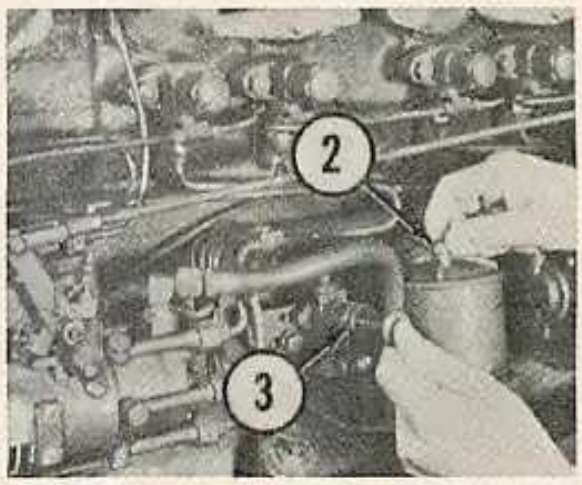


Fig. O82 — View showing method of bleeding final fuel filter. Refer to text.

112. **ENGINE DOES NOT RUN PROPERLY.** If the engine will start but does not run properly (smokes excessively, mis-fires, etc.), possible causes of trouble are as follows:

Water in fuel
Inferior fuel
Fuel filter partially clogged
Air cleaner element clogged
Air traps in fuel system
Pump out of time
Faulty fuel injectors
Low compression on one or more cylinders
Faulty fuel injection pump

BLEEDING THE SYSTEM

113. To bleed the diesel fuel system, proceed as follows: Open fuel tank shut-off valve, then remove the plug from primary fuel filter (1—Fig. 081) and allow fuel to flow until all bubbles disappear. Reinstall plug. Loosen bleed screw (2—Fig. 082) on final fuel filter and actuate hand primer pump (3) or, on later models, primer lever on fuel supply pump, until bubble free fuel appears; then tighten bleed screw. Continue to operate the hand primer pump or primer lever on fuel supply pump for an additional fifteen or twenty strokes to force any remaining air in the low pressure lines through the lines and into the tank.

Attempt to start engine, and if engine fails to start, or runs unevenly, loosen lines at injectors and bleed air from them either by placing fuel stop in run position and operating starting motor, or allowing engine to run at low idle. Tighten connections when bleeding is completed.

INJECTOR NOZZLE

Series 1600 and 1650 engine are equipped with throttling pintle type fuel injection nozzles. In operation, some fuel is atomized to start the combustion process, but much of the fuel is emitted from the nozzle as a solid "core" which crosses the combustion chamber and enters the energy cell. As the power stroke continues, the fuel-air mixture

is ejected from the energy cell into the combustion chamber where burning of the fuel is completed.

WARNING: Fuel leaves the injector nozzle with sufficient force to penetrate the skin. Keep your person clear of the nozzle spray when testing nozzles.

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

With the engine operating at low idle speed, loosen the high pressure connection at each injector in turn. As in checking spark plugs, the faulty

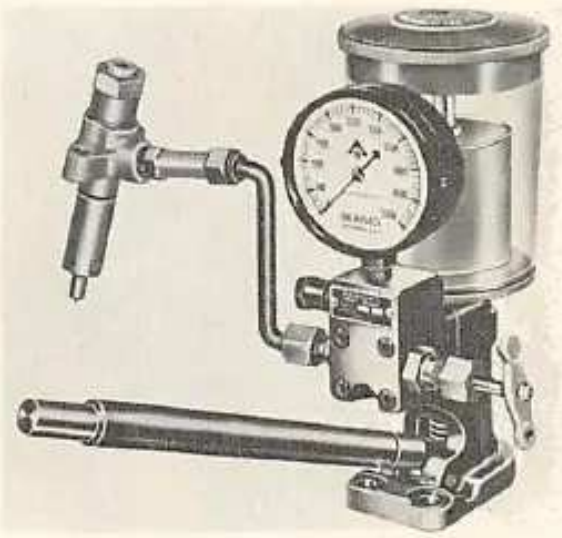
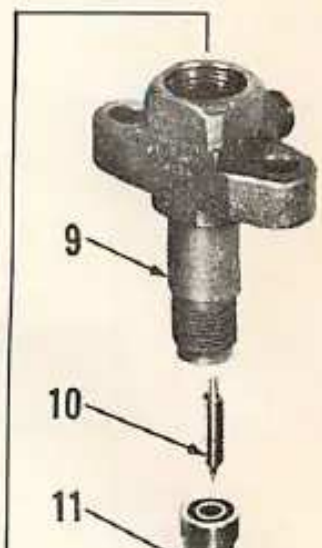


Fig. O83 — An injector tester such as one shown is necessary to test and adjust fuel injectors.



116. **NOZZLE TESTER.** A complete

unit is the one which, when its line is loosened, least affects the running of the engine.

If a faulty nozzle is found and considerable time has elapsed since the injectors have been serviced, it is recommended that all injectors be removed and new or reconditioned units be installed, or the nozzles be serviced as outlined in the following paragraphs. Also, energy cells should be removed and cleaned as in paragraphs 128 and 129 as a faulty injector can cause an energy cell to become carbon-fouled.

115. **REMOVE AND REINSTALL.** Before loosening any fuel line connections, thoroughly clean the head surface, lines and injectors by washing with diesel fuel or a suitable solvent. After disconnecting the pressure and leak-off lines, cap all connections to prevent entry of dirt or other foreign material into fuel system. Loosen pressure line connections at injection pump to prevent bending the lines. Remove the retaining screws and carefully withdraw the injector assembly from cylinder head being careful not to strike the tip end of nozzle against any hard surface.

Thoroughly clean the nozzle recess in cylinder head before reinserting the injector assembly. No hard or sharp tools should be used for cleaning. A piece of wood dowel or brass stock properly shaped, or an approved nozzle bore cleaner should be used. Install injector with a new copper gasket and loosely install retaining nuts until all fuel lines are connected; then, tighten injector retaining nuts to a torque of 13-17 Ft.-Lbs. Bleed the injectors and lines as outlined in paragraph 113. Tighten the fuel injector inlet lines after bleeding.

job of testing and adjusting the injector requires the use of a special tester such as that shown in Fig. 083. Only clean approved testing oil should be used in the tested tank.

The injector should be tested for spray pattern, seat leakage, back leakage and opening pressure as follows:

117. SPRAY PATTERN. Operate tester handle until oil flows from injector connection, then attach the injector assembly. Close the valve to tester gage and operate tester handle a few quick strokes to purge air from injector and tester pump, and to make sure injector is not plugged or inoperative.

If a straight, solid core of oil ejects from nozzle tip without undue pressure on tester handle, open valve to tester gage and remove cap nut (1—Fig. 084). Slowly depress the tester handle and observe the pressure at which the nozzle valve opens. If opening pressure is not approximately 1925 psi (new spring) or 1750 psi (used spring), loosen locknut (3) and turn adjusting screw (4) until opening pressure is 1925 psi when testing a new injector or an injector assembly in which a new spring has been installed, or 1750 psi when testing an injector with used spring.

When opening pressure has been adjusted, again close valve to tester gage and operate tester handle at approximately 100 strokes per minute while observing spray core. Fuel should emerge from nozzle opening in one solid core in a straight line with injector body, and with no branches, splits or dribbling.

NOTE: The tester pump cannot duplicate the injection velocity necessary to obtain the operating pattern of the throttling pintle type nozzles. Also absent will be the familiar popping sound associated with the nozzle opening of spray type nozzles. Under operating velocities, the observed solid core will cross the combustion chamber and enter the energy cell. In addition, a fine conical mist surrounding the core will ignite in the combustion chamber area above the piston. The solid core cannot vary more than 7½ degrees in any direction and still enter the energy cell. While the core is the only spray characteristic that can be observed on the tester, absence of any core deviation is of utmost importance.

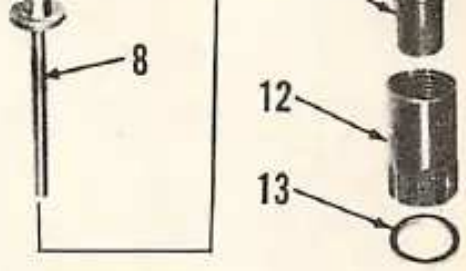


Fig. O84—Exploded view of C.A.V. throttling pintle type injector used on Series 1600 and 1650 diesel engines. Opening pressure is adjusted by screw (4).

1. Cap nut
2. Copper gasket
3. Lock nut
4. Adjusting screw
5. Retainer nut
6. Spring seat
7. Spring
8. Seat & spindle
9. Holder
10. Nozzle valve
11. Nozzle body
12. Cap nut
13. Copper washer

118. SEAT LEAKAGE. The nozzle valve should not leak at pressures of 150 psi less than opening pressure. To check for seat leakage, open the valve to tester gage and actuate tester handle slowly until gage pressure is 150 psi less than opening pressure of the nozzle. Maintain this pressure for at least 10 seconds, then observe the flat surface of nozzle body and the pintle

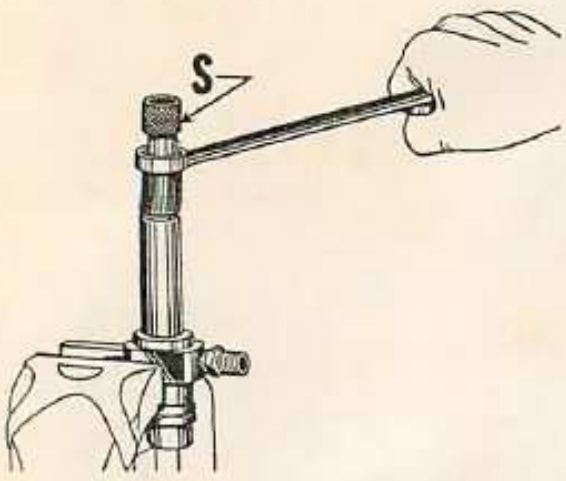
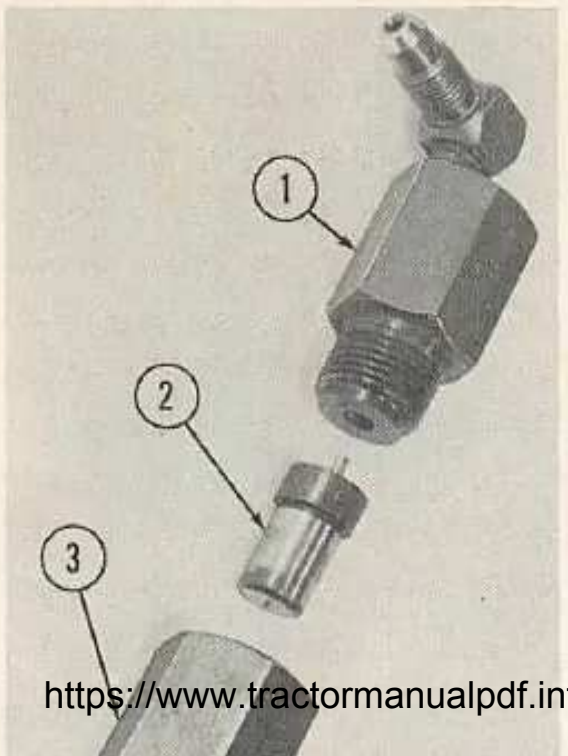


Fig. O85 — Clamp squared portion of injector holder in soft jawed vise when disasembling injector. Use centering sleeve (S) when reassembling nozzle and holder.

tip for drops or undue wetness. If drops or wetness appear, the injector



Disassemble only one injector at a time or provide a way to keep parts of one injector assembly together. To disassemble injector, proceed as follows: Clamp the squared upper part of injector holder body in a soft jawed vise, tightening vise only enough to keep injector from slipping, or use a holder fixture. Remove cap nut (1—Fig. 084), loosen lock nut (3) and back out the adjusting screw (4) until all tension is removed from spring. Then, remove the nozzle holder nut (12). Withdraw the nozzle valve (10) from nozzle body (11) with the stem end, or if valve is stuck, use the special extractor as shown in Fig. 086. NEVER loosen valve by tapping on exposed pintle end of valve. Remove spring retainer cap nut (5), spring seat (6), spring (7) and the seat and

must be disassembled and overhauled as outlined in paragraph 121.

119. BACK LEAKAGE. A back leak test will indicate the condition of the internal sealing surfaces of the nozzle assembly. Before checking the back leakage, first check for seat leakage as outlined in paragraph 118; then proceed as follows:

Turn the adjusting screw (4—Fig. 084) inward until nozzle opening pressure is set at 2300 psi. Operate the tester handle to bring gage pressure to just under the 2300 psi opening pressure, then release tester handle and observe the length of time required for gage needle to drop from 2200 psi to 1500 psi. The time should not be less than 6 seconds. A faster drop would indicate wear or scoring between piston surface of needle (10) and nozzle (11), or leakage due to improper sealing of pressure face surfaces of nozzle and holder body (9). NOTE: Leakage at tester connections or at tester check valve will show up as fast leak back in this test. If all injectors tested fail to pass the back leakage test, the tester, rather than the injectors, should be suspected.

120. OPENING PRESSURE. To assure peak engine performance, it is recommended that the six injectors installed in any engine be adjusted as nearly as possible to equal opening pressure. The recommended opening pressure is 1925 psi for a new nozzle (or used nozzle with new spring); or 1750 psi for used nozzle with a used spring. When a complete new injector and holder assembly, or a used assembly in which a new spring has been installed, is installed in an engine, the injector opening pressure will drop as the spring becomes seated during constant operation.

Fig. O86 — Hydraulic nozzle valve extractor for use with injector tester to remove stuck valves.

After the opening pressure has been adjusted, tighten locknut (3) and install cap nut (1). Then, recheck opening pressure to be sure adjusting screw did not move while tightening the locknut and cap nut.

121. **MINOR OVERHAUL.** The maintenance of absolute cleanliness in the overhaul of injector nozzle assemblies is of utmost importance. Of equal importance is the avoidance of nicks or scratches on any of the lapped surfaces. To avoid damage to any of the highly machined parts, only the recommended cleaning kits (Oliver kit No. STAS-115-B or Bacharach kit No. 66-5034) and oil base carbon solvents should be used in the injector repair sections of the shop. The nozzle valve and body are individually fit and hand lapped, and these two parts should always be kept together as mated parts.

Before disassembling a set of injectors, immerse the units in a clean carbon solvent and thoroughly clean the outer surfaces with a brass wire brush. Be extremely careful not to damage the pintle end of the nozzle valve extending out of nozzle body. Rinse the injectors in clean diesel fuel.

spindle (8). Renew spring if rusted, cracked or distorted in any way. Carefully examine the spring seats and spindle and renew if chipped, cracked or damaged in any way.

Examine the lapped pressure faces of nozzle body (11) and holder (9) for nicks or scratches, and examine piston portion (large diameter) of nozzle valve (10) for scratches or scoring. Clean the fuel gallery with the special hooked scraper as shown in Fig. 087 by applying side pressure as the nozzle body is rotated. Clean the valve seat with the brass seat tool as shown in Fig. 088. Polish the seat with the pointed wooden polishing stick and a small amount of tallow as shown in Fig. 089. Clean the pintle orifice from the inside using the proper size probe. Polish the nozzle valve seat and pintle with a piece of felt and some tallow, loosening any particles of hardened carbon with a pointed piece of brass stock. Never use a hard or sharp object such as a knife blade as any scratches will cause distortion of the injection core.

As the parts are cleaned, immerse them in clean diesel fuel in a compartmented pan. Insert the nozzle body while holding both parts below the fuel level in pan and assemble to nozzle holder while wet. Use the centering sleeve (Oliver tool No. STA-115-B or Bacharach tool No. 66-0064) when reassembling as shown in Fig. 085 and tighten the holder nut to a torque of approximately 45-50 Ft.-Lbs. Install spindle and seat (8—Fig. 084), spring (7), seat (6) and cap nut (5) and tighten the cap nut to a torque of 50-60 Ft.-Lbs. Install screw (4) and lock nut (3), adjusting the screw to obtain proper nozzle open-

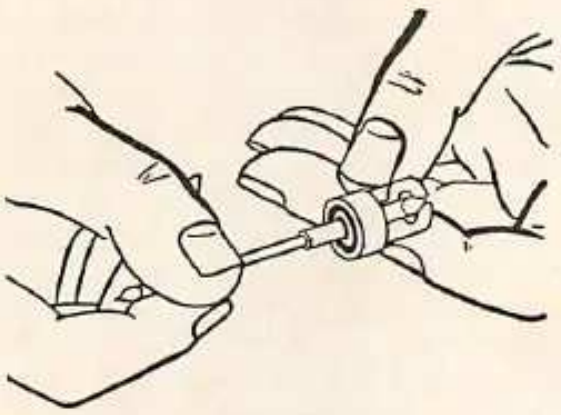


Fig. O87 — Using special scraper to clean carbon from fuel gallery in nozzle body as shown in cut-away view above.

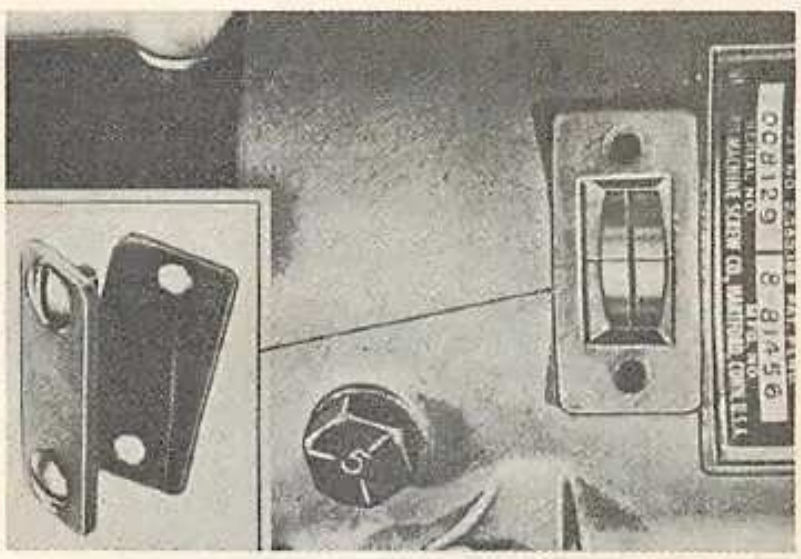


Fig. O90 — When No. 1 cylinder is on compression stroke and proper flywheel timing mark is aligned with pointer, injection pump timing marks should be aligned as shown.

equipped with a Roosa-Master DBGFC 629-1DH fuel injection pump with in- [illegible] advance mechanism.

aligned with pointer and recheck timing marks in pump timing window. Readjust timing if necessary. CAUTION: **Do not** loosen the pump mount-

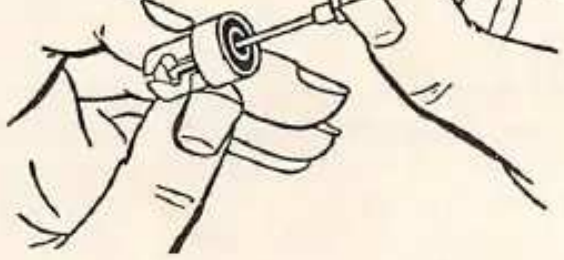


Fig. O88 — Use brass seat tool to remove carbon from valve seat.

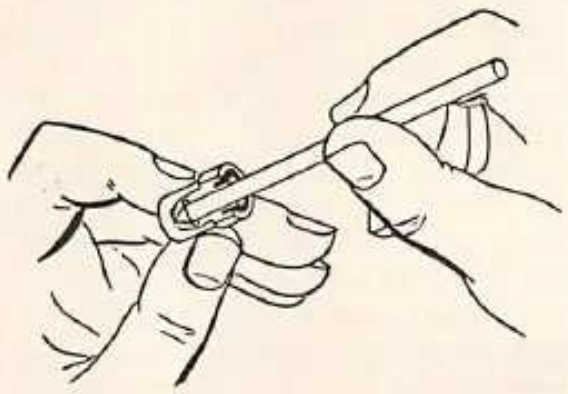


Fig. O89 — Use wooden stick and small amount of tallow to polish valve seat.

ing pressure. Test the overhauled injector assembly as outlined in paragraphs 116 through 120.

FUEL INJECTION PUMP

All Diesel Models

122. Early Series 1600 diesel models were equipped with a Roosa-Master Model DBGFC 629-7BH fuel injection pump; later Series 1600 models were equipped with a Roosa-Master DBGFC 629-1DH fuel injection pump. These two pumps are of the non-automatic timing advance type and can be used interchangeably on all Series 1600 diesels. The Series 1650 diesel is

Because of the special equipmment needed, and the skill required of the servicing personel, service of injection pumps is generally beyond the scope of that which should be attempted in the average shop. Therefore, this section will include only timing of pump to engine, removal and installation and the linkage adjustments which control engine speeds.

If additional service is required, the pump should be turned over to an Oliver facility that is equipped for diesel injection pump service, or to an authorized Roosa-Master diesel service station. Inexperienced personnel should never attempt to service diesel fuel injection pumps.

122A. **PUMP TIMING.** To check injection pump timing, shut-off the fuel supply valve and remove timing window cover from fuel injection pump. Turn engine so that No. 1 piston is coming up on compression stroke; then, continue to turn engine slowly until the 7 degree BTDC timing mark (Series 1600 models) or the 2 degree BTDC timing mark (Series 1650 models) on engine flywheel is aligned with pointer. The timing marks in pump timing window should then be exactly aligned as shown in Fig. 090. If the pump timing marks are not in register as shown, loosen the three injection pump mounting stud nuts and rotate the pump in the slotted mounting holes as necessary to align the timing marks. While holding pump in this position, tighten the three mounting stud nuts securely. Then, either turn the engine through two revolutions or turn backward about one-half turn, then forward until flywheel timing mark is again

ing stud nuts while engine is running if setting timing by dynamometer method.

NOTE: When aligning flywheel timing mark with pointer, engine must be turned in normal direction of rotation. If mark is turned past pointer, continue to turn the engine through two revolutions to again align mark and pointer, or back engine up at least ¼-turn and then turn forward to timing mark. Turning the engine backwards to just the point where timing mark is aligned with pointer will result in incorrect timing due to gear backlash.

123. **R&R PUMP.** Thoroughly clean outside of pump, lines and connections. Shut off the fuel supply valve, remove timing window cover from fuel injection pump and turn engine so that both timing marks are visible in timing window and the 7 degree BTDC (Series 1600) or 2 degree BTDC (Series 1650) flywheel timing mark is aligned with pointer. Then reinstall injection pump timing window cover.

Disconnect battery ground strap to prevent engine from being turned accidentally while pump is removed; then, proceed as follows: Disconnect throttle rod, stop control wire and cable, fuel supply line and excess fuel return line from fuel injection pump. Remove the injector pressure line clamps and disconnect the lines at connections near pump end of lines. Loosen the injector pressure line connections at injectors so lines can be spread to remove pump and immediately cap all open lines and connectors. Protective caps and plugs are available and are listed in Oliver parts catalog. Remove the three pump mounting stud nuts and remove pump

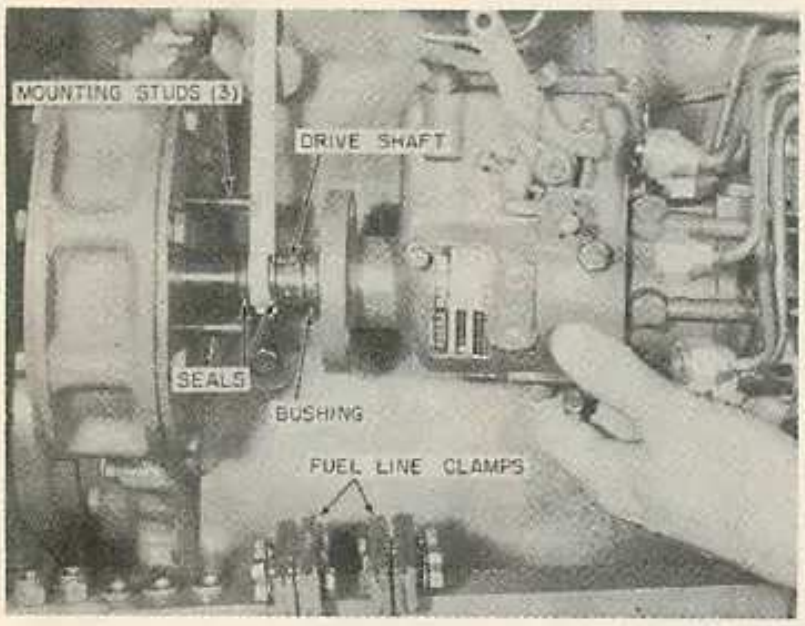


Fig. O91 — Remove fuel line clamps and spread fuel lines as shown to remove pump. Use Roosa-Master seal compressor tool 13371 as shown to aid in reinstalling pump over drive shaft seals.

from mounting studs and drive shaft, spreading the injector lines to allow pump to be moved rearward. After removing pump, remove seals from

timing marks are aligned. Install two new pump drive shaft seals on shaft with lips of seals facing away from each other. Lubricate the seals and

outer side of injection pump to drain fuel; otherwise, diesel fuel will run into engine when shaft is removed. Then, withdraw the drive gear, hub and shaft assembly from opening in front of timing gear cover. Cut the locking wire and remove the drilled head cap screws retaining gear to hub. Clamp tang of drive shaft in soft jawed vise and remove the hub retaining nut. Pull or press hub from shaft and Woodruff key. If fuel injection pump was not removed, install new drive shaft as outlined in paragraph 125. If pump is removed, new shaft can be installed in pump, then install pump and shaft as outlined in paragraph 126; or if desired, pump can be reinstalled without shaft and the shaft can then be installed as in paragraph 125.

pump drive shaft and carefully inspect the shaft. If shaft is broken at the safety groove or is otherwise damaged, renew shaft as outlined in paragraph 124.

NOTE: Aligning flywheel and pump timing marks prior to removing pump is not required procedure, but is an aid in reinstalling pump. If pump drive shaft is removed or renewed in conjunction with pump removal, either reinstall pump without regard to timing procedure and reinstall drive shaft as outlined in paragraph 125, or install shaft in pump and reinstall pump and shaft as assembly as outlined in paragraph 126.

Before reinstalling pump, check to be sure engine was not turned while pump was removed. If engine was turned, or pump was removed without aligning timing marks as outlined in removal procedure, proceed as follows: Either remove the rocker arm cover and turn engine until intake valve of No. 1 cylinder just closes or loosen the No. 1 cylinder injector mounting stud nuts and turn engine until compression leak occurs around the loosened injector. Then, continue to turn engine slowly until the 7 degree BTDC (Series 1600) or 2 degree BTDC (Series 1650) flywheel timing mark is aligned with pointer and reinstall the rocker arm cover, or remove the No. 1 cylinder injector and reinstall same with new sealing washer.

Remove the timing window cover from outer side (throttle control rod side) of fuel injection pump and with a screwdriver inserted in rotor drive slot, turn pump rotor so that pump shaft area between seals with Lubriplate or equivalent grease and carefully install the pump over drive shaft and seals. Take care not to roll lip of rear seal back as pump is being installed; if this happens, remove pump and renew the seal. (Note: Use of Roosa-Master seal installation tool 13369 is recommended to install seals on shaft and use of Roosa-Master seal compressor tool 13371 is recommended when installing pump over the drive shaft seals.) When pump is installed over drive shaft far enough to engage drive shaft tang with slot in pump rotor, it may be necessary to rock the rotor slightly with pencil eraser tip inserted through timing window or to rock the pump assembly slightly to engage the drive shaft tang and rotor slot. When pump mounting slots are engaged with the mounting studs and pump body contacts mounting plate, rotate the pump assembly in the mounting slots as required to bring the pump timing marks into exact alignment, then securely tighten the pump mounting nuts. Turn the engine through two revolutions, or back engine up at least ¼-turn, then slowly turn forward until flywheel timing mark is again aligned with pointer and recheck pump timing marks. Loosen the pump mounting stud nuts and adjust timing if necessary.

Bleed the fuel system as outlined in paragraph 113.

124. RENEW PUMP DRIVE SHAFT. To remove the pump drive shaft, gear and hub assembly, remove the gear cover from front side of timing gear cover. If injection pump is installed, shut off the fuel supply valve and remove the timing window cover from

125. To install new drive shaft with pump installed on tractor, proceed as follows: Check to see that injection pump is mounted so that mounting studs are centered in slots; if not, loosen the stud nuts, turn pump so that studs are centered in slots and tighten the nuts. Turn engine until No. 1 piston starts up on compression stroke, then continue to turn engine slowly until 7 degree BTDC (Series 1600) or 2 degree BTDC (Series 1650) flywheel timing mark is aligned with pointer. Clamp tang of drive shaft in soft jawed vise, install Woodruff key in slot and install drive hub with retaining nut and washer. Tighten the nut to a torque of 35-40 Ft.-Lbs. Remove shaft from vise and install new drive shaft seals with seal lips facing away from each other. Use of Roosa-Master seal installation tool 13369 is recommended. Lubricate the seals and shaft area between seals with Lubriplate or similar grease. Note the offset dimples in end of drive tang on shaft and in slot of pump rotor. Carefully insert shaft into pump with offset dimples on shaft tang and rotor slot aligned and work the rear seal lip into bore of pump body with a dull pointed tool. When drive tang is engaged in rotor slot, remove timing window cover from fuel injection pump and turn the drive shaft and hub so that pump timing marks are aligned as shown in Fig. 090. While holding pump rotor from turning with screwdriver inserted in slot below the timing marks in timing window, install drive gear on hub and turn gear counter-clockwise as far as possible to eliminate gear backlash. Install the two drilled head cap screws in set of two holes that are aligned in gear

and hub, tighten the capscrews securly and install locking wire. Insert thrust spring and thrust button in front end of drive shaft and install drive gear cover to timing gear cover with new gasket. Recheck pump timing marks and adjust if necessary as outlined in paragraph 123. Bleed diesel fuel system as in paragraph 113.

126. To install new drive shaft when fuel injection pump is removed, either reinstall pump and then install shaft as outlined in paragraph 125, or proceed as follows:

Remove timing window cover from outer side of fuel injection pump. Install new seals on drive shaft with lips of seals facing away from each other. Use of Roosa-Master seal installation tool 13369 is recommended.

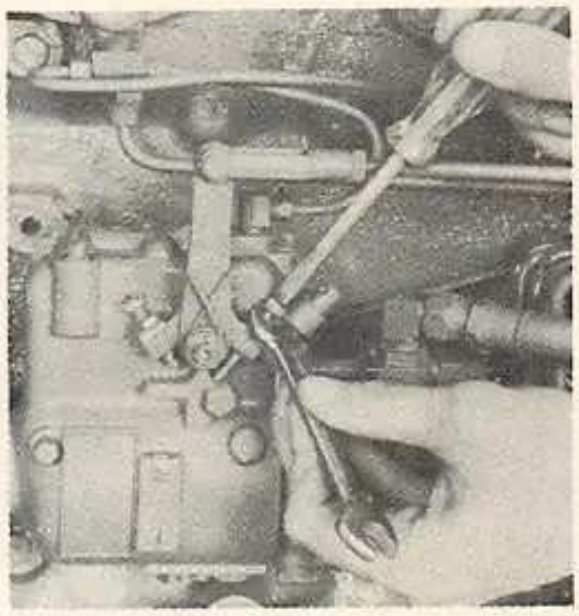


Fig. O92 — Adjusting the high speed screw. Low idle speed is adjusted by front screw.

a new gasket. Recheck pump timing

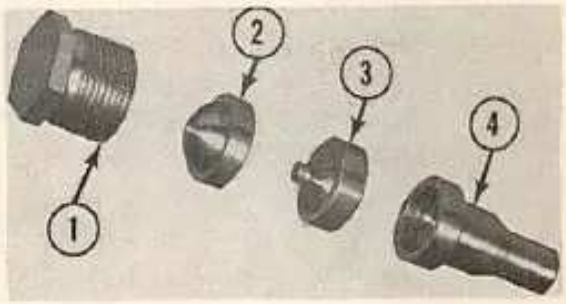


Fig. O93 — Energy cells should be removed and cleaned when servicing injectors.

1. Holder plug
2. Spacer
3. Energy cell cap
4. Energy cell body

injection pump throttle shaft against the low idle speed stop, adjust length of control rod so that injection pump throttle lever must be moved 1/16-1/8 inch against spring pressure to reinstall the linkage pin. Then tighten lock nut on control rod and move the hand throttle lever to high idle

Lubricate seals and shaft area between seals with Lubriplate or similar grease, then carefully insert shaft into pump so that offset dimple in end of shaft tang is aligned with offset dimple in slot of pump rotor. Using a dull pointed tool, carefully work lip of rear seal into bore of pump housing or compress seal with Roosa-Master seal compressor tool 13371 when installing shaft. With drive tang of shaft engaged in slot of pump rotor, install the pump on tractor with mounting hole slots centered on the mounting studs. Insert Woodruff key in slot in pump shaft. Be sure that drive gear is a free fit on hub, then install hub, washer and retaining nut on shaft. Temporarily install drive gear on hub in any position and with the drilled head cap screws finger tight. Then, tighten the hub retaining nut to a torque of 35-40 Ft.-Lbs. and remove the drive gear. Turn engine so that No. 1 piston is coming up on compression stroke, then continue to turn engine slowly until the 7 degree BTDC (Series 1600) or 2 degree BTDC (Series 1650) flywheel timing mark is aligned with pointer. Turn injection pump drive shaft so that the pump timing marks are aligned as shown in Fig. 090. While holding pump from turning with screwdriver inserted in slot below pump timing marks, install pump drive gear on hub and turn gear as far counter-clockwise as possible to eliminate all gear backlash. Install the two drilled head cap screws into a set of holes that are aligned in drive gear and hub, tighten the capscrews and secure with wire. Insert the thrust button spring and thrust button in front end of pump drive shaft and install drive gear cover to timing gear cover using as outlined in paragraph 122A and readjust if necessary. Bleed the diesel fuel system as outlined in paragraph 113.

127. **GOVERNOR ADJUSTMENT.** Both the high idle speed and low idle speed adjustments are preset at the factory and normally should not be disturbed. However, should it become necessary, adjust the governed speeds as follows:

Start engine and bring to normal operating temperature. Break the seals on the high idle (rear) adjusting screw and/or low idle adjusting screw as necesary (refer to Fig. 092); then, proceed as follows:

To adjust high idle speed, place throttle lever in high idle position, loosen lock nut and turn adjusting screw in or out as required to obtain a high idle speed of 2100 RPM on Series 1600 models or 2450 RPM on Series 1650 models. Tighten the lock nut and install new wire seal.

To adjust low idle speed, position throttle lever at low idle position, loosen lock nut and turn adjusting screw (front screw) in or out to obtain a low idle speed of 675 RPM on Series 1600 models or 650 RPM on Series 1650 models. Tighten lock nut and install new wire seal.

NOTE: The throttle control lever on fuel injection pump is spring loaded and should slightly over-travel the high and low speed stops on the injection pump governor control shaft. To properly adjust the throttle linkage, proceed as follows: With engine not running, disconnect throttle control rod at fuel injection pump and place hand throttle lever in slow idle position. Loosen the lock nut on front end of control rod. While holding the speed position. Loosen the lock nut on stop screw in throttle bellcrank at instrument support panel, adjust the stop screw until the injection pump lever over-travels high idle speed stop $\frac{1}{16}$ to $\frac{1}{8}$-inch and then tighten the lock nut.

If throttle hand lever tends to creep at high idle speed, tighten the friction adjusting nut located at lever end of control lever shaft in instrument panel support.

ENERGY CELLS

These assemblies (Fig. O93) are mounted directly opposite from the fuel injectors in the cylinder head.

In almost every instance where a carbon-fouled or burned energy cell is encountered, the cause is traceable either to a malfunctioning injector, incorrect fuel or incorrect installation of the energy cell. Manifestations of a fouled or burned unit are misfiring, exhaust smoke, loss of power or pronounced detonation (knock).

128. **REMOVE AND REINSTALL.** Any energy cell can be removed without removing any engine component. To remove an energy cell, first remove the threaded cell holder plug (1) and take out the cell holder spacer (2). With a pair of thin nosed pliers, remove cell cap (3). To remove the cell body (4), screw a $\frac{1}{4}$-20 NF bolt into the threaded end of the cell body. A nut and collar on the bolt will make it function as a puller. If puller is not available, remove the fuel injector; and use a brass rod to drift the cell body out of the cylinder head. Clean unit as outlined in paragraph 129 and reinstall by reversing the removal procedure.

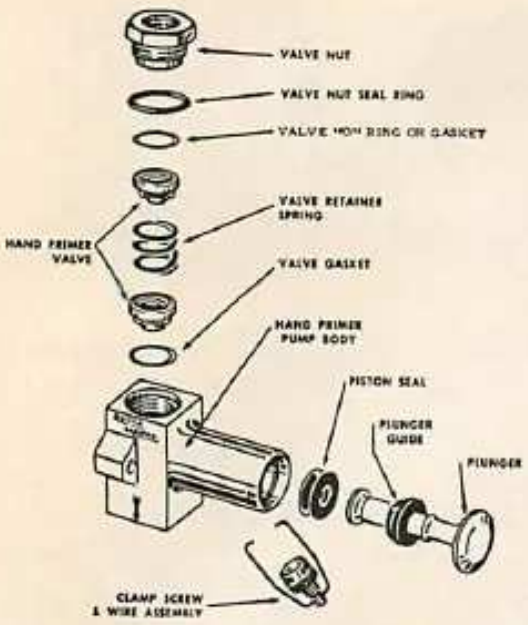


Fig. O94 — Exploded view of diesel fuel system primer pump used on early Series 1600; late Series 1600 and Series 1650 tractors are equipped with a fuel pump which incorporates a hand primer pump.

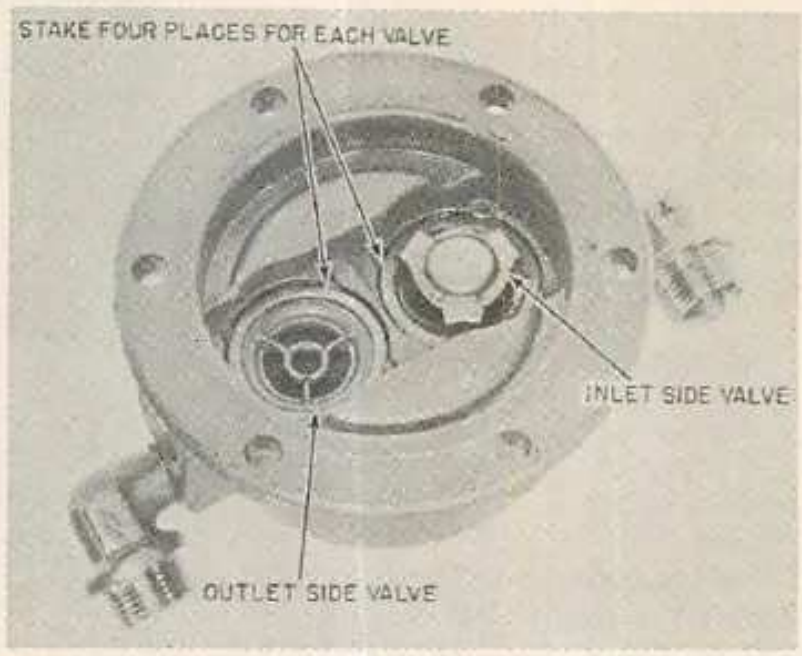


Fig. O95—Inlet and outlet valves of fuel lift pump are retained by staking as shown.

FUEL SUPPLY PUMP

Series 1650, Late Series 1600

new valve in place as shown in Fig. 095.

129. **CLEANING.** Clean all carbon from front and rear crater of cell body using a brass scraper or a shaped piece of hard wood. Clean the exterior of the energy cell with a brass wire brush, and soak the parts in carbon solvent. Reject any part which shows signs of leakage or burning. If parts are not burned, re-lap sealing surfaces of cap (3) and body (4) by using a figure 8 motion on a lapping plate coated with fine compound.

PRIMER PUMP

Early Series 1600

130. **R&R AND OVERHAUL.** Shut off fuel, disconnect inlet and outlet lines from primer pump and cap off open ends of fuel lines. Remove the two mounting screws and remove pump from tractor.

Refer to Fig. 094. Loosen bail clamp from plunger, then disengage ends of bail wire from primer pump body. Remove plunger, plunger guide and piston seal from body. Place pump body in vise, then remove valve nut. Seals, valves and spring can now be removed.

Examine all parts for tears, undue wear, or other damage and renew as necessary. If plunger guide is to be renewed, old guide can be cut. Lubricate new guide and slide over plunger with chamfer toward inside of pump body. Install valves so that they open in the same direction as the arrow embossed on the primer pump body.

Bleed system as outlined in paragraph 113.

131. Late Series 1600 and Series 1650 diesel models are equipped with a diaphragm type fuel supply pump which incorporates a fuel system primer. Note: Engine may stop in a position that hand primer level will not operate fuel pump diaphragm; if so, turn engine so that camshaft is in different position.

Overhaul of the fuel lift pump is conventional. Inlet and outlet valves are retained by staking metal of cover at four points around the valve. To renew valves, remove the staking with a small sharp chisel and stake

MANIFOLD PREHEATER

All Models So Equipped

132. The inlet manifold is fitted with a solenoid controlled preheater unit which is installed in lower side of manifold.

Operation of the preheater can be checked by depressing the control switch located on the instrument panel for about 30 seconds and then placing your hand on the manifold to see if it is warm.

Service on the preheater and solenoid is accomplished by renewing the units.

NON-DIESEL GOVERNOR

Series 1600 and 1650 non-diesel engines are fitted with a flyweight type governor that is mounted on the front face of engine timing gear cover and is driven by the camshaft gear. While changes were made on the governor used on Series 1650 engines, the Series 1600 and Series 1650 governors are basically similar.

ADJUSTMENT

All Non-Diesel Models

133. **GOVERNOR TO CARBURETOR LINKAGE.** Refer to Fig. 096 and check adjustment of carburetor to governor linkage as follows: With engine not running, disconnect link from governor to carburetor at governor lever end and place throttle lever in high idle speed position. With carburetor throttle shaft in wide open position, forward end of link should be

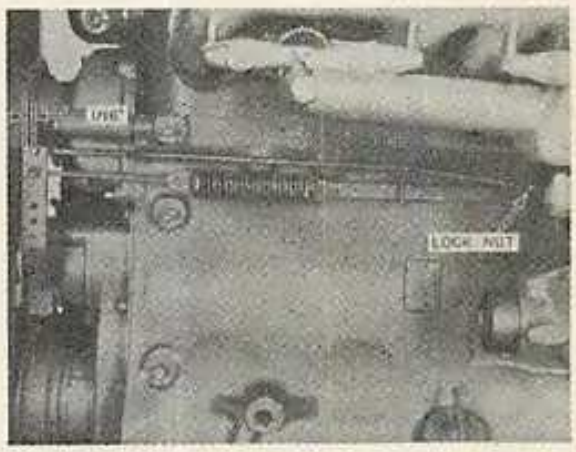


Fig. O96 — View showing adjustment of governor arm to carburetor throttle shaft link. Although Series 1600 is shown, adjustment of Series 1650 is similar.

$\frac{1}{16}$-inch forward of the top hole in governor lever. If not, loosen lock nut at carburetor end of link and turn link in or out until length is correct. Reinstall link in governor lever and tighten lock nut.

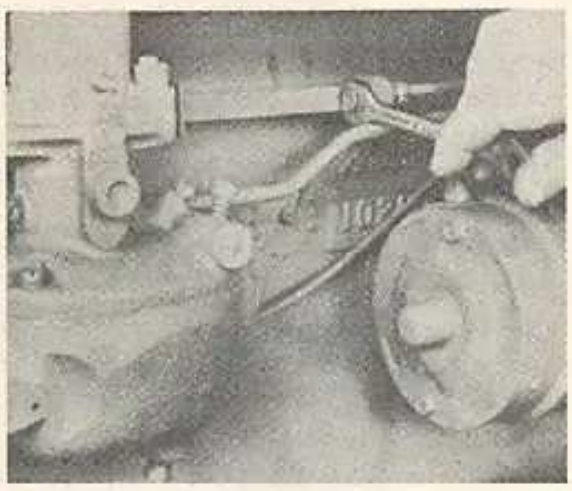
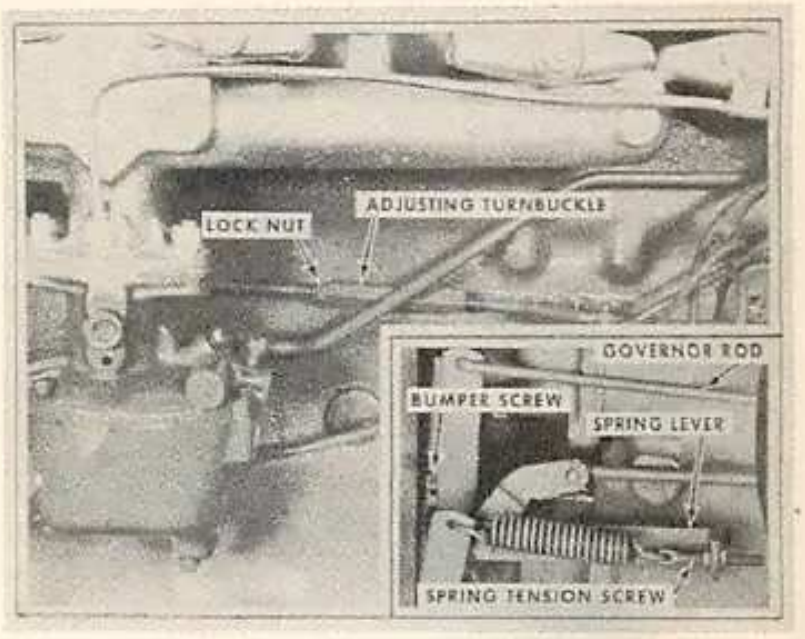


Fig. O97 — Adjusting throttle linkage on Series 1600. Refer to Fig. O98 for Series 1650.

Fig. O98 — Adjustment points for Series 1650 throttle linkage. Refer to text for adjustment procedure. Series 1600 throttle linkage adjustment is shown in Fig. O97.



134. **LOW IDLE SPEED.** After adjusting carburetor to throttle linkage

as outlined in paragraph 133, start engine and bring to normal operating temperature. Place throttle lever in slow idle position and check slow idle speed. Readjust throttle stop screw on carburetor if necessary to obtain a slow idle speed of 300 RPM on Series 1600 gasoline models, 500 RPM on Series 1600 LP-Gas models or 450 RPM on Series 1650 gasoline and LP-Gas models.

135. **HIGH IDLE SPEED.** Prior to checking high idle speed, check carburetor to governor linkage adjustment as outlined in paragraph 133 and slow idle speed as in paragraph 134. Then, with engine running and at normal operating temperature, place throttle lever in high idle position and check engine RPM. High idle speed on Series 1600 models should be 2100 RPM, and on Series 1650 models, should be 2450 RPM. If high idle speed is not as specified, stop engine, place throttle lever in slow idle position, loosen bumper screw lock nut (see Fig. 099) and back-out bumper screw until governor operating lever is released. Then, proceed as follows:

SERIES 1600 MODELS. Refer to Fig. 097 and loosen adjusting nuts on governor control rod at rear of carburetor. Start engine and with throttle lever in high idle speed position, adjust length of control rod by turning adjusting nuts in or out to obtain high idle speed of 2100 RPM. If length of threads on rod does not permit proper high idle speed adjustment, stop engine and readjust position of stop screw on bellcrank in instrument panel support at rear end of control rod. When proper high idle speed is obtained with adjusting nuts on control rod and jam nut on bellcrank stop screw tight, readjust bumper screw as outlined in paragraph 136.

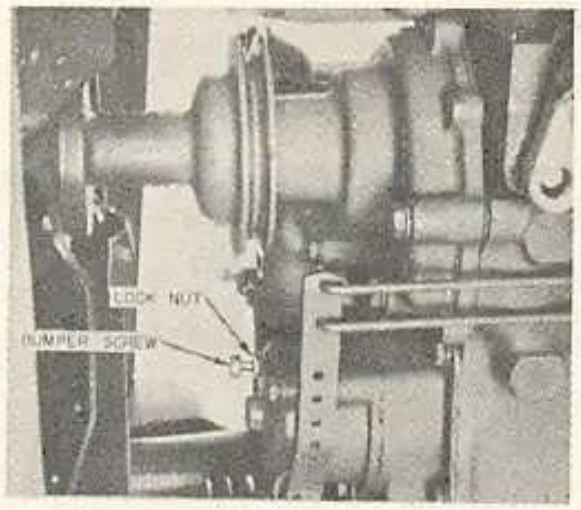


Fig. O99 — Adjust bumper screw to minimize surging at high idle no load speeds. Refer to text for proper adjustment procedure.

SERIES 1650 MODELS. Refer to Fig. 098 and with engine not running, place throttle lever in high idle speed position. If spring lever (see inset) is not parallel with engine crankshaft, loosen lock nut and turn adjusting turnbuckle on governor control rod to bring spring lever to this position. If length of threads on governor control rod do not permit this adjustment, loosen jam nut on stop screw in bellcrank at rear end of governor control rod in instrument panel support and adjust stop screw so that spring lever is parallel with engine crankshaft. Tighten lock nut and/or jam nut. Start engine, place throttle lever in high idle position and adjust spring tension screw (see inset) so that engine high idle speed is 2450 RPM with spring tension screw lock nuts tight. Then, readjust bumper screw as outlined in paragraph 136.

136. **BUMPER SCREW.** Engine surging at high idle speed can be eliminated by adjustment of the bumper screw (Fig. 099). Stop engine, loosen bumper screw lock nut and turn bumper screw inward slightly. Restart engine and check for surging at high idle speed. Continue to make slight adjustments to bumper screw until surging is eliminated. DO NOT turn bumper screw while engine is running or turn screw in farther than necessary to eliminate surging. Tighten bumper screw lock nut and recheck low idle RPM as in paragraph 134.

R&R AND OVERHAUL

137. Governor can be removed after disconnecting linkage and removing the governor to timing gear cover retaining cap screws. Carefully withdraw the unit from timing gear cover. DO NOT lose the thrust washer which is located between governor gear and crankcase.

Refer to Fig. 0100 for exploded

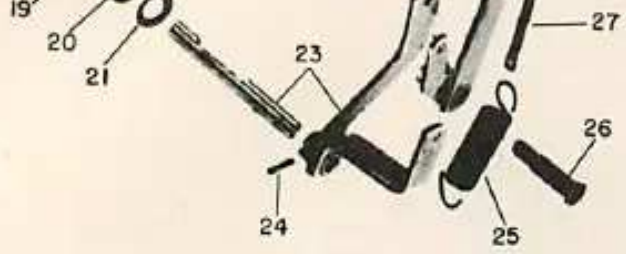
Fig. O100 — Exploded view of Series 1650 governor assembly. Series 1600 governor is similar except that a single control arm as shown in Fig. O96 is used.

3. Thrust washer
4. Drive gear
5. Snap rings
6. Pins
7. Governor weights
8. Shaft & spider
9. Sleeve
10. Bearing
11. Screw & lock washer
12. Fork
13. Bushing
14. Housing
15. Bushing
16. Spring
17. Bumper screw
18. Nut
19. Bearing
20. Seal
21. Retainer
22. Shaft & lever assy.
24. Nut
25. Spring
26. Pivot bolt
27. Nut
28. Lever
29. Governor gear

view of the governor used on Series 1650 models. Series 1600 governor is similar except that a single control arm as shown in Fig. 096 is used. Governor gear (4—Fig. 0100) can be removed by using a suitable puller. Disassembly of weight unit and thrust bearing assemblies is evident.

Governor gear hub rotates in a sleeve and bushing assembly which is pressed into front face of crankcase. The sleeve and bushing assembly can be renewed by removing timing gear cover and using a suitable puller. Inside diameter of governor gear bushing is 1.0015-1.002. Outside diameter of governor gear *is 0.999-0.9995* and should have 0.002-0.003 operating clearance in bushing. Renew bushing and/or gear when operating clearance exceeds 0.005.

Any further disassembly and/or



27. Adjusting screw
28. Lock nuts
29. Lever

overhaul is obvious after an examination of the unit and reference to Fig. 0100.

After reinstallation, readjust governor as outlined in paragraphs 133 through 136.

COOLING SYSTEM

RADIATOR

138. To remove the radiator, first drain cooling system, then remove hood side panels and hood. Unbolt fan blades from hub and let fan rest in fan shroud. Disconnect upper and lower hoses, unbolt radiator from tractor front frame and lift same from tractor. Grille need not be disturbed.

WATER PUMP

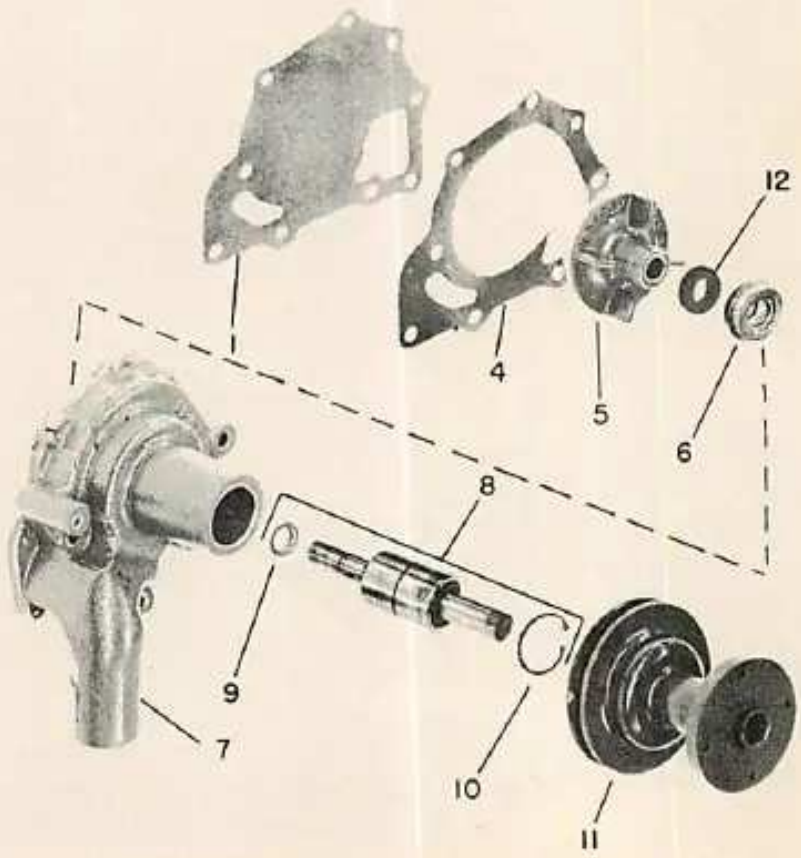
139. **R&R AND OVERHAUL.** To remove water pump, drain cooling system and remove left side panel. Unbolt fan blades from hub and let fan blades rest in fan shroud. Remove fan belt, disconnect lower radiator hose from pump, then unbolt and remove pump from left side of tractor.

To disassemble the water pump, refer to Fig. 102 and proceed as follows: Remove pump pulley and pump cover. Remove snap ring from front of shaft, then using a press, push the shaft and bearing assembly out of impeller and pump body. Seal, seal seat and slinger can now be renewed. Shaft and bearing assembly are available as a unit only.

When reinstalling impeller, press same on shaft until rear side is flush with rear end of pump shaft.

Fig. O102 — Exploded view of water pump assembly used on all models.

1. Cover
4. Gasket
5. Impeller
6. Seal
7. Body
8. Shaft & bearing assy.
9. Slinger
10. Snap ring
11. Pulley
12. Seal seat

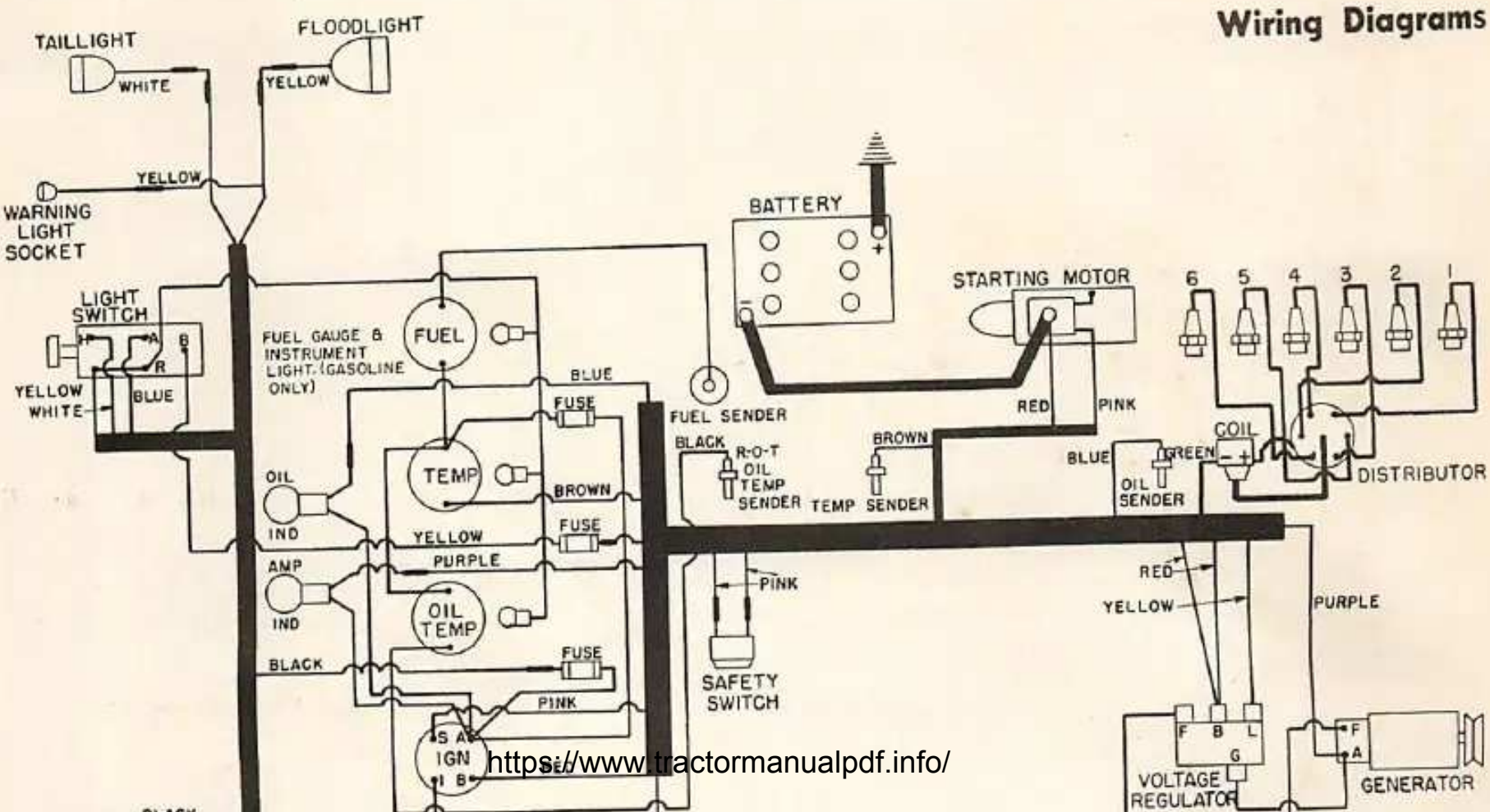


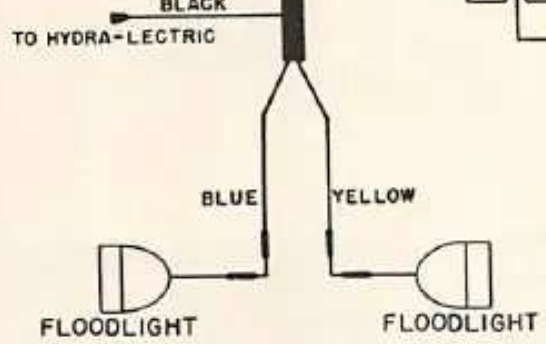
THERMOSTAT

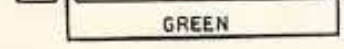
140. To remove thermostat, remove hood side panels and hood. Drain coolant and disconnect upper radiator hose. Remove cap screws from air cleaner bracket and remove air cleaner, thermostat housing and thermostat.

Thermostat may be either a bellows or a pellet type. Bellows type should start to open at 167-172 degrees F. and be fully open at 200 degrees F. The pellet type should start to open at 175 degrees F. and be fully open at 190 degrees F.

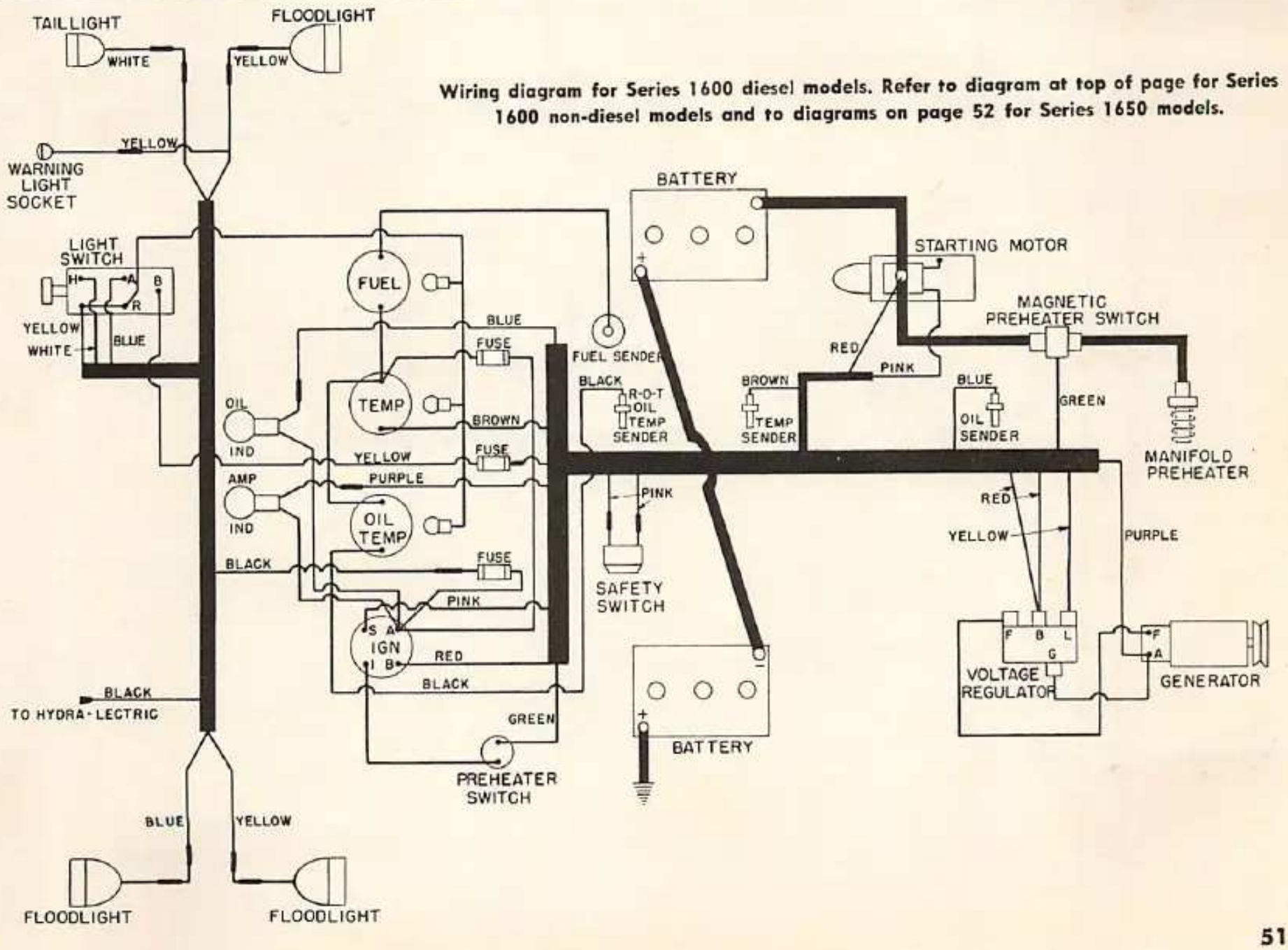
Wiring Diagrams



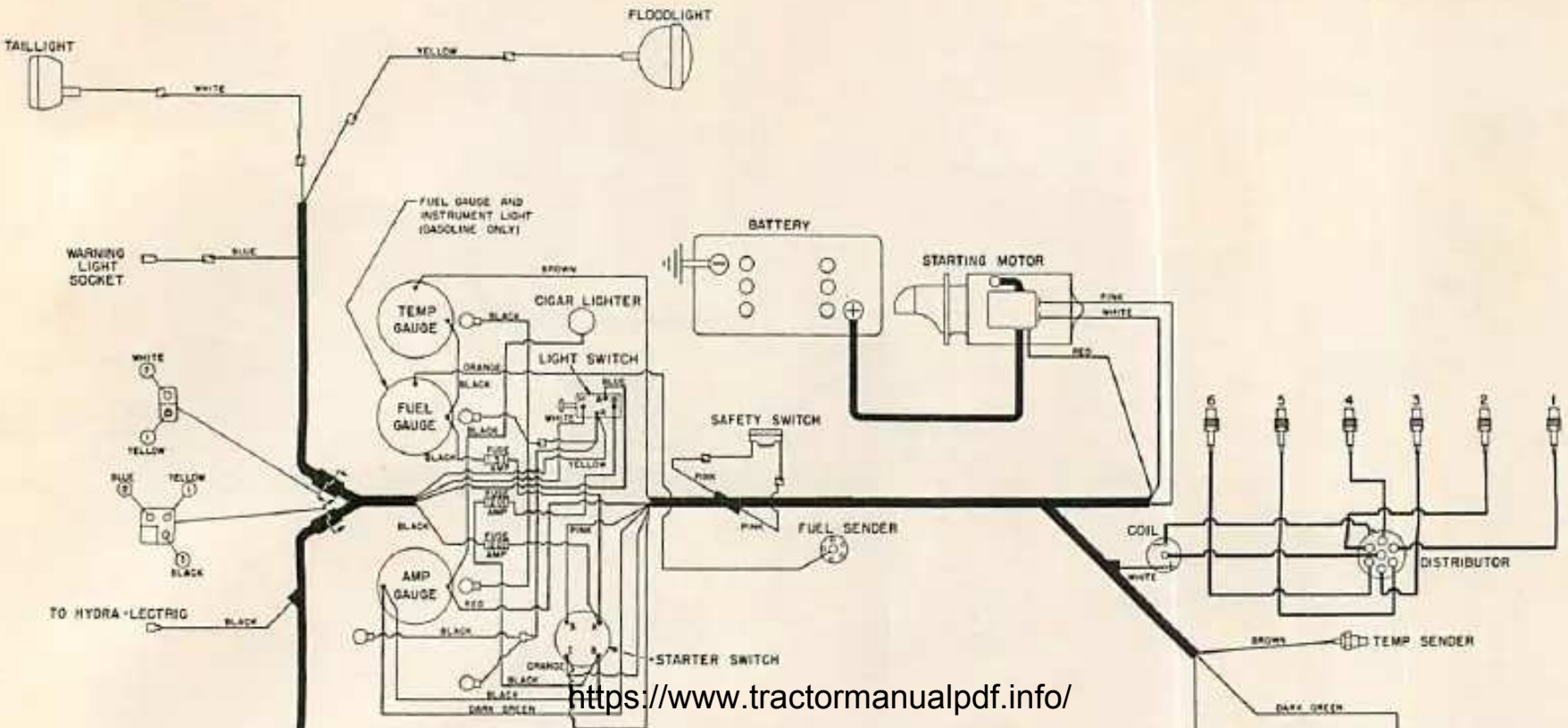


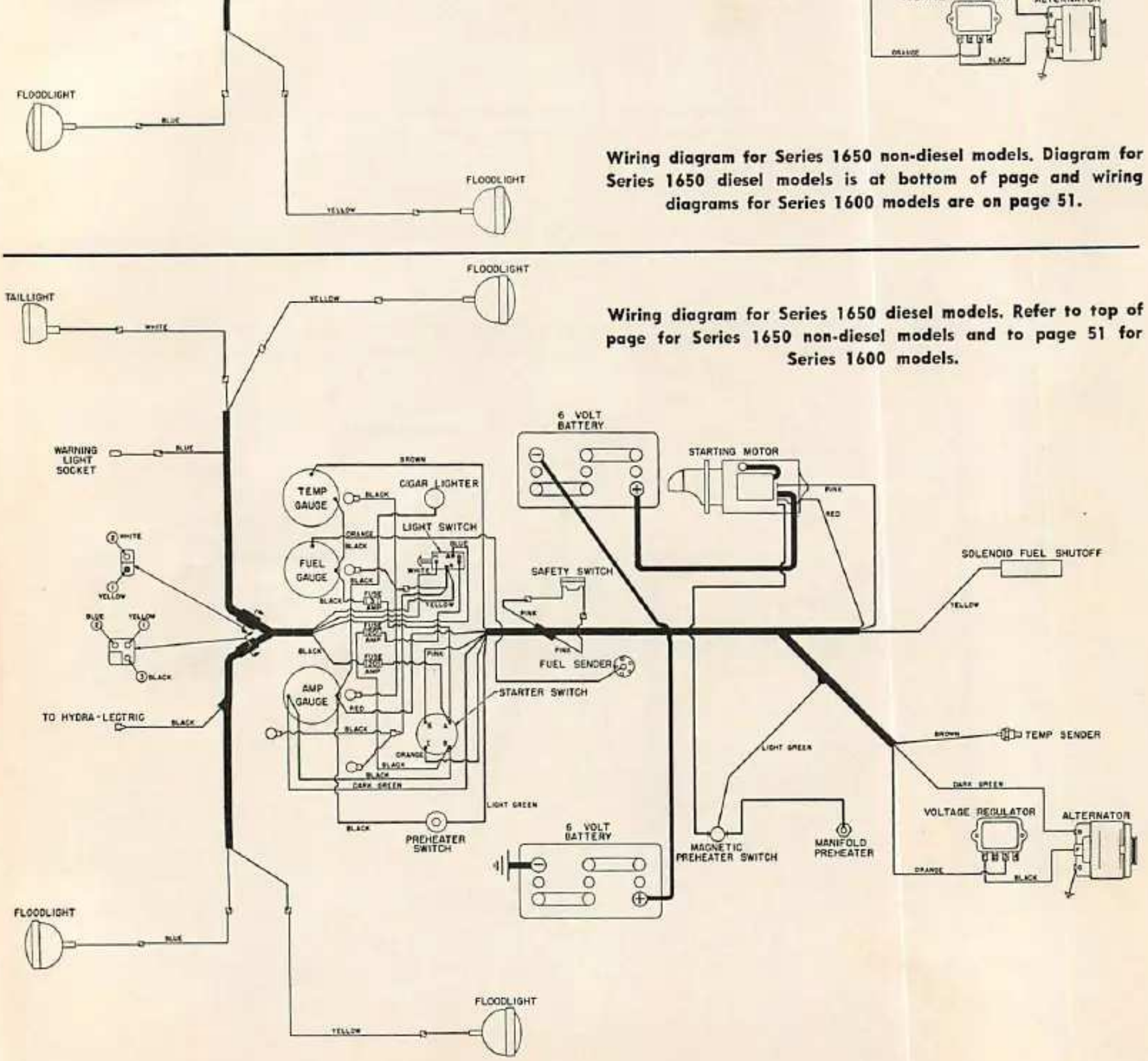


Wiring diagram for Series 1600 non-diesel models. Refer to diagram at bottom of page for Series 1600 diesel models and to diagrams on page 52 for Series 1650 models.



Wiring diagram for Series 1600 diesel models. Refer to diagram at top of page for Series 1600 non-diesel models and to diagrams on page 52 for Series 1650 models.





Wiring diagram for Series 1650 non-diesel models. Diagram for Series 1650 diesel models is at bottom of page and wiring diagrams for Series 1600 models are on page 51.

Wiring diagram for Series 1650 diesel models. Refer to top of page for Series 1650 non-diesel models and to page 51 for Series 1600 models.

IGNITION AND ELECTRICAL SYSTEM

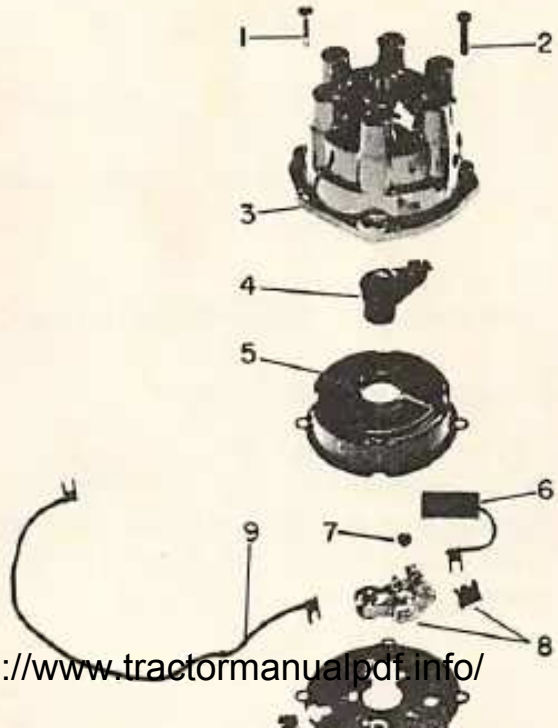
SPARK PLUGS

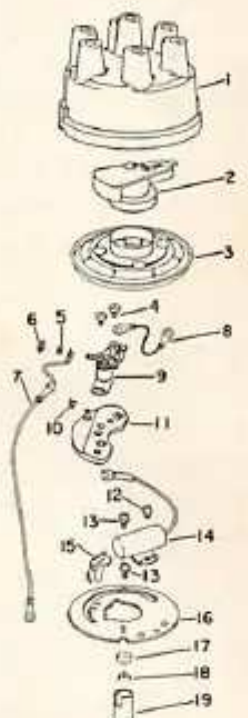
All Non-Diesel Models

141. Recommended spark plugs for normal and heavy duty service are as follows:

Manufacturer	Gasoline	LP-Gas
AC	44XLS	C44XL
Autolite	AG42	AG4
Champion	N-11-Y	N-6
Prestolite	14GT42	14G3

Electrode gap on all plugs should be set to 0.025 for gasoline engines or 0.020 for LP-Gas engines. If using a torque wrench to install plugs, use new gasket and tighten plugs to a torque of 30 Ft.-Lbs.





DISTRIBUTOR

Series 1600 Non-Diesel Models

142. Series 1600 non-diesel models are equipped with a Delco-Remy 1112632 ignition distributor. Refer to Fig. 0103. Specifications are as follows:

D-R 1112632 Distributor

Breaker contact gap.....0.016
Cam angle, degrees.....31-34
Breaker arm spring tension, oz..17-21
Start advance .....0.7-3.5 @ 300
Intermediate advance ...2.5-4.5 @ 370
7.5-9.5 @ 850
Maximum advance.....11-13 @ 1200

Advance data is in distributor degrees and distributor RPM. Breaker arm spring tension is taken at center of breaker contact point and is 19-23 ounces if taken at rear of contact point.

Series 1650 Non-Diesel Models

143. Series 1650 non-diesel models are equipped with a Holley D-2563AA ignition distributor. Refer to exploded view in Fig. O104. Specifications are as follows:

Holley D-2563AA

Breaker contact gap.....0.025
Cam angle, degrees @
idle speed.....35-38

Centrifugal advance curve:

Distributor RPM	Degrees Advance
225	0-1½
275	½-2¾
325	2-4
900	8-10
1200	11-13

Vacuum advance @ 1000 distrbutor RPM:

Inches Hg.	Degrees Advance
7	0
10	0-3
13	3-6
16	6-8
20	6-8

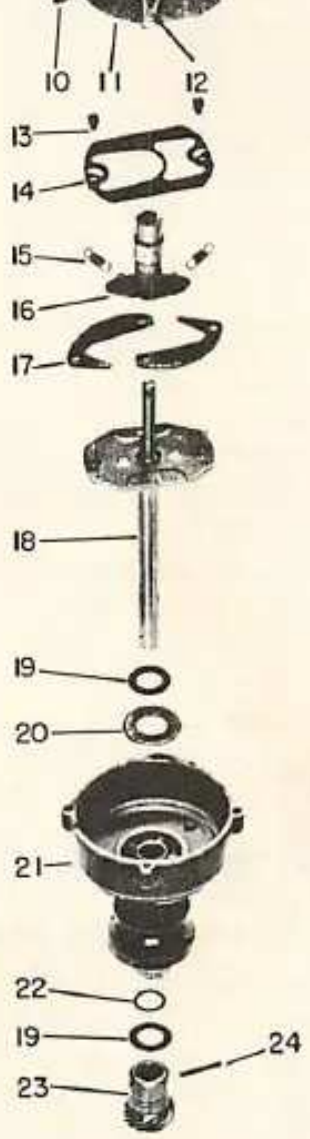


Fig. O103 — Exploded view of Delco-Remy distributor used on Series 1600 non-diesel models. Refer to Fig. O104 for exploded view of ignition distributor used on Series 1650.

1. Screw, No. 8-32
2. Screw, No. 10-32
3. Cap
4. Rotor
5. Dust cover
6. Condensor
7. Screw
8. Contact set
9. Low tension lead
10. Grommet
11. Breaker plate
12. Screw
13. Screw & lock washer
14. Plate
15. Springs
16. Cam
17. Weights
18. Shaft & weight plate
19. Washers
20. Seal
21. Housing
22. Shim(s), 0.005 & 0.010
23. Gear & coupling
24. Pin

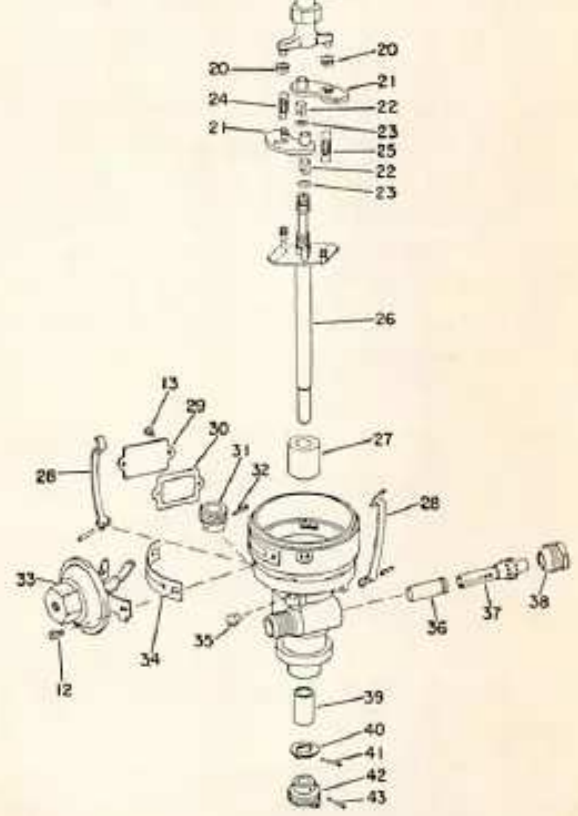


Fig. O104 — Exploded view of Holley distributor used on Series 1650 non-diesel models. The Holley distributor incorporates a vacuum spark advance as well as a centrifugal advance. Timing is checked with vacuum line disconnected and plugged. To remove shaft (26), it is first necessary to remove pin (32) from Tachometer drive gear (31) and pins (41 and 43) from lower end of shaft. Pin (32) is accessible after removing plate (29).

1. Cap
2. Rotor
3. Dust cover
7. Low tension lead
8. Ground wire
9. Contact set
11. Breaker plate
14. Condensor
15. Spring
16. Base plate
17. Wick
18. Retainer
19. Cam
20. Bushings
21. Weights
22. Bearing strip
23. Washer
24. Primary spring
25. Secondary spring
26. Shaft & weight plate
27. Bushing
28. Clamps
29. Cover plate
30. Gasket
31. Tachourmeter drive gear
32. Pin
33. Diaphragm assy.
34. Gasket
35. Plug
36. Bushing
37. Gear & sleeve
38. Retainer
39. Bushing
40. Washer
41. Pin
42. Coupling
43. Pin

IGNITION TIMING

All Non-Diesel Models

144. Ignition distributor can be installed and timing can be adjusted by static timing as outlined in paragraph 145. However, to obtain more accurate timing adjustment, ignition timing should be adjusted by using timing light as outlined in paragraph 146.

145. **DISTRIBUTOR INSTALLATION AND STATIC TIMING.** Remove flywheel timing hole cover and turn engine until the No. 1 piston is starting up on compression stroke. Then, continue turning engine slowly until the proper flywheel timing mark is aligned with pointer. Be sure ignition breaker point gap is properly adjusted as specified in paragraph 142 or paragraph 143. If engine has been

Series 1600 gasoline models,
231 cu. in.
displ.....19° BTDC @ 1900 RPM
248 cu. in.
displ.....21° BTDC @ 1900 RPM
All Series 1600
LP-Gas...24° BTDC @ 1900 RPM
All Series 1650 Non-
Diesel.....22° BTDC @ 2200 RPM

GENERATOR AND REGULATOR

All Series 1600 Models

147. All Series 1600 models are equipped with a Delco-Remy 1100419 generator and a Delco-Remy 1118997 voltage regulator. Specification data follows:

1100419 Generator:

Brush spring tension.....28 oz.

3. Never attempt to polarize the alternator.

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

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

148. All Series 1650 models are equipped with a Delco-Remy (Delcotron) 1100725 alternator (A. C. generator) and a Delco-Remy 1119517 voltage regulator. Refer to CAUTION preceding this paragraph. Specification data follows:

Alternator—1100725

Ground .....negative
Field current @ 12V.

overhauled or oil pump has been removed, check to see that oil pump drive gear is properly installed in time as shown in Fig. O64. Then, install distributor so that rotor is aligned with No. 1 cylinder terminal of distributor cap and breaker points are just starting to open. Tighten the clamp cap screws to hold distributor in this position.

Static ignition timing specifications (in flywheel degrees) are as follows:

Series 1600 gasoline models,
231 cu. in. displacement..0° (TDC)
248 cu. in. displacement..2° BTDC
All Series 1600 LP-Gas models .....5° BTDC
All Series 1650 non-diesel..0° (TDC)

146. **ADJUST TIMING WITH TIMING LIGHT.** To check timing with timing light, remove the flywheel timing hole cover and connect timing light according to manufacturer's instructions. On Series 1650 models, disconnect the vacuum advance line from distributor and plug open end of line. Start engine and run at recommended RPM and check to see that correct flywheel timing mark aligns with pointer by using timing light. If correct timing mark is not aligned with pointer, loosen distributor clamp cap screws and rotate distributor body as required to bring mark into alignment with pointer. Recheck timing after tightening the distributor clamp cap screws.

Specifications in flywheel degrees and engine RPM for adjusting timing by timing light are as follows:

Field draw @ 80° F.
Volts 12
Amperes 1.5-1.62
Output (cold)
Amperes (max.) 25
Volts 14.7
RPM 2710

1118997 Regulator:

Cut-out relay
Air gap 0.020
Point gap 0.020
Closing voltage range.....11.8-14.0
Adjust to 12.8
Voltage regulator
Air gap 0.075
Voltage range 13.6-14.5
Adjust to 14.0
Ground polarity .....positive

ALTERNATOR AND REGULATOR

All Series 1650 Models

CAUTION: An alternator (A.C. generator) is used to supply charging current for the Series 1650 electrical system. Due to the fact that certain components of the alternator can be seriously damaged by procedures that would not affect a D.C. generator, the following precautions must be observed:

1. Always be sure that when installing batteries or connecting a booster battery, the negative posts of all batteries are grounded.

2. Never short across any of the alternator or regulator terminals.

(at 80° F.).....2.2-2.6 Amps.
Cold output:
Specified voltage 14
Amps. @ 2000 RPM.....21
Amps. @ 5000 RPM.....30
Rated Hot Output.....32 Amps.

Regulator—1119517

Relay unit:
Air gap 0.015
Point opening 0.030
Closing voltage 1.5-3.2
Regulator unit:
Air gap .....0.067[1]
Point opening 0.015
Voltage setting:

Temp., °F.[2]	Volts[3]
65	13.9-15.0
85	13.8-14.8
105	13.7-14.6
125	13.5-14.4
145	13.4-14.2
165	13.2-14.0
185	13.1-13.9

[1] Air gap setting of 0.067 is for starting adjustment after bench repairs only; correct air gap is obtained by adjusting unit for proper voltage regulation.

[2] Ambient temperature measured ¼-inch away from voltage regulator cover; adjustment should be made only when at normal operating temperature.

[3] Regulated voltage when regulator is working on upper set of points; when unit is working on lower set of points, voltage should be 0.05-0.4 volts less than given in table.

STARTING MOTOR

149. Series 1600 non-diesel engines are equipped with a Delco-Remy 1107682 starter and Series 1650 non-diesel engines are equipped with a Delco-Remy 1107358 starter. All diesel engines are equipped with a Delco-Remy 1113098 starter. Specification data follows:

Starter—1107682, 1107358

Brush spring tension (min.), 35 oz.
No-load test:
Volts 11.6
Max. amps. 94
Min. RPM 3240
Resistance test:
Volts 3.5
Min. amps. 325
Max. amps. 390

Starter—1113098

Brush spring tension (min.), 48 oz.
No-load test:
Volts 11.5
Min. amps. (includes solenoid).57.0
Max. amps. (includes solenoid).70.0
Min. RPM 5000
Max. RPM 7400
Lock test:
Volts 3.4
Amperes 500
Torque (Ft.-Lbs.) 22

ENGINE CLUTCH

The engine clutch for both the Series 1600 and Series 1650 models is a dry type single plate spring loaded clutch. Series 1600

link and remove chain from sprockets. Disengage snap ring from groove in clutch shaft at front side of front

Reinstall clutch assembly by reversing the removal procedure. Position driven disc so that wide hub flange is to rear and use clutch shaft as a pilot to align disc. Apply a light coat of molybedenum disulphide grease to splines of clutch shaft and transmission input shaft when assembling coupling sprockets.

Models With 4-Wheel, Hydra-Power or Creeper Drive

152. To remove clutch from tractors equipped with four-wheel drive, Hydra-Power Drive or Creeper Drive, the engine must first be removed from tractor with clutch housing or the Hydra-Power or Creeper Drive attached as outlined in paragraph 60. On four wheel drive models with direct drive, remove the clutch housing as follows: Remove starting motor and dust shield from front side of engine front plate and clutch housing. Unbolt

models are equipped with a 11 inch diameter clutch; Series 1650 models have a 12 inch clutch. Service procedure is similar for both the 11 and 12 inch clutch assemblies.

ADJUSTMENT

All Models

150. Clutch pedal free travel is measured at clutch pedal pad and should be ¾-inch. To adjust pedal free travel, loosen jam nut at clevis end of clutch rod, disconnect clevis from clutch release shaft lever and turn clevis as required to obtain free travel of ¾-inch when measured at pedal pad. When adjustment is correct, install new clevis pin retaining cotter pin and tighten the jam nut.

R&R ENGINE CLUTCH

All Direct Drive Models Except With 4-Wheel Drive

151. If tractor is equipped with a power-take-off, remove the pto shaft and clutch on Series 1600 as outlined in paragraph 221 or Series 1650 pto input shaft as in paragraph 226. If equipped with a hydraulic system, but not equipped with power take-off, remove the hydraulic pump drive shaft as outlined in paragraph 248. Disconnect the battery ground strap, then proceed as follows:

Remove left hood side panel and remove governor or fuel injection pump control rod. Disconnect clutch control rod from release shaft lever. Remove drive shaft shield. Disconnect coupling sprocket chain at master sprocket and slide the snap ring and front sprocket forward on clutch shaft. Slide the rear sprocket forward off of transmission input shaft and remove sprocket from between clutch shaft and input shaft. Slide front sprocket back off of clutch shaft and remove from between clutch shaft and input shaft.

Remove starting motor and remove dust shield from lower front side of clutch housing. On models with manual steering, loosen the steering shaft from bearing supports at right side of clutch housing and disconnect the shafts at "U-joint" at rear of shaft bearing support. Remove the clutch shaft felt seal and seal retainer from rear of clutch housing. Unbolt clutch housing from engine rear plate and slide housing rearward until front side of housing can be tipped upward. Remove clutch shaft by pushing it out rear opening of housing and down through opening in main frame. If so desired, the clutch housing can be removed at this time as follows: Shut off the fuel supply valve and remove the fuel line and sediment bowl. With front (open) side of clutch housing up and top side of housing to rear, withdraw the housing from between fuel tank and main frame. If not necessary to remove housing, return it to upright position and move it rearward out of way. Loosen the clutch cover retaining cap screws evenly to avoid distorting the clutch cover and remove the cover assembly from flywheel. Remove the clutch driven (friction) disc assembly.

and remove the clutch housing and clutch shaft as a unit. On Hydra-Power or Creeper Drive, remove the drive unit as outlined in paragraph 155 or paragraph 172.

Loosen the clutch cover retaining cap screws evenly to avoid distorting the cover and remove the cover assembly and friction disc from engine flywheel. Clutch cover assembly can be overhauled as outlined in paragraph 153.

When reinstalling clutch on four wheel drive models with direct drive, the clutch shaft can be removed from rear of clutch housing and used as a pilot for the friction disc. On Hydra-Power or Creeper Drive Models, a spare clutch shaft or suitable pilot must be obtained for use in reinstalling friction disc. Tighten the cover retaining cap screws evenly to avoid distorting the cover.

OVERHAUL CLUTCH COVER ASSEMBLY

All Models

153. Remove the clutch assembly as outlined in paragraph 151 or 152 and proceed as follows: Place cover assembly in press, pressure plate side down, on a block that will permit downward movement of the cover. Place a bar across the cover and compress the unit slightly. Remove the nuts from the

three eye bolts and slowly release pressure from the clutch cover. Lift cover from pressure plate and remove springs, release levers, eye bolts and pins and the struts from pressure plate. Remove the anti-rattle springs from cover.

Carefully inspect all parts and renew any that are excessively worn or otherwise damaged. Springs of two different pressure ranges are used in each clutch assembly. Renew springs if rusted, cracked or distorted, or if they fail to meet the following specifications:

Oliver Part No. 1L-559-A (9 used in both 11 and 12 inch clutch)

Color .....Unpainted
Spring pressure.....189-201 lbs. @ 1½ in.

Oliver Part No. 1M-559 (3 used in 11 inch clutch)

Color .....Tan

HYDRA-POWER DRIVE UNIT

Series 1600 and Series 1650 tractors have available as optional equipment a Hydra-Power drive unit which is located between the engine clutch and tractor transmission. This auxiliary drive unit provides both direct drive and underdrive speed ratios for the transmission input shaft. It is a self-contained unit and includes a hydraulically operated multiple disc clutch, a hydraulic pump, filter and heat exchanger. The gear type pump is mounted on inner side of drive unit housing cover and furnishes pressurized oil to operate the multiple disc clutch as well as providing lubrication for the drive unit. In direct drive position, the multiple disc clutch is engaged and a "straight through" power flow is obtained. In the under-drive position, the multiple disc clutch is disengaged and power flow is directed to the countershaft which reduces the [illegible] and the transmission input shaft, approxi-

b. Oil passages obstructed.
c. Defective clutch.
d. Oil collector sealing rings worn or broken.
e. Defective oil collector "O" ring.
f. Foreign material in clutch.

5. ABNORMAL LUBRICATION CIRCUIT PRESSURES (TOO HIGH OR TOO LOW).
a. Defective pump.
b. Pump inlet clogged.
c. Defective by-pass spring.
d. By-pass valve plunger not seating properly.
e. Low oil level.

6. LOW CLUTCH OPERATING PRESSURE.
a. Low oil level.
b. Defective pump.

Spring
pressure.....155-165 lbs. @ 1½ in.

Oliver Part No. 1H-559 (3 used in 12-inch clutch)
Color .....Orange
Spring
pressure.....165-175 lbs. @ 1½ in.

Reverse disassembly procedure to reassemble the clutch unit. When placing the twelve springs on pressure plate, place a tan spring (11 inch clutch) or orange spring (12 inch clutch) at the second spring position in a counter-clockwise direction from each lever assembly and place the nine unpainted springs in the remaining spring positions. After the cover and pressure plate unit is reassembled, adjust release lever position as follows:

With flywheel removed from crankshaft and pilot bearing retainer removed from flywheel, place flywheel on bench with clutch friction surface up. Place three pieces of 0.330 thick key stock equidistantly apart on clutch friction surface of flywheel, then attach clutch cover to flywheel tightening the retaining cap screws evenly to avoid distortion of cover. Adjust the three eye bolt nuts so that distance from release bearing contact surface of each release finger to pilot bearing retainer mounting flange of flywheel is 3¾ inches. Stake the nuts to the eye bolts when adjustment is correct. Remove the cover from flywheel and reinstall the flywheel and clutch assembly on engine crankshaft.

mately 26 per cent. The Hydra-Power drive unit can be shifted while tractor is in motion.

Some modifications have been made in the Hydra-Power drive unit and where these changes affect service procedures, it will be noted in the following paragraphs.

TROUBLE SHOOTING

154. The following symptoms and their causes will be helpful in trouble shooting the Hydra-Power unit.

1. OPERATING TEMPERATURE TOO HIGH.
   a. Coolant hoses, heat exchanger or oil lines obstructed.
   b. Multiple disc clutch slipping.
   c. Engine cooling system overheated.
   d. Low pump pressure.
   e. Defective or improperly adjusted bearings.

2. INOPERATIVE OR HESITATES IN HYDRA-POWER DRIVE.
   a. Defective over-running clutch.
   b. Defective clutch.
   c. Weak retractor spring.

3. INOPERATIVE OR HESITATES IN DIRECT DRIVE.
   a. Multiple disc clutch slippage or defective.
   b. Clutch operating pressure low.

4. MULTIPLE DISC CLUTCH SLIPPING.
   a. Clutch operating pressure low.
   c. Pump inlet clogged.
   d. Oil collector sealing rings worn or broken.
   e. Defective clutch "O" ring.
   f. Defective clutch piston ring.
   g. Defective regulator spring.
   h. Regulator valve spool stuck open.
   i. Clogged oil passage.

7. HIGH CLUTCH OPERATING PRESSURE.
   a. Defective regulator spring.
   b. Regulator valve spool stuck closed.
   c. Clogged oil passage.

8. ERRATIC CLUTCH OPERATING PRESSURE.
   a. Regulator valve spool installed backward.

OPERATING PRESSURE

154A. Hydra-Power drive unit has two oil pressure circuits; a clutch operating circuit and a lubrication circuit. Both circuits can be checked at the same point using a single gage.

To check the Hydra-Power drive operating pressures, proceed as follows: Remove the pipe plug, which is located in side cover directly below the filter to heat exchanger tube, and install, as shown in Fig. O105, a pressure gage capable of registering at least 300 psi. Be sure oil level in Hydra-Power drive is at the proper level, then start engine and run until

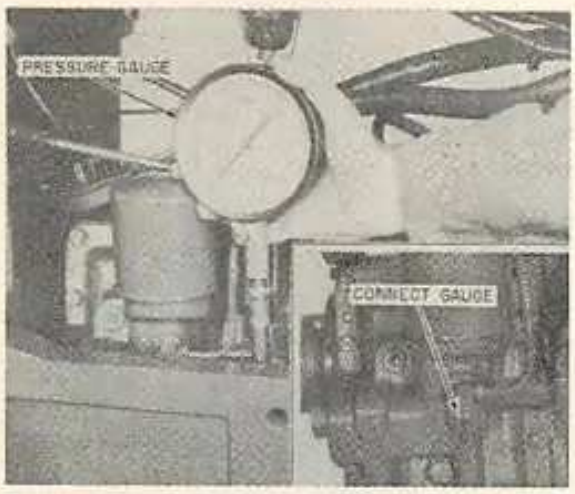


Fig. O105 — When checking operating pressure of the Hydrapower drive unit, install pressure gage as shown.

oil in Hydra-Power drive is at operating temperature. With oil warmed, operate engine at approximately 2000 rpm, place Hydra-Power Drive unit in direct drive and observe pressure gage. Gage should read 140-190 psi. If pressure is not as specified, and no

9. Snap ring
23. Control lever
25. Pin
26. Bushing
27. Snap ring
28. Drive gear
29. Woodruff key
30. Plug
31. Crush washer
32. Regulator spring
33. Regulator spool
34. By-pass spring
35. Plug
36. By-pass valve plunger
37. Gasket
38. Cover
41. Plug
42. Plug
43. Gasket
44. Oil pump
47. Elbow
48. "O" ring
49. Control valve spool
50. Detent ball
51. Detent spring
55. Adapter
56. Oil filter
57. Oil line
58. Heat exchanger
62. Bracket
65. Oil line
67. Hose clamp
68. Inlet hose
69. Outlet hose
180. "O" ring
181. Shim

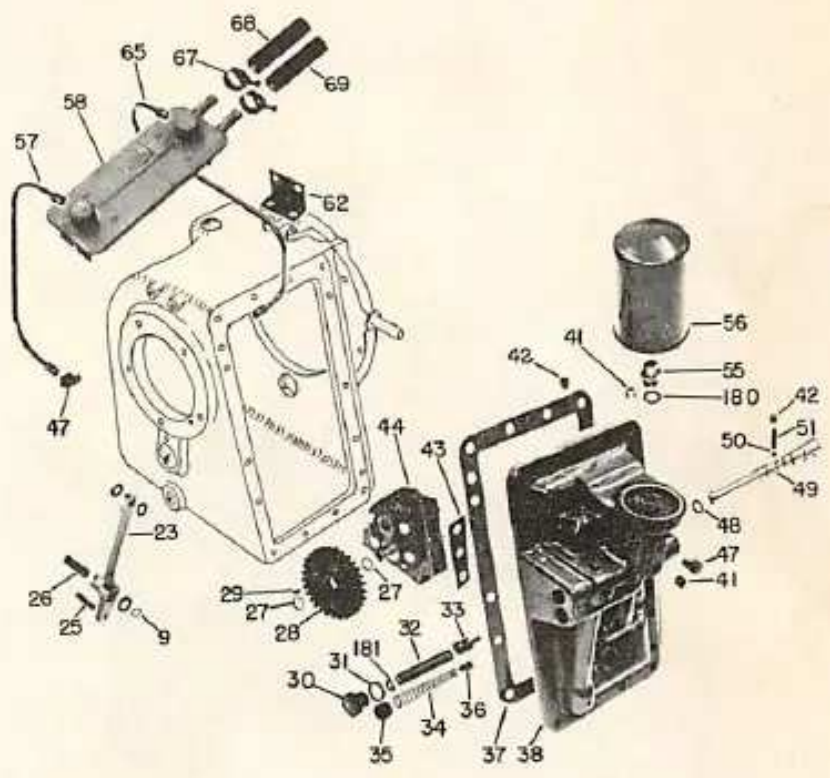


Fig. O106 — Exploded view of the early Hydro-Power drive cover showing component parts. Later cover assemblies are similar.

malfunctions of the unit are evident, add shims (181—Fig. O106) behind the regulator valve spool spring to raise pressure. Shims are 0.0359 thick and each shim will raise the pressure approximately 5 psi.

Place Hydra-Power unit in the under-drive position and with engine running at 2000 rpm, observe the gage pressure which should be 20-60 psi. If gage reading is not as specified, refer to the Trouble Shooting section or the section pertaining to overhaul.

REMOVE AND REINSTALL

155. To remove the Hydra-Power drive unit, it is necessary to remove engine and Hydra-Power drive as a unit as outlined in paragraph 60. With engine and drive unit removed, support engine on blocks so that oil pan will not be damaged, then remove clutch housing lower dust shield and starter. Disconnect coolant lines from heat exchanger. Unbolt and remove clutch housing and Hydra-Power unit from engine. Remove clutch release bearing and lubrication hose. Remove cap screw and key from release bearing fork and pull cross shaft from fork and clutch housing. Unbolt and remove the clutch housing from Hydra-Power unit.

Reinstall the Hydra-Power drive unit by reversing the removal procedure.

OVERHAUL

156. **DISASSEMBLY PROCEDURE.** With unit removed as outlined in paragraph 155, drain unit and on early models so equipped, remove front control rod. Remove valve control lever and, if necessary, lever bushing can be renewed at this time. Remove filter to heat exchanger line, then unbolt and remove housing cover and attached pump.

Remove clutch release bearing tube support (142—Fig. O107) and retainer (140). Remove snap ring from outer race of input shaft bearing (137) and bump off input shaft bearing support plate (118). Remove support shaft lock (90), pull support shaft (96) and allow countershaft assembly to rest on bottom of housing. Remove and discard support shaft "O" ring from shaft and bore in housing. Pull input shaft (136), bearing (137), input gear (120) and clutch hub (121) as an assembly from housing. Remove snap ring (123) from front end of output shaft (104), then unbolt output shaft bearing retainer (81). Pull output shaft rearward and remove the clutch and oil collector assembly and the output gear (105) from housing as the shaft is withdrawn. Countershaft assembly can now be removed from housing. If necessary, the heat exchanger, filler neck and valve spool control lever shaft can also be removed.

At this time all of the components of the Hydra-Power drive unit are accessible for inspection and/or overhaul. Refer to the appropriate following paragraphs:

157. CONTROL VALVE SPOOL, REGULATOR VALVE AND BY-PASS VALVE. The control valving can be removed from housing cover as follows: Remove the Allen plug (42—Fig. O106) on top side of control valve bore and remove detent spring (51) and ball (50). Pull control valve spool (49) forward out of its bore, then remove and discard "O" ring. Remove plugs, then remove regulator valve (33) and by-pass valve (36) assemblies. Save any shims (181) which may be present behind the regulator valve spring.

NOTE: Removal of the regulator and by-pass valves can be accomplished with Hydra-Power drive unit on tractor.

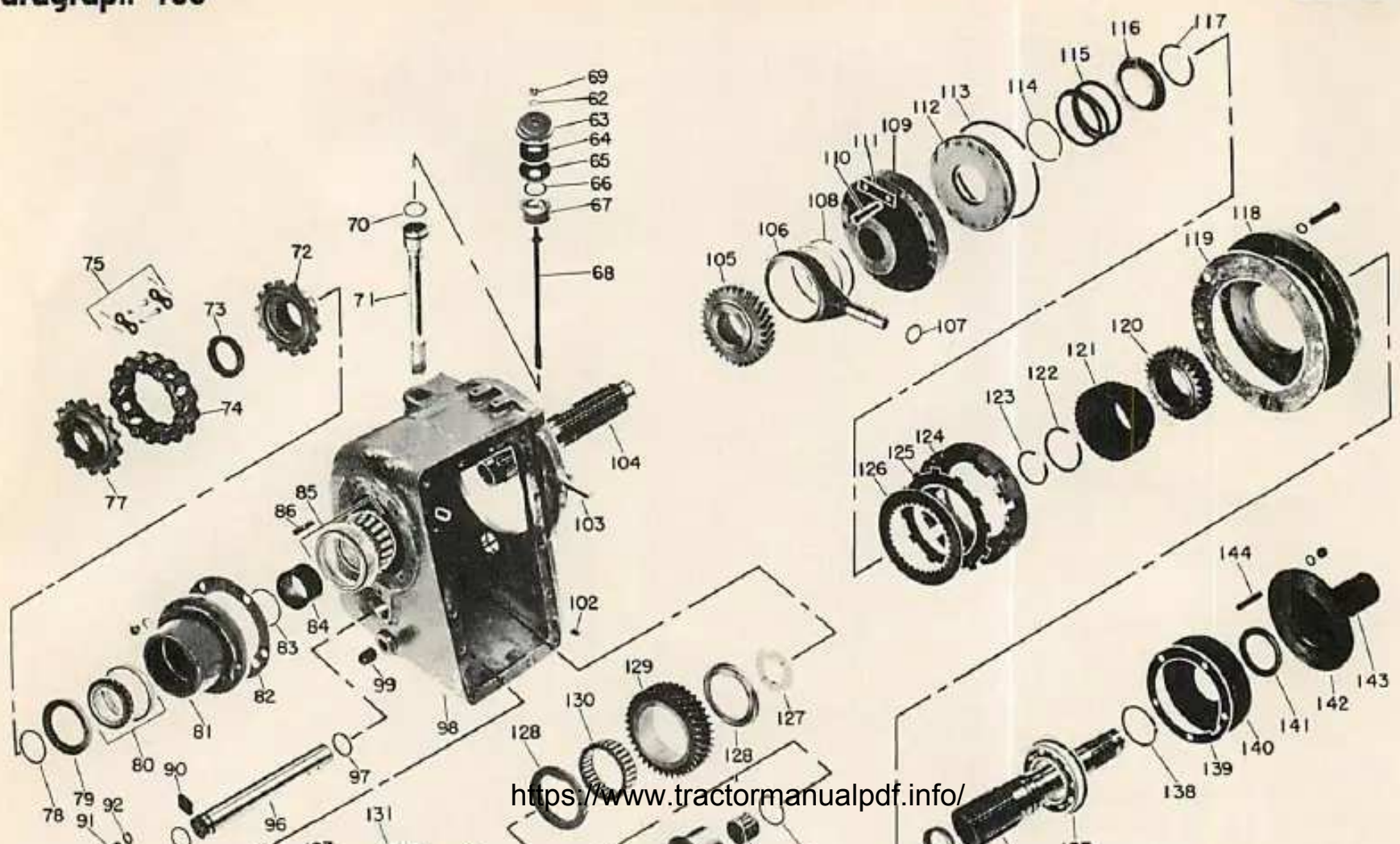
Check springs against the values which follow:

Detent spring
Free length.....1 3/32 in.
Test lbs. @ inches.15.3-18.7 @ 7/8

Regulator spring
Free length.....3 5/8 in.
Test lbs. @ inches...55-67 @ 2 3/4

By-pass spring
Free length.....3½ in.
Test lbs. @ inches.5½-6½ @ 2 7/16

Outside diameter of regulator valve spool and land of control valve spool is 0.6865-0.6869 and their bore inside diameters are 0.6875-0.6883.



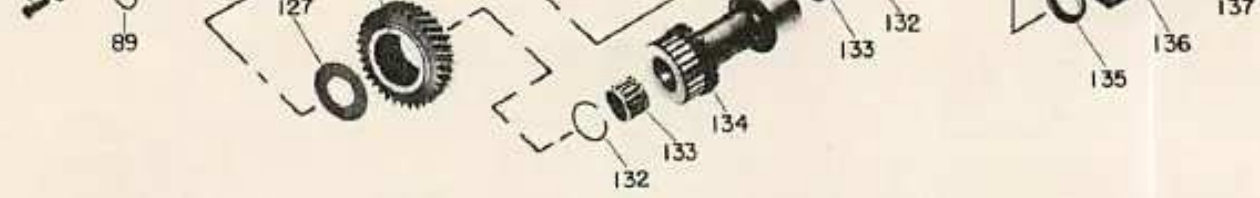


Fig. O107 — Exploded view of the latest Hydra-Power drive unit. Earlier units did not use bearing spacer (84), clutch gear bearings (128) were retained by snap rings (not shown) and pump was driven by double gear (131) (see Fig. O113) instead of gear integral with countershaft (134). Refer to text for difference in service procedure on early and late output shaft assemblies.

62. Washer
63. Cap
64. Filter element
65. Cup
66. Gasket
67. Cap
68. Dip stick
69. Nut
70. "O" ring
71. Filler tube
72. Sprocket, front
73. Nut
74. Coupling chain
75. Master link
77. Sprocket, rear
78. "O" ring
79. Oil seal
80. Rear bearing assy.
81. Bearing retainer
82. Gasket
83. Shim
84. Spacer
85. Front bearing assy.
86. Stud
89. "O" ring
90. Retainer
96. Support shaft
97. "O" ring
98. Housing
99. Drain plug
102. Dowel
103. Lever shaft
104. Output shaft
105. Output gear
106. Oil collector
107. "O" ring
108. Sealing rings
109. Clutch spider
110. Cap screw
111. Lock plate
112. Piston
113. Piston ring
114. Seal ring
115. Release spring
116. Spring retainer
117. Snap ring
118. Bearing support
119. Gasket
120. Input gear
121. Clutch hub
122. Snap ring
123. Snap ring
124. Plate retainer
125. Driven plate
126. Drive plate
127. Thrust washer
128. Clutch gear bearing
129. Clutch gear
130. Sprag clutch (overrunning)
131. Gear
132. Snap ring
133. Bearing
134. Countershaft
135. Oil seal
136. Input shaft
137. Ball bearing
138. Snap ring
139. Gasket
140. Retainer
141. Oil seal
142. Tube support
144. Stud

When reassembling, use new "O" ring on control valve spool and install regulator valve with pin inward. If any shims were present behind regulator spring during disassembly, be sure to reinstall them. Prior to installing cover on housing, renew "O" ring on stem of oil collector and in oil collector stem bore of housing cover (early models not converted).

158. **OIL COLLECTOR MODIFICATION.** A field service package, Oliver part No. 159 346-AS, is available to correct oil leakage problems which occur between the oil collector stem and housing cover on Hydra-Power units prior to unit Serial No. 16234. Installing this package reroutes the clutch operating oil and oil collector stem "O" rings are no longer pressurized. The package contains a new oil collector, necessary oil lines and fittings. To install the field service package, a gasket and "O" ring package, Oliver part No. 155 234-AS, is also required.

To re-work housing cover and install oil collector service package, proceed as follows: Remove Hydra-Power drive unit from tractor as outlined in paragraph 155, then remove housing cover, input shaft assembly and output shaft assembly as in paragraph 156. Remove and discard the oil collector ring. Remove oil filter and if so equipped, remove the control valve front control rod. Remove control valve spool lever, then remove Allen plug, detent spring and ball and withdraw control valve spool from bore.

Remove the Allen plug at top of oil collector stem bore in cover and drive the tapered brass plug (included in kit) into oil passage as shown in Fig. O108; top of plug should be $\frac{1}{16}$-inch below flush with stem bore. Reinstall Allen plug.

Refer to Fig. O109 and center punch cover at the two locations indicated. Drill top hole with a 37/64-inch drill bit and bottom hole with a 21/64-inch drill bit; top hole is to be drilled completely through housing cover and bottom hole is to be drilled to a depth of $\frac{5}{8}$-inch. CAUTION: Be accurate in

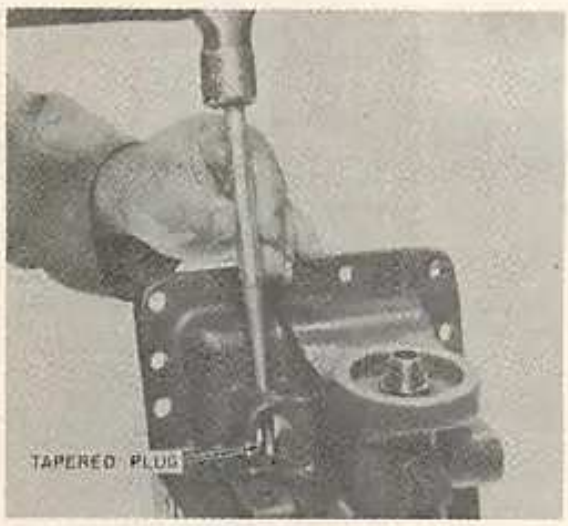
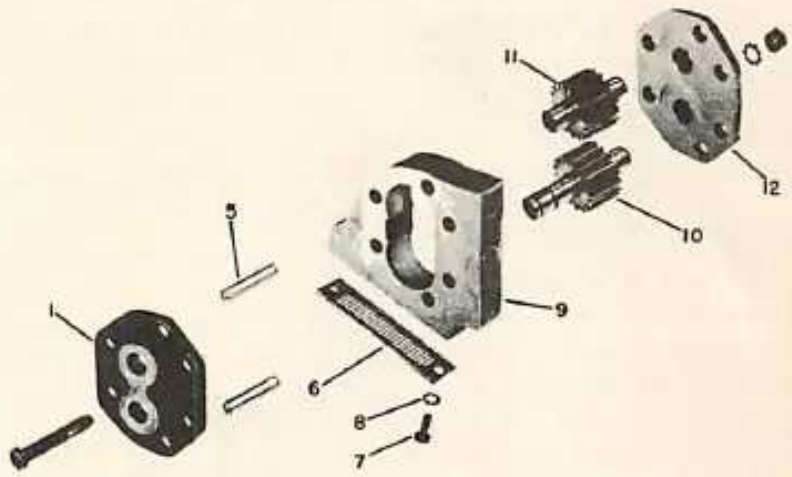


Fig. O108 — Drive tapered plug to 1/16-inch below flush of oil hole.

Fig. O112 — Exploded view of the Hydra-Power drive oil pump.

1. Rear plate
5. Dowel
6. Screen
9. Center plate
10. Drive shaft and gear
11. Idler shaft and gear
12. Front plate



locating and drilling these holes; a depth stop is suggested for drilling the bottom hole which intersects the control valve spool bore. Carefully remove all burrs from spool bore. Tap top hole from outside using a $\frac{3}{8}$-inch NPTF tap so that the threaded adapter (included in kit) will be approximately flush with inner side of cover when tightly installed. Take care not to tap the hole too deeply. Tap bottom hole from inside of cover using a $\frac{1}{8}$-

Pump body width	0.9995-1.0000
Gear shaft diameter	0.6247-0.6250
Shaft bore diameter	0.6265-0.6275
Shaft operating clearance	0.0015-0.0028

Reassemble by reversing disassembly procedure and use new gasket when mounting pump on housing cover. Heads of through bolts should be on drive gear side of pump and

Fig. O109 — Use illustration to locate the holes to be drilled when reworking Hydra-Power drive cover. Also refer to text.

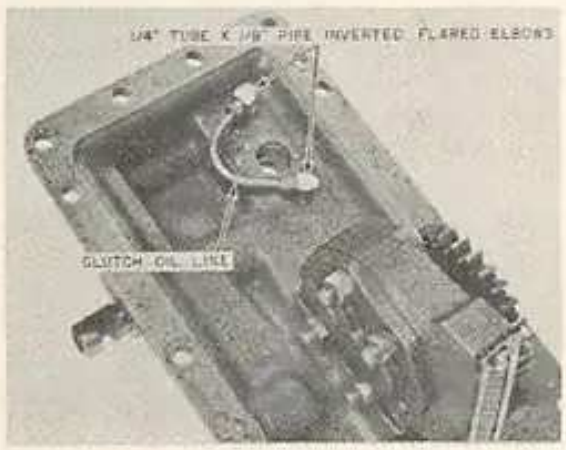


Fig. O110 — View showing installation of interior oil line.

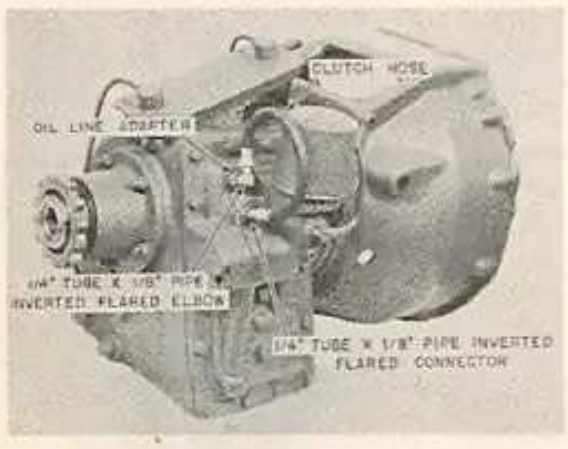


Fig. O111 — View showing installation of exterior oil hose.

inch NPTF tap. Install elbow fittings in threaded adapter and tapped bottom hole and connect with oil line as shown in Fig. O110.

Place new oil collector on clutch spider with word "FRONT" on collector towards spider. Reinstall output shaft assembly, input shaft assembly and the cover. Install elbow in threaded adapter and connect the elbow and new oil collector stem with hose as shown in Fig. O111.

Complete balance of reassembly and reinstall the Hydra-Power drive unit.

159. **PUMP OVERHAUL.** After removing cover from Hydra-Power drive unit as outlined in paragraph 156, unbolt pump from cover and discard gasket. Remove drive gear outer retainer snap ring, remove gear and key from pump drive shaft, then remove inner gear retainer snap ring. Remove the through bolts and separate pump. Dowels can be driven out and the screen removed if necessary. See Fig. O112.

NOTE: If the pump gears and shafts are to be reinstalled, mark idler gear so that it will be reinstalled in its original position.

Pump dimensional data are as follows:

Gear width.....0.9975-0.9980

dowels should be installed prior to tightening through bolts.

160. **INPUT SHAFT ASSEMBLY.** Remove input shaft assembly as in paragraph 156. To disassemble input shaft assembly, remove snap ring (122—Fig. O107) and pull clutch hub (121) and input gear (120) from input shaft. Remove snap ring (138) and press bearing from shaft. Oil seal (135) can be removed from rear end of input shaft at any time.

Inspect input shaft, input gear and clutch hub for damaged or worn splines or teeth. Check condition of input shaft bearing. Renew parts as necessary.

Reassemble input shaft as follows: Install oil seal in rear end of input shaft with lip facing toward front of shaft. Press bearing on shaft with snap ring groove in bearing outer race toward front of shaft, install retaining snap ring, then press bearing toward snap ring to insure that bearing inner race is tight against snap ring. Install input gear on shaft with hub next to bearing, then install the clutch drive hub on shaft with its hub toward input gear and install the retaining snap ring.

161. **CLUTCH ASSEMBLY.** Remove clutch assembly as outlined in paragraph 156. To disassemble the clutch

assembly, first pull oil collector (106—Fig. O107) from clutch spider hub, then remove the two sealing rings (108). Straighten tabs of lock plates (111), remove clutch plate retaining cap screws and lift clutch spider (109) from plate retainer (124). Clutch plates can now be removed from plate retainer. Place clutch spider in a press, depress the spring retainer (116) slightly and remove retainer snap ring (117). Release press and remove retainer and retractor spring (115), then remove piston (112) from clutch spider either by bumping spider hub on a wood block, or by carefully applying air pressure to the oil hole located in land between oil collector sealing rings.

Clean and inspect all parts. Use the following specification data as a guide for renewing parts.

Clutch reaction spring test.....155-185 lbs. @ $1\frac{3}{16}$ in.

Driven plate thickness.....0.112-0.120

Driving plate thickness....0.064-0.067

with word "Front" toward clutch spider and remove wire as oil collector goes over sealing rings. Lubricate the clutch plates.

162. **OUTPUT SHAFT ASSEMBLY.** Early Hydra-Power drive units were equipped with an output shaft which was not shouldered. Subsequently, a field service package, Oliver part No. 158 601-AS, was made available which used a shouldered input shaft along with a spacer and shims to provide for bearing adjustment. In addition to the shouldered output shaft, spacer and shims, the package also includes a new output gear, one new bearing cone and a new lock nut. To install the field package, a seal and gasket package, Oliver part No. 155 234-AS is required.

163. To disassemble the output shaft assembly, unstake lock nut (73—Fig. O107) and using a spanner wrench (Oliver No. ST-149 or equivalent), remove nut. Remove sprocket (72) and "O" ring (78) from shaft, then press shaft from rear bearing and retainer. On early units with shoulder-

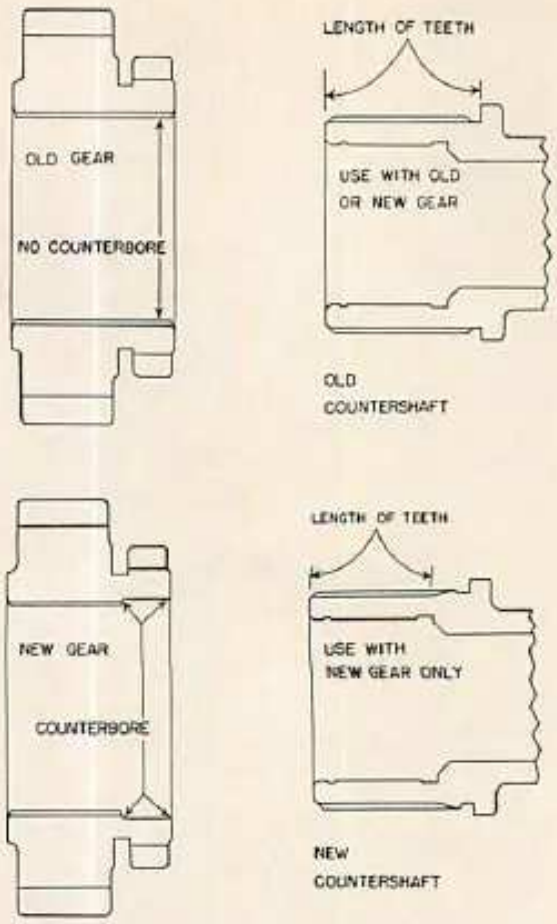


Fig. O113 — When servicing Hydra-Power drive on series 1600, be sure to use correct countershafts and double gears as shown.

Max. allowable cone.....0.010

Clutch piston ring:

Width 0.123-0.124
End gap (desired).....0.005-0.015
Max. allowable 0.025
Side clearance (desired).0.003-0.006
Max. allowable 0.025

Oil collector hub O.D.....3.544-3.546

Oil collector I.D.....3.550-3.552

Oil collector seal ring:

Width 0.0930-0.0935
End gap (desired).....0.003-0.008
Max. allowable 0.020

Reassemble clutch as follows: Install new seal ring in I. D. of clutch piston. Install piston ring on O. D. of clutch piston. Start piston into spider with flat side toward oil cavity and install by compressing piston ring with fingers. Place clutch spider in a press, position retractor spring and retainer and compress retainer until snap ring can be installed. Start with an external lug clutch plate (driven) and alternate with an internal spline plate (drive) and install the six driven plates and five drive plates. Install the clutch spider on plate retainer, install lock plates and cap screws and tighten cap screws to 14-15 Ft.-Lbs. torque. Secure cap screws with lock plates. Install sealing rings on oil collector hub and compress rings with soft wire. Start oil collector over hub less shaft, note location of front bearing on shaft, then press bearing from shaft. On later units having shouldered shaft, remove shims and spacer, then press front bearing from shaft. Remove oil seal and rear shaft bearing from retainer and, if necessary, pull bearing cups from retainer.

Clean and inspect all parts and renew as necessary. Always use new "O" ring and oil seal when reassembling unit.

164. Assemble early output shaft as follows: Start front bearing on shaft with smaller diameter towards threaded end (rear) of shaft and press bearing onto shaft until inner race is even with rear edge of ground (polished) surface on shaft. Note: This is to insure sufficient room for installation of spider retaining ring.

If necessary, install bearing cups in bearing retainer with smaller diameters toward center, then insert shaft and bearing in retainer. Use coupling sprocket as a driver and press rear bearing on shaft. Remove coupling sprocket, install new "O" ring and oil seal (lip inward), then reinstall coupling sprocket. Install new lock nut and tighten only finger tight at this time. Refer to paragraph 168 in assembly procedure for information concerning bearing adjustment.

165. Assemble later output shaft assembly as follows: Place front bearing on rear of output shaft with smaller diameter toward rear and press bearing on shaft until it bottoms against shoulder. If necessary, install bearing cups in retainer with smaller diameters towards inside. Place spacer (84) on output shaft with the counterbored end next to front bearing cone, then install shims (83) that were previously removed or, if service package is being installed, install all shims that are included in package. Place shaft in bearing retainer (81), install rear bearing, sprocket (72) and the lock nut (73); tighten lock nut to a torque of 200 Ft.-Lbs. Check shaft bearing adjustment which should be from a maximum of 0.001 shaft end play to a maximum shaft rolling torque of 5 inch pounds. If bearing adjustment is not within these limits, remove lock nut, sprocket and rear bearing and vary the number of shims (83) as necessary. Shims are available in thicknesses of 0.004, 0.007 and 0.015. When bearing adjustment is within the desired limits, remove the lock nut and sprocket and install new "O" ring (78) and oil seal (79). Seal is installed with lip forward. Install sprocket and lock nut, tightening the lock nut to a torque of 200 Ft.-Lbs. Stake nut in position.

166. **COUNTERSHAFT ASSEMBLY.** Lift countershaft from housing, if necessary, and retrieve both thrust washers. Pull gear (131—Fig. O107) from rear of shaft. Note: On series 1600 a double gear is used as shown in Fig. 0113. Remove retaining ring (Series 1600) and front bearing from front end of shaft and pull clutch gear from the sprag clutch. Note position of sprag clutch, then remove clutch from shaft. Remove snap ring (Series 1600) and rear bearing from shaft. Remove snap rings and needle bearings from I. D. of countershaft.

Clean and inspect all parts and renew as necessary. Use the following data as a guide for renewing parts.

Front thrust washer
thickness 0.060-0.062

Rear thrust washer
thickness 0.060-0.062

Countershaft support
shaft O. D.....1.3745-1.3750

Countershaft O. D.
clutch end 2.8429-2.8434
Max. allowable taper.....0.0002

Clutch gear I. D.....3.4988-3.4998

gear has a counterbore in the front I. D., whereas the early gear is not counterbored. Early countershaft will work with either gear but late countershaft must be used only with the late double gear. Part numbers remain the same, so identification of parts must be visual. Therefore, when ordering new parts, be sure the correct combination of double gear and countershaft is obtained. On Series 1650, a single gear is used at rear of countershaft and pump is driven from a gear which is integral with countershaft.

167. **REASSEMBLY PROCEDURE.** Install oil filter tube, heat exchanger and bracket, control valve spool lever shaft or input shaft support studs if removed.

Use heavy grease on the countershaft thrust washers and position washers in housing with tangs in the slots provided. On early models, the thrust washer with the largest outside diameter is the rear washer; on late models, front and rear washer are identical. Place assembled countershaft in case with double output [illegible] assembly to rest in bottom of case. Take care

not available, tighten nut so that shaft end play is 0.001 or slightly less than 0.001. Bump output shaft both ways when adjusting bearings to be sure bearings are seated. When proper adjustment point is reached, bump forward end of output shaft to be sure snap ring is seated against clutch spider and recheck shaft rolling torque or end play. Readjust bearings if necessary. When certain that bearing adjustment is correct, stake lock nut to slot in shaft and at 180 degrees away from slot to maintain bearing adjustment.

169. Align splines of clutch drive (internal splined) plates and insert input shaft assembly. All five of the driven discs will rotate if drive hub is properly positioned. Use new gasket and install bearing support so notch in support aligns with notch in housing. Then install snap ring on outer race of input shaft bearing. Install new seal in bearing retainer with lip of seal toward front, then install the bearing retainer and the release bearing tube and support. Align notches in gasket and bearing retainer with oil drain hole in bearing support.

NOTE: A new release bearing tube

Max. allowable I. D. taper...0.0003

Front and rear clutch gear bearing:
Bearing surface O. D...3.4968-3.4978

To reassemble countershaft, proceed as follows: Install needle bearings in I. D. of countershaft only far enough to allow installation of snap rings. Place rear clutch gear bearing on shaft with bearing surface toward front and install rear snap ring. Note: On Series 1600, rear clutch gear bearing is notched; on Series 1650, front and rear clutch bearings are identical and no snap rings are used. Install the sprag clutch on countershaft so that the drag strips point toward rear bearing. Install clutch gear over the sprag clutch and rotate clutch gear clockwise around the sprag clutch to assist in installing gear. After installation, clutch should overrun (turn freely) when gear is turned clockwise but lock up when counterclockwise gear rotation is attempted. Install the front gear bearing and on Series 1600, install retaining ring and the output double gear with smaller gear next to shaft shoulder. On Series 1650, Install rear gear next to pump drive teeth on countershaft.

NOTE: On Series 1600, some differences exist in countershafts and the double countershaft gears as shown in Fig. 0113. Note that the later double not to dislodge the thrust washers. Delay installation of countershaft support shaft until input shaft assembly has been installed.

Use a new bearing retainer gasket and start output shaft into rear of housing. As shaft is moved forward, install output gear with hub to rear and clutch assembly with oil collector to rear. Align notches of gasket and retainer with oil drain hole in housing, install lock washers and nuts on bearing retaining studs and tighten the nuts securely. Install clutch spider retaining ring on front of output shaft.

168. At this time, adjust output shaft bearings on units not having a shouldered shaft. Bump front end of output shaft to insure that snap ring is seated against clutch spider. Install "O" ring and coupling sprocket on output shaft, if not already installed, then install and tighten lock nut until only a slight amount of shaft end play exists. Now, use an adapter such as Oliver tool No. ST-152 with an inch-pound torque wrench and check torque required to rotate shaft; record this torque which is the amount of oil seal and bearing drag. Continue to tighten lock nut until torque required to rotate shaft is 2 to 5 inch-pounds greater than torque due to seal and bearing drag. Note: If inch-pound torque wrench and adapter is can be installed in tube support if necessary. Install tube so that it protrudes 4 inches from front flange of tube support and be sure tube is not cocked during assembly. Any misalignment of release bearing tube will result in rapid wear of the clutch release bearing.

170. Install the countershaft support shaft as follows: Install new "O" ring in shaft bore in front of housing. Install new "O" ring on rear of shaft and, if necessary, install oil line elbow in rear of shaft. Lubricate both "O" rings, make certain that both thrust washers are in position, then lift countershaft assembly to align bores and install countershaft support shaft from rear. Install shaft retainer and support shaft to heat exchanger oil line.

171. To install housing cover, install "O" ring on stem of oil collector (early units only) and install "O" ring in oil collector stem bore in housing cover (all units). Place new cover gasket on housing, lift stem of oil collector and start stem into bore in cover, then carefully install cover to housing by rotating cover slightly as stem enters cover bore. Tighten cover retaining cap screws securely.

Fill unit with 5 quarts of Type A Automatic Transmission fluid.

CREEPER DRIVER UNIT

Some models of the Series 1600 and 1650 may be equipped with a Creeper Drive unit which provides direct drive and creeper drive speeds. The Creeper Drive operation can be used only in conjunction with 1st, 2nd and 4th speed positions of the tractor main transmission as a lock-out system prevents creeper drive operation in the other three speeds. The Creeper Drive unit must not be shifted while tractor is in motion.

REMOVE AND REINSTALL

Models So Equipped

172. To remove the Creeper Drive unit, first remove engine with Creeper Drive unit attached, as outlined in paragraph 60.Support engine on wood blocks so oil pan will not be damaged. Remove starting motor and dust shield from lower front of clutch housing. Disconnect throw-out bearing grease tube, then remove throw-out bearing, clutch cross shaft and release fork. Creeper Drive unit can now be removed from clutch housing.

Reinstall by reversing the removal procedure.

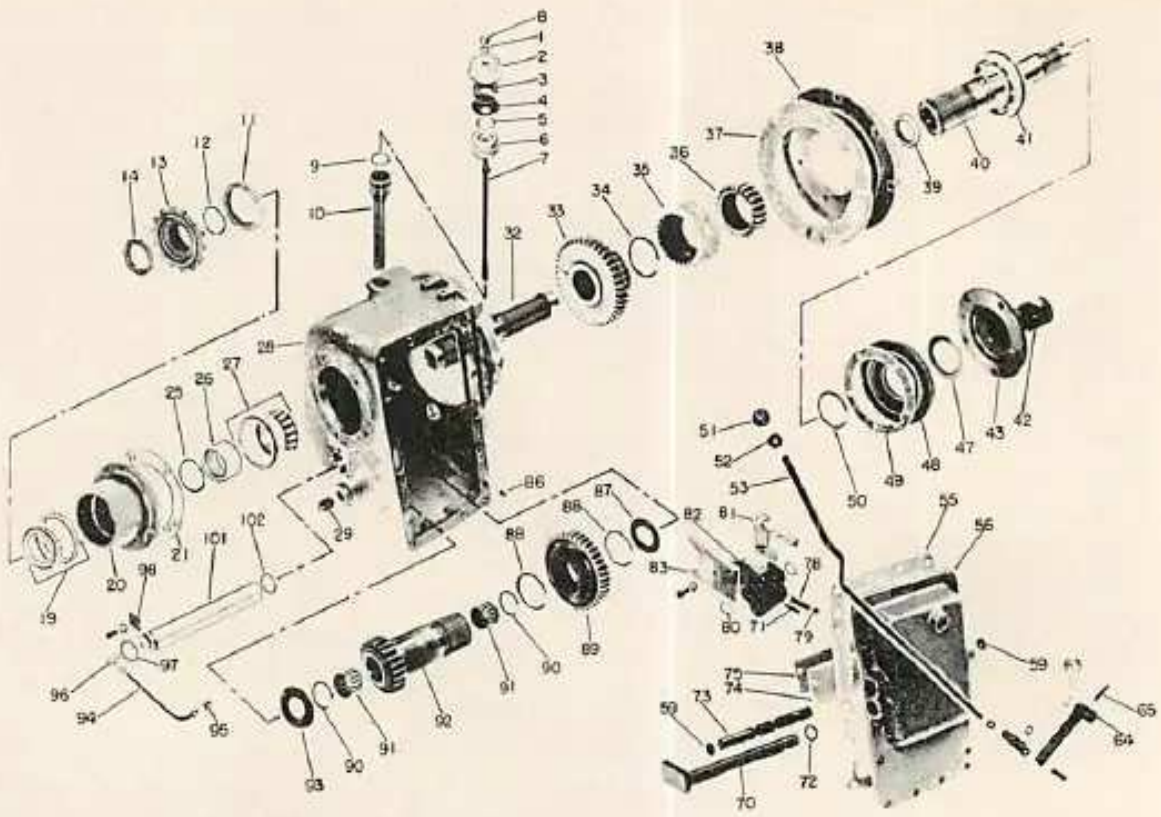


Fig. O114 — Exploded view of Creeper Drive unit.

1. Washer
2. Cap
3. Element
4. Cup
5. Gasket
6. Cap
7. Dip stick
8. Nut
9. "O" ring
10. Filler tube
11. Oil seal
12. "O" ring
13. Coupling sprocket
14. Lock nut
19. Rear bearing
20. Snap ring
21. Front bearing
25. Gasket
26. Cup
27. Front bearing
28. Housing
29. Drain plug
32. Output shaft
33. Output gear
34. Snap ring
35. Coupling
36. Input gear
37. Gasket
38. Bearing support
39. Oil seal
40. Input shaft
41. Ball bearing
42. Tube
43. Tube support
47. Gasket
48. Cover
49. Plug
50. Oil seal
51. Knob
52. Bushing
53. Control rod
55. Gasket
56. Cover
59. Plug
63. Oil seal
64. Shifter lever
65. Groove pin
70. Lock-out rod
71. Roll pin
72. "O" ring
73. Shifter rail
74. Gasket
75. Plate
80. Gasket
81. Shifter arm
82. Hub
83. Shifter fork
86. Dowel
87. Thrust washer
88. Snap ring
89. Countershaft gear
90. Snap ring
91. Bearing
92. Countershaft
93. Thrust washer
94. Oil line
95. Connector
96. Elbow
97. "O" ring
98. Gasket
101. Tube
102. Tube support

20. Retainer
21. Gasket
25. Shim
26. Spacer
47. Oil seal
48. Retainer
49. Gasket
50. Snap ring
78. Detent spring
79. Detent ball
80. Snap ring
98. Retainer
101. Support shaft
102. "O" ring

OVERHAUL

Models So Equipped

173. With unit removed as outlined in paragraph 172, drain unit, if necessary, then refer to the following appropriate paragraphs for disassembly and reassembly of the cover assembly, input shaft assembly, output shaft assembly and the countershaft assembly.

174. **COVER ASSEMBLY.** To disassemble the cover assembly, remove the countershaft support shaft oil line, then unbolt and remove cover assembly from housing. Drive out roll pin (65—Fig. O114), pull shift lever (64) from shifter arm (81), then pull arm from cover. Seal (63) can now be renewed. Remove baffle plate (75) and gasket (74). Remove one plug (59), lift snap rings (80) from their grooves, then bump out shifter rail (73) and catch detent ball (79) and spring (78) as shift rail clears shifter hub (82). Note: Remaining plug (59) will be removed by shift rail as it is bumped out. Remove shifter fork (83) if necessary, then drive out roll pin (71) and remove interlock (lockout) rod (70) and hub (82) from cover. "O" ring (72) can now be renewed.

Clean and inspect all parts and renew as necessary. Use new "O" ring and seal and reassemble by reversing disassembly procedure.

175. **INPUT SHAFT ASSEMBLY.** To remove the input shaft assembly, first remove cover as outlined in paragraph 174. Remove shaft retainer (98), pull countershaft support shaft (101) and let countershaft assembly rest in bottom of housing. Remove throwout bearing tube and support (43) and bearing retainer (48), then pull input shaft assembly from bearing support (38) and housing. Bump off bearing support (38). Remove snap ring (50) and press input shaft (40) from bearing (41). Remove snap ring from outer race of bearing (41). Push gear (36) and coupling (35) forward on input shaft to ease removal of snap ring (34), then remove snap ring, coupling and gear from input shaft. Seal (39) can now be removed from rear of input shaft and seal (47) can be removed from retainer (48).

Clean and inspect all parts and renew as necessary. Use new gaskets and seals during assembly. Seal (39) is installed with lip facing toward front of input shaft. Seal (47) is installed with lip toward rear.

Reassemble the input shaft by reversing the disassembly procedure.

176. **OUTPUT SHAFT ASSEMBLY.** To remove the output shaft assembly, remove the cover as outlined in paragraph 174, then unbolt bearing retainer (20), pull shaft assembly rearward and remove gear (33) from side of housing.

With shaft assembly removed, unstake lock nut (14), then using a spanner wrench (Oliver No. ST-149, or equivalent), remove nut, coupling sprocket (13) and "O" ring (12). Press output shaft from rear bearing and retainer, remove shims (25) and spacer (26), then press output shaft from front bearing. Remove oil seal (11) and rear bearing from retainer. If necessary, bearing cups can now be removed from retainer.

Clean and inspect all parts and pay particular attention to the bearings and bearing cups. Use new "O" ring, seal and gasket during assembly. Assemble output shaft components and adjust bearings as outlined in paragraph 176A prior to installing shaft assembly in housing.

176A. To assemble shaft and adjust bearings, proceed as follows: Install bearing cups in retainer (20) with smaller diameters toward inside. Press front bearing on shaft with smaller diameter toward rear. Place spacer (26) and the original shims (25) on shaft, insert shaft in retainer and press on rear bearing with smaller diameter toward front. Sprocket coupling can be used as a driver. Install a new lock nut (14) on shaft and tighten nut to a torque of 200 Ft.-Lbs. Check the shaft bearing adjustment which should be between 0.001 shaft end play and 5 inch pounds rolling torque. If adjustment is not as stated, remove nut, coupling sprocket and rear bearing and vary shims (25) as required. Shims are available in thicknesses of 0.004, 0.007 and 0.015.

With shaft adjustment made, remove nut and coupling sprocket and install new "O" ring (12) and oil seal (11) with lip toward front. Reinstall coupling sprocket and lock nut, tighten nut to a torque of 200 Ft.-Lbs. and stake nut in position.

177. **COUNTERSHAFT ASSEMBLY.** With cover assembly off, remove retainer (98) and pull countershaft support shaft (101). The countershaft assembly (92) and thrust washers (87 and 93) can now be removed from housing. Removal of gear (89) and bearings (91) is obvious.

Clean and inspect all parts and renew as necessary.

When reassembling, install gear (89) on shaft with hub rearward. Install needle bearings (91) into countershaft only far enough to install the retaining snap rings.

ASSEMBLY

178. To reassemble Creeper Drive unit, proceed as follows: Start output shaft into housing and place gear (33) on shaft with shifter fork groove toward front. Align notches in gasket (21) and retainer (20) with oil drain-back hole in housing and secure retainer. Use new gasket (37) and place bearing support (38) on housing with cut-out in O. D. of support at the 9 o'clock position. Insert input shaft assembly into housing and over pilot of output shaft. Install snap ring on O. D. of input shaft bearing. Align notches of gasket (49) and bearing retainer (48) with oil drain-back hole in bearing support and install bearing retainer and throw-out bearing tube and support (43). Use grease to hold thrust washers (87 and 93) in place and install thrust washer with larger O. D. at rear. Place countershaft assembly in position, insert support shaft (101) and install retainer (98). Align shifter fork with fork groove of gear (33), then install cover and and oil line (94). Disassemble breather assembly and clean or renew the breather filter element (3) and fill unit with 5 quarts of SAE 80 multi-purpose lubricant.

The Reverse-O-Torc Drive is a forward and reverse auxiliary transmission mounted in front of the tractor transmission providing a 1:1 direct (forward) drive ratio and a 1.1:1 reverse drive ratio to the transmission input shaft. The unit consists of a planetary gear set, a multiple disc forward clutch and a multiple disc reverse clutch which are connected coaxially and are mounted in a cast iron housing. The clutches are controlled by hydraulic pistons that are actuated by a hydraulic pump and valving located within the unit. A hydraulic torque converter mounted on the engine flywheel drives the forward and reverse unit. Operating fluid and charging pressure for the converter is provided by the Reverse-O-Torc pump via a pressure regulating valve.

Reverse-O-Torc Drive is available on Industrial models only. Models so equipped do not have an engine clutch or reverse gears in the tractor transmission as the forward and reverse clutches within the auxiliary drive are utilized for starting and stopping the tractor as well as providing a reverse ratio for each of the transmission forward gears. Also, models equipped with Reverse-O-Torc Drive cannot be equipped with a power take-off or a hydraulic system.

Industrial Models So Equipped

179. **OPERATION.** The Reverse-O-Torc unit is controlled by two foot pedals located at right side of operator's platform. Depressing the foot pedal marked "F" will start the tractor in forward motion when tractor transmission is shifted into gear. Depressing the pedal marked "R" will start the tractor in a reverse direction. Additional downward movement of either pedal will increase engine speed. In addition to the pedals marked "F" and "R", a foot accelerator pedal is located at the right side of operator's platform and depressing the accelerator pedal will increase engine speed without activating the Reverse-O-Torc unit.

Shift transmission only when Reverse-O-Torc pedals are in neutral. Engage the Reverse-O-Torc pedals only when engine is at slow idle speed. Stop tractor with brakes before changing direction of travel. If torque converter heat indicator is in "SHIFT" range on dial, slow engine to 1000 RPM until indicator drops to "Normal" range.

180. **TROUBLE SHOOTING.** The following will serve as a guide when trouble shooting problems encountered with the Reverse-O-Torc Drive unit:

1. NOISY IN NEUTRAL. Could be caused by:
   a. Worn bushings in pump assembly.
   b. Worn sprag or sprag races in converter assembly.
   c. Low oil level.
2. NOISY IN REVERSE. Could be caused by:
   a. Worn or rough planetary gears.
3. OVERHEATING. Could be caused by:
   a. Improper operation.
   b. Worn or damaged pump.
   c. Converter sprag clutch worn and slipping.
4. WILL NOT PULL. Could be caused by:
   a. Converter drive lugs sheared or not engaged in pump.
   b. Pump gears seized and converter drive lugs sheared.
   c. Low oil level.
   d. Worn or dameged bushings.

Fig. O115 — Reverse-O-Torc Drive unit (19) is driven by torque converter (36) mounted on engine flywheel and is coupled to transmission input shaft by sprockets (1 and 6) and chain (2). Refer to Fig. O116 for exploded view of the Reverse-O-Torc unit. Converter is serviced as a complete assembly only.

WILL NOT PULL IN FORWARD DIRECTION. Could be caused by:
a. Worn or broken sealing rings in forward clutch.
b. Damaged sealing rings in forward clutch cylinder.
c. Clutch plates worn or broken in forward clutch assembly.

WILL NOT PULL IN REVERSE DIRECTION. Could be caused by:
a. Worn or damaged sealing rings reverse clutch piston.
b. Broken or worn reverse clutch plates.

7. HARD SHIFTING (PEDAL ACTION). Could be caused by:
   a. Rotary control valve burred or nicked.
   b. Linkage bent or seizing.

181. **R&R REVERSE - O - TORC DRIVE.** To remove the Reverse-O-Torc Drive unit, first remove the engine and drive unit as an assembly as outlined in paragraph 60. Then, unbolt and remove the drive unit (19—Fig. O115) from torque converter housing (30).

When reinstalling the drive unit, lubricate rear hub of converter (36) and seal in pump housing on front face of drive unit. Carefully install drive unit to rear of torque converter housing and tighten the retaining cap screws (20) to a torque of 40-45 Ft.-Lbs. Reinstall engine and drive unit in tractor as outlined in paragraph 60.

182. **R&R TORQUE CONVERTER.** To remove torque converter (36—Fig. O115), first remove Reverse-O-Torc Drive unit as outlined in paragraph 181. Then, proceed as follows:

Remove dust shield (42) from lower front side of torque converter housing. Unbolt and remove torque converter housing from engine. Unbolt adapter plate (37) from flywheel and remove adapter plate and converter as a unit. Unbolt adapter plate from front face of converter.

The torque converter is serviced as a complete assembly only. Renew converter if damaged or if it is not operating properly. Reinstall by reversing removal procedure.

183. **OVERHAUL REVERSE - O - TORC DRIVE UNIT.** After removing the drive unit as outlined in paragraph 181, remove unit oil filter and external oil lines. Then, refer to Fig. O116 and proceed as follows:

Place the drive unit in a suitable stand or support with front end of unit up. Remove the cap screws (82) retaining pump assembly (80) to front adapter (85) and lift the pump assembly from unit. To disassemble pump, remove the two flat head screws (81). Fry oil seal (83) from pump housing.

Remove the socket head cap screws (86) retaining front adapter (85) to housing (18) and lift the front adapter and piston (78) assembly from unit. Be careful not to drop pressure plate (77) if it sticks to piston. Piston can be removed from front adapter by applying air pressure to clutch oil passage in front adapter. Remove sealing rings (78 and 89) from piston and hub of front adapter.

Lift pressure plate (77) from unit if not removed with front adapter and piston. Remove the 12 pressure plate springs (76) and the three dowel pins (75) from outer perimiter of housing. Remove the three inner clutch plates (73) and the two outer plates (74). Depress converter regulator valve (44) to be sure valve is free in housing and then remove valve and valve spring (43).

Remove thrust washer (72) from thrust face of the forward clutch cylinder (67). Remove the snap ring (70) from input shaft at front side of bearing (69); however, DO NOT remove the snap ring (71) from clutch cylinder (67) at this time. Lift the input shaft and forward clutch assembly from unit. With a soft hammer, tap

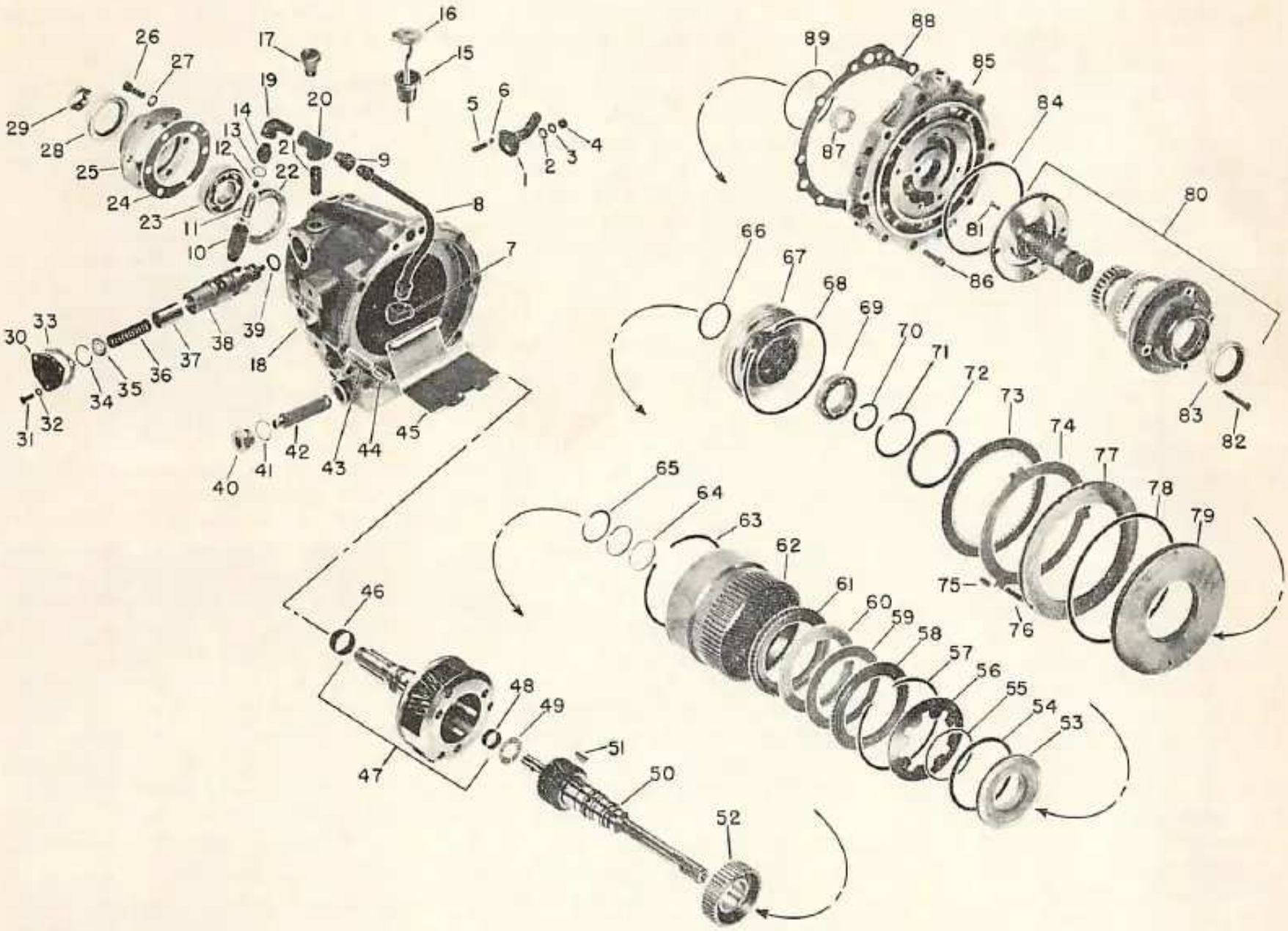


Fig. O116 — Exploded view of the Reverse-O-Torc drive unit showing component parts and their relative positions.

1. Shift lever
2. Flat washer
3. Lock washer
4. Nut
5. Detent spring
6. Detent ball
7. Elbow
8. Oil tube
9. Connector
10. Check valve body
11. Spring
12. Check valve ball
13. Copper gasket
14. Valve seat
15. Filler
16. Dip stick
17. Breather
18. Housing
19. Elbow
20. Tee
21. Nipple
22. Sleeve
23. Bearing
24. Gasket
25. Bearing retainer
28. Oil seal
29. Nut
30. Cover
33. Gasket
34. Snap ring
35. Spring retainer
36. Spring
37. Regulator valve
38. Control valve
39. "O" ring
40. Reducing bushing
41. Copper gasket
42. Strainer
43. Spring
44. Converter regulator valve
45. Baffle
46. Bushing
47. Output shaft assembly
48. Bushing
49. Thrust washer
50. Drive shaft
51. Woodruff key
52. Clutch hub (forward)
53. Piston, front clutch
54. Piston ring
55. Spring bearing ring
56. Clutch spring
57. Snap ring
58. Pressure plate (front)
59. Clutch plate (inner)
60. Clutch plate (outer)
61. Pressure plate (rear)
62. Ring gear
63. Snap ring (selective)
64. Seal ring
65. Snap ring
66. "O" ring
67. Clutch cylinder
68. Snap ring
69. Bearing
70. Snap ring
71. Snap ring
72. Thrust washer (selective)
73. Clutch plate (inner)
74. Clutch plate (outer)
75. Dowel
76. Spring
77. Pressure plate
78. Seal ring
79. Piston
80. Oil pump assembly
81. Flat head screw
83. Oil seal
84. Gasket
85. Front adapter
86. Socket head screw
87. Bushing
88. Gasket
89. "O" ring

on front end of input shaft to drive the shaft and clutch hub (52) assembly rearward out of the forward clutch assembly and ring gear (62). Remove the clutch sealing (cast iron) rings (64) from input shaft. If clutch hub (52) or input shaft (50) is to be renewed, remove snap ring (65) and press input shaft from clutch hub.

To disassemble the forward clutch unit, place the clutch and ring gear assembly in a press with splines on outer diameter of ring gear up. With a suitable arbor placed on hub of clutch cylinder (67), press the cylinder just far enough into ring gear to allow removal of snap ring (68). Slowly release pressure and remove the clutch cylinder (67) and piston (53) assembly. Piston can be removed from cylinder by applying air pressure to holes in inner diameter of cylinder. Remove snap ring (71) and bump bearing (69) from clutch cylinder.

Remove bearing ring (55) if not removed with clutch piston. Lift out spring (56) and remove snap ring (57), then remove the clutch discs (59 and 60) and pressure plates (58 and 61). Remove snap ring (63) from ring gear (62).

To remove the plantetary gear unit and output shaft assembly (47), remove the plug (5—Fig. O115) from sprocket (6). Then, hold sprocket with suitable tool and remove nut (29—Fig. O116) from rear end of output shaft. With a suitable soft drift, bump rear end of output shaft until free of bearing (23) and remove the shaft and planetary assembly from housing. Unbolt retainer (25) from rear end of housing. Drive bearing (23) and seal (28) out of retainer. Sleeve (22) can be pressed from rear of housing (18) and is available for service; however, renewal of sleeve should not be necessary. Baffle (45) can be snapped out of housing for cleaning purposes; note position of baffle before removing same.

To remove the control valve (38), remove nut (4) and lever (1) being careful not to lose detent ball (6) and spring (5). Remove plate (30), then push the valve assembly out of bore in housing. To remove regulating plunger (37), support valve in arbor press so that valve will not be damaged and push retainer (35) in so that snap ring (34) can be removed. Slowly release pressure and remove retainer (35), spring (36) and plunger (37). Remove and clean the suction screen (42).

The two bushings (46) in housing (18) for the output shaft, bushings (48) in front bore of output shaft (47) and bushing (87) in front adapter (85) can be renewed at this time if excessively worn or scored. Bushings are pre-sized and reaming should not be necessary if bushings are carefully installed. Be sure that regulator valve (44), control valve (38) and valve plunger (37) are not scored and fit snugly, yet slide freely in their bores. Renew any parts that are excessively worn, scored or otherwise damaged.

184. To reassemble the Reverse-O-Torc Drive unit, refer to Fig. O116 and proceed as follows: If removed, snap the baffle (45) into place inside housing; two holes in rear end of baffle should fit over two bosses cast into the housing. Reinstall filter screen (42).

Lubricate the pressure regulator valve (37) and insert it, hollow end out, in bore of control valve (38). Insert spring (36) in bore of regulator valve, place retainer (35) on top of spring and compress retainer and spring into control valve in an arbor press so that snap ring (34) can be installed. Note: Support valve carefully in arbor press to avoid damage to valve surfaces. Lubricate and install control valve in bore of housing and then install retaining plate (30) with new gasket (33). Tighten the cap screws (31) to a torque of 10-15 Ft.-Lbs. Insert detent spring (5) and ball (6) in bore at opposite side of housing and install control lever (1). Tighten the lever retaining nut to a torque of 12-14 Ft.-Lbs.

Drive the ball bearing (23) into retainer (25) until firmly seated. Install new seal (28) into rear side of retainer with lip of seal forward (to inside). Then, using new gasket (24), install retainer on rear of housing tightening the retaining cap screws to a torque of 40-45 Ft.-Lbs. Insert the pinion gear and output shaft assembly (47) through rear bore of housing and bump the assembly rearward until shoulder on shaft is firmly seated against ball bearing. Lubricate seal and seal contact surface of sprocket (6—Fig. O115) and place on rear end of output shaft. Install a new self-locking nut (29—Fig. O116) and tighten the nut securely. Install a new plug (5—Fig. O115) in rear end of sprocket (6).

To reassemble the forward clutch unit, place ring gear (62—Fig. O116) on bench with front end (end with splines on outside) up. Place rear pressure plate (61) in ring gear with flat machined side up. Lubricate the clutch plates (59 and 60) and place the plates alternately in ring gear with plate having internal teeth next to the pressure plate. Install front pressure plate (58) with flat machined side down and secure pressure plate with snap ring (57). Note: Be sure proper snap ring is used; snap ring thickness should be 0.090-0.093 and free diameter should be approximately 5$\frac{19}{32}$ inches. Place clutch spring (56) on snap ring with concave side of spring towards snap ring. Lubricate and install "O" rings (54 and 66) in grooves of piston (53) and cylinder (67). Install piston in cylinder with flat side in. With heavy grease, stick spring bearing ring (55) in groove in face of piston. Install the assembled cylinder in ring gear being careful that ring (55) does not drop out. Place the unit in an arbor press and with a proper size arbor, compress cylinder against clutch spring and install snap ring (68). Release pressure and turn the assembly over with ring gear (rear) end up. Place a proper size arbor against clutch pressure plate (61) and compress the clutch components against snap ring (68). Measure the clearance between pressure plate and rear side of snap ring groove inside the ring gear. Then, install the proper thickness of snap ring (63) to provide 0.056-0.086 clearance between pressure plate and snap ring. Snap rings are available in three thicknesses of 0.050-0.054, 0.074-0.078 and 0.096-0.100 which are color coded respectively, green, orange and white.

If clutch hub (52) was removed from input shaft (50), insert Woodruff key (51) in shaft and press hub onto shaft being sure that flat side of hub is towards gear and that slot in hub is aligned with key. With hub bottomed against drive gear, install hub retaining snap ring (65). Lubricate and install the two sealing rings (64) in ring grooves of input shaft. Lock ends of rings together and be sure they turn freely in grooves.

Fabricate an assembly tool by drilling a hole that will accommodate rear (pilot) end of input shaft in a hard wood block; block should be larger than the ring gear.

Set the input shaft pilot end in the hole in wood block. Lower the assembled ring gear and forward clutch unit down over the input shaft. To align clutch discs with splines on clutch hub, partially support the clutch unit and turn unit back and forth. Clutch unit is properly installed when ring gear is resting on wood assembly block (rear end of ring gear is flush with rear face of drive gear). CAUTION: **Do not** remove the unit from assembly block or lift by the input shaft at this time as any forward movement of the input shaft beyond proper location in clutch will disengage the clutch discs and the seal rings on input shaft. Move the unit on the assembly block to a press and install bearing (69) on input shaft. Then install the bearing retaining rings (70 and 71) in cylinder and on input shaft; the unit can then be removed from the assembly block.

Support the housing (18) with front end up and proceed as follows: Using light grease, stick the thrust washer (49) onto rear face of drive gear on input shaft (50). Install the assembled shaft and clutch unit in housing so that drive gear engages the pinion gears in the carrier on output shaft. Lay a straight edge across front face of housing and measure distance between straight edge and thrust face of the forward clutch cylinder. If distance is 0.405 or less, install a 0.061-0.063 thrust washer (72); if distance is more than 0.405, install a 0.085-0.087 thrust washer on the forward clutch cylinder thrust surface.

Insert converter regulator valve spring (43) and valve (44) in bore of housing with closed end of valve out. Insert the twelve clutch pressure plate springs (76) in the four sets of three holes in reverse clutch cavity of housing (18). Using grease, stick the three dowels (75) in grooves in side of reverse clutch cavity.

Insert one of the clutch discs (73) with internal teeth into the clutch cavity with teeth engaged in splines on outside of ring gear. Insert one of the discs (74) with external lugs with notches in the lugs engaged on dowel pins (75) placed in the housing. NOTE: One of the three lugs is odd

shaped; that is, the notch is not centered in the lug. This lug must engage the dowel nearest the oil screen retaining fitting (40) with the notch offset towards bottom (filter screen) side of housing. Repeat this procedure to complete the installation of the three internal notched plates and the two plates with external lugs. Install the reverse clutch pressure plate (77) with the cast notch in edge of plate aligned with large oil hole at top of housing (18) and with the three machined notches engaging the three dowel pins. The pressure plate should drop into position approximately flush with front face of housing; if not, remove plate and check dowels and springs for misalignment.

Lubricate and install the "O" rings (78 and 89) on reverse clutch piston (79) and inner hub of front adapter (85). Insert piston in adapter with flat side in (forward); also note that chamfered side of hub must be inward. Install adapter and piston assembly on housing with new gasket (88). Tighten the adapter retaining cap screws to a torque of 28-30 Ft.-Lbs.

Install new oil seal (83) in pump cover with lip of seal to rear (inward) and reassemble pump using Fig. O116 as a guide. Tighten the flat head screws (81) to a torque of 17-22 Ft.-Lbs. Pump gears should turn freely at this time. Lubricate the pump and install pump on front adapter plate with a new gasket (84). Tighten the retaining cap screws to a torque of 17-22 Ft.-Lbs. Note: Be sure that the long cap screws are installed at the thick pump bosses.

Reassemble the charge pressure and safety control valve parts (items 10 through 14) in order shown and reinstall oil filter and external oil lines.

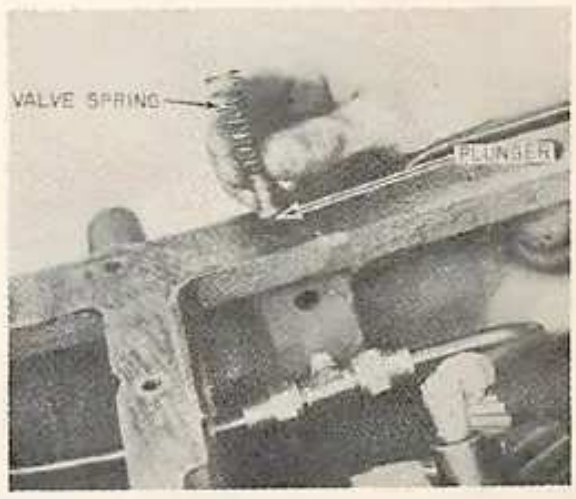


Fig. O117—Transmission lubrication circuit by-pass valve removed from bore in rear main frame. Valve plunger and spring are retained by an expansion plug (not shown).

TRANSMISSION

Series 1600 and Series 1650 are equipped with a constant mesh, helical gear type transmission having six forward and two reverse speeds. On Industrial models equipped with a Reverse-O-Torc auxiliary transmission, the transmission reverse gearing is omitted as the Reverse-O-Torc provides a forward and reverse drive for each of the six basic transmission speeds. When equipped with an auxiliary Hydra-Power Drive, two different speed ratios are available for each transmission gear providing twelve forward and four reverse speeds. Optional transmission gears are available for some models which provide different transmission speed ratios. Also, a Creeper Drive is available which provides an underdrive in 1st, 2nd, 5th and R1 transmission speeds.

NOTE: Although not absolutely necessary, it is advisable to split tractor for transmission overhaul; refer to paragraph 194. Also, overhaul of transmission will usually require removal of four-wheel drive transfer case (paragraph 41), bull gear cover (paragraph 193) or hydraulic lift system (paragraph 253), bull gears (paragraph 210), differential assembly (paragraph 204), power take-off shaft (paragraph 221 or 226) or hydraulic pump drive shaft (paragraph 248).

LUBRICATION

190. **LUBRICANT.** Transmission and differential are lubricated from a common oil supply. Oil level should be maintained at check plug opening located at rear side of right rear axle housing in the main frame. Filler cap is located in front end of bull gear cover or hydraulic lift system housing under the center platform plate. Two drain plugs are used; front plug is located under front center of main frame and drains transmission compartment and rear plug is located at rear end of main frame and drains the differential and final drive compartment. Also, pressure lubrication pump suction screen should be removed and cleaned whenever lubricating oil is drained. Screen is located on plug which is threaded into bottom of differential and final drive compartment just to rear of the transmission compartment drain plug.

Recommended transmision, differential and final drive lubricant is SAE 80 multi-purpose gear lubricant. SAE 90 multi-purpose gear lubricant may be used in temperatures above 32° F. All gear lubricant must conform to Military Specification MIL-L-2105. Sump capacity is 32 quarts. Lubricant should be changed yearly or after each 1000 hours of operation. Oil filter should be renewed after each 500 hours of operation.

191. **PRESSURE LUBRICATION SYSTEM.** The transmission and differential are lubricated by a pressure oiling system. Pressure is provided by a G-rotor type pump driven from rear end of transmision countershaft. Oil from pump is directed from pump to an externally mounted oil filter. From the oil filter, oil is directed to the differential shaft and to the transmission input and bevel pinion shafts. A by-pass (pressure relief) valve in the transmission circuit limits system pressure to 8-14 psi. Oil by-passed by this valve is returned to the transmission compartment via a hole in the tractor main frame. Refer to Fig. O117.

With the lubricating oil at operating temperature and engine running at 1900 RPM, system pressure should be 8-14 psi with the transmission shift lever in either neutral position. Pressure can be checked by teeing into the line to the transmission pinion shaft at connection under the left foot platform section. If pressure is below 8 psi, drain transmission and differential compartments, renew the transmission oil filter and refill to proper level with specified lubricant. Refer to paragraph 190. Faulty oil pump, broken oil tube or faulty by-pass valve could also cause low oil pressure. Refer to paragraph 198 for pump servicing information. If pressure is higher than 14 psi, check the by-pass valve. (Fig. O117). If valve is OK, check for obstruction in oil tubes and passages.

192. **TRANSMISSION SHIFT AND INTERLOCK COVER.** Remove the right hand and center platform sections and disconnect the wires that lead into the shift lever cover. Then, unbolt and remove the shift lever and interlock cover as an assembly.

Disassembly is evident after inspection of the unit and reference to Fig. O118. Before installing on transmission, check the safety switch (28) and if necessary, readjust position of switch so that it opens when roller is about half way up the ramp on interlock (18 or 19). Refer also to Fig. O119.

Use new gasket (14) and reinstall by reversing removal procedure.

193. **R&R BULL GEAR COVER.** On models equipped with hydraulic system, refer to paragraph 253. On models without hydraulic system, disconnect battery ground strap and remove the battery or batteries and case as a unit. On models so equipped, remove the platform enclosures and wheel guard extensions. Remove the side and center foot platforms. Remove the seat assembly from bull gear cover and remove shift lever and interlock cover as in paragraph 192. Unbolt and remove bull gear cover.

Reinstall bull gear cover by reversing removal procedure and using new gaskets.

194. **SPLIT TRACTOR.** To split tractor between the front and rear main frames, disconnect battery ground strap and proceed as follows: Disconnect battery cable to cranking motor and safety starting wires from connector. On models so equipped, remove the platform enclosure. On models with hydraulic system, disconnect the oil cooler lines from the flow divider valve. On models with four-wheel drive, remove the engine as outlined in paragraph 60. Disconnect the rear light wires. Remove the sprocket chain connector from between clutch shaft and transmission input shaft. Support tractor front frame in manner which will prevent it from tipping and support front end of rear frame with rolling floor jack. Working through opening in bottom of rear frame (except on four-wheel drive models), remove the front frame to rear frame retaining cap screws and separate tractor. Note:

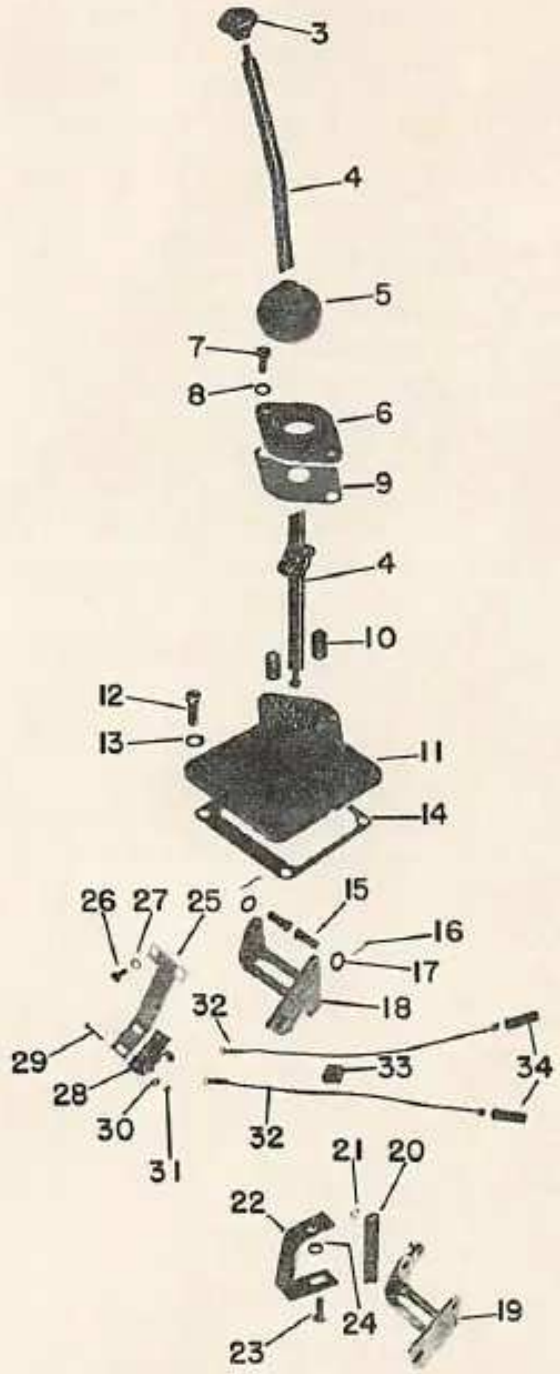


Fig. O118 — Exploded view of transmission shift and interlock cover. Interlock (18) is used on Row Crop and Wheatland models; interlock (19) is used on Industrial and Utility models and is optional on Row Crop and Wheatland models. Refer to Fig. O119 for safety starting switch adjustment.

4. Shift lever	19. Interlock
6. Cover	20. Arm
9. Gasket	21. Snap ring
10. Springs	22. Guide
11. Support	25. Support
14. Gasket	28. Safety switch
15. Pins	32. Wires
17. Washers	33. Seal
18. Interlock	34. Connectors

These 12-point cap screws are torqued to 300 Ft.-Lbs. and will require a heavy duty socket for removal and re-torqueing when reassembling tractor.

195. **INPUT SHAFT.** Refer to the appropriate sections (see note preceding paragraph 190) and remove the pto assembly or hydraulic pump drive shaft, the hydraulic lift system or bull gear cover and either split the tractor as outlined in paragraph 194 or remove the clutch shaft as in paragraph 151 or the engine and drive

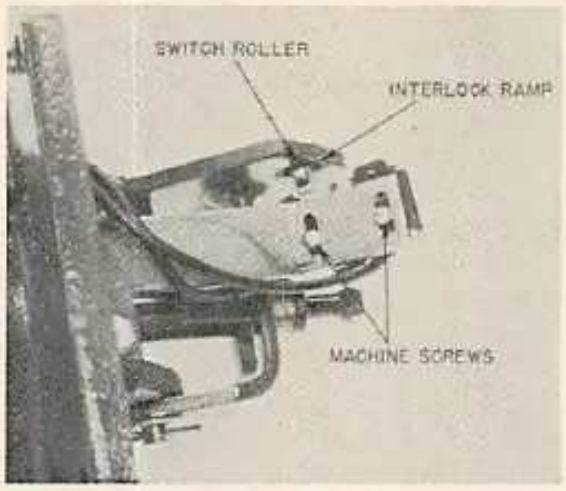


Fig. O119 — View showing adjustment of safety starting switch. Refer to text for procedure.

unit as in paragraph 60. Then, proceed as follows:

Remove snap ring from bore in main frame at rear side of the hydraulic pump drive pinion bearing (24—Fig. O120) and push the pinion (22) and bearing out to rear. Remove coupling sprocket and snap ring from front end of input shaft. Note: Snap ring is used on direct drive models only. Remove input shaft front bearing retainer (2) taking care not to lose or damage shims (3) and remove seal (1) from retainer. Remove oil tube that is connected to the oil collector (17). Unstake and remove nut (21) from rear of input shaft; discard nut as it should not be reused.

On Row Crop and Wheatland models, move shifter coupling (13) onto rear gear (14) and place a spacer between coupling and front side of main frame. The spacer can be made by cutting a 3½ inch I. D. pipe to a length of 2½ inches, then cutting the pipe in half lengthwise. Spacer is not required on Utility or Industrial models.

With Oliver ST-101 shaft driver or equivalent tool, drive input shaft forward until free of rear bearing cone; take care not to damage shaft threads. Remove shaft and components from main frame. Remove gears and collector ring from mounting sleeves and collector ring seals from rear sleeve. Press thrust washer and front bearing cone from shaft. Remove snap ring and rear bearing cup from main frame.

Carefully inspect all parts and renew as necessary. On Industrial models with Reverse-O-Torc, be sure that a sealing plug is installed in bore of input shaft; obtain and install plug is shaft is not so fitted.

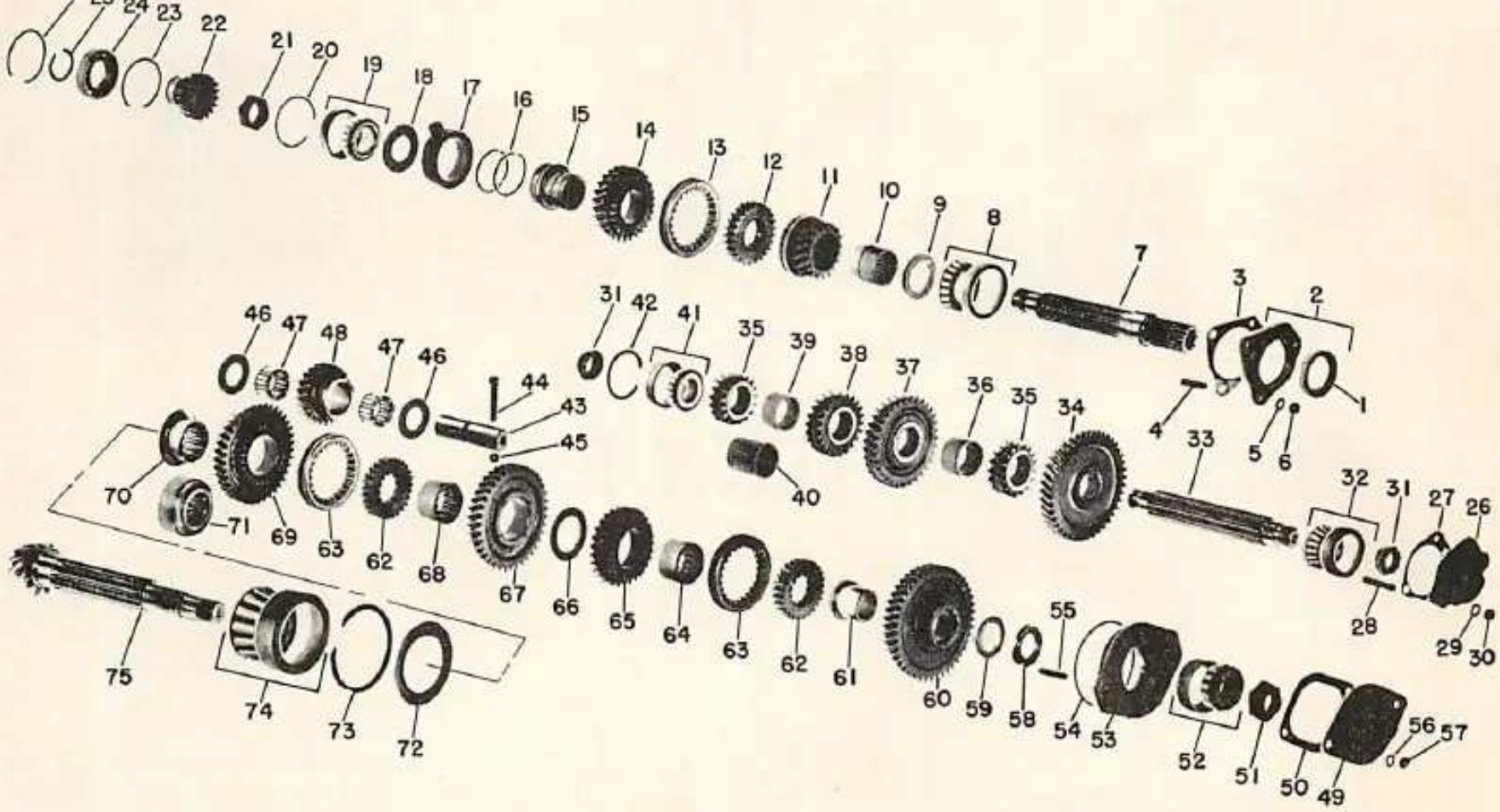


Fig. O120 — Exploded view of transmission gears and shafts. Reverse gears (35 rear, 48 and 69) are not used on models with Reverse-O-Torc Drive; spacers (40 and 71) instead of gears are used on output shaft and countershaft. Refer to Fig. O121 for parts used when four-wheel drive case is mounted on front end of main frame.

1. Seal
2. Retainer
3. Shims
7. Input shaft
8. Bearing assy.
9. Washer
10. Sleeve
11. Gear (19 or 31 teeth)
12. Splined collar
13. Coupling
14. Gear (26 teeth)
15. Sleeve
16. Seal rings
17. Oil collector
18. Washer
19. Bearing assy.
20. Snap ring
21. Nut
22. Hydraulic pump drive gear
23. Snap rings
24. Bearing assy.
25. Snap ring
26. Cover
27. Shims
31. Nut
32. Bearing assy.
33. Countershaft
34. Gear (41 or 28 teeth)
35. Gears (17 teeth)
36. Spacer (1¼ in.)
37. Gear (37 teeth)
38. Gear (22 or 19 teeth)
40. Spacer (R-O-T only)
41. Bearing assy.
42. Snap ring
43. Reverse idler shaft
46. Washers
47. Bearings
48. Reverse idler gear
49. Cover
50. Gasket
51. Nut
52. Bearing assy.
53. Bearing cage
54. "O" ring (gasket also used on 1650)
58. Nut
59. Washer
60. Gear (44 teeth)
61. Sleeve
62. Splined collar
63. Coupling
64. Sleeve (1⅝ in.)
65. Gear (27 or 23 teeth)
66. Washer
67. Gear (38 or 41 teeth)
68. Sleeve (1 9/32 in.)
69. Gear (38 teeth)
70. Sleeve
71. Spacer (R-O-T only)
72. Seal
73. Snap ring
74. Bearing assy.
75. Bevel pinion shafty gear (7, 8, 9 or 10 teeth)

196. Reinstall input shaft as follows: Install new seal (1) in retainer (2) with lip of seal to rear. Install snap ring (20) in main frame and firmly seat rear bearing cup against snap ring. Press thrust washer (9) and front bearing cone (8) onto shaft. Install sealing rings (16) on rear mounting sleeve (15) and install collector (17) over the sealing rings with counterbore in collector over flange of sleeve. Place rear gear (14) onto rear sleeve with helical teeth toward collector ring. Move shifter fork to forward position. Insert front sleeve (10) in front gear (11), place shift coupling (13) on front gear and place the assembly in main frame with coupling engaged in shift fork. Insert input shaft through the front gear and sleeve and install drive collar (12) on shaft. Place rear bearing cone in cup, position rear sleeve with collector and gear installed in the main frame and push shaft into rear sleeve. Place the collector washer (18) between rear bearing cone and collector and push input shaft into bearing cone. With Oliver ST-101 shaft driver or equivalent tool, drive input shaft rearward. Install front bearing cup into main frame bore and install bearing retainer with shim pack originally removed. Install new nut (21) on rear end of input shaft and tighten nut to a torque of 150 Ft.-Lbs. Stake the nut in place on shaft and adjust input shaft bearings by varying the number of shims under front bearing retainer. Bearing adjustment is correct if shaft end play does not exceed 0.001, or if bearing preload is such that rolling torque is 5 inch pounds or less above oil seal drag. Shims are available in thicknesses of 0.004, 0.007 and 0.015. Reinstall oil tube, hydraulic pump drive pinion and pinion bearing retaining snap ring.

197. **SHIFT RAILS AND FORKS.** After removing input shaft assembly as an paragraph 195, proceed as follows:

Remove cap screws retaining shifter forks to shift rails. Remove the cap

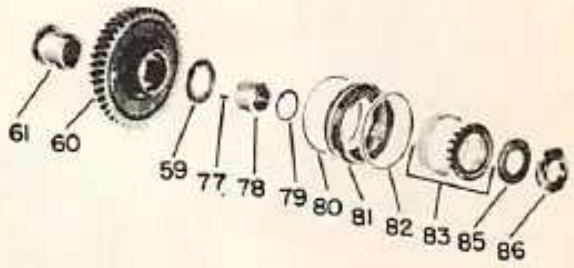


Fig. O121 — Above parts are used on four-wheel drive models to permit front wheel drive case to be attached to front of main frame.

59. Washer
60. Gear (44 teeth)
61. Sleeve
77. Key
78. Sleeve
79. Shims
80. "O" ring
81. Bearing cage
82. "O" ring
83. Bearing assy.
85. Washer
86. Nut

screws retaining shifter guide (60—Fig. O122) on Creeper Drive models, or the cover (56) on other models, and the poppet block (53) to front face of main frame and withdraw the shift rails and poppet block as a unit. Refer to exploded view in Fig. O122 as a guide for disassembly and reassembly of the shift rails and poppet block.

Reinstall the shift rails and forks

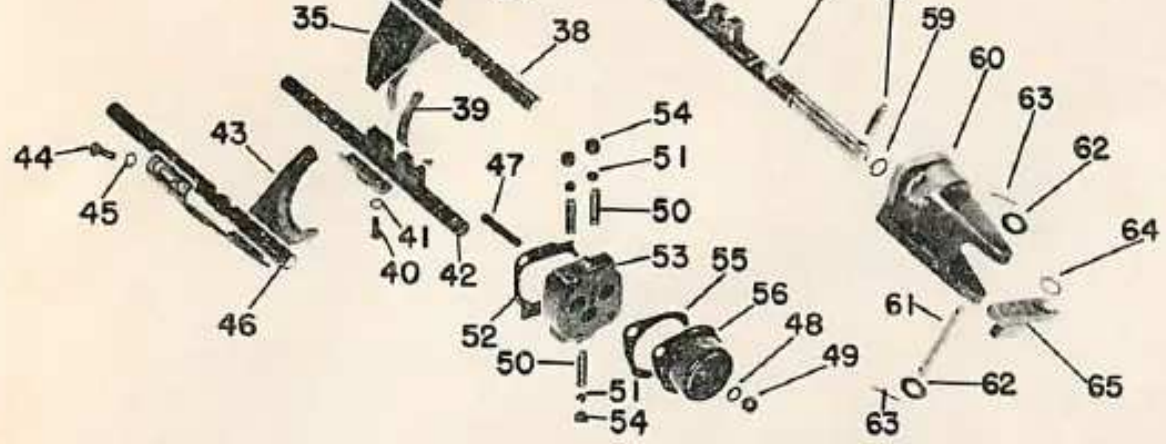


Fig. O122 — Exploded view of shift rails and detent block with related parts. On models equipped with Creeper Drive, special shift rail (57) and guide (60), with related parts (58 through 65), are used providing a lock out for transmission speeds 3, 4, 6 and R2 when Creeper Drive is engaged.

35. Shift fork
38. Shift rail
39. Shift fork
42. Shift rail
43. Shift fork
46. Shift rail
50. Detent springs
51. Detent balls
52. Gasket
53. Detent block
54. Plugs
55. Gasket
56. Cover
57. Shift rail
58. Pin
59. "O" ring
60. Guide
61. Pin
62. Washer
64. Washer
65. Arm

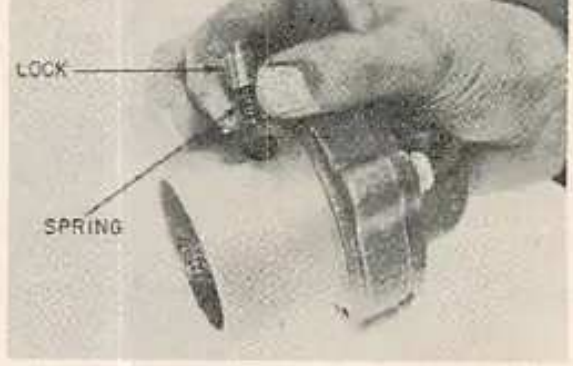


Fig. O124 — Installing pump lock and spring.

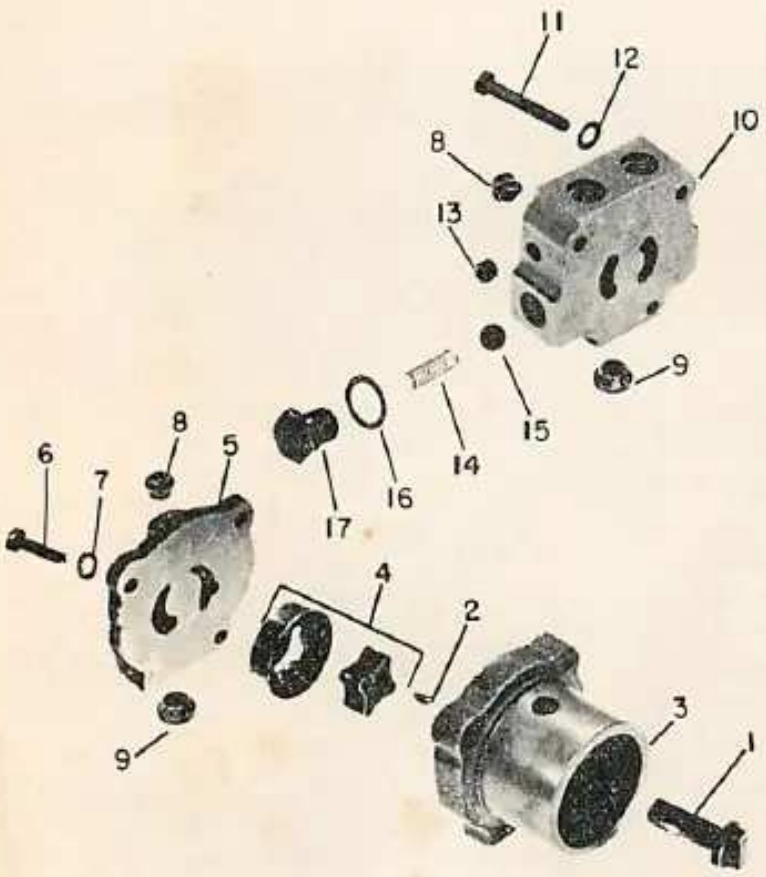


Fig. O123 — Exploded view of transmission lubrication pump. Cover (5) is used on all models except those equipped with Reverse-O-Torc Drive. On Reverse-O-Torc equipped models, valves (15) in pump cover (10) allow pump to pressurize the transmission lubrication circuit when rotating in either direction.

1. Shaft
2. Key
3. Body
4. Rotor set
5. Cover
8. Tubing seats
9. Tubing seats
10. Cover (R-O-T only)
13. Plug
14. Valve springs (4)
15. Valve balls (4)
16. Sealing washers (4)
17. Plugs (4)

by reversing removal procedure. Reassemble using new gaskets and new shakeproof washers under the shifter fork retaining cap screws.

198. **LUBRICATION PUMP.** The transmission pressure lubrication system pump can be removed after removing the hydraulic lift system or bull gear cover. To remove pump, proceed as follows:

Disconnect suction tube from pump and remove the pressure tube (pump to oil filter tube). Depress the pump housing lock with a small rod or punch inserted through hole in main frame casting at front of pump and withdraw pump assembly from bore in main frame.

Refer to exploded view of pump in Fig. O123 for disassembly and reassembly. Inner rotor should be a free fit on pump shaft (1) with drive key (2) installed. Polish shaft with crocus cloth or file key if binding occurs. Some shafts have two key slots; in some cases, binding condition can be corrected by moving key to other slot. On Industrial models with Reverse-O-Torc, pump cover (10) is fitted with four check balls (15), springs (14) and retainers (17). Install new sealing washers (16) when reinstalling the retainers (17). If damaged, tubing seats (8 and/or 9) can be removed by threading with tap and pulling the seats from pump cover.

To reinstall pump, insert lock spring and plunger in pump body (See Fig. 0124), depress the lock and insert pump in bore of main frame. Tang on shaft (1—Fig. O123) must enter slot in end of transmission countershaft. Reconnect suction line and reinstall pressure line.

199. **TRANSMISSION COUNTERSHAFT.** The countershaft can be removed after removing input shaft as in paragraph 195, shift rails and forks as in paragraph 197 and the pressure lubrication pump as in paragraph 198. See note preceding paragraph 190 and refer to appropriate paragraphs for removing the bull gears and differential. Then, proceed as follows:

On models not equipped with four wheel drive, remove the transmission bevel pinion shaft oil line. On four-wheel drive models, remove the transfer case as outlined in paragraph 44. Remove the countershaft front bearing retainer (26—Fig.0120) taking care not to lose or damage shims (27). Remove and discard the nut (31) from rear end of countershaft. Rework a soft drift punch so that it will enter the slot in rear of countershaft and seat against the bottom of slot. Then, with the *reworked drift*, drive countershaft forward until front bearing cup is free of main frame and shaft is free of rear bearing cone. Remove the shaft and components from main frame. Press front bearing cone from shaft. To remove rear bearing cup from main frame, it will be necessary to first remove the re-

verse idler gear as in paragraph 201. NOTE: On Row Crop and Wheatland models, front countershaft gear (34)

202. **BEVEL PINION SHAFT.** The transmission bevel pinion shaft can be removed after removing the input

on models with Reverse-O-Torc, on shaft against the bearing cone. Insert shaft through rear bearing cup and

has 41 teeth; gear (37) has 33 teeth. On Series 1650 Wheatland models only, gear (38) has 19 teeth; on all other models, gear (38) has 22 teeth. On Utility and Industrial models, and as optional usage on Row Crop and Wheatland models, front countershaft gear (34) has 28 teeth; gear (37) has 37 teeth. On Industrial models with Reverse-O-Torc, long spacer (40) is used instead of short spacer (39) and rear countershaft gear (35).

200. To install transmission countershaft, proceed as follows: If removed, reinstall the countershaft rear bearing cup and then install the reverse idler as in paragraph 201. Press front bearing cone onto countershaft, install new nut (31) and tighten nut to a torque of 150 Ft.-Lbs. Insert countershaft through bore in front face of main frame and install components in following order: Front countershaft gear (34) (41 or 28 teeth); gear (35) (17 teeth); spacer (36) (1¼ inches long); center countershaft gear (37) (33 or 37 teeth); gear (38) (22 or 19 teeth); spacer (39) (1$\frac{1}{16}$ inches long) or long spacer (40) (2$\frac{5}{32}$ inches long) and place rear bearing cone in cup and gear (35) (17 teeth) if used. Drive the countershaft rearward until nut (31) can be installed. Use new nut and tighten nut to a torque of 150 Ft.-Lbs. Install front bearing cup in bore of main frame, then install retainer (26) with shims (27) removed on disassembly. Be sure bearing cups are seated and check shaft end play with dial indicator. Note: Do not check end play by placing indicator against gear as gears are loose on shaft. Vary the number of shims as required to obtain a shaft end play of 0.001-0.003. Shims are available in thicknesses of 0.004, 0.007 and 0.015.

201. **REVERSE IDLER GEAR.** The reverse idler gear and shaft (not used on models with Reverse-O-Torc) can be removed after removing the transmission input shaft as in paragraph 195 and the transmission countershaft as in paragraph 199. To remove idler shaft, first remove the bolt (44—Fig. O120) and self-locking nut (45). Then push shaft forward out of bore in main frame and remove the idler gear (48), thrust washers (46) and bearings (47). To reinstall, reverse the removal procedure and install gear with long hub forward. Secure the idler shaft with the bolt (44) and self-locking nut.

202. **BEVEL PINION SHAFT.** To remove the bevel pinion shaft, first remove the transmission input shaft as in paragraph 195 and the countershaft as in paragraph 199. To remove bevel pinion shaft, proceed as follows:

On four-wheel drive models, unstake and remove the nut (86—Fig. 0121) from front end of bevel pinion shaft. Save nut for adjusting bearing preload on reassembly. Then, remove the washer (85) and shims (79) from shaft.

On all models except four wheel drive, remove cover (49—Fig. 0120) from front of bearing cage (53), unscrew and discard the nut (51), then using two ½-13 cap screws threaded into the tapped holes in the bearing cage, pull bearing cage and bearing (52) from front of bevel pinion shaft and front face of main frame. Using a small chisel, unstake the spanner nut (58) and remove nut (left-hand threads) with Oliver ST-127 Spanner Wrench or equivalent tool. Discard the nut.

Then, on all models, slide the bevel pinion shaft rearward and remove components as shaft is withdrawn. Remove the oil seal (72), snap ring (73) and rear bearing cup from rear bore in main frame. Remove the front bearing cup from bearing cage (53), or (81—Fig. O121), and remove rear bearing cone from shaft.

NOTE: On models equipped with Reverse-O-Torc, spacer (71—Fig. O120) is used on bevel pinion shaft instead of sleeve (70) and gear (69). On Row Crop and Wheatland models, gear (65) has 27 teeth; on Utility and Industrial models, and as option on Row Crop and Wheatland models, gear (65) has 23 teeth. On Series 1650 Wheatland models only, gear (67) has 41 teeth; on all other models, gear (67) has 38 teeth. On early production Series 1600 models, thrust washer (66) had only one internal tooth to engage splines of bevel pinion shaft; if one of these washers is encountered, it should be renewed using late type washer with 14 internal teeth.

203. To install bevel pinion shaft, proceed as follows: Install snap ring (73—Fig. O120) in rear bearing bore in main frame. Install seal (72) against front side of snap ring with lip of seal forward. Firmly seat rear bearing cup against rear side of snap ring. Press rear bearing cone firmly against shoulder on bevel pinion shaft and install sleeve (70), or spacer (71) Gear (69) (38 teeth-thin hub) (except on Reverse-O-Torc equipped models) with clutch teeth forward. Install rear drive collar (62). Place rear shifter coupling (63) over collar. Install splined sleeve (68) (1$\frac{9}{32}$ inches long). Place gear (67) (38 teeth-thick hub) over sleeve with clutch teeth rearward. Install washer (66) with 14 internal teeth. (Renew washer if it has only one internal tooth.) Install sleeve (64) (1⅜ inches long). Place gear (65) (27 or 23 teeth) on sleeve with clutch teeth forward. Install front drive collar (62). Place front shifter coupling (63) on drive collar. Install splined sleeve (61) with flange to rear. Install gear (60) (44 teeth) with clutch teeth rearward. Place washer (59) on shaft with bent tang engaged in slot of sleeve (61).

On models except those with four-wheel drive, install nut (58) and tighten to a torque of 150 Ft.-Lbs. Firmly seat the front bearing cup in the bearing cage (53) and install new "O" ring (54). (On Series 1650, use new gasket between bearing cage and front face of main frame.) Install the bearing cage and temporarily install and tighten retaining nuts (57). Buck up against rear end of bevel pinion and drive front bearing cup onto front end of shaft. Install new nut (51) and adjust bearing preload with nut as follows: Tighten nut so that there will be a small amount of end play in the pinion shaft bearings. It may be necessary to bump front end of shaft to seat front bearing cone against the nut. Wrap a cord around the front bevel pinion shaft gear (60) and attach a pull scale to the cord and engage shift collar to gear. The pull required to rotate the shaft steadily will represent the seal drag on the shaft. Then, tighten nut so that a pull of 2½-4 pounds in excess of that determined as seal drag will be required to rotate the shaft steadily. Remove the bearing cage retaining nuts and install cover (49) with new gasket (50).

On four-wheel drive models, refer to Fig. O121 and proceed as follows: Insert key (77) in slot of bevel pinion shaft and install spacer (78). Install new "O" ring (80) on rear end of bearing cage (81) and firmly seat front bearing cup in cage. Install cage in front bore of main frame and place bearing cone in cup and over spacer

sleeve (78). Place shims (79) removed on disassembly next to spacer and install washer (85) and old nut (86). Tighten nut so that there is a slight

resent seal drag. Then, tighten nut to a torque of 150 Ft.-Lbs. and again

adjustment is correct if pull required

torque (bearing preload) is excessive, or remove shims if tightening nut does not increase the shaft rolling torque 2½ to 4 pounds on pull scale.

amount of bearing end play and check shaft rolling torque by attaching pull scale to cord wrapped around gear (60). Engage shifter collar to gear. Pull required to rotate shaft will rep-

to rotate shaft with nut tightened is 2½-4 pounds greater than that noted when checked with end play in bearings. Add shims (79) between spacer (78) and washer (85) if shaft rolling

When bearing preload is correct, remove and discard the **old** nut (86), install and tighten a **new** nut to a torque of 150 Ft.-Lbs. and stake nut to slot in bevel pinion shaft.

DIFFERENTIAL, BEVEL GEARS, FINAL DRIVE AND REAR AXLES

DIFFERENTIAL

204. **REMOVE AND REINSTALL.** On models with a hydraulic lift system, first drain the hydraulic system fluid as outlined in paragraph 233. Then, drain the transmission and final drive lubricant and proceed as follows:

On Series 1600 models with PTO, remove the PTO clutch and drive shaft as outlined in paragraph 221. On Series 1650 models with PTO, remove the PTO drive shaft as outlined in paragraph 226 and remove the PTO housing and gear assembly as in paragraph 229. On models not equipped with a PTO, but having a hydraulic lift system, remove the hydraulic pump drive shaft as outlined in paragraph 248. Remove the hydraulic lift system as outlined in paragraph 253 or, on models not equipped with hydraulic system, remove the bull gear cover as outlined in paragraph 193. Disconnect light wires, remove both rear fenders, support the tractor and remove both rear wheel and tire units.

If equipped with a three-point hitch, remove the draft control spring. Remove snap ring from inner end of each axle shaft and remove bearing retainers from outer end of each rear axle carrier (housing). Withdraw both axle shafts far enough to disengage the shafts from the bull gears and allow the shafts to rest in the carriers. It may be necessary to use a pry bar to move the axle shafts out of the bull gears. Lift the bull gears from rear main frame.

Remove brake adjusting nuts, both brake covers and withdraw the brake discs from the brake housings and bull pinion shafts. Unbolt the **left** brake housing from rear main frame

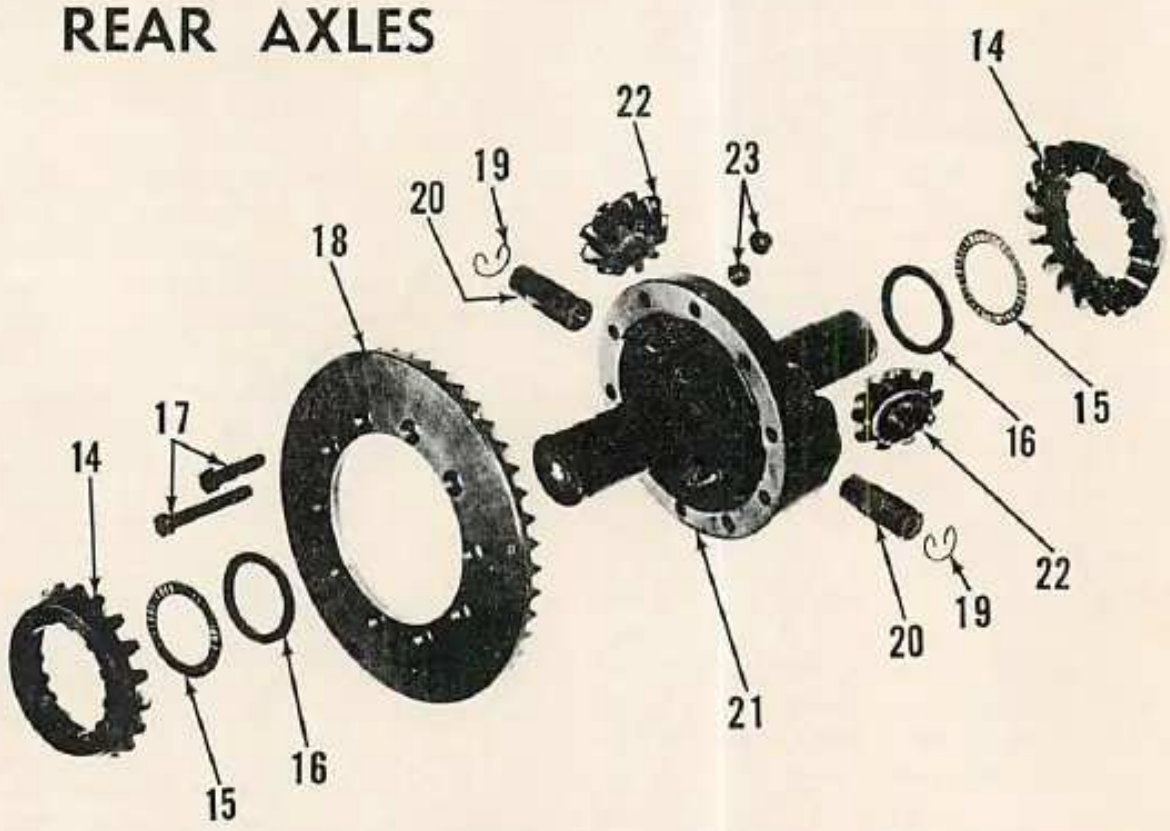


Fig. O125 — Exploded view of Series 1600 and Series 1650 differential assembly. Differential side gears (14) are carried on inner ends of the final drive bull pinions (13—Fig. O126). Outer ends of differential pinion shafts (20) are drilled and tapped to aid in removing them from differential spider.

14. Side gears
15. Thrust bearings
16. Thrust washers
17. Ring gear retaining bolts
18. Bevel ring gear
19. Snap rings
20. Pinion shafts
22. Differential pinions
23. Nuts

and withdraw the left bull pinion and brake housing taking care not to lose or damage the shims located between brake housing and rear main frame. Identify the shims so that they can be reinstalled in same position. Note that the left bull pinion (13—Fig. O126) has sealing rings installed in grooves (G). Also see Fig. O127.

Unbolt the right brake housing and remove the housing and right bull pinion from rear main frame. The right bull pinion also has grooves (G), but does not have sealing rings installed in the grooves.

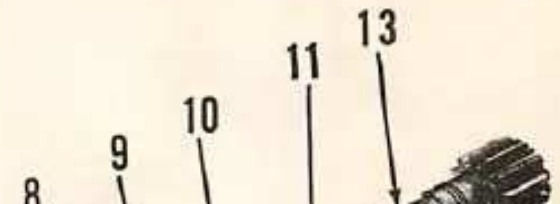
Remove the thrust bearings (15—Fig. O125), thrust washers (16) and side gears (14) from the differential and identify them so that they can be reinstalled in their original positions. Turn the left end of differential towards left front corner of compartment and lift differential from tractor.

Reinstall differential by reversing removal procedure. Refer to paragraph 208 for information concerning the sealing rings on left bull pinion. Adjust the differential bearings and backlash of bevel ring gear to bevel pinion as outlined in paragraph 205.

205. BEARINGS ADJUST. Differential end play and gear backlash are controlled by the shim packs interposed between the brake housings and the rear main frame. When adjusting bearings, do not depend on a shim count or prior assembly. Use a micrometer to measure shim pack thickness. Shims are available in thicknesses of 0.004, 0.007 and 0.015.

Mount a dial indicator and check the differential end play which should

be 0.001-0.003. Add or subtract shims as necessary to obtain the specified end play, however, BE SURE to maintain some gear backlash during this operation.



With differential end play adjusted, use the dial indicator to check the backlash between bevel pinion and bevel drive gear. Transfer shims from one brake housing to the other until the dial indicator reading agrees with the backlash reading etched on bevel drive gear. Note: Only transfer shims. Do not add or remove shims or the previously adjusted end play will be changed.

Mesh position of bevel gears is fixed and non-adjustable.

206. **OVERHAUL.** Remove differential as outlined in paragraph 204. Remove pinion pin retaining snap rings, then with puller Oliver No. STS-100, or equivalent, threaded into tapped hole of pinion pin, pull pinion pins and remove pinions.

When reassembling, install pinions with taper facing inward and tapped hole of pinion pin facing outward. When mounting bevel drive gear to spider, install bolts with heads next to bevel drive gear. Tighten nuts alternately and evenly to a torque of 110-115 Ft.-Lbs.

Note: When installing new spider, it may be necessary to ream holes in spider to 0.511-0.513 as follows: Place bevel drive gear on spider, ream one hole and install bolt. Now ream the hole which is directly opposite and install bolt. Tighten nuts to hold bevel drive gear in position and ream balance of holes. Install remainder of bolts and tighten nuts alternately and evenly to a torque of 110-115 Ft.-Lbs.

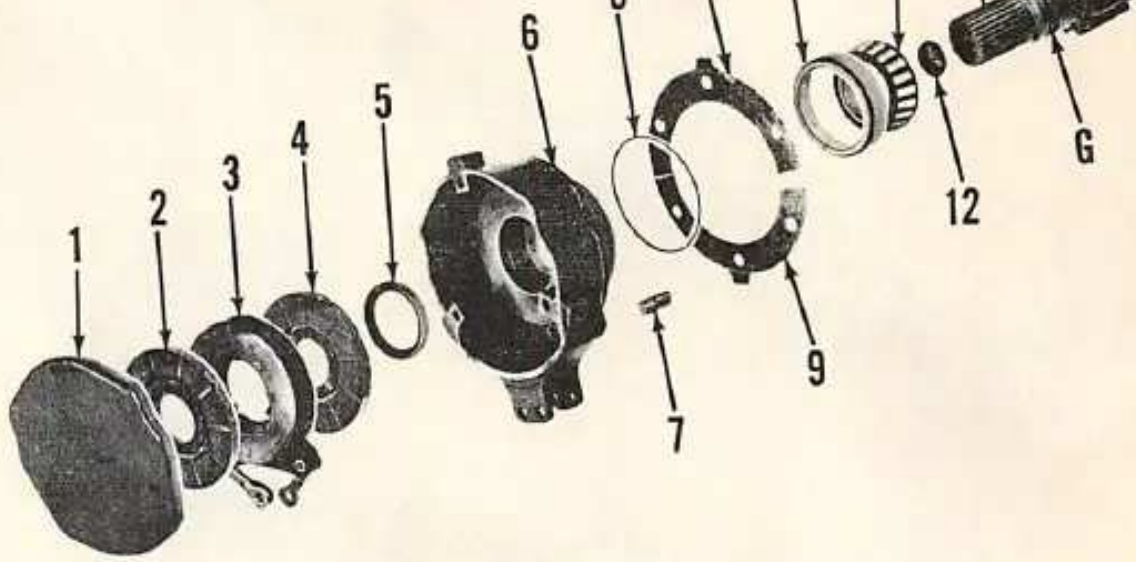


Fig. O126 — Exploded view of brakes, brake housing and bull pinion unit. On left bull pinion only, sealing rings are placed in grooves (G); refer to Fig. O127. Refer to Fig. O129 for exploded view of brake actuating assembly (3).

1. Brake cover
2. Brake disc
3. Actuating assy.
4. Brake disc
5. Oil seal
6. Brake housing
7. Dowels
8. "O" rings
9. Shims
10. Bearing cup
11. Bearing cone & roller assy.
12. Expansion plug
13. Bull pinion

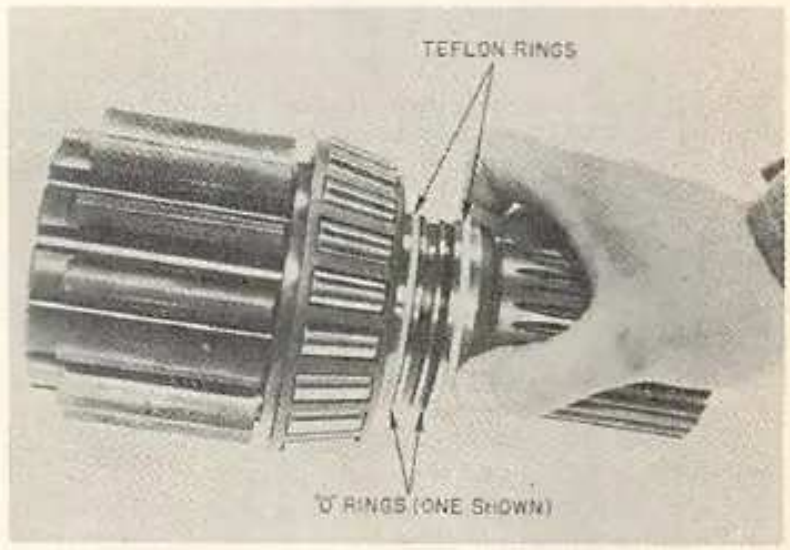


Fig. O127 — On left bull pinion, "O" rings are placed in the sealing grooves (G—Fig. O126) and Teflon rings are installed on top of the "O" rings. View shows installation of Teflon ring over the outer "O" ring.

BEVEL GEARS

207. The bevel pinion shaft extends through the transmission and carries the transmission driven gears. For information concerning removal and installation of the bevel pinion shaft, refer to paragraph 202 in TRANSMISSION section of this manual.

The bevel ring gear is bolted to the differential spider. Refer to paragraps 204 and 206 for differential service information which includes procedure for renewing the bevel ring gear.

FINAL DRIVE & REAR AXLE

208. **BULL PINION GEARS.** To renew a bull pinion gear, drain lubricant from final drive housing and proceed as follows:

Remove brake covers from both sides of tractor. Remove brake adjusting nuts and remove the brake discs and actuating assembly from side of tractor on which bull pinion shaft is to be removed. Mount a dial indicator against outer end of either bull pinion shaft and, with assistant, pry against ends of bull pinion shafts and note end play of differential unit on the dial indicator. Desired end play is 0.001-0.003; if end play is excessive, it is recommended that the hydraulic lift system (see paragraph 253) or bull gear cover (paragraph 193) be moved so that bevel gear backlash can be checked after readjusting differential end play on reassembly. If differential end play is not excessive, bevel gear backlash can be considered satisfactory and it will not be necessary to remove hydraulic lift system or bull gear cover; record differential end play and proceed as follows:

Unbolt brake housing on side from which bull pinion is to be removed and, while holding bull pinion in place, remove the brake housing. Be careful not to lose or damage the shims located between brake housing and rear main frame. Carefully withdraw bull pinion from differential shaft so that differential side gear will be removed with the bull pinion. Remove and inspect the roller type thrust bearing (15—Fig. O125) and thrust washer (16). If any rollers fall from bearing, be sure to retrieve them from final drive compartment. Renew

access for removing the differential assembly, or for renewal of a bull gear, proceed as outlined in paragraph 210.

To renew an axle shaft, axle carrier (housing) and/or axle shaft bear-

ings, refer to procedure outlined in paragraph 211.

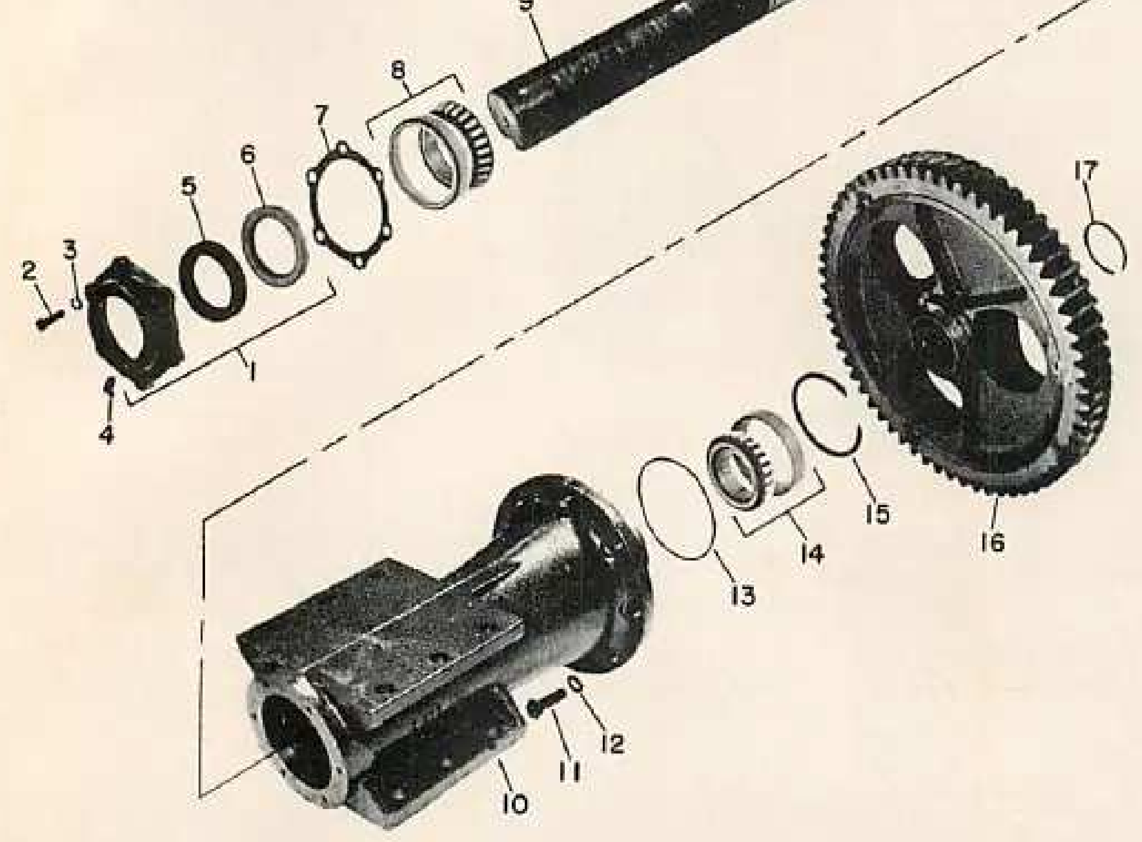


Fig. O128 — Exploded view of rear axle, carrier and bull gear assembly. Axle shaft bearing preload is adjusted by varying thickness of shims (7). Bull gears are retained on inner end of axle shafts by snap rings (17).

1. Retainer assembly
4. Grease fitting
5. Felt dust seal
6. Grease seal
7. Shims
8. Bearing assy.
9. Axle shaft
10. Axle carrier (housing)
13. "O" ring
14. Bearing assembly
15. Snap ring
16. Bull gear
17. Snap ring

the thrust bearing and/or washer if worn or rough.

If the left bull pinion shaft has been removed, condition of the bevel pinion and bevel ring gear teeth can be checked through opening in housing. Note: If the hydraulic lift system or bull gear cover is not removed, it is recommended that only one brake housing and bull gear be removed at a time.

To install a new bull pinion, be sure that expansion plug is installed in outer end and proceed as follows: Install thrust washer next to shoulder on differential shaft and place the thrust bearing next to washer.

The left bull pinion shaft is fitted with sealing rings and acts as a collector for oil under pressure from the transmission lubrication circuit for lubrication of the differential shaft bearing surfaces. If installing the left bull pinion, install new "O" rings in bottom of grooves (G—Fig. O126) and then install new Teflon rings on top of the "O" rings. Refer to Fig. O127. After installing the Teflon rings, wait for the plastic material to retract to normal size before proceeding with assembly. Note: Stretch the Teflon rings as little as possible when installing them.

Renew the oil seal in brake housing, installing seal with lip to inside. Install new "O" ring on shoulder of brake housing. Lubricate seal and, if installing left bull pinion, lubricate the sealing rings on pinion shaft. Place differential side gear on inner end of bull pinion and carefully install bull pinion on differential shaft. Reinstall brake housing with same number of shims as were removed.

Check end play of the differential asembly as outlined in removal procedure. If end play is not within 0.001 to 0.003, refer to paragraph 205.

209. **BULL GEARS, WHEEL AXLE SHAFTS AND AXLE CARRIERS (HOUSINGS).** Removal of the bull gears, wheel axle shafts and axle carriers (housings) is inter-related; however, removal procedure may vary according to which elements are to be serviced.

If removing the bull gears to gain

210. R&R BULL GEARS. To remove the bull gears, first drain and remove the hydraulic lift system, if so equipped, as outlined in paragraph 253. If not equipped with a lift system, remove the bull gear cover as outlined in paragraph 193. Drain the final drive compartment, support rear of tractor and remove rear wheel and tire units. (If only one bull gear is to be removed, remove wheel and tire unit on that side only.)

On Series 1600 models, remove the pto clutch and drive shaft assembly as outlined in paragraph 221. On Series 1650 models, remove the pto drive shaft as outlined in paragraph 226 and remove the pto housing and gear unit as outlined in paragraph 229. On models not equipped with a power take-off, but having a hydraulic system, remove the hydraulic pump drive shaft as outlined in paragraph 248.

If equipped with a three point hitch, remove the draft control spring. Remove snap rings from inner ends of the axle shafts and remove bearing retainers from outer ends of the axle carriers. Take care not to lose or damage any of the shims located between retainer and outer end of carrier. Withdraw axle shafts far enough to disengage the shafts from bull gears and allow the shafts to rest in the carriers. It may be necessary to use a pry bar to force the shafts from the gears. Lift the bull gears from rear main frame.

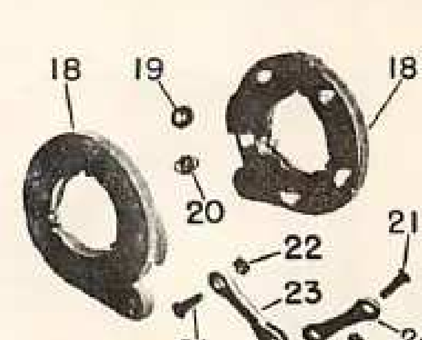
Reinstall bull gears by reversing removal procedure and reinstall rear axle shaft bearing retainer to carrier with same number of shims as were removed.

211. R&R AND OVERHAUL AXLE SHAFT, BEARINGS AND/OR AXLE CARRIER. On Series 1650 models only, the bull gear retaining snap rings can be removed after removing the pto gear and housing unit as outlined in paragraph 229. Then, support rear of tractor and remove the rear wheel and tire units and rear fenders. Attach a hoist to the rear axle carrier, unbolt carrier from rear main frame and withdraw the axle and carrier as a unit from the rear main frame and bull gear.

On Series 1600 models, and as optional procedure on Series 1650 models, follow the general procedures as outlined for removal of bull gears in paragraph 210, except that the bull gears need not be removed from the rear main frame. To inspect or renew the axle shaft inner bearing cup, it is necessary to remove the carrier

BRAKES

The brakes, which are mounted on outer ends of bull pinions are the self-energizing disc type. The actuating assembly has a slot which fits over a boss in the brake housing to



from the rear main frame and it is suggested that the axle and carrier be removed as a unit, instead of removing the bearing retainer and withdrawing the shaft.

After the axle and carrier unit is removed, proceed as follows: Unbolt and remove the bearing retainer from outer end of axle carrier and remove the axle shaft and bearing cone and roller assemblies. Using a press or a bearing puller, remove the cone and roller assemblies from each end of axle shaft. Drive the inner bearing cup away from retaining snap ring, remove the snap ring, then pull bearing cup from inner end of axle carrier. Remove the outer bearing cup, seal assembly and felt dust seal from the bearing retainer.

Reassemble the axle shaft and carrier unit as follows: Drive inner bearing cup into inner end of axle carrier with tapered side of cup inward. Install the bearing cup retaining snap ring, then seat the cup against the snap ring. Heat the bearing cone and roller assemblies in hot oil to approximately 200° F. and bump the assemblies onto axle shaft. (As optional procedure, install the bearing cone and roller assemblies in a press or with a bearing puller attachment.) Place a new felt seal in bearing retainer, then drive new oil seal into retainer with lip to inside. Drive bearing cup into retainer with tapered side of cup to inside.

Install the axle shaft and bearings assembly into carrier, then install retainer with proper thickness of shims to provide a shaft rolling torque (bearing preload) of 84-108 inch-pounds (including seal drag). If bull gear is removed, the rolling torque can be checked by placing gear on inner end of axle shaft, wrapping a cord around the gear and checking pull required to rotate shaft with a spring pull scale. Bearing adjustment is correct if pull on cord required to rotate shaft and gear is 9 to 12 pounds. Shims are available in thicknesses of 0.004, 0.007 and 0.015.

To reinstall axle, lubricate bore of rear main frame with grease, install a new "O" ring in groove at inside end of axle carrier, then reinstall the unit by reversing removal procedure.

over a boss in the brake housing to prevent rotation.

All Models

212. **ADJUSTMENT.** To adjust brakes, loosen jam nut on brake actuating rod and turn adjusting nut until the third or fourth notch of brake lock will engage the platform wear plate when the brake pedal is depressed moderately. Adjust both brakes the same.

213. **R&R AND OVERHAUL.** Unhook brake return springs and remove step assembly from left side of tractor. Remove jam nut and adjusting nut from brake actuating rods. Remove brake housing covers and the brake assemblies.

Disassembly of the actuating assembly is accomplished by removing actuating rod from links and disengaging the three extension springs. If necessary, polish the steel balls and the ball ramps. A small amount of Lubriplate may be used on steel balls during reassembly.

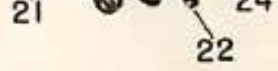


Fig. O129 — Exploded view of brake actuating assembly. Refer to Fig. O126 also.

21. Studs
23. Yoke link
24. Plain link
18. Disc
19. Steel balls (7/8-inch)
20. Springs

Linings are bonded to brake discs and renewal requires that a complete new disc be used.

Adjust brakes as outlined in paragraph 212.

BELT PULLEY ASSEMBLY

A belt pulley assembly is available for use in conjunction with the single speed 540 RPM power take-off assembly or with the 540 RPM shaft of the dual speed power take-off assembly. Belt pulley is controlled by the pto clutch and is mounted on rear face of the pto housing.

All Models So Equipped

214. **REMOVE AND REINSTALL.** Procedure for removal of belt pulley assembly is evident on inspection of unit. However, pulley must be to left side of unit when being installed.

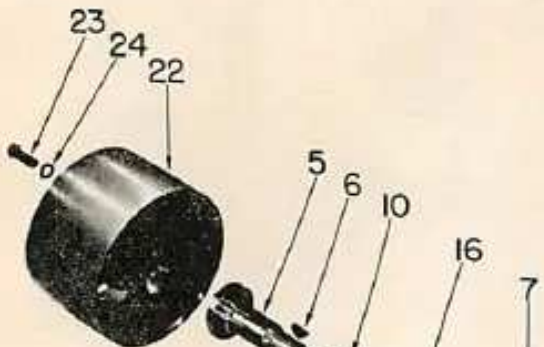
If an original installation of belt pulley is being made, proceed as follows: Remove the pto safety shield. If tractor has three-point hitch, remove left lifting link and lower link. Mount belt pulley unit onto pto housing so that pulley is on left side of tractor.

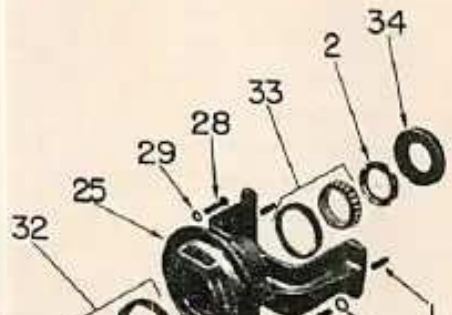
215. **OVERHAUL.** With belt pulley removed, drain oil and proceed as follows: Remove pulley from pulley shaft (5—Fig. O130); then, unbolt and remove drive shaft (30) and carrier (25) assembly from housing (35). Remove "O" ring (39), shims (38) and oil seal (34) from carrier, then using Oliver ST-142 Spanner Wrench or equivalent tool, remove adjuster nut (2). Press the drive shaft (30) and gear (3) from carrier. Remove snap ring (15) and pull bevel drive gear from drive shaft. Press inner bearing from drive shaft and remove bearing cups from carrier. Remove expansion plug (31) from drive shaft only if it shows signs of leakage.

Unbolt pulley shaft carrier (7) from housing and remove carrier and pulley shaft (5) assembly from housing. Remove shims (11) from carrier, unstake and remove adjuster nut (12) and use a puller to remove pinion gear (4) and bearing cone from pulley shaft. Press pinion gear from bearing. Press pulley shaft (5) from carrier, then remove outer bearing and oil seal (10). Remove bearing cups from carrier. Remove expansion plugs (36, 37 & 37A) from pulley housing only if they show signs of leakage.

Remove cap screw (14) and disassemble breather assembly.

216. Inspect all parts for excessive wear, scoring, chipping or other damage and renew parts as necessary. Reassemble unit as follows: Place new oil seal (10) on pulley shaft with lip of seal inward (away from pulley





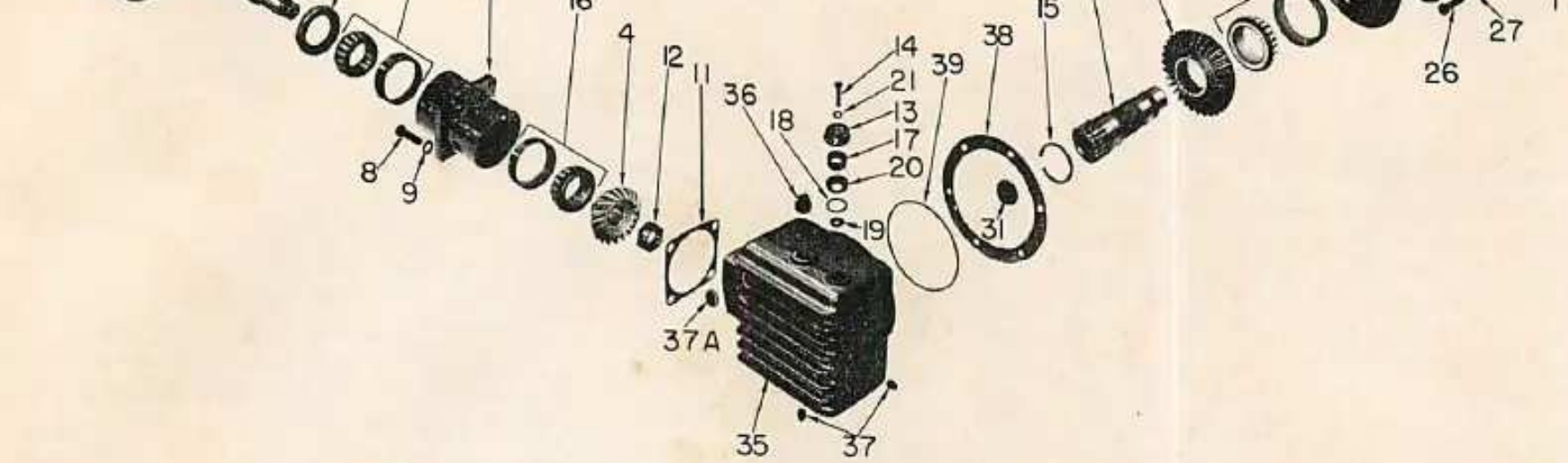


Fig. O130 — Exploded view of belt pulley assembly. Unit can be installed on tractors equipped with either the single speed 540 RPM power take-off, or with the 540 RPM pto shaft installed in the dual speed power take-off.

1. Dowel pins
2. Spanner nut
3. Bevel drive gear
4. Bevel pinion gear
5. Pulley shaft
6. Woodruff key
7. Carrier
10. Seal
11. Shims
12. Nut
13. Cap
15. Snap ring
16. Bearing
17. Breather element
18. Gasket
19. Baffle
20. Cup
21. Seal
22. Pulley
25. Carrier
30. Shaft
31. Expansion plug
32. Bearing
33. Bearing
34. Seal
35. Housing
38. Shims
39. "O" ring

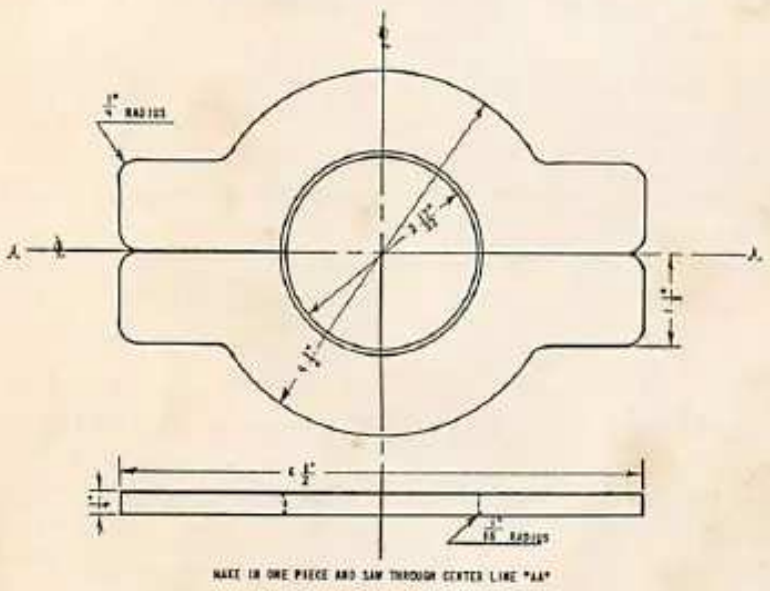


Fig. O131 — Seal installation tool can be made from piece of ¼-inch thick steel plate. Refer to dimensions shown on drawing.

Fig. O132 — Measurement between points shown is used in determining thickness of shims to use for proper location of gear in housing. Refer to text for procedure.

mounting flange), then install bearing cone with bevel towards housing. Install bearing cone on drive pinion with bevel away from gear. Install bearing cups in carrier, then with an oil seal installation tool similar to that shown in Fig. O131 positioned between pulley flange of shaft and oil seal (10—Fig. 0130), press oil seal and pulley shaft into carrier. Install the pinion and bearing on pulley shaft and screw the nut (12) onto shaft so that a slight end play of shaft in bearing remains. Use a spring scale and note effort required to rotate carrier on shaft. Tighten nut until the spring scale reads 5 to 6 pounds more than reading taken prior to tightening nut. This will give the desired 10-12 inch pounds bearing preload.

With the bearing preload set, the pulley shaft location in housing must be determined as follows: Measure distance between flat surface of pinion gear and mounting flange of carrier as shown in Fig. O132. To this measurement, subtract dimension stamped on housing as shown in Fig. O133. To the result, add 1.157. If a plus or minus value is etched on pinion gear, add or subtract this value accordingly and this will give thickness of shims (11—Fig. 0130) required between carrier and housing. Shims are available in thicknesses of 0.005, 0.007 and 0.020.

Assemble drive shaft and install in drive shaft carrier. Tighten adjusting nut (2) until bearings have 10-12 inch pounds preload and stake nut. Install

SINGLE SPEED PTO

The single speed power take-off unit is mounted on the rear face of the rear main frame (transmission housing) and receives its drive directly from the engine via the drive shaft (8—Fig. O136) which is splined into a drive hub mounted on the engine flywheel. Power to the external drive shaft (35) is controlled by an over-center clutch (1) to provide independent operation of the

hooked onto lever at this point to check for proper clutch adjustment.

If pull required to engage clutch is less than 43 pounds, remove the pto cover as outlined in paragraph 218 and proceed as follows: Loosen the six cap screws (10—Fig. O134) retaining the plate (9) to housing (25).

Fig. O133—Assembly dimension is stamped on housing as shown.

oil seal (34) with lip facing inward. Note the backlash value stamped on bevel drive gear and vary shims (38) located between carrier and housing to obtain this backlash value. Shims are available in thicknesses of 0.004, 0.007 and 0.015.

Clean and reinstall breather assembly with new element (17). Fill unit with 6½ pints of SAE 80 multi-purpose lubricant conforming to military specification MIL-L-2105.

unit.

Optional gears (15 and 29) and drive shaft (35) are available to convert the unit from a 540 RPM pto to a 1000 RPM pto.

The single speed power take-off can be used only on Series 1600 models. Tractors having a Reevrse-O-Torc Drive cannot be equipped with a power take-off. For information on the dual speed power take-off that is available for Series 1650 models, refer to paragraph 224.

All Series 1600 Models So Equipped

217. **ADJUST PTO CLUTCH.** The double plate over-center type clutch used in the single speed pto has a shim type adjustment for wear. Clutch should engage (go over-center) when a pull of 43-55 pounds is applied to control lever just below the lever knob. A spring pull scale can be

Remove two of the cap screws holding a shim set (12) and remove two or three of the 0.007 brass shims from the set. Reinstall shims remaining with long lobed ends facing in a counter-clockwise direction. Repeat the procedure for the other two shim sets removing the same number of 0.007 brass shims as were removed from first set. Tighten the plate retaining cap screws, reinstall pto cover and recheck pull required to engage clutch. Remove more shims if pull is less than 43 pounds or add shims if pull required to engage clutch is more than 55 pounds.

218. To remove pto cover (43—Fig. O136), first move clutch lever to disengaged position. Disconnect linkage from clutch lever to actuating shaft. Remove the two cap screws retaining safety shield to pto gear housing and the four cap screws securing pto cover to housing. Remove cover, safety shield and dust seal from pto gear housing.

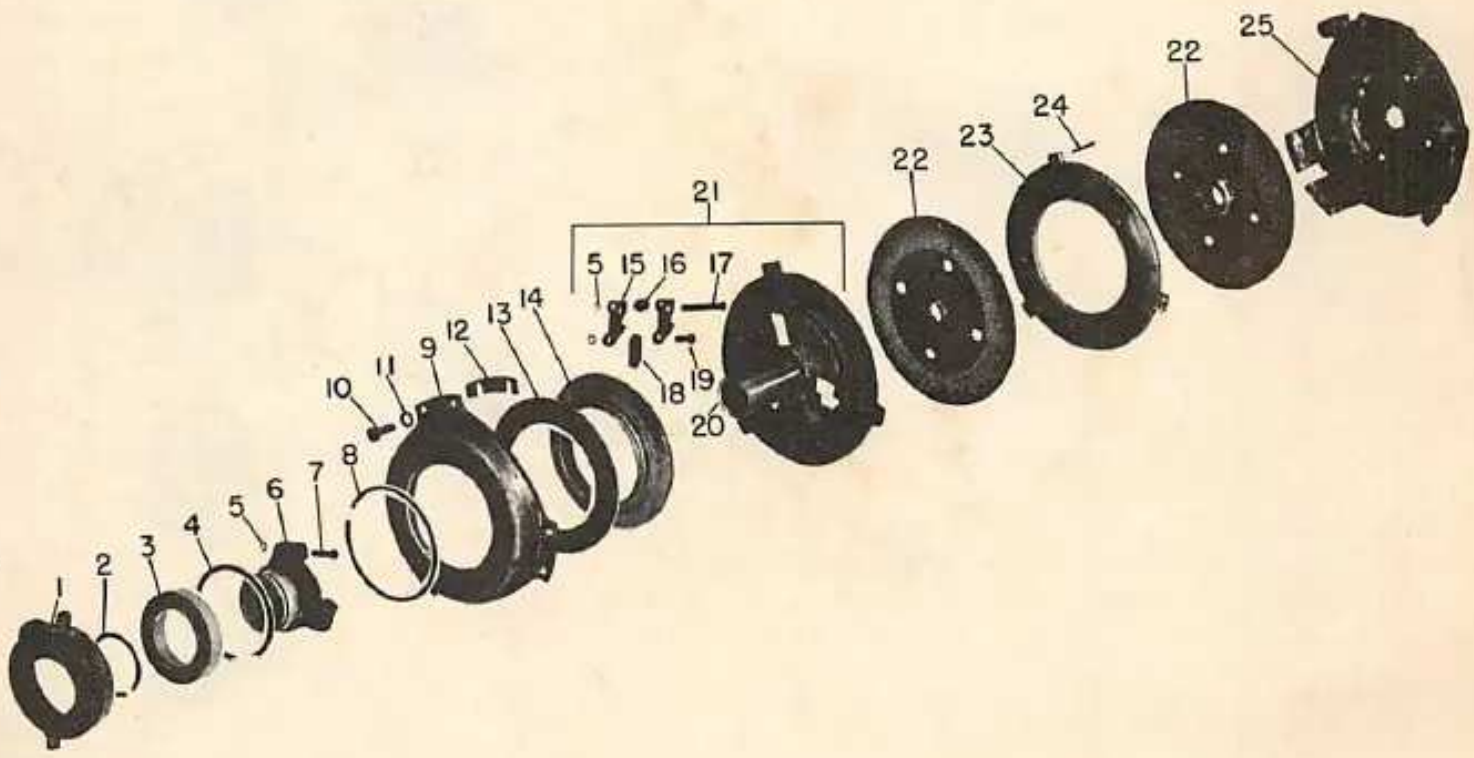
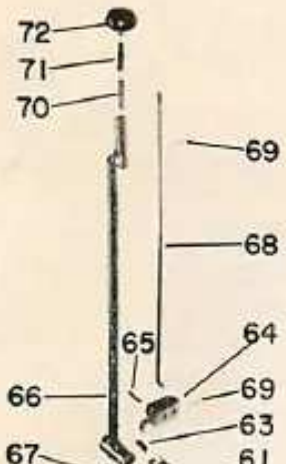


Fig. O134 — Exploded view of the dual disc pto clutch assembly used in Series 1600 single speed power take-off unit. Refer to Fig. O136 for exploded view of complete pto assembly.



219. **CLUTCH OVERHAUL.** The pto clutch can be disassembled and overhauled after removing pto cover as outlined in paragraph 218, or after removing the clutch and drive shaft assembly as outlined in paragraph 221.

To disassemble clutch, proceed as follows: Remove the six plate retaining cap screws (10—Fig. O134) and the adjusting shims (12), taking care not to lose any shims. Remove the back plate (9), over-center link-

back plate and plate (14) in a press to compress the spring washer (13) and remove snap ring (8).

220. Reverse the disassembly procedure to reassemble unit. If new lined discs (22) are being installed, reassemble using three new sets of shims (12) and check clutch adjustment as outlined in paragraph 217 after reinstalling unit. If reassembling clutch with used discs, but with new plates (20 and/or 23) or new housing (25) it may be necessary to

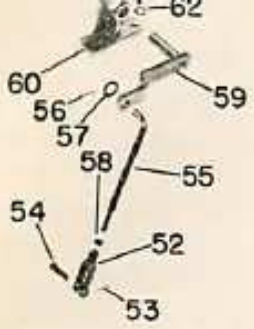


Fig. O135—Exploded view of single speed pto clutch lever assembly and linkage. Yoke (52) should be adjusted on rod (55) so that latch (64) locks control lever firmly in disengaged position.

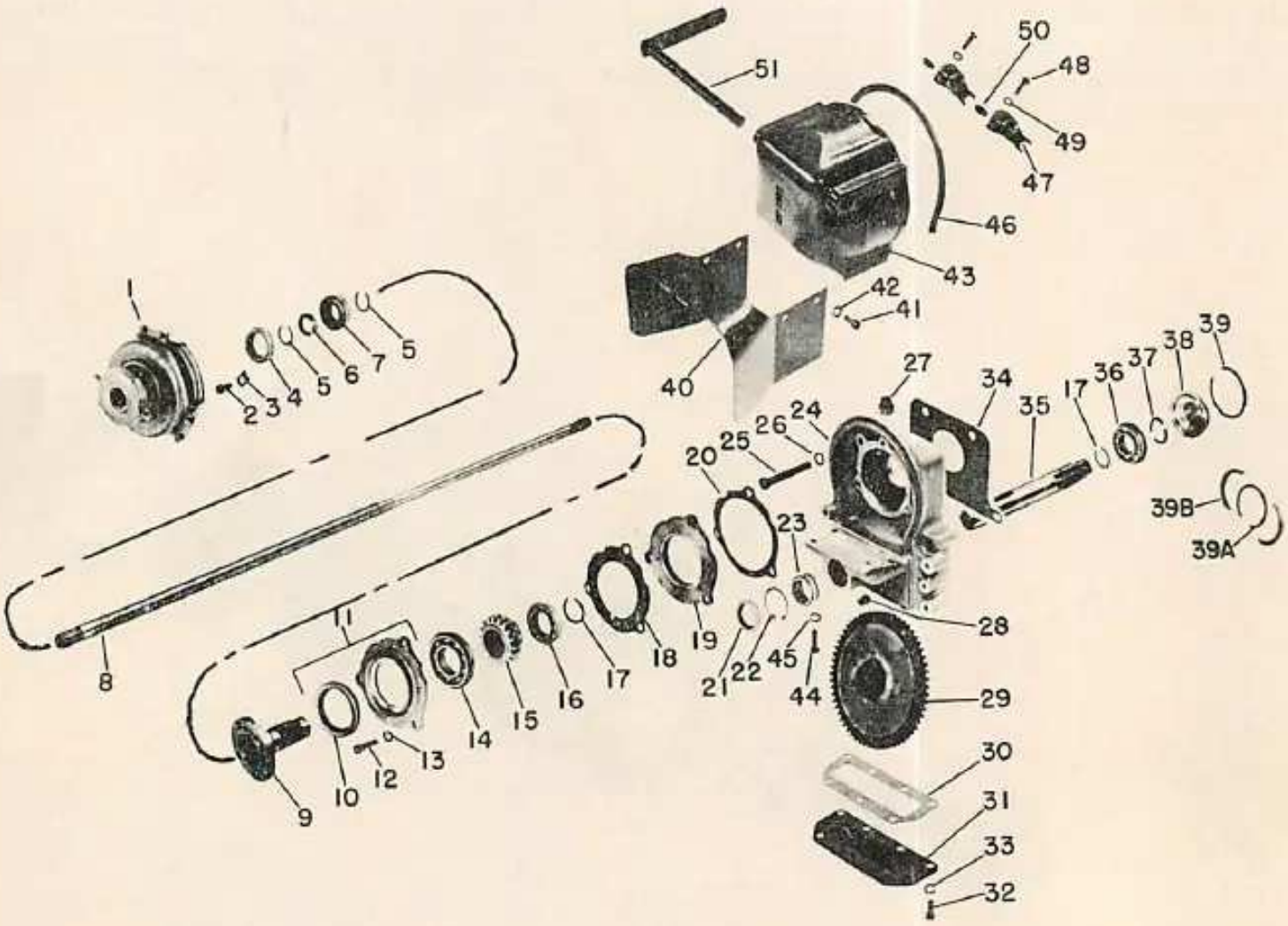
52. Yoke
55. Link rod
59. Shaft
60. Bracket
64. Latch
66. Lever
68. Rod
70. Spring
71. Plunger
72. Knob

age and pressure plate (21) as an assembly. Remove the two discs (22) and center plate (23) taking care not to lose the three springs (24). The housing (25) can then be unbolted and removed from the mounting sleeve (9—Fig. O136) if necessary.

To disassemble the back plate, over-center linkage and pressure plate assembly, refer to Fig. O134 and proceed as follows: Disconnect overcenter linkage from pressure plate (20) and sleeve (6). Remove snap ring (4) from inner side of carrier (1) and remove sleeve and bearing from carrier. Remove snap ring (2) and remove bearing (3) from sleeve. Place

add shims to those removed in disassembly. If desired, thickness of shim sets for initial adjustment of clutch (always recheck adjustment **after** reinstalling unit) can be determined as follows:

Remove the housing (25) from mounting sleeve and assemble the clutch unit in a press, but do not install the cap screws (10) or adjusting shims (12). With the over-center linkage in disengaged position, apply about 100 pounds force evenly to back plate (9) and check gap between back plate and housing at shim installation points with feeler gage. Average the three measurements and subtract



1. Clutch assembly
4. Seal
5. Snap rings
6. Spacer
7. Ball bearing
8. Input shaft
9. Mounting sleeve
10. Seal
11. Retainer
14. Ball bearing
15. Pinion
16. Ball bearing
17. Snap ring
18. Gasket
19. Adapter
20. Gasket
21. Seal
22. Snap ring
23. Needle bearing
24. Gear housing
27. Filler plug
28. Oil level plug
29. Output gear
30. Gasket
31. Cover
34. Gasket
35. Output shaft
36. Bearing
37. Retainer
38. Cover
39. Snap ring
39A. Snap ring
39B. Retainer
40. Safety shield
43. Pto cover
46. Dust seal
47. Actuator arms
50. Keys
51. Actuator shaft

Fig. O136 — Exploded view of the single speed power take-off unit that is available for Series 1600 models. Refer to Fig. O134 for exploded view of clutch assembly (1), and to Fig. O135 for control lever and linkage.

0.050; this should give the thickness of shim sets necessary for initial adjustment.

221. **R&R PTO DRIVE (INPUT) SHAFT AND CLUTCH ASSEMBLY.** To remove the pto drive shaft and clutch as an assembly, remove pto cover as outlined in paragraph 218, remove cap screws (12—Fig. O136) securing retainer (11) to gear housing (24); then, withdraw the clutch and shaft assembly from rear of gear housing and tractor rear main frame.

When reinstalling clutch and shaft lip forward. Position adapter (19) over bearing (14) with new gasket (18) between adapter and retainer (11). Install the shaft assembly with new gasket (20); then, reinstall clutch assembly as in paragraph 221.

NOTE: The pto drive shaft is supported midway between the flywheel and pto clutch unit by the hydraulic system pump drive pinion and bearing assembly. Refer to paragraph 249 for servicing the pump drive pinion and bearing. (Pump drive pinion and bearing are installed on tractors without hydraulic system to support the pto drive shaft and are accessible on these

about half way through front bearing, move gear forward on shaft and move snap ring (17) to front side of snap ring groove. Then drive shaft rearward out of bearing and gear and remove gear from housing. Drive the shaft and front bearing forward out of housing. Remove bearing from shaft. Remove oil seal (21), snap ring (22) and rear shaft bearing (23) from rear bore of housing.

To reassemble unit, proceed as follows: Press or drive on lettered side of needle bearing cage (23) only to install bearing, then install snap ring

assembly, renew the gasket (20). Check clutch adjustment as outlined in paragraph 217 after unit is installed. Note: Also renew gasket (18) if retainer (11) pulled away from adapter (19) when removing the unit.

222. **OVERHAUL PTO DRIVE (INPUT) SHAFT ASSEMBLY.** Remove the drive shaft and clutch assembly as outlined in paragraph 221 and remove clutch unit from mounting sleeve as outlined in paragraph 219. Refer to Fig. O136 and proceed as follows:

Bump front (flywheel) end of shaft (8) to remove shaft, bearing (7) and seal (4) from rear end of mounting sleeve (9). Remove snap ring (5) from rear of spacer (6) and pull bearing and spacer from rear end of shaft.

Separate the adapter (19) from retainer (11) and remove snap ring (17) from front of mounting sleeve. Use pullers and center plug to remove front bearing (16) and slide pinion (15) from sleeve. Use pullers and center plug to pull retainer (11) and rear bearing (14) from sleeve. Remove seal (10) from retainer.

Renew the seals (4 and 10) and other parts as required and reassemble unit as follows: Install seal (10) in retainer with lip to front. Place retainer and seal assembly on mounting sleeve (9) and press rear bearing (14) against shoulder on sleeve with snap ring on outer race of bearing to rear. Install pinion (15) with long hub forward and then install front bearing (16) and snap ring (17). Install front snap ring (5) on shaft (8), press bearing (7) against snap ring, install spacer (6) against bearing with taper to rear and install rear snap ring (5). Bump mounting sleeve into position over bearing (7) from front of shaft and install oil seal (4) in sleeve with

models after removing the bull gear cover.)

223. **OVERHAUL PTO OUTPUT SHAFT AND GEAR.** To renew the pto output shaft, bearings, seal and/or gear, remove the pto clutch and input shaft as an assembly as outlined in paragraph 221, then proceed as follows:

Remove the four cap screws retaining the gear housing (24—Fig. O136) to the rear face of tractor rear main frame, and remove the housing from tractor. Remove the snap ring (39) on early production units, or snap ring (39A) and bearing retainer (39B) on later production units, and bump the shaft (35) forward to remove bearing cover (38). Working through bottom opening in housing, disengage snap ring (17) from groove in shaft and move the snap ring about ¼-inch to rear. Support rear end of shaft and drive the front bearing (36) to rear until bearing retainer (37) can be removed from front end of shaft. Using a soft drift, drive shaft rearward (22). Insert shaft (35) through needle bearing and place snap ring about ¼-inch to front of groove in shaft. Place gear in housing with long hub to rear, slide shaft through gear and move snap ring to rear side of groove in shaft. Install front bearing (36) on shaft with snap ring side forward, install bearing retainers (37) and drive the shaft and bearing rearward into position. Engage snap ring (17) in groove of shaft at rear side of gear. Install bearing cover (38) and retaining snap ring (39) (early production) or retainer (39B) and snap ring (39A) (late production). Install shaft oil seal (21) with lip to inside (forward).

Reinstall unit on rear face of tractor rear main frame using new gasket (34). Install bottom cover (31) with new gasket (30) and fill housing to level of test plug (28) opening with SAE 80 multi-purpose gear lubricant conforming to military specification MIL-L-2105. Reinstall pto clutch and shaft unit, reinstall pto clutch cover and check clutch adjustment as outlined in paragraph 217.

DUAL SPEED PTO

A dual speed power take-off unit is available for Series 1650 models except those equipped with Reverse-O-Torc Drive. The pto unit is mounted on rear face of rear main frame and is utilized as a main frame cover. Power is taken directly from the engine flywheel and pto is controlled by a multiple disc over-center type clutch within the unit, providing independent control of the pto output shaft. Conversion from 540 RPM pto to 1000 RPM pto is made by changing the pto output shaft which automatically "shifts" the unit to the corresponding pto speed.

The pto control lever engages the clutch when in forward position. When lever is in rear position, the clutch is disengaged and further movement of the control lever rearward applies a pto holding brake. It should be noted that the pto holding brake is not to be used to stop motion of a pto driven implement.

All Series 1650 Models So Equipped

224. **CLUTCH ADJUSTMENT.** To adjust the pto clutch, stop engine and move control lever to point midway between engaged and disengaged positions and proceed as follows:

Remove the pipe plug (9—Fig. O138 or 16—Fig. O137A) from top of hous-

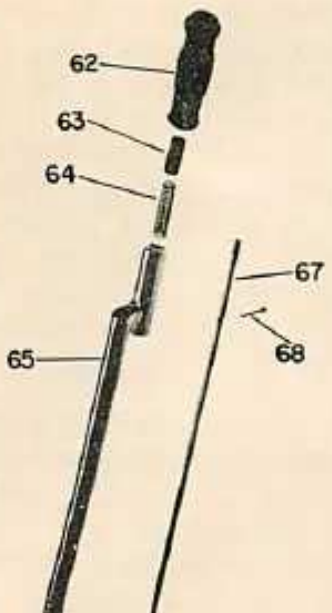
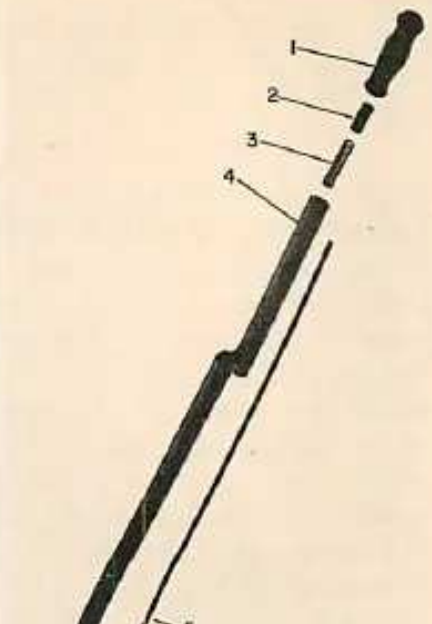
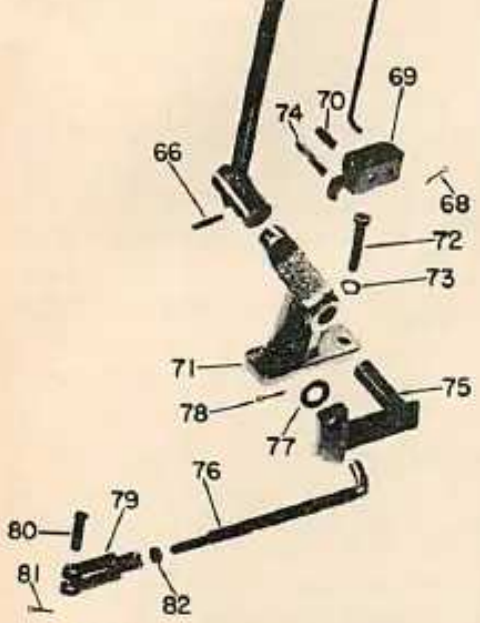
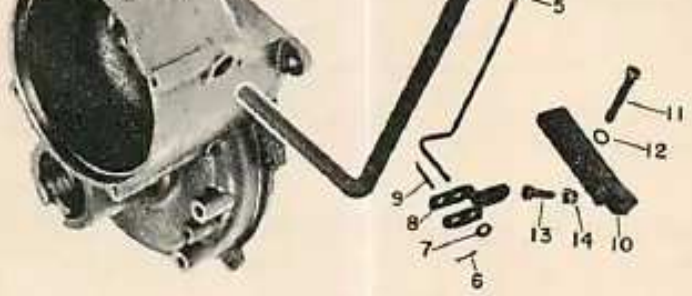


Fig. O137A — On Series 1650 models equipped with depth stop cylinder hydraulic system, the PTO clutch lever is differently constructed than on other models. However, adjustment of PTO clutch remains the same. To adjust lever latch, move lever to disengaged position, loosen locknut (14) and adjust stop bolt so that it just contacts latch (8).







5. Latch rod
8. Latch
9. Pin
10. Bracket
13. Latch stop bolt
14. Lock nut
15. Dual speed pto housing
16. Adjustment plug
17. Plug

Fig. O137 — Pto clutch lever assembly and linkage for dual speed power take-off. Latch (69) locks lever in disengaged position.

62. Grip
63. Plunger
64. Spring
65. Lever
66. Roll pin
67. Rod
69. Latch
71. Support
74. Pin
75. Shaft
76. Link
79. Link end
82. Lock nut

ing and rotate clutch assembly so that adjusting ring lock pin (12—Fig. O139) can be seen through plug opening. Depress the lock pin and turn adjusting ring (11) with screwdriver. Turn ring to left to increase pressure, or to right to decrease pressure required to engage clutch. Clutch adjustment is correct when 48-52 pounds pull is required to engage clutch. Adjustment can be checked with a spring pull scale attached to control lever just below the lever grip. Move adjusting ring just one notch at a time and recheck clutch adjustment. When adjustment is correct, reinstall pipe plug.

225. **CONTROL LEVER ADJUSTMENT.** Refer to Fig. O137. The yoke (79) should be adjusted on rod (76) so that clutch control lever is locked firmly in disengaged position by latch (69). To adjust yoke, remove pin (80), loosen lock nut (82) and turn yoke in or out to obtain desired adjustment. Reinstall pin and tighten lock nut when adjustment is correct. NOTE: On late Series 1650 models equipped with depth stop cylinder hydraulic system, refer to Fig. O137A; adjustment of control lever latch differs on these models.

226. **R&R CLUTCH DRIVE (PTO INPUT) SHAFT.** Refer to Fig. O138 and proceed as follows. Unbolt and remove cover (59) and "O" ring (58). Working through openings in hub of spider (57), disengage snap ring (56) from rear of bearing (55) in bore of clutch assembly (51). Then, withdraw spider, bearing and shaft (50) from rear of pto housing. Remove snap ring (53) and pull spider from shaft. Shaft is supported at mid length by the hydraulic system pump drive pinion and pinion bearings; refer to paragraph 249 for servicing the pinion and bearings.

Reverse removal procedures to reinstall the clutch drive shaft. Renew sealing "O" ring (58) when reinstalling cover (59).

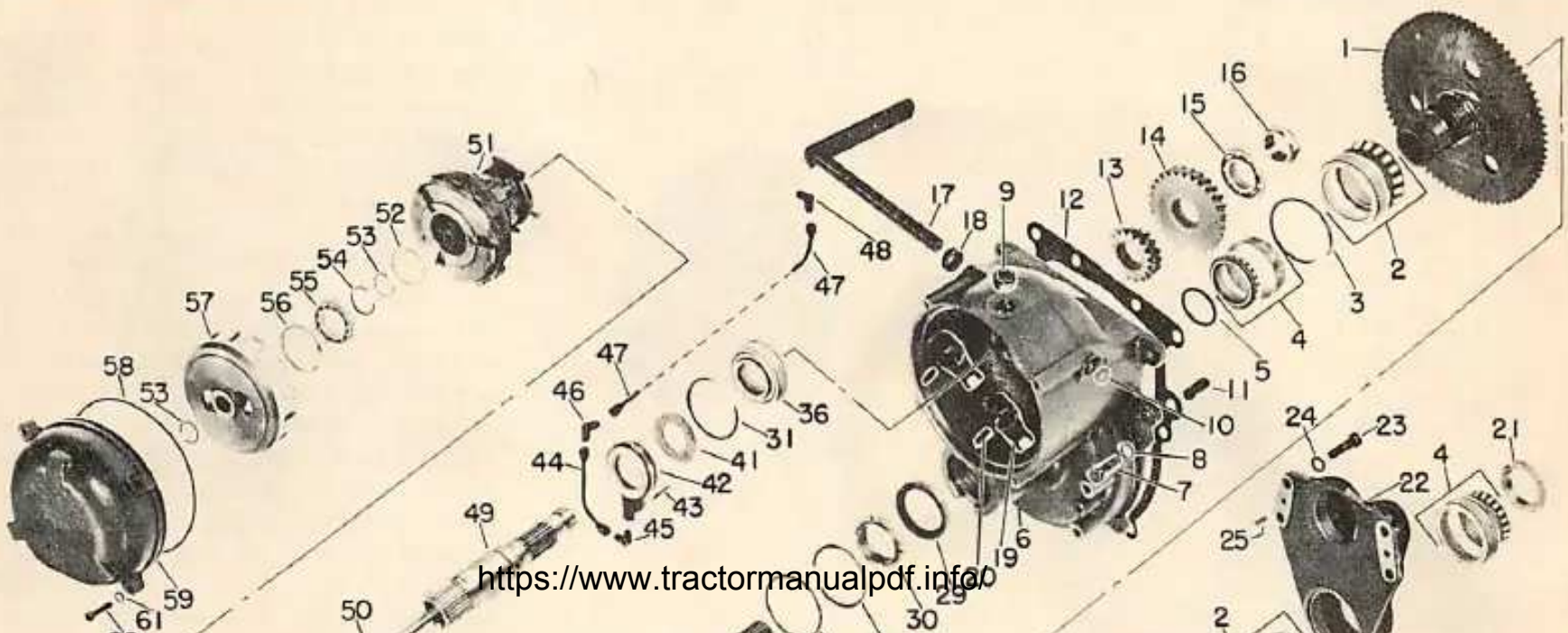
227. **OVERHAUL PTO CLUTCH ASSEMBLY.** To remove the pto clutch assembly, first remove the drive shaft as outlined in paragraph 226. Then, remove snap ring (52) from groove in rear end of clutch shaft (49), disconnect linkage between pto clutch lever and actuator lever (17) and withdraw clutch assembly from shaft and pto housing.

For disassembled view of the clutch assembly, refer to Fig. O139. Drive out the roll pins (16), remove pins (15), sliding collar (5), levers and sleeve collar (1) from floating plate (14). Depress locking pin (12), unscrew adjusting ring (11) and remove adjusting ring, floating plate and clutch discs from clutch hub (19). Any further disassembly which may be required is evident from inspection of unit.

When reassembling, be sure to stake retaining screws (21) if drive keys (20) were removed. Renew clutch discs (17 and/or 18) if coned more than 0.005. Install pins (6, 8 & 15) with heads in direction of clutch rotation. Lubricate clutch discs with transmission lubricant prior to assembly.

If desired, clutch can be adjusted prior to installation as follows: Place clutch assembly in a press and turn adjusting ring (11) as necessary so that a force of 195 pounds is required to engage clutch (snap lever arms over-center). If equipment to apply measured force of 195 pounds is not available, adjust clutch after installation as outlined in paragraph 224.

Reinstall clutch by reversing removal procedure. Clutch adjustment should be rechecked and adjusted, if



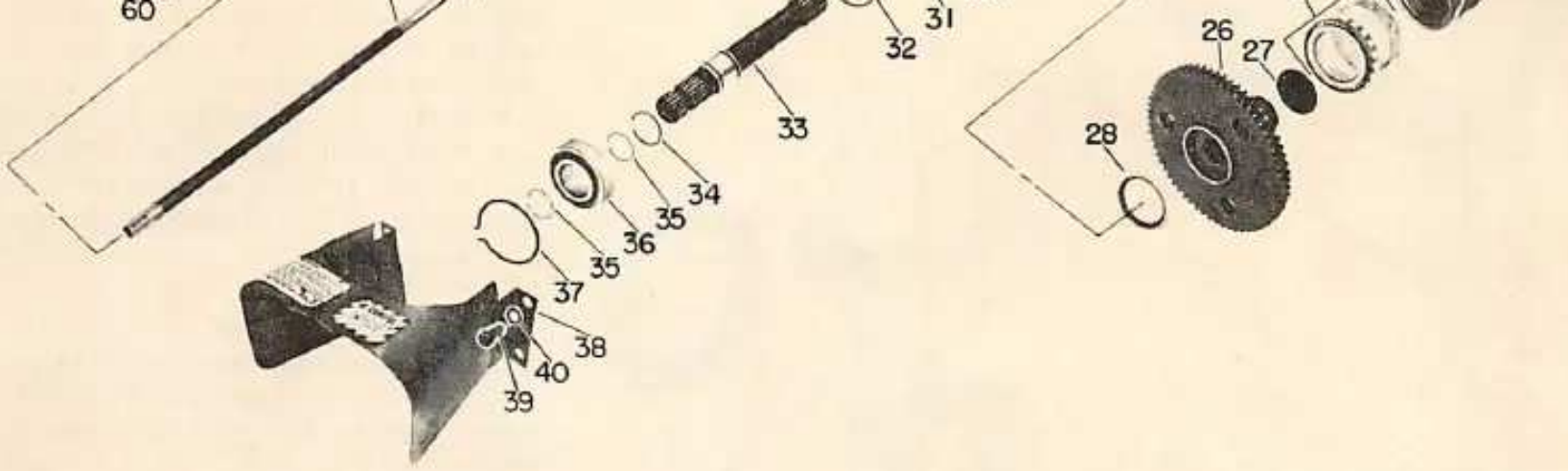


Fig. O138 — Exploded view of dual speed pto unit that is available on Series 1650 models. A wet type multiple disc clutch (51) is used; over center linkage is actuated by hand lever (Fig. O137 or O137A). Refer to Fig. 0139 for exploded view of clutch unit (51).

1. 540 RPM gear
2. Tapered roller bearing
3. Snap ring
4. Tapered roller bearing
5. "O" ring
6. Housing
9. Pipe plug
10. Expansion plug
11. Dowels
12. Gasket
13. 540 RPM pinion
14. 1000 RPM pinion
15. Ball bearing
16. Nut
17. Arm & shaft assy.
18. Seal
19. Arms
20. Pins
21. Nut
22. Carrier
25. Dowels
26. 1000 RPM gear
27. Expansion plug
28. Seal
29. Seal
30. Nut
31. Snap ring
32. "O" ring
33. Output shaft
34. Snap ring
35. Snap rings
36. Bearing
37. Snap ring
38. Safety shield
41. Disc
42. Oil collector ring
43. Pin
44. Tube
45. Elbow
46. Elbow
47. Tube
48. Elbow
49. Clutch shaft
50. Drive shaft
51. Clutch assembly
52. Snap ring
53. Snap ring
54. Snap ring
55. Bearing
56. Snap ring
57. Spider
58. "O" ring
59. Cover

necessary, as outlined in paragraph 224. Check and adjust lever linkage as outlined in paragraph 225.

228. **CHANGE PTO OUTPUT SHAFT.** The power take-off on Series 1650 models can be converted from 540 RPM to 1000 RPM output shaft speed, or vice versa, by changing to the appropriate output shaft (33—Fig. 0138). To change output shaft, remove snap ring (37) from PTO housing and withdraw the shaft and bearing (36) assembly. Renew the "O" ring (32) in bore of housing if necessary; then, insert the alternate shaft and bearing assembly and secure with snap ring (37).

The alternate PTO output shaft furnished with tractor is fitted with bearing and bearing retaining snap rings. If necessary to renew either the bearing or the shaft, procedure for doing so is evident from inspection of unit and reference to exploded view in Fig. 0138.

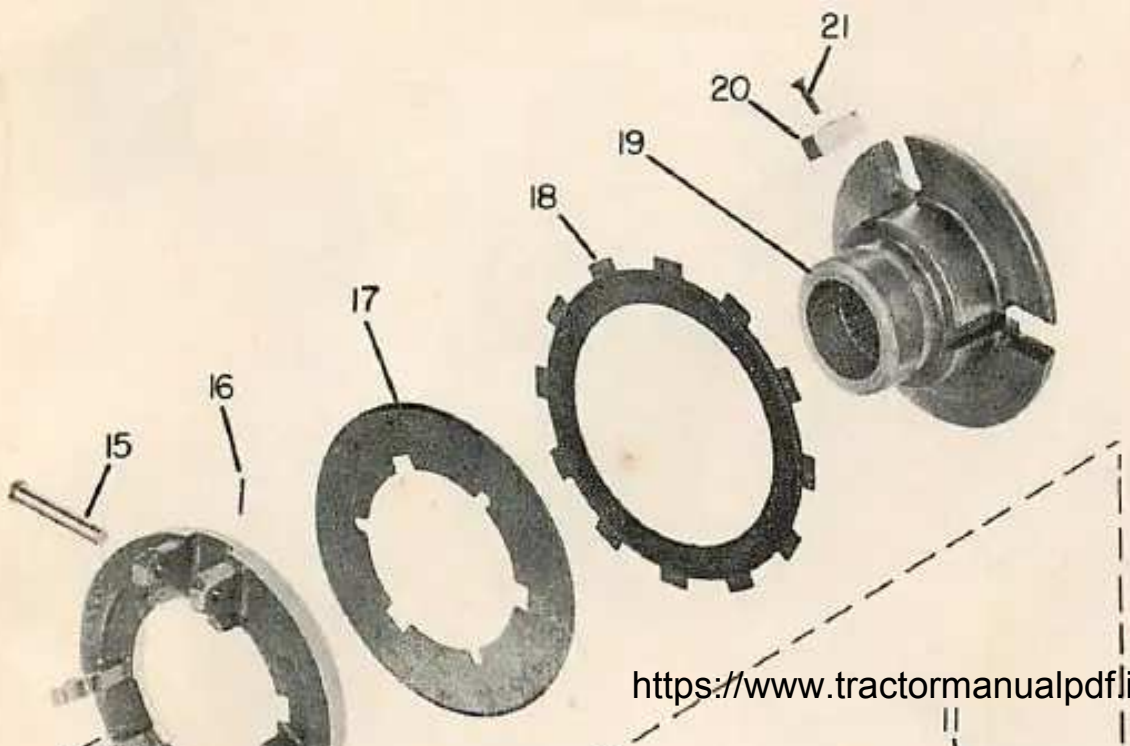
229. **R&R PTO HOUSING AND GEAR ASSEMBLY.** To remove the PTO assembly from rear of tractor main frame, first remove the drive (PTO input) shaft as outlined in paragraph 226 and remove the clutch unit as outlined in paragraph 227. Drain transmission lubricating oil, then proceed as follows:

Disconnect rear oiling tube (44—Fig. 0138) from front tube (47) at the elbow connector (46). Then, unbolt and remove PTO housing and gear assembly from rear of tractor main frame. Note that housing is located on tractor main frame by two dowels (11).

Reinstall PTO housing and gear assembly on tractor main frame using new gasket (12). Connect the oiling tube, then reinstall clutch unit, drive shaft and spider.

230. **OVERHAUL PTO HOUSING AND GEAR ASSEMBLY.** Remove the housing and gear assembly as outlined in paragraph 229, then disassemble unit as follows:

Remove the cap screws (23) retaining carrier (22) to front of PTO housing and remove carrier from the two locating dowel pins (25), front bearing (15) and housing. Unstake and remove nut (21) from hub of gear (26) and remove gear by bumping it rearward out of carrier and front bearing assembly (4). Remove rear bearing cone and roller assembly from gear and remove the bearing cups from carrier. Remove seal (28) from rear face of gear (26); it is not necessary to remove expansion plug (27)



Drive new seal (29) into housing bore from rear until seated against shoulder and with lip of seal facing forward. Place rear bearing cone and roller assembly in bore and drive rear bearing cup into bore far enough to install snap ring (3) in groove. Then, bump bearing forward so that cup is firmly seated against snap ring. Drive front bearing cone and roller assembly onto gear (1) firmly against shoulder on hub and drive front bearing cup in firmly against shoulder in housing bore. Insert gear hub through housing bore and drive rear bearing cone and roller onto hub so that there is some end play of gear in bearings. Place "O" ring (5) in groove on hub, lubricate lip of seal and loosely install nut (30). Check the torque required to rotate gear in bearings (be

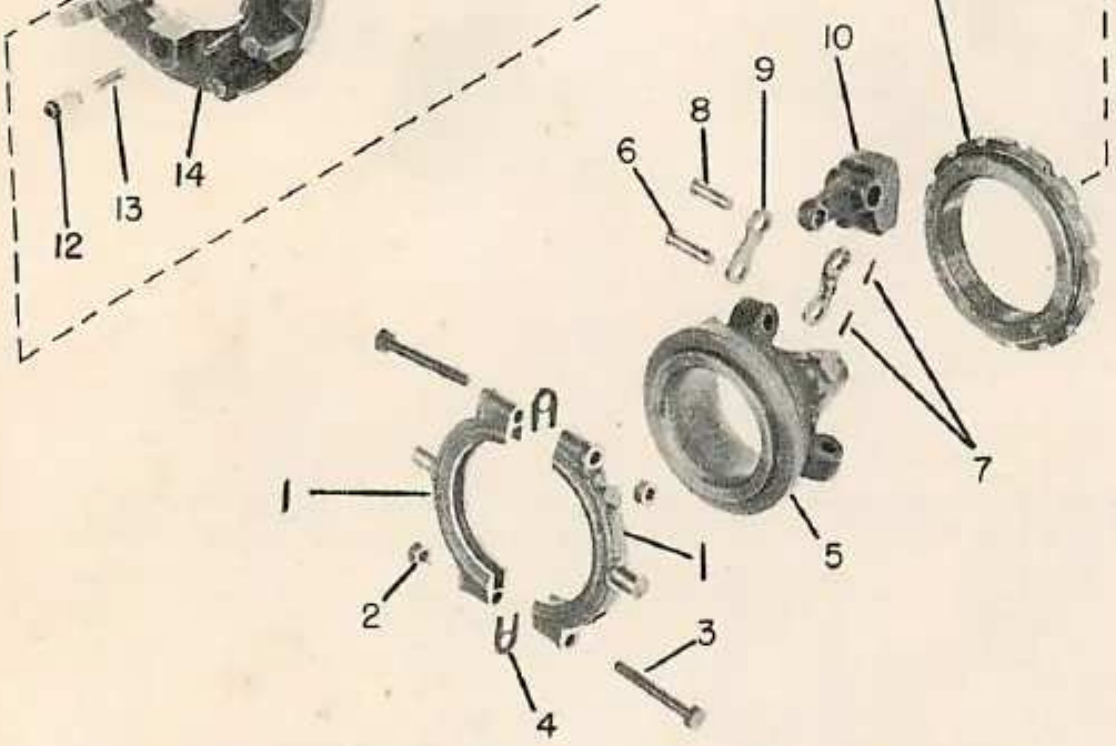


Fig. O139 — Exploded view of the multiple disc clutch assembly used in dual speed pto. Refer to Fig. O138 for complete pto assembly.

1. Collar
2. Nut
3. Bolts
4. Shims
5. Sliding sleeve
6. Pins
7. Cotter pins
8. Pins
9. Links
10. Levers
11. Adjusting ring
12. Lock pin
13. Spring
14. Floating plate
15. Pins
16. Cotter pins
17. Driven plates (4)
18. Driving plates (5)
19. Hub
20. Drive keys
21. Screws

from gear if there is no evidence of oil leakage.

Unstake and remove nut (16) from front end of clutch shaft (49) and bump the shaft rearward out of bearing (15), gears (13 and 14) and the rear bearing (36). Remove oil collector ring (42) and PTO brake washer (41) from shaft. Be careful not to lose oil collector ring pin (43). Remove snap ring (31) and drive the bearing (36) rearward out of housing.

Remove snap ring (37) and pull output shaft (33) and bearing assembly (36) from housing. Remove snap ring (31) and "O" ring (32) from bore and using Oliver Spanner Wrench ST-127 or equivalent tool, unscrew nut (30) from hub of gear (1). Remove "O" ring (5) from hub and bump gear forward out of bearing (4). Remove cone and roller assembly of front bearing from gear hub and the front bearing cup from housing. Bump rear bearing cup rearward away from snap ring (3), remove snap ring and drive the rear bearing assembly forward out of housing. Drive the oil seal (29) rearward out of housing.

Clean and carefully inspect all parts. Renew parts as required and reassemble using all new "O" rings, seals and nuts (16, 21 and 30). To reassemble the unit, proceed as follows:

sure that nut turns in seal and not on shaft); this value will represent seal drag. Then, tighten nut until an additional 5 to 10 inch-pounds torque is required to rotate gear in bearings and stake nut to slot in gear hub.

Drive bearing (36) into housing bore and install bearing retaining snap ring (31). If removed, drive oil collector locating pin (43) into hole in housing and make sure that oil collector will slide freely on pin. Place oil collector on shaft (49) with small hub against shoulder (PTO brake friction surface forward) and place PTO brake disc (41) on shaft next to oil collector. Insert shaft through bearing (36), align hole in oil collector with pin (43) and bump shaft forward until PTO brake disc is held tightly between inner race of bearing and shoulder on shaft. Check to be sure oil collector will slide back and forth between shoulder on shaft and PTO brake disc. Place rear pinion (13) (18 teeth) on shaft with either side forward. Place front pinion (14) (28 teeth) on shaft with long hub forward (flat side against rear pinion). Install bearing (15) and nut (16) on shaft, tighten nut to a torque of 125-150 Ft. Lbs. and stake nut to shaft.

If expansion plug (27) was removed from gear (26), install new plug. Drive rear bearing cone and roller assembly firmly against shoulder on hub of gear (26) and drive bearing cups into carrier (22) until firmly seated. Insert gear through bearing cups and carrier bore and drive front bearing cone and roller assembly onto gear hub so that there is some end play of gear in bearings. Install nut (21) and tighten nut to preload bearings so that a torque of 5 to 10 inch-pounds

is required to rotate gear in bearings. Stake nut to slot in gear hub when bearing preload is properly adjusted. Drive new seal (28) into rear hub of gear with lip of seal to rear (out), and lubricate seal lip.

Carefully install carrier and gear assembly onto dowel pins (25), bearing (15) and hub of rear gear (1) taking care not to damage seal in gear (26). Tighten the carrier retaining cap screws securely.

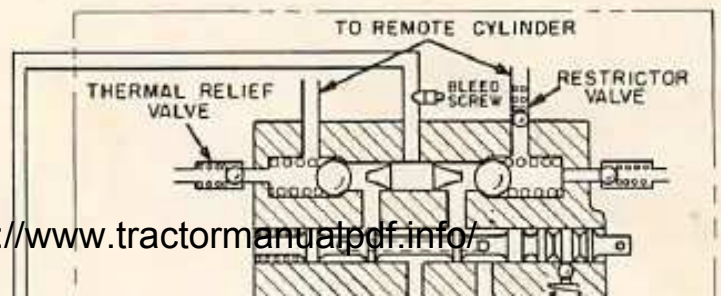
HYDRAULIC LIFT SYSTEM

(Except Depth Stop Cylinder Control System)

The hydraulic system for Series 1600 and Series 1650 tractors can be as follows:

(A). A 3-point hitch system with draft control;

(B). A remote control system for one remote cylinder only;



(C). A remote control system for two remote cylinders;

(D). A system combining (A) and (B); or

(E). A system combining (A) and (C).

The service information in this section is based on a system having a 3-point hitch with draft control and valving to operate two remote cylinders (system E) as this will include all components of the other systems (A, B, C and D) available. Refer to the appropriate paragraph or paragraphs when servicing models equipped with system A, B, C or D.

231. **TROUBLE SHOOTING.** The following are troubles and causes which may be encountered when operating the hydraulic system. Also, refer to schematic diagram of the hydraulic circuit in Fig. 0140 and to the cross-sectional view of the Hydra-Lectric control unit in Fig. 0141. When tests indicate that trouble is in the electrical portion of the hydraulic lift system, refer to paragraph 232.

INTERNAL OIL LEAKS. Could be caused by: Defective pump mounting gasket, pump shaft seal or housing gasket.

UNIT OVERHEATS. Could be caused by: Unit overloaded. Relief valve improperly adjusted. Low oil level, oil of wrong viscosity being used or oil contaminated.

NOISY UNIT. Could be caused by: Worn or damaged pump or pump drive gear. Internal high pressure leaks. Low oil level or oil too heavy. Oil filter plugged. By-pass valve plugged or defective manifold.

OIL FOAMS OUT OF BREATHER. Could be caused by: Oil level too high or too low. Oil of wrong viscosity.

UNIT WON'T LIFT. Could be caused by: Pressure relief valve improperly adjusted or defective. Pump

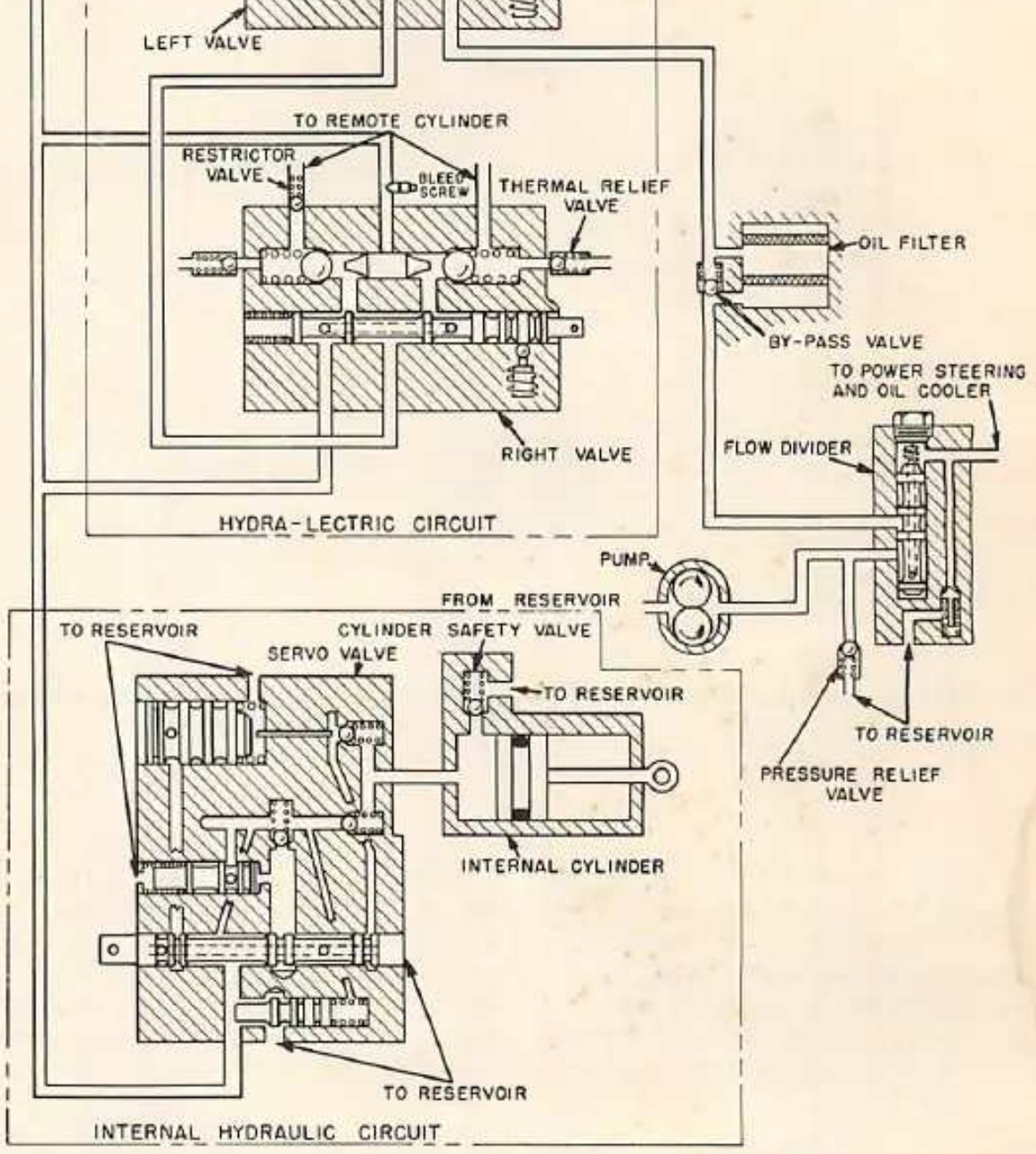
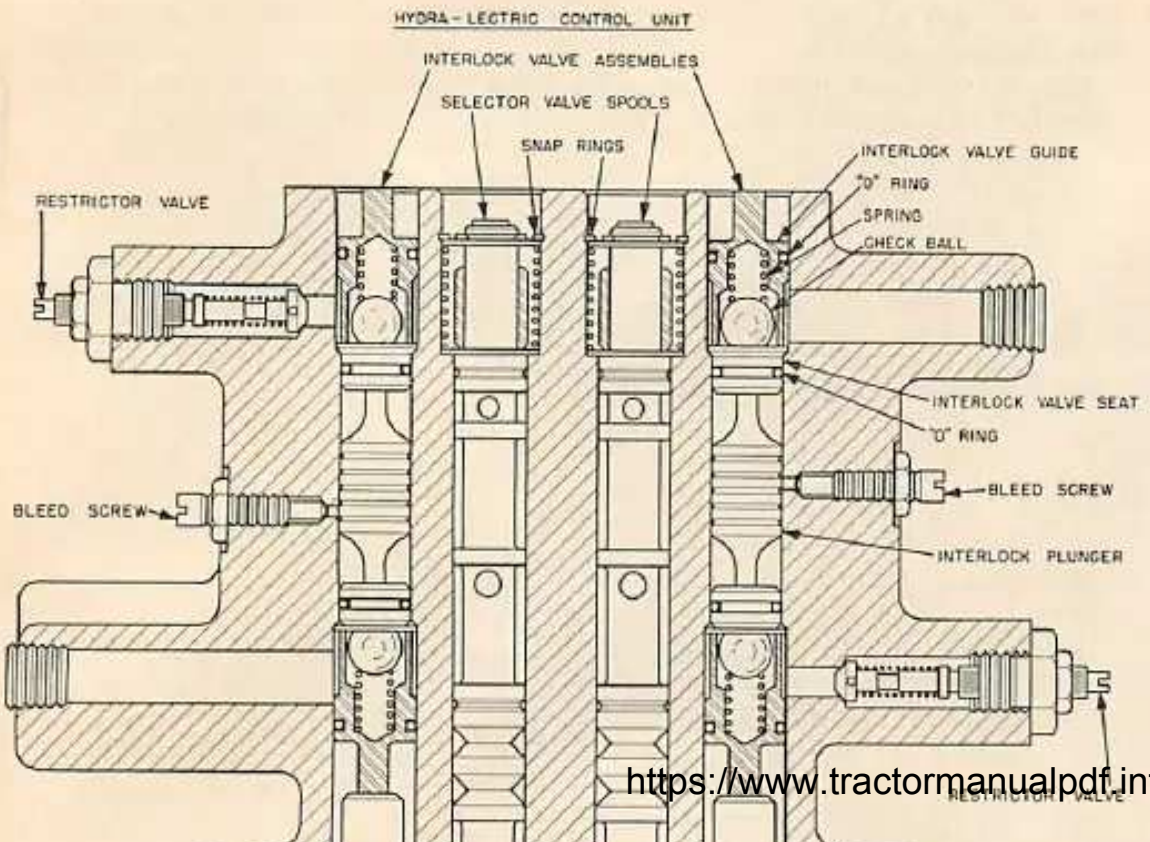


Fig. 0140 — Schematic diagram of Series 1600 hydraulic circuit which includes Hydra-Lectric valves for two remote cylinders and draft control for the 3-point hitch. Series 1650 is similar except that the oil filter is located between the pump and flow divider valve and servo valve is slightly different.



Selector valve sticking. Shorted "up" switch. Contact arm of "up" switch not opening. Hand control lever not returning to neutral due to defective or maladjusted solenoid or solenoid switch, valve centering springs or remote cylinder switches.

RELIEF VALVE BLOWS WHEN REMOTE CYLINDER IS CONTRACTED. Could be caused by: Control lever held too long in "down" position. Selector valve sticking. Defective or maladjusted "down" switch. Remote cylinder friction collar improperly adjusted. Hand control lever not returning to neutral due to defective or maladjusted solenoid or solenoid switch, valve centering springs or remote cylinder switches.

RELIEF VALVE BLOWS DURING REMOTE CYLINDER EXTENDING STROKE. Could be caused by: Exces-

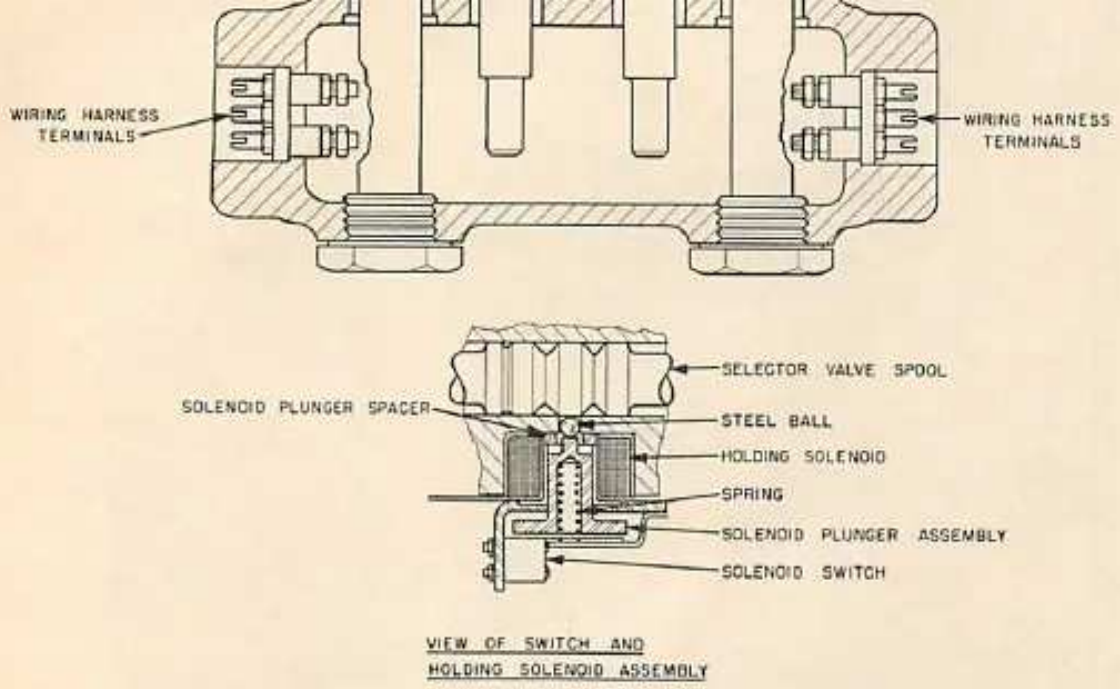


Fig. O141 — Cross-sectional view of Hydra-Lectric control unit and the solenoid holding switch assembly. Refer to Fig. O159 for exploded view of the unit.

or pump drive failure. Pump not primed. Dirty or faulty servo valve. Bent or broken internal linkage. Low oil level or excessive leakage. Broken housing, cylinder, piston or defective piston seal. Faulty remote cylinder. Mechanical failure of lifting mechanism parts.

UNIT WILL NOT LOWER. Could be caused by: Servo valve pilot spool sticking. Lowering valve worn or not opening.

RELIEF VALVE BLOWS AFTER LIFTING. Could be caused by: Improper adjustment of unit. Servo valve pilot spool not returning to neutral.

UNIT GOES OUT OF ADJUSTMENT. Could be caused by: Broken linkage spring inside pilot spool in servo valve. Loose servo valve mounting cap screws. Draft control linkage broken or worn. Lifting mechanism worn or loose.

ERRATIC DRAFT CONTROL OPERATION. Could be caused by: Servo valve sticking. Worn or binding linkage or lift mechanism. Unit out of adjustment. Broken or loose draft control spring.

RELIEF VALVE BLOWS WHEN REMOTE CYLINDER IS EXTENDED. Could be caused by: Control lever being held too long in up position. Excessive load. Restricted piston stroke. Binding lift linkage. Couplings improperly connected. Restrictor valve stuck or passageway plugged.

RELIEF VALVE BLOWS DURING REMOTE CYLINDER CONTRACTING STROKE. Could be caused by: Restrictor valve improperly adjusted, stuck or oil line blocked. Couplings improperly connected. Bleed screw not properly adjusted when single acting cylinder is used.

UNIT WILL NOT HOLD LOAD. Could be caused by: Fittings or couplings leaking. Thermal relief valve leaking. Cylinder scored or worn or piston seal leaking. Interlock seals or seats leaking. Oil passage connectors leaking.

ERRATIC REMOTE CYLINDER OPERATION. Could be caused by: Loose or corroded electrical connections. Defective or bent cylinder stop collar. Bent "up" switch contact arm. Defective solenoid assemblies. Weak or broken valve centering spring.

REMOTE CYLINDER STOP COLLAR FAILURE. Could be caused by: Excessive air gap between collar and magnet. Cylinder solenoid not energized.

ELECTRICAL TESTS

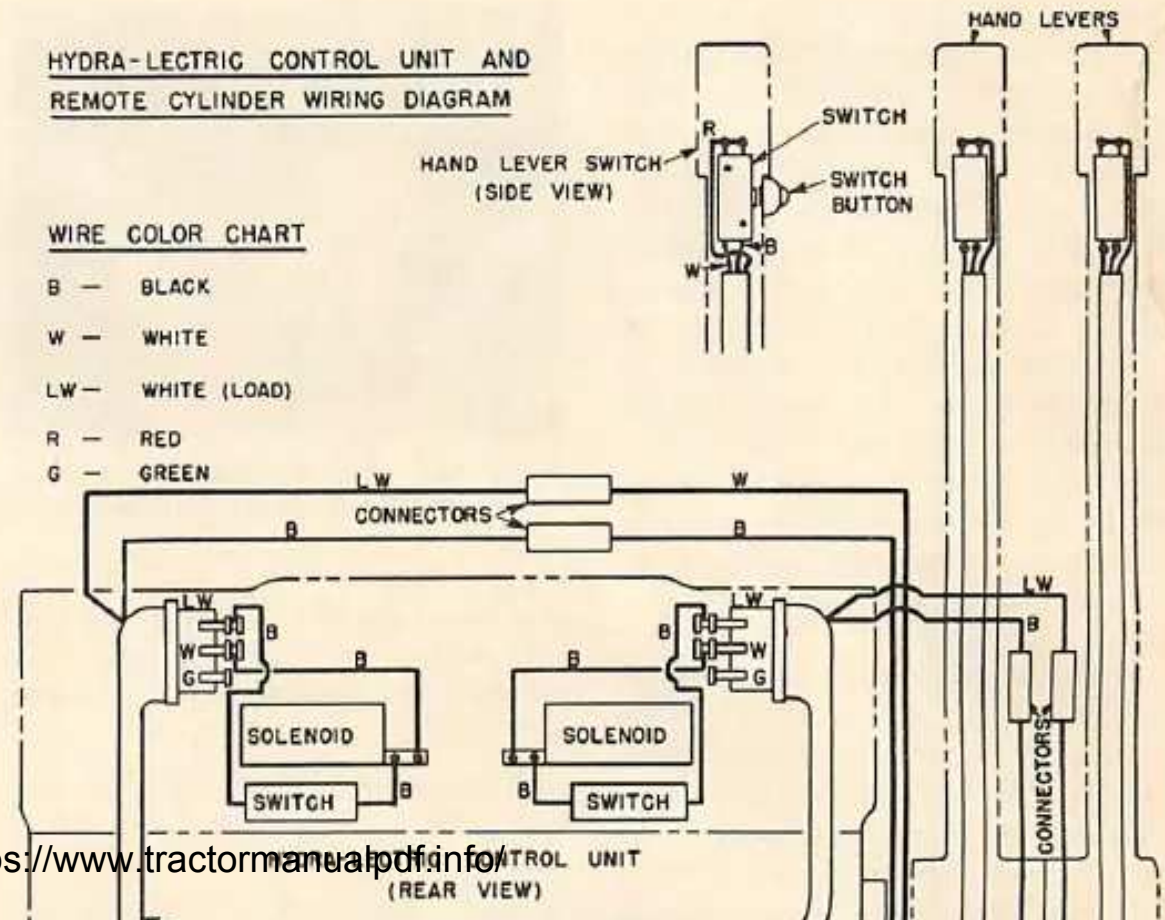
Electrical malfunctions fall into two classes; a dead circuit and a shorted circuit. When making electrical tests, determine first which kind of malfunction is involved.

It is necessary to have a test light

assembly to perform the electrical tests and if one is not available, make one up as follows: Use two lengths of insulated wire and attach battery clips to one end of each wire. Place a 12-volt bulb and socket in series in one of the two wires. On remaining ends of the two wires, affix stiff, insulated probes.

Before initiating any electrical tests, be sure the trouble is not caused by a dead battery, blown fuses, loose or corroded connections or broken wiring. Use wiring diagram shown in Fig. O142 as a guide.

232. **TESTING ELECTRICAL CIRCUITS.** Before starting test, remove hood and instrument panel cover. Disconnect all wire connectors except the connector for the fuse holder in the instrument panel support. Unplug wiring harness from Hydra-Lectric control unit and the cables from remote cylinders.



Attach test lamp assembly to battery, remove right hand fuse holder cap and remove the fuse from cap. Put fuse back into holder, place one probe on exposed end of fuse and the other on the Hydra-Lectric terminal of ignition switch. If bulb lights, circuit is satisfactory from ignition switch to fuse.

Replace fuse cap and fuse in holder, then move same probe that was used on fuse to the double connector located below the hand control levers. If the bulb lights the circuit between ignition switch and the double connector is satisfactory.

Check wiring and switches in each hand control lever by placing one probe on red wire and the other on black wire. Light should come on when switch is depressed. Now move the probe from the black wire to the white wire (other probe still on red wire). The light should come on but will go off when the switch is depressed. If both these conditions are met, the wiring and switches in hand control levers can be considered satisfactory.

Check the wiring, solenoids and switches in the Hydra-Lectric unit by placing a probe on each of the solenoid terminals on right side of tractor. Bulb should light when left hand control lever is pushed forward or rearward. Note: The solenoid switches are in off position when levers are in neutral position and bulb will not light. Repeat this operation for opposite side of tractor, using other control lever, if unit utilizes two remote cylinders. If bulb does not light as already indicated, remove the Hydra-Lectric control unit and check the solenoids and switches individually for complete circuits. Bulb should light when probes are placed on solenoid leads.

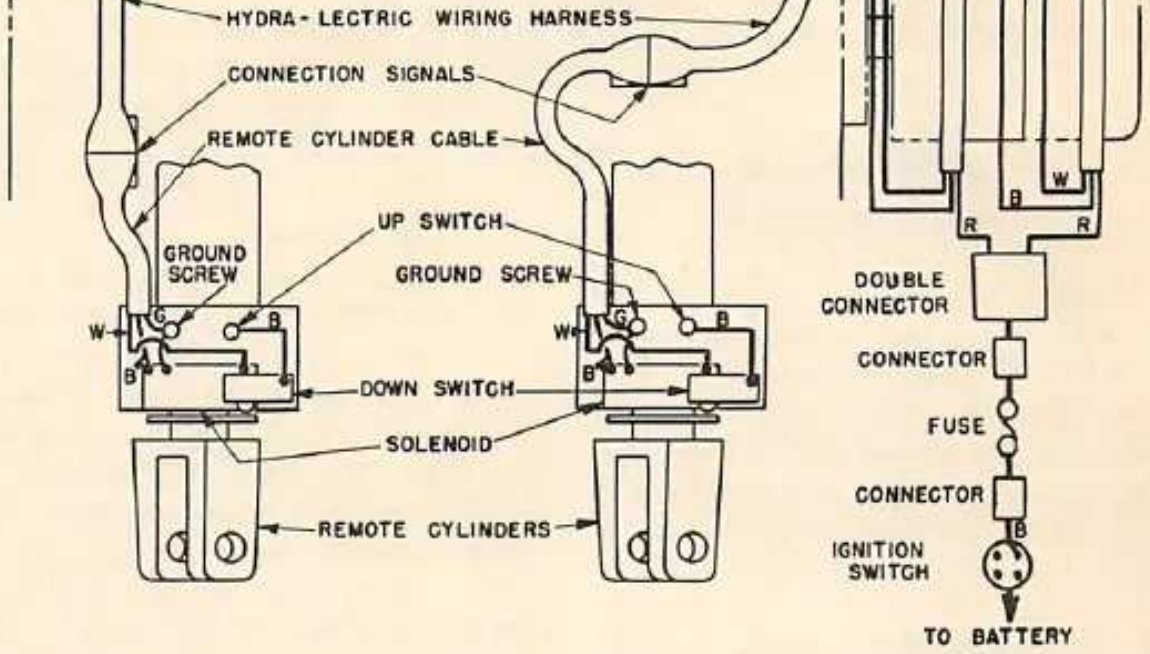


Fig. O142 — Wiring diagram for the Hydra-Lectric control unit and remote cylinders.

Test continuity of Hydra-Lectric wiring harness as follows: Place one probe on black pig tail and the other on the "B" terminal of the male plug. Bulb should light. Place one test probe on white pig tail and the other on "LW" terminal of 90 degree plug. Bulb should light. Test "G" and "W" circuits by placing a probe on corresponding letters of each plug. Bulb should light on both tests.

Test continuity of remote cylinder wiring harness by placing a test probe on same lettered terminals of each plug (W, B & G). Bulb should light in each case.

Check circuits of remote cylinder as follows: Remove cylinder head cover. Place one probe on "B" terminal of cable female connector and ground other probe to an unpainted surface of cylinder. Bulb should light indicating solenoid circuit is satisfactory. Move probe from "B" terminal to "G" terminal of cable. Bulb should light indicating ground circuit is satisfactory. Move probe from "G" ter-

minal to "W" terminal of cable. Bulb should light indicating circuit through "down" switch and "up" switch is satisfactory. Make a further check of down switch by actuating switch several times. Bulb should go off and on each time switch is operated, indicating satisfactory operation of "down" switch. Also move piston rod to the completely extended position at which time the bulb should go off. Now move piston rod in and out a short distance. Bulb should go off and on each time rod moves in and out, indicating that the "up" switch is operating satisfactorily.

If all the conditions outlined under electrical tests are met, the electrical system can be considered satisfactory. However, if bulb does not react as indicated, the circuit is probably short circuited and a search should be made for loose or corroded connections, or broken, frayed or bare wires.

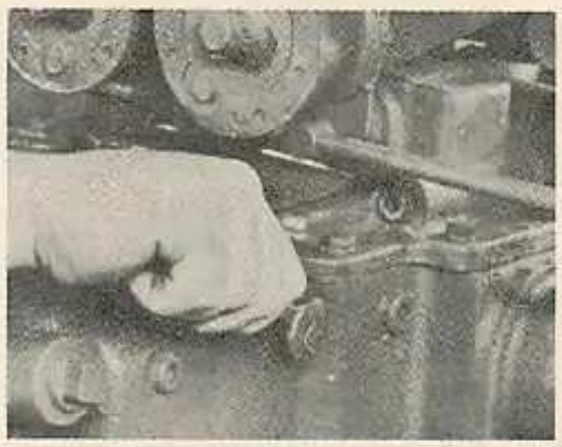


Fig. O143 — View showing hydraulic drain plug location on Series 1600 models.

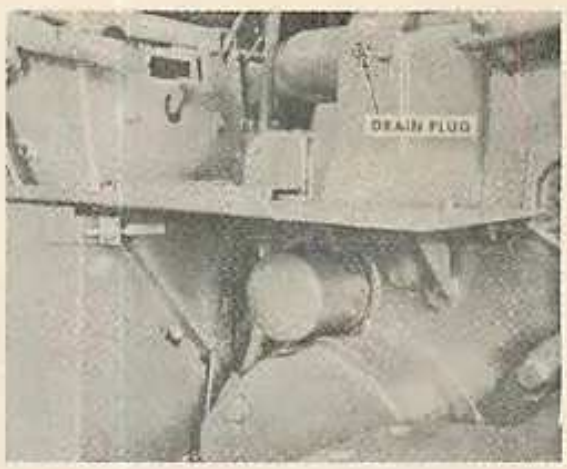


Fig. O144 — View showing hydraulic drain plug location on Series 1650 models.

sion fluid. System should be drained and refilled with new oil each year or after every 1000 hours of operation.

Reconnect any hoses that were disconnected and reinstall drain plug. Fill reservoir to "FULL" mark on dipstick. Start engine and cycle all hydraulic cylinders several times. Recheck fluid level and add fluid, if

quires removal of hydraulic housing from tractor and removal of the lift cylinder from hydraulic housing. On Series 1650 hydraulic system, bypass valve retaining plug is located just to rear of drain plug location shown in Fig. 0144.

LUBRICATION AND MAINTENANCE

NOTE: When performing service or maintenance of any kind on the hydraulic lift system, the practice of cleanliness is of the utmost importance. Pump, valves and cylinders are manufactured to close tolerances and dirt or foreign material is most detrimental and should be avoided at all times.

233. **DRAIN AND REFILL.** To drain the hydraulic system, place lift arms in down position and retract any remote cylinders; then, remove the drain plug as shown in Fig. 0143 or Fig. 0144, attach hose to opening, start engine and run engine at 1000 RPM until oil is pumped from reservoir. Stop engine as soon as oil stops flowing; DO NOT operate engine when hydraulic system is without oil. If lift system is equipped with remote cylinders, remove hose and move cylinder piston in and out to clear cylinders of oil.

Capacity of hydraulic unit is 20 quarts of oil if equipped with 3-point hitch, or 26 quarts of oil when equipped with Hydra-Lectric remote control only. Recommended hydraulic fluid is SAE 10W Supplement 1 motor oil or "Type A" automatic transmission fluid. Check hydraulic fluid level and add fluid, if necessary, to bring level to "FULL" mark on dipstick.

234. **BREATHER.** A micronic element type breather is located on top side of hydraulic housing near the right front corner or, on some models, on left front corner as a part of the oil dipstick assembly. Under normal conditions, the element should be renewed when the hydraulic fluid is being changed (see paragraph 233). In abnormally dusty conditions, more frequent renewal of the element is required.

Renewal of element is evident after removing cap screw or not from top of the breather assembly. Use new gaskets and crush washers when reassembling breather.

235. **OIL FILTER.** The hydraulic lift system is equipped with a full flow renewable element type oil filter. Filter is located on left side of hydraulic housing on Series 1600 and on front end of housing on Series 1650. A by-pass valve which opens at approximately 20 psi pressure differential is incorporated in the hydraulic circuit. The by-pass valve will open if the filter becomes plugged. Service of the by-pass valve (76—Fig. O154) on Series 1600 hydraulic system remains evident after unscrewing filter body from hydraulic housing. When reinstalling, place a new "O" ring on filter body, lubricate the "O" ring and tighten the filter body to a torque of 150-200 Ft.-Lbs.

SYSTEM ADJUSTMENTS

The adjustments in this section will include only those external adjustments which can be accomplished with no disassembly of the hydraulic system. For internal adjustments requiring disassembly, refer to appropriate overhaul paragraph.

236. **LIFT ARM FREE TRAVEL.** Refer to Fig. O145 and proceed as follows: With engine running, move the lift arm (3-point hitch) control lever to fully raised position and allow lift arms to raise to upper limit. If at this point, the lift arm free travel is not within the range of ½ to 1 inch as shown, loosen lock nut and turn linkage adjusting screw as necessary to obtain specified free travel of lift arms after lift arms reach the fully raised position. Shorten linkage to increase or lengthen linkage to decrease the lift arm free travel. Tighten lock nut and recheck.

Fig. O145 — View showing lift link free free travel adjustment.

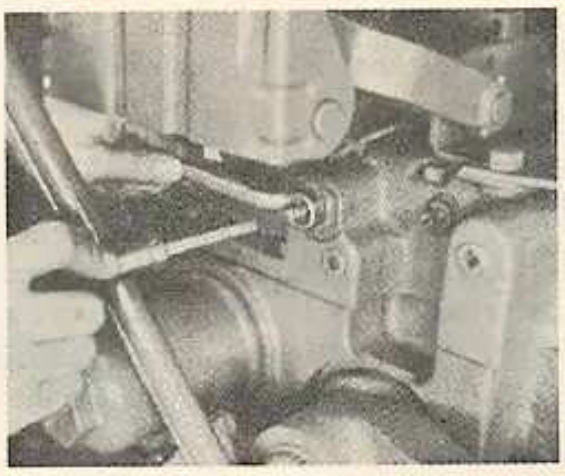


Fig. O147 — Adjusting the Hydra-Lectric restrictor valve. Refer to text for procedure.

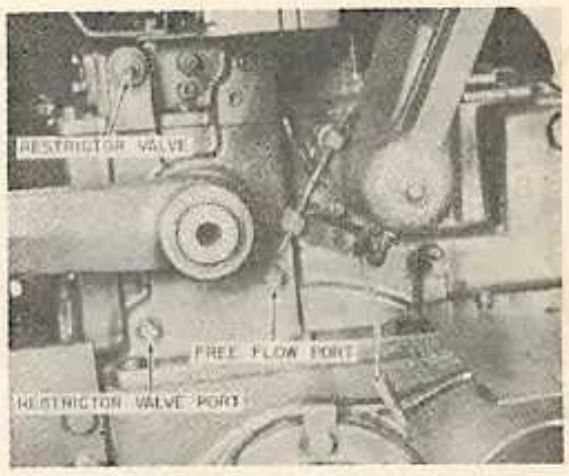
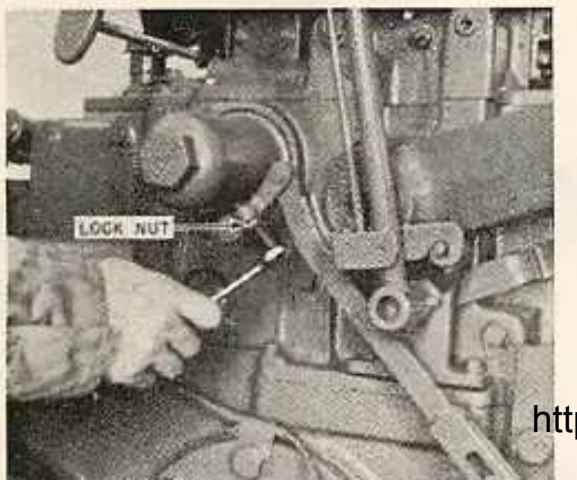
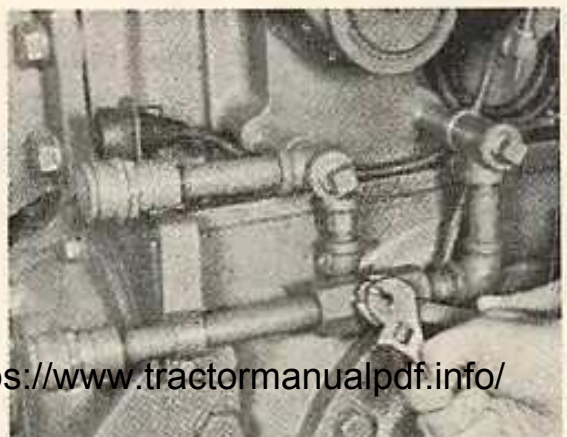


Fig. O149 — View showing location of restrictor valve port and free flow port for Hydra-Lectric control unit on right side of tractor; free flow port is at rear and restrictor port is at front on left side of unit.





single acting remote cylinder or to the base end of a double acting cylinder must be connected to the restricted outlet.

Location of the restrictor valve adjusting screw for the left Hydra-Lectric circuit is shown in Fig. O147.

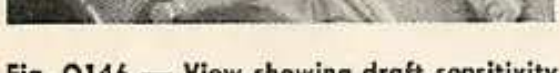


Fig. O146 — View showing draft sensitivity adjustment on Series 1600 models. Adjustment on Series 1650 models is similar except that screw is adjusted against stop instead of the hydraulic oil filter body.

Fig. O148 — Adjusting the auxiliary Hydra-Lectric restrictor valve on models so equipped. Refer to text for procedure.

237. **DRAFT SENSITIVITY.** Refer to Fig. O146. For position control only, loosen lock nut on cap screw in draft signal lever and turn the cap screw in against oil filter (or stop on Series 1650). When this adjustment is completed, the pin in upper end of draft signal arm attached to lower link support should be against front end of slot in draft signal link on Utility models, or against rear end of slot in draft signal link on all other models. Do not adjust the cap screw so that pin applies tension or pressure on the draft signal link.

On Series 1650 and late production Series 1600, lower link supports have three attaching points for the lower (draft) links. For position control only, attach the lower links in the bottom hole in supports on Utility models only, and in the upper hole in supports on all other models.

For draft control, loosen lock nut (Fig. O146) and back cap screw out until there is ¾-inch clearance between oil filter (Series 1600) or stop (Series 1650) and end of cap screw; then tighten the lock nut. Also, on Series 1650 and late production Series 1600, the lower links must be attached to the middle or upper set of holes in supports on Utility models, or in the middle or lower set of holes on all other models. Attaching the lower links in the upper set of holes on Utility models, or in the lower set of holes on all other models, provides maximum draft sensitivity. Attaching the lower links in the middle set of holes provides medium draft sensitivity on all models. Lower link supports on early Series 1600 have only one hole for attaching the lower links.

238. **RESTRICTOR VALVE.** A restrictor valve is located in one of the remote outlets of each Hydra-Lectric control unit. Refer to cross-sectional view of Hydra-Lectric control unit in Fig. O141. The hose attached to a Adjusting screw for right circuit is located diagonally across the Hydra-Lectric control unit on right side of tractor. Note: Before making any adjustment to the restrictor valve, remove load from remote cylinder.

If bouncing or jerking is encountered or system relief valve blows when a remote cylinder is being contracted, refer to Fig. O147 and adjust the restrictor valve on side of control unit to which the remote cylinder hose is connected. To minimize bouncing or jerking, loosen the lock nut and turn the adjusting screw in (clockwise) to increase the restriction. If too much restriction results in the system relief valve blowing when the cylinder is being contracted, loosen the lock nut and turn the adjusting screw out (counterclockwise) as necessary to prevent blowing of the relief valve. Tighten the lock nut after making adjustment.

239. **AUXILIARY RESTRICTOR VALVE.** An externally mounted valve is available for installation when it is desirable to restrict return flow of oil from the rod end of a remote cylinder. See Fig. O148. When installing an auxiliary restrictor valve, be sure that the arrow embossed on valve body points toward the valve port in hydraulic housing and that the valve is installed in the line connected to the free-flow port; see Fig. O149.

When equipped with an auxiliary

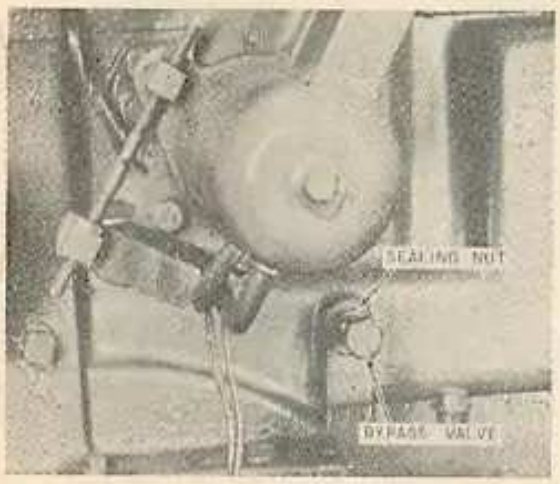
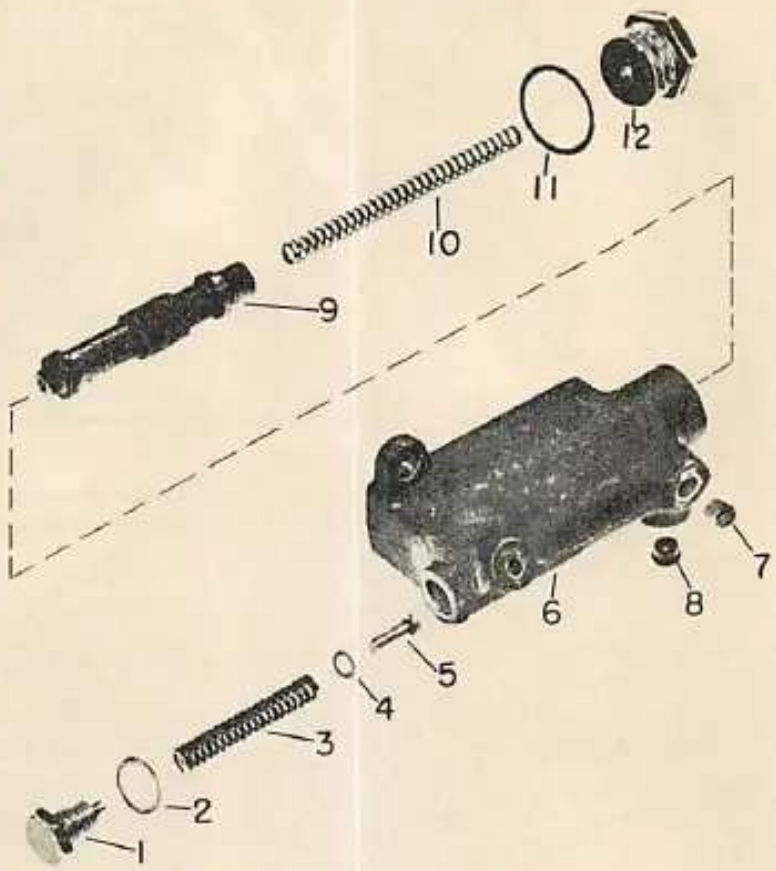


Fig. O150 — View showing location of bypass valve on right side of hydraulic housing. Refer to text for adjustment information.

Fig. O152 — Exploded view of flow divider valve assembly. Valve is mounted on front end of the hydraulic housing on Series 1600 models and on left side of hydraulic housing on Series 1650 models.

1. Relief valve plug
2. Sealing washer
3. Spring
4. Shims
5. Plunger
6. Valve body
7. Pipe plug
8. Tubing seat
9. Flow divider spool
10. Spring
11. Crush washer
12. Plug



out five to six turns. Refer to Fig. O150. When using a double-acting re- registering at least 2000 psi. Start engine and bring hydraulic fluid to per-

Fig. O151 — Adjusting the interlock bleed screw. Refer to text for adjustment procedure.

restrictor valve, the control unit restrictor valve for the base end of the cylinder and the auxiliary restrictor valve for the rod end of the cylinder should be adjusted for as nearly equal restriction as possible. If restriction is too great, system relief valve will blow when remote cylinder is being actuated.

To adjust the auxiliary restrictor valve, remove load from remote cylinder, refer to Fig. O148 and proceed as follows: Loosen the lock nut and turn the adjusting screw in to increase restriction or out to reduce restriction, then tighten the lock nut. When properly adjusted, the remote cylinder should extend or retract smoothly at engine high idle speed. If relief valve blows, back adjusting screw out to reduce restriction. Refer also to paragraph 238.

240. **BY-PASS VALVE.** When using a single-acting remote cylinder, the by-pass valve lock nut must be loosened and the adjusting screw backed out three full turns. When operating a double-acting remote cylinder, the by-pass valve adjusting screw must be turned in tight.

The by-pass valve is a steel ball (16—Fig. O156) which is retained in the lift cylinder (14) by a snap ring (17). Turning the adjusting screw (18) in tight holds the by-pass valve ball seated.

241. **INTERLOCK BLEED SCREW.** When using a single-acting remote cylinder, the interlock bleed screw (see cross-sectional view of Hydra-Lectric control unit in Fig. O141) on the side of the unit to which the cylinder is connected must be backed out three full turns. When operating a double-acting remote cylinder, the interlock bleed screw, or screws, must be turned all the way in. Fig. O151 shows location of the interlock bleed screw on right side of tractor; interlock bleed screw on left side of tractor is located diagonally opposite on left side of unit.

242. **SYSTEM OPERATING PRESSURE.** The hydraulic system pressure relief valve should open (cracking pressure) at 1750 psi and provide a full flow relief pressure of 1500-1600 psi. To check system relief pressure, remove the drain plug (refer to Fig. O143 for Series 1600, Fig. O144 for Series 1650) and insert gage capable of reading 2000 psi in the hydraulic system. Start engine and bring hydraulic fluid to normal operating pressure. If equipped with Hydra-Lectric control unit, overload the system by placing a remote control lever in a power position. If not equipped with Hydra-Lectric remote control unit, temporarily shorten the linkage for the 3-point hitch (refer to paragraph 236 and Fig. O145) so that there is no free travel of lift arms and overload the system by placing the control lever in fully raised position. With the engine running at 2000 RPM, gage reading should be 1500 to 1600 psi.

If full flow relief pressure is not within the range of 1500 to 1600 psi, record the gage reading and readjust pressure as follows: Remove the relief valve plug (51—Fig. O154) located at right front corner of the hydraulic housing and withdraw the spring (49), shims (48) and plunger (47). Add or remove shims (48) as necessary to obtain correct relief pressure. Each shim will change the relief pressure approximately 75-100 psi. Renew the sealing "O" *ring (50)* when reinstalling plug (51). Readjust linkage as outlined in paragraph 236, if necessary.

243. **FLOW DIVIDER VALVE RELIEF PRESSURE.** A relief valve within the flow divider valve assembly (see Fig. O152) controls pressure of hydraulic fluid flowing to the

power steering system and/or hydraulic oil cooler.

On early Series 1600 models (prior to Serial No. 141 288) equipped with a single vane Hydramotor unit, flow divider valve relief pressure should be 1150 to 1250 psi. On late Series 1600 and all Series 1650 models equipped with dual vane Hydramotor, flow divider valve relief pressure should be 1450-1550 psi. On models not equipped with power steering, flow divider relief valve pressure is not of importance as the fluid is merely circulating through the hydraulic oil cooler.

To check flow divider valve relief pressure, remove the plug (7) adjacent to the pressure line to power steering connection and insert a 2000 psi capacity hydraulic gage. With the hydraulic fluid at normal operating temperature and engine running at 2000 RPM, turn the front wheels in either direction against stop and observe gage pressure.

To adjust flow divider relief pressure, refer to Fig. O152, remove the relief valve plug (1), spring (3) and plunger (5) and add or remove shims (4) as necessary to bring relief pressure to specified value. Each shim will change the relief pressure approximately 75-100 psi. Renew the sealing "O" *ring (2)* when reinstalling plug (1).

FLOW DIVIDER VALVE

244. **R&R AND OVERHAUL.** Refer to Fig. O152 and proceed as follows: Disconnect the pressure tube from the flow divider valve, then unbolt and remove the valve assembly from front end of hydraulic housing on Series 1600 models, or from left side of hydraulic housing on Series 1650 models.

Unscrew plug (12) and withdraw spring (10) and flow divider spool (9). Spool should slide smoothly in its bore and be free of any nicks or burrs. Free length of spring (10) is 4$\frac{13}{32}$ inches and spring should exert 13 to 15 pounds force when compressed to a length of 3$\frac{3}{8}$ inches. Renew spring if it does not meet specifications or any defects are noted. Lubricate the valve spool and reinstall spool and spring. Reinstall plug (12) with new crush washer (11).

Unscrew plug (1) and withdraw spring (3), shims (4) and plunger (5). If spring is unpainted, it should be renewed using a Field Package, Oliver Part No. 157 958-AS if tractor is equipped with a single vane Hydramotor steering unit or Oliver Part No. 158 315-AS if tractor is equipped with a dual vane Hydramotor steering unit. The Field Package includes a new

housing and the two nuts from pump mounting studs. Lift pump and manifold from hydraulic housing.

246. **OVERHAUL.** With the pump and manifold removed as outlined in paragraph 245, remove cap screws and separate pump and manifold. Refer to Fig. O153 and proceed as follows: Place a scribe mark across front plate, body and back plate to insure proper assembly. Place pump in a vise and remove cap screws (2) which hold pump together. Remove pump from vise and while holding pump in hands, bump drive shaft against wood block and separate pump. If body (6) remains with either front plate (13) or back plate (1), remove by tapping with a soft faced hammer, or by installing drive shaft in bearing and bumping shaft. Removal of diaphragm (7), spring (11), ball (12), gaskets and oil seal (14) is obvious.

Clean all parts and inspect as follows: Check pump shafts for wear or scoring and if diameter of shafts at bearing area is less than 0.685, renew shafts and gears as they are not available separately. Measure gear width and if less than 1.107, renew shaft and gear assembly. Measure inside diam-

sure within the desired limits. NOTE: Three different pressure relief valve springs (3) have been used in the flow divider valve assembly. Early units were equipped with an unpainted spring and were adjusted to 1000 psi; later units were equipped with a blue painted spring and were adjusted to 1200 psi; latest units are equipped with a purple painted spring and are adjusted to 1500 psi, and the latest valve assembly is identified by "1500" stamped on the relief valve plug. If an early unit with unpainted relief valve spring is encountered, power steering performance can be improved by renewing the spring using Field Package (see paragraph 244) containing a blue or purple spring depending on whether the tractor is equipped with a single or dual vane power steering Hydramotor unit. Refer to paragraphs on Hydramotor steering unit in POWER STEERING section of this manual for means of identifying single or dual vane Hydramotor unit. CAUTION: Do not adjust flow divider relief valve pressure higher than 1250 psi when tractor is equipped with single vane Hydramotor unit, or higher than 1600 psi when equipped wth dual vane Hydramotor unit.

The Field Package includes a new hardened relief valve seat, a new blue coded spring (in Part No. 157 958-AS) or purple coded spring (in Part No. 158 315-AS) and adjusting shims. Check the relief valve spring against the following values:

Part No. 157 875-A (Painted Blue):
Free length.....$2\frac{27}{32}$ in.
Lbs. pressure @ 2¼ in.....59

Part No. 157 953-A (Painted Purple):
Free length.....2¾ in.
Lbs. pressure @ 2¼ in.....74

The relief valve seat is serviced only in the Field Packages mentioned in previous paragraph or as an assembly with the valve body (6). When valve is reassembled and reinstalled on tractor, check relief pressure as outlined in paragraph 243 and adjust by adding or removing shims (4) as necessary.

PUMP

245. **REMOVE AND REINSTALL.** The hydraulic pump and the pump manifold are removed as a unit as follows: Remove the hydraulic lift unit as outlined in paragraph 253. Remove the cylinder and piston assembly, then remove the two cap screws which retain manifold to hydraulic

eter of bearings and if greater than 0.691, renew complete front or back plate as bearings are not available separately. Bearings should be flush with pattern islands. If wear or scoring in face of back plate exceeds 0.0015, renew back plate. Measure gear pockets of body (6) and if diameter exceeds 1.719, renew body.

When reassembling, use of repair kit which contains new diaphragm, diaphragm seal, back-up gasket, protector gasket, shaft oil seal, back plate "O" ring, check ball and spring is recommended. Note: Check ball and spring are not used in Series 1650 pump or in late Series 1600 pump. Also, install new manifold "O" rings which are not included in the repair kit.

Lubricate all parts with oil and reassemble pump as follows: Install new shaft seal in front plate with lip of seal towards inside of pump. Using a dull tool, tuck diaphragm seal into grooves in front plate with "V" section of seal down. Press the protector gasket, and then the backup gasket into diaphragm seal. These gaskets must be pushed as far down into the grooves as possible and be completely inside the seal lip. On early pump

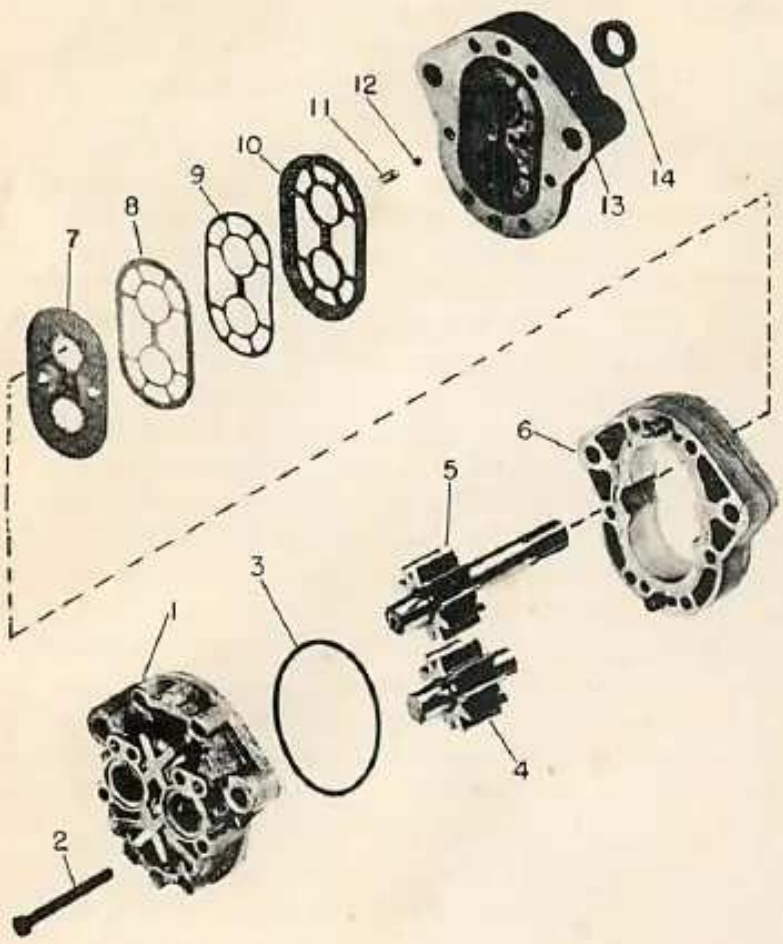


Fig. O153 — Exploded view of the hydraulic pump assembly. Check ball (12) and spring (11) are used on early Series 1600 pump assembly only.

1. Rear plate
2. Capscrews
3. "O" ring
4. Idler gear
5. Drive gear
6. Pump body
7. Diaphragm
8. Backup gasket
9. Protector gasket
10. Diaphragm seal
11. Spring
12. Check ball
13. Front plate
14. Shaft seal

249. **R&R PUMP DRIVE PINION.** Remove hydraulic housing as outlined in paragraph 253. Remove the PTO shaft (Series 1600) as outlined in paragraph 221, or on Series 1650, as outlined in paragraph 226, or on models having no PTO, remove hydraulic pump drive shaft as outlined in paragraph 248. Remove snap ring from rear side of pinion bearing (24—Fig. O120) and bump pinion and bearing rearward out of housing wall. Remove snap ring (25) from rear of pinion hub and press bearing from pinion (22).

When reinstalling, lubricate bearing and install pinion gear with long hub on rear side.

HYDRA-LECTRIC CONTROL UNIT

The Hydra-Lectric control unit serves as a top cover for the hydraulic unit and contained within it are the control valve spools, interlock assemblies, restrictor valves, interlock bleed screws and the Hydra-Lectric switches and solenoids. Refer to Fig. O159 for an exploded view of the unit and to Fig. O141 for cross-sectional view.

250. **R&R AND OVERHAUL.** Remove the seat and tool box, then

only, drop steel ball into seat in suction side of front plate and place spring on top of ball; spring and ball are not used in late pump assemblies. Place diaphragm, with bronze side up, on top of backup gasket so that smaller hole in diaphragm is over the ball and spring, or on late pumps, towards suction side of front plate. Press diaphragm down into seal and be sure seal lip completely encircles diaphragm.

Dip the gear assemblies in oil and install through diaphragm and front plate; take care not to damage shaft seal when installing drive gear. Apply a thin coat of heavy grease to milled surfaces of body and front plate and install body over the gears with side having smallest port cavity openings toward the front plate. Place large "O" ring in the irregular groove in back plate, apply a thin coat of heavy grease to the "O" ring and milled surfaces of back plate and pump body, then install back plate. Tighten the retaining cap screws to a torque of 27-30 Ft.-Lbs. Install manifold with new "O" rings and tighten the manifold retaining cap screws to a torque of 14-15 Ft.-Lbs.

After pump is assembled, torque required to turn pump drive shaft should not exceed 3½ Ft.-Lbs. and after pump is installed in hydraulic housing, torque required to turn pump drive shaft should not exceed 4 Ft.-Lbs.

HYDRAULIC PUMP DRIVE SHAFT AND PINION

247. The hydraulic pump is driven from an idler gear which is in turn driven from a pinion gear mounted in the wall which separates the final drive and transmission compartments. This internally splined drive pinion (22—Fig. O120) is driven by the pto shaft on tractors so equipped, or by a separate shaft (80—Fig. O154) on those tractors having no power take-off. Refer to PTO section for information on the PTO shaft and to paragraph 249 for information on pinion gear.

248. **R&R PUMP DRIVE SHAFT.** Remove cap screws that retain bearing carrier (86—Fig. O154) to rear frame or rear frame cover and pull carrier and shaft assembly from tractor rear frame. Remove snap ring (82) from rear end of shaft and remove bearing (83) from shaft.

When reinstalling shaft assembly in tractor, it may be necessary to engage starter momentarily to engage splines of shaft and flywheel.

unbolt and remove the Hydra-Lectric control unit from hydraulic lift housing.

Remove the interlock valve guide retainers (50—Fig. O159) and turn unit bottom side up. Identify and disconnect the wires from terminals in housing. Remove solenoid cap (75), then disconnect the wires from switches and remove switches from bracket and tube assembly (64). Remove the solenoid springs (74) and the solenoid plungers (70). Overtravel springs are riveted to plungers and should not be removed. If spring is defective, renew complete plunger assembly. Also, do not remove the small positioning roll pins from solenoid spring unless necessary. Remove the bracket and tube assembly (64), solenoids (63) and two small ¼-inch steel balls (71) from their recesses in the housing.

Drive roll pins (11) from inner ends of spools, remove end plate (1), then remove snap rings from spool bores and push spools out rear of housing. Centering spring (8), washers (7) and travel limiter (9) can be removed from spool, if necessary, by removing snap ring (6). Grasp stem of rear interlock valve guides (14) with a pair

preset at the factory to relieve at 4400-5100 psi and are non-adjustable. A faulty valve is renewed as an assembly.

251. Clean and inspect housing bores, valve spools and all other parts for scoring, nicks or other damage. Spools and interlock plungers should be a snug fit in bores, yet slide freely. Check all springs for fractures or other damage. Check wiring, solenoids and terminals for damage. Check switch action and continuity. If deemed necessary, resistance of solenoid can be checked with an ohmmeter. Solenoid should show approximately 4 ohms resistance.

252. Reassemble by reversing the disassembly procedure. Coat all working parts with engine oil to provide initial lubrication. Coat all "O" rings and seals with heavy grease to prevent damage during installation and be sure to use new "O" rings, gaskets and seals.

NOTE: If a new control housing is being installed, be sure the two ¼-inch steel sealing balls are installed. One is located in right top side of housing directly above the right interlock bleed screw and the other in left lower mounting surface directly below left interlock bleed screw. If necessary, drive the steel balls into housing and peen around the outside area to retain balls in

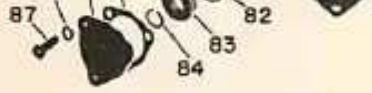


Fig. O154 — Exploded view of the hydraulic housing used on Series 1600 models. Series 1650 hydraulic housing is similar except oil filter (1) is located on front end of housing and flow divider valve assembly is located on left side of housing. Cover (6) shown is used on units not equipped with Hydra-Lectric control unit; refer to Fig. O159 for the Hydra-Lectric unit. On models not equipped with three-point hitch, rockshaft holes are closed with plugs (63).

1. Oil filter body
2. "O" ring
3. Spring
4. Retainer
5. Filter element
6. Cover
11. Dipstick
12. "O" ring
13. Tube
15. Cap
17. Breather element
18. Cup
19. Gasket
20. Baffle
21. Gasket
22. Cap
23. Gasket
24. Insert
25. "O" ring
26. "O" ring
27. Flow divider valve
30. Plug
31. Snap ring
32. Snap ring
33. Carrier
34. Bearing
35. Pinion
36. Plug
37. Dowel
38. Support
41. Washer
42. Gear
43. Bearing
44. Snap ring
45. Washer
46. Seat
47. Plunger
48. Shims
49. Spring
50. "O" ring
51. Retainer
52. Gasket
53. Pump assembly
55. Copper washers
56. "O" ring
57. "O" ring
58. Pump manifold
62. Dowels
62A. Crush washer (w/o 3-pt. hitch)
63. Plug
64. Plug
65. Plug
66. Plug
67. Hydraulic housing
72. Plug
73. ¼ x 4 in. pipe
74. "O" rings (4)
75. Connectors (2)
76. Oil filter by-pass valve
77. Spring
78. Dowels
79. Gaskets
80. Drive shaft
81. Oil pan
82. Snap ring
83. Bearing
84. Snap ring
85. Gasket
86. Retainer

of pliers and pull from housing. Remove spring (17) and check ball (15). Use a soft drift of not more than ½-inch diameter and drive front valve guide (14), spring (17), check ball (15), valve seat (18) and plunger (20) forward out of housing. Work from front of housing and bump valve seat (18) from housing.

Restrictor valves and interlock bleed screws can be removed at any time and the procedure for doing so is obvious.

The two (early models) or four (late models) thermal relief valves (59) located in bottom side of cover (21) can be removed and inspected if necessary. Thermal relief valves are

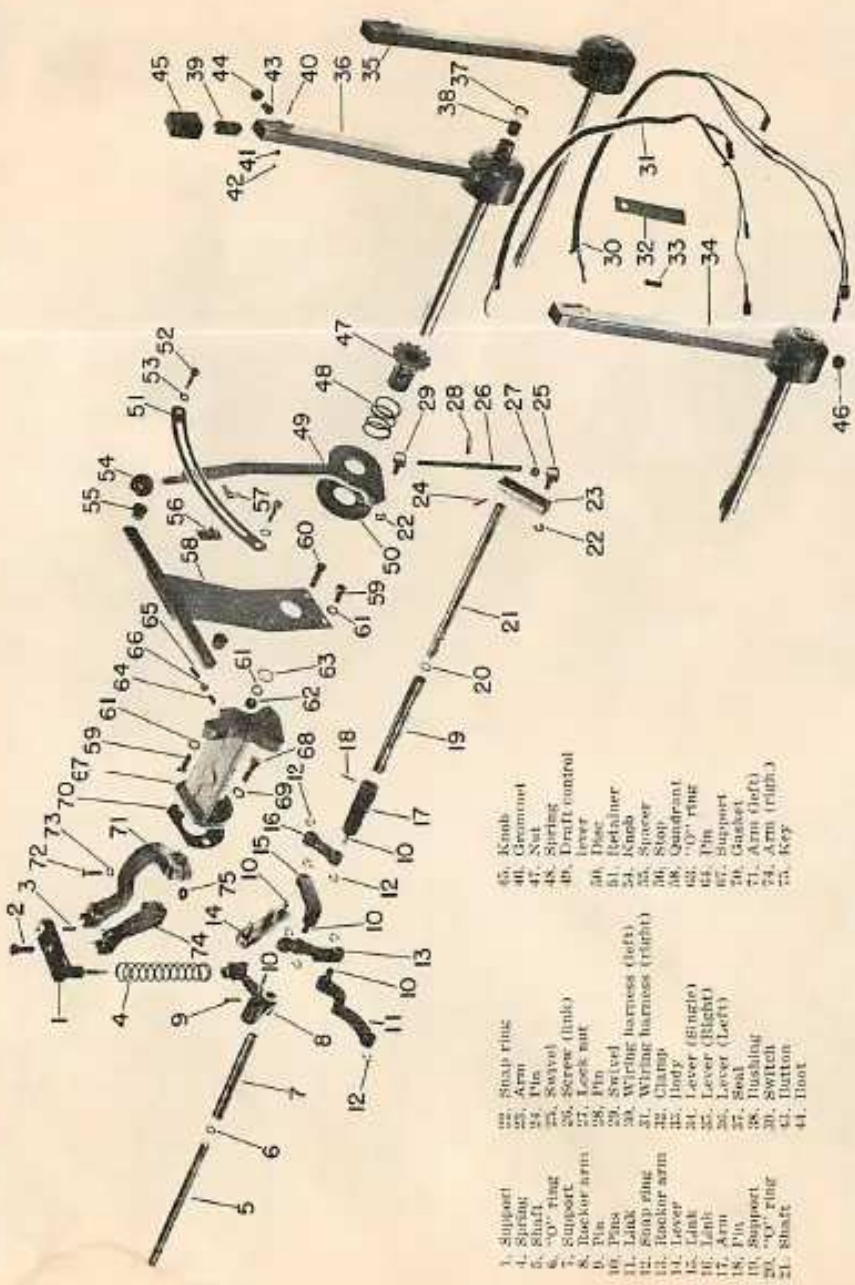
position.

After assembly, be sure to check operation of solenoid switches by actuating valve spools. A click should be heard when spools are moved either way. Be sure that all six passage connectors (56—Fig. O159) are in place before installing control unit to hydraulic housing.

HYDRAULIC HOUSING

The hydraulic housing (67—Fig. O154) contains the hydraulic pump and manifold, servo valve and control lever linkage along with the rockshaft and its operating mechanism. The type of hydraulic system will determine what components are included in the hydraulic housing as well as whether a cover (6) or the Hydra-Lectric control unit shown in Fig. O159 is used as a top cover.

Everything except the hydraulic pump, manifold, piston rod and the piston and cylinder assembly can be serviced without removing the hydraulic unit from tractor.



1. Support
4. Spring
5. Shaft
6. "O" ring
7. Support
8. Rocker arm
9. Pin
10. Pins
11. Link
12. Snap ring
13. Rocker arm
14. Lever
15. Link
16. Link
17. Arm
18. Pin
19. Support
20. "O" ring
21. Shaft
22. Snap ring
23. Arm
24. Pin
25. Swivel
26. Screw (link)
27. Lock nut
28. Pin
29. Swivel
30. Wiring harness (left)
31. Wiring harness (right)
32. Clamp
33. Body
34. Lever (Single)
35. Lever (Right)
36. Lever (Left)
37. Seal
38. Bushing
39. Switch
43. Button
44. Boot
45. Knob
46. Grommet
47. Nut
48. Spring
49. Draft control lever
50. Disc
51. Retainer
52. Spacer
53. Stop
54. Gasketset
55. Spacer
56. Stop
58. Gasketset
62. "O" ring
63. Pin
66. Support
70. Gasket
71. Arm (left)
72. Arm (right)
75. Key

Fig. O155 — Exploded view of hydraulic control linkage used on models equipped with draft control (3-point hitch) and two Hydra-Lectric control valves for remote cylinders. A dash pot piston (37—Fig. O156) is attached to arm (8). Arms (71 and 74) are connected to the Hydra-Lectric control valves and lever (114) is connected to the servo valve pilot spool.

hydraulic housing and remove oil pan (81). Now set unit on a bench, or preferably, mount unit on an engine stand if complete overhaul is anticipated.

Reinstall by reversing the removal procedure.

CONTROL LEVERS AND LINKAGE

254. **R&R AND OVERHAUL.** The Hydra-Lectric and draft control levers assembly can be removed as follows. Right fender must be in outermost position (or removed), then remove the Hydra-Lectric control unit as outlined in paragraph 250. Refer to Fig. O155. Remove the cap screws and keys from control arms (71 and 74) at inner ends of Hydra-Lectric lever shafts and remove control arms. Pull retaining rings (22) from swivels of adjusting link (screw) (26) and remove link from draft control lever (49) and external servo valve control arm (draft control arm) (23). Remove cap screws which retain the lever support (67) to hydraulic housing and pull support and levers assembly from hydraulic housing. Drive roll pin (9) from draft control shaft inner arm (8), pull shaft from support and remove arm. Balance of internal linkage can be removed after removing the actuating rocker arm spring support (1) and spring and servo valve. Draft control shaft support (19) and actuating rocker shaft support (7) can be removed from hydraulic housing if necessary.

When installing new draft control shaft support, drive support into housing until it protrudes about 3⅛-inch inside housing. When installing new actuating rocker arm pivot, install with ring groove toward inside and drive pivot into housing until rocker arm (16) operates freely on pivot with the retaining ring installed.

Any further disassembly and/or overhaul of the levers assemblies or linkage is obvious.

SERVO VALVE

255. **R&R AND OVERHAUL.** To remove and overhaul the servo valve first drain hydraulic unit, then remove hydraulic housing cover or the Hydra-Lectric control unit as outlined in paragraph 250. Remove the actuating rocker support (1—Fig. O155) and spring, then unbolt and remove servo valve.

NOTE: A production change has been made in the servo valve. Refer to Fig. O157 for exploded view of early valve assembly and to Fig. O158 for exploded view of late valve assembly. As the valves are basically similar, the following procedures will refer to Fig. O157 only. On late valves disregard reference to the two check valve units; only one is used as shown in Fig. O158.

With servo valve removed it can be disassembled as follows: Refer to Fig. O157 and push pilot spool (4) in as far as possible; then tap lightly to bump out retainer (32). Remove pilot spool assembly from body (13), then remove nuts and retainer (32), drive out roll pin (7) and remove spring (5) from pilot spool. Remove plug (1), spring (2) and snap spool (3). Remove snap ring (8), install a cap screw in plug (9) and pull plug. Remove lowering spool (11) and spring (12). Remove the two check valve caps (20), springs (22) and balls (18). Remove cap (27), then remove spring (26), ball (17) and lowering valve pin (25) from body. Remove cap (28), spring (30) and flow control spool (31).

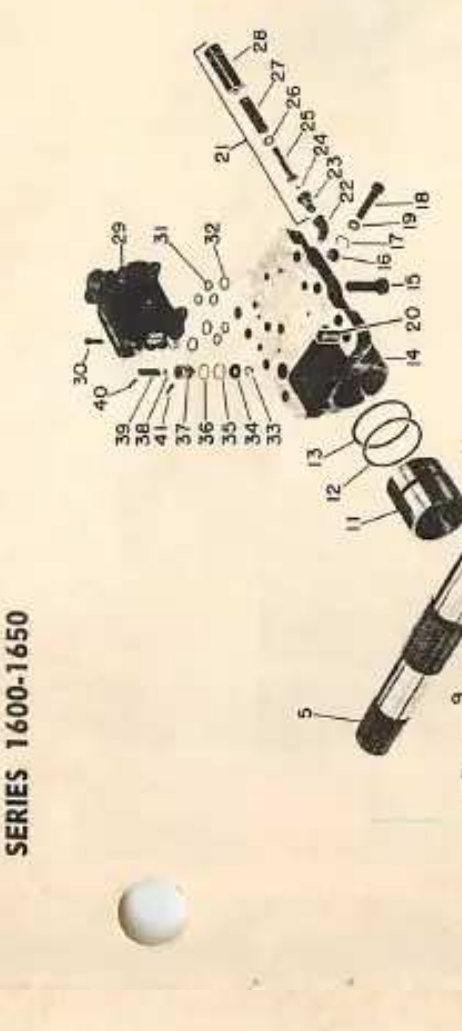


Fig. O156 — Exploded view of rockshaft and rockshaft lift cylinder with related parts. Exploded view of servo valve (29) is shown in Fig. O157 (early) or Fig. O158 (late production). Dash pot piston (37) is connected to rocker arm (8—Fig. O155) with link (39), and works in bore drilled in lift cylinder housing (14). Cylinder safety valve assembly is (21).

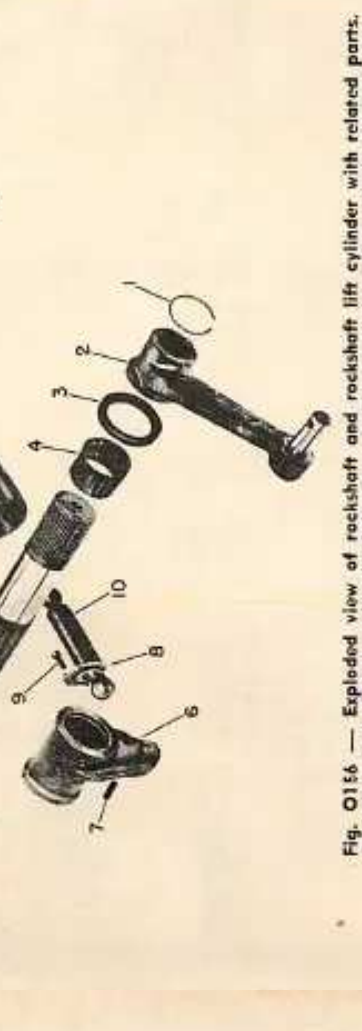


Fig. O157 — Exploded view of early servo valve (3-point hitch control valve). Late production valve (see Fig. O158) has redesigned snap spool (13) which eliminates need of extra check valve (18) shown at upper left side of valve body (13).

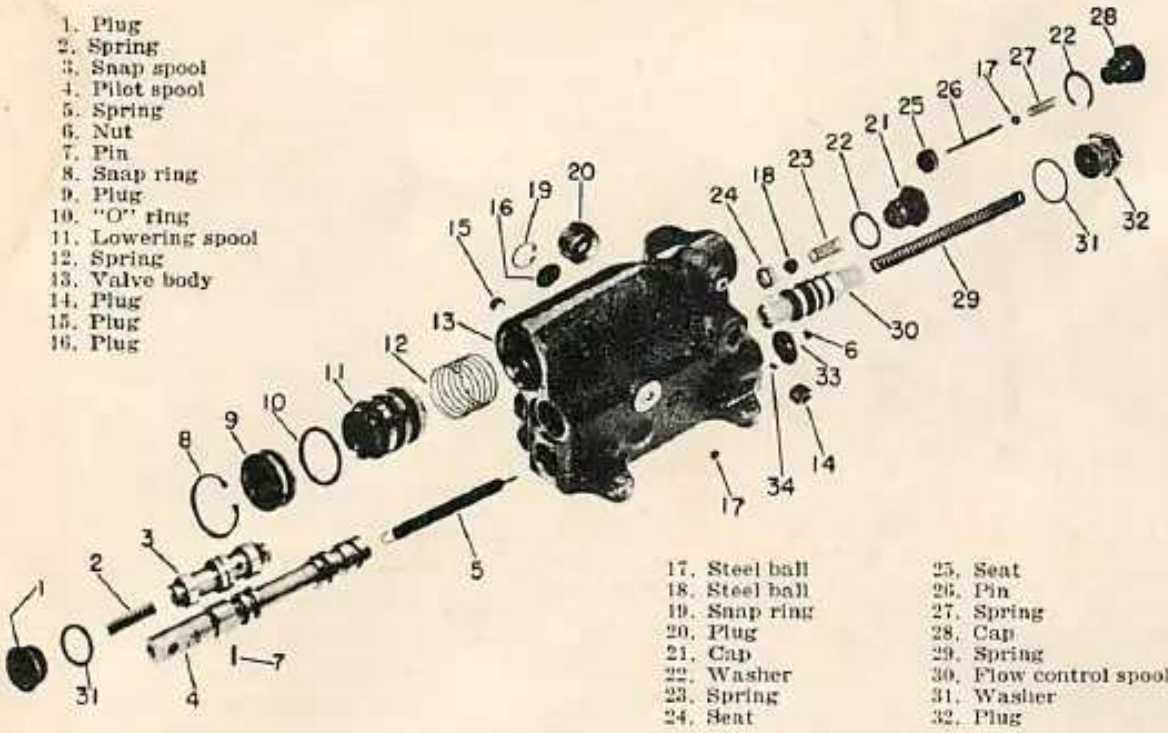


Fig. O158 — Exploded view of late production servo valve assembly. Refer to Fig. O157 for early valve unit. Lowering spool (11) operates check valve ball (17) via the pin (26).

250. To provide removal clearance, remove either fender and the tire and wheel. Refer to Fig. O156. Disconnect lift links, then remove snap rings (1) from outer ends of rockshaft and remove lift arms (2). Use a soft faced hammer and bump rockshaft out of housing and rocker arm (6).

Note: This operation will force oil seal (3) and bushing (4) out on the side rockshaft is being removed from. The seal will be damaged and will require renewal, however, bushing can be salvaged if caution is used. Opposite oil seal and bushing can now be removed, if necessary. Rocker arm can be removed after disconnecting piston rod (10) and the rocker arm feed-back link.

When reinstalling, insert rockshaft from side of housing that has no bushing, align blind splines of rockshaft and rocker arm and slide rockshaft into position. Use Oliver driver No. ST-144, or equivalent, and install bushing. Lubricate lip of oil seal and coat outer edge with sealant. Slide seal over rockshaft and drive into counterbore.

ROCKSHAFT CYLINDER AND PISTON

257. **R&R AND OVERHAUL.** Refer

14. Guide
15. Steel ball
16. "O" ring
17. Spring
18. Valve seat
19. "O" ring
20. Plunger
21. Housing
24. Plug
25. Gasket
26. Interlock bleed screw
27. Lock nut
28. Support
29. "O" ring
30. Restrictor adjusting screw
31. Spring
32. Plunger
33. Ground post
34. Solenoid post
35. Nuts
36. Insulator
37. Tube
38. "O" ring
39. Dipstick
40. Nut
41. Baffle
42. Cap
43. Gasket
44. Cup
59. Thermal relief valve
63. Solenoid
64. Bracket and tubes
65. Switch
69. Wire
70. Plunger assembly
71. Steel ball
72. Pin
73. Rivet
74. Spring
75. Cap
78. Spacer

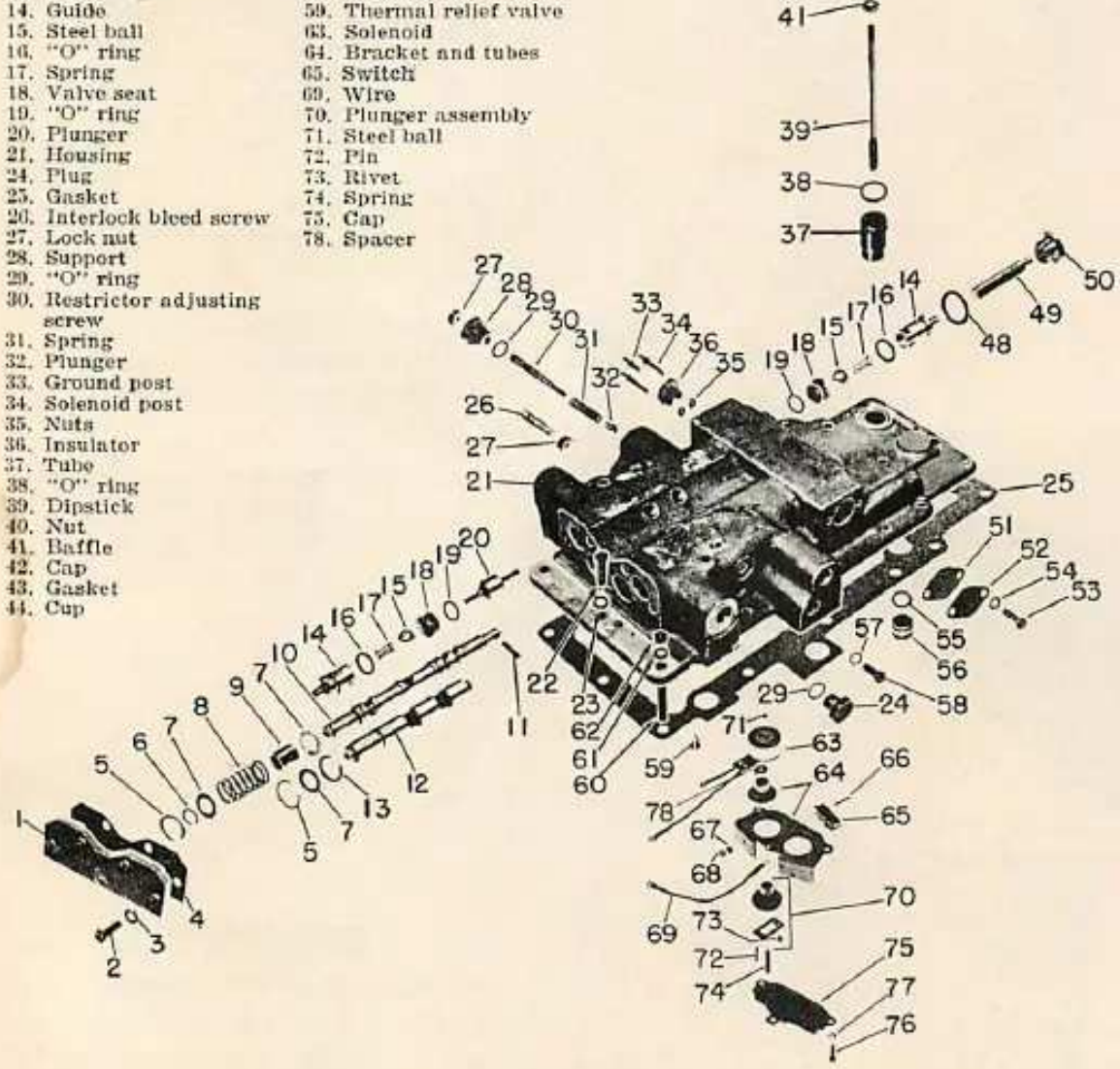


Fig. O159 — Exploded view of Hydra Lectric control unit. Refer to Fig. O141 for cross-sectional view of the unit.

to Fig. O156. The work cylinder and piston assembly can be removed after removing the hydraulic housing as outlined in paragraph 253.

With hydraulic housing and oil pan removed, unscrew the by-pass valve cap screw (18—Fig. O156) from outside of housing until its clears cylinder; then unbolt and remove cylinder (14) and piston assembly. Piston (11) can be removed from cylinder assembly by bumping open end of cylinder on a wood block.

Note: At this time, the oil filter by-pass valve on Series 1600 hydraulic system can be serviced, if necessary. Valve is disassembled by removing the plug located in the left rear of the cylinder mounting flange.

Piston rod can be removed after removing the piston rod retainer.

When reassembling, be sure piston "O" ring (13) is on pressure side, that is, toward closed end of piston and leather backup ring (12) is towards open end of piston. Grease "O" ring prior to installation into cylinder.

DRAFT CONTROL ACTUATING ASSEMBLY

258. This part of the hydraulic lift (three-point hitch) is located in the bottom rear of the tractor rear main

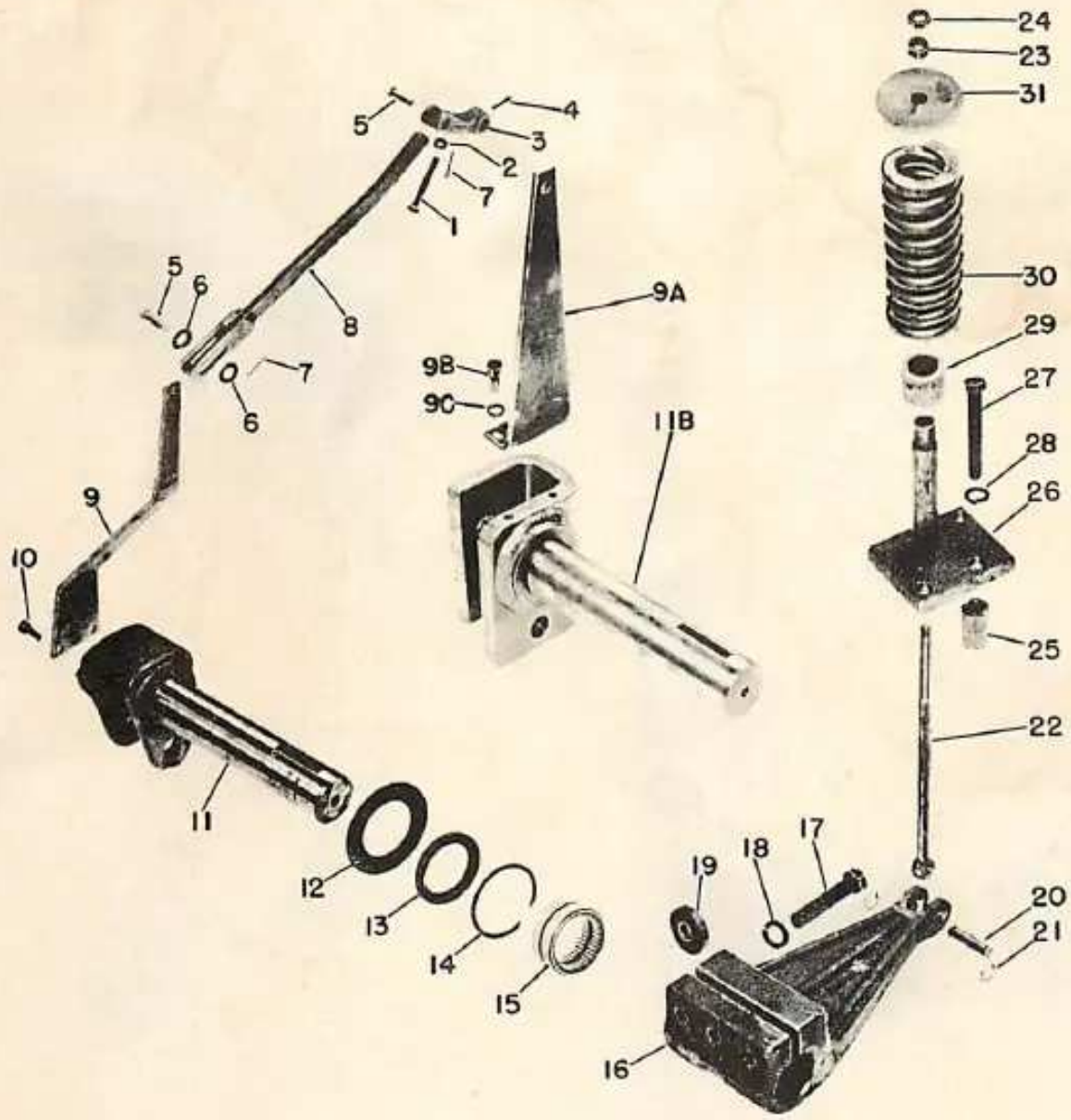


Fig. O160 — Exploded view of draft control actuating assembly used on all tractors equipped with draft control (3-point hitch) except Utility models. Refer to Fig. O161 for

(17) and keys (19) and pull lower link supports (11) and thrust washers (12) from rear main frame. Remove actuating arm (16) from rear main frame and, on all except utility models, remove pin (20) and rod (22) from actuating arm. Pry out oil seals (13) remove snap rings (14), then, using suitable driver, remove bearings (15) from housing. Note: Seals will be damaged beyond further use when removing from housing; do not remove seals and/or bearings unless necessary.

Reassemble by reversing removal procedure using Fig. O161 as a guide on Utility models and Fig. O160 for all other models. Adjust draft control spring as outlined in paragraph 260.

260. **ADJUST DRAFT CONTROL SPRING.** On all models, turn nut (23—Fig. O160 or 17—Fig. O161) down until all free play is removed from draft control spring, then continue to tighten the nut an additional 2½ turns, or until spring is compressed ⅛-inch from its free length. Then, tighten the jam nut (24—Fig. O160 or 18—Fig. O161) to retain adjusting nut in this position.

HYRA-LECTRIC (REMOTE) CYLINDERS

draft control actuating assembly used on Utility models.

1. Adjusting screw
2. Lock nut
3. Draft signal lever
4. Pin
5. Pin
6. Washers
7. Pin
8. Link
9. Arm (early)
9A. Arm (late)
11. Lower link support (early)
11B. Lower link support (late)
12. Washer
13. Seal
14. Snap ring
15. Bearing
16. Actuating lever
19. Key
20. Pin
22. Rod
23. Adjusting nut
24. Jam nut
25. Spacers
26. Support
29. Guide
30. Draft control spring
31. Retainer

frame and includes the lower link supports, actuating lever assembly and the draft control spring.

To service these parts, refer to the appropriate sections and remove the pto clutch and drive shaft (Series 1600 models) or the complete pto assembly (Series 1650 models). On Series 1650 models not equipped with pto, remove the rear frame cover. On all models, remove the hydraulic housing.

NOTE: The draft control actuating assembly on Utility models differs from that used on other models in that the lower links impart a counter-clockwise force (as viewed from right side of tractor) to the actuating lever when draft loads are encountered; whereas, on other models, the force is in a clockwise direction. Differences in construction can be viewed in Figs. O160 and O161, and will be noted in the following paragraphs where service procedure is affected.

259. **R&R AND OVERHAUL.** With units removed for access as noted in paragraph 258, refer to Fig. O160 and proceed as follows: Loosen jam nut (24), then remove the jam nut and adjusting nut (23). Remove retainer (31) and spring (30). On utility models, remove retainer (24—Fig. O161) and spacer (26), then withdraw bolt (16) from bottom of main frame. On all other models, remove guide (29—Fig. O160), then unbolt and remove support (26) and spacers (25) from rear main frame. On all models, refer to Fig. O160 and remove cap screws

Hydra-Lectric cylinders are available in three and four inch sizes.

Both size cylinders are similar in construction, with the exception that the cylinder head is bolted to the barrel on three inch cylinders while the four inch cylinder head is retained to the barrel with a snap ring. Any differences in service procedure will be noted.

261. **R&R AND OVERHAUL.** Removal of cylinder for service work is obvious.

Clear fluid from cylinder by moving piston in and out, then thoroughly clean assembly. Remove the 45 degree elbow, pipe nipple and the cable clamp from cylinder. On three inch cylinders, unbolt cylinder head. On four inch cylinders, insert small punch through hole in cylinder barrel and push snap ring out of its groove. Remove snap ring using a small screw driver. Note: It may be necessary to bump cylinder head into barrel slightly to take pressure off snap ring. Use a series of sharp jerks on piston rod and bump cylinder head from barrel. Remove piston lock nut, then remove piston and cylinder head

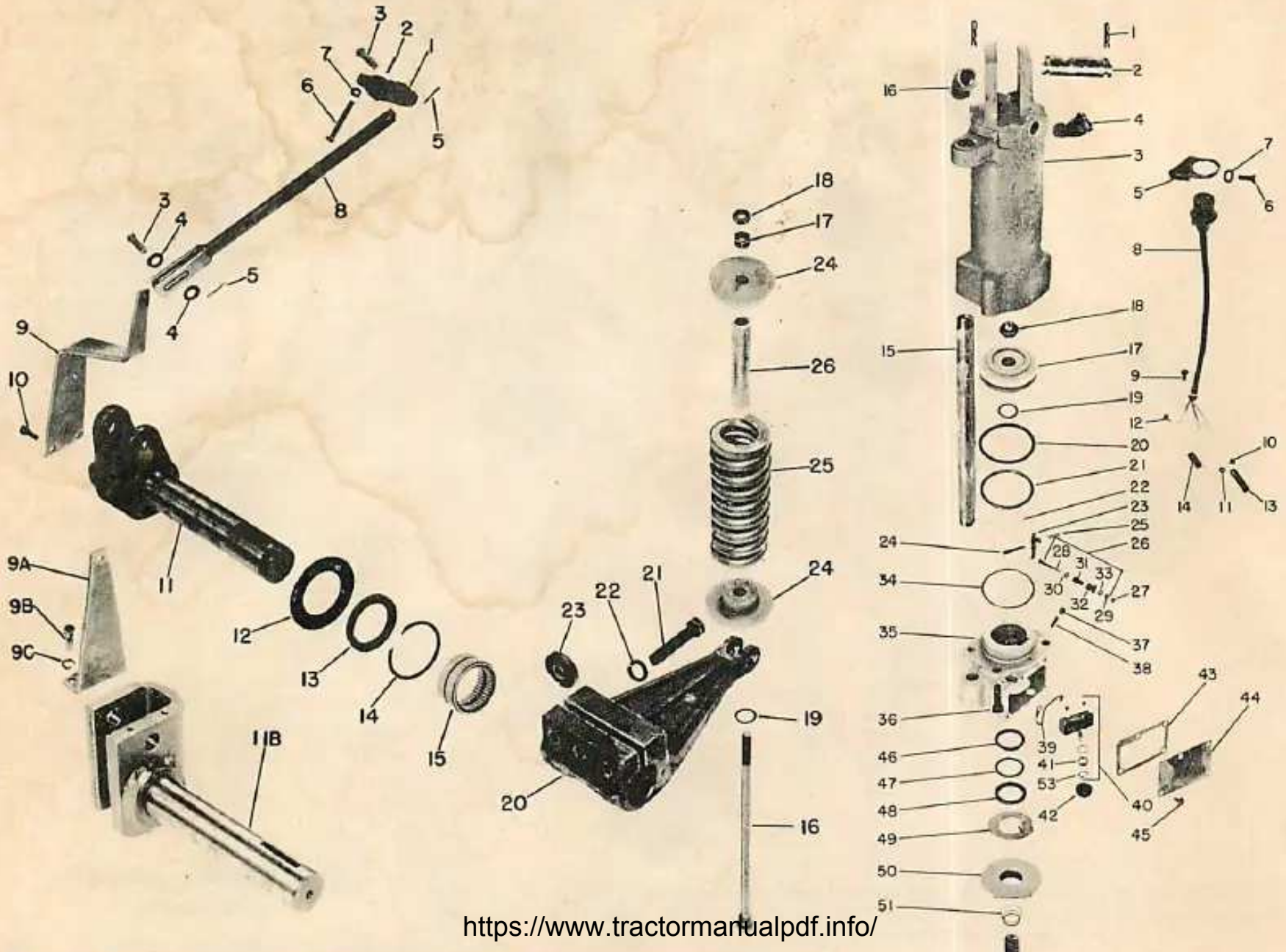


Fig. O161—Exploded view of the draft control actuating assembly used on Utility models.

Fig. O161—Exploded view of the draft control actuating assembly used on Utility models. Refer to Fig. O160 for view of draft control actuating assembly used on other models.

1. Draft signal lever
2. Pin
3. Pin
4. Washers
6. Adjusting screw
7. Lock nut
8. Link
9. Arm (early)
9A. Arm (late)
11. Lower link support (early)
11B. Lower link support (late)
12. Washer
13. Seal
14. Snap ring
15. Bearing
16. Rod
17. Adjusting nut
18. Jam nut
19. Crush washer
20. Actuating arm
23. Key
24. Retainer
25. Draft control spring
26. Spacer

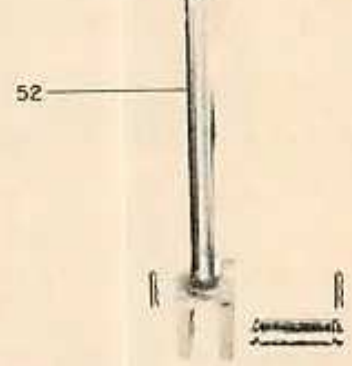


Fig. O162 — Exploded view of 3-inch Hydra-Lectric remote double acting cylinder.

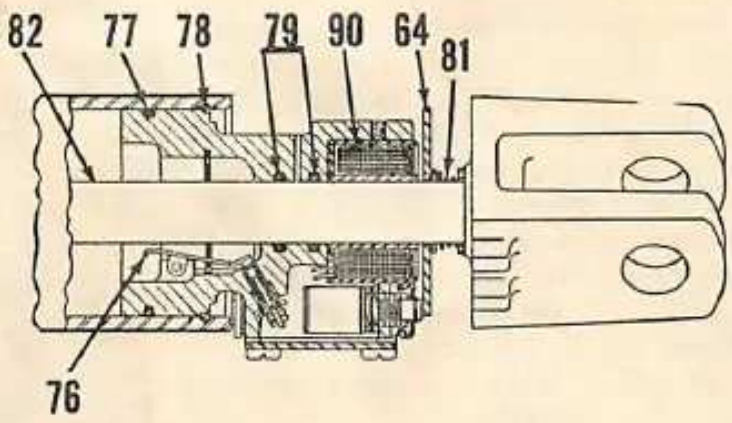
3. Barrel
5. Bracket
8. Cable
13. Tubing
14. Tubing
15. Pipe
17. Piston
18. Nut
19. "O" ring
20. Washer, backup
21. "O" ring
22. Spring
23. Arm
24. Pivot
25. Pivot
26. Terminal assy.
28. Terminal
30. "O" ring
31. Insulator
32. Sleeve
33. Washer
34. "O" ring
35. Head
37. Set screw
38. Pin
39. Wire
40. Switch assy.
42. Boot
43. Gasket
44. Cover
46. Packing
47. Washer
48. Seal
49. Coil
50. Stop
51. Spring
52. Rod

from piston rod. If desired, stop collar and spring can also be removed. "O" rings and back-up washers can now be removed from cylinder head and piston. Remove "Up" switch contact arm outer shaft from cylinder head by pushing on inner end. The four inch cylinder outer shaft has an "O" ring. Remove the "Up" switch contact arm, spring and inner shaft from inside cylinder head. Remove cover from cylinder head, identify and disconnect wire from "Up" switch terminal, then remove the set screw and nylon locking pin which retain "Up" switch terminal and remove terminal. Remove snap ring and rubber boot from "Down" switch, remove switch retaining nut, then pull switch from cylinder head. Identify and disconnect wires and remove switch. Identify and disconnect remaining wires, then loosen solenoid retaining set screw and remove solenoid. On three inch cylinders, the cylinder rod dust seal located directly behind the solenoid can also be removed, if necessary.

Any further disassembly required will be obivous. Clean and inspect all parts and renew any which show signs of undue wear, scoring, or other damage. Use all new "O" rings, gaskets and back-up washers when reassembling. Pay close attention to wiring and renew any that show signs of fraying or other deterioration. Adjust cylinder as outlined in paragraph 262.

Fig. O163 — Cross-section view of 4-inch Hydra-Lectric cylinder. Cylinder head is retained by snap ring (78); whereas 3-inch cylinder head is retained by capscrews as shown in Fig. O162.

64. Stop collar
76. Contact arm
77. "O" ring
78. Snap ring
79. "O" ring
81. Spring
82. Piston rod
90. Solenoid



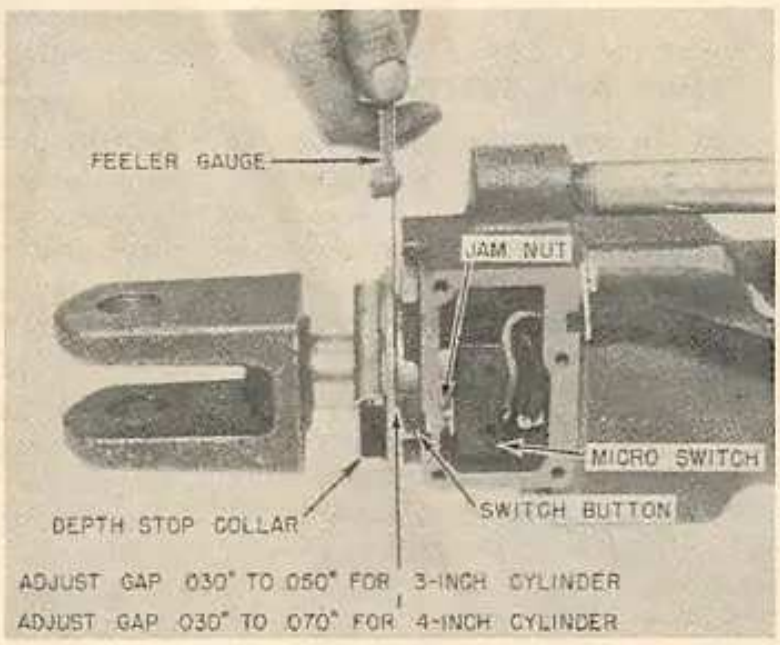


Fig. O164—Position stop collar as shown when adjusting "Down" switch.

Fig. O165 — "Up" switch must be activated when piston is 1/8-inch from cylinder head as shown. Refer to text.

262. CYLINDER ADJUSTMENT. Adjust the Hydra-Lectric "Down" switch as follows: Extend the piston rod a short distance and remove cover from cylinder head. Now push stop collar toward "Down" switch until a gap of 0.030-0.050 for three inch cylinders, or 0.030-0.070 for four inch cylinders, exists between stop collar and cylinder magnet as shown in Fig. O164. Loosen jam nut and adjust "Down" switch until it just breaks the electrical circuit with stop collar in the position stated above. This point can be determined by a click of the switch, or by the light going off if a test light is used. Tighten switch jam nut and recheck the adjustment.

263. To check the adjustment of the "Up" switch, a test light is required and is accomplished as follows: Connect one test light probe to the "Up" switch terminal, or the "W" terminal of plug connector, and ground the other probe to an unpainted surface of the cylinder. Light should come on as points of switch are normally closed. Now extend piston rod to its limit at which time light should go out. Measure the exposed portion of the piston rod, then push the piston

fer to text.

rod inward ⅛-inch. Light should now come on. If light does not come on, loosen the "Up" switch terminal locking set screw and adjust terminal until the ⅛-inch piston rod movement described above will activate switch. Tighten set screw and recheck the adjustment.

DEPTH STOP CYLINDER HYDRAULIC SYSTEM

Late production Series 1650 models are available with a "depth stop cylinder hydraulic system" for use with one or two remote double acting "depth stop" cylinders. One or two additional control valve units may be added to the control valve assembly increasing the capacity of the system to operate either three or four cylinders.

Maximum recommended lifting capacity of each 3½ inch diameter "depth stop" cylinder is 16,150 pounds. The system is equipped with an 18.5 gpm hydraulic pump (at rated engine speed); the flow divider valve diverts 4.5-5 gpm to the power steering and/or hydraulic oil cooler resulting in a net capacity of 13.5-14 gpm available for operation of remote hydraulic cylinders.

SYSTEM ADJUSTMENTS

265. **SYSTEM RELIEF PRESSURE.** System relief pressure is controlled by the plunger type relief valve (24—Fig. O171) and is adjusted by varying the number of shims (23) located between the valve and spring (22). To check relief pressure, connect a 3000 psi capacity hydraulic gage to one of the remote cylinder quick disconnect couplings and pressurize that port by holding the control valve lever in proper position. Note: Hold lever in pressurized position only long enough to observe pressure gage reading. With engine running at 2200 RPM and hydraulic fluid at normal operating temperature, system relief pressure

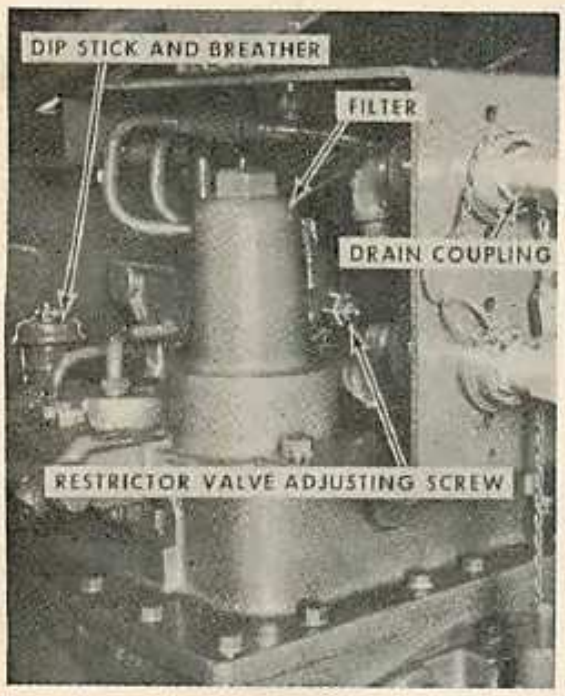


Fig. O170 — View of left rear corner of depth stop cylinder hydraulic housing (with shroud removed) showing location of hydraulic fluid dipstick, filter, drain coupling and restrictor valve adjusting screw on left control valve unit.

should be 2050-2150 psi. If not within the range of 2050-2150 psi, stop engine, remove the valve plug (20), spring (22), shims (23) and plunger (24). Add or remove shims as necessary to obtain correct relief pressure and renew the sealing "O" ring (21) when reinstalling plug. Note: If adding shims does not increase the system relief pressure, a faulty hydraulic system pump should be suspected.

266. **FLOW DIVIDER RELIEF PRESSURE.** A relief valve within the

(clockwise) to increase restriction. Note: Remove load on remote cylinder before attempting to adjust the restrictor valve. If adjusting screw is turned in too far resulting in too much restriction, the relief valve will blow causing a buzzing noise whenever remote cylinder is retracted. If this occurs, turn the screw out (counterclockwise) to correct the condition. Tighten lock nut to maintain restrictor valve adjustment.

FLUID AND SYSTEM FILTER

268. Recommended fluid for the system is SAE 10W Supplement 1 motor oil or Type "A" Automatic Transmission Fluid. Reservoir capacity is 4 gallons. System fluid should be changed yearly or after each 1000 hours of operation, and the filter should be renewed whenever the fluid is changed.

To drain the hydraulic system, connect an open end hose to the upper left quick disconnect coupling ("Drain Coupling"—Fig. 0170), start engine and move inner (left) control lever forward to pump fluid from the unit.

CAUTION: Stop engine as soon as flow has diminished. Remove hose from quick disconnect port. Disconnect hoses from cylinders and work piston rods in and out to expel all fluid. Renew the filter element, connect hoses and refill unit with new, clean recommended fluid. Start engine and move control lever to pump fluid several times to bleed all air trapped

hydraulic system" is same as that used on models with Hydra-Lectric and/or three-point hitch hydraulic systems. Refer to paragraph 244 for information on servicing the flow divider valve.

270. **HYDRAULIC PUMP.** After removing the hydraulic housing as outlined in paragraph 273, disconnect the pump pressure line (52—Fig. 0171) from manifold (54) and housing (9). The pump (58) can then be removed and overhauled as outlined in paragraph 246.

271. **PUMP DRIVE SHAFT AND PINION.** After removing the hydraulic housing as outlined in paragraph 273, service procedure for the pump drive shaft and the pump drive pinion is the same as outlined in paragraphs 247 through 249.

272. **CONTROL VALVE UNITS AND ASSEMBLY.** Two, three or four control valve units are mounted on top of the hydraulic housing in an assembly as shown in Fig. 0172. To remove the valve assembly, first remove the operator's seat and the shroud from the seat support bracket. Disconnect the remote cylinder tube and hose assemblies from the valve ports, then, unbolt and remove the seat support bracket, hose and quick disconnect coupling units from the tractor as an assembly. Drive the roll pin (86—Fig. 0172) from valve assembly manifold (82) and lever pivot shaft (97), then remove the shaft and levers. Disconnect the pressure line (81) and return line (80); then, re-

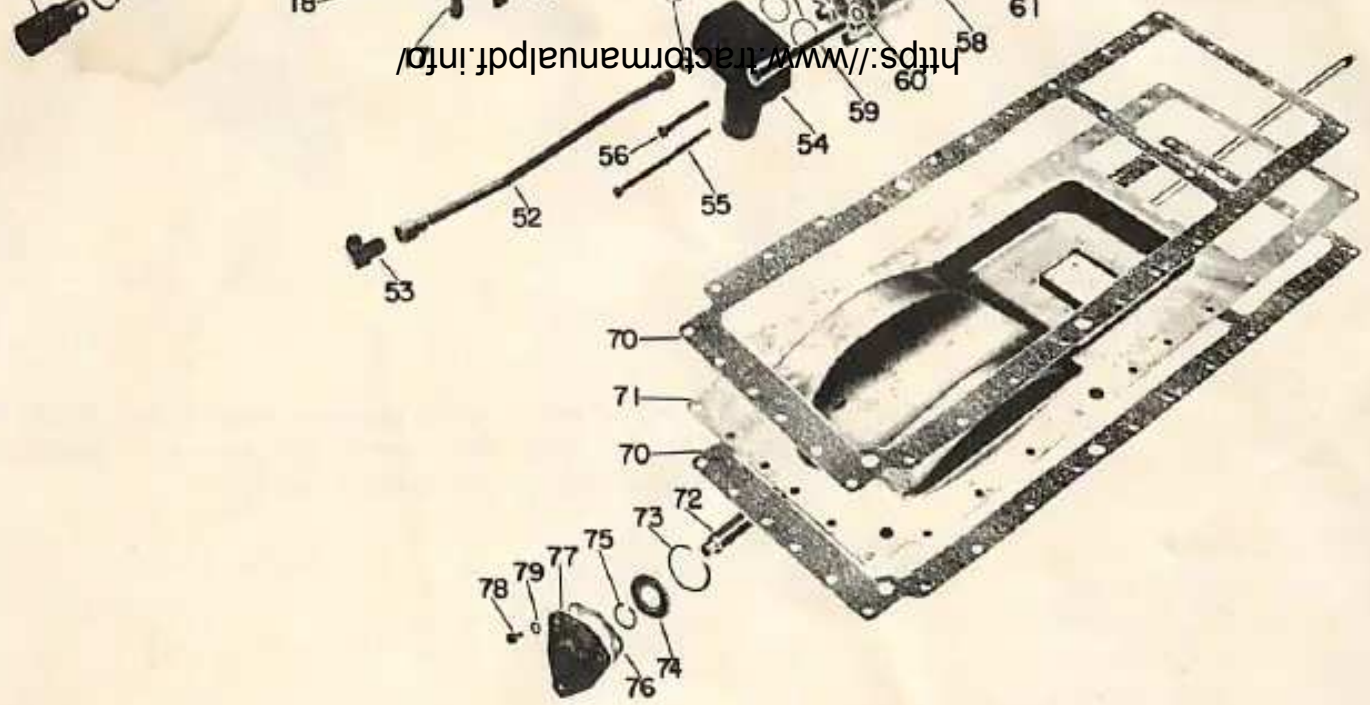


Fig. O171 — Exploded view of depth stop cylinder hydraulic system housing (9) and related parts. Refer to Fig. O172 and Fig. O173 for exploded views of the control valve assembly and control valve unit. The oil by-pass valve (29) will allow oil to by-pass filter if filter element becomes plugged. Breather element (37) and oil filter element (33) should be renewed each time hydraulic fluid is changed.

1. Plug
2. Snap ring
3. Snap ring
4. Carrier
5. Bearing
6. Pinion
7. Transmission filler cap
8. Gasket
9. Housing
10. Pipe plug
13. Plastic plugs
14. Guide
15. Tube insert
16. Center dowel
17. Rear dowel
18. Restrictor
20. Retainer
21. "O" ring
22. Spring
23. Shims
24. Plunger
25. Seat
26. Crush washer
27. Stop pin
28. Spring
29. Plunger
30. Body
31. Spring
32. Retainer
33. Element
34. "O" ring
35. Seal
36. Cap
37. Element
38. Cup
39. Gasket
40. Cap
41. Dipstick
43. "O" ring
44. Filler tube
45. Flow divider valve
48. "O" ring
49. "O" ring
50. Backup ring
51. Backup ring
52. Pressure tube
53. Elbow
54. Manifold
57. "O" ring
60. Copper washer
61. Gasket
62. Snap ring
63. Thrust washer
64. Bearing
65. Idler gear
66. Support
69. Dowels
70. Gasket
71. Reservoir (oil pan)
72. Pump drive shaft
73. Snap ring
74. Bearing
75. Snap ring
76. Gasket
77. Bearing retainer (housing)

by driving against hex nut portion with brass drift; this unseats detent balls from groove inside cap. Catch the four detent balls as cap is removed. Place small spanner wrench in detent ball holes of retainer (31) and unscrew retainer from valve spool. Remove washer (27), spring (28) and washer (29) from retainer. Remove snap ring (39) from detent retainer, then remove washer (38), spring (37), plunger (35) and piston (33), with "O" ring (34), from retainer. Slide bushing (26) and "O" ring (25) from spool. Run a small (tag) wire into open end of valve spool through the shims (24), spring guide (23), spring (22) and poppet (21); then remove spool from vise and tip lever end up to let shims, etc., slide down the wire. Keep these parts on wire for cleaning. Unscrew plug (1) and remove spring (4), poppet (5) and seat (6). Remove lockout plunger (15). Unscrew plug assembly (19) and remove spring (4), poppet (5) and seat (16). Remove steel ball

267. RESTRICTOR VALVE ADJUSTMENT. A restrictor valve on the rear of each control valve unit (See Fig. 0170) controls the flow of fluid returning to the hydraulic sump from the base end of the remote cylinder connected to that valve unit. An implement will have a tendency to bounce as it is lowered if flow is not sufficiently restricted. If bouncing is encountered, loosen lock nut (18—Fig. 0173) on restrictor valve adjusting screw (17) and turn screw in to increase restriction or out to decrease restriction. Tighten lock nut after adjustment is made.

OVERHAUL

269. FLOW DIVIDER VALVE. Except for tubing seats, flow divider valve used on "depth stop cylinder hydraulic system housing (9) and related parts. Refer to Fig. O171 and Fig. O173 for exploded views of the control valve assembly and control valve unit. The oil by-pass valve (29) will allow oil to by-pass filter if filter element becomes plugged. Breather element (37) and oil filter element (33) should be renewed each time hydraulic fluid is changed.

1. Plug
2. Snap ring
3. Snap ring
4. Carrier
5. Bearing
6. Pinion
7. Transmission filler cap
8. Gasket
9. Housing
10. Pipe plug
13. Plastic plugs
14. Guide
15. Tube insert
16. Center dowel
17. Rear dowel
18. Restrictor
20. Retainer
21. "O" ring
22. Spring
23. Shims
24. Plunger
25. Seat
26. Crush washer
27. Stop pin
28. Spring
29. Plunger
30. Body
31. Spring
32. Retainer
33. Element
34. "O" ring
35. Seal
36. Cap
37. Element
38. Cup
39. Gasket
40. Cap
41. Dipstick
43. "O" ring
44. Filler tube
45. Flow divider valve
48. "O" ring
49. "O" ring
50. Backup ring
51. Backup ring
52. Pressure tube
53. Elbow
54. Manifold
57. "O" ring
60. Copper washer
61. Gasket
62. Snap ring
63. Thrust washer
64. Bearing
65. Idler gear
66. Support
69. Dowels
70. Gasket
71. Reservoir (oil pan)
72. Pump drive shaft
73. Snap ring
74. Bearing
75. Snap ring
76. Gasket
77. Bearing retainer (housing)

To renew the filter, unscrew the cast iron filter body (See Fig. 0170) and remove the old element. Clean the filter body, spring and retainer with clean solvent. Install new "O" ring on filter body, lubricate "O" ring and "O" ring seat in hydraulic housing with grease and assemble as follows: Hold element in upright position, place retainer on upper end of element and place spring on top of retainer. Position filter body over spring, retainer and element and carefully install the unit on hydraulic housing. Tighten the filter body to a minimum of of 150 Ft.-Lbs. torque.

To disassemble the control valve assembly and individual units, use Figs. 0172 and 0173 as guides and proceed as follows: Remove the cap screws (94—Fig. 0172) retaining the end plate (93) and valve units (92) to manifold (82) and carefully separate the parts. "O" rings (88, 89 and 91) are used to seal passages between valve units, end plate and manifold. A backup ring (90) is used with "O" ring (89).

Thoroughly clean outside of control valve unit in suitable solvent, refer to Fig. O173 and proceed as follows: Unscrew detent cap (36) and remove complete detent and valve spool assembly from valve body. Clamp flat (lever) end of valve in vise and remove detent cap (36) from assembly

Paragraph 273

(12) and retainer (13); it is not necessary to remove pin (14) from retainer (13) unless pin is to be renewed. Unscrew lock nut (18) and remove restrictor adjusting screw (17). Remove both thermal-relief plugs (8) and shims (not shown), springs (10) and poppets (11). NOTE: Identify each thermal-relief plug, shim, spring and poppet unit so that they may be reinstalled in same location from which they were removed, using the same number of shims between plug and spring as were removed. Remove and discard all "O" rings and back-up washers.

Thoroughly clean all parts in solvent and dry thoroughly. Small nicks and burrs should be removed with fine emery cloth. The control valve spool and valve body are not serviceable items; if either of these parts are damaged, a new valve unit assembly must be installed. Inspect point of poppet (21) and mating seat in valve spool for excessive wear. Check to be sure small orifice hole in valve spool is open and clean, and be sure small drilled holes in thermal-relief bores are clean. Inspect detent grooves inside cap (36) for excessive wear. Inspect large hole in side of lockout seat (16) for excessive wear from ball (12). Inspect all springs for excessive weakness, wear or breakage.

Lubricate all parts before reassembly and reassemble as follows: Install new "O" ring (34) on detent piston (33) and install piston in the detent retainer (31). Place detent release plunger (35) in detent retainer, place spring (37) inside plunger and washer (38) on spring, then install snap ring (39) to retain washer, spring and

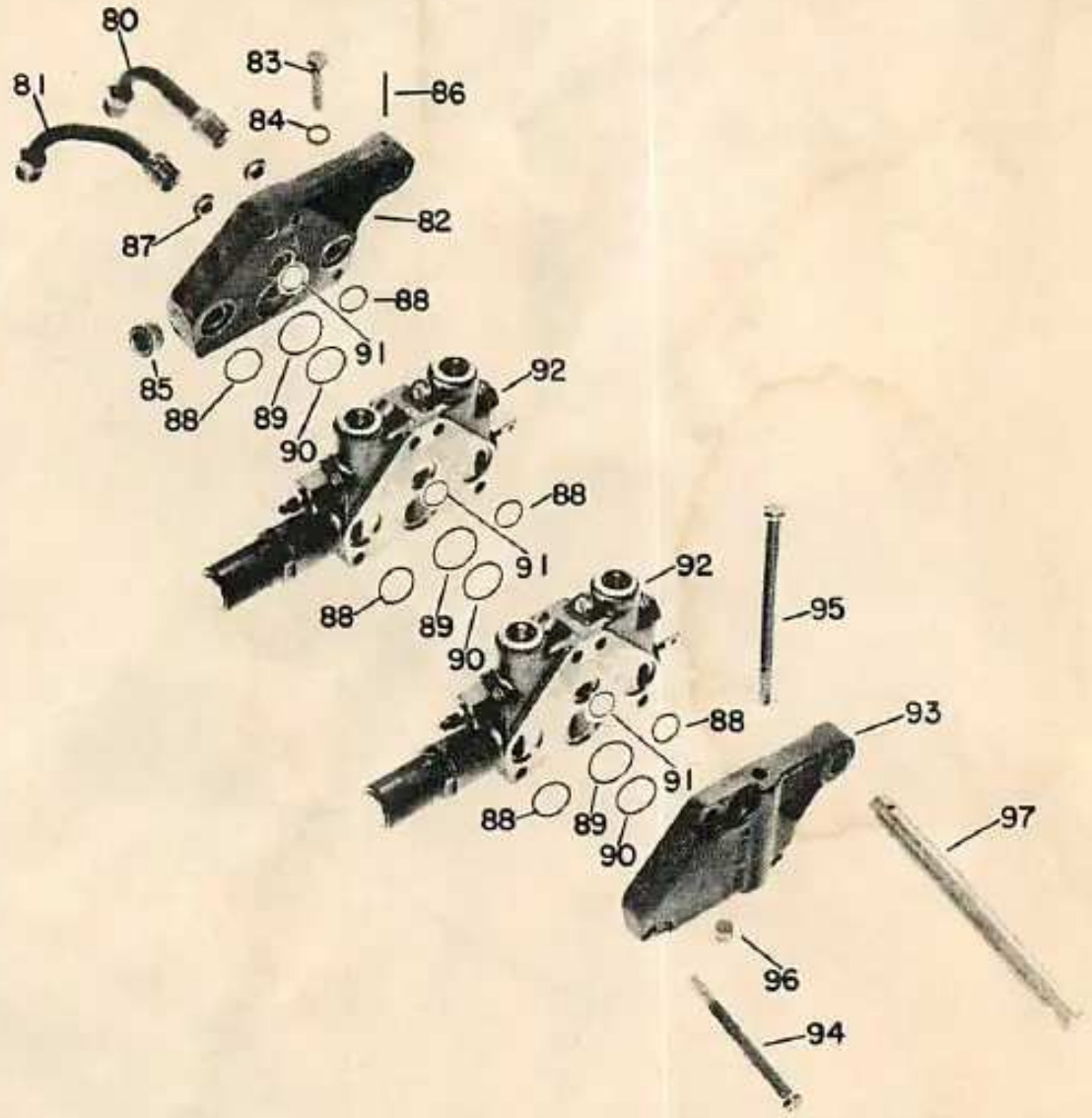


Fig. O172 — Exploded view of control valve assembly. Refer to Fig. O173 for exploded view of each control valve unit (92). Two control valve units are standard; one or two more units may be added as an option.

80. Return line
81. Pressure line
82. Manifold
83. Plug
86. Roll pin
87. Tube inserts
88. "O" ring
89. "O" ring
90. Backup ring
91. "O" ring
92. Valve unit (See Fig. O173)
93. Plate
97. Lever shaft

steel balls, then use plastic hammer (5), spring (4) and plug assembly

(39) to retain washer, spring and plunger in detent retainer. Install new "O" ring (30) on outside of detent retainer, then place washer (29), centering spring (28) and washer (27) over retainer. Place shims (24), spring guide (23), spring (22) and poppet (21) on tag wire and slide parts into position inside valve spool. Be sure parts are seated correctly, then clamp valve spool flat end in vise with open end up. Install new "O" ring (25) and bushing (26) over spool, then thread detent sub-assembly into spool and, using small spanner wrench, tighten to a torque of 5-8 Ft.-Lbs. Stick detent balls in holes of detent retainer with heavy grease. Carefully lower detent cap (36) over detent retainer until cap comes in contact with the to drive cap down over the balls until the balls engage the second detent groove in cap. Install new "O" ring (40) in spool bore of valve body, then install the detent and spool assembly tightening the detent cap snugly. NOTE: Be sure arrow on flat (lever) end of valve spool points toward ports of the valve unit. Install new back-up washer (41) in bore of plug (19) and place new "O" ring (20) in plug at inner side of back-up washer. Thread restrictor adjusting screw (17) into plug (19), then install lock nut (18) on adjusting screw. Install back-up washer (2) and "O" ring (3) on outside of plugs (19 and 1). Install new "O" rings (7) on seats (16 and 6). Install seat (16) in lockout bore being sure large hole in seat is aligned with port to allow seating of ball (12). Install poppet (19). Install lockout plunger (15) in bore, then install remaining seat (6), poppet (5), spring (4) and plug (1). Install steel ball (12) and retainer (13) in port towards the restrictor adjusting screw (17). Install the thermal-relief poppets (11), springs (10), shims and plugs (8), with new "O" rings (9), in bores from which they were removed. Install button plug (42) in detent cap.

273. **R&R HYDRAULIC HOUSING.** First, drain hydraulic system fluid as outlined in paragraph 268; then, proceed as follows:

If removing the housing for access to the hydraulic pump, bull gears, etc., it will not be necessary to remove the seat support, control valve assembly or remote hose and connectors from the hydraulic housing. Re-

1. Plug assembly
2. Washer
3. "O" ring
4. Spring
5. Poppet (check valve)
6. Seat
7. "O" ring
8. Plug
9. "O" ring
10. Spring
11. Poppet (thermal relief valve)
12. Steel ball
13. Retainer
14. Pin
15. Plunger
16. Seat
17. Restrictor screw
18. Lock nut
19. Plug
20. "O" ring
21. Detent poppet valve
22. Spring
23. Guide
24. Shims
25. "O" ring
26. Bushing
27. Washer
28. Spring
29. Washer
30. "O" ring
31. Retainer
32. Detent balls (4)
33. Detent piston
34. "O" ring
35. Plunger
36. Detent cap
37. Spring
38. Washer
39. Snap ring
40. "O" ring
41. Backup washer
42. Plug

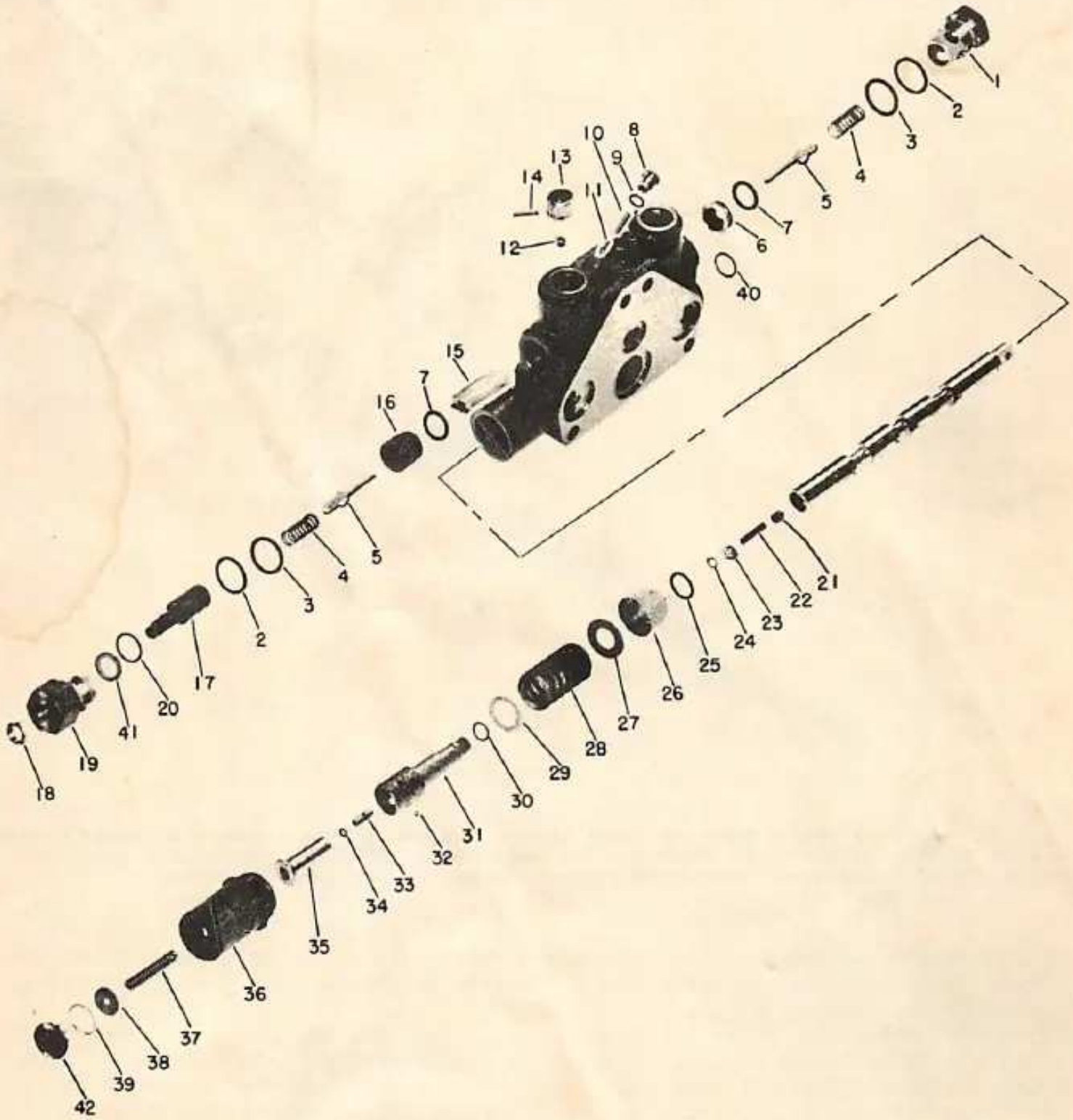


Fig. O173 — Exploded view of one control valve unit; tractor may be equipped with two, three or four units. Refer to Fig. O172 for view showing assembly of two control units. The restriction valve for each control unit must be individually adjusted; adjusting screw is (17).

move the operator's seat assembly, shroud from around seat support and the platform panels. Thoroughly clean the unit. Disconnect pressure line to power steering and/or oil cooler from flow divider valve and disconnect return line from hydraulic housing. Hook a chain sling to seat support, unbolt hydraulic housing from rear main frame and lift unit from tractor. While unit is still supported (if necessary to gain access to hydraulic pump), drive the dowels from hydraulic housing and remove the oil pan.

The seat support and control valve

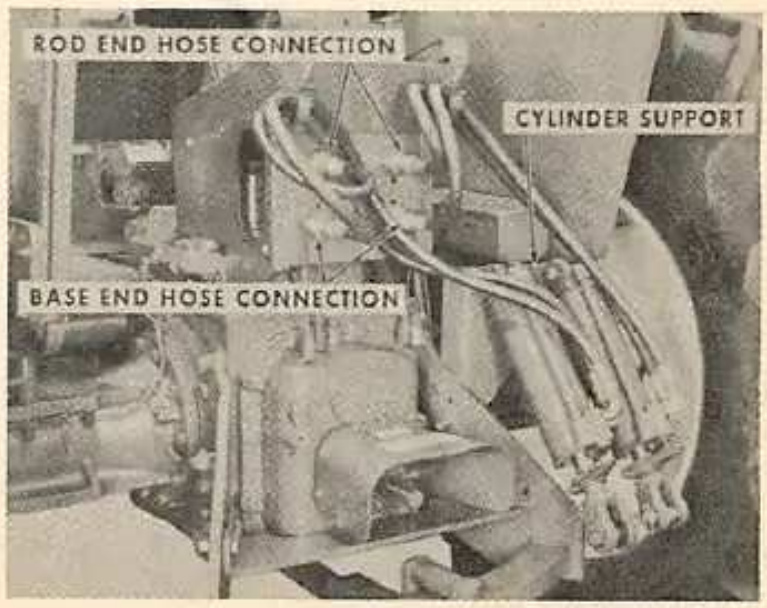


Fig. O174 — Note that hose from base end of depth stop control cylinder must be coupled to lower connector and hose from rod end coupled to upper connector. That is, the hose from base end of cylinder must be connected to restrictor port of control valve unit.

1. Cylinder tube
2. Elbows
3. Nut
4. Wear ring
5. Ring
6. "O" ring
7. "O" ring
8. Piston
9. "O" ring
10. Washer
11. Bearing
12. Snap ring
13. Seal
14. Seal
15. Stop arm
18. Piston rod
19. Elbow
20. Tube
21. Washer
22. "O" ring
23. Stop valve housing
26. Seal
27. Valve
28. "O" ring
29. Guide

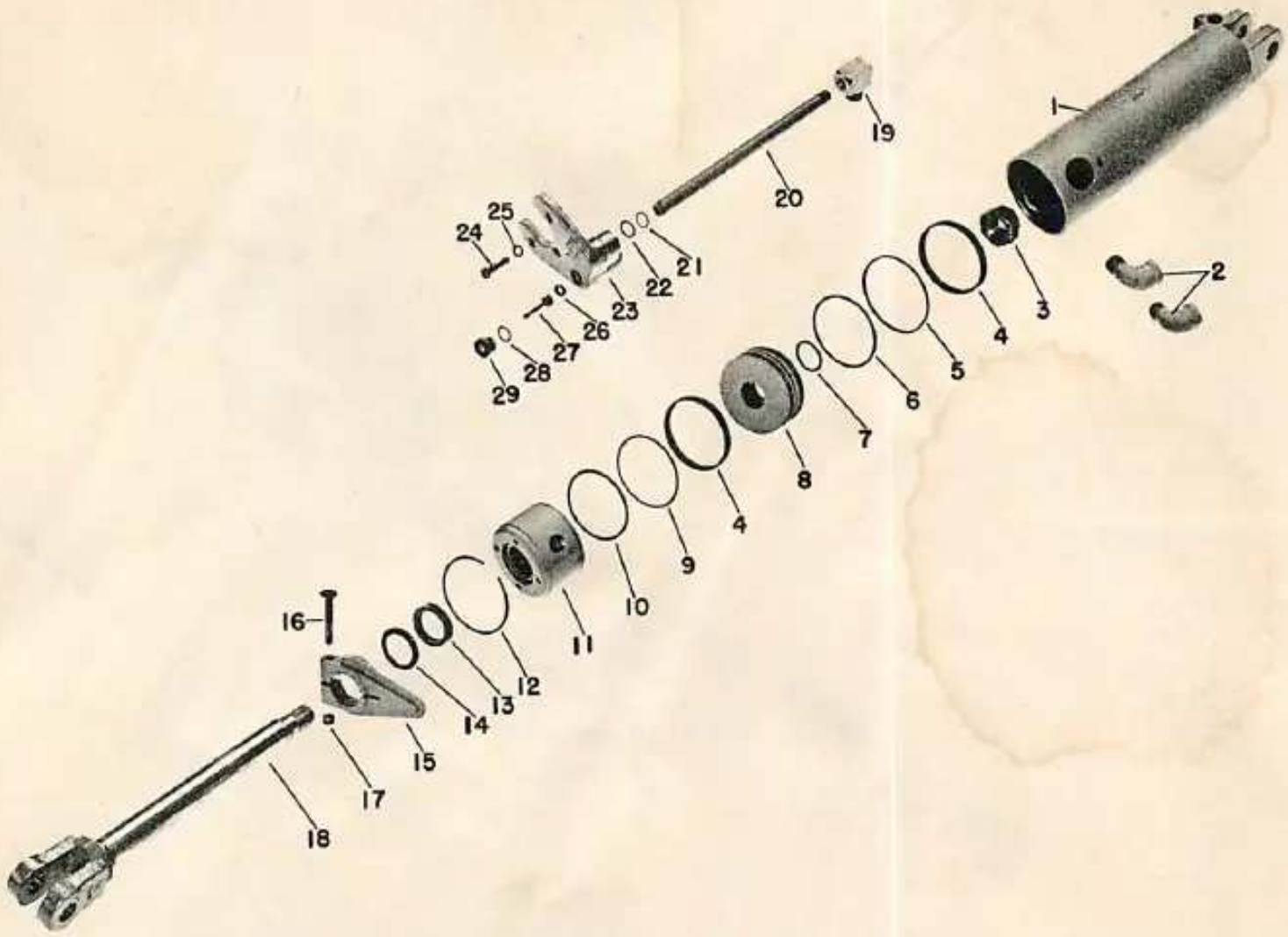


Fig. O175 — Exploded view of depth stop control cylinder. Stop arm (15) can be clamped in different positions on piston rod (18) to adjust length of cylinder stroke. When stop arm contacts valve (27), pressure build up in control valve opens poppet valve (21—Fig. O173) in valve spool releasing detent and allowing valve to return to neutral position.

assembly can be removed from the hydraulic housing as outlined in paragraph 272 either before or after removing the housing from tractor. If removing hydraulic housing with seat bracket and hydraulic control valve assembly already removed, attach lift chain with the forward seat support bracket retaining cap screws.

Reverse removal procedure to reinstall unit on tractor and refill the system as in paragraph 268.

274 **OVERHAUL CYLINDER.** Refer to exploded view of cylinder in Fig. 0175 and proceed as follows:

Loosen nut (17) and slide stop arm (15) to yoke end of piston rod (18). Remove cap screws (24) retaining stop valve housing (23) to bearing (11) and withdraw valve housing from end of tube (20). Unscrew guide (29) and remove stop valve (27).

Push bearing (11) into cylinder tube (1) far enough to allow removal of snap ring (12), then bump bearing from cylinder tube with piston (8) by working piston rod in and out.

Remove nut (3), piston (8) and bearing (11) from piston rod. Need and procedure for further disassembly is evident on inspection of unit.

Install new piston rod seals (13 and 14) in bearing (11) and reassemble unit using all new "O" rings, wear rings and backup rings. Reverse disassembly procedure to reassemble the cylinder.