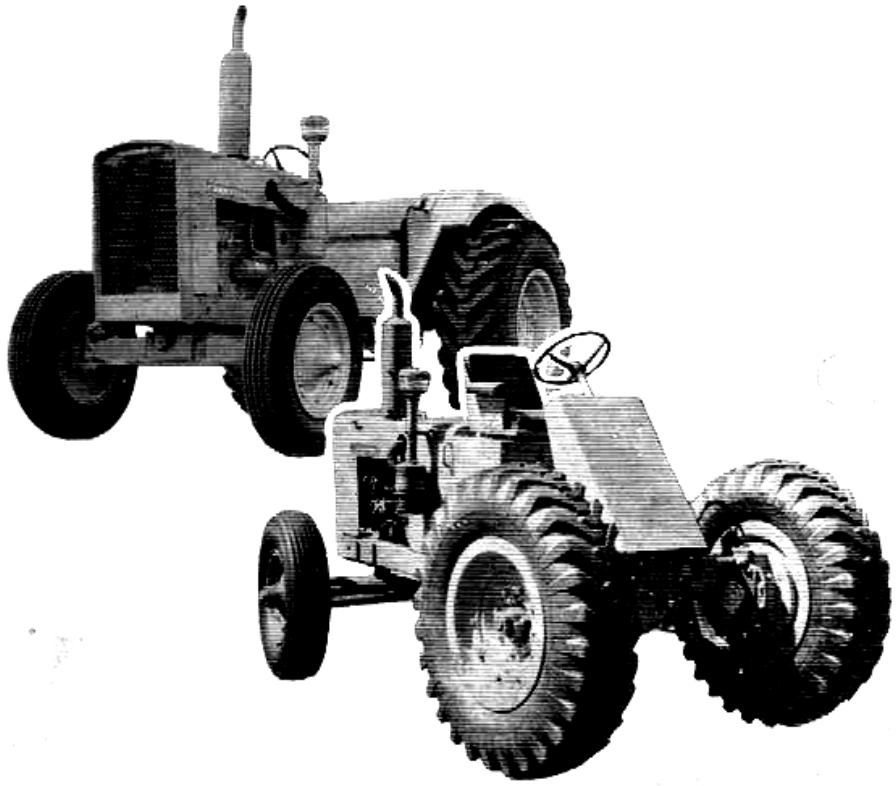
Chamberlain Service Manual

Champion Mark 3 CHAM 41450

Tractor Issue 1

(All Models)



CHAMBERLAIN

SERVICE MANUAL

for

CHAMPION INDUSTRIAL MARK 3

STANDARD MANUAL
STANDARD TORQUE CONVERTER
F.W.D. MANUAL
F.W.D. TORQUE CONVERTER

PART NUMBER 41450
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CHAMBERLAIN INDUSTRIES PTY. LTD.
WELSHPOOL — WESTERN AUSTRALIA

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Foreword

THIS MANUAL has been compiled as a guide and reference book for the complete servicing of the following Champion Tractor models :

CHAMPION INDUSTRIAL MARK 3

STANDARD MODELS MANUAL & TORQUE CONVERTER	FRONT WHEEL DRIVE MODELS MANUAL & TORQUE CONVERTER

In most cases work can be carried out without disturbing the related parts and by combining a series of operations a major overhaul can be effected.

For convenience each operation has been covered in the following manner—

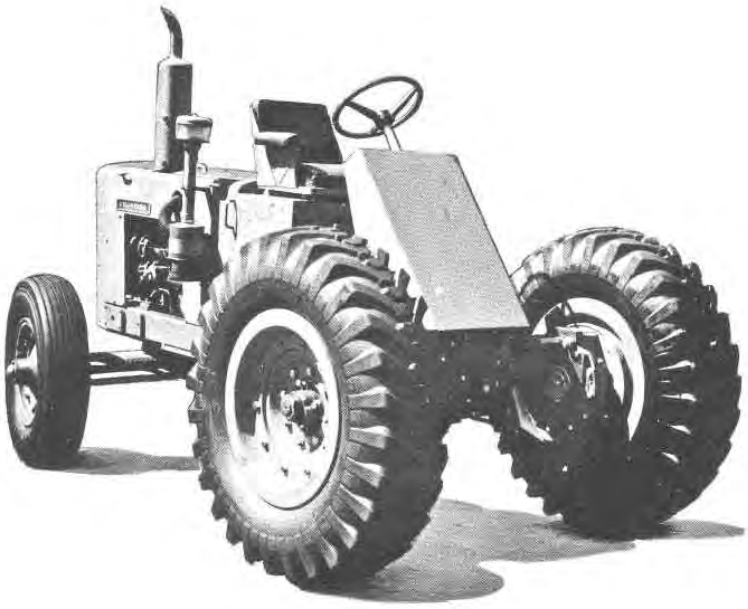
1.—Removal.

2.—Inspection.

3.—Replacement and repair of worn parts.

4.—Re-assembly and adjustment.

CHAMPION STANDARD INDUSTRIAL MARK 3



CHAMPION FRONT WHEEL DRIVE INDUSTRIAL MARK 3

SECTION **A**

STEERING GEAR AND FRONT SUSPENSION

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

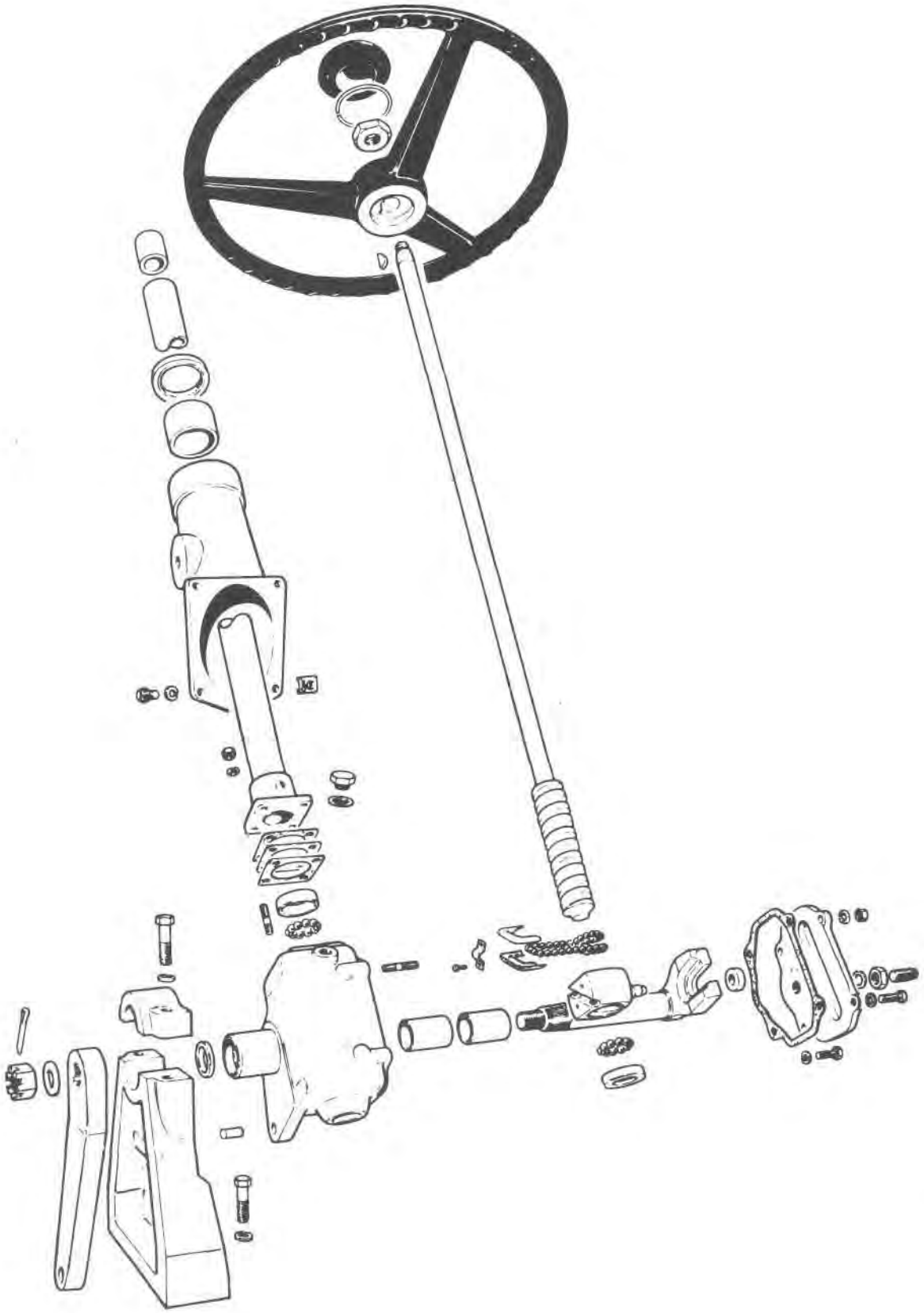


Fig. A1 — Steering Gear — Standard Manual and T.C. Models

STEERING GEAR ASSEMBLY

for: Champion Industrial Mark 3 Standard Model
Manual and Standard Model T.C.

DESCRIPTION

The steering gear is of the re-circulating ball type, the balls acting as contact between the worm and nut. The nut operates on a fork integral with the rocker shaft.

The steering wheel is connected by a shaft to the worm which is supported by angular contact ball bearings. Bearing adjustment is by shims fitted under the steering column tube.

The nut has a spiral groove cut in its internal face to coincide with the spiral groove of the worm, and ball bearings occupy the cavity thus provided. When the worm is rotated by the steering wheel, the nut is moved by the ball bearings along the length of the worm. The balls are collected, when discharged from the nut, by a pressed metal guide and returned to the other end of the groove. A smooth, low friction drive is thus obtained.

The nut is provided with an extension on which is fitted a roller. This roller runs in a groove cut in the side cover, allowing free side travel of the nut, but preventing it from turning with the worm.

A conical face on the nut engages with tapered faces on the inside of the rocker shaft fork, the clearance between the two faces being adjustable by a screw. The rocker shaft is supported by two bushes and is provided with a spring loaded type oil seal.

SPECIFICATION

Type	— Re-circulating ball.
Make	— Burman.
Gear Ratio	— 22.3 : 1.
Bearings	— Worm — Angular ball.
	— Shafts — Bronze bushes.
Steering Wheel	— 18" dia. dished. Keyed on taper.

MAINTENANCE

Check oil level (up to the level plug) every 600 operating hours. Top-up as necessary. If the unit appears to be leaking excessively, repairs should be carried out.

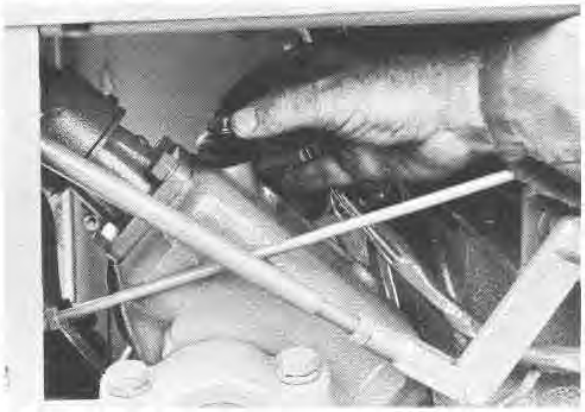


Fig. A3 — Check Oil Level

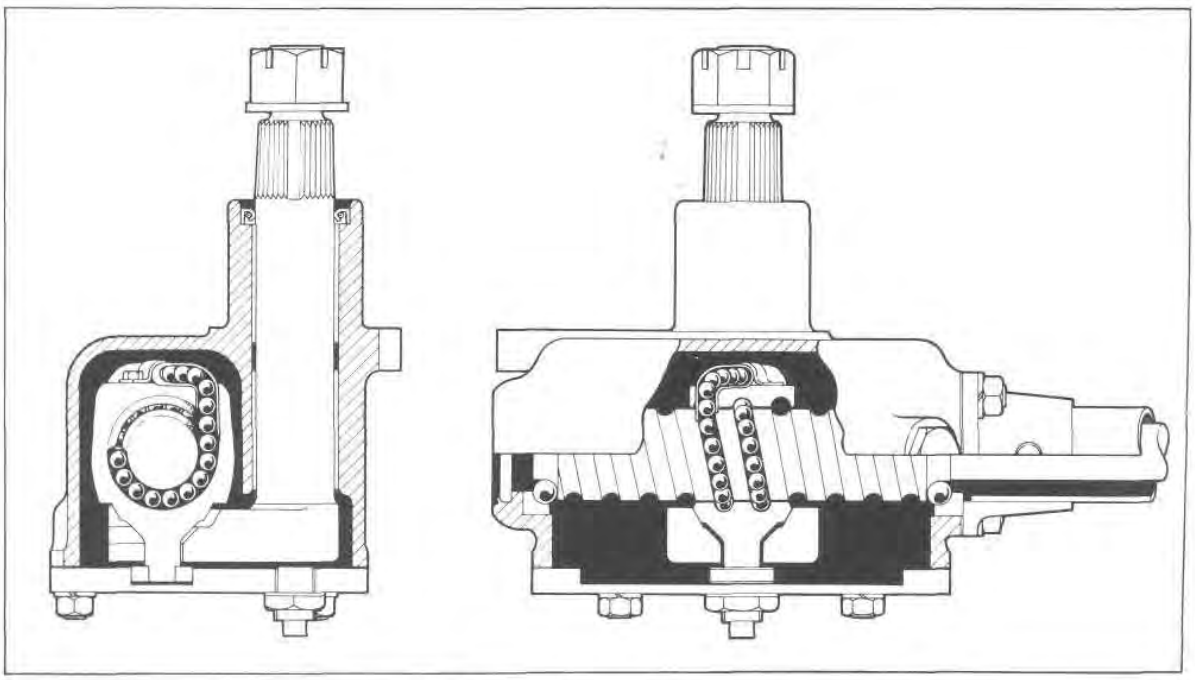


Fig. A2 — Section Through Steering Box

MAINTENANCE CHECKING

The condition of the internal mechanism may be checked as follows :—

1. Disconnect the draglink and check the adjustment as detailed under "Adjustment".

Note : When removing ball joints from their taper sockets, use a heavy hammer and strike the component containing the taper adjacent to the balljoint, to shock the balljoint free. Do not hammer the balljoint on the threaded end.

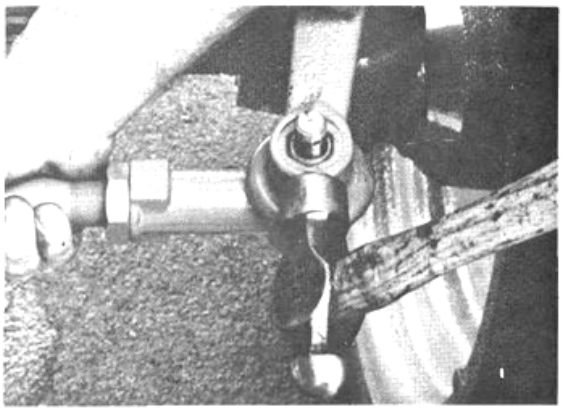


Fig. A4 — Balljoint Removal — Correct Method

2. Turn the steering wheel slowly and carefully to determine if the operation is rough or lumpy.

Rough or lumpy action indicates worn or damaged bearings. In order to service these, it will be necessary to remove and dismantle the unit.

SERVICE

Steering Box Removal :

1. Remove the right hand rear cowl.

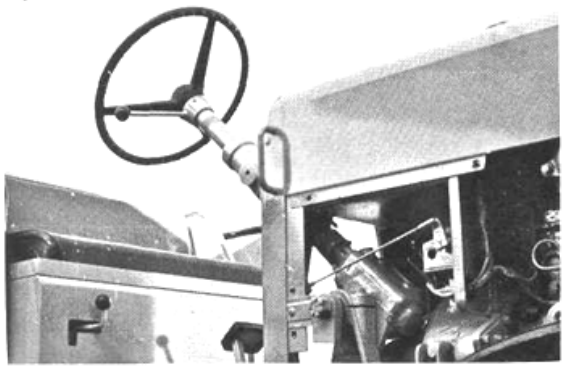


Fig. A5 — Steering Box Exposed

2. Remove the splitpin, nut and washer from the rocker shaft and, using a suitable puller, remove the pitman arm.

3. Remove the grub screws from the handlever assembly (or collar on the T.C. model) below the steering wheel and allow the assembly to slide down the column.

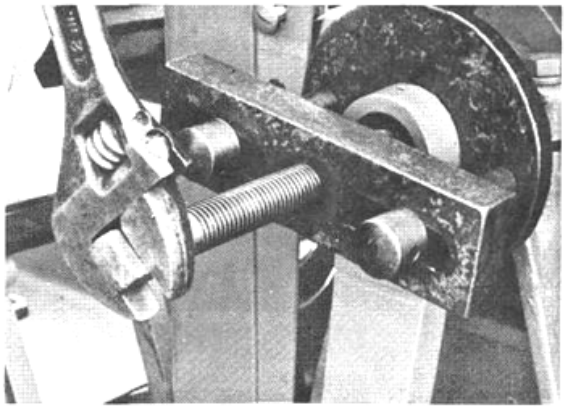


Fig. A6 — Pitman Arm Removal

4. Prise the cap and emblem from the steering wheel remove, the steering wheel retaining nut and, using a suitable puller, remove the steering wheel. Remove the handlever assembly (or collar) from the column.

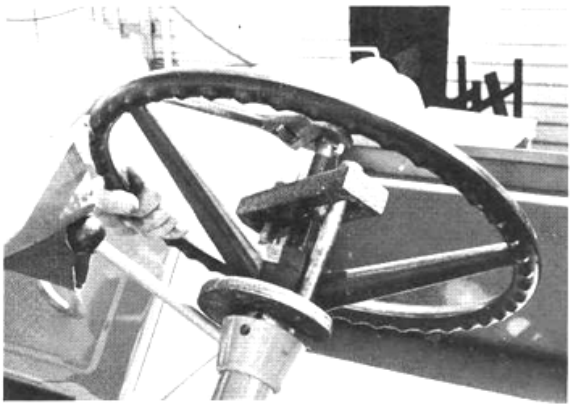


Fig. A7 — Steering Wheel Removal

5. Remove the column support bracket, (on T.C. models, firstly remove two setscrews connecting the forward and reversing control lever to the support bracket).

6. Remove two setscrews holding the friction plate bracket to the rear cowl support, (Std. Manual models only).

7. Disconnect the bellcrank to over-rider link at the over-rider end and the bell crank to cross-shaft link at the bellcrank end, (on T.C. models, bellcrank to cross-shaft link only).

8. Remove the bolts retaining the lower steering box bracket to the chassis and manoeuvre the steering gear assembly from the tractor.

Steering Box Dismantling :

Use a clean bench and clean tools. The lower steering box bracket can be used as a support while working on the box.

1. Unlock and slacken the adjusting screw.
2. Remove the nuts and setscrews from the side cover, remove the side cover and the nut roller. Drain the oil.

Fig. A8 — Side Cover and Roller Removal

3. Clean any paint from the outer end of the shaft and remove the rocker shaft out through the side opening.

4. Remove the nuts securing the column tube to the housing. Withdraw the worm and tube by screwing them out of the nut, at the same time pressing the tube against the upper race to keep the ball bearings in position. Collect the nut, and ball bearings from the bottom race.

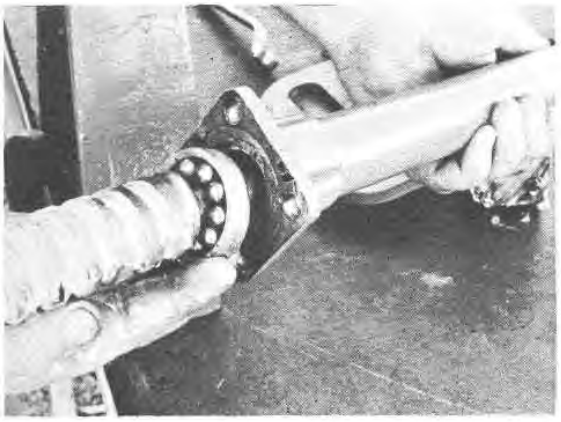


Fig. A9 — Column and Shaft Upper Ball Bearing

Steering Box Inspection :

1. Inspect the balls for pitting. If any are found to be faulty, replace the complete set.

2. Check the surfaces of the worm, nut and bearing races for wear or pitting. Replace if necessary. Inspect the nut roller and side cover slot.

3. Check the fit of the rocker shaft in its bushes and the column shaft in the tube upper bush. Replace the bushes if they are worn excessively.

Steering Box Re-Assembly :

Re-assembly is a reversal of the dismantling procedure, with the following points noted :—

1. The use of heavy grease to hold the balls in place will facilitate re-assembly.

2. Ensure that the correct steel balls are used, P/N 20388, $\frac{3}{8}$" dia. in the bearings and P/N 1067, 5/16" dia. in the worm and nut.

3. Ensure that **all** the balls are fitted in the appropriate places, 39 in the worm and nut, and 10 in each of the bearings.

4. Assemble the column tube with the rivets at the top and bottom, **not** at the sides.

5. Fill the box to the correct level with the recommended oil.

6. Adjust and check the steering box operation as described under the headings "Adjustment" and "Maintenance Checking".

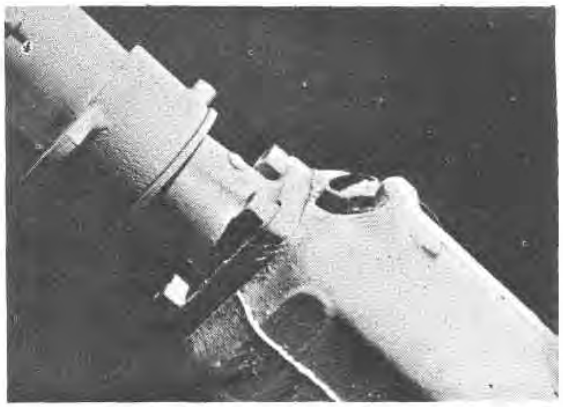


Fig. A10 — Correct Column Rivet Assembly

ADJUSTMENT

Worm Bearings :

Adjust by adding or removing shims from the flange of the column tube. Adjust to remove all end float without allowing the pre-load on the bearings to exceed 10 lbs./inches. (A spring balance attached to the outer end of one of the steering wheel spokes should not read more than $1\frac{1}{2}$ lbs. when the steering wheel is being turned by the balance). Firmly tighten the nuts before taking readings. Place a gasket between the housing and shim to prevent oil leaks.

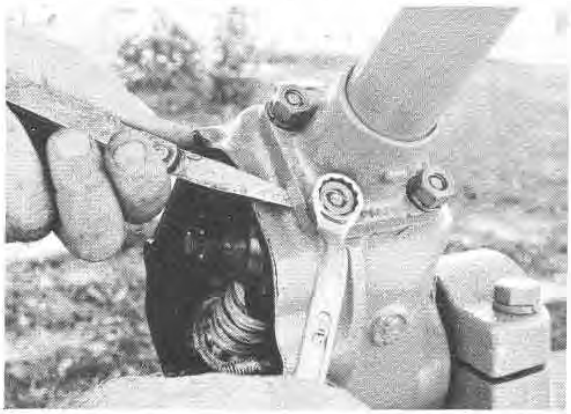


Fig. A11 — Shaft Bearing Shim Adjustment

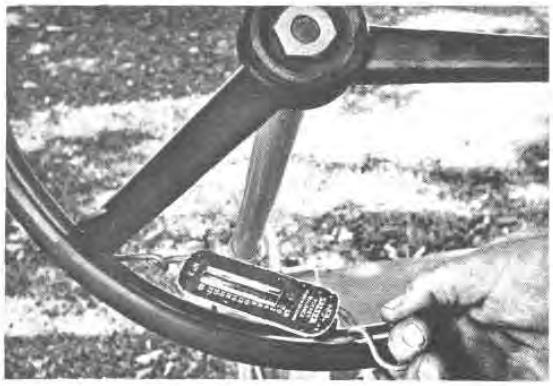


Fig. A12 — Check Bearing Pre-Load

Fig. A13 — Rocker Shaft Screw Adjustment

Rocker Shaft :

Backlash between the rocker shaft fork and the worm nut is decreased by screwing in the adjusting screw.

Adjust to remove all backlash at the centre of travel. Check that the force required to turn the steering wheel does not exceed 2½ lbs. after adjusting the backlash. Check through the full travel of the box.

POWER STEERING

for : Champion Industrial Mark 3 Standard Model Manual and Standard Model T.C.

DESCRIPTION

The power steering system provides effortless steering for all applications. Steering is positive under any driving condition as the steering mechanism is hydraulically locked while the hydraulic pump is operating. A ball check valve is incorporated in the booster to enable the tractor to be steered manually if the hydraulic pump is not operating.

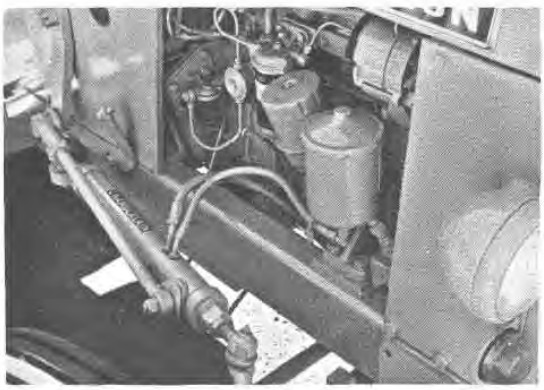


Fig. A14 — Power Steering — Standard Manual and T.C. Models

The system comprises a direct engine driven vane type pump, with remote mounted reservoir, ram type booster cylinder for actuation, hoses (connecting the pump, reservoir and booster), and a drag link to connect the booster to the pitman arm. A lug welded to the chassis anchors the booster, and the booster extension rod socket locates in the stub axle steering arm; a special stop bracket being attached to the chassis to prevent the steering box from "bottoming" in either direction.

SPECIFICATION

Pump	— Vickers VTM27 vane type with remote mounted reservoir.
Capacity	— 4 g.p.m. nominal.
Relief valve pressure	— 750 p.s.i.
Booster	— Vickers S22N.
Rated thrust capacity	— 1500 lbs. @ 600 p.s.i. pressure.
Cylinder bore	— 2".
Maximum piston stroke	— 10½".
Lubrication	— Chassis grease.

MAINTENANCE

The sealed system requires a periodical oil level check and, at 1200 hours, renewal of the oil and filter element.

Oil Level :

Remove the filter cover and check that the oil is within ¼" of the lip of the barrel when the booster is fully retracted. Add oil, of the recommended type, as necessary.

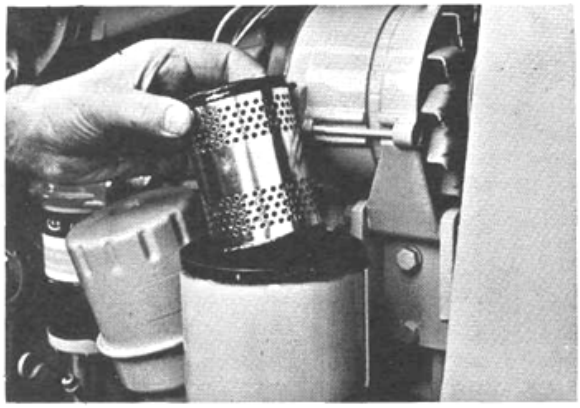


Fig. A15 — Remove the Oil Filter Element

Oil and Filter Element Renewal :

Drain the reservoir oil, remove the element and thoroughly clean inside the barrel. Instal a new element and, with the booster fully retracted, fill with new oil allowing sufficient time for the element to absorb oil and air to escape. Operate the steering to each full lock to bleed the system of air and, when no more bubbles are apparent with the booster fully retracted, top up the reservoir to within ¼" of the barrel lip. Instal the cover ensuring that the seal is correctly located.

Caution : Absolute cleanliness is essential as any dirt introduced into the oil will cause premature component wear.

HYDRAULIC PUMP

Pumps are composed principally of a pressure plate, ring, rotor, vanes and wear plate. The rotor is driven within the cartridge by a drive shaft, the power source being an attached gear inserted into the engine gear train. As the rotor speed increases, centrifugal action causes the vanes to follow the cam-shaped contour of the pump ring. System pressure fed behind the vanes assures sealing contact of the vanes on the ring cam contour during normal operation.

The ring is shaped so that two opposing pumping chambers are formed, thus cancelling any hydraulic loads. Radial movement of the vanes, and rotation of the rotor, causes the chamber area between vanes to increase in size at the inlet (large diameter) section of the ring. This results in a low pressure, or vacuum in the chamber. This pressure differential causes oil to flow into the inlet, where it is trapped between the rotating vanes and is forced, through porting in the pressure plate to discharge into the system as the chamber size decreases at the pressure quadrant (small diameter) of the ring.

Maximum pump delivery and maximum system pressure are determined by the integral flow control

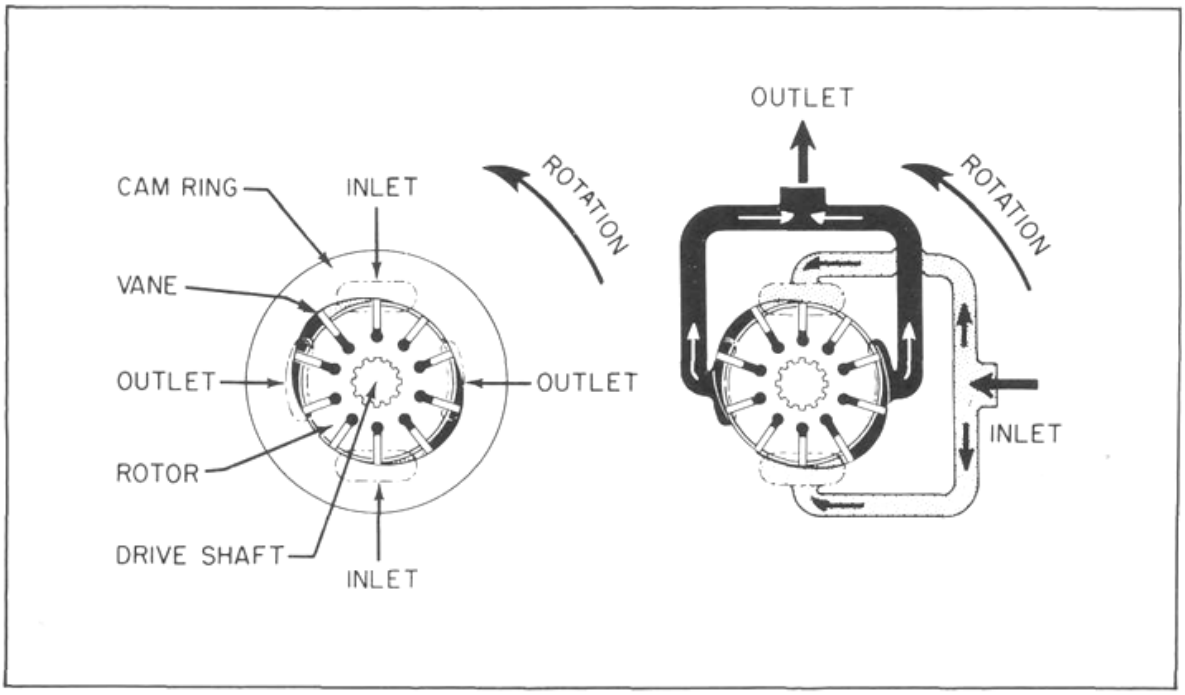


Fig. A16 — Schematic Oil Flow and Hydraulic Balance

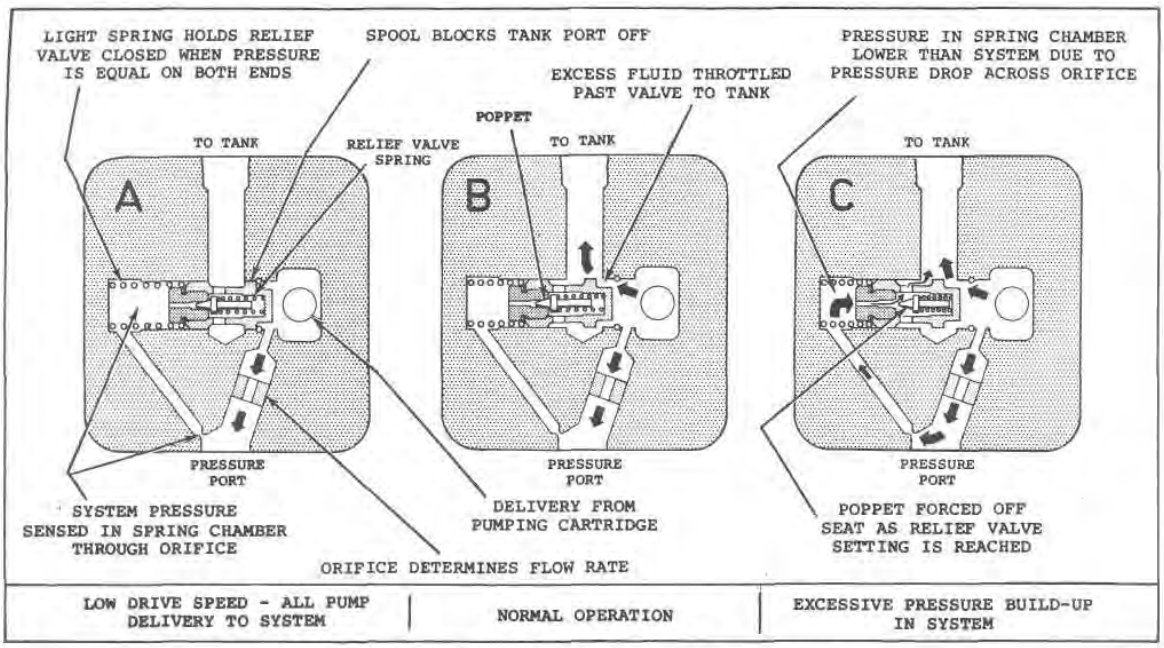


Fig. A17 — Schematic Flow Control and Relief Valve in Outlet Cover

and relief, valve in the outlet cover. Figure A17. illustrates this feature schematically. An orifice in the cover limits maximum flow. A pilot-operated type relief valve shifts to divert excess fluid delivery to tank, thus limiting the system pressure to the prescribed maximum.

Fig. A17a shows the condition when the total pump delivery can be passed through the orifice. This condition usually occurs only at low drive speeds. The large spring chamber is connected to the pressure port through an orifice. Pressure in this chamber equalises pressure at the other end of the relief valve spool and the light spring holds the spool closed. Pump delivery is blocked from the tank port by the spool land.

When pump delivery is more than the flow rate determined by the orifice plug, a pressure build-up forces the spool open against the light spring. Excess fluid is throttled past the spool to the tank port as shown in Figure A17b.

If pressure in the system builds up to the relief valve setting (Figure A17c), the pilot poppet is forced off its seat. Fluid in the large spring chamber flows through the spool and out to tank. This flow causes a pressure differential on the spool, shifting it against the light spring. All pump delivery is thus permitted to flow to the tank.

Relief valves are pre-set and no field adjustment should be made. If the relief valve setting must be changed, a replacement valve should be installed.

Pumps must be driven in the direction of rotation indicated by the arrow cast on the surface of the pump ring, this application being right hand rotation, which is clockwise when viewed from the shaft end. Direction of rotation may be changed by reversing the pump ring. Pumps may be damaged if driven in the wrong direction of rotation.

PUMP OVERHAUL

1. Drain the oil by disconnecting the pump hose and pipe.
2. Remove two setscrews from the pump mounting plate and lift the pump assembly from the engine.
3. Remove the drive gear setscrew from the end of the shaft then, using an appropriate puller, remove the gear from the shaft. Remove the shaft key.
4. Remove the adaptor and 'O' ring.
5. Remove three setscrews from the pump cover manifold (observing the location of the one copper washer) and remove the manifold and gasket from the cover.

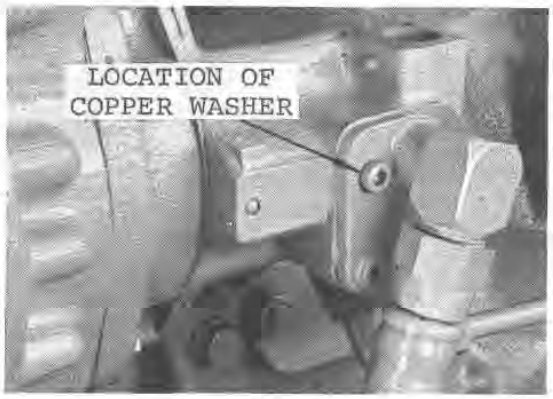


Fig. A18 — Pump Cover Manifold Copper Washer

6. Clamp the pump mounting flange in a vise, being certain to use protective jaws. Remove the four cover mounting capscrews. Separate the cover from the pump body. Remove the pump ring (observing direction of rotation), locating pins, rotor and vanes, 'O' rings, pressure plate and spring.

7. Mount the cover in a vise and drive out the relief valve retaining pin with a pin punch. Protect the relief valve plug and sub-assembly against falling from the bore. Work the plug, valve and spring from the bore.

Note: Access to the relief valve plug and sub-assembly may be gained through the large chamfered hole which leads to the relief valve bore from inside the cover.

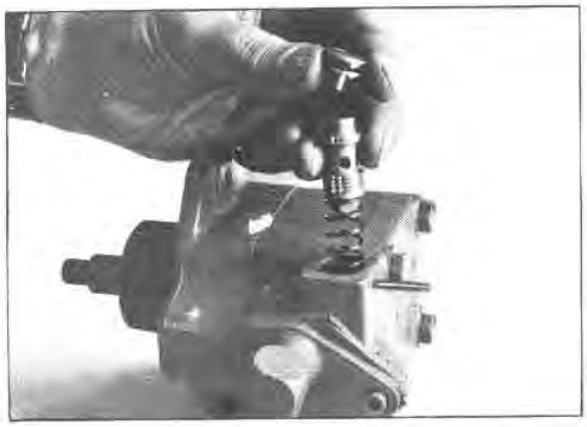


Fig. A19 — Relief Valve Removal

8. Remove the bearing retaining circlip from the pump body. Support the shaft end of the pump body in a 2" straight pipe coupling and, using an arbor press, remove the shaft assembly from the body, ensuring that it is not damaged when it drops from the body. Remove the shaft circlip and press the bearing from the shaft.

9. Use a pin punch and hammer to remove the shaft seal from the pump body.

INSPECTION

Wash all parts, except 'O' ring seals, in clear mineral solvent. Blow the parts dry with filtered compressed air. After drying thoroughly, lay the parts on a clean, lint-free surface. All internal oil passages of the pump cover, housing and body must be thoroughly cleaned. All 'O' rings, and the shaft seal should be replaced at reassembly.

Inspect the surfaces of all parts which are subject to wear, i.e. ring, rotor, vanes, pressure plate, body. Light scoring may be removed from the faces of the body or pressure plate with crocus cloth (by placing the cloth on a flat surface), or by lapping. Check the edges of the vanes for wear. Vanes must not have excessive play in the slots or burrs on the edges. Replace if necessary. Check each rotor slot for sticky vanes or wear. Vanes should drop into the rotor slots by their own weight when both slot and vane are dry.

Insert the relief valve into its bore in the pump cover. There should be no binding. Check the valve and bore for excessive wear or scoring. Replace if necessary. Inspect the bearing thoroughly and replace if any doubt exists regarding its serviceability.

Replace the shaft seal at each overhaul to prevent oil leakage. Check the drive shaft oil seal diameter for wear or scoring. Do not instal a new seal on a shaft which is worn or damaged at the oil seal diameter. Replace the shaft if it is worn. Stone and polish the sharp edges on the shaft to prevent damage to the seal.

Stone all mating surfaces of the body and cover with a medium stone to remove all burrs and sharp edges. Re-wash all parts after stoning.

REASSEMBLY

1. Immerse all parts in clean hydraulic oil to facilitate reassembly.

2. Position the seal on the shaft end of the body with the lip inwards, being careful not to damage the seal. Using a proper seal installation tool, press the seal in until it engages the shoulder in the body. This shoulder acts as a positive stop for the seal. Do not over-press as damage to the seal will result.

3. Press the bearing onto the shaft and assemble the small snap ring onto the shaft. Install the shaft assembly in the body and insert the large circlip in the body groove to retain the bearing.

4. Install the locating pins in the body and assemble the ring over the pins in the correct direction of rotation. Rotation is indicated by the arrow cast on the surface of the pump ring and should be right hand, which is clockwise when viewed from the shaft end.

5. Install the rotor with the chamfered edge of the splined hole "in" or toward the body. The chamfer facilitates assembly.

6. Install the vanes in the rotor with their radius edge toward the inner ring contour.

7. Oil the cartridge with clean oil and install the pressure plate.

8. Install the 'O' rings, pressure plate spring and cover. Tighten the cover screws to 25-30 lb./ft. torque.

9. Insert the pressure compensating spring in the relief valve bore and insert the valve assembly with the hexagon toward the spring. Install the plug with the 'O' ring in the bore and hold it in position while driving in a new retaining pin.

10. Install the gasket on the pump cover and secure the manifold to the pump body with the screws. The copper washer is used on the screw where the tapped hole enters the oil passage.

11. Insert the key in the pump shaft and install the gear, securing it in position with the setscrew and washer fitted to the end of the shaft.

12. Locate the pump in the mounting plate, ensuring that the gear is correctly engaged, and secure the pump with two setscrews.

13. Reconnect the pump hose and pipe and refill the system with clean, new oil to the correct level. Ensure that all air has been bled from the oil prior to securing the filter cover.

TROUBLE SHOOTING

Trouble	Probable Cause	Remedy
PUMP NOT DELIVERING OIL	Driven in wrong direction of rotation.	Check direction of pump shaft rotation.
	Flow control valve stuck open.	Disassemble pump and wash control valve in a clean solvent. Return valve to its bore and slide it back and forth. No stickiness in movement should occur. If a gritty feeling is noted on the valve O.D. it may be polished with crocus cloth. Avoid removal of excess material or rounding of valve edges during this operation. Do not attempt to polish the valve bore. Wash all parts before reassembly of pump. Flush entire system thoroughly and fill with clean oil as recommended at the rear of the book.
	Vane or vanes stuck in rotor slots.	Disassemble pump, examine rotor slots for dirt, grime or small metal chips. Clean rotor and vanes in a good grade solvent (mineral spirits or kerosene) reassemble parts and check for free vane movement.
	Oil viscosity too heavy to pick up prime.	Use fluid of the proper viscosity as recommended.
	Pump intake partially blocked.	Drain system completely; flush to clear pump passages. Flush and refill system with clean oil as per recommendations.
	Dirty strainer.	Check filter in tank for clogged condition. Drain, flush and add clean oil to system if strainer was clogged.
PUMP MAKING NOISE	Restricted or partially clogged intake line or clogged filter.	Pump must receive intake oil freely or cavitation will result. Drain system, and clean intake line and strainers. Add new oil.
	Air leak at pump intake piping joints or pump shaft seal.	Test by pouring oil on joints and around drive shaft. Listen for change in operation. Tighten joints affected and replace pump drive shaft seal according to service instructions outlined in this manual.
	Reservoir or manifold seal leakage.	Leakage between manifold or reservoir. Check manifold gasket or reservoir seal ring.

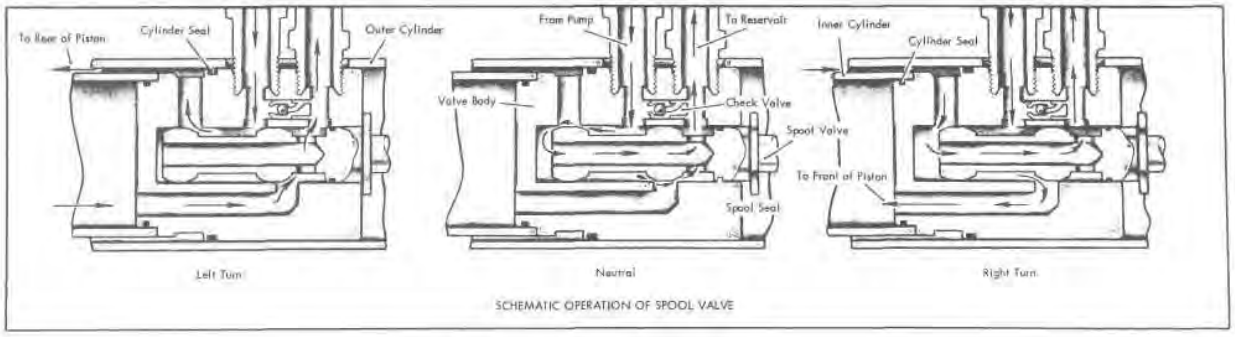


Fig. A20 — Booster Valve Schematic

BOOSTER CYLINDER

When the tractor wheels are in the straight ahead position, the booster valve spool is in the neutral position, allowing oil from the pump to be directed through passages to the outlet pipe and thence back to the pump. This is shown in the schematic oil flow diagram Fig. A20.

Movement of the steering wheel causes the booster control ball stud to operate the valve spool in the desired direction, causing oil flow to operate the piston to turn the wheels in the direction required.

Caution : Carefully check for stub axle clearance on both locks as it is important that these do not make actual contact before the pitman arm stops block the pitman arm swing. Adjust the booster connections as necessary.

Booster Overhaul :

Any overhaul necessitating the dismantling of the valve assembly should only be carried out in a workshop equipped with the correct type of testing facilities.

Should an oil leak be apparent in the cylinder, it is advisable to replace all seals.

To replace the seals, proceed as follows :—

1. Prepare a clean work area and thoroughly clean the cylinder.
2. Cut through the piston and seal holding cap locking strips with a hacksaw.
3. Clean the paint from the valve body through the unused ports in the outer cylinder and remove the hose adaptor nipples.
4. Unscrew the end cap and withdraw the piston. The inner cylinder and valve body will usually be withdrawn at the same time but, if this is not the case, tapping of the outer cylinder on a piece of wood will dislodge these parts.
5. Remove the valve body from the inner cylinder and the inner cylinder from the piston.
6. Remove the piston pin, the piston from the rod, and the retainer and seal assembly.

Note : This operation need only be done if an oil leak from the retainer has been apparent.

7. Remove the 'O' rings and thoroughly inspect all parts including the cylinder bore and piston ring. Replace if necessary.

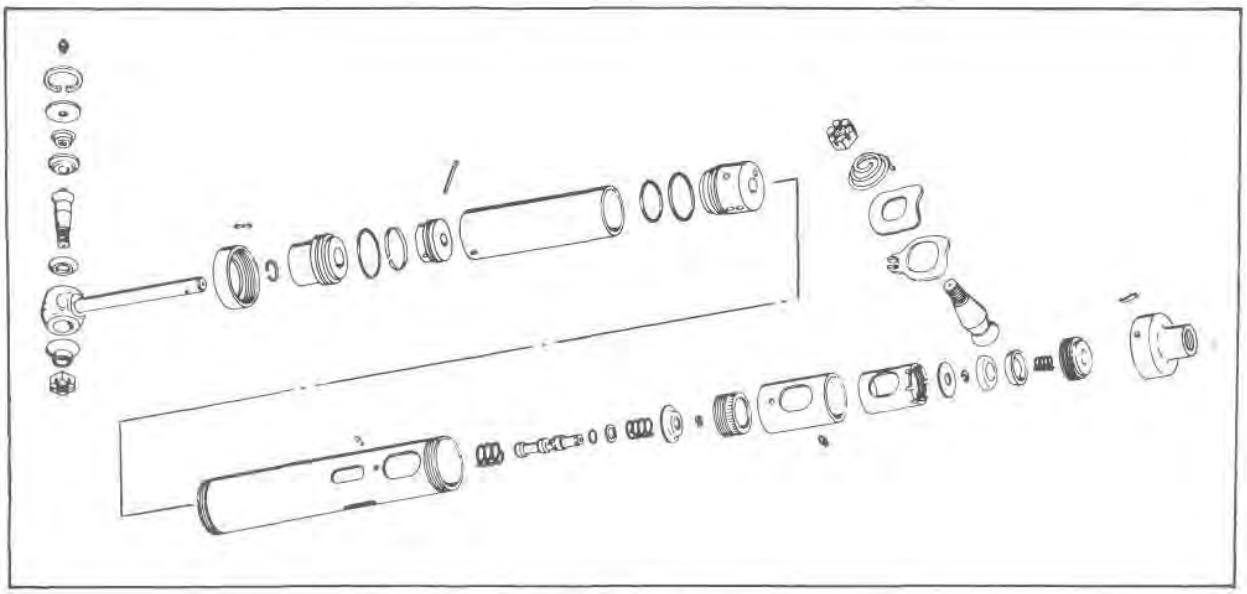


Fig. A21 — Booster Parts

8. Clean all parts and fit new 'O' rings.
9. Lubricate the dismantled parts, and re-assemble in the following order :

(a) Assemble the retainer assembly to the piston rod, with the retainer 'O' ring away from the threaded end of the rod, and assemble the piston and pin to the piston rod, the piston pin boss being closest to the seal retainer.

(b) Slide the inner cylinder onto the piston and over the seal retainer 'O' ring, ensuring that the two holes in the end of the cylinder are towards the retainer.

(c) Fit the valve body to the inner cylinder and install in the outer cylinder, ensuring that the body locates correctly on the spool, and that the hose adaptor holes are facing the correct port (90° counter-clockwise from the ball stud when looking towards the front of the booster).

(d) Install and tighten the retainer end cap and lock in position with spot weld on the locking strips.

(e) Re-assemble the hose adaptors, long return hose elbow nearest to the ball stud.

10. Fit the booster to the tractor, connect the hoses, and operate the power steering to bleed the system, to check adjustment and to check for oil leaks.

Booster Adjustment :

If the booster pulls in one direction when the steering is centralised, an adjustment can be made to re-centralise the body and spool :—

(a) Jack front wheels off the ground.

(b) Disconnect the drag link from the ball stud and remove the stud spring, dust cover and shield.

(c) Remove the square head setscrew contained by the shield and this will expose the knurled edge of the centralising nut.

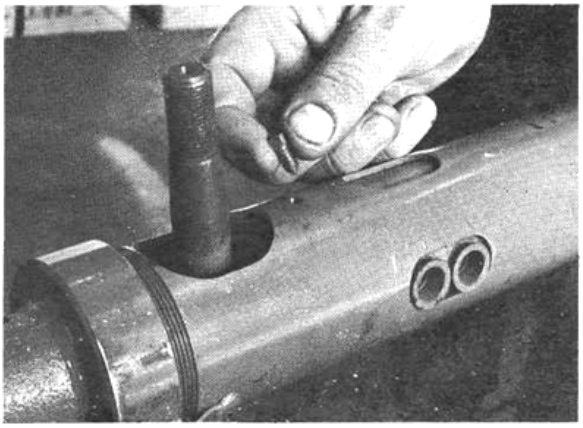


Fig. A22 — Booster Adjustment

(d) Apply hand pressure to the ball stud to relieve the pressure on the centralising nut and, using a small screw driver through the setscrew hole, turn the nut approx. 2 grooves in the knurling. (Clockwise if pulling to the right, anti-clockwise if pulling to the left).

(e) Refit the setscrew and the drag link to the ball stud, and check the booster operation. Re-adjust the centralising nut one groove at a time as necessary to give correct operation. Ensure that the setscrew is tightened to retain the centralising nut when the adjustment is correct.

BOOSTER TROUBLE SHOOTING

Trouble	Remedy
Oil leak along piston rod.	Replace retainer and seal assembly.
Oil leak from retainer end cap.	Replace retainer 'O' ring.
Oil leak from hose adaptor slots in outer cylinder.	Replace valve body 'O' ring.
Oil leak from booster ball stud.	Leaking spool quadring. Have booster overhauled.
Booster pulling one-way in operation.	Adjust centring nut with front wheels off the ground.
Booster overheating.	(a) Insufficient or incorrect oil. Replenish or replace. (b) Air trapped in booster. Remove return hose and bleed booster.

FRONT SUSPENSION

for : Champion Industrial Mark 3 Standard Model Manual and Standard Model T.C.

DESCRIPTION

The rigid beam, unsprung steering axle and yoke are a welded unit connected to the underside of the chassis crossmember beneath the radiator by a bolted swivel block and pin, and retained in a ball joint housing attached to the chassis crossmember under the flywheel housing. The balljoint is a bolt-on component and the pivot pin is retained by a lockplate, two setscrews and a locktab. Taper lock pins position and secure the kingpins in the axle ends which are recessed on the underside to accommodate thrust bearings. Adjustable steering stops are fitted to the axle but, when optional power steering is fitted, the stops must be removed.

Note : The steering stops are retained on the F.W.D. model Manual and Torque Converter transmission tractor steering system.

The axle assembly is rated to 1200 lbs. but this figure is subject to tyre manufacturers load recommendations.

Forged integral with the stub axles are bush lined kingpin supports, with the kingpin holes sealed top and bottom by cover plates to prevent the ingress of dirt. Steering arms fitted by a taper, key and nut to the lower section of the stub axles, are connected by an adjustable ball jointed track rod.

Standard model Manual and Torque Converter transmission tractors are fitted with a drag link to couple the steering box pitman arm to the drag link arm attached to the upper section of the stub axle, whilst F.W.D. model Manual and Torque Converter transmission tractors use two hydraulic cylinders to couple the drag link arms to anchor points located centrally on the axle.

Taper roller bearings are used to mount the wheels on the stub axles, and an oil seal with leather wiper assists to seal the lubricant in and exclude dirt.

LIGHT DUTY AXLE — OPTIONAL ALTERNATIVE EQUIPMENT

The rigid beam, unsprung steering axle and radius rod are a welded unit connected to the underside of the chassis crossmember beneath the radiator by a bolted swivel block and pin, and retained in a ball joint housing attached to the chassis crossmember under the flywheel housing. The ball joint is a bolt-on component and the pivot pin is retained by a lockplate, two setscrews and a lock tab. The axle ends are fitted with bushes to support the kingpins.

The axle assembly is rated to 6000 lbs. but this figure is subject to tyre manufacturers load recommendations.

The kingpins are secured to the forged stub axles by a taper, key and nut, and roller thrust bearings, fitted over the kingpins, support the axle. Steering arms, fitted to the upper ends of the kingpins, are connected by an adjustable, ball jointed track rod. A

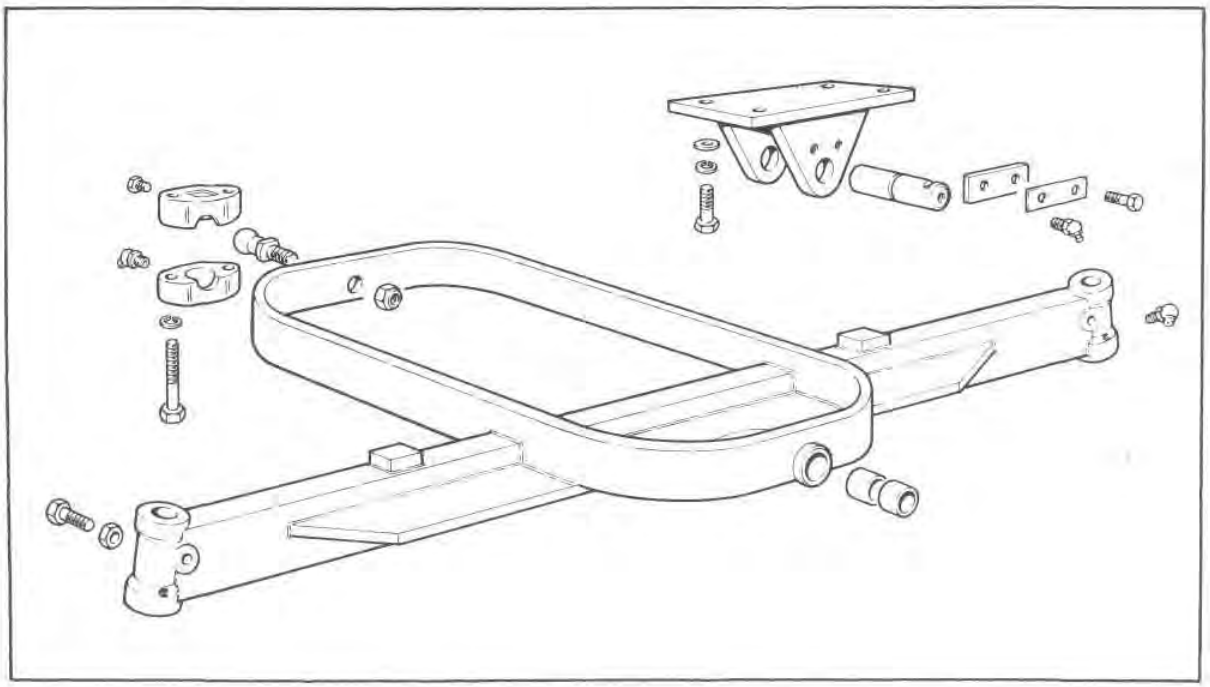


Fig. A23 — Heavy Duty Steering Axle (typical)

drag link, complete with a ball joint and locknut each end, couples the steering arm with the steering box pitman arm. Adjustable steering stops are fitted to the stub axle flanges.

Taper roller bearings are used to mount the wheels on the stub axles, and an oil seal with a leather wiper assists to seal the lubricant in and exclude dirt.

STEERING TYRES AND WHEELS

Cast split wheels are standard equipment, the Standard model Manual and Torque Converter transmission tractors having 8.25 x 50 x 8 ply tyres whilst the F.W.D. model Manual and Torque Converter transmission tractors use 9.00 x 20 x 8 ply tyres. A range of optional alternative tyres and wheels, including special flotation type, are available for heavy or light duty axle operation. Operating conditions and load requirements have considerable affect on tyre pressures and recommendations should be obtained from tyre companies for individual applications.

MAINTENANCE

Every 10 operating hours lubricate the grease nipples. Do not over-lubricate. Check tyres for faults and pressure.

Every 1200 operating hours, or once per annum, dismantle, clean and inspect the front wheel bearings. Re-assemble with the hub cavity half filled with grease, tighten the nut whilst turning the wheel by hand, until the bearings start to bind, then back the nut off sufficiently to allow the wheel to spin freely, but without perceptible side play (about $\frac{1}{8}$ of a turn). Re-pin the axle nut and replace the hub cap using a new gasket.

Periodically (at least once per annum) check on suspension nut tensions, particulary those securing parts in tapers, i.e. balljoints.

SERVICE

To Remove the Assembly :

1. Disconnect the draglink from the pitman arm or, if power steering is fitted, disconnect the booster

SPECIFICATIONS

	Std. Model	F.W.D. Model
Wheel Track		
Steering track — H.D. axle	64"	64"
Steering track — L.D. axle	60-5/16"	N.A.
Driving track — 18.4 x 28 tyres (cast wheels)	72-1/2"	18.4 x 28 tyres (cast wheels) 72-1/8"
Driving track — 14.00 x 28 tyres (cast wheels)	70-1/2"	14.00 x 28 tyres (cast wheels) 73-1/4"
Driving track — 18.4 x 28 tyres (pressed centre wheels)	66-3/8"	18.4 x 28 tyres (rolled rim) 70-1/8"
Camber	2°	2°
Castor	Nil	8°
Kingpin inclination — H.D. axle	4°	4°
Kingpin inclination — L.D. axle	6°	N.A.
Clearance turning circle —	Right lock — 30' 11" Left lock — 30' 11"	Right lock — 32'11" Left lock — 32'11"
Wheel base —	96"	96"
Wheel bearings —	Sealed H.D. taper roller	Sealed H.D. taper roller
Stub axles —	Forged steel	Forged steel
— H.D. axle	6° inclined	6° inclined
L.D. axle	8° inclined	N.A.
Lubrication —	See Chart	See Chart

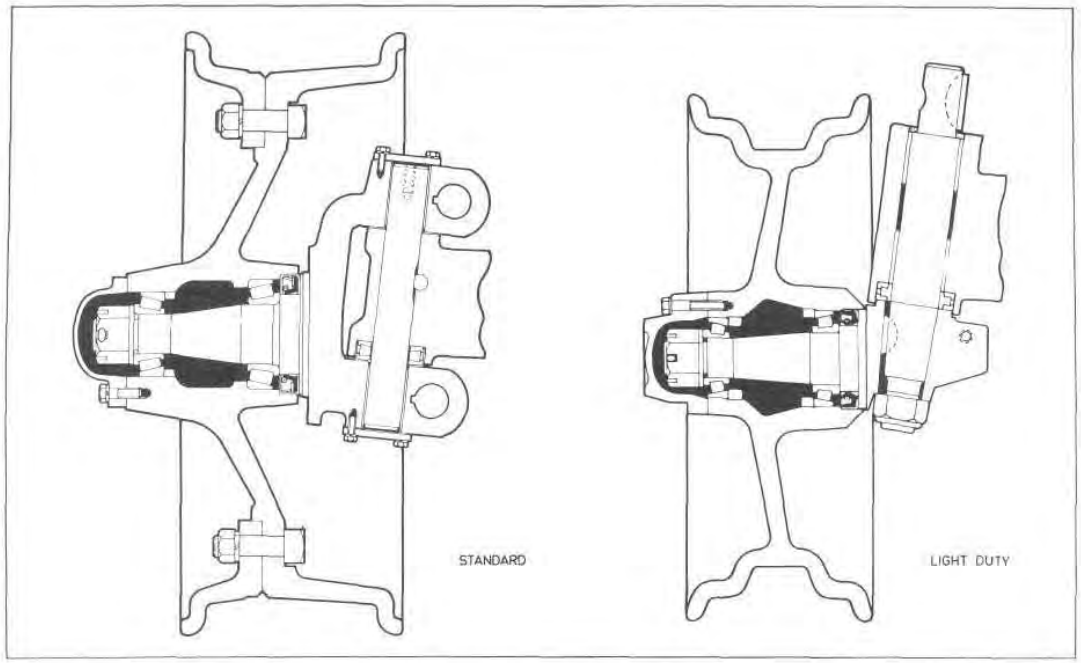


Fig. A24 — Steering Axle Wheel Sections

from the draglink, or on F.W.D. model tractors, disconnect the hydraulic cylinder hoses, capping them to prevent the entry of dust.

2. Jack under the chassis of the tractor beneath the radiator to relieve the weight on the steering wheels, and support the tractor with jacking stands under the chassis, behind the steering wheels.

3. Remove the bolts holding the axle swivel block to the chassis crossmember.

4. Remove the bolts and balljoint cap and raise the tractor to clear the swivel block.

5. Wheel the axle assembly clear of the tractor.

To Replace the Assembly :

Replacement is a reversal of the above procedure with care being taken with these points :—

(a) Locate the balljoint in its housing on the crossmember before tightening the swivel block bolts.

(b) Lower the tractor before finally tightening all nuts and bolts.

(c) If the draglink adjustment has been disturbed re-centralise the steering by moving the wheels to the straight ahead position, turning the steering wheel through its full travel and then halving this travel. Offer the draglink balljoint to the pitman arm, turn the draglink as necessary to align the balljoint and hole, and assemble the nut and splitpin.

(d) If the booster cylinder balljoint adjustment (power steering equipped tractors) has been disturbed, centralise the steering box and wheels and connect the booster to the draglink. Raise the tractor

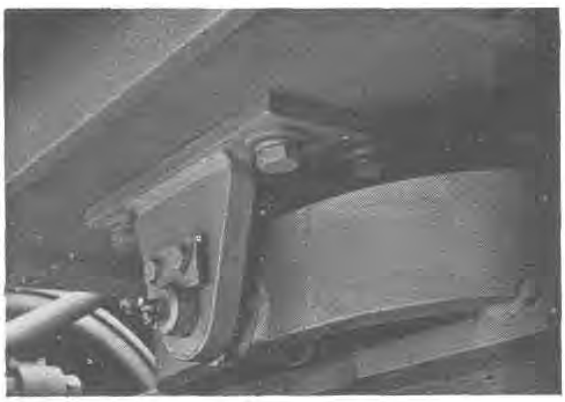


Fig. A25 — Axle Swivel Block Location

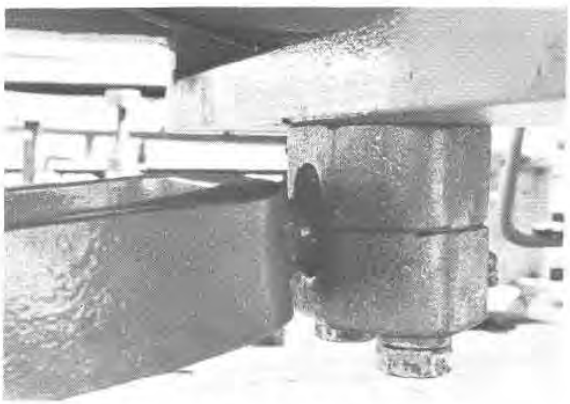


Fig. A26 — Radius Rod Ball Joint Location

and operate the steering lock to lock, and, if necessary, adjust the balljoint to obtain correct adjustment.

(e) If the hydraulic cylinder balljoints have been disturbed on F.W.D. model tractors, ensure that both cylinder lengths are equal prior to re-assembly, then check that the stub axles contact the stops before the cylinders bottom when the re-assembly is completed.

Kingpin Bush Removal :

1. Jack under the axle until the tyre is just resting on the ground.
2. Remove the wheel from the stub axle.
3. Remove the steering arm balljoint and, if fitted, the draglink balljoint.
4. Remove the kingpin top and bottom cover plates.
5. Remove the kingpin cotter pin. Do not damage the pin thread during removal as the nut must be assembled when the pin is replaced to ensure that the pin remains tight in service.
6. Using the tapped hole in the top of the kingpin to mount a puller, withdraw the kingpin upwards through the axle and support. Lift the stub axle clear of the axle.
7. Remove the bushes from the supports.
8. Press the replacement bushes into position, carefully aligning the grease hole. The inside diameter of the fitted bushes should be 1.3760" — 1.3780" after assembly, giving .001" — .0035" clearance when the kingpin is fitted. The bushes are not meant to be reamed.

Fig. A27 — Kingpin Cover Removal

Examine the kingpin and thrust bearing, and replace, if necessary.

10. Re-assemble by reversing the procedure, ensuring that the thrust bearing is fitted with the movable face toward the lower support.

Light Duty Axle Kingpin Bush Renewal :

1. Jack under the axle until the tyre is just resting on the ground.
2. Remove the clamp bolt from the steering arm and prise the arm from the kingpin. Remove the key.

Fig. A28 — Thrust Bearing Position

3. Jack up the axle so that the kingpin can be removed. If the tractor cannot be raised high enough, remove the wheel.
4. Remove the bushes from the axle.
5. Press the replacement bushes into position, carefully aligning the grease hole. The inside diameter of the fitted bushes should be 1.8755" — 1.8775" after assembly, giving .001 — .0035" clearance when the kingpin is fitted. The bushes are not meant to be reamed.
6. Examine the kingpin and roller thrust bearing, and replace, if necessary.
7. Re-assemble by reversing the procedure, ensuring that the thrust bearing is fitted with the movable face toward the kingpin flange boss.
8. When the steering arm is correctly repositioned, tighten the clamp bolt to 260 lb./ft.

Wheel Alignment :

1. Mark the inside edge of each wheel rim and move the wheels until these marks are at the farthest position from the driving wheels and horizontal with the centre of the wheels.
2. Measure the distance between the marks. The use of a telescopic rod is the most convenient method, but a rule used in conjunction with a straight length of rod can, if used with care, give satisfactory results.

Fig. A29 — Checking Wheel Alignment

3. Move the tractor until the two marks are at the closest position to the driving wheels and horizontal with the wheel centres. Compare the distance between the marks in this position with the original distance. It should be $\frac{1}{8}$" greater.

4. Repeat the procedure with two more marks opposite the original marks to check the accuracy of the previous measurement.

5. Adjust as necessary by loosening the balljoint locknuts and adjusting the wheel positions to suit. Tighten the locknuts and re-check the measurement.

MANUAL STEERING TROUBLE SHOOTING CHART

Trouble	Probable Cause
Broken Column Shaft.	Incorrect column rivet alignment. Loose steering box mounts. Incorrectly adjusted steering stops. Steering column bent sideways in mounting.
Hard Steering.	Incorrect tyre pressures. Incorrect front wheel alignment. Incorrect steering box adjustment. Lack of steering box lubrication. Seized column upper bearing. Lack of kingpin lubrication. Incorrectly fitted kingpins. Collapsed kingpin thrust bearing.
Scuffed Tyres.	Incorrect tyre inflation. Incorrect wheel alignment. Worn balljoints.
Wheel Wobble or Shimmy.	Uneven tyre inflation. Incorrectly mounted tyre. Incorrect wheel bearing adjustment. Worn balljoints. Loose steering box adjustment. Loose steering box mounts. Pivot pin loose and working out. Incorrectly machined rim.
Difficult to Control Steering.	Incorrect wheel alignment. Cracked balls.

'ORBITROL' POWER STEERING

for : Champion Industrial Mark 3 F.W.D. Manual Model and F.W.D. T.C. Model

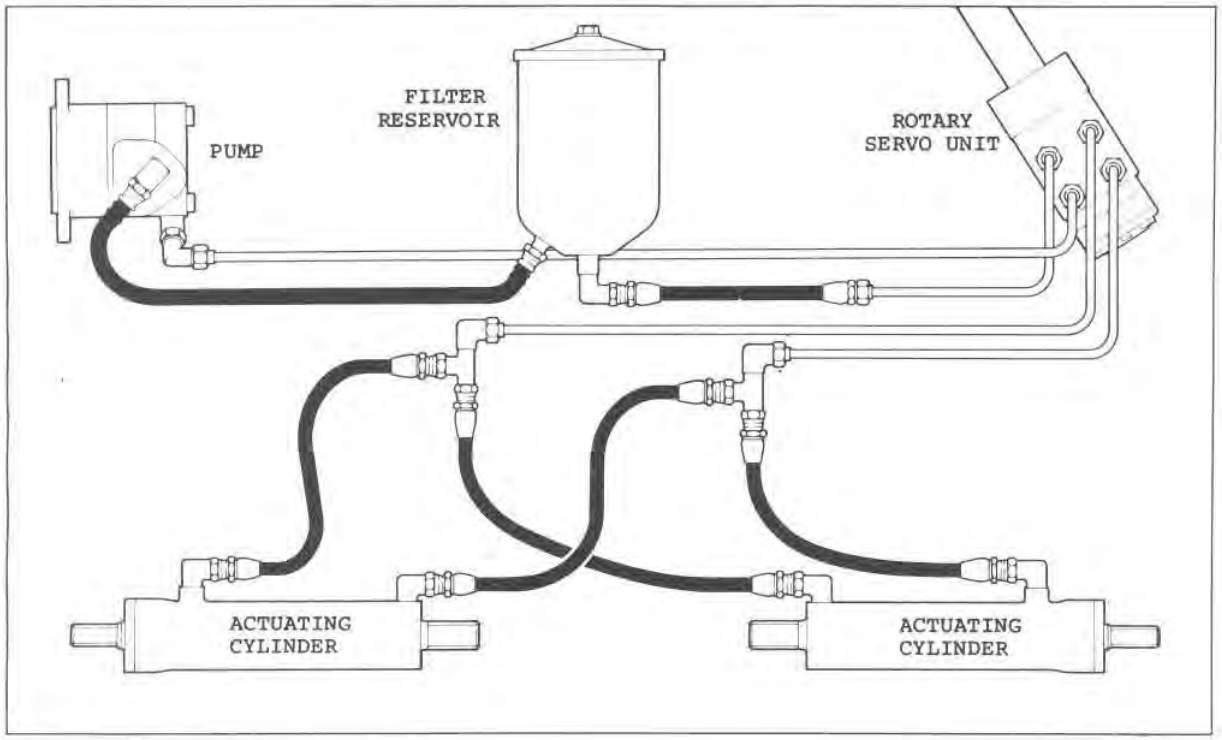


Fig. A30 — Power Steering — F.W.D. Manual and T.C. Models

DESCRIPTION

The power assisted steering system provides effortless steering as it requires low input torque, which is helpful in reducing operator fatigue. The system comprises a direct engine driven vane type pump with remote mounted reservoir, rotary servo control unit, actuating cylinders connected to the steering arms and anchored centrally on the axle, and pipes and hoses connecting the reservoir, pump, control and cylinders.

No worm gear or lower steering column bearings are used, as the 'Orbitrol' is a remote rotary hydraulic control with the steering wheel attached. Both the control valving and fluid meter are contained in one integral unit which feeds fluid as directed by the manually controlled valving, measures the fluid required to control steering and uses the fluid measuring meter to reposition the steering reference base. A ball valve enables the unit to revert to emergency manual control automatically in the event of supply pressure loss.

SPECIFICATIONS

Pump	— Vickers VTM27 vane type with remote mounted reservoir.
Capacity	— 4 g.p.m. nominal.
Relief valve pressure	— 750 p.s.i.
Rotary servo unit	— Char-Lynn 'Orbitrol'.
Model	— WC-11 (load reaction).
Displacement (cu. in. per steering wheel revolution)	— 6.2 cu. in.
Capacity	— 6 g.p.m. maximum.
Input torque	— 26 lbs./ins.
Max. "out" port back pressure	— 30 p.s.i.
Port threading	— $\frac{3}{4}$" — 16 UNF.
Actuating cylinders	— Malcolm Moore.
Bore	— 2".
Stroke	— 6".

MAINTENANCE

The sealed system requires a periodical oil level check and, at 1200 hours, renewal of the oil and filter element.

Oil Level :

Remove the filter cover and check that the oil is within $\frac{1}{4}$" of the lip of the barrel when the boosters are centralised. Add oil, of the recommended type, as necessary.

Oil and Filter Element Renewal :

Drain the reservoir oil, remove the element and thoroughly clean inside the barrel. Instal a new element and, with the boosters centralised, fill with new

oil allowing sufficient time for the element to absorb oil and air to escape. Operate the steering to each full lock to bleed the system of air and, when no more bubbles are apparent with the boosters centralised, top up the reservoir to within $\frac{1}{4}$" of the barrel lip. Instal the cover ensuring that the seal is correctly located.

Caution : Absolute cleanliness is essential as any dirt introduced into the oil will cause premature component wear.

OPERATION

The pump Description, Overhaul and Trouble Shooting procedures, contained in pages A 6. to A10. of this Section also apply to this power steering system and should be used as necessary.

In the basic 'Orbitrol' unit depicted in Fig. A32 the primary control valve maintains an open-centre circuit which recirculates fluid from the pump back to the pump reservoir. A relatively low pressure drop is experienced with the 'Orbitrol' in the neutral position (zero force on the steering wheel).

When steering action is initiated by rotation of the steering wheel, the control spool is rotated by direct connection from the input shaft. Rotation of the spool closes the neutral porting while opening ports allowing fluid to be fed to the meter section of the unit. The fluid displaced by the meter is then ported to feed the proper cylinder control port. The alternate cylinder port is simultaneously coupled to return displaced cylinder fluid to the system reservoir. At slow steering speeds, when all of the fluid delivered to the 'Orbitrol' is not needed at the remote steering cylinder, partial closing of the control porting allows part of the fluid to be routed back to the reservoir without passing through the meter and actuator circuit.

While measuring fluid required by the remote cylinder, the 'Orbitrol' metering section is in motion. This motion is fed back through the unit to reposition the control sleeve, providing a rotary follow-up action in the steering wheel. This feature is responsible for the sensitive feel experienced at the steering wheel when using the 'Orbitrol'.

In the event of pump or power source failure the 'Orbitrol' automatically reverts to a manual steering system. In this condition the fluid metering section becomes a rotary hand pump and directs fluid to move the cylinder in either direction when the steering wheel is manually rotated. A check valve within the unit allows recirculation of the fluid within the remote cylinder system.

SERVICE

Functional Check :

A normal periodic functional check of the entire power steering system will generally be adequate to ensure satisfactory service. The oil level of the reser-

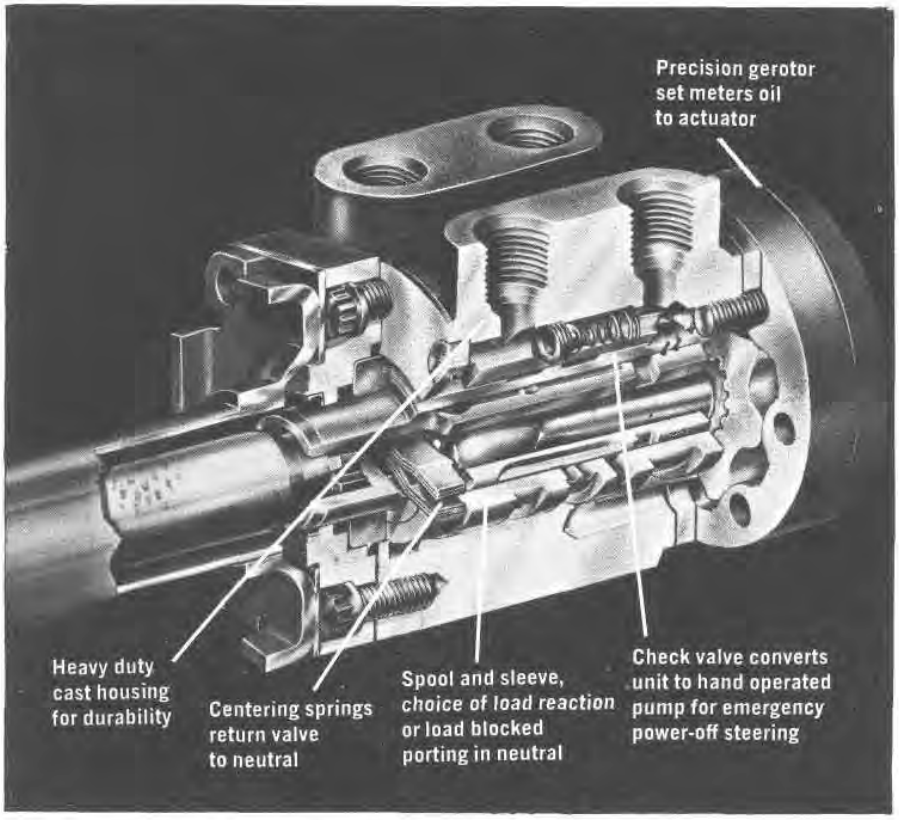


Fig. A31 — Rotary Servo Control

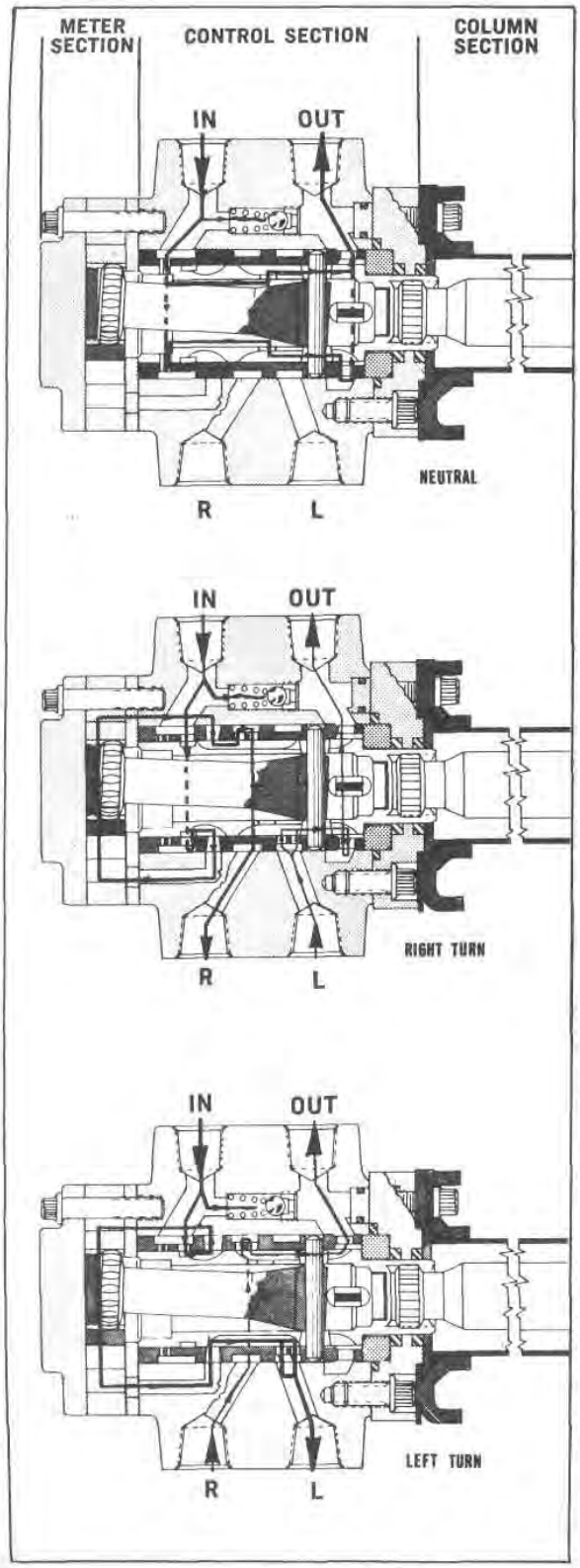


Fig. A32 — Rotary Servo Unit Operation

voir is MOST IMPORTANT. If the oil level drops appreciably over short periods of use, it will be wise to search for a leak in the system.

A black accumulation of dirt at a fitting can indicate a leakage point. If the fitting is taken apart to correct leakage, first — clean the area completely with a solvent-wetted cloth, steam clean, or otherwise clean off any debris from the immediate area and any dirt accumulation above the area so that contaminatioin will not enter the system while the connection is open. Then tape the connection or, if compound is used, use it sparingly on the male fitting only. Do not let any compound enter an area in which it may be washed into the oil stream.

Warning : Never use fluid system 'stop leak' additives to attemp to seal fluid leakage. Many good power steering systems have been ruined by such attempts.

To continue the functional check of the system, turn the steering wheel through the full travel with the engine operating. Do this at engine idle and full throttle — with the machine standing with the front wheels on a hard dry surface and the machine rolling slowly. Note any speed irregularities and sticky sensation. These may indicate dirt in the fluid. If under any of these conditions the steering wheel continues to rotate when started and released, a condition known as MOTORING exists. This may also indicate dirty fluid in the system.

If dirty fluid is suspected, clean or replace the filter element in the reservoir. There is no filter in the 'Orbitrol'. Drain and replace as much of the oil as possible; jack the front wheels off the ground and swing the cylinders through a full travel pushing on the wheels; but **do not** forcibly rotate the 'Orbitrol' steering wheel if dirty fluid is suspected. Refill the system with clean, new oil, run the system briefly, recheck and refill as necessary, to obtain proper fluid level. Operate the system for a short time to determine whether a correction has resulted. It is sometimes less costly to rinse and reclean the system twice than to completely tear down and re-assemble a unit, and the clean fluid will definitely protect all the components of the system.

In the functional check, determine also that the actuating cylinders achieve full travel without hesitation. If the cylinders seem to pause in their travel while they should be moving smoothly, this may indicate that they contain trapped air. In filling and refilling a system, it is sometimes necessary to lift the tractor weight off the steered axle or to remove the cylinders and hold them in a position so that the ports are uppermost so that air will be bled back to the system reservoir and effectively exhausted from the system at the reservoir vent. During this inspection, determine that the mechanical limit stops at the axle are functioning properly. Proper wheel alignment is every bit as important on power-steered tractors as on any other to insure satisfactory tyre life and geometrically true steering.

Inspect to insure that the system has adequate power. If there is an indication of "hard-steering", this can indicate either a reduced oil flow to the control or a reduced system relief pressure. Adequate

oil low under all conditions can best be checked by timing the full travel of the cylinders with the steered axle unloaded and loaded. If there is a great difference at low engine and slight difference at high engine speed, this may indicate a defective pump drive. Adequate oil presure can only be determined by connecting a pressure gauge (2000 p.s.i. full scale recommended at the pump outlet port or at the "IN" port of the ORBITROL. With the engine running at a medium speed, turn the steering wheel to one end of the travel and hold the cylinder at the travel limit briefly — just long enough to read the pressure gauge. Never hold a system at relief pressure for more than a few seconds at a time. Longer operation at relief pressure can overheat most systems quite rapidly. The pressure relief valve in the pump is a protection for all of the various parts of the steering system. There is no pressure relief in the ORBITROL.

If the system is reported to operate extremely hot, connect a pressure gauge as above and operate the engine at near full throttle. Rotate the steering wheel slowly in each direction and bring the wheel to the position that shows the lowest pressure reading. This places the control section of the unit in neutral. Then turn the steering wheel to a limit stop and hold it there for one or two seconds. Release the steering wheel gently and watch the gauge. If the pressure does not drop to very nearly the same neutral pressure as measured when placing the control in neutral deliberately, a binding control shaft or dirt between the spool and sleeve of the control valve can be the cause of the difficulty.

If the recentering characteristics as measured above are erratic and if the control feels slightly sticky through most of the travel, apply the pressure gauge in the "OUT" line of the ORBITROL. This return line pressure should be below 30 p.s.i. during all periods of normal operation. Check this "downstream" line to insure that no fittings are obstructed.

If after the inspections described, a functional difficulty is indicated in the 'Orbitrol', use the following procedure for disassembly, inspection and reassembly.

Preparation for Removal:

1. Before removing the 'Orbitrol' from the tractor, be certain that it — the entire area around it — and the connecting hoses are cleaned free from dirt and contamination.
2. Seal the "IN", "OUT", "L" and the "R" ports against dirt.

'Orbitrol' Removal :

1. Drain the system oil from the reservoir. Jack the wheels and turn the steering wheel to exhaust as much oil as possible from the system.
2. Disconnect the pipes from the 'Orbitrol' and remove the connectors. Seal the ports against the ingress of dirt.
3. Remove the steering wheel. Prise the cap and emblem clear, remove the shaft nut and use a puller to remove the steering wheel.
4. Remove the upper column support retaining setscrews.
5. Remove the lower support bracket retaining setscrews and slide the unit downward free of the instrument panel. Manoeuvre the unit free of the tractor.

Preparation for Disassembly :

1. If there is a functional problem or leakage at the control end of the unit only, the disassembly of the control end of the unit will be required and it is generally advisable to leave the 7-bolted end assembled.
2. For any disassembly, an extremely clean bench area is necessary. Do not use shop cloths or cotton waste to wipe or clean the parts. The lint deposited by these can disrupt function, or cause leaks.
3. If a complete dismantling and reassembly of the unit is planned, clean all paint and surface contamination from the unit at points of separation. This is extremely important at the meter end of the unit so that no paint flakes or particles will enter these closely fitted parts as they are being reassembled. To clean the unit adequately, first plug all four ports, then wire brush around the meter area and rinse and blow all surface contamination before any disassembly is begun.
4. Assembly is generally easier and more satisfactory with clean dry parts. After parts are rinsed clean in solvent, they may be blown dry with an air hose (filtered supply) or placed on clean paper towelling to drain and air dry.

Disassembly :

Place the unit in a vise, control end up. Clamp across port surface and opposite side of housing lightly. Remove the four cap screws that fasten the column to the lower unit. Use a 5/16" Inhex socket wrench. Remove column and set aside. (Mark the four cap screw holes so that the ports will be in the proper direction when re-assembled). Figures Nos. A33, A34, A35.

Observe the shaft area of the lower unit immediately upon removal of the column assembly. If it shows an appreciably oil-wetted appearance, this indicates that the shaft seal may have been leaking.

Note : Check the length of the capscrews as they are removed and, if there is any length variation, replace them in their former positions.

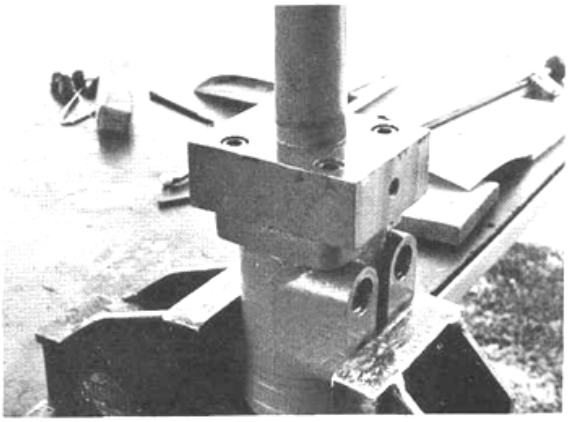


Fig. A33 — Unit Prepared for Disassembly

Fig A34

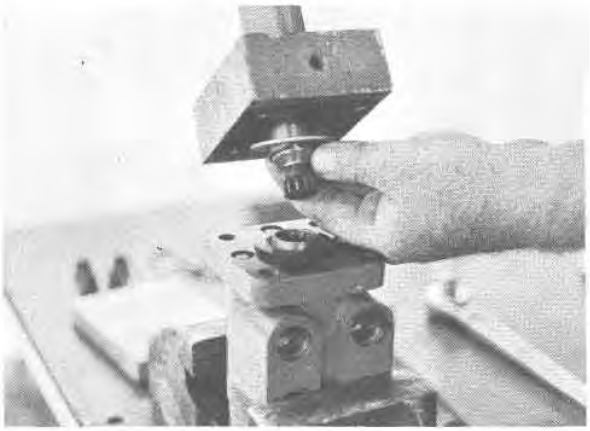


Fig. A35

Fig. A36

Fig. A37

Fig. A38

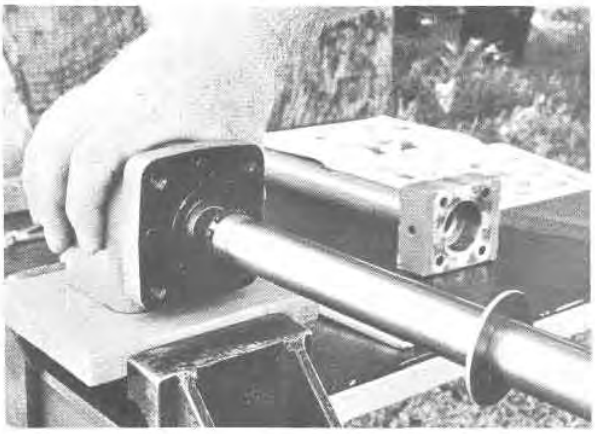


Fig. A39

Clamp the unit in the vise across the mounting plate edges with the meter end up and remove 7 cap screws. Use a $\frac{1}{4}$" A.F. 12 pt. socket or ring spanner. Fig. A36.

Remove the control assembly from the vise and check for free rotation of the control spool and sleeve parts with the column shaft. Fig. A39.

Place clean wooden block across the vise throat to support the spool parts and clamp the unit across the port face with the control end up. Remove and set aside four capscrews. Use a 5/16" 12 pt. socket. Fig. A40.

Hold the spool assembly down against the block in the vise and lift off the end cap. Fig. A41.

Inspect mating surfaces for obvious leakage path wear. seal condition. Fig. A42.

Remove the cap locator bushing. Fig. A43.

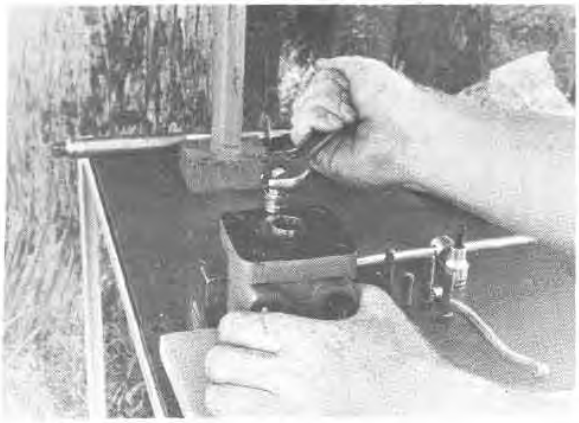


Fig. A40

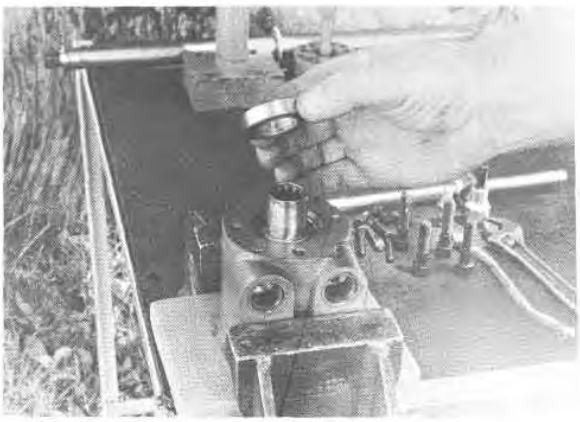


Fig. A43

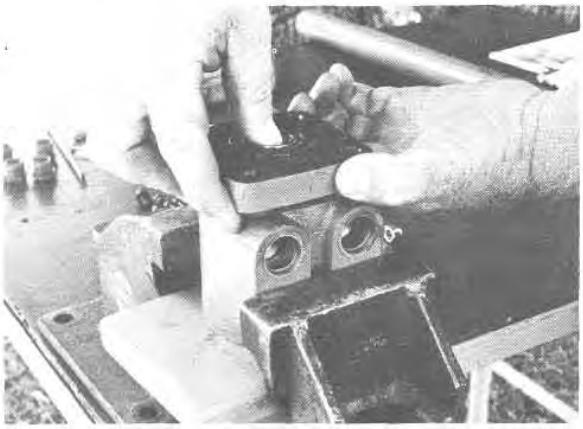


Fig. A41

Fig. A44

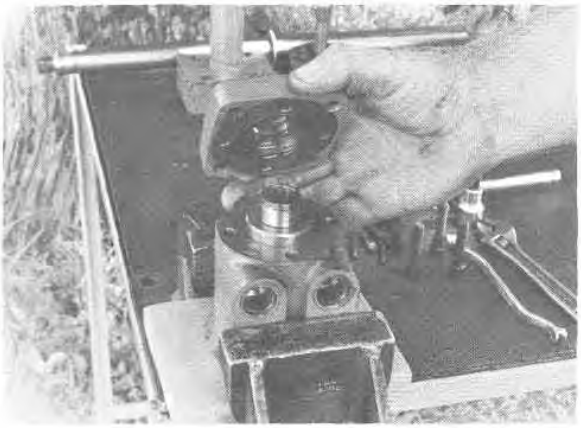


Fig. A42

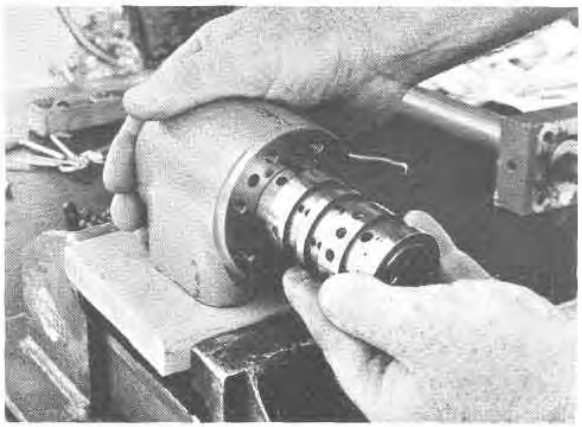


Fig. A45

Place the housing on a solid surface with the port face down so that it can be held securely and remove the spool-sleeve assembly from the 14 hole end of the housing. Fig. A44.

Be extremely careful to prevent these parts from binding as they are very closely fitted and must generally be rotated slightly as they are withdrawn. Fig. A45.

Use a small bent tool or wire to remove the check valve seal plug from the housing (Do NOT pry against the edge of the hole in the housing bore). Tool shown in Section P, Fig. P11. Fig. A46.

Place the housing in the vise, control end up, and unscrew the check valve seat with 3/16" hex. wrench. Fig. A47.

Fig. A46

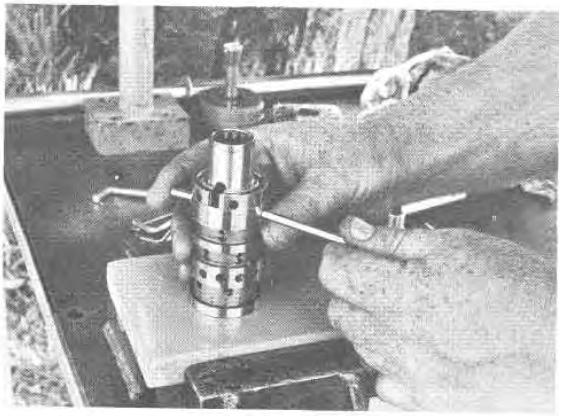


Fig. A49

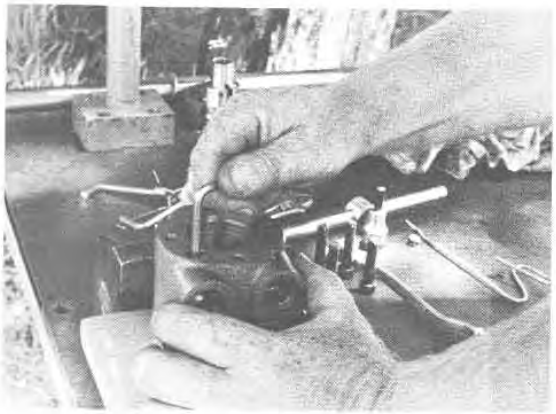


Fig. A47

Fig. A50

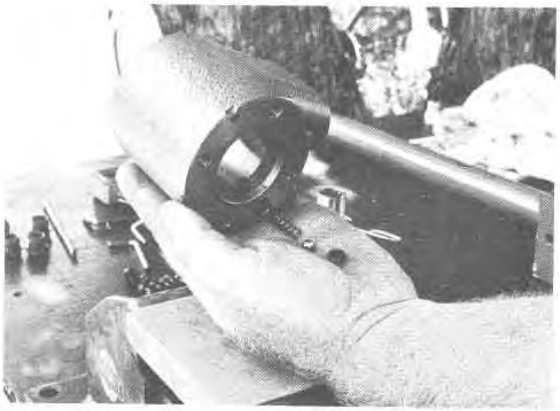


Fig. A48

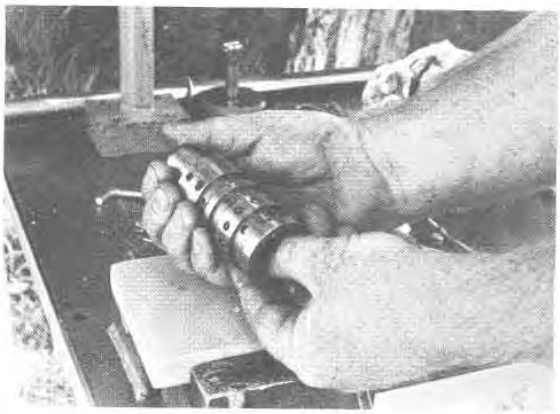


Fig. A51

Up end the housing and tap lightly with the butt of hand. Hold the check valve hole toward the lowest corner and remove the check valve seat, ball and spring. Fig. A48.

In the spool assembly, push the cross pin to loosen from the sleeve assembly. Fig. A49.

Remove the cross pin and set aside. Fig. A50.

Push the inside lower edge of the spool so that the spool moves towards the splined end and remove carefully from the sleeve. Fig. A51, and Fig. A52.

Push the centering spring set out of the spring slot in the spool. Observe the spring position for re-assembly. Fig. A53 and Fig. A54.

At this point all parts have been disassembled and removed from the unit. Each should be rinsed carefully in clean solvent, even such exterior parts as all cap screws and all seals that appear to be reusable. If in doubt, replace with new seals. It is good service

Fig. A52

Fig. A54

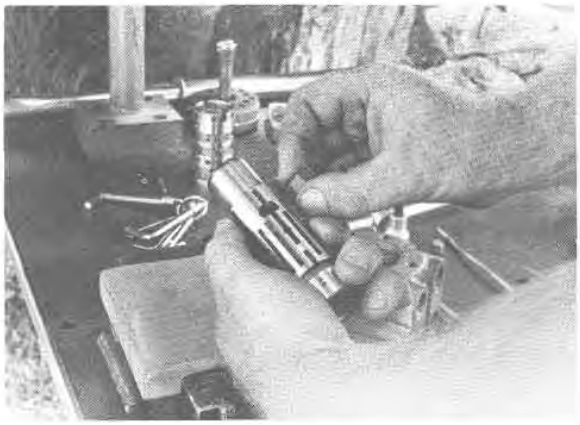


Fig A53

policy to replace all seals when the unit is reassembled. They are available in kit form. Rinsing and cleaning can be done while other parts of the unit are being disassembled and parts can be set to dry on clean paper towel. The meter gear set must be disassembled and cleaned similarly.

Inspect all moving surfaces to ensure that they have not been scored or abraded by dirt particles or otherwise disrupted. Smooth burnished surfaces are normal in many areas. Slightly scored parts can be cleaned with 600 grit abrasive paper by hand rubbing only.

To prepare all surfaces of the meter section for reassembly and ensure that all edges of the parts are burr free, place a piece of 600 grit abrasive paper face up on an extremely flat, clean, hard surface. The surface to be used for this purpose should be as flat as plate glass or better. If the 600 grit paper is new it should first be rubbed down with a scrap steel part to remove sharp grit which would produce scratches. The ends of the star gear can be used for this purpose if necessary. Then both sides of the ring gear, both sides of the plate, the 14 hole end of the housing and the flat side of the end cap should be cleaned lightly.

Stroke each surface across the abrasive several times and observe the part. Fig. A55. Any small bright area near an edge indicates a burr which must be removed. Hold the part so that contact with the abrasive is as flat as possible (Do not push one edge down hard or the flatness will become rounded). Check each part after 6 to 10 strokes across the abrasive. After polishing each part, rinse clean in solvent and blow dry. Keep these parts absolutely clean until they are assembled.

Fig. A55

Fig. A56

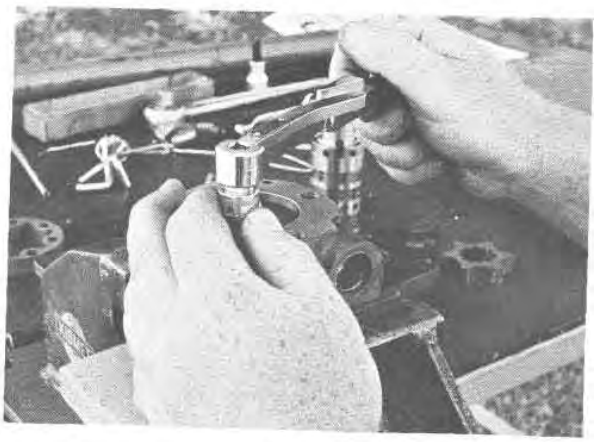


Fig. A59

Fig. A57

Fig. A60

Fig. A58

Fig. A61

Re-assembly :

Place the housing in the vise with the control end up. Protect the 14 hole end as before, and clamp across the port surface lightly. Drop the check valve spring into the check hole with the large end down. Fig. A56. Drop the check ball into the check hole and insure that it rests on top of the small end of the spring within the hole. Place the check valve seat on the hex wrench and screw into threads within the check hole so that the machined counterbore of the check seat is towards the ball. Fig. A58. Tighten the check seat to 150 inch-pounds torque Fig. A59.

Test the check ball action by pushing the ball with the small clean pin against the spring force. Ball need NOT be snug against the seat for proper function.

Install the spool within the sleeve carefully so that the spring slots of both parts will be at the same end. Rotate while sliding parts together. Fig. A60 and Fig. A61. Test for free rotation. The spool should

Fig. A62

Fig. A63

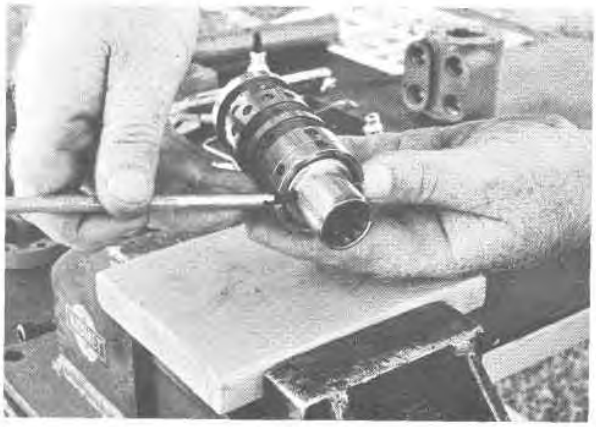


Fig. A64

Fig. A65

Fig. A66

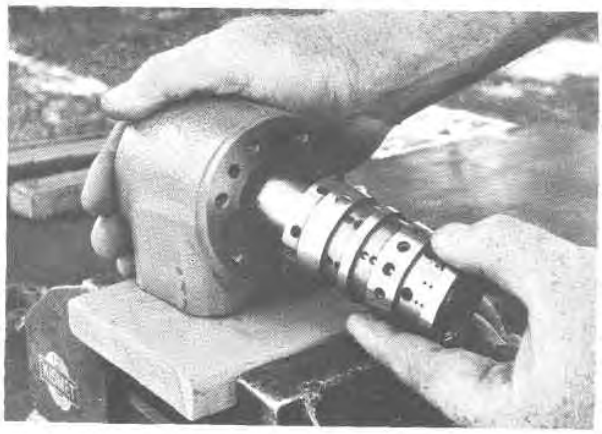


Fig. A67

rotate smoothly in the sleeve with finger tip force applied at the splined end.

Bring the spring slots of both parts in line and stand parts on the end of the bench. Insert spring installation tool through the spring slots of both parts. The tool shown in Section P, Fig. P 12. Position 2 sets of 3 each centering springs on the bench so that extended edge is down and arched center section is together. In this position, enter one end of the entire spring set into the spring installation tool. Fig. A62.

Compress the extended end of the centering spring set and push into the spool sleeve assembly withdrawing the installation tool at the same time. Fig. A63.

Center the spring set in the parts so that they push down evenly and flush with the upper surface of the spool and sleeve. Fig. A64.

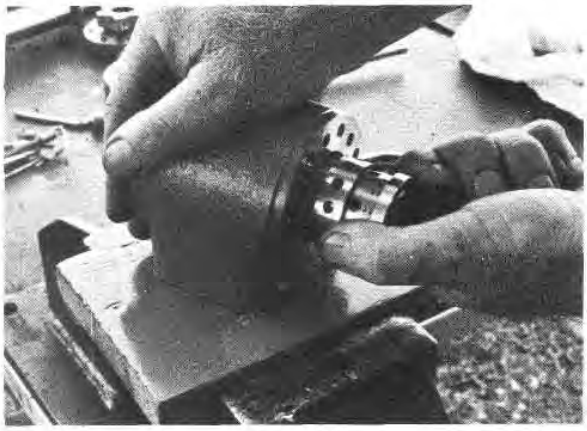


Fig. A68

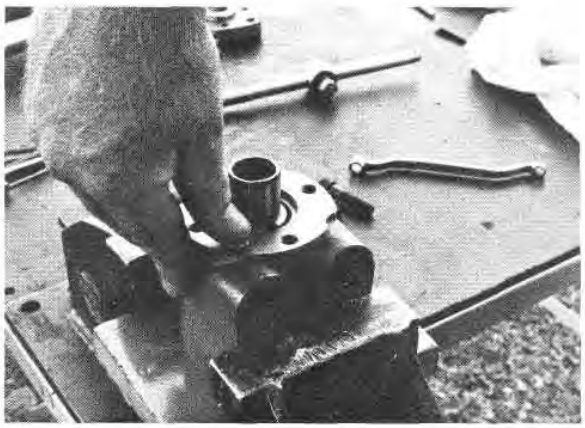


Fig. A71

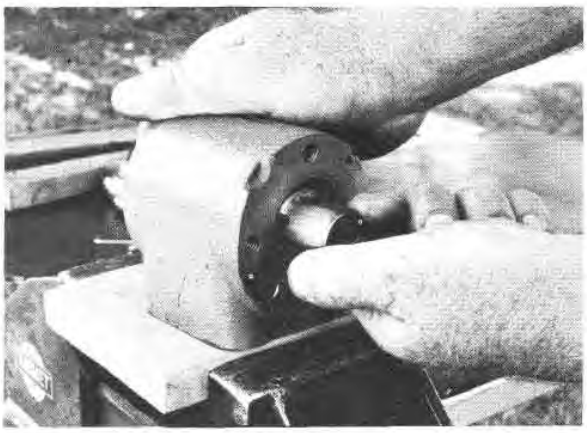


Fig. A69

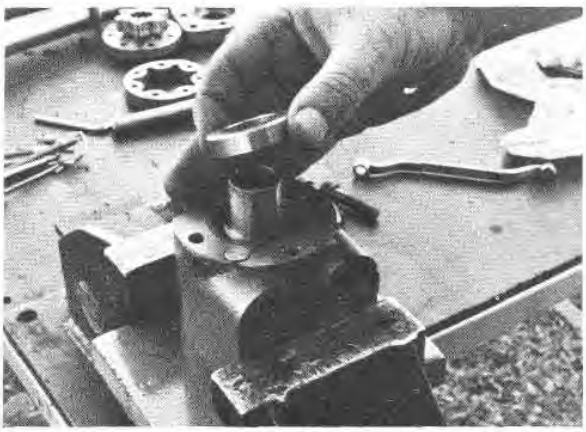


Fig. A72

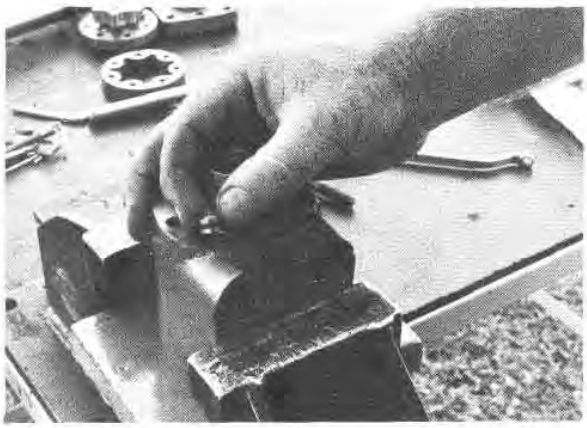


Fig. A70

Install the cross pin through the spool assembly Fig. A65.

Push into place until the cross pin is flush or slightly below the sleeve diameter at both ends. Fig. A66.

Position the housing on a solid surface with the port face down. Start the spool assembly so that the splined end of the spool enters the 14 hole end of the housing first. Fig. A67.

Be extremely careful that the parts do not cock out of position while entering. Push gently into place with slight rotating motion. Fig. A68.

Bring the spool assembly entirely within the housing bore until the parts are flush at the meter end or 14 hole end of the housing. Do not pull the spool assembly beyond this point to prevent the cross pin from dropping into the discharge groove of the housing. With the spool assembly in this flush position, check for free rotation within the housing by turning with light finger force at the splined end. Fig. A69. Hold the parts in this flush position and rest the 14 hole end of the assembly on the protective block on the vise throat and clamp lightly across the port face with the vise.

It is good service policy to replace all seals when the unit is re-assembled. They are available in Kit form.

Check the condition of the 'O' Ring seal on the check plug and replace it if necessary. Install the check plug in the check hole with a steady pressure while rocking it slightly so that the 'O' Ring feeds in smoothly without cutting. Figs. A70 and A71.

Position the cap locator bushing with the large O.D. chamfer UP partly into the end of the housing. Fig. A72. Ensure that it seats against the spool assembly flat and smooth by rotation with finger tips.

Check the mounting plate and shaft seal carefully to insure that they are clean and in good condition.

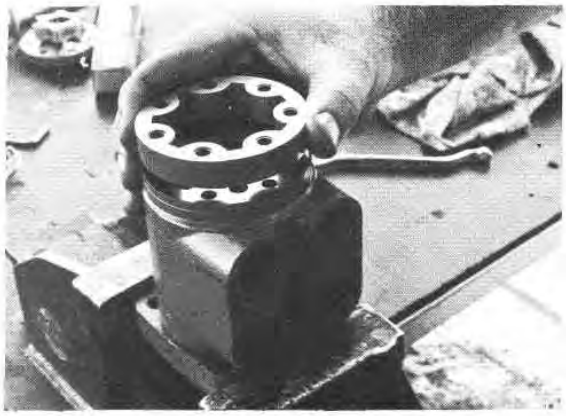


Fig. A79

Fig. A82

Fig. A80

Fig. A83

Fig. A81

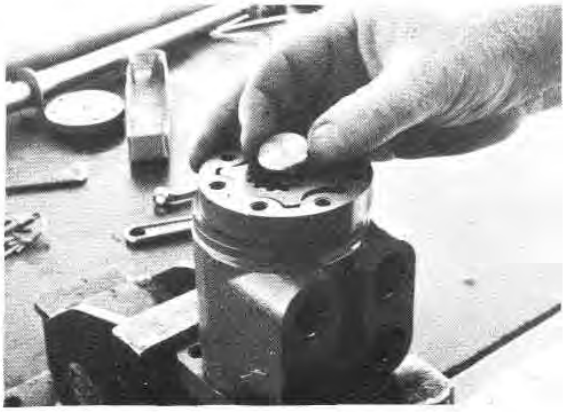


Fig. A84

Reposition in the vise and clamp across the edges of the mounting plate. Check to ensure that the spool and sleeve are flush or slightly below the 14 hole surface of the control housing. Fig. A76.

Clean the upper surface of the housing by wiping with the back of a clean hand or the butt of the thumb. Clean each of the flat surfaces of the meter section parts as it is ready for assembly in a similar way. Fig. A77.

Place the plate over this assembly so that th bolt holes in the plate align with the tapped holes in th housing. Fig. A78. Place the meter gear ring on the assembly so that the bolt holes align. Fig. A79.

Place the splined end of the drive within the meter gear star so that the slot at the control end of the drive is in alignment with the valley between the meter gear teeth. Fig. A80. Push the splined end of the drive through the gear so that the spline extends about one half its length beyond the meter gear star and hold it in this position while installing into the unit. Note the position or direction of the cross

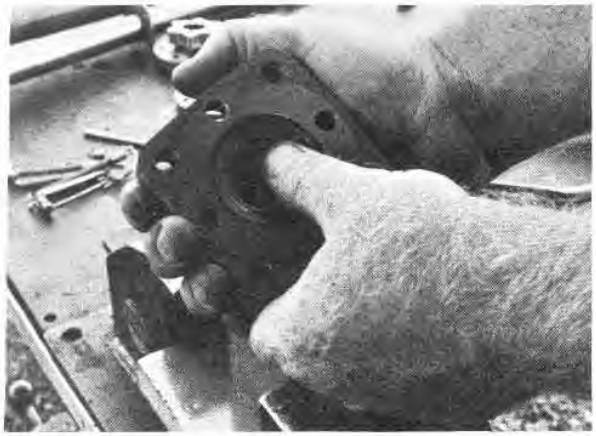


Fig. A73

Fig. A74

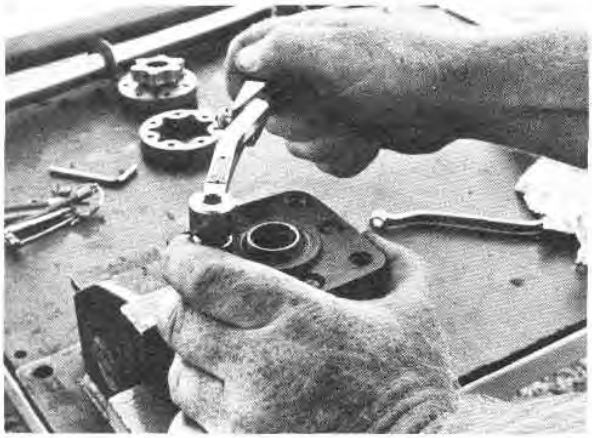


Fig. A75

Insure that the mounting plate seal grooves are clean and smooth. Each of these seals is slightly larger than its seal groove so that they will be adequately retained in service. Push each gently into place and smooth down into the seal groove with finger tip Fig. A73.

Thin oil seal at exterior of mounting plate is a dirt exclusion seal and does not generally need replacement. If this is replaced it should be pressed into the counterbore so that the lip is directed away from the unit.

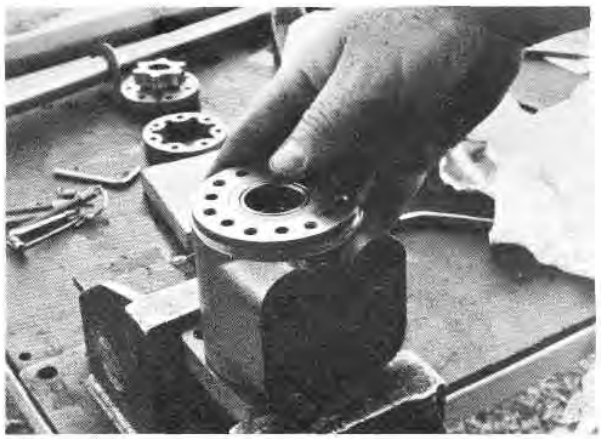


Fig. A76

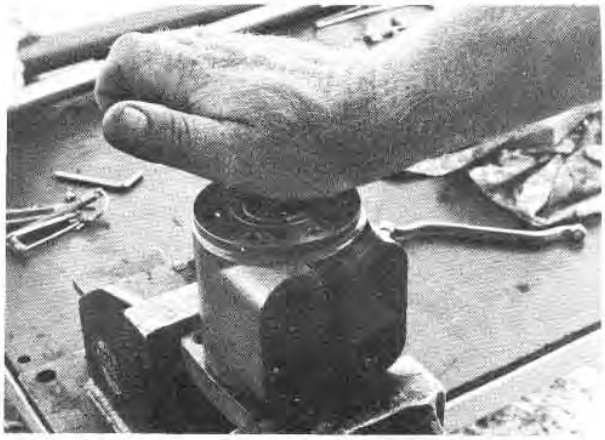


Fig. A77

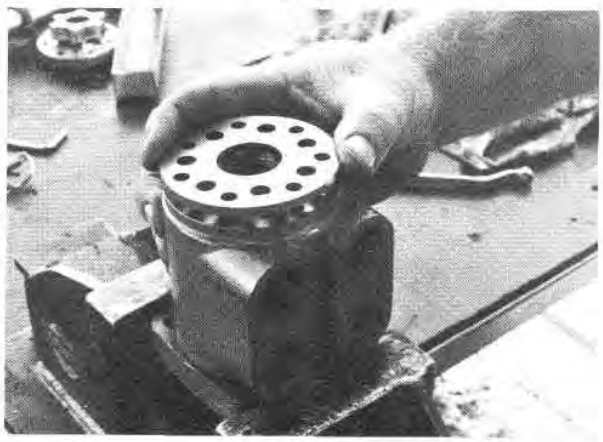


Fig. A78

Place the mounting plate sub-assembly over the spool shaft and slide down into place over the cap locator bushing smoothly so that seals will not be disrupted in assembly. Fig. A74. Align the bolt holes with tapped holes. Be certain that the mounting plate rests fairly flush against the end of the housing assembly so that the cap locator bushing is not cocked and install four mounting plate cap screws. Tighten these evenly and gradually to a torque setting of 250 inch pounds. Fig. A75.

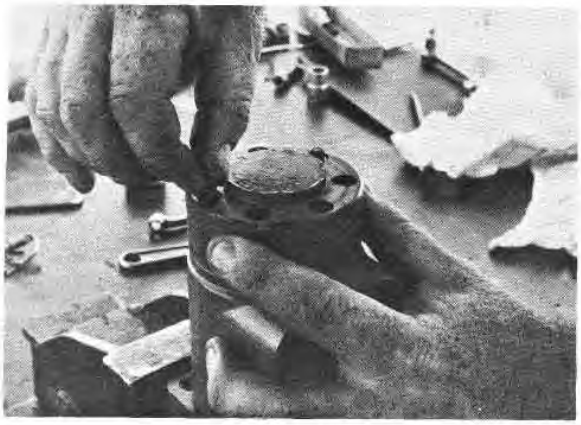


Fig. A85

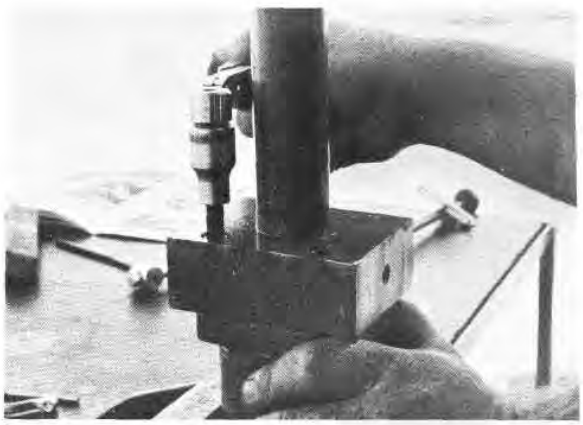


Fig. A88

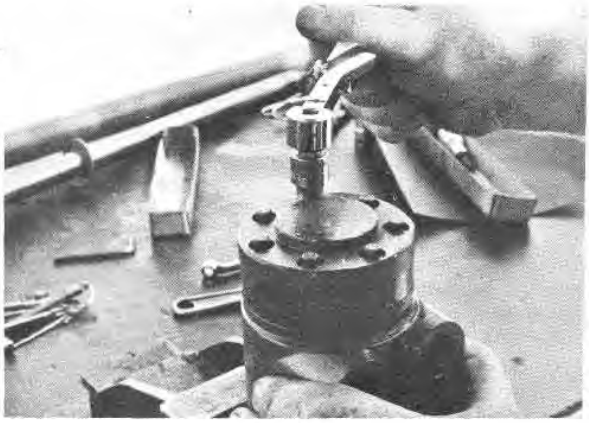


Fig. A86

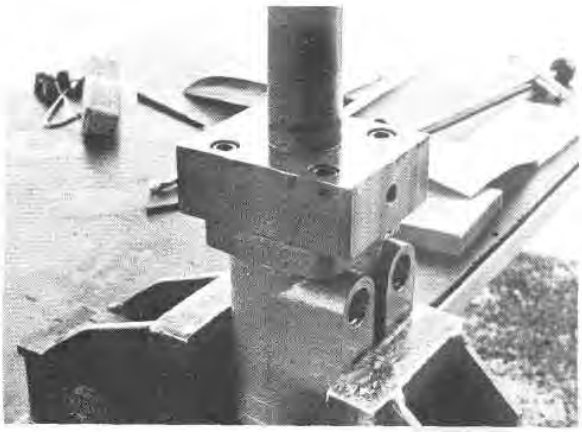


Fig. A89

Fig. A87

pin within the unit. Enter the meter gear star into the meter gear ring and wiggle the parts slowly in position so that the drive does not become disengaged from the meter gear star. Hold the plate and meter gear ring in position on the assembly while the star is being installed. Rotate the meter gear star slightly to bring the cross slot of the drive into engagement with the cross pin and the splined end of the drive will drop against the plate. Figs. A81 and A83.

Warning :

Alignment of the cross slot in the drive with valleys between the teeth of the meter gear star determines proper valve timing of the unit. There are 12 teeth on the spline and 6 pump teeth on the star. Alignment is exactly right in 6 positions and exactly wrong in 6 positions. If the parts slip out of position during this part of the assembly, repeat until you are certain that correct alignment is obtained. Fig. A80.

Place the spacer in position within the end of the meter gear star. Fig. A84. If the spacer does not drop flush with the gear surface, the drive has not properly engaged the cross pin — RECHECK. Place the meter end cap over the assembly and install two cap screws, finger tight, to maintain alignment of the parts. Fig. A85. Install all seven cap screws and bring them gradually and evenly to 150 inch pounds torque. Fig. A86.

Check the condition of the column assembly, clean it, and replace on the unit with four cap screws oriented as before. Rotate the steering shaft while bringing the surfaces into contact to allow splines to engage. Fig. A87. If in doubt, follow the orienation as shown. Tighten the cap screws to 280 inch pounds. Fig. A88.

To re-asemble the unit to the tractor, reverse the 'Orbitrol' Removal instructions, Page A - 21.

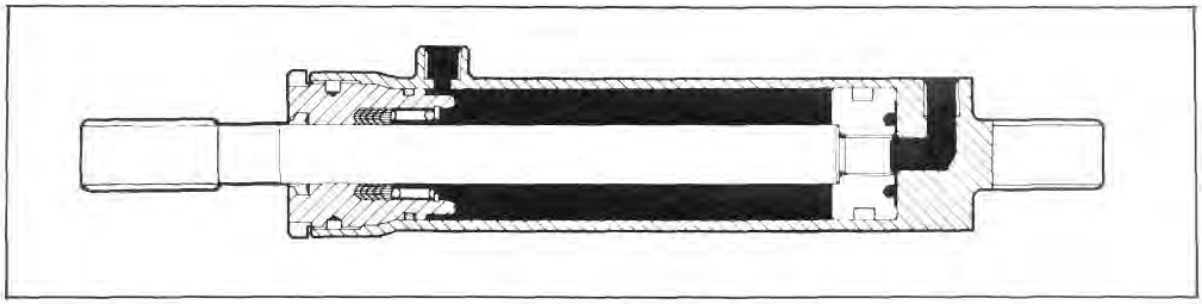


Fig. A90 — Actuating Cylinder

HYDRAULIC CYLINDER

Cylinder Removal :

1. Drain the system oil. Jack the steering wheels and turn the steering to exhaust as much oil as possible.
2. Disconnect the hoses from the cylinders, fitting hose dust caps to exclude dirt.
3. Release the balljoints from the anchors and steering levers and lift the cylinders clear of the tractor.

Cylinder Dismantling :

1. Clamp the cylinder in a soft-jawed vise, piston balljoint upwards, using sufficient pressure to hold the unit without distortion.
2. Use a spanner on the piston rod flats provided to hold the rod, and remove the balljoint.
3. Use a spanner to slacken and remove the gland nut.
4. Withdraw the piston and rod.
5. Use the vise or a press and a bar or pipe to take the weight of the spring off the circlip inside the gland nut, and remove the circlip. Release the spring and salvage the spring and seal packing.
6. Thoroughly examine the piston seal, packing and gland dust excluding seal and replace, if necessary. Inspect the cylinder bore and, if badly scored, replace the cylinder. Clean the parts for re-assembly.
7. Reverse the dismantling and removal procedures and test the system operation.

TROUBLE SHOOTING

Trouble	Probable Cause	Remedy
STEERING WHEEL DOES NOT CENTER	Binding in linkage valve. Broken centering springs.	Re-align. Replace spring (see page A - 27).
NO RESPONSE WHEN STEERING WHEEL IS TURNED SLOWLY	Dirt in system. Oil level is low.	Drain, flush and refill with clean oil (see page A - 20). Fill to proper level
SLOW OR HARD STEERING	Dirt in system. Wear on sleeve and spool. Wear on Orbit gear. Oil level low. Trouble in pump. Trouble in actuator. Trouble in lines or filter.	Drain, flush and refill. Replace. Replace. Fill to proper level. Check and correct. Check and correct. Check and correct.
WRONG RESPONSE TO STEERING WHEEL	Lines hooked up to wrong ports. Orbit gear misaligned.	Reconnect. Realign (see page A - 30).
CONTINUOUS STEERING WHEEL ROTATION	Dirty fluid. Broken centering springs. Input linkage is binding. Burr on sleeve or spool.	Drain, flush and refill. Replace (see page A - 27). Realign. Repair (see page A - 25).
NO RESPONSE	Sleeve and spool locked. Pump failure. Hose or filter clogged. Relief valve stuck.	Disassemble, repair or replace. Check and correct. Check and correct. Drain, flush and refill.

CHAMBERLAIN

SECTION **B**

THE 4-236 ENGINE

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

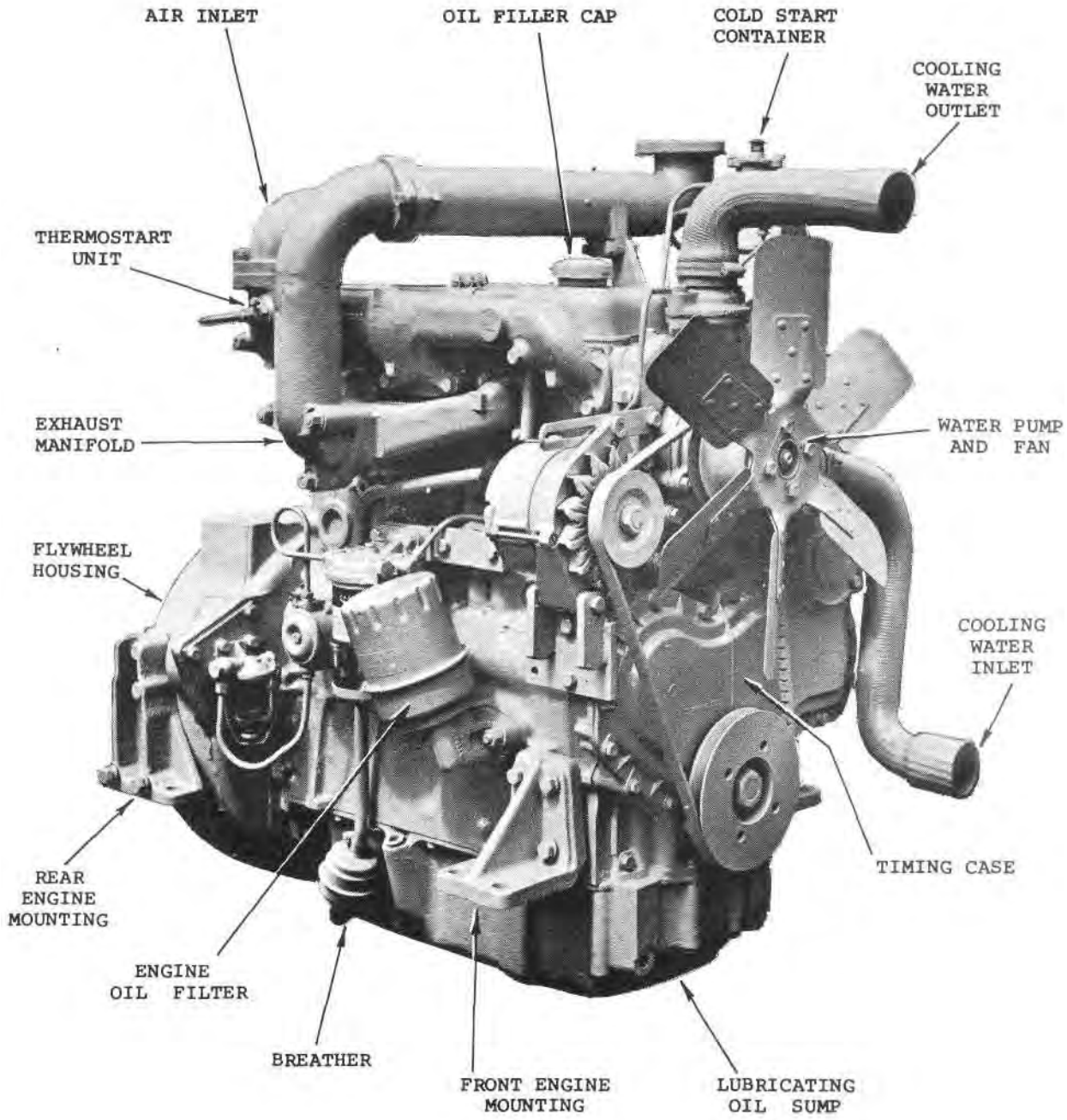


Fig. B1 — The Engine

ENGINE

DESCRIPTION

The 4-236 Diesel Engine is a direct injection, four cylinder, four stroke power unit having a bore, of 3.875" and a stroke of 5".

"Right hand side" or "left hand side" means the side of the engine as seen from the flywheel end.

Cylinder Block and Crankcase :

The cylinder block is cast integrally with the crankshaft centre-line to form a stiffening skirt.

Dry type, renewable cast iron liners are pressed into the block. The water jackets are carried down the full length of the cylinders and a water space is provided between each cylinder.

Cylinder Head and Valves :

The cast iron cylinder head is secured to the cylinder block by studs and nuts. the joint being made by a black rubber-asbestos (Klinger) type gasket.

One inlet and one exhaust valve is provided for each cylinder, and operate directly in, and seat on, the cylinder head. One spring is used for each valve and is retained by a steel cap and split cone collets. The springs seat on steel washers located in a machined recess in the cylinder head.

Combustion System.

A direct injection system is employed, the pistons having a combustion chamber formed in their crowns. Fuel is injected into each chamber by means of a four hole injector nozzle.

Valve Mechanism Assembly :

The valve rocker mechanism assembly is mounted on top of the cylinder head and is enclosed by a steel cover.

The valves are operated by cast iron rocker levers and push rods from tappets located on the camshaft in the cylinder block. The valve mechanism is lubricated by an intermittent oil feed taken from the centre camshaft bearing via drillings in the block and cylinder head and an integral pipe to the hollow rocker shaft.

Valve adjustment is effected by a screw and lock nut at the push rod end of each rocker lever.

Crankshaft :

The crankshaft main and big end journals are hardened to reduce wear.

The front oil seal, of the rubber lip type, is fitted to the timing case cover and the rear oil seal, of the rope type, is retained in a split housing around the rear journal of the crankshaft.

Crankshaft end float is controlled by four thrust washers, located on both sides of the centre main bearing housing and centre main bearing cap.

A special pulley is driven from the front of the crankshaft and is retained by a plain setscrew.

Main Bearings :

Five main bearings are provided for the crankshaft and the cast iron bearing caps are secured to the crankcase by two setscrews, and are located by ring dowels.

Camshaft :

The cast iron camshaft is located in a low position on the right hand side of the cylinder block and is supported by three bearings machined directly in the block. Each bearing is pressure lubricated by means of internal drillings.

Connecting Rods :

The connecting rods are fitted with small end bushes and pre-finished big end bearings. The big end bearing caps are located by serrations on the big end faces, at right angles to the rod axis.

Timing Drive :

The camshaft and fuel pump are driven by helical gears from the crankshaft via one idler gear. The gears are enclosed by an aluminium timing case and cover. A separate detachable cover provides access to the fuel pump drive gear.

Pistons and Gudgeon Pins :

The aluminium pistons are fitted with five rings, three compression rings and two oil scraper rings, one fitted above the gudgeon pin and one fitted below. The gudgeon pins are fully floating and located axially in the pistons by circlips.

Lubrication System :

The lubrication of the engine is by pressure feed from an oil pump, driven via helical gears from the front end of the crankshaft. An oil strainer is provided at the pump suction pipe inlet. Oil is delivered through a full flow filter on the right hand side of the cylinder block to the main oil gallery drilled lengthwise through the crankcase. From the gallery the oil follows drillings to the main bearing bores and from the main bearings through the crankshaft to the big end bearings. Oil also follows drillings from the main gallery to the camshaft bearings and to the idler gear hub. From the centre camshaft bearing oil is fed up to the cylinder head and valve gear. The timing gears are lubricated by oil escaping from the ilder gear hub through a hole drilled in the idler gear. Cylinder bores, small end bushes and tappets are splash lubricated. An oil pressure gauge may be connected to the main gallery. A spring loaded relief valve controls the maximum oil pressure.

Cooling System :

Water is circulated by a belt driven centrifugal pump mounted on the front of the cylinder block. Water leaves the engine through an outlet body on the front of the cylinder head, the flow being controlled by a thermostat mounted in the outlet body.

A pressed steel fan is mounted on the water pump pulley.

Lubricating Oil Sump :

A cast iron sump is supplied and an oil level dipstick and tube is fitted.

Fuel Injection Equipment :

A distributor type fuel injection pump is flange mounted in a horizontal position at the rear of the timing case on the left hand side of the engine.

A paper element type fuel oil filter is bracket mounted onto the cylinder head. A diaphragm type fuel lift pump is mounted on the right hand side of the cylinder block and is driven by an eccentric on the engine camshaft.

The injectors are located in an accessible position on the left hand side of the cylinder head. They are housed in cast sleeves in the head, cooled by water jets from cast deflectors in direct communication with the main water gallery.

Electrical Equipment :

A 12 volt electrical system is used. The alternator is bracket mounted on the right hand side of the engine and is belt driven from the front of the crankshaft, the belt tension adjusted by means of a slotted link supporting the alternator.

The solenoid operated starter motor is flange mounted to the flywheel housing.

Induction Manifold :

A die cast aluminium induction manifold is fitted to the right hand side of the cylinder head.

Exhaust Manifold :

A cast iron exhaut manifold is fitted to the right hand side of the cylinder head.

Crankcase Ventilation :

A breather pipe is located on the cylinder head rocker cover, and extends down the right hand side of the cylinder block.

Starting Aid :

To aid starting under cold conditions a "Thermostart" heater is fitted into the induction manifold.

SPECIFICATIONS

Bore	— 3.875".
Stroke	— 5".
No. of cylinders	— 4.
Cubic capacity	— 236 cu. ins.
Compression ratio	— 16 : 1.
Firing order	— 1, 3, 4, 2.
Valve clearance (hot)	— 0.010".
Cam lift	— 0.3035".
Valve seat and face angle	— 45°.
Fuel injection timing (static)	— 22° B.T.D.C.
Injector setting pressure	— 170 ats.

Recommended Torque Tensions	**lbs./ft.**
Cylinder head nuts	— 80-85
Connecting rod nuts	— 65-70
Main bearing setscrews	— 140-150
Idler gear hub nuts	— 21-24
Flywheel setscrews	— 74-80
Sump setscrews	— 9-10
Camshaft gear retaining setscrew	— 45-50
Crankshaft pulley setscrew	— 280-300
Injector securing nuts	— 10-12

OPERATION

Starting the Engine :

If the engine is warm and has only been stopped for a short period, place the engine speed control in the fully open position and engage the starter motor by turning the starter switch in a clockwise direction.

Note : On Manual transmission models it is also necessary to depress the clutch pedal, and on T.C. transmission models to place the Forward and Reversing unit hand lever in neutral, due to the isolating switch incorporated in the system.

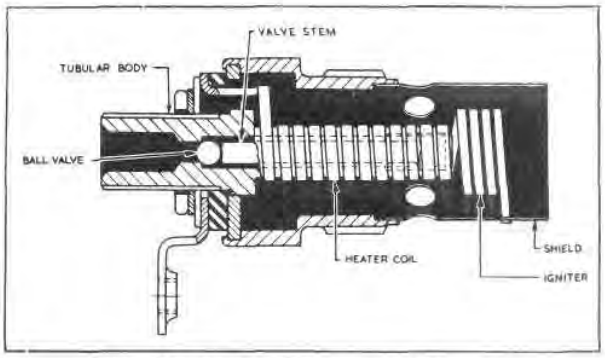


Fig. B2 — Sectional Diagram of Thermostart.

If the battery is well up, enough to turn the starter motor quickly, the engine should start.

Cold Starting Aid :

Referring to Fig. B2, the cold start unit comprises a tubular valve body carried in a holder which screws into the inlet manifold, and surrounded by a heater coil, an extension of which forms an igniter coil. The valve body houses a needle, the stem of which holds a ball valve in position against its seating. The whole is surrounded by an open perforated shield. Fuel oil from the container enters through an adaptor.

When the unit is cold, the ball valve is held closed. On switching on the coil, the valve body is heated and expands, opening the ball valve and permitting the entry of fuel. The fuel is vapourised by the heat of the valve body and when the engine is cranked and air is drawn into the manifold, the vapour is ignited by the coil extension and continues to burn, thus heating the inlet air.

When the coil is switched off, the flow of air in the manifold cools the valve body rapidly and the valve closes.

Using the Equipment :

To start the engine, proceed as follows :—

Ensure the engine stop control is in the run position.

Turn the starter switch in an anti-clockwise direction to "heat" position for 15 seconds.

With the engine speed control in the fully open position, turn the switch a further anti-clockwise movement, thereby engaging the starter motor. If the engine does not start after 15 seconds, return the switch to the "heat" position for 5 seconds and then re-engage the starter motor. As soon as the engine starts, the switch should be returned to the "off" position.

Things to Note :

Always be sure that the starter pinion has stopped revolving before re-engaging the starter, otherwise the ring gear or pinion may be damaged.

Fig. B3 — Starter Switch (showing cold start positions)

Ensure that the electrical connection to the cold starting aid is correctly made.

Always ensure that the reservoir feeding fuel to the cold starting aid is fully primed and is not leaking.

In the event of difficult starting, check that fuel is reaching the cold starting aid in the induction manifold by unscrewing the inlet fuel connection. If fuel is reaching it satisfactorily, then it may be that the cold starting aid itself is not working correctly. This can be checked by removing the air cleaner hose and elbow and watching the cold starting aid whilst the equipment is used. When the starting switch is turned to the "heat" position, the element should become red hot, and on engagement of the starter motor, it should burst into flame.

The 4-236 engine is fitted with efficient cold starting equipment and no responsibility can be accepted for any damage caused by unauthorised starting aids.

ROUTINE MAINTENANCE

Daily or 10 Hours :

Check the oil level in the sump with the tractor on level ground. Top-up as necessary with the correct grade of engine oil.

Drain off any water or sediment which has accumulated in the fuel tank sump. Check the glass bowl of the agglomerator for water or sediment. Drain and clean, if necessary.

Check the level of dust in the pre-cleaner bowl. Empty and clean before the dust reaches the marked level. Check for dust in the bowl under the air cleaner body.

Note : Always stop the engine before removing the bowl.

50 Hours :

Check the condition and tension of the fan belt.

150 Hours :

Drain the oil from the sump and replace with new engine oil. The sump drain plug is located on the left hand side of the sump. Drain while hot.

Check the engine for oil leaks or loose nuts.

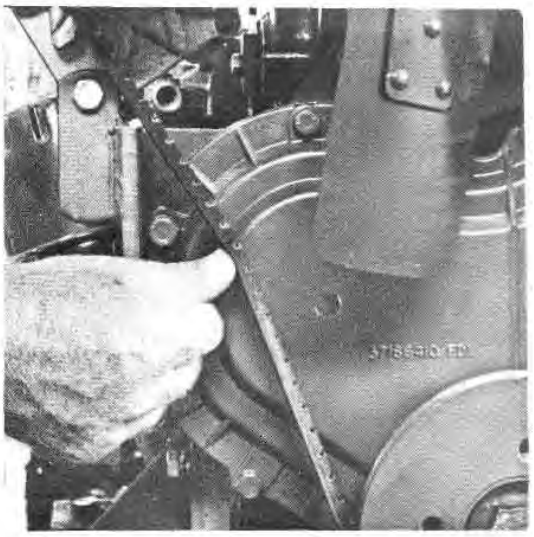


Fig. B5 — Checking Fan Belt Tension

Dry Type Air Cleaner :

Remove the element and closely examine for damage. Clean the element. Check the tubes in the lower body for plugging and clean as necessary.

300 Hours :

Renew the lubricating oil filter.

600 Hours :

Clean the gauze strainer in the fuel lift pump. Replace the agglomerator paper element (it is not possible to clean the element).

Check the valve clearance and inspect the valve springs and rocker mechanism.

Drain and reverse flush the radiator.

1200 Hours :

Replace the fuel system final micronic filter element.

Fig. B4 — Pre-Cleaner Dust Level

Fig. B6 — Remove Dry Air Cleaner Element

Oil Bath Air Cleaner :
Remove and clean the body.

Dry Type Air Cleaner :
Renew the element.
Remove the plugs and clean out the spark arrestor ash.

AIR CLEANER

The **Standard** air cleaner is an oil bath type with a transparent bowl centrifugal pre-cleaner. Every 10 hours check the level of dust in the pre-cleaner bowl and empty and clean before the dust reaches the marked level. The regularity of maintenance of the oil bath depends entirely on the conditions under which the tractor is operating. The importance of preventing this unit from becoming inefficient connot be over-emphasised, as the economical life of the engine is largely dependent on its correct maintenance.

To service the oil bath, release the bowl retaining clips, lower the bowl and move it sideways clear of the tractor. Clean out the oil and dirt in the bowl, re-fill with the new, recommended oil to the marked level and re-fit to the air cleaner body. Under some conditions once every 50 hours will be sufficient for this service, but when working in very dusty conditions, it may be necessary to clean the bowl daily, or more often.

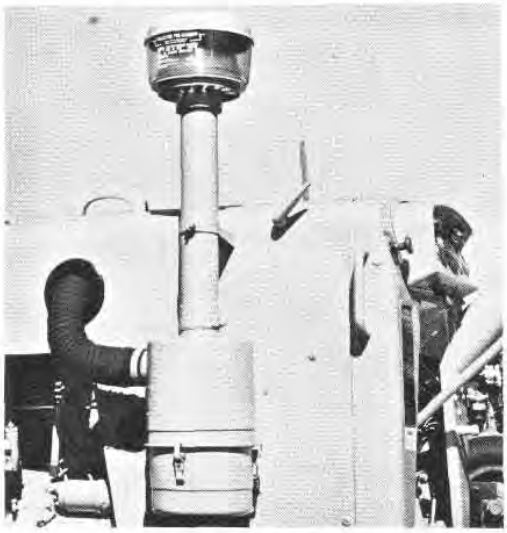


Fig. B7 — The Oil Bath Air Cleaner

Inspect the cleanliness of the oil at least every 10 hours.

Every 1200 hours, or more often if conditions warrant it, remove the air cleaner body from the tractor and wash the body thoroughly in distillate. Use enough fuel to submerge the body and pump it up and down so that any dust or dirt in the element is removed. Place the body right way up on a clean surface and let it drain for at least two hours before re-installing it on the tractor.

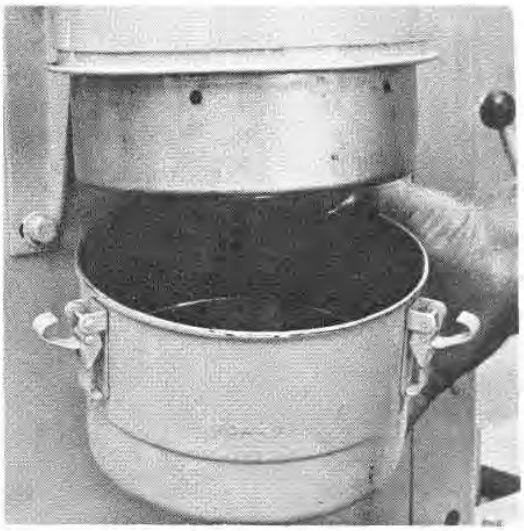


Fig. B8 — Removing the Oil Bath

Periodically check that the pre-cleaner extension pipe bore is clean as the engine air intake will be restricted if this pipe is obstructed. Clean by washing or pushing a cloth down through the bore if necessary.

The **Optional** dual dry type air cleaner combines a centrifugal cleaning stage with a paper filter element. The transparent bowl centrifugal pre-cleaner dust level should be checked every 10 hours and the bowl emptied and cleaned before the dust reaches the marked level.

A daily check should also be made of the dust in the cup reservoir at the bottom of the air cleaner body, the dust level should not be allowed to build up to less than one inch from the bottom of the tubes.

Caution : Do not use oil in the dust cup.

Regularly check all connections to the air cleaner to ensure that no air leaks exist.

Fig. B9 — Dry Type Air Cleaner Dust Reservoir

Maintenance schedules listed for the air cleaner are nominal and will need to be varied by the operator to suit working conditions. Under some conditions, the element will not need to be cleaned for several hundreds of hours, but in other conditions, frequent cleaning may be necessary. Clogging of the filter restricts the supply of air to the engine and is clearly evident due to loss of power, increased heavy load exhaust smoke and increased fuel consumption.

At every 150 hours, remove the element by releasing the three cover retaining clips and lifting the cover, then the element from the top of the air cleaner body. Examine the inside of the element for signs of dust which could indicate a ruptured element, or inadequate sealing. If the element is not damaged, it may be cleaned by either of the following methods :—

(a) If a clean dry compressed air supply is available, a stream of air may be directed against the inside of the element. Pressure must not exceed 100 p.s.i. and the nozzle must be kept a reasonable distance from the paper.

(b) Obstinate dirt can be removed by washing the element in a warm (120° — 140°F) solution of water and non-foaming detergent. Rinse the element clean, and thoroughly dry it after washing. Do not dry with compressed air.

After cleaning, carefully inspect the element, preferably with the aid of a bright light passed through the centre of the element. Inspect the cover gasket and replace it if defective. When re-assembling the cover to the air cleaner body, press the cover down into position, then secure the clips. Do not attempt to pull the cover down with the clips.

At every 150 hours, also check the tubes in the air cleaner lower body for plugging. Light dust plugging of the tubes can be removed with a stiff fibre brush. If heavy plugging with fibrous material is evident, release the lower body section clamp and remove the section for cleaning with compressed air or water not exceeding 150°F. Inspect the body gasket and replace it if defective.

Every 1200 hours, renew the air cleaner element.

OIL FILTERS

There are two filters for the lubricating oil in or about the engine.

The first filter is in the sump. This is a gauze strainer. Whenever the sump is removed for any purpose, this strainer should be thoroughly washed. If the oil pressure is low and all other possible causes have been checked, remove the sump and check the strainer for a blockage.

The second filter is mounted on the offside of the cylinder block. The oil passes through this filter after it has left the oil pump and before it reaches the bearings. Replace the element every 300 hours as follows :—

(a) Unscrew the container. A strap wrench will be required if a firm grasp is insufficient to unscrew the container.

(b) With a spanner; slacken, then remove the stand pipe from the oil filter. Two flats are provided on the flange of the stand pipe at the bottom of the filter to allow the use of the spanner.

(c) Discard the used oil filter.

(d) Fit the stand pipe to a new filter.

(e) Check that the seal is in good condition, then install the new filter. Tighten firmly by hand.

DIFFICULT STARTING

No Fuel at Injectors :

(a) No fuel in tank.
(b) Fuel lift pump not working.
(c) Slack connections in the fuel system.
(d) Air in the fuel system (trace from fuel tank via the lift pump to the injectors).

Go over the whole of the above and make sure that the injectors are fully primed.

Fig. B10 — Dry Type Air Cleaner Lower Body Tubes

Fig. B11 — Fitting Standpipe to New Engine Oil Filter

Engine not being turned over quickly enough :

(Particularly in cold weather).

(a) Incorrect grade of lubricating oil.

(b) Battery not fully charged. Fit fully charged battery.

(c) Engine "gummy" due to standing in the cold. Use the cold starting equipment.

Injectors Faulty :

When it is certain that there is no air in the fuel system and that fuel is reaching the injectors, and it is suspected that an injector is faulty, take it out for examination.

If in doubt as to the particular injector which is faulty, slacken off the union nut on the injector end of each fuel pipe, one at a time, with the engine running at fast idling speed.

This prevents fuel being pumped to the nozzle of that particular injector.

Do this with each injector in turn, tightening the union of one before proceeding to the next.

Keep the engine idling all the time and note the effect of cutting out an injector.

If cutting one particular injector out has no effect on the running, that is the faulty one.

Remove the suspected injector from the cylinder head and test with an injector testing pump.

Sticking Valves :

Trouble with sticking valves may be due to overheating, the result of choked injectors, or the use of unsuitable lubricating oil.

Test the injectors as recommended and clean them if necessary.

The lubricating oil used should be of an approved type.

Sticking Rocker :

If the rockers stick the cause may be : The use of unsuitable oil, shortage of oil, or sludging. Use only oil of an approved type. If there is a shortage of lubricant, the passages and pipes to the rockers should be checked.

Fuel Oil :

It is esential to use clean fuel oil free from water, dirt, or sand. Providing clean fuel is used, no trouble should be experienced with the fuel system but dirty fuel will lead to trouble due to choked filters, damaged fuel pump and injectors. If the engine tends to run well for a short period and then to die away or stop altogether, the fuel system should immediately be suspected. The trouble may be due to the lift pump not working properly, to a loose pipe joint allowing air to get into the fuel system, to a dirty fuel filter, or to a choked fuel pipe. If the conditions lead to dust or contamination of the fuel, decrease the maintenance interval.

Always, after disturbing fuel line washers, replace with new washers to ensure the joints are air tight.

CYLINDER HEAD

The number of hours of operation has no bearing on when to overhaul the cylinder head on these engines as carbon, beyond a superficial coating, does not form and accumulate on the cylinder head and pistons if all systems are functioning correctly.

Ease of starting and performance are the determining factors, therefore the cylinder head should only be removed when it is absolutely necessary.

Cylinder Head Removal :

1. Drain the cooling system from the plug in the lower tank of the radiator and the tap on the right hand side of the engine cylinder block.
2. Remove the top radiator hose.
3. Remove the water temperature gauge bulb from the left hand side of the water outlet body. On F.W.D. model tractors, it is only necessary to disconnect the electrical wiring from the bulb.
4. Remove the air cleaner hose.
5. Remove all the bolts connecting the right hand top side cowl to the radiator shell, rear lower side cowl and rear cowl support, and lift the side cowl and top cowl as an assembly clear of the tractor.
6. Remove the spark arrestor, exhaust pipe and manifold elbow as an assembly from the tractor. Remove the exhaust pipe to cylinder head support bracket.
7. Remove the fuel injector pipes, covering all exposed openings.
8. Remove the fuel injector overflow pipe, then the injectors.
9. Slacken the rocker cover to breather pipe connecting hose clips and twist the hose clear of the rocker cover. Remove the rocker cover.

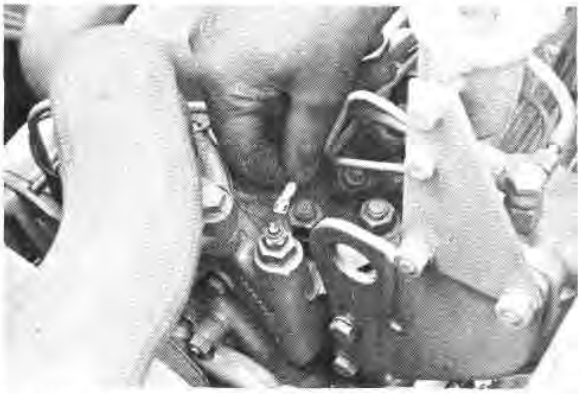


Fig B12 — Disconnecting Temperature Gauge Wiring (F.W.D. Model)

10. Remove the bolt retaining the cold start reservoir fuel return line to the cylinder head and remove the section of return line between the reservoir and joint at the rear of the cylinder head.
11. Disconnect the cold start unit wiring and remove the reservoir to unit pipe.
12. Disconnect all pipes attached to the micronic filter and remove the filter and cold start reservoir from the engine lifting bracket.
13. Lift the rocker gear slightly and pull each push rod down to its seat in the tappet, remove the rocker gear and then the push rods. This procedure is necessary as the push rods can drop through the engine into the sump.
14. Remove the cylinder head nuts in the reverse order of the tightening sequence. Fig. B20.
15. Using a suitable lifting gear, lift the cylinder head clear of the tractor. Do not insert a screwdriver

or any other sharp instrument between the cylinder head and block. When removed place the cylinder head on a flat surface, preferably wood, to avoid damage.

16. Remove intake and exhaust manifolds.

To Remove the Valves :

All valves are numbered. The cylinder head is marked with corresponding numbers (Fig. B13).

1. Compress spring caps and springs with a suitable valve spring compressor (Fig. B14) and remove the two half conical collets from each valve.

2. Remove spring caps, springs and rubber oil deflectors from valve stems. Remove valves.

Cleaning :

1. Remove all traces of carbon from cylinder head.

2. If the water jacket of the cylinder head shows signs of excessive scale, a proprietary brand of descaling solution should be used.

3. Blank off rocker oil feed oil-way between numbers 2 and 3 cylinders and remove carbon from pistons and cylinder block face.

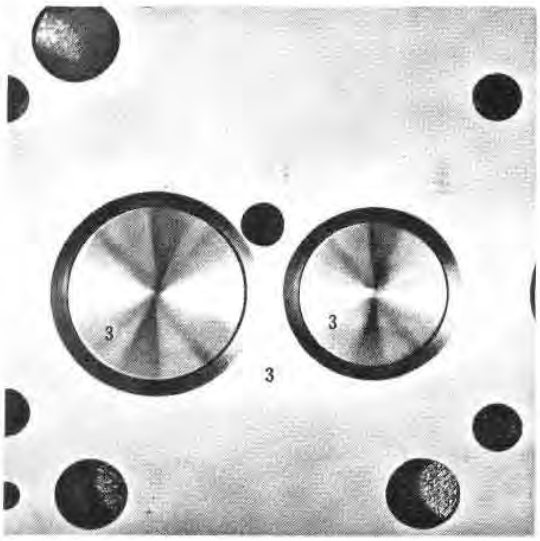


Fig. B13 — Numbering of Valves

4. After valve seat machining and valve grinding operations have been carried out, all parts should be thoroughly washed.

Valve Guides :

These engines are not fitted with detachable valve guides, the valve bores being machined direct into the cylinder head.

When wear takes place in the valve bores, valves with oversize stems should be fitted. Three service valves are available, for both inlet and exhaust, with oversize stems of 0.003", 0.015" and 0.030" respectively.

To fit oversize valves, the bores in the cylinder head must be reamed with a piloted reamer.

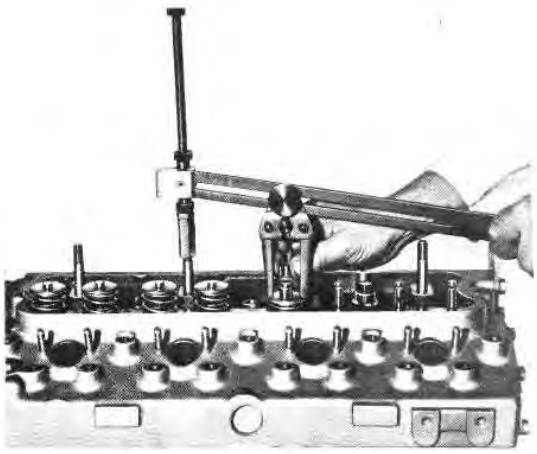


Fig. B14 — Removing Valve Collets.

Valves and Valve Seats :

Check the valve stems for wear and their fit in the guides.

Examine the valve faces for pitting or distortion. Valve refacing should be at an angle of 45°.

All valves are numbered from the front of the engine as follows : 1,1; 2,2; 3,3; 4,4; with the corresponding number adjacent to each valve seat (Fig. B13). Number all new valves to correspond with the numbering of the old valves. When fitting new valves ensure that the valve head depth relative to the cylinder head face is not less than 0.029" and not greater than 0.055" for exhaust and not less than 0.035" and not greater than 0.061" for inlet.

The valve seats in the cylinder head should be reconditioned by means of cutters or specialised grinding equipment, at an angle of 45°.

As narrow a seat as possible should always be maintained.

Fig. B15 — Checking Valve Depths

Hand Grinding :

When grinding in valves it is essential that no signs of pitting are left on the seatings. At the same time care should be taken to avoid unnecessary grinding away of the seat.

After grinding operations have been completed, check the valve head depths relative to the cylinder head face (Fig. B15) and wash the cylinder head.

Valve Seat Inserts :

Valve seats inserts are not fitted to 4-236 production engines but may be fitted in service.

When fitting inserts ensure that genuine parts are used and proceed as follows :

Using the appropriate size piloted reamer — 0.015", or 0.030" according to the condition of the valve bores in the cylinder head — ream out the bores.

Proceed as follows :—

1. Using the new valve bore as a pilot, machine the recess in the cylinder head face to the dimensions in Fig. B16.

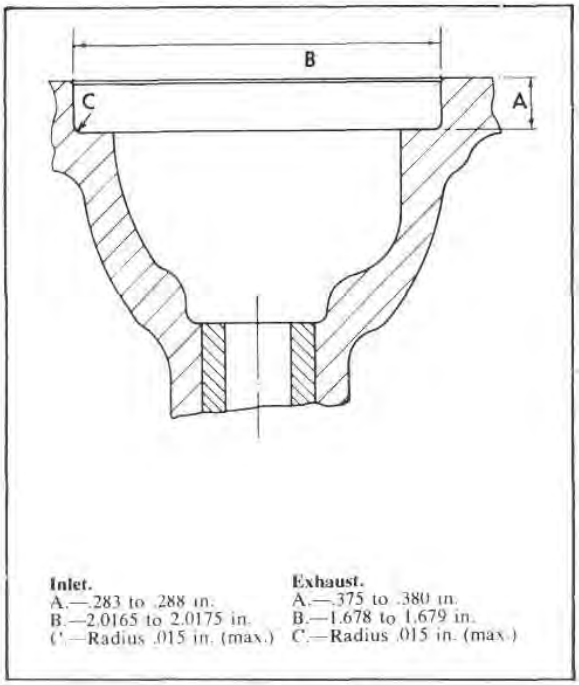


Fig. B16 — Valve Seat Cutting Dimensions

2. Remove all machining swarf and clean the insert recess. Using the valve bore as a pilot, press the insert home using the inserting tool (Fig. B17).

Under no circumstances should the insert be hammered in, neither should lubrication be used during pressing in.

3. Inspect to ensure that the insert has been pressed fully home and is flush with the bottom of the recess.

4. Using the valve bore as a pilot, machine the "flare" to the dimensions in Fig. B18.

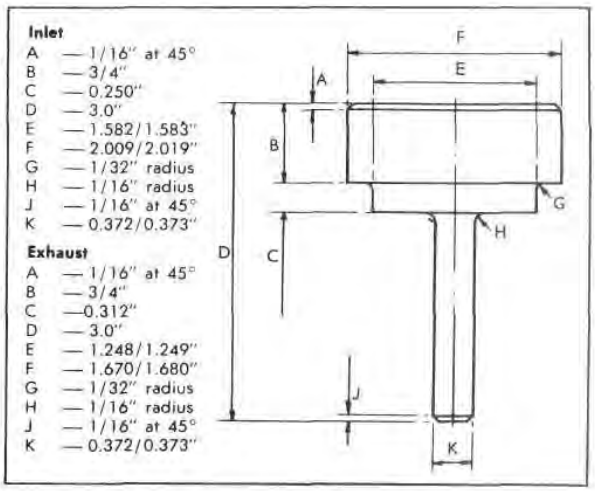


Fig. B17 — Press Tool for Valve Seat Inserts

5. Remove all machining swarf and burrs.

6. Re-cut the valve seat at an included angle of 90°, so that the valve head depth below the cylinder head face is within the production limits of 0.029/0.039 for exhaust valves and 0.035/0.045" for inlet valves.

Note : Work as closely as possible to the minimum figure to allow for re-seating at a later date. When re-facing a valve the included angle of the contact face is 90°.

If the cylinder head face has been skimmed since the fitting of valve seat inserts, then the following is allowed :—

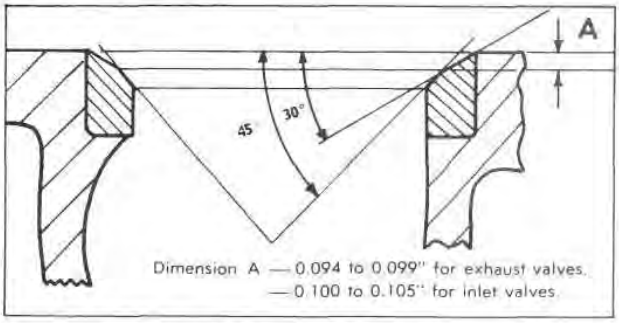


Fig B18 — Flare to be cut at 30°

(a) Machine to the dimensions given in Fig. B18 and continue as in stages 5 and 6.

(b) If the insert is damaged or unserviceable through wear, it must be removed and replaced with a new one. Before fitting, however, the back of the insert should be surface ground, removing sufficient material to give a flush fitting. Do not forget to re-chamfer the insert as it was prior to grinding, i.e. 0.020/0.030" at 45°. Then proceed as in stages 2 — 6.

Skimming of Cylinder Head :

A maximum of 0.012" may be removed providing the nozzle protrusion is not greater than 0.175". This figure must not be obtained by the use of additional

washers to the injectors as these may be removed at a later date and result in loss of power.

Valve Springs :

A new set of valve springs should always be fitted at every major overhaul.

Examine the valve springs with regard to squareness of ends and pressures developed at the specified lengths detailed in "Manufacturing Data and Dimensions".

Each spring incorporates damper coils at one end and these must be fitted towards the cylinder head.

Rocker Shaft Assembly :

To Dismantle :—

1. Remove circlips and washers from each end of the rocker shaft.
2. Withdraw the rocker levers, springs and support brackets.
3. Remove the locating screw from the rocker oil feed connection and withdraw the connection. Examine the rocker lever bores and shaft for wear. Rockers should be an easy fit on the shaft without excessive side play.

To Re-assemble :

1. Fit oil feed connection to rocker shaft and secure with the locating screw, ensuring that the screw enters the locating hole in the shaft.
2. Refit the support brackets, springs, and rocker levers in the correct order (Fig. B19). The support brackets are interchangeable and when fitting them ensure that the securing stud holes are to the right viewing the shaft from the front end, with each pair of rockers inclined away from each other at the valve end.
3. Fit securing washer and circlip to each end of the shaft.

Push Rods :

Check the push rods for straightness. If any are bent, fit replacements.

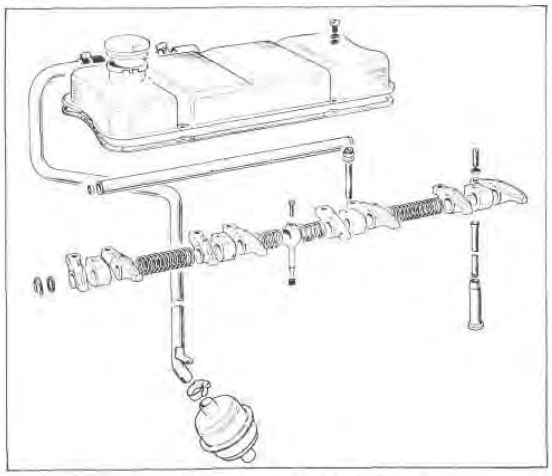


Fig. B19 — Rocker Shaft Assembly

To Re-assemble the Cylinder Head :

1. Lightly oil valve stems.
2. Fit valve to its correct guide or bore.
3. Fit valve oil seals with open end towards cylinder head.
4. Locate spring seat washers, valve springs and spring caps in position.
5. Compress each valve spring and fit the valve collets.

Cylinder Head Gasket :

Always use a new cylinder head gasket.

To Refit the Cylinder Head :

Ensure that the rocker assembly oil feed passage in the cylinder head is free from obstruction. When refitting the cylinder head a new gasket should be used.

Current KLINGER type cylinder head gaskets should be fitted DRY. Jointing compound must not be used. Gaskets are marked "Top Front".

Lightly oil nuts and studs before fitting. Tighten cylinder head nuts progressively in three stages in the order shown in Fig. B20 until a torque of 85 lbs./ft. is achieved. The final stage should be repeated.

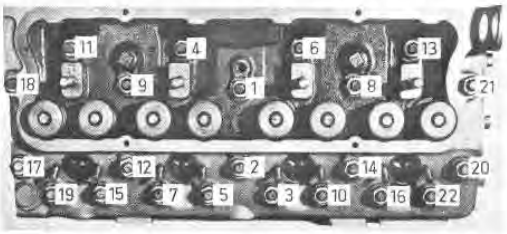


Fig. B20 — Cylinder Head Nut Tightening Sequence

Fit the push rods and refit the rocker shaft assembly tightening the assembly progressively from the centre outwards to a torque of 28-32 lbs./ft. Fit a new rubber sealing ring to the rocker oil feed connection.

The rubber olive should be fitted in the recess in the cylinder head before fitting the rocker shaft assembly.

Reverse the cylinder head removal procedure but do not replace the side cowl, exhaust pipe assembly, the air cleaner hose or the rocker cover.

Adjust the valve clearance to 0.012", bringing the respective pistons to T.D.C. on compression by turning the engine as necessary.

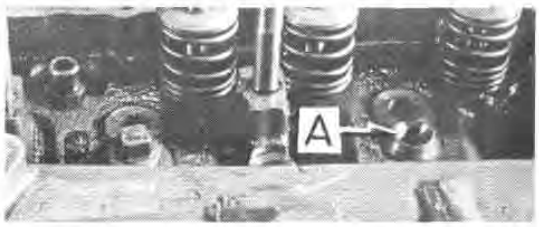


Fig. B21 — Location of Olive at 'A'

Clearance adjustment involves slackening the locknut and inserting the correct feeler gauge between the top of the valve stem and the rocker lever face, turning the adjusting screw with a screwdriver until the correct clearance is obtained, and retightening the locknut.

Fig. B22 — Checking Engine Valve Clearance

FINAL ADJUSTMENT

Prime the fuel system as described in Section D.

Lubricate the valves and rockers with engine oil so that they do not run dry on initial starting, and replace the rocker cover using a new gasket. Replace the exhaust pipe assembly and the air cleaner hose.

Start the engine and run it under load to ensure that it is completely warmed up to the correct operating temperature. Ideally, the radiator should be blanked off until an outlet temperature of approximately 200°F (93°C) is obtained.

Shut the engine down, remove the rocker cover and rocker gear and re-tighten the cylinder head nuts to the correct torque and in the correct sequence. It is not sufficint to tighten the exposed nuts only.

Note : The cylinder head nuts will require tightening again after the first 50 hours in service.

Replace the rocker gear, set the valve clearance to 0.012", replace the rocker cover, exhaust pipe and inlet hose, and warm the engine. Stop the engine, remove the rocker cover, reset the valve clearance to 0.010" **hot** and replace the rocker cover ensuring that the gasket is correctly positioned and is making an adequate seal. Replace the exhaust pipe and inlet hose, and assemble the right hand top side cowl and top cowl assembly.

PISTONS AND CONNECTING RODS

The pistons are of light alloy and have an offset toroidal cavity in the crown to form the combustion chamber. The cavity is to assist the correct swirling and eventually complete combustion of the fuel sprayed from the injectors.

To ensure correct positioning of the cavity of the piston within the cylinder bore each piston has the word "FRONT" stamped on its crown. When the piston and connecting rod are fitted to the engine ensure that the portion stamped "FRONT" on the piston faces the front of the engine.

Pistons are numbered 1 to 4 commencing with No. 1 at the front of the engine.

The connecting rods and caps are also numbered, 1 and 1; 2 and 2, etc. To ensure the correct positioning of the rod and cap their sealing faces are serrated and should on no account be filed.

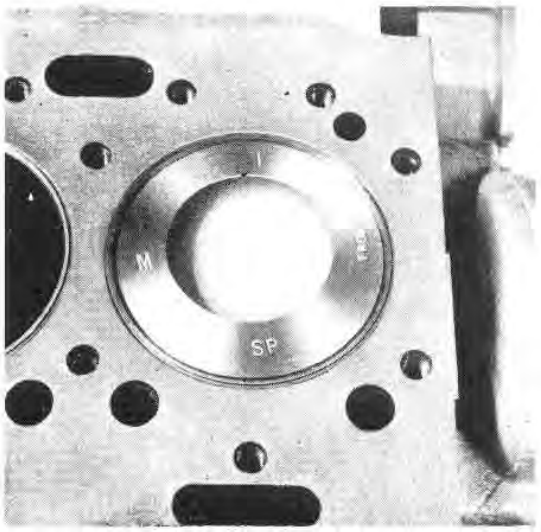


Fig. B23 — Piston Markings

The fully floating gudgeon pins work in the connecting rod small end bush and are held in position in the piston by circlips.

All big end bearings, within the individual engine, are interchangeable when new, the rod bearing with the cap bearing and vice versa, but, when fitting serviceable old bearings, care must be taken to return them to their original position.

To Remove Pistons and Con-Rod Assemblies :

Remove the front axle assembly. Drain the engine oil and remove the sump. It will be necessary to move the engine breather pipe because the support lug is attached by a sump bolt under the sump flange. Remove the dipstick and tube.

Remove the cylinder head assembly (Page B8).

Remove any ridges apparent at the top of the cylinder bores before attempting to remove the pistons.

Turn the engine crankshaft until two big ends are at bottom centre and remove the self-locking nuts, caps, bearing shells and big end bolts.

Push the pistons and connecting rods out through the top of the cylinders and keep the assemblies, including bearings, separate each to each as marked.

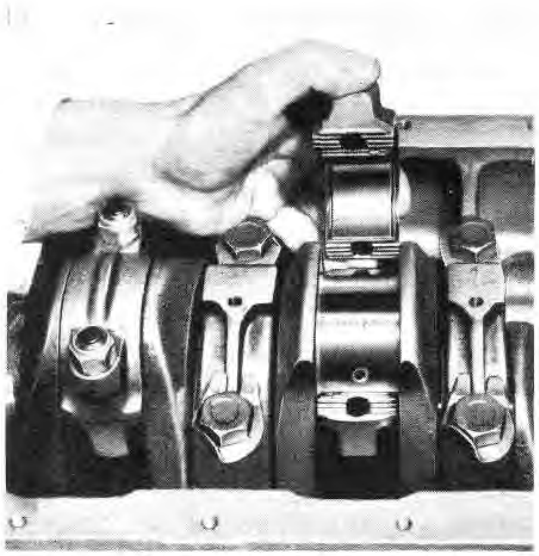


Fig. B24 — Removing a Big-End Bearing Cap

Turn the crankshaft until another two big ends are at the bottom centre and repeat the removal operations.

To Remove Gudgeon Pins :

Using circlip pliers, remove the circlips from the pistons.

The gudgeon pins can then be pushed out if the pistons are warmed in clean liquid to a temperature of 100°F — 120°F.

To Fit Small End Bush :

Remove gudgeon pins (See above).

The small end bushes are a press fit in the connecting rod.

Press out old bush using suitable tool.

Remove any sharp edges around the small end parent bore.

Fig. B25 — Removing Piston and Connecting Rod

Press in new bush, ensuring that the oil hole in the bush coincides with the hole in the connecting rod. Ream out new bush to suit gudgeon pin (See Schedule) and check for parallelism.

To Assemble Piston and Connecting Rod :

First warm the piston in clean liquid to a temperature of 100°F. — 120°F. Then with the stamped mark "FRONT" on the piston crown away from you and the toroidal cavity towards the left hand side, place the connecting rod in position, taking care to note that the number on the rod is to the left-hand side. Insert the gudgeon pin into position and fit circlips ensuring that they fit correctly into the grooves in the piston.

If the original pistons are being used they must be assembled to the same connecting rods, e.g. piston stamped 1 must go with the connecting rod marked 1. For markings of connecting rod see Fig. B23.

It is advisable to fit new circlips even if the old ones do not appear damaged or strained.

Fitting New Rings :

Piston rings must be thoroughly washed to remove any oil or grease which may be present.

Check the rings for correct gap which must be within the limits given in the Schedule.

When fitting new rings to original pistons, clean out piston ring grooves using the old ring from the appropriate groove for this purpose.

Examine the piston skirt and if there is any scoring the piston must not be used again.

The piston should be examined carefully for bruising of the ring grooves and to ensure that the rings move freely when fitted. If the piston ring grooves are worn in excess of .008" with new rings fitted, renew the piston.

In the top ring groove, fit the chrome compression ring and, in the next two grooves, fit the internally stepped compression rings, ensuring that the "step" is towards the piston crown.

Fit the oil control rings one above and one below the gudgeon pin.

Piston rings should be arranged so that their gaps are equally spaced around the piston and not in line with one another.

To Fit Piston and Connecting Rod to Cylinder Bore :

All connecting rods and caps are plainly marked with a number corresponding to their position in the engine. For method of marking see Fig. B26.

When fitting pistons and connecting rods to cylinder block and crankshaft, ensure that the side of the connecting rod which is stamped with the number, goes opposite the camshaft side of the engine.

Before assembling the connecting rod bolts to the rods, make sure that each bolt receives a very careful inspection.

Insert the pistons and connecting rods into the cylinder bores from the top, ensuring that piston and rod stamped No. 1 are fitted into No. 1 cylinder bore and No. 2 into No. 2 cylinder bore, and so on, count-

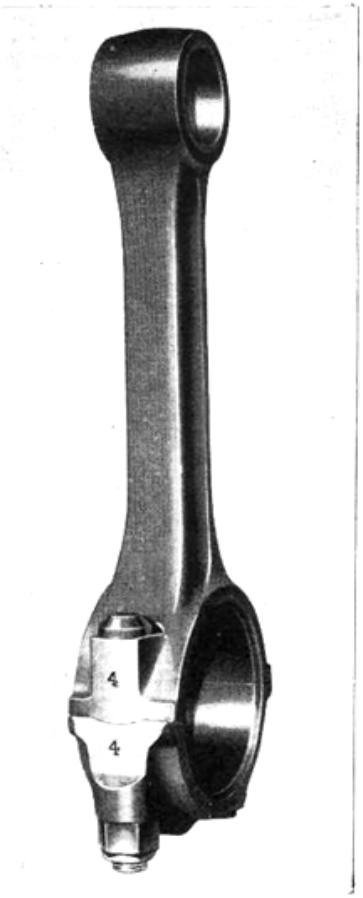


Fig. B26 — Connecting Rod and Cap Numbering

ing from the front of the engine. Turn the crankshaft until the appropriate crankpins are at B.D.C.

To minimise the possibility of breaking piston rings, it is advisable to use a piston ring guide (See Fig. B27). Should a piston accidentally drop partly into the bore and is held suspended by a piston ring it must be taken out again and the ring examined to see if it is cracked or broken.

Pull the connecting rod to the crankpin and insert the half bearing.

Refit the conrod bolts.

Fit the connecting rod cap and half bearing.

Tighten the connecting rod nuts using a torque wrench set to the tension of 65-70 lbs./ft.

Note : Connecting rod nuts are of the self locking type and should be replaced whenever the big ends are disturbed.

Fitting New Pistons :

When fitting new pistons it is essential to see that the piston and connecting rod are assembled correctly before fitting them to the engine, see "To Assemble Piston and Connecting Rod".

Before pulling the connecting rod to the crankshaft, check that the word "FRONT" stamped on the piston

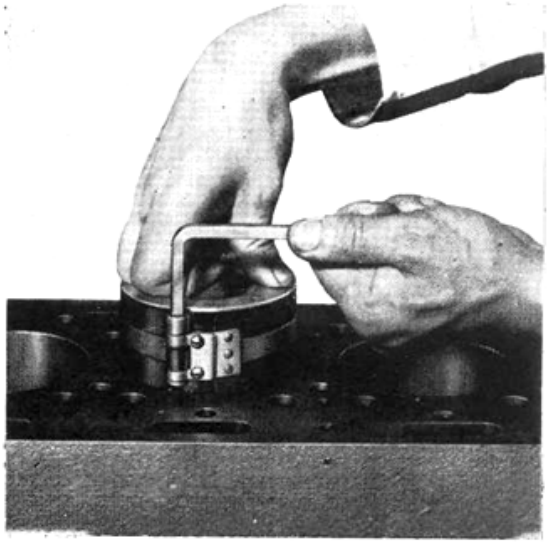


Fig. B27 — Piston Fitting with aid of an Adjustable Ring Clamp

crown is towards the front of the engine (See Fig. B23).

Ensure that genuine parts are used, so that the new piston will, when assembled in the engine, comply with the tolerances as listed in the Schedule.

The piston, if correctly fitted, should not be less than 0.003", or more than 0.010" above the top face of the cylinder block.

CYLINDER BLOCK AND LINERS

The cylinder block is fitted with renewable high duty cast iron dry liners. Replacement liners are supplied, semi-finished, and require boring and honing to 3.877"/3.878" diameter after fitting.

As the efficient running of a Diesel engine is particularly dependent on good compression the engine should be relined or rebored to +.030" oversize when the cylinder bores are worn to such an extent whereby engine performance is affected.

When reboring, begin by assembling a set of +.030" oversize pistons and rings.

During reboring, it is most important to take care that the true alignment of the bores relative to the crankshaft axis be maintained.

To Renew Cylinder Liners :

Obtain a new set of liners and a set of standard pistons and rings.

Remove all component parts from cylinder block (See appropriate sections for removal of these).

Remove cylinder head studs from cylinder block.

Press out old liners from bottom of cylinder block.

Check that the cylinder block parent bores are perfectly clean.

Ensure that the outside diameters of the new liners are prefectly clean and lightly coated with oil.

Press in new liners, using a suitable press. When inserting new liners, the load should be released several times during the first inch, so as to allow the liner to centralise itself in the cylinder block parent bore.

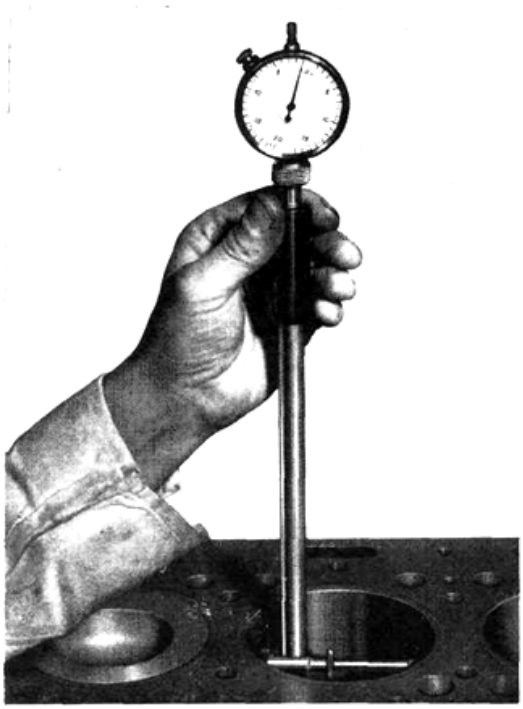


Fig. B28 — Dimensional Check of Cylinder Bore

Cylinder liners should be fitted to give a protrusion of 0:030"/0.035" above the top face of the cylinder block.

As the liners are to be bored in situ, this protrusion may create difficulties where the boring equipment is mounted on the top face of the cylinder block. This may be overcome by making a parallel plate to fit between the boring bar and the cylinder block face. Such a plate should be thicker than 0.035" and have holes cut in it to give clearance around the protruding liners.

Check new rings for size and assemble to the pistons.

Fit the new pistons, ensuring that the dimension between the piston crown and cylinder block face is maintained.

Re-assemble the engine as required and to instructions given for various components.

CRANKSHAFT AND MAIN BEARINGS

The crankshaft runs in five pre-finished replaceable shell bearings lined with aluminium tin.

End float of the crankshaft is provided by four thrust washers which fit on both sides of the centre main bearing housing. 0.0075" oversize thrust washers are available which may be combined with standard thrust washers to give an adjustment of 0.0075" or when used on both sides of the bearing housing, give an adjustment of 0.015".

The main bearings are located in position by tabs fitting into slots machined in the bearing housing.

Fitting New Main Bearing and Thrust Washers :

Under normal circumstances, by the time the main bearings and thrust washers require renewing the crankshaft will need to be removed for regrinding. However, if for any reason one or more of the bearings or thrust washers have to be renewed or removed for inspection, this can be carried out without removing the crankshaft from the engine.

Remove the front axle assembly. Drain the oil and remove the sump. It will be necessary to move the engine breather pipe as the support lug is attached by a sump bolt under the sump flange.

Disconnect and remove the oil pump suction pipe. Disconnect and remove the oil delivery pipe between the pump relief valve housing.

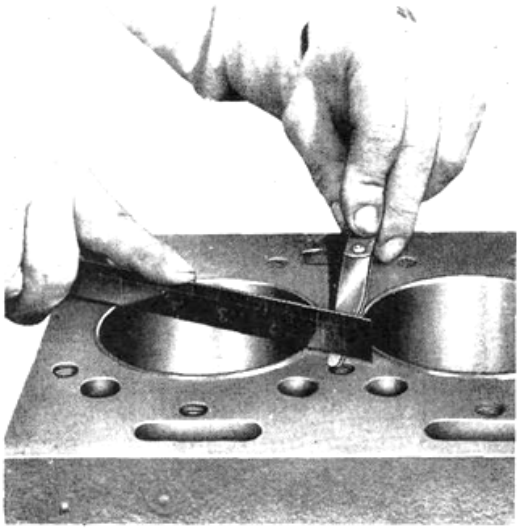


Fig. B29 — Checking Cylinder Liner Protrusion above Cylinder Block Top Face

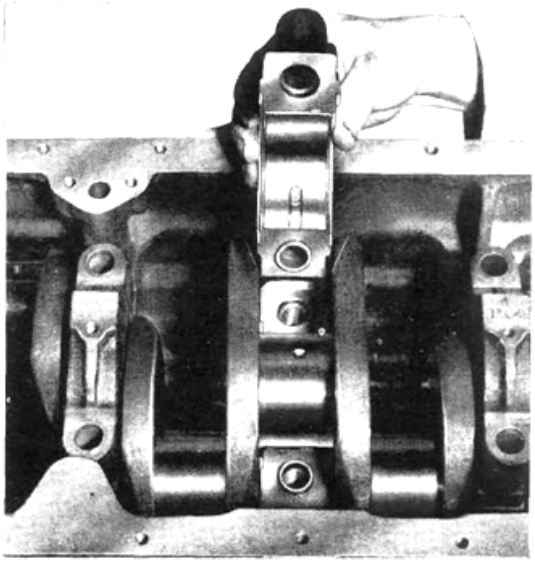


Fig B30 — Removing a Main Bearing Cap

To remove a main bearing, take off the cap of the bearing in question. To gain access to the rear main bearing setscrews, the rear main bearing bridge piece must be removed. This is secured by two recessed setscrews to the cylinder block and the two lower rear main oil seal housing securing setscrews. Access to the front main bearing setscrews can be achieved by removing the lubricating oil pump (see under Lubricating System).

Do not remove more than one bearing cap at a time.

Slacken the remaining bearing cap setscrews one or two turns.

Remove the lower half of the bearing from the bearing cap.

With a suitable piece of wood push out the top half of the bearing by rotating it on the crankshaft, applying the tool to the opposite side of the bearing lip. (See Fig. B31).

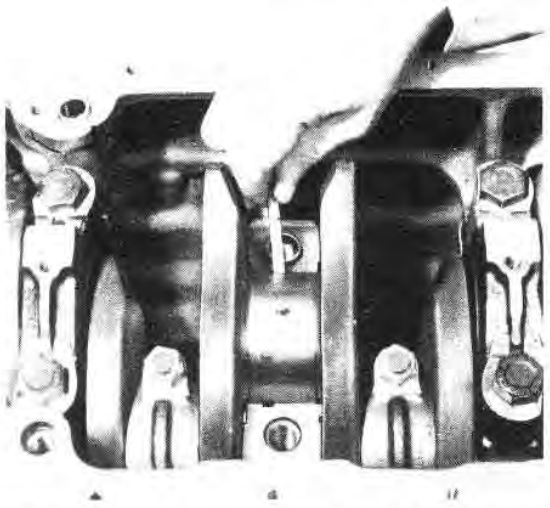


Fig. B31 — Removing a Main Bearing Shell with the Crankshaft "in-situ"

The locating lips are on the camshaft side of the engine.

Inspect the bearing shells and if they require renewing, insert a new half bearing in the top, inserting the plain end first. Fit new half bearing to cap.

Replace cap and tighten setscrews lightly before proceeding to the next bearing.

Having replaced the bearings and caps pull down the setscrews with a torque wrench set to the tension of 140 - 150 lbs./ft.

If the rear bridge piece has been removed lightly coat the metal to metal faces with a good jointing compound and refit it, ensuring that it is correctly aligned with the block face. (See Fig. B32). Fit bridge piece oil seal.

The thrust washers fit in recesses provided on either side of the centre main bearing housing and cap.

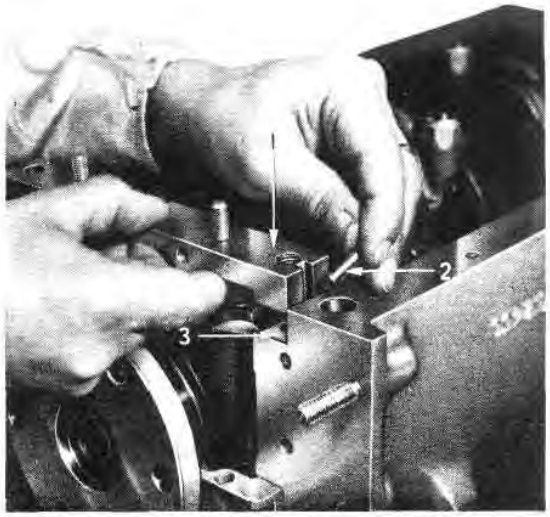


Fig. B32 — Re-fitting the Cylinder Block Bridge-Piece

To renew the thrust washers remove the centre main bearing cap.

Remove the two bottom half thrust washers from the main bearing cap.

The two top half washers can be removed by sliding them round from one side with a piece of wood or the like and rotating them until they can be removed.

To fit new thrust washers, lightly coat the two upper halves with lubricating oil and slide them into the recesses provided on either side of the centre main bearing housing. The steel side of the thrust washers should be towards the bearing housing.

Place the two lower halves on either side of the centre main bearing cap and replace the cap.

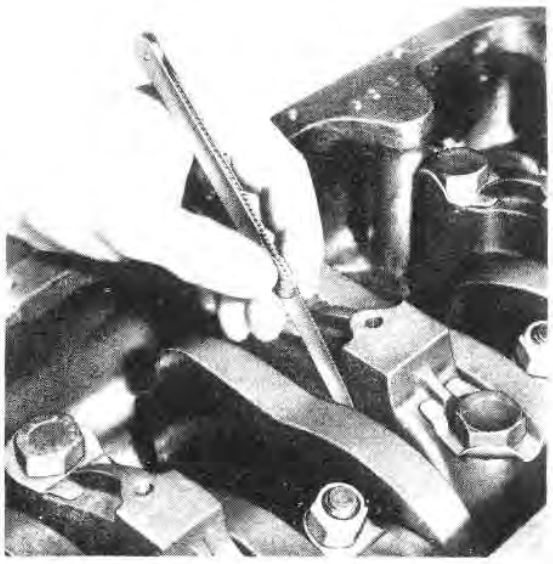


Fig. B33 — Checking the Crankshaft End Float

The bearing cap securing setscrews should be pulled down with a torque wrench set to the tension given of 140-150 lbs./ft. Crankshaft end float should be from .002 to .014". For method of checking see Fig. B33.

To remove the crankshaft, it will be necessary to remove the engine from the tractor as follows :—

TO REMOVE THE ENGINE FROM THE TRACTOR

Standard Manual :

1. Remove the top cowl and bulkhead as one unit :—

(a) Remove the spark arrestor and exhaust pipe, aircleaner hose and the batteries.

(b) Remove the rear side cowls, pitman arm and aircleaner.

(c) Remove the screws from the handlever assembly, slide the assembly down the steering column and remove the steering wheel (1½" AF socket for the retaining nut). Remove the handlever assembly.

(d) Remove the steering column support, bellcrank to cross-shaft link and the bellcrank to overrider link.

(e) Remove the support bracket bolts, steering box bracket to chassis bolts and manoeuvre the column from the tractor.

(f) Remove the foot throttle shaft.

(g) Disconnect these items :— Wiring harness to radiator terminal block, wiring harness to engine retaining clips, alternator wiring, starter motor wiring, water temperature gauge capilliary, cold start heater connections, isolating switch wires, reservoir to fuel tank return line, pressure switch to engine oil pipe, stop cable and tractometer cable (at angle drive end).

(h) Remove the nuts from the radiator upper mountings.

(i) Use suitable lifting gear to support the cowl and bulkhead assembly with a three point lift just forward of the bulkhead and under the centre of the rear cowl. Remove the cowl to chassis bolts, bulkhead to flywheel housing bolts and top side cowl to front lower side cowl and radiator shell bolts. Lift the assembly back, then up and clear of the tractor.

2. Remove the primary gearbox :—

(a) Drain the gearbox oil.

(b) Remove the centre floor plate.

(c) Remove the clutch linkage and pedal as an assembly (including the spring adjuster bracket). Disconnect the isolating switch from the clutch cross-shaft and remove the switch from the chassis to prevent damage.

(d) Remove the main drive coupling shaft.

(e) Remove the gearbox gear lever assembly.

(f) With the gearbox suitably supported, remove the securing setscrews and move it back so that the shafts clear the clutch. Lift the gearbox clear of the tractor.

NOTE : If adequate lifting facilities are available, the gearbox and engine can be removed as a unit, and the gearbox parted from the engine on the work bench.

3. Engine removal :—

(a) Drain the radiator and remove the upper and lower hoses.

(b) Turn the fuel tank tap off and disconnect the fuel line at the primary filter.

(c) Disconnect the fuel return line support clips from the cylinder head and starter motor.

(d) Using suitable lifting gear attached to the engine lifting lugs, take the weight of the engine and remove the engine mount to chassis bolts. Move the engine to clear the fan shroud, then up and clear of the tractor.

F.W.D. Manual :

1. Remove the top cowl and bulkhead as one unit :—

(a) Remove the spark arrestor and exhaust pipe, aircleaner hose and the batteries.

(b) Remove the rear side cowls and air cleaner.

(c) Disconnect and remove the fuel pump control rod and the foot throttle to bellcrank control rod.

(d)) Disconnect these items :— Wiring harness to radiator terminal block, wiring harness to engine retaining clips, alternator wiring, engine water temperature gauge capilliary wire, cold start unit wire, starter motor and pressure switch wires, fuse box and regulator connections, stop cable, pressure switch to engine oil pipe, and reservoir to tank return line.

(e) Remove the radiator upper mountings.

(f) Remove the seat assembly, seat support and gear lever linkage assembly.

(g) Use suitable lifting gear to support the cowl and bulkhead assembly with a three point lift just forward of the bulkhead and under the centre of the rear cowl. Remove the cowl to chassis bolts, bulkhead to flywheel housing bolts and top side cowl to front lower side cowl and radiator shell bolts. Lift the assembly up and clear of the tractor.

2. Remove the primary gearbox :—

(a) Drain the gearbox oil .

(b) Remove the clutch link from the pedal and cross-shaft. Disconnect the isolating switch from the clutch cross-shaft and remove the switch from the chassis to prevent damage.

(c) Remove the main drive coupling shaft.

(d) With the gearbox suitably supported, remove the securing setscrews and move it back so that the shafts clear the clutch. Lift the gearbox up and clear of the tractor, ensuring that no pipes, located inside chassis member, are damaged.

NOTE : If adequate lifting facilities are available the gearbox and engine can be removed as a unit, and the gearbox parted from the engine on the work bench.

3. Engine removal :—

(a) Drain the radiator and remove the upper and lower hoses.

(b) Turn the fuel tank tap off and disconnect the fuel line at the primary filter.

(c) Disconnect the fuel return line support clips from the cylinder head and starter motor.

(d) Drain the hydraulic oil, disconnect the filter hoses and the hose and pipe from the hydraulic pump.

(e) Using suitable lifting gear attached to the engine lifting lugs, take the weight of the engine and remove the engine mount to chassis bolts. Move the engine to clear the fan shroud, then up and clear of the tractor.

Standard Torque Converter :

1. Remove the top cowl and bulkhead as one unit :—

(a) Remove the spark arrestor and exhaust pipe, aircleaner hose and the batteries.

(b) Remove the rear side cowls, pitman arm and air cleaner.

(c) Remove the coupling shaft tunnel, centre floor-plate and bulkhead blanking plate.

(d) Disconnect the Forward and Reverse lever control linkage.

(e) Remove the steering column sleeve screws, slide the sleeve down the column and remove the steering wheel (1½" A.F. socket for the retaining nut). Remove the sleeve.

(f) Remove the steering column support, the Forward and Reverse handlever assembly and the throttle bellcrank to cross-shaft link.

(g) Remove the column support bracket bolts, steering box bracket to chassis bolts and manoeuvre the column from the tractor.

(h) Remove the foot throttle shaft.

(i) Disconnect these items :— Wiring harness to radiator terminal block, wiring harness to engine retaining clips, alternator wiring, starter motor wiring, engine water temperature gauge capilliary, cold start heater connections, isolating switch wires, forward and reversing unit instrument connections, cold start reservoir to fuel tank return line, pressure switch to engine oil pipe, stop cable and tractometer cable and surge tank hose.

(j) Remove the nuts from the radiator upper mountings.

(k) Use suitable lifting gear to support the cowl and bulkhead assembly with a three point lift just forward of the bulkhead and under the centre of the rear cowl. Remove the cowl to chassis bolts, bulkhead to flywheel housing bolts and top side cowl to front lower side cowl and radiator shell bolts. Lift the assembly back, then up and clear of the tractor.

2. Remove the Forward and Reversing unit :—

(a)) Drain the oil.

(b) Disconnect the oil cooler hose and the filter to adaptor block pipes.

(c) Remove the main drive coupling shaft.

(d) With the unit suitably supported, remove the securing setscrews and move it back to clear the drive lugs, and then clear of the tractor.

NOTE : If adequate lifting facilities are available, the engine and forward and reversing unit can be removed as an assembly, and the unit parted from the engine on the work bench.

3. Engine removal :—

(a) Drain the radiator and remove the upper and lower hoses.

(b) Turn the fuel tank tap off and disconnect the fuel line at the primary filter.

(c) Disconnect the fuel return line support clips from the cylinder head and starter motor.

(d) Using suitable lifting gear attached to the engine lifting lugs, take the weight of the engine and remove the engine mount to chassis bolts, move the engine to clear the fan shroud, then up and clear of the tractor.

F.W.D. Torque Converter :

1. Remove the top cowl and bulkhead as one unit :—

(a) Remove the spark arrestor and exhaust pipe, aircleaner hose and the batteries.

(b) Remove the rear side cowls and air cleaner.

(c) Disconnect and remove the fuel pump control rod and the foot throttle to bellcrank control rod.

(d) Remove the seat assembly and seat support.

(e) Disconnect these items :— Wiring harness to radiator terminal block, wiring harness to engine retaining clips, alternator wiring, engine water temperature gauge capilliary wire, fuse box and regulator connections, stop cable, pressure switch to engine oil pipe, cold start reservoir to tank return line, and surge tank hose.

(f) Remove the radiator upper mountings.

(g) Use suitable lifting gear to support the cowl and bulkhead assembly with a three point lift just forward of the bulkhead and under the centre of the rear cowl. Remove the cowl to chassis bolts, bulkhead to flywheel housing bolts, and top side cowl to front lower side cowl and radiator shell bolts. Lift the assembly up and clear of the tractor.

2. Remove the Forward and Reversing unit :—

(a) Drain the oil.

(b) Disconnect the oil cooler hose and the filter to adaptor block pipes.

(c) Disconnect the forward and reversing unit instruments.

(d) Disconnect the control linkage and remove the cross-shaft.

(e) Remove the main drive coupling shaft.

(f) With the unit suitably supported, remove the securing setscrews and move it away from the drive lugs, and then clear of the tractor.

NOTE : If adequate lifting facilities are available, the engine and forward and reversing unit can be removed, as an assembly, and the unit parted from the engine on the work bench.

3. Engine removal :—

(a) Drain the radiator and remove the upper and lower hoses.

(b) Turn the fuel tank tap off and disconnect the fuel line at the primary filter.

(c) Disconnect the fuel return line support clips from the cylinder head and starter motor.

(d) Using suitable lifting gear attached to the engine lifting lugs, take the weight of the engine and, remove the engine mount to chassis bolts. Move the engine to clear the fan shroud, then up and clear of the tractor.

All Model Tractors :

4. Remove the crankshaft :—

(a) Remove the flywheel and flywheel housing.

(b) Support the engine on a suitable turnover workstand and ensure that the oil is drained.

(c) Remove the sump, sump strainer and the oil pump suction and delivery pipes.

Fig. B35 — Bedding-in the Rear Main Oil Seal

When fitting the seal with the crankshaft in position, the following procedure should be adopted.

Set up a half housing in a vice with the seal recess uppermost.

Settle approximately 1" of the strip, at each end, into the ends of the groove ensuring that each end of the strip projects .010/.020" beyond the half housing joint face. Allow the middle of the seal to bulge out of the grove during this operation.

With the thumb or finger press the remainder of the strip into the groove, working from the centre. Then use any convenient round bar to further bed in the strip by rolling and pressing its inner diameter. This procedure takes advantage of the friction between the strip and the groove at the ends, to compact the rope, whilst ensuring that the projections of the end faces of the rope remain as set.

Fit the seal to the other half housing in a similar manner.

Remove all traces of the old joint from the cylinder block rear face and fit new joint treated with a suitable jointing compound.

Lightly paint the faces of the housing with a suitable jointing compound.

Spread a film of graphited grease over the exposed inside diameter surface of the strip.

Assemble the half housings around the crankshaft rear journal and fasten together by the two setscrews. (See Fig. B36).

Swivel the complete seal housing on the shaft to bed in the strips, and to establish that the assembly turns easily on the shaft.

Bolt the seal housing in position on the block and rear main bearing cap bridge piece and finally tighten with setscrews and spring washers.

TIMING CASE AND DRIVE

The camshaft, which is supported by three pressure fed bearings machined in the cylinder block, is mounted in a low position and driven by helical gears.

The thrust washer to control end float of the shaft is fitted in a recess machined in the cylinder block and is located by a dowel. The timing case must be removed to expose the thrust washer before the camshaft can be removed.

To Remove the Timing Case Cover :

1. Remove the fan belt.
2. Remove the crankshaft pulley.
3. Withdraw the setscrews and remove the timing case cover taking care not to damage the crankshaft oil seal which is located in the cover.

To Renew the Crankshaft Front Oil Seal :

1. Using a suitable dolly and press, remove the oil seal from the timing case cover.
2. With the seal lip facing inwards, press the new seal into position from the front, until the front face is $\frac{1}{8}$" below the front face of the cover.

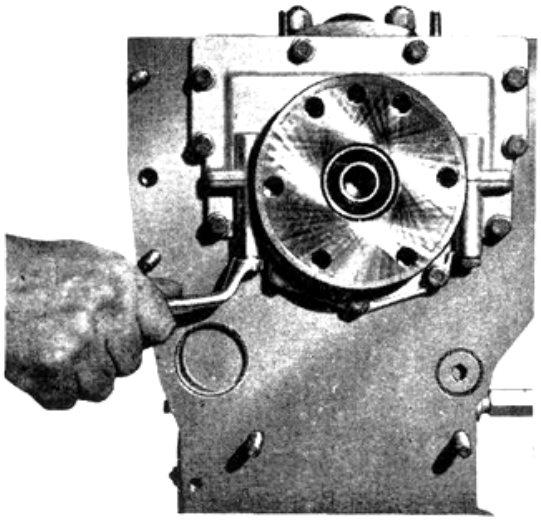


Fig. B36 — Tightening Oil Seal Housing Securing Setscrews

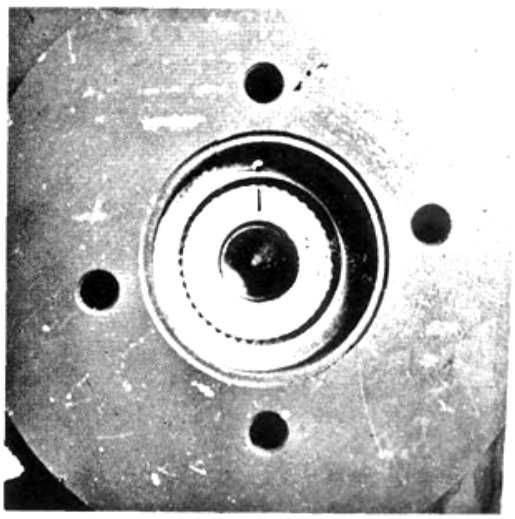


Fig. B37 — Pulley and Crankshaft Markings Correctly Aligned

To Refit the Timing Case Cover :

1. Refit the cover, ensuring that the oil thrower is correctly installed, and slide the crankshaft pulley into position, centralising the cover. Tighten all exposed setscrews and then remove the pulley to gain access to the nuts at the bottom of the cover. Evenly tighten all the securing screws and nuts.

2. Refit the crankshaft pulley with the centre punch mark on the pulley aligned with the line on the front face of the crankshaft. Fit the retaining setscrew and washer and tighten to a torque of 280/300 lb./ft.

3. Refit and correctly tension the fan belt.

Checking the Timing Gear Backlash :

1. Remove the timing case cover.

2. Check the timing gear backlash using a clock gauge or feeler gauges. This should be between 0.003/0.006 in.

3. If the backlash is within these limits, refit the timing case cover. If not, replace the timing gears affected.

To Remove the Idler Gear and Hub :

1. Remove the timing case front cover.

2. Remove idler gear retaining plate.

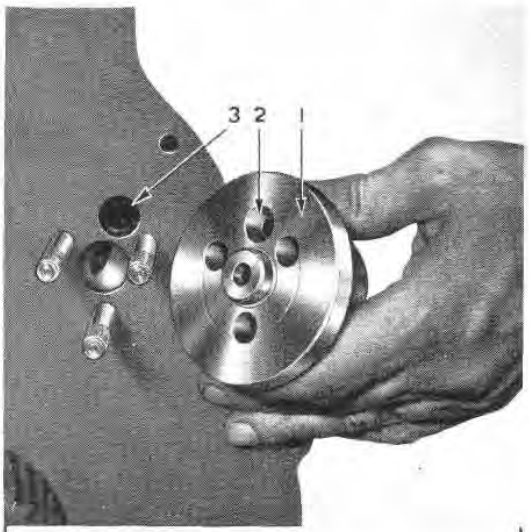
3. Remove the idler gear from the hub which can now be withdrawn from the timing case (Fig. B38).

4. Examine the gear and hub for wear, cracks, and pitting, etc.

To Refit the Idler Gear and Hub :

1. Refit the hub to its location in the timing case.

2. Remove the top cover and slacken off the rocker assembly securing nuts.



1. Idler Gear Hub.
2. Oil Passage.
3. Oil Pressure Rail.

Fig. B38 — Idler Gear Hub Location

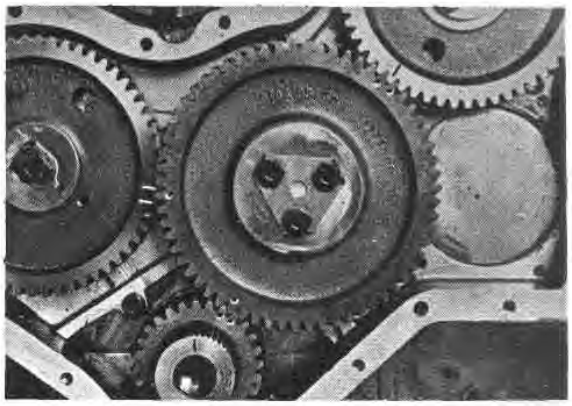


Fig. B39 — Driving Gear Timing Marks

3. Turn the crankshaft to T.D.C. No. 1 and 4 cylinders, i.e., with the crankshaft gear keyway at the top of its periphery.

4. Refit the idler gear to its hub with the timing marks on the crankshaft, camshaft, fuel pump and idler gears aligned (Fig. B39).

5. Refit the ilder gear retaining plate with the three setscrews tightened to a torque of 21/24 lb./ft. and secure with lockplate. Check idler gear end float (Fig. B40). This should be between 0.003/0.077 in.

6. Tighten down the rocker assembly and adjust the valve clearance to 0.012 in. cold.

7. Refit the timing case front cover.

To Remove the Camshaft Gear :

1. Remove the timing case front cover.

2. Remove the camshaft gear retaining setscrew, locking washer and retaining plate.

3. Using a suitable extractor, remove the camshaft gear (Fig. B41).

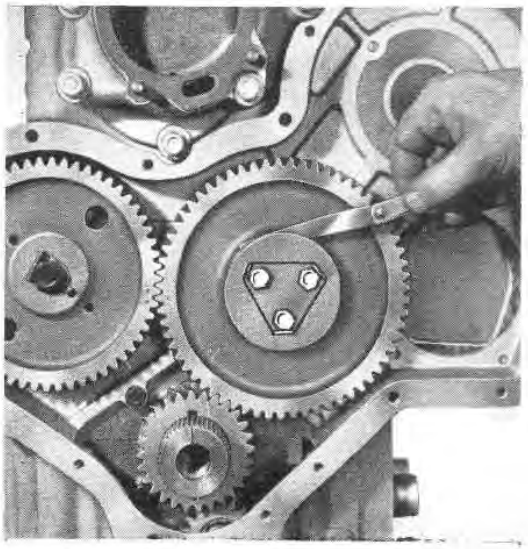


Fig. B40 — Checking Idler Gear End Float

(d) Remove the crankshaft pulley and the timing case cover.

(e) Remove the timing gears and the timing case.

(f) Remove the connecting rod caps and big end bearings.

(g) Remove the rear main bearing oil seal housing and the bearing bridge piece.

(h) Remove the oil pump.

(i) Remove the main bearing setscrews, caps and half bearings. Lift out the crankshaft and remove the remaining half bearings.

Should it be necessary to replace the crankshaft gear, ensure that the timing mark is to the front when the gear is fitted.

If the main bearings are to be used again, they should be suitably marked, so that they may be replaced in the same position from which they were removed.

Regrinding the Crankshaft :

Before regrinding the crankshaft, the following points should be checked to ensure it is suitable for further machining.

(a) The crankshaft should be crack-detected before regrinding. It must, of course, be remembered to demagnetise the crankshaft after crack detecting, in order to remove any polarisation which may be present.

(b) The main journal and crankpin diameters should be checked to ascertain the next appropriate size to which the crankshaft can be reground, i.e. — .010", — .020", or — .030".

If the crankshaft requires to be reground below — .030" it is recommended that a new crankshaft is fitted.

NOTE : It is important that the radii on the main journals and crankpins are maintained. If these are neglected, a fracture is liable to occur.

After regrinding, the sharp corners on the oil holes should be removed and the crankshaft crack detected again and demagnetised.

Replacing Crankshaft :

Ensure that all oilways are clear.

Check main bearing setscrews for stretch or damage to threads. Affected setscrews must be scrapped.

In no case should setscrews other than those supplied by the engine manufacturer be used as they are of special heat treated high grade steel.

Clean the bearing housings and place top half bearings in position.

Place crankshaft in position.

Lightly smear the two upper thrust washers with lubricating oil and slide in recesses provided on either side of the centre main bearing housing.

Fit lower halves of main bearings to bearing caps and place in position ensuring that the thrust washers on the centre main bearing cap are fitted.

When replacing the main bearing caps, ensure that they are fitted in their respective position, also that they are fitted the correct way round. The caps are numbered, No. 1 commencing at the front of the engine. Each cap is also marked with a serial number as stamped on the cylinder block bottom face. These should read in line.

Place shim washers in position and tighten setscrews.

For final tightening of the setscrews, a torque wrench should be used, set to the tension of 140-150 lbs./ft.

Check the crankshaft end float to ensure that a clearance of 0.002"/0.014" exists. Oversize thrust washers may be fitted.

Re-assemble engine as required and to the instructions given for the various operations.

Crankshaft Rear End Oil Seal :

The housing consists of two halves bolted around the rear of the crankshaft which has a shallow spiral oil return groove recessed to a depth of .004 to .008". The bore of the housing is machined to accommodate a rubber cored asbestos strip. The strip consists of two sections, one for each half of the oil seal housing.

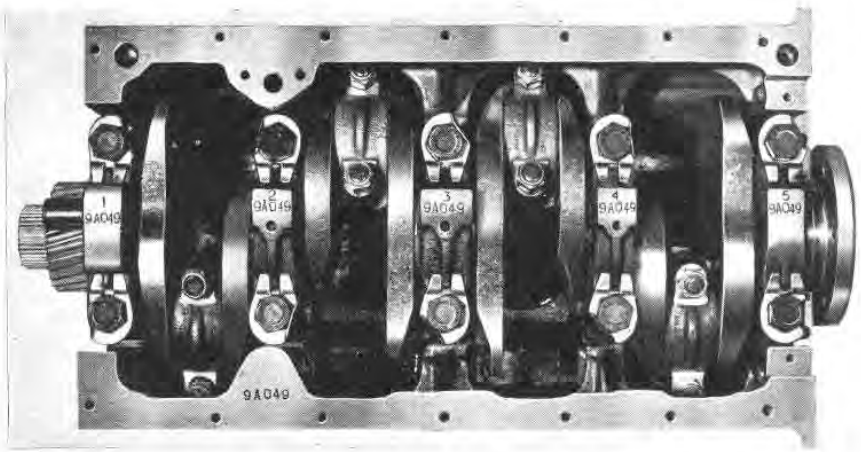
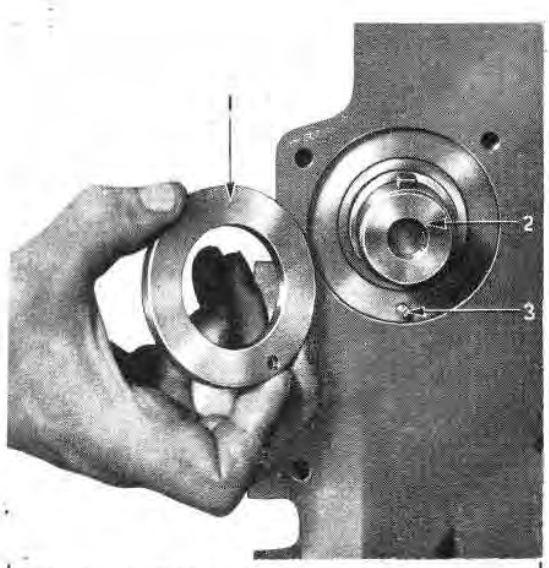


Fig. B34 — Main Bearing Cap Indentification



1. Camshaft Thrust Washer.
2. Camshaft.
3. Thrust Washer Dowel Pin.

Fig. B44 — Removing the Camshaft Thrust Ring

ring is dowelled and held in position by the timing case.

To remove the camshaft proceed as follows :—

1. Remove the rocker cover, rocker assembly and push rods.
2. Remove the timing case front cover, timing gears and timing case.
3. Turn the engine over so that the sump is uppermost.
4. Remove the sump.
5. Remove the fuel lift pump (Fig. B43).
6. Remove the camshaft thrust ring (Fig. B44).
7. Withdraw the camshaft, supporting the tappets if the engine has not been removed. If a workstand is being used, turn the engine upside down before withdrawing the camshaft.

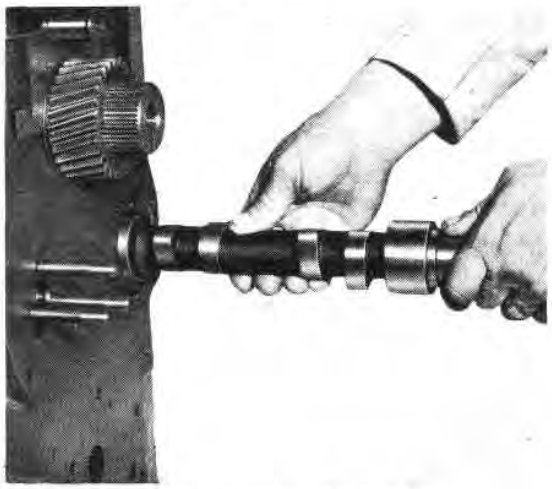


Fig. B45 — Removing the Camshaft

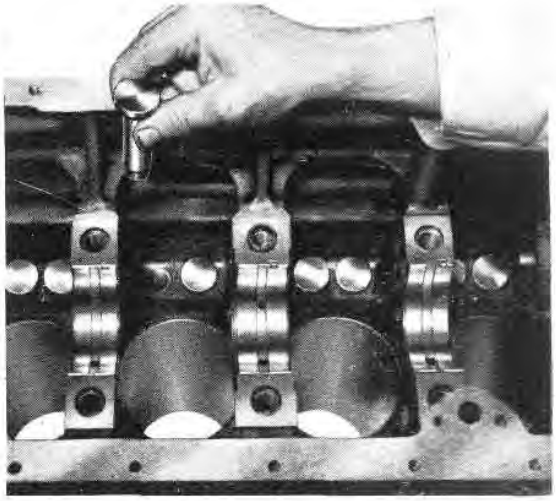


Fig. B46 — Removing a Tappet

To Refit the Tappets and Camshaft :

1. Refit the tappets (Fig. B46).
2. Refit the camshaft.
3. Refit sump.
4. Fit the camshaft thrust ring on the dowel in the front face of the cylinder block (Fig. B44). Check the protrusion beyond the front face of the cylinder block. This should be 0.026/0.031 in.
5. Refit the fuel lift pump.
6. Refit the timing case, timing gears, front cover and sump.
7. Refit the push rods and rocker assembly. Adjust the valve clearances to 0.012 in. cold. Refit the rocker cover.

VALVE TIMING

Checking Valve Timing :

1. Turn the crankshaft until the valves on No. 4 cylinder are "on the rock".
2. Set the valve clearance of No. 1 inlet valve to 0.047 in.

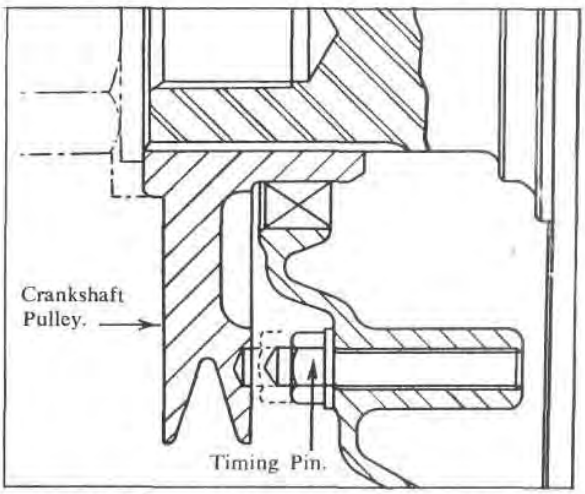


Fig. B47 — Timing Pin Located in Crankshaft Pulley

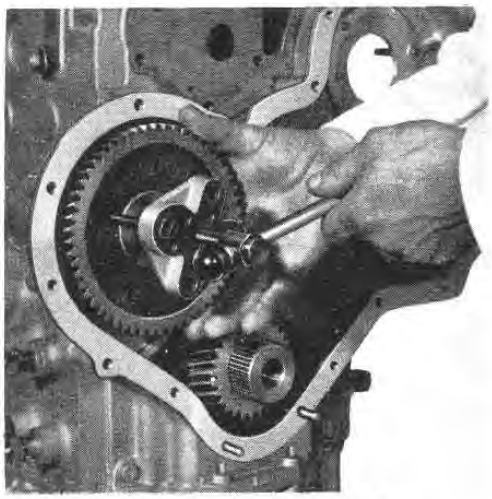


Fig. B41 — Camshaft Gear Removal

4. Examine the gear for wear, cracks and pitting, etc.

To Refit the Camshaft Gear :

1. Remove the idler gear.
2. Slacken off the rocker assembly securing nuts.
3. Refit the gear to the camshaft by drawing it onto the shaft with the retaining plate, new tab-washer and setscrew.
4. Turn the engine until No. 1 piston is at T.D.C., with the crankshaft gear keyway at the top of its periphery.
5. Refit the idler gear to its hub ensuring all timing marks are aligned (Fig. B39). Fit the idler gear retaining plate and secure to a torque of 21/24 lb./ft.
6. Tighten the camshaft setscrew to a torque of 45/50 lb./ft. and lock the tabwasher.
7. Refit the timing case front cover.
8. Tighten down the rocker assembly and adjust the valve clearance to 0.012 in. cold.

To Remove the Fuel Pump Gear :

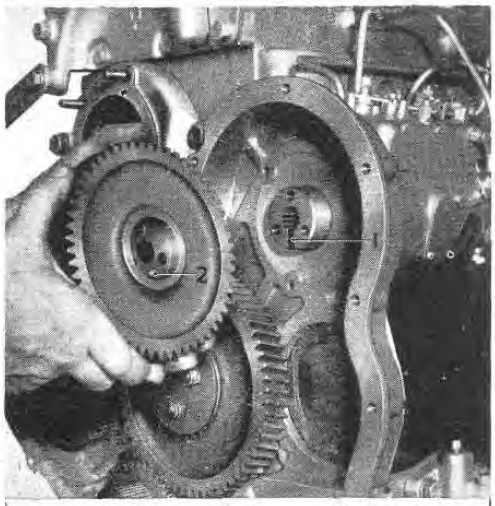
1. Remove the timing case cover.
2. Re-align all timing marks (Fig. B39) by removing and replacing idler gear.
3. Remove the three setscrews and spring washers which secure the gear to the fuel pump.
4. Withdraw the gear from its dowelled location on the fuel pump (Fig. B42).

To Refit the Fuel Pump Gear :

1. Fit the fuel pump gear to the shaft, locating the dowel of the gear into the slot on the fuel pump shaft and align the punch mark with the double punch marks on the idler gear (Figs. B39 and B42).
2. Secure the gear with the three setscrews and spring washers.
3. Refit the timing case front cover.

To Remove the Timing Case :

1. Remove the timing case front cover and timing gears.



1. Slot in Fuel Pump Hub. 2. Dowel.

Fig. B42 — Removing the Fuel Pump Gear

2. Remove the fuel pump.
3. Remove the nine setscrews and spring washers securing the timing case to the cylinder block.
4. Remove the four setscrews and washers securing the sump to the timing case.
5. Withdraw the timing case from the cylinder block.

To Refit the Timing Case :

1. Refit the timing case to the cylinder block.
2. Secure the sump to the timing case.
3. Refit the fuel pump.
4. Refit the timing gears and front cover.

To Remove the Camshaft and Tappets :

Camshaft end float is controlled by a thrust ring located in the front face of the cylinder block. The

Fig. B43 — Removing the Fuel Lift Pump

3. Turn the engine in the normal direction of rotation until the valve clearance of No. 1 inlet valve is just taken up.

4. Check that Nos. 1 and 4 pistons are now at T.D.C. by means of the timing pin. Unscrew the pin until it locates in the hole machined in the rear face of the crankshaft pulley as shown in Fig. B47.

The valve timing tolerance is $\pm 2\frac{1}{2}°$. When the timing is found to be correct, return the timing pin to its location and reset the valve clearance of No. 1 inlet valve to 0.010 in. hot. The only error possible is in the fitting of the timing gears, providing the crankshaft pulley is correctly fitted.

FLYWHEEL AND FLYWHEEL HOUSING

To Remove the Flywheel :
Manual Transmission :

1. Remove the gearbox, fit the "keeper" bolts to the clutch assembly, then remove the clutch.
2. Release the flywheel setscrew lock washer tabs, remove the setscrews and lift the flywheel and pilot bearing retainer from the crankshaft flange.

Torque Converter Transmission :

1. Remove the Forward and Reversing unit.
2. Remove the cover from the bottom of the flywheel housing and turn the engine to allow removal of the nuts securing the torque converter straps, Remove the torque converter.
3. Release the flywheel setscrew lock washer tabs, remove the setscrews and lift the flywheel from the crankshaft flange.

To Renew the Flywheel Ring Gear :

1. Place the flywheel in a suitable container of clean **cold** water and support it by positioning four blocks under the outer edge. Arrange the flywheel assembly so that, when submerged in water, the ring gear is uppermost and clear of the water by approximately $\frac{1}{4}$". Heat the ring gear evenly around its circumference, thus expanding the ring, which will allow it to be lifted from the flywheel. Lift out the flywheel and thoroughly dry off.
2. Ensure that the registering faces of the flywheel and new ring gear are clean and free from burrs.
3. Heat the new ring gear uniformly to a temperature of 350° — 400°F. Fit the gear over the flywheel and tap gently into position. If the gear cannot be tapped **gently** onto the flywheel, it must be removed and reheated. When it is correctly positioned, allow the gear to cool in the atmosphere. Do **not** use artificial cooling methods.

To Refit the Flywheel :

1. It is most essential before fitting a flywheel that the crankshaft flange face and periphery are perfectly clean and free from burrs. The mating faces of the flywheel must also be absolutely clean and free from burrs.
2. It will be noted that there is a seventh untapped hole in the crankshaft flange, which is at the bottom dead centre when the crankshaft is at T.D.C. Nos. 1 and 4 cylinders. Mount the flywheel to the crankshaft flange so that the untapped hole in the flange is in line with the unused hole in the flywheel.

Fig. B48 — Alignment of Flywheel Periphery

3. Refit the pilot bearing retainer (Manual Transmission only) and assemble the six flywheel securing setscrews with new locking washers and tighten to a torque of 74-80 lbs./ft.

4. Set up an indicator dial gauge with the base secured to the flywheel housing or cylinder block and adjust the dial so that the plunger is contacting the flywheel periphery. Turn the crankshaft and check the run-out. The flywheel should run true within 0.012" total indicator reading.

5. Adjust the dial gauge so that the plunger is at right angles to the crankshaft flange and rests on the vertical machined face of the flywheel at the outermost point of the face. Press the crankshaft one way, to take up the end float, and turn the flywheel. The run-out on the flywheel face should be within 0.001"

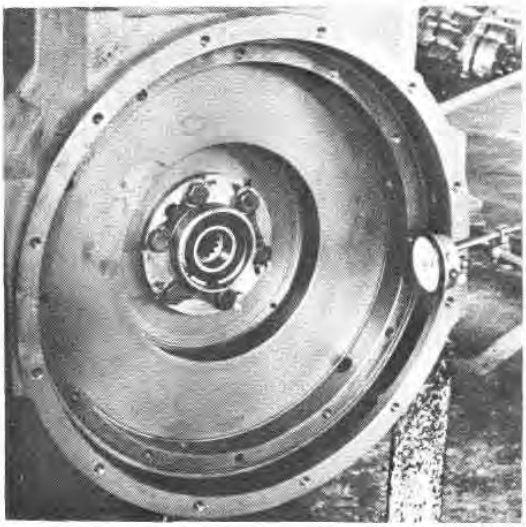


Fig. B49 — Alignment of Flywheel Face

per inch of flywheel radius from the crankshaft axis to the dial gauge plunger.

6. When the flywheel has been checked for alignment lock the setscrews with the tab washers.

7. Rfit the other assemblies that were removed.

To Remove the Flywheel Housing :

1. Remove the flywheel.

2. Remove the starter motor.

3. Remove the setscrews securing the flywheel housing to the cylinder block and tap the housing clear of the locating dowels.

4. Examine the housing for cracks and damage, etc.

To Refit the Flywheel Housing :

1. Ensure that the rear face of the cylinder block and the flywheel housing face are perfectly clean and free from burrs.

2. Remove the locating dowels and fit the housing to the cylinder block. Refit the securing setscrews, but do not over-tighten as the housing may require adjustment after the alignment check has been carried out.

3. Mount a dial gauge with the base secured to the crankshaft flange and set the point of the gauge plunger on the inner face of the housing bore. Rotate the crankshaft and check the reading on the dial gauge. The inner bore of the flywheel housing should be central within 0.008" T.I.R.

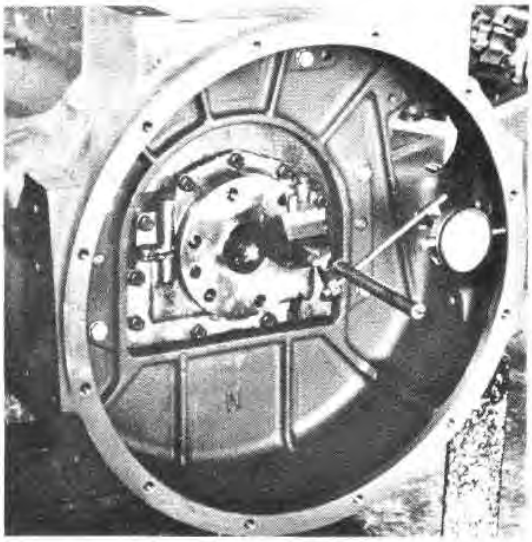


Fig. B50 — Alignment of Flywheel Housing Bore

4. With the base of the dial gauge still bolted to the crankshaft flange, adjust the dial so that the point of the plunger is against the vertical machined face of the housing and again turning the crankshaft check that this face is perpendicular to the crankshaft axis. This facing should be within 0.008" T.I.R.

5. All adjustments to bring the flywheel housing within these limits must be carried out on the flywheel housing and under **NO CONDITIONS** must the

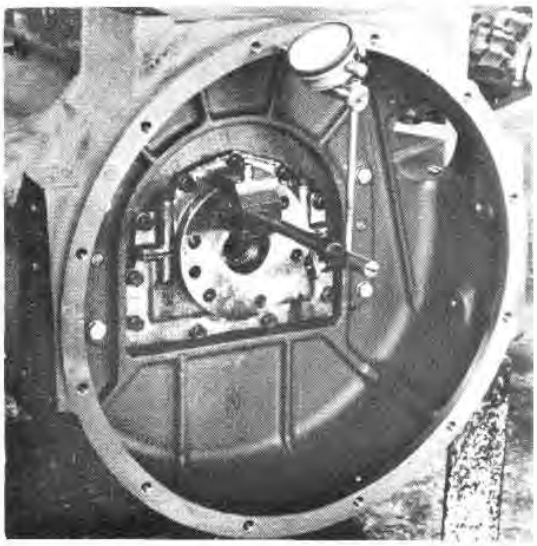


Fig. B51 — Alignment of Flywheel Housing Face

the rear face of the cylinder block be interfered with.

6. When the housing is properly aligned, tighten the securing setscrews evenly.

7. Ream the dowel holes and fit the correct length and size dowels.

8. Refit the flywheel, etc.

LUBRICATING SYSTEM

The importance of correct and clean lubrication cannot be stressed too highly and all reference to engine oil should be taken to mean lubricating oil which falls within the specification given. Care should be taken that the oil chosen is that specified for the climatic conditions under which the engine is operated.

The sump should be filled with a suitable lubricant to the correct level but do not attempt to overfill above the full mark. Before filling, or checking the dipstick, ensure that the tractor is on level ground.

DESCRIPTION

The lubrication is of the forced feed type, the oil being circulated by a lobed rotor type oil pump driven through an idler gear by the crankshaft gear. The oil is drawn through a sump strainer to the pump. Oil is then pumped to the relief valve housing and the full flow filter.

Oil passes through the filter to the pressure rail.

From the pressure rail the oil is fed to the main bearings and big ends. A seal prevents oil leaking along the crankshaft at the rear end.

The camshaft bearings are lubricated from numbers one, three and five main bearings.

The camshaft centre bearing supplies a controlled feed of oil to the rocker shaft assembly. This is achieved by allowing oil to be forced to the rocker shaft only when the oilways in the camshaft journal and camshaft centre bearing are in line. Oil from the rocker shaft escapes through a small bleed hole in each rocker lever and lubricates the valves and guides by splash.

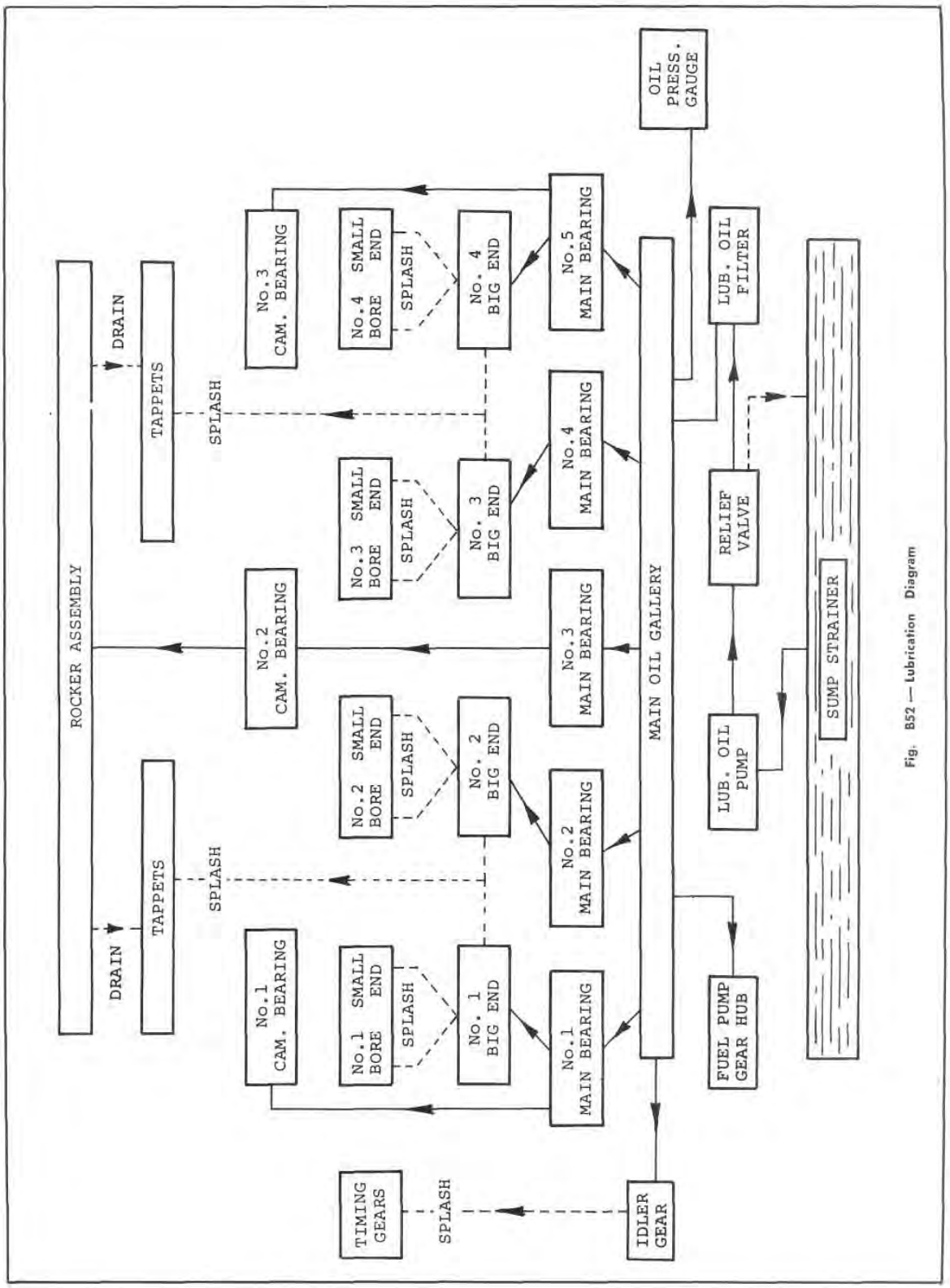


Fig. B52 — Lubrication Diagram

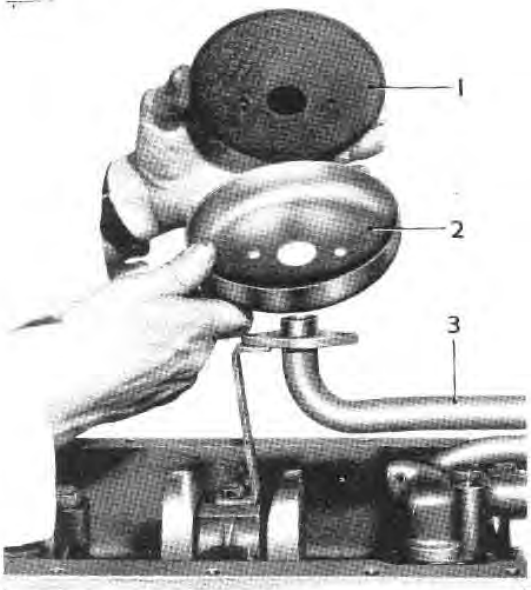
The idler gear and hub are pressure lubricated direct from the pressure rail. Oil enters the rear of the hub and passes through drillings to lubricate the idler gear bush and gear retaining plate. Timing gear teeth are splash lubricated by surplus oil from the front camshaft bearing idler gear hub and fuel pump hub.

Pistons, cylinder liners and connecting rod small end bearings are lubricated by splash and oil mist, also the cams and tappets of the valve mechanism.

THE OIL PUMP

The oil pump is secured to the front main bearing cap by three setscrews. The oil pump gear is driven through a bushed idler gear.

The oil pump drive gear is pressed and keyed on to the pump driven shaft on the other end of which is pressed and pinned a three lobed rotor. This rotor meshes with a four lobed driven rotor, which is free to rotate in the cast iron pump body.



1. Sump Strainer.
2. Srainer Cover.
3. Oil Pump Suction Pipe.

Fig. B53 — Removing Sump Strainer From Oil Pump Suction Pipe

To Remove the Oil Pump :

1. Remove the sump.
2. Remove the strainer (Fig. B53).
3. Remove the suction pipe.
4. Remove the oil delivery pipe between the pump and relief valve housing.
5. Remove the crankshaft pulley, timing case front cover, timing gears and timing case.
6. Remove the idler gear circlip and idler gear (Figs. B54 and B55).
7. Remove the three setscrews securing the pump to No. 1 Main bearing cap and withdraw the pump from the cap (Fig. B56).

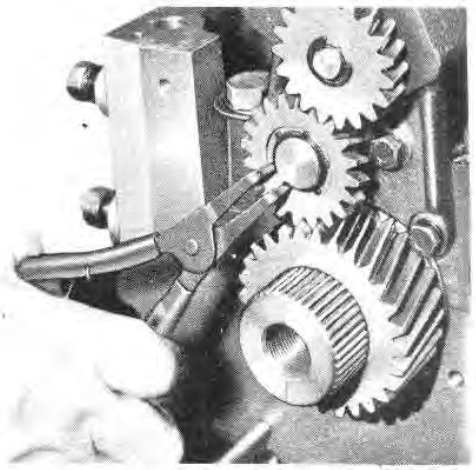


Fig. B54 — Removing the Oil Pump Idler Gear Retaining Circlip

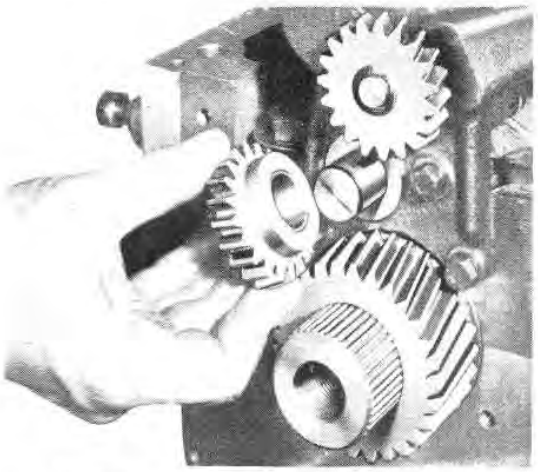


Fig. B55 — Removing the Oil Pump Idler Gear

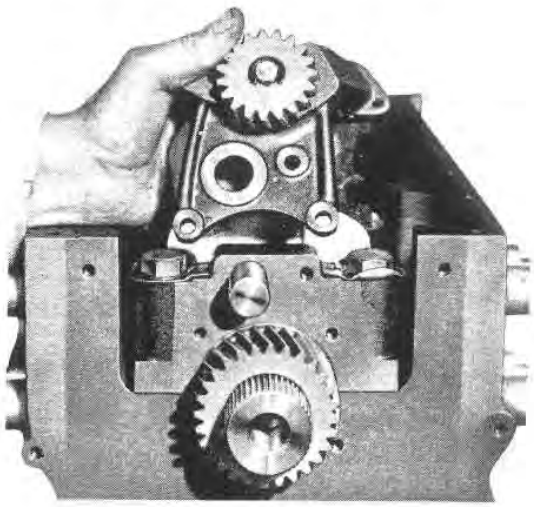


Fig. B56 — Removing the Oil Pump

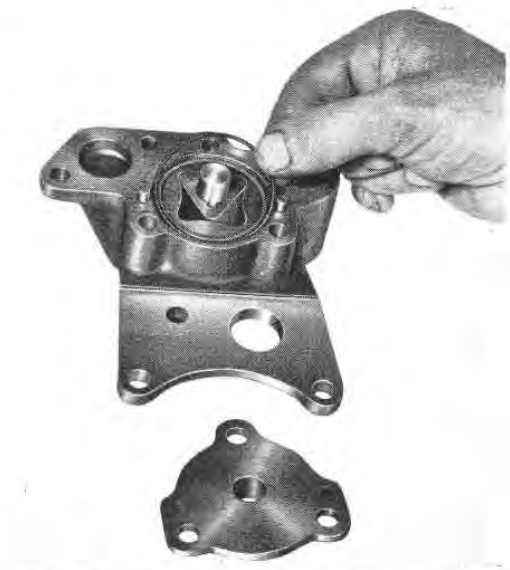


Fig. B57 — Removing the 'O' Sealing Ring from the Oil Pump

Fig. B58 — Checking Inner and Outer Rotor Clearance

Fig. B59 — Checking Outer Rotor to Body Clearance

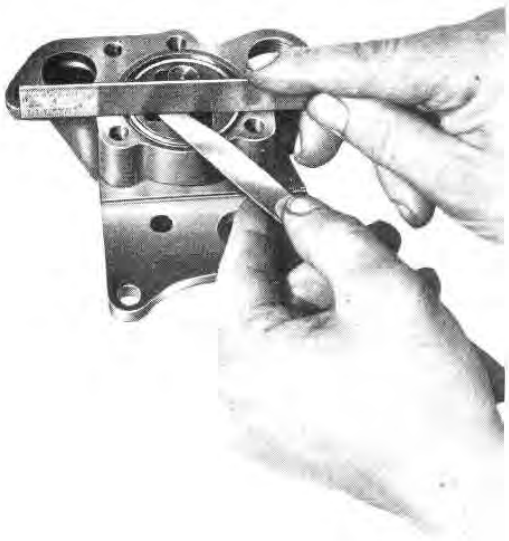


Fig. B60 — Checking Rotor End Clearance

To Dismantle the Oil Pump :

1. Remove the oil pump drive gear retaining circlip and the drive gear.

2. Remove the key from the keyway of the drive shaft.

3. Remove the end plate.

4. Remove the drive and driven rotors from the pump body.

5. Remove the "O" sealing ring from the pump body (Fig. B57).

Inspection :

1. Examine all parts for signs of cracking, wear or corrosion.

2. Install the inner and outer rotors in the pump body. The chamfered edge of the outer rotor enters the pump body first.

3. The clearances of a new pump are given in the schedule and are checked as shown in Figs. B58, B59 and B60.

NOTE : Should an oil pump be worn to such an extent it adversely affects the working pressure, a replacement pump should be fitted. Parts of the pump are not supplied individually.

To Assemble the Oil Pump :

1. Fit the drive and driven rotors to the pump body entering the chamfered end of the outer rotor to the body first. Refit the "O" sealing ring and end plate.

2. Refit the key and the drive gear to the shaft with the flat face towards the circlip groove. There should be a clearance of 0.003/0.007 in. between the rear face of the gear and the pump body.

3. Fit the drive gear retaining circlip.

To Refit the Oil Pump :

1. Fit the oil pump to No. 1 main bearing cap.

2. Refit the idler gear to the shaft with the recessed face towards the front and secure with the circlip. Check the idler gear end float which should be 0.002/0.016 in. Check the backlash between oil pump gear and idler gear which should be 0.006/0.009 in. Fig. B61.

3. Refit timing case, timing gears, timing case front cover and crankshaft pulley.

4. Refit the oil delivery pipe between the oil pump and pressure relief valve housing.

5. Refit the suction pipe to the oil pump.

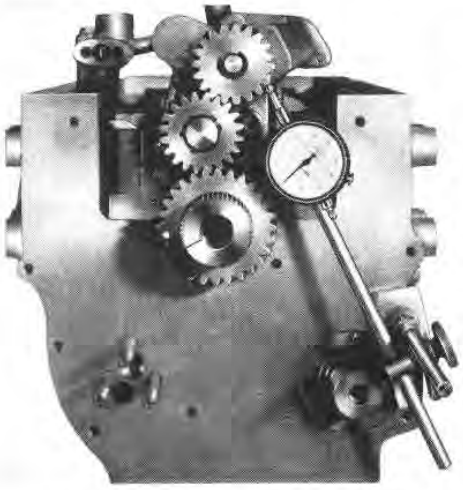


Fig. B61 — Checking Oil Pump Gear Backlash

6. Fit the sump strainer to the pump suction pipe, and refit the sump to the engine. Refill the sump with oil of an approved grade.

OIL PRESSURE RELIEF VALVE

The oil pressure relief valve is contained in a housing bolted to the bottom face of the cylinder block and is set to operate at 50/60 lb. per sq. in.

To Remove and Dismantle the Relief Valve Assembly :

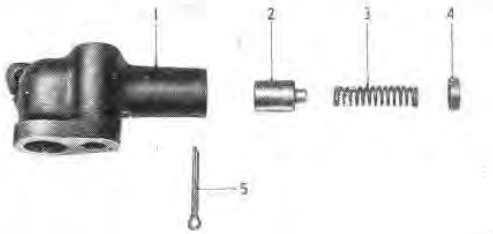
1. Remove the sump.

2. Disconnect the oil pump delivery pipe at the relief valve end.

3. Remove the relief valve housing.

4. Remove the splitpin from the end of the relief valve housing and withdraw the cap, spring and plunger. (Fig. B62).

5. Thoroughly clean all parts and inspect them for wear or damage.



1. Relief Valve Body.
2. Plunger.
3. Spring.
4. Spring Retaining Cap.
5. Splitpin.

Fig. B62 — Exploded View of Relief Valve

To Assemble and Refit the Relief Valve Assembly :

1. Fit the plunger, spring and cap to the relief valve housing and secure with the split pin.

2. If possible, check the pressure setting of the relief valve. The valve should lift between 50/60 lb. per sq. in. If not, extreme caution is advised when starting the engine until it is certain that the pressure relief valve is working correctly.

3. Refit the relief valve housing to the cylinder block.

4. Connect the oil pump delivery pipe to the relief valve housing.

5. Ensure that the sump strainer is correctly positioned on the oil pump suction pipe.

Refit the sump and refill with oil of an approved grade.

MANUFACTURING DATA AND DIMENSIONS

Cylinder Block

Height between top and bottom faces	17.367 - 17.375"
Parent bore diameter for cylinder liner	4.0615 - 4.0625"
Main bearing parent bore diameter	3.166 - 3.167"
Camshaft bore diameter No. 1	2.000 - 2.001"
Camshaft bore diameter No. 2	1.990 - 1.9918"
Camshaft bore diameter No. 3	1.970 - 1.9718"

Cylinder Liners

Type	Dry — Interference fit
Outside diameter of cylinder liner	4.0655 - 4.0665"
Interference fit of liner in block parent bore	0.003 - 0.005"
Finished bore diameter for cylinder liner	3.877 - 3.878"
Height of liner above cylinder block face	0.030 - 0.035"
Maximum rebore oversize	+0.030"
Overall length of liner	9.005 - 9.015"

Pistons

Type	Toroidal cavity in crown
Overall height (skirt to crown)	4.7596"
Centre line of gudgeon pin to piston crown	2.7586 - 2.7596"
Piston skirt diameter (across thrust)	3.8699 - 3.8707"
Piston crown diameter (across thrust)	3.8508 - 3.8528"
Piston to bore clearance (across thrust)	0.0063 - 0.0091"
Piston height in relation to cylinder block	0.003 - 0.010"
Bore diameter for gudgeon pin	1.37485 - 1.37505"
Compression ring groove width — Nos. 1, 2, 3.	0.0957 - 0.0967"
Scraper ring groove width — Nos. 4 and 5.	0.2525 - 0.2535"
Weight of piston	2 lb. 9⅛ oz. ±¼ oz.

Piston Rings

Top compression	Chromium plated — parallel face.
Second and third compression	Internally stepped.
Fourth and fifth — scraper	Maxigroove.
Compression ring width — top	0.0928 - 0.0938"
Groove width	0.0957 - 0.0967"
Ring clearance in groove	0.0019 - 0.0039"
Compression ring width — second and third	0.0928 - 0.0938"
Groove width	0.0957 - 0.0967"
Ring clearance in groove	0.0019 - 0.0039"
Scraper ring width — fourth and fifth	0.249 - 0.250"
Groove width	0.2525 - 0.2535"
Ring clearance in groove	0.0025 - 0.0045"
Ring gap — chrome compression	0.015 - 0.019"
Ring gap — internally stepped compression	0.011 - 0.016"
Ring gap — maxigroove scraper	0.011 - 0.016"

Gudgeon Pin

Type	Fully floating.
Outside diameter	1.375 - 1.3748"
Length	3.297 - 3.312"
Fit in piston boss	—0.00015" to +0.00025"

Small End Bush

Type	Steel backed, lead bronze lined.
Outside diameter	1.535 - 1.536"
Length	1.339 - 1.349"
Inside diameter before reaming	1.359 - 1.363"
Inside diameter after reaming	1.37575 - 1.3765"
Clearance between bush and gudgeon pin	0.00075 - 0.0017"

Connecting Rod

Type	"H" section.
Cap location to con rod	Serrations.
Big end parent bore diameter	2.6460 - 2.6465"
Small end parent bore diameter	1.53125 - 1.53225"
Length of C/L of big end to C/L of small end	8.624 - 8.626"
Big end, width	1.577 - 1.579"
Con rod end float on crankpin	0.0095 - 0.0145"
Big end bolt diameter	0.500"
Bolt thread	U.N.F.
Type of big end nut	Self locking.

Connecting Rod Alignment

Large and small end bores must be square and parallel with each other within the limits of ±0.010" measured 5" each side of the axis of the rod on a test mandrel. With the small end bush fitted, the limit of ±0.010" is reduced to ±0.0025".

Crankshaft

Overall length	24.01 - 24.04"
Main journal diameter	2.9985 - 2.999"
Main journal length — No. 1	1.453 - 1.473"
Main journal length — Nos. 2, 4 and 5	1.545 - 1.549"
*Main journal length — No. 3	1.738 - 1.741"
*Main journal fillet radii	0.145 - 0.156"
Crankpin diameter	2.499 - 2.4995"
*Crankpin length	1.5885 - 1.5915"
*Crankpin fillet radii	0.145 - 0.156"
*Surface finish — all journals	16 micro inches
Main journal and crankpin regrind undersizes	—0.010, —0.020 & —0.030"
Oil seal helix diameter	3.124 - 3.125"
Oil seal helix width	0.050 - 0.080"
Oil seal helix depth	0.004 - 0.008"
Flange diameter	5.248 - 5.250"
Flange width	0.500"
Crankshaft end float	0.002 - 0.014"
Pulley retaining setscrew thread	$\frac{7}{8}$" U.N.F. 14 T.P.I.

* Fillet radii and surface finish must be maintained during crankshaft regrinding. Length of No. 3 main journal not to exceed 1.759" after regrinding. Width of crankpins must not exceed 1.635" after regrinding. Where necessary use oversize thrust washers to suit.

Crankshaft Thrust Washers

Type	Steel backed, lead bronze faced.
Position in engine	Centre main bearing.
Thrust washer thickness (std.)	0.089 - 0.093"
Thrust washer thickness (O/size.)	0.0965 - 0.1005"
Thrust washer outside diameter	4.088 - 4.098"
Thrust washer inside diameter	3.420 - 3.430"

Main Bearings

Type	Pre-finished, steel backed, aluminium tin faced.
Shell width, Nos. 1, 2, 4 and 5	1.245 - 1.255"
Shell width, No. 3	1.435 - 1.445"
Outside diameter of main bearing	3.167"
Inside diameter of main bearing	3.0015 - 3.003"
Main bearing running clearance	0.0025 - 0.0045"
Steel thickness	0.070"
Aluminium thickness	0.012 - 0.0125"

Connecting Rod Bearings

Type	Pre-finished, steel backed, aluminium tin faced.
Shell width	1.245 - 1.255"
Outside diameter of conrod bearing	2.6465"
Inside diameter of conrod bearing	2.501 - 2.502"
Conrod bearing running clearance	0.0015 - 0.003"
Steel thickness	0.050"
Aluminium thickness	0.02225 - 0.0225"

Camshaft

No. 1 journal length	1.2105"
No. 1 journal diameter	1.9965 - 1.9975"
No. 1 cylinder block camshaft bore diameter	2.000 - 2.001"
No. 1 journal running clearance	0.0025 - 0.0045"
No. 2 journal length	1.625"
No. 2 journal diameter	1.9865 - 1.9875"
No. 2 cylinder block camshaft bore diameter	1.990 - 1.9918"
No. 2 journal running clearance	0.0025 - 0.0053"
No. 3 journal length	1.1875"
No. 3 journal diameter	1.9665 - 1.9675"
No. 3 cylinder block camshaft bore diameter	1.970 - 1.9718"
No. 3 journal running clearance	0.0025 - 0.0053"
Cam lift	0.3035"
Oilways for rocker shaft lubrication	No. 2 journal

Camshaft Thrust Washer

Type	360°
Outside diameter	2.872 - 2.874"
Cylinder block recess diameter for thrust washer	2.875 - 2.885"
Clearance fit of washer in recess	0.001 - 0.013"
Thrust washer inside diameter	1.750"
Thrust washer thickness	0.216 - 0.218"
Cylinder block recess depth for thrust washer	0.187 - 0.190"
Thrust washer protrusion beyond cylinder block front face.	0.026 - 0.031"
Camshaft end float	0.004 - 0.016"

Cylinder Head

Length	19.875"
Depth	4.0625 ± 0.015"
Skimming allowance on cylinder head face	0.012"
Minimum cylinder head depth after skimming	*4.0355"
Maximum nozzle protrusion after skimming	0.175"
Leak test pressure	30 lbs. per sq. in.
Valve seat angle	45°
Valve bore in cylinder head	0.375 - 0.376"

* Minimum cylinder head depth quoted is nominal and skimming allowance must be governed by the maximum nozzle protrusion permissible.

Exhaust Valves

Valve stem diameter	0.372 - 0.373"
Clearance fit of valve in head	0.002 - 0.004"
Valve head diameter	1.438 - 1.442"
Valve face angle	45°
Valve head depth below cylinder head face	0.029 min. - 0.055" max.
Overall length of valve	4.845 - 4.862"
Service valve stem oversizes	0.003, 0.015 & 0.030"
Sealing arrangement	Deflectors

Inlet Valves	
Valve stem diameter	0.3725- 0.3735"
Clearance fit of valve in head	0.0015 - 0.0035"
Valve head diameter	1.742 - 1.746"
Valve face angle	45°
Valve head depth below cylinder head face	0.035 min. - 0.061" max.
Overall length of valve	4.830 - 4.845"
Service valve stem oversizes	0.003, 0.015 & 0.030"
Sealing arrangement	Deflectors
Valve Springs	
Fitted length	1.780"
Load at fitted length	40 lb. ± 2 lb.
Fitted position	Damper coils to cylinder head.
Tappets	
Overall Length	2.96875"
Outside diameter of tappet shank	0.7475 - 0.7485"
Cylinder block tappet bore diameter	0.750 - 0.75125"
Tappet running clearance in bore	0.0015 - 0.00375"
Outside diameter of tappet foot	1.375"
Rocker Shaft	
Overall length	16.796"
Outside diameter	0.7485 - 0.7495"
Rocker Levers	
Inside diameter of lever bore	0.7505 - 0.7520"
Lever clearance on rocker shaft	0.001 - 0.0035"
Valve Clearances	
Between stem and rocker lever	0.010 hot - 0.012" cold.
TIMING GEARS	
Camshaft Gear	
No. of teeth	56
Inside diameter of gear boss	1.375 - 1.376"
Outside diameter of camshaft hub	1.375 - 1.3757"
Interference fit of gear on hub	0.0007 - 0.0009"
Fuel Pump Gear	
No. of teeth	56
Inside diameter of gear bore	1.750 - 1.751"
Fuel pump hub diameter	1.748 - 1.7488"
Idler Gear and Hub	
No. of teeth	63
Bore diameter of gear bush (bored in situ)	1.9998 - 2.0007"
Outside diameter of gear hub	1.996 - 1.997"
Running clearance of gear on hub	0.0028 - 0.0047"
Idler gear width (including bushes)	1.1865 - 1.1875"
Hub width	1.1905 - 1.1935"
Idler gear end float	0.003 - 0.007"
Crankshaft Gear	
No. of teeth	28
Gear bore	1.875 - 1.876"
Crankshaft diameter for gear	1.8750 - 1.8755"
Timing Gear Backlash	
All gears	0.003 - 0.006"
LUBRICATION SYSTEM	
Lubricating oil pressure	30/60 lbs. per sq. inch at max. engine speed and normal working temperature.
Oil Pump	
Type of pump	Rotor type.
No. of lobes — inner rotor	Three.
No. of lobes — outer rotor	Four.
Drive position on engine	By idler gear from crankshaft gear.

Pump Clearances	
Inner rotor to outer rotor	0.001 - 0.003"
Inner rotor end clearance	0.0015 - 0.003"
Outer rotor end clearance	0.0005 - 0.0025"
Outer rotor to pump body	0.001 - 0.003"
Oil Pump Delivery	
Engine r.p.m.	1000 - 2000
Imperial gall./min.	2.5 - 5.0
Oil Pump Drive Gear	
No. of teeth	19
Inside diameter of gear bore	0.497 - 0.4978"
Outside diameter of oil pump shaft	0.4990 - 0.4995"
Interference fit of gear on shaft	0.0012 - 0.0025"
Clearance between drive and pump body	0.003 - 0.007"
Oil Pump Idler Gear	
No. of teeth	20
Inside diameter of gear bore	1.000 - 1.0012"
Outside diameter of gear bush	1.000 - 1.0008"
Inside dameter of gear bush	0.8750 - 0.8763"
Outside diameter of idler gear shaft	0.8737 - 0.8742"
Running clearance of gear on shaft	0.0008 - 0.0026"
Idler gear end float	0.002 - 0.016"
Relief Valve	
Type	Spring loaded plunger.
Pressure setting	50/60 lbs. per sq. in.
Length of plunger	0.9375"
Outside diameter of plunger	0.5585 - 0.5595"
Inside diameter of valve housing bore	0.5605 - 0.5625"
Clearance of plunger in bore	0.001 - 0.004"
Outside diameter of spring	0.368 - 0.377"
Spring — free length	1.500"
Spring — solid length	0.754"

COOLING SYSTEM

Type of Cooling System	
Cylinder head	Water pump circulation.
Cylinder block	Thermo-Syphon.
Engine water capacity (less radiator)	16.5 Imp. pints.
Thermostat	
Type	Wax capsule type.
Operating temperature	178°F.
Water Pump	
Type	Centrifugal.
Pump — free delivery — engine r.p.m.	2000
— imp. gall. per minute	25
Outside diameter of shaft for pulley	0.7501 - 0.7506"
Inside diameter of pulley bore	0.7500 - 0.7508"
Transition fit of pulley on shaft	0.0006 - 0.0007"
Outside diameter of shaft for impeller	0.6262 - 0.6267"
Inside diameter of impeller bore	0.6249 - 0.6257"
Interference fit of impeller on shaft	0.0005 - 0.0018"
Outside diameter of impeller	3.094 - 3.096"
Impeller blade to body clearance	0.012 - 0.032"
Water pump seal type	Synthetic rubber — carbon faced.
Outside diameter of seal	1.656 - 1.718"
Inside diameter of seal for impeller shaft	0.678 - 0.684"
Bearing seal type	Tallow impregnated felt.
Bearing seal thickness	0.218"
Outside diameter of seal	1.375"
Inside diameter of seal	0.921"

CHAMBERLAIN

SECTION **C**

COOLING SYSTEM

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

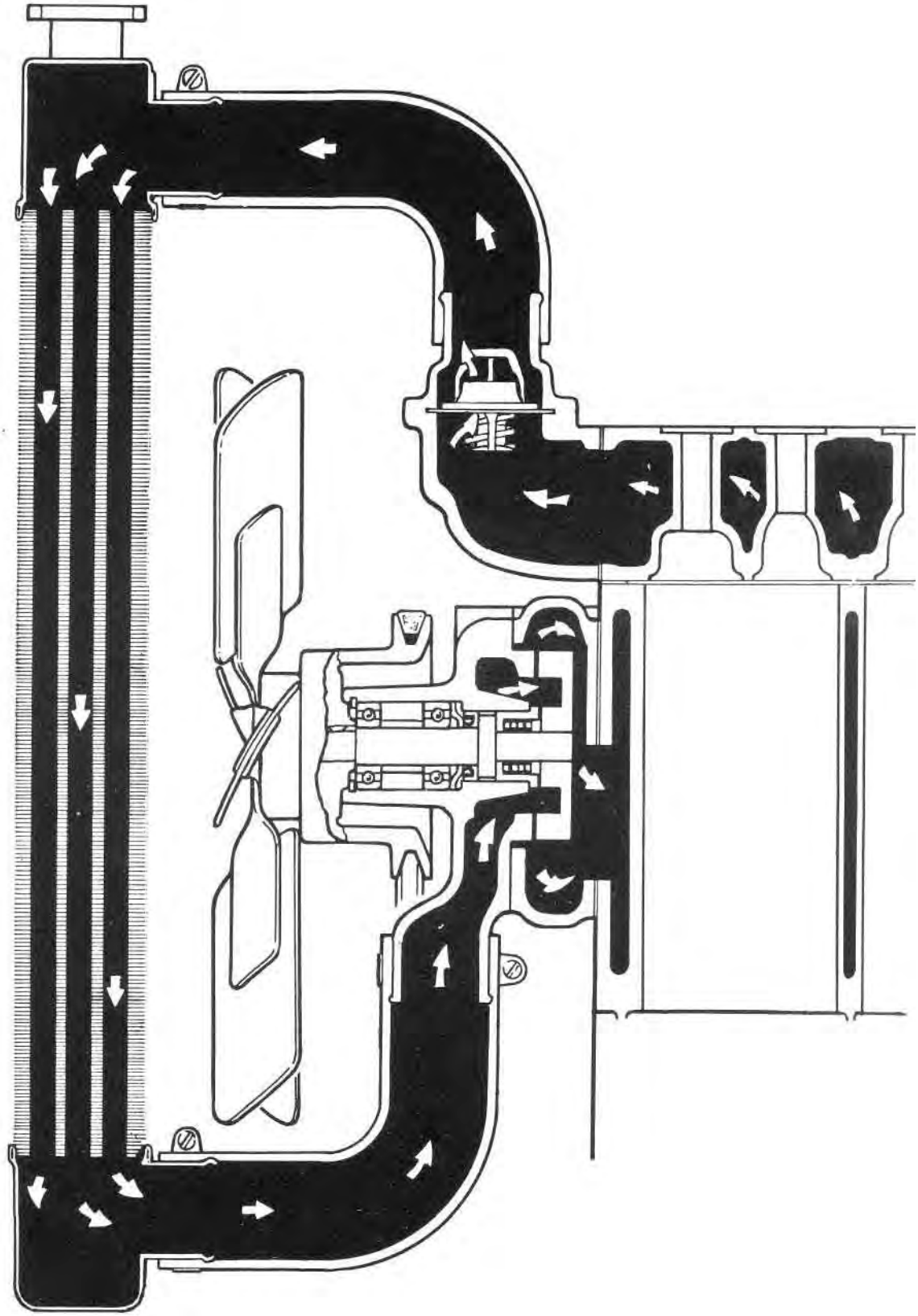


Fig. C1 — Cooling System

COOLING SYSTEM

DESCRIPTION

The engine is cooled by water circulation through passages in the cylinder block and head. Circulation is by thermo-syphon action assisted by an impeller type water pump, mounted on the front face of the cylinder block and driven by a "V" belt from the crankshaft pulley. The water pump works in conjunction with a radiator through which the water passes in the process of cooling. Heavy duty, "Silentruba" type mounts are used on the radiator which accommodates the crankshaft driven hydraulic pump drive and provides mountings for a torque converter transmission heat exchanger.

The pump mounted cooling fan draws air through the radiator core, thus lowering the temperature of the water while it is passing from top to bottom in the core.

Internal water temperature is automatically controlled by a wax capsule type thermostat mounted in the water outlet body at the end of the cylinder head. Thermostat opening temperature is approximately 178°F and prior to its opening, water is retained in the cylinder block and head to rapidly raise the temperature to the operating range when the engine has been started from cold. When the thermostat is fully open, the water is then circulated right through the cooling system. A jiggle pin in the thermostat enables air to be bled from the system when refilling.

SPECIFICATION

Radiator	— Tubular core — integral top and bottom tanks with mounting brackets attached. Pressurised cap.
Circulation	— Centrifugal type water pump mounted on engine block.
Heat regulation	— Wax capsule thermostat.
Pressure cap	— 7 p.s.i.
Water capacity	— 30 pints.
Fan	— 17" diameter, 6 blade.
Fan drive	— "V" belt driven from crankshaft pulley in conjunction with alternator.
Belt adjustment	— Adjustable stay on alternator — ¾" deflection between alternator and crankshaft pulleys with thumb pressure of 15-20 lbs.

MAINTENANCE

In order that the system may function efficiently it is essential that the water and air passages are free from obstruction, and periodic attention should be given to the cooling system to ensure this condition.

It is advisable to service the cooling system every six months or after 600 operating hours, but more frequently if it is not possible to obtain clean "soft" water for filling purposes. The use of some approved type of flushing compound may be found necessary, and the use of a good corrosion inhibitor is recommended. Follow the manufacturers instructions carefully to avoid damage to hoses, etc.

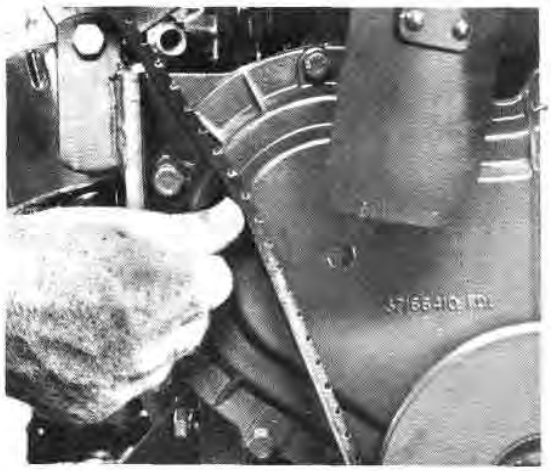


Fig. C2 — Checking Fan Belt Tension

Drain the water from the radiator and engine by removing the drain plug in the bottom tank of the radiator and opening the drain cock on the side of the engine block. Reverse flushing of the system is recommended.

Remove the upper and lower hoses and carefully remove the thermostat at the front of the cylinder head. With the thermostat removed, apply water under pressure to the front of the cylinder head. This has the effect of causing a flow of water in the opposite direction to the normal operating flow which will give thorough scavenging action to the system. Check that the radiator overflow pipe is clear as blockage of this pipe will result in undue pressure being developed in the system with possible damaging effect. A blockage may be cleared by applying water pressure at the lower end.

Fig. C3 — Replacing the Thermostat

After the cooling system has been cleaned, replace the thermostat, ensuring that it is correctly seated, and reconnect the hoses. It is good practice to add a good quality rust inhibitor when the system is filled with clean "soft" water. If soluble oil is used, caution should be exercised as excessive quantities will cause deterioration of the connecting hoses.

Clean the radiator air passages by applying a jet of water to the rear of the core.

Keep a close watch at all times of the water level in the top tank and for signs of water leakage. Failure of the cooling system due to lack of water will result in overheating and damage to the engine.

Check the fan belt tension every 50 operating hours and adjust the tension by slackening the adjustable stay bolt, swinging the alternator inwards or outwards until the belt can be deflected ¾" with 15-20 lbs. thumb pressure midway between the alternator and crankshaft pulleys, and retightening the adjustable stay bolt. A slack fan belt may cause overheating of the engine and low alternator output through slippage or, alternatively, overtightening could result in excessive bearing loads to the alternator and water pump, and possible belt breakage.

No lubrication of the pump is necessary as the bearings are specially treated on assembly. The bearings are sealed, and protected from the ingress of dirt and water by a felt seal at the rear and by the shape of the pulley at the front.

SERVICE

To Service the Radiator :

(a) Drain the cooling system.

(b) Remove the grill and radiator shell.

(c) Remove the retaining nuts or setscrews on the upper and lower radiator mounts, slacken the top and bottom hose clips and remove the radiator out through the cowling.

Note : If a torque converter is fitted it is first necessary to drain the converter oil.

(d) Thoroughly clean the radiator core air passages and reverse flush the radiator. Carry out any necessary repairs.

(e) Replace the radiator by reversing instructions (a), (b) and (c).

To Service the Water Pump :

It is possible to remove the thermostat housing, fan and fan belt, and then the water pump, but for ease of working, the radiator should first be removed.

Water Pump Removal :

(a) Remove the radiator.

(b) Remove the fan belt. Slacken the alternator adjusting link to ease the belt tension.

(c) Remove the fan.

(d) Remove the lower radiator hose, the pump to cylinder block mounting setscrews and lift the pump from the engine.

Note : The setscrew nuts foul the pulley and require the pump body to be eased forward to enable them to be completely unscrewed.

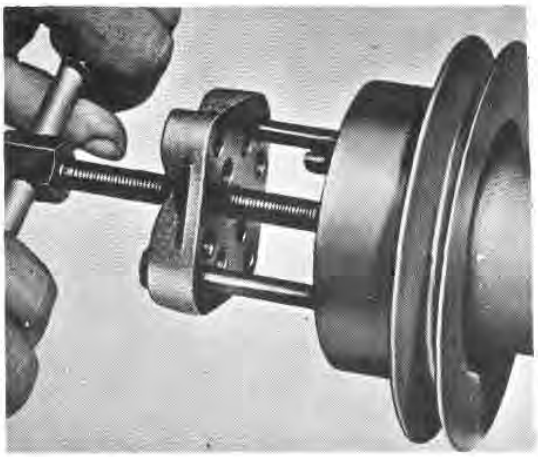


Fig. C4 — Removing the Water Pump Pulley

Water Pump Overhaul :

1. Unscrew the self-locking nut securing the pulley to the pump shaft and remove the nut and plain washer.
2. With the aid of a suitable puller, remove the pulley and then the pulley key.
3. Press the pump shaft complete with impellor out of the body from the front of the pump.
4. Remove the impellor from the shaft, using a suitable press.
5. Remove the rear seal from the pump shaft.
6. Remove the bearing retaining circlip from the pump body.
7. Press the two bearings and distance piece out of the pump body.
8. Remove the front seal, seal retainer and flange from the pump body.
9. Clean and examine all parts thoroughly :—

(a) The pump housing for cracks, damage or corrosion.

(b) The shaft for wear, ensuring that the bearing inner races are a satisfactory fit on the shaft. The shaft should be renewed if wear in this area is sufficient to allow the races to rotate on the shaft.

(c) Remove rust and scale from the impellor and visually inspect for cracks or damage. Examine the hub sealing face for excessive wear or scoring. Renew if unserviceable.

(d) Examine the rear seal for damage. Excessive wear, scoring or cracks in the carbon sealing face will necessitate renewal.

10. Press the rear bearing onto the shaft, fit the bearing distance piece and press on the front bearing. Ensure that the bearing seals face outward, towards the front and rear of the shaft.
11. Fit the front seal retaining plate in position against the back face of the rear bearing. This retaining plate is "dished" and when positioned, the centre of the plate must **not** be in contact with the bearing.
12. Fit the felt seal and seal retainer housing so that these bear on the retaining plate.
13. Half to two thirds fill the space between the two bearings with the correct grade of high melting point

grease and press the complete assembly into the pump housing from the front end. Securely position the retaining circlip in the recess of the housing immediately forward of the front bearing.

14. Fit the rear seal into the housing ensuring that the carbon face is positioned towards the rear. When fitted, the seal must rest squarely on its seat and not be canted in any way. At this stage, the shaft should be turned by hand to ensure that no undue resistance to rotation exists.

15. Fit the pulley driving key and press on the pulley, making certain that no rearward axial movement of the shaft is incurred.

16. Press the impellor onto the shaft ensuring that a clearance of .012" — .032" is maintained between the inner edge of the impellor vanes and the pump body.

17. Refit the plain washer and pulley retaining self-locking nut, tightening to a torque of 55-60 lbs/ft.

18. Re-assemble the pump to the engine.

Fig. C5 — Checking the Impellor to Water Pump Body Clearance

Thermostat Testing :

If it is suspected that the thermostat is not operating correctly, it should be tested in the following manner :—

1. Immerse the thermostat in a suitable container of water and gradually heat the water. The thermostat should be suspended and not touch the container or testing element at any point.

2. Check the water temperature with a thermometer of known accuracy.

3. The thermostat valve should commence to open at the temperature stamped on the top face of the thermostat.

4. If the thermostat does not function correctly, no adjustment is posssible. Replace it with a new unit.

TROUBLE SHOOTING

Overheating :

Due to

(a) Lack of water.
(b) Faulty temperature gauge
(c) Clogged water passages.
(d) Clogged core air passages.
(e) Loose fan belt.
(f) Faulty thermostat.
(g) Incorrect radiator cap .
(h) Water pump failure.
(i) Tractor overloaded.
(j) Leaking head gasket or cracked head.

Underheating :

(a) Insufficient tractor loading.
(b) Faulty temperature gauge.
(c) Incorrectly seated thermostat.
(d) Faulty thermostat operation.

CHAMBERLAIN

SECTION **D**

FUEL SYSTEM

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

FUEL SYSTEM

The equipment for the supply, filtration and delivery of fuel to the engine consists of a fuel tank, primary strainer and water trap, a diaphragm type fuel lift pump, an agglomerator, a final micronic filter, a distributor type fuel injection pump and four injectors. There is also a small reservoir, fed from the injector leak-off pipe, to provide a gravity feed to the cold starting aid in the air intake manifold.

Particular stress is laid on the importance of clean filtered fuel oil if longevity and trouble free operation is to be obtained.

SPECIFICATIONS

Fuel Oil	— Distillate to B.S.2869 (1957) Class 'A' (Cetane No. 45 min.)
Fuel Tank Capacity	— Std. Manual and T.C. — 18.5 imp. galls.
	— F.W.D. Manual and T.C. — 12.0 imp. galls.
	— Std. Manual with 3 P.L. — 14.25 imp. galls.
Fuel Filter	— Two with replaceable paper elements, primary filter incorporates transparent bowl.
Fuel Lift Pump	— A.C. Delco V.P. Series.
Drive Method	— Eccentric on camshaft.
Delivery Pressure	— 2¾ lbs - 4¼ lbs./sq. in.
Injection System	— Direct injection.
Injection Pump	— CAV Distributor type fitted with mechanical governor.
Pump Model	— 324 - 8440.
Pump Setting Code	— PS61/850/5/2160.
Pump Rotation	— Clockwise.
Plunger Diameter	— 8.5 m.m.
Timing Letter	— "C".
No. 1 Cyl. Outlet	— "W".
Injection Timing (Static)	— 22° B.T.D.C.
Fuel Injectors :	
CAV Holder	— BKBL67S5151.
CAV Nozzle	— BDLL150S6435 - AB.
Working Pressure	—170 atmospheres.
Setting Pressure	— 175 atmospheres.

FUEL FILTERS

Care has been taken in the design of the fuel system to ensure that only clean fuel oil reaches the fuel pump,

Fuel oil filters are provided, in addition to a dirt and water trap in the fuel tank sump. This trap requires opening daily or at 10 operating hours to drain off any accumulated water or sediment.

The F.W.D.model tractors are also provided with a gauze trap in the filler of the fuel tank. This must not be removed when fuel is being poured into the tank. Take it out when necessary, clean, wash in clean fuel oil and replace it immediately.

When re-fueling standard model tractors, which do not have a filter in the filler, pour the fuel through a fine gauze strainer.

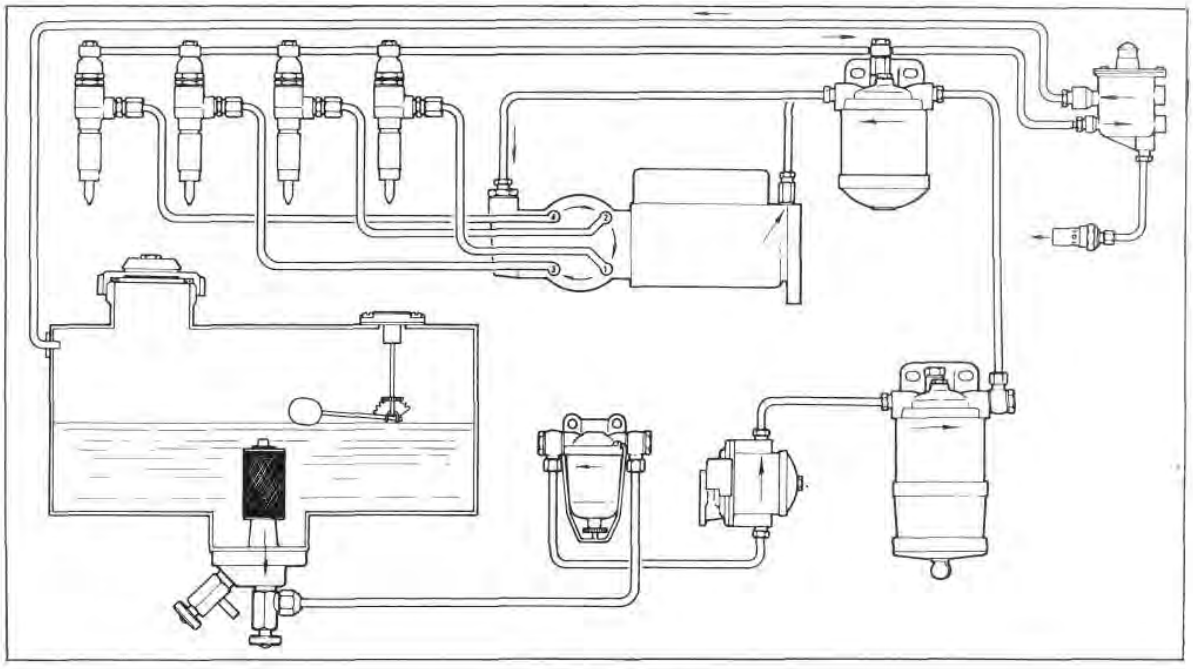


Fig. D1 — Fuel System

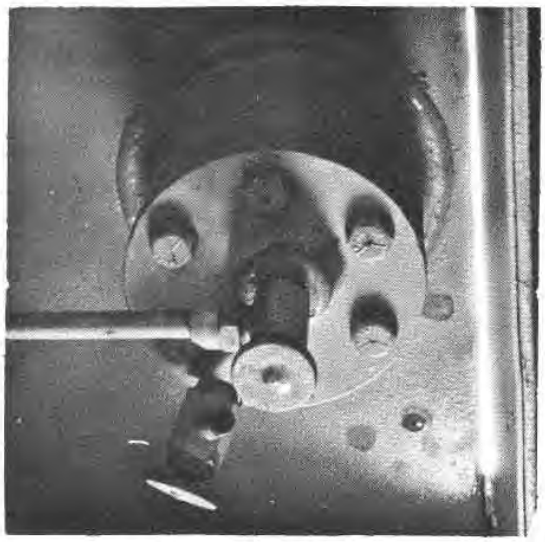


Fig. D2 — Fuel Tank Sump Drain

Fig. D4 — Removing the Water Trap Glass Bowl

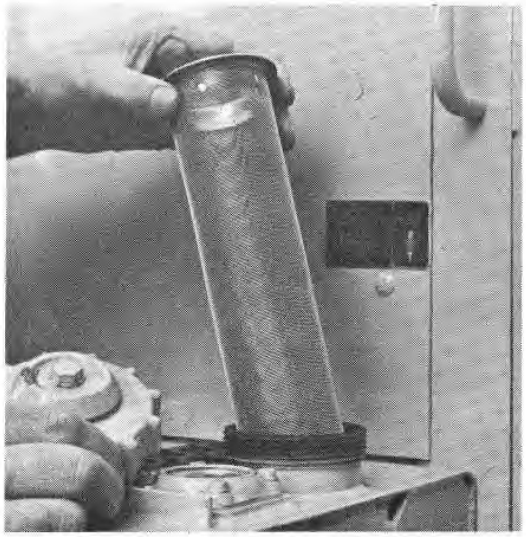


Fig. D3 — F.W.D. Model Filler Gauze Strainer

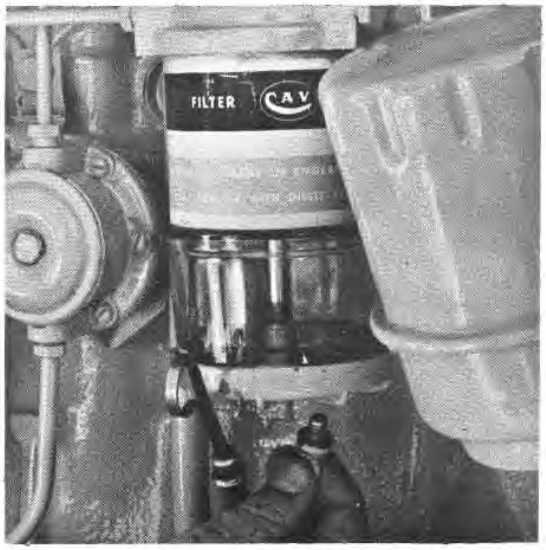


Fig. D5 — Draining the Agglomerator

The pre-strainer and water trap is fitted between the fuel tank and lift pump. The glass bowl of the water trap requires checking daily or at 10 operating hours for water or sediment, and to be drained and cleaned as necessary. At 600 hours the pre-strainer gauze should be removed and cleaned. This is accessible when the glass bowl is removed.

The fuel lift pump should be dis-assembled by unscrewing the bolt securing the pulsator cover and cleaned every 600 hours, unless conditions of the fuel warrants more regular attention. When reassembling, ensure that a good joint is made between the pulsator cover and body as any leakage of air here may cause air locks in the fuel system.

The agglomerator transparent bowl requires daily checking, and to be drained and cleaned as necessary. At 600 operating hours, replace the agglomerator paper element as it is not possible to clean the element.

Note : Dirt trapped by the agglomerator filter is held **above** the filter and is not evident in the transparent bowl, water only appearing trapped in the bowl. In the event of a fuel starvation problem, do **not** assume that the agglomerator filter is not clogged because the fuel bowl is clear. A choked filter could be the problem.

To Renew the Element :

(a) Unscrew the bolt in the centre of the top filter cover.

(b) Lower the filter bottom cover and the glass bowl clear.

(c) Remove and discard the element.

(d) Clean the filter top and bottom covers with distillate before positioning the new element.

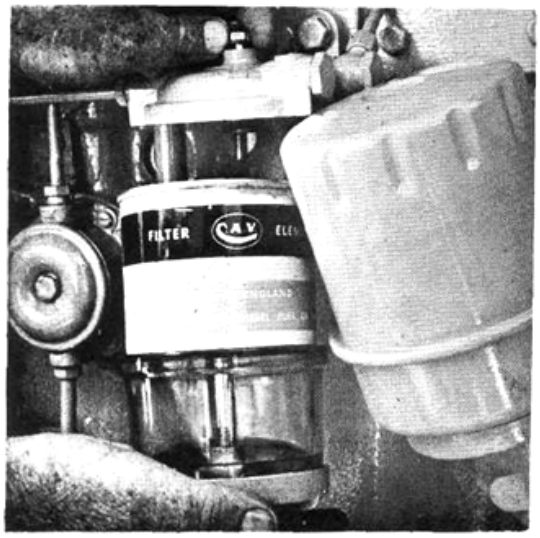


Fig. D6 — Removing the Agglomerator Paper Element

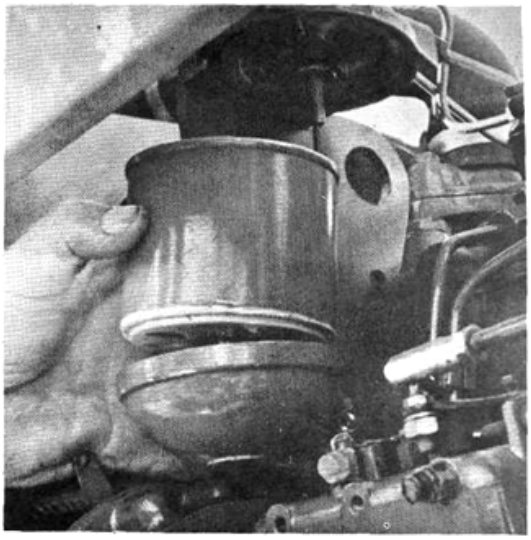


Fig. D7 — Removing the Final Fuel Filter

(e) Use new rubber joints if the old ones are not in good condition.

(f) When the agglomerator is reassembled, bleed the fuel system as described at the end of the section.

The final micronic filter is located on the left hand side of the cylinder head and the element requires replacing at 1200 operating hours. Element replacement is similar to the agglomerator except that there is no transparent bowl to be fitted between the element and bottom cover.

FUEL LIFT PUMP

The diaphragm type fuel lift pump, mounted on a boss on the right hand side of the cylinder block, is operated by an eccentric on the camshaft.

Testing the Pump in Position :

1. Disconnect the outlet pipe (lift pump to agglomerator) leaving a free outlet from the pump.
2. Rotate the engine. There should be a spurt of fuel from the outlet port once every two revolutions.

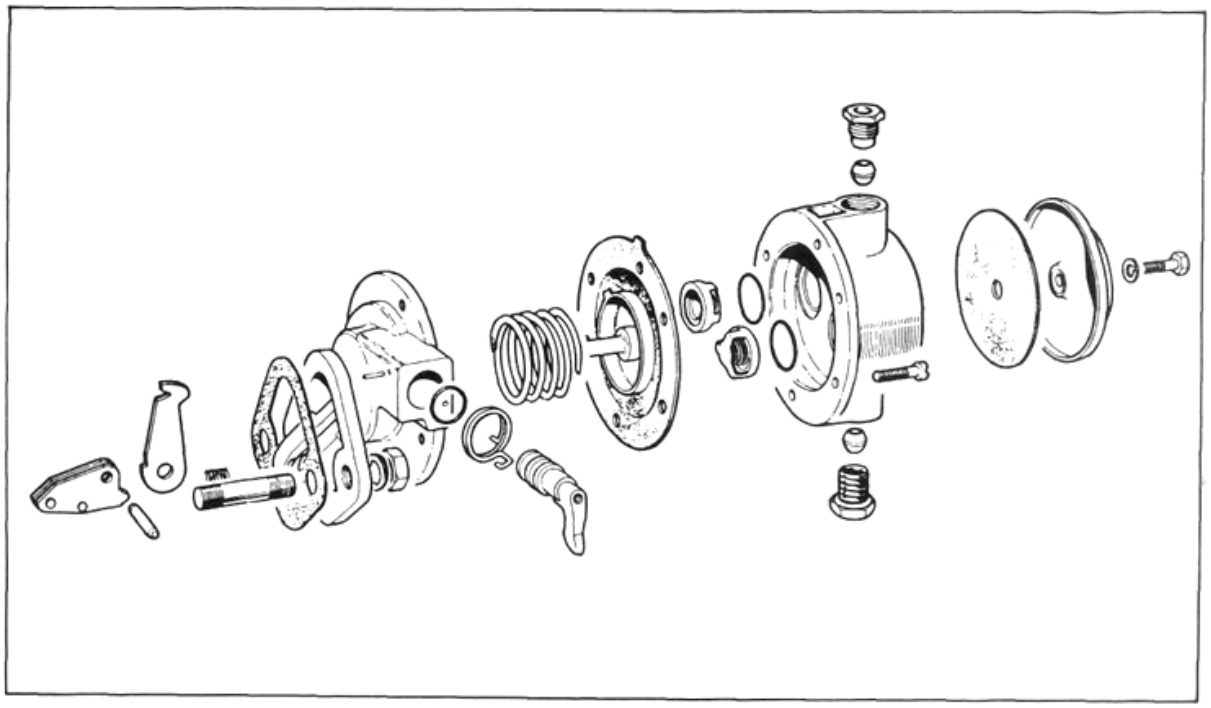


Fig. D8 — Exploded View — Fuel Lift Pump

To Remove the Pump from the Engine :

1. Disconnect the pipes from the inlet and outlet ports. Seal the ends of the pipes to prevent the entry of dirt, etc.
2. Remove the setscrews securing the pump to the cylinder block and withdraw the pump and joint.

Dismantling the Pump :

1. Make a file mark across the two flanges for guidance in re-assembly.
2. Remove the pulsator cover and pulsator diaphragm.
3. Remove the setscrews and washers which secure the pump cover to the body and separate the two halves.
4. Remove the diaphragm by unhooking it from the rocker arm link. The diaphragm spring can now be withdrawn.
5. Drive out the rocker arm pivot pin and withdraw the rocker arm, spring and link.
6. Dismantle the priming lever by removing the lever retaining pin.
7. Remove the valves by levering from their locations. Remove the valve gaskets.

Cleaning ond Inspection of Parts :

1. Check the diaphragm for hardening or cracking and examine the pull rod for wear at the point where it connects with the rocker lever link.
2. The diaphragm spring should be renewed if corroded or distorted. Ensure the new spring has the same (green) colour identification.
3. The valves should be replaced. The two valves are identical and may be used for inlet or outlet.
4. Examine the rocker, arm, link, spring and pin for wear.
5. Check the pulsator diaphragm for condition.
6. Examine the flanges of the two pump halves for distortion. If necessary, lightly linish to restore flatness.

To Re-assemble the Pump :

1. Fit the new valve gaskets and valves to the cover. The inlet valve must be fitted so that it can open to admit fuel i.e. the spring must protrude into the pump chamber. The outlet valve must be fitted in the reverse position to the inlet valve. Stake the casting with a suitable punch in four places to retain the valves.
2. Insert the rocker arm pin through its hole in the body, at the same time engaging the link and the rocker arm. Tap the rocker arm pin in until it is flush with the pump body. Stake the casting in three places each side to retain the pin.

Note : The fitting of the rocker arm pin can be simplified by first inserting a piece of .240" diameter rod through the pin hole in one side of the body to engage the rocker arm and link,and then pushing the rocker arm pin in from the opposite side, removing the temporary rod as the pin takes up its proper position.

3. Place the diaphragm spring in position.
4. Place the diaphragm assembly over the spring, the pull rod being downwards, and centre the upper end of the spring in the lower diaphragm protector washer.
5. Press downward on the diaphragm and make sure that the downward tag on the lower diaphragm protecting washer is on the priming lever side of the body. This tag is required to be in the hole of the body ready for fitment of the priming lever. Engage the diaphragm pull rod with the link and at the same time match up the holes in the diaphragm.
6. Push the rocker arm towards the pump until the diaphragm is level with the body flanges. Place the upper half of the pump into position as shown by the file mark on the flanges. Install the screws and washers and tighten only until the heads engage the washer. Release the rocker arm and push on the spaded end of the rod so as to hold the diaphragm at the top of the stroke, and while so held tighten the securing screws diagonally.

Note : The edges of the diaphragm should now be flush with its two clamping flanges. Any appreciable protrusion of the diaphragm indicates incorrect fitting.

7. Fit the primer to the side of the body and retain with the pin. Clip on the priming lever spring.
8. Fit the pulsator diaphragm and cover.
9. Test the pump to ensure that it is working correctly.

To Refit the Pump :

1. Using a new joint, refit the pump to the cylinder block and secure with the setscrews and washers.
2. Reconnect the fuel lines and vent the system of air.

FUEL INJECTION PUMP

Description :

The fuel injection pump is of the D.P.A. distributor type, flange mounted to, and driven from the engine timing case.

The pump is a compact, oil tight unit, lubricated throughout by fuel oil and requiring no separate lubrication system. The fuel is pumped by a single element, and fuel charges are distributed in the correct firing order at the correct time to each cylinder in turn, by means of a rotary distributor within the pump. In consequence, equal amounts of fuel delivery to each injector is an inherent feature of the pump and deliveries are not subject to maladjustment from one injector to another.

Accurate phasing is also a feature of the pump, as the timing intervals between injection strokes are determined by an accurate spacing of distributor ports and the high precision cam ring and therefore, not subject to adjustment.

Sensitive speed control is maintained by a governor of the mechanical operated type and automatic variation of the commencement of injection is obtained with an automatic advance unit.

Note : Unless proper test equipment and the relevant Test Plan for the fuel pump is available, adjustment or maintenance of the fuel pump should not be contemplated.

The Working Principle :

The opposed plungers are actuated by cam rollers carried in shoes sliding in the rotor body. The cam ring is carried in the pump housing and has as many lobes as there are engine cylinders. The plungers move in-

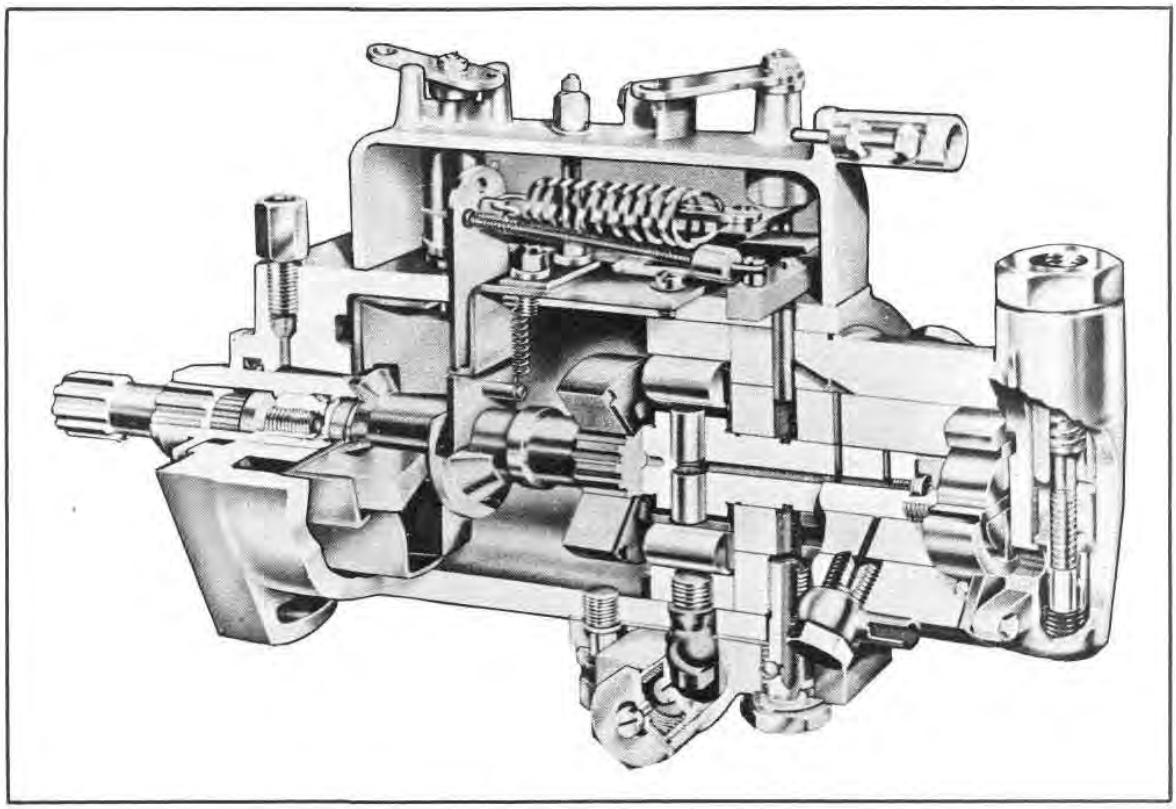


Fig. D9 — Fuel Injection Pump

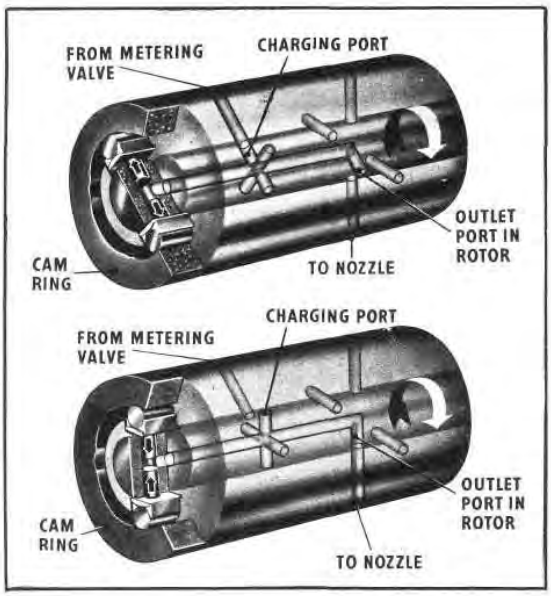


Fig. D10 — Metering of Fuel

wards simultaneously as the rollers contact cam lobes which are diametrically opposite. No return springs are fitted, the plungers being returned by the pressure of inflowing fuel.

The working principle of the pump can be followed readily if reference is made to the simple diagrams Fig. D11a and D11b. In Fig. D11a the rotor, referred to as the pumping and distributing rotor, is seen in the stationary hydraulic head in the "inlet" position.

The pump plungers are seen moving outwards under pressure from fuel flowing in from a port in the hydraulic head, known as the metering port, through a filling port in the rotor to a central axial passage opening to the plunger chamber.

As the rotor turns, the inlet port is cut off (Fig. D11b), and a second radial hole in the rotor, known as the distributor port, comes into register with an outlet port in the hydraulic head. The plungers are forced inwards and fuel passes up the central bore and out to one of the injectors.

In the actual pump there are as many inlet or filling ports as there are engine cylinders; similarly, the distributor port also comes into register with an outlet port in the hydraulic head. The plungers are forced inwards and fuel passes up the central bore and out to one of the injectors.

A sliding vane type transfer pump, carried on the rotor inside the hydraulic head, supplies fuel oil from the pump inlet at an intermediate pressure through

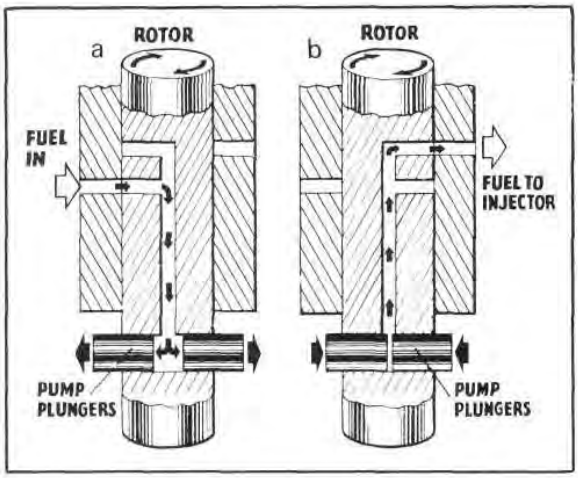


Fig. D11 — Pumping and Distribution

fuel passages to the pumping element. The flow of fuel is regulated by a metering valve before it reaches the element, the valve being actuated by the engine control lever or by the governor.

Since the opposed pump plungers are separated by inflowing fuel, the outward displacement of the plungers is determined by the amount of fuel oil delivered to the plunger chamber, which varies in accordance with the setting of the fuel metering valve and the speed at which the pump is rotating. In consequence, the rollers which operate the plungers do not follow the contour of the internal cam ring entirely, but will contact the cam lobes at points which will vary according to the amount of plunger displacement. The maximum amount of fuel delivered at one charge can thus be regulated by restricting the outward limit of travel of the plungers. This is described in greater detail later.

The contour of the cam provides for relief of the pressure in the injector lines at the end of the injection cycle, and prevents "dribble" at the nozzles.

The timing interval between pump injection is governed by the accurate spacing of the cam lobes and the delivery ports.

Components which affect the timing relationship of the functional sequences of the pump are designed with one assembly position only and are manufactured with great precision, ensuring accuracy of setting and eliminating all possibility of maladjustment.

The pump rotor is rotated by means of a dowelled drive gear inserted into the timing gear train.

The end plate of the pump, mounted on the hydraulic head, houses a priming and regulating valve assembly, the functions of which are given in detail later.

In these pumps fitted with the mechanical governor, the governor weight assembly is mounted on the drive shaft and is completely contained within the pump housing. Suitable linkage transmits the movement of the governor sleeve to the control lever on the metering valve, the governor mechanism being enclosed in a cover mounted on the pump body.

Maximum Fuel Adjustment :

Maximum fuel settings are made by limiting the maximum outward travel of the pumping plungers at a point where the desired fuelling is obtained.

The cam rollers (A, Fig. D12) are carried in shoes by the incoming fuel. The shoes slide in guides machined in the rotor, and are retained in an endwise sense by top and bottom adjusting plates. "Ears" (F), integral with the roller shoes, project into eccentrically cut slots (G) in both adjusting plates. The "ears" are shaped to match the contour of the slots.

The bottom adjusting plate is rigidly clamped between the drive plate and the end of the rotor. The screws which secure the drive plate pass through elongated holes (E) in the adjusting plate so that the adjusting plates can be moved when the screws are slackened. Top and bottom plates are located one to the other by lugs integral with the top plate.

The plungers reach their outward limit of travel when the "ears" on the roller shoes contact the curved sides of the slots in the adjusting plates. In Fig. D12 the adjusting plates are shown in the position which would provide the lowest possible maximum fuel setting. Since the slots in the adjusting plates are eccentric, maximum plunger travel will be increased if

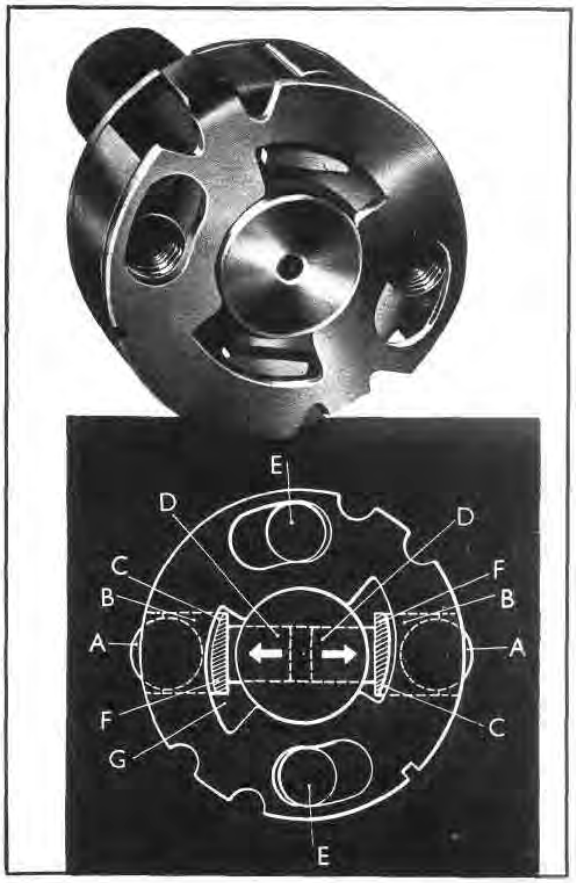


Fig. D12 — Maximum Fuel Adjustment

the adjusting plates are moved in a clockwise direction in relation to the rotor. The movement provided permits a wide range of maximum fuel settings.

Clearance "C" indicates the remaining travel to bring the plungers to the maximum fuel position.

Fuel Metering :

Apart from small losses which occur during the injection stroke, the total volume of fuel introduced is effected therefore, by regulating the volume of fuel which enters the element at each charging stroke. The volume of the charge is governed by two principal factors — the fuel pressure at the inlet port, and the time available for fuel to flow into the element while the inlet ports in the rotor and the hydraulic head are in register. It is by controlling the pressure at the inlet port that accurate metering is achieved.

Fuel oil enters the fuel injection pump at feed pressure and passes into the transfer pump which boosts the pressure to a level known as transfer pressure.

Transfer pressure is related to engine speed, and rises as the speed of rotation is increased. A predetermined relationship between transfer pressure and the speed of rotation is maintained by a regulating valve situated in the end plate of the pump.

Fuel at transfer pressure passes through passages in the hydraulic head to a metering valve which controls the flow of fuel through a metering port. The effective area of the metering port is controlled by moving the metering valve, which is connected by suitable control linkage to the accelerator pedal and to the governor.

A pressure drop occurs as fuel passes through the metering orifice, reducing the fuel pressure to a level known as metering pressure. The smaller the metering orifice, the greater will be the decrease in pressure and vice versa.

Fuel at metering pressure passes to the inlet port, through an obliquely drilled passage in the hydraulic head.

At idling speeds both transfer pressure and metering pressure are at their minimum value. Depression of the accelerator moves the metering valve to a position where the effective area of the metering port is increased. This brings about an increase in metering pressure and a consequent increase in the quantity of fuel entering the pumping element at each charging stroke. The engine will then accelerate in response to increased fueling until a speed corresponding to the position of the accelerator pedal is attained.

If the pedal is then released, the effective area of the metering orifice is reduced, and engine speed will fall as the result of decreased fuelling.

When an engine is running at a fixed speed setting, the governor controls the position of the metering valve and maintains the selected speed within close limits by causing compensating changes of fuelling.

CONSTRUCTIONAL DETAILS

General Assembly (See Fig. D9) :

The aluminium pump housing contains the pumping and distributing rotor, the hydraulic head, and the cam ring. It also houses the driving hub which transmits the drive to the rotor through a drive shaft.

The hydraulic head and the cam ring are stationary components and are located and secured in the pump housing by screws.

The driving hub is coupled to the engine by a dowelled gear. The drive shaft is splined at either end, and carries the mechanical governor flyweight assembly. The transmission to the pumping and distributing rotor is effected by a splined drive plate secured to the base of the rotor.

A support washer, which is specially shaped to permit assembly and location in a recess between the two sets of splines in the drive hub, bears against the end of the inner set of splines. The hub securing screw bears against this washer.

The levers, springs and shafts of the governor mechanism are enclosed by an oil-tight cover attached to the pump body.

A cover, secured by two hexagon-headed screws, is provided on the side of the pump housing to give access to the interior of the pump when making the maximum fuel setting. An oil seal, which is fitted at the driving end of the pump housing, prevents leakage of oil between the housing and the drive hub.

The sliding vane transfer pump is housed within the hydraulic head, the liner being located in the head, while the rotor is attached to the pumping and distributing rotor.

Pumping and Distributing Rotor :

The pumping and distributing rotor and the hydraulic head are machined to extremely fine limits, and form a mated assembly. One part must not be replaced as an individual unit. The lower part of the rotor is bored transversely to house the twin opposed pump plungers which operate in unison. The plungers are in contact with shoes which slide in parallel guide slots in the base of the rotor and carry cam rollers. The cam rollers are operated by the cam ring. There is no spring between the plungers, for, as presviously stated, these are forced outwards on their return stroke by the fuel which enters the centre passage at metering pressure.

Lugs on the roller shoes, which register in eccentric slots in top and bottom adjusting plates, provide the means of limiting the outward travel of the plungers. This provides the maximum fuel adjustment, as already mentioned.

The rotor has a central axial passage which connects the pumping space between the plungers with radial holes drilled in the rotor at two levels. These provide for fuel inlet and delivery. The single port nearest the upper end of the rotor is the distributing port. As the rotor turns, the distributing port aligns successively with the outlet ports in the hydraulic head, from which the injectors are fed via external high pressure pipes.

At an intermediate level a number of radial holes are spaced equally round the rotor, the number being equal to the number of engine cylinders. These are the inlet ports, and as the rotor turns, each one comes into register with a single port in the hydraulic head known as the fuel inlet or charging port.

The upper end of the pumping and distributing rotor carries the transfer pump rotor, which is screwed into it. The thread may be either left or right-handed,

depending on the direction of rotation of the pump, normal working tending to tighten the transfer pump rotor. The transfer pump rotor also locates the main rotor in the hydraulic head in an endwise sense.

The lower end of the rotor carries an internally splined drive plate, which meshes with the end of the drive shaft and thus drives the rotor. It is provided with two holes for the securing screws, and is scribed on its circumference with marks which are used when timing. The securing screws are not diametrically opposite, so that the drive plate can only be assembled in one position on the rotor, thus ensuring the correct relationship between the plate (which carries a master locating spline) and the ports in the rotor. The setting of the top and bottom adjusting plates, clamped by the drive plate securing screws, has been described above (see Maximum Fuel Adjustment).

The Hydraulic Head :

. The hydraulic head is located in the pump housing and secured by three screws, one of which is a locating screw of larger diameter than the others to permit only one assembly position. When an automatic advance unit is fitted (as in Fig. D13), this screw is replaced by the head locating fitting which provides a passage for fuel at transfer pressure to the advance piston chamber.

The upper end of the hydraulic head is counterbored to house the transfer pump liner, and a passage is drilled from the base of this counter-bore to allow the passage of fuel to an annular groove on the pumping and distributing rotor and thence to the chamber in which the metering valve is housed.

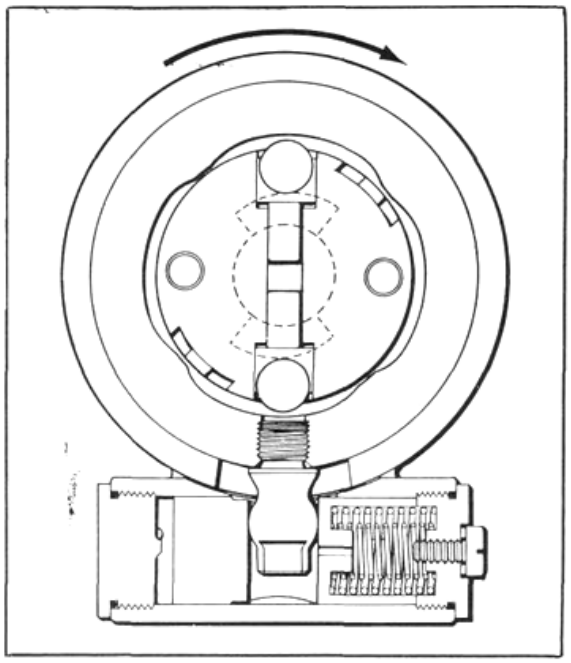


Fig. D13 — Automatic Advance

The metering valve regulates the flow of fuel through an obliquely drilled hole connecting with the single inlet port which is swept by the inlet ports in the pumping and distributing rotor.

Above the inlet port the hydraulic head contains the equally spaced delivery ports with which the distributor port of the rotor registers. These lead to the injector pipe connections.

An "O" seal is carried in an annular groove in the periphery of the hydraulic head to prevent leakage of oil from the pump housing, and another seal in the upper face of the head makes an oil-tight joint between the hydraulic head and the end plate. The end plate is secured by four screws.

The Transfer Pump :

The transfer pump rotor carries a pair of sliding vanes running in a liner. The liner is located in the hydraulic head by a dowel in the pump end plate which engages with a slot in the periphery of the liner.

As stated under "Pumping and Distributing Rotor" the transfer pump rotor is attached by either a right-hand or left-hand thread, according to the direction of pump rotation.

The End Plate (Fig. D14) :

The end plate, which serves as a cover for the transfer pump, is secured to the hydraulic head by four unequally spaced screws, so that it has but one position of assembly. An "O" seal is fitted between the end plate and the hydraulic head. A dowel pin, fitted on the inner face of the end plate, engages a slot in the periphery of the transfer pump liner. Two assembly positions marked "A" (anti-clockwise) and "C" (clockwise) are provided in the end plate face. "A" and "C" indicate the dowel assembly positions for pumps of anti-clockwise and clockwise directions of rotation respectively, the direction of rotation being viewed from the drive end of the pump.

Housed within the end plate are the regulating valve assembly and a fine mesh nylon filter. The fuel inlet connection which locates and secures this assembly is mounted externally.

The end plate illustrated in Fig. D14 is of recent manufacture and is an aluminium die casting. End plates of earlier manufacture were made of steel and contained a similar regulating valve which was located on a centre line at right angles to that of the fuel inlet connection. Functionally, the valves in both end plates are identical.

The Regulating Valve (Fig. D14) :

The regulating valve, situated within the end plate, performs two separate functions. Firstly, it controls fuel pressure, maintaining a predetermined relationship between transfer pressure and the speed of rotation. Secondly, it provides means of by-passing the vanes of the transfer pump when the pump is stationery, so that the fuel passages in the hydraulic head can be primed.

Fuel entering the end plate at feed pressure passes to the inlet side of the transfer pump through the nylon filter (2) and the upper fuel passage (9).

Transfer pressure is transmitted to the underside of the regulating piston (5) through the lower fuel

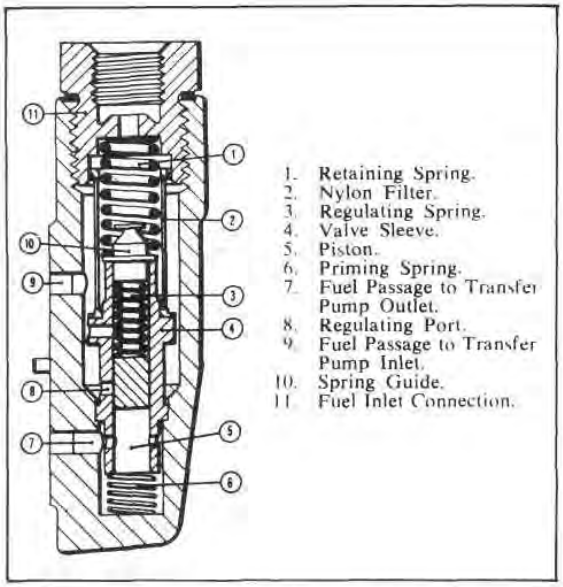


Fig. D14 — End Plate and Regulating Valve

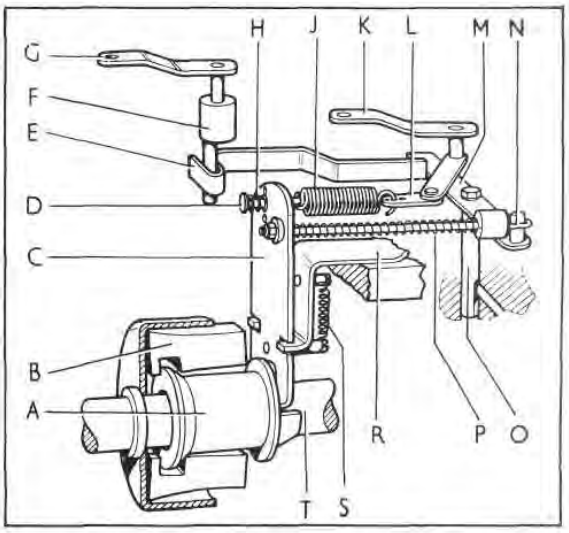


Fig. D15 — Mechanical Governor Control Mechanism

passage (7) and tends to force the piston upwards. This force is opposed by pressure exerted on the upper face of the piston by the regulating spring (3).

As transfer pressure rises with increasing engine speed the piston is forced upwards and the regulating spring is compressed. Such movement of the piston progressively uncovers the regulating port (8) and regulates transfer pressure by permitting a metered flow of fuel back to the inlet side of the transfer pump. The effective area of the regulating port is increased as engine speed is raised, and is reduced as engine speed falls.

When priming a stationary pump, fuel entering the end plate cannot pass through the transfer pump and into the fuel passages in the hydraulic head in the normal way. Fuel at priming pressure enters the valve sleeve and acts on the upper face of the regulating piston. The piston is forced to the lower end of the valve sleeve, compressing the retaining spring (6) and uncovering the priming ports. Fuel then passes through the priming ports and the lower fuel passage (7) to the outlet side of the transfer pump, and thence into the fuel passage within the hydraulic head.

Mechanical Governor :

The mechanical governor is of the flyweight type, and gives sensitive control throughout the complete speed range and at all loads. The weights are held in a carrier, clamped between the driving hub and a step on the driving shaft. Weight assembly, drive shaft and hub thus rotate as a single unit. The weights are a sliding fit in the carrier pockets, and are shaped so that in operation they pivot about one edge. As the weights move in or out under varying centrifugal force according to the pump speed, they operate a thrust sleeve which is a sliding fit on the drive shaft, moving it axially to control the admission of fuel by rotating the metering valve.

The governor control linkage, which transmits movement of the control sleeve to the metering valve, is enclosed by the governor control cover mounted on the upper face of the pump housing. Throttle and "shut-off" shafts project through this cover and control levers are mounted externally.

The governor mechanism is shown in detail in Fig. D15. Movement of the governor weights (B) causes the control sleeve (A) to move axially along the drive shaft (T). The governor control arm (C) is free to pivot about a fulcrum provided on the control bracket (R) and is held in contact with the end face of the thrust sleeve by spring tension. A spring-loaded hook lever (N) connects the upper end of the governor control arm with the lever (M) which is secured to the metering valve (O). Any movement of the governor weights in response to fluctuations of engine speed results in movement of the metering valve and a corresponding change of fuelling.

The cranked "shut-off" shaft (F) is operated by movement of the lever (G). Movement of the shaft is transmitted to the control lever (M) on the metering valve by the "shut-off" bar (E), and rotates the metering valve to a position where the metering port is completely closed. The hook lever (N) is spring-loaded so that this movement can be achieved without need for overcoming the resistance of the governor weights. When the "shut-off' control is operated, the light spring (P) is compressed and the end of the hook lever passes through the governor control arm.

Speed selection is made by moving the throttle lever (K) which is mounted on the throttle shaft. A swivel link (L) is connected to a lever which is integral with the throttle shaft. The governor spring (J) connects the swivel link with the idling spring guide (D) which passes through a hole in the governor control arm. When the lever is moved to obtain increased engine speed, the light idling spring (H) is compressed

as the guide is drawn through the control arm and tension is then applied to the main spring. Tension of the main spring acting on the control arm is transmitted to the control sleeve, and provides resistance to movement of the governor weights.

The metering valve (O) consists of a small shaft, slotted at one end. The valve is situated in a chamber in the hydraulic head, through which the fuel passes from the transfer pump to the inlet ports of the rotor. Rotation of the valve controls the area of the metering orifice, and regulates the fuel supply to the element by controlling the metering pressure in the oblique fuel passage.

Operation of the Mechanical Governor :

Variations in the speed of the engine, and therefore of the pump, cause movement of the flyweights which is transmitted to the thrust sleeve, and thence to the governor control arm. This is spring-loaded during idling by the light idling spring, and at higher speeds by the main control spring.

When starting, the throttle lever (K, Fig. D15) is put hard over, holding the metering valve in the full fuel position. As the engine fires the lever can be brought back, and the governor then operates in the idling position.

Movement of the throttle lever adjusts the load on the governor control spring, bringing about a change in the position of the control arm, and hence of the metering valve, admitting more or less fuel to the pump as required. When the selected speed has been reached, it will be maintaind within close limits by governor action. An increase in engine speed resulting from decreased engine load will cause the weights to move outwards. Such movement turns the metering valve towards the closed position, and engine speed falls in response to reduced fuelling. If engine speed falls, the weights move inwards, causing an increase of fuelling which restores the selected engine speed.

Tensioning of the governor spring provides increased resistance to movement of the governor control arm under the influence of the governor weights, so that with greater tension, resulting from increased throttle opening, governor control will be at higher r.p.m.

Within the ilding speed range, tension is removed from the governor spring (J), and the light idling spring (H) gives sensitive control at low r.p.m.

At any moment the engine can be shut down by means of the fuel shut-off lever. The shut-off bar overides the governor, to rotate the metering valve to the "no fuel" position regardless of the position of the throttle lever.

AUTOMATIC CONTROL OF INJECTION TIMING

Inherent Timing Changes :

Under full load conditions, the maximum amount of fuel is introduced into the element, and the plungers and actuating rollers are forced outwards to the limit of their travel. As the rotor turns, the rollers are brought into contact with cam lobes on the cam ring. The point of contact is near the base of the cams.

Under lightly loaded conditions, fuelling is decreased and the plunger travel is proportionally reduced. Contact between roller and cam is now made at a point near the cam peak.

It follows that injection timing becomes progressively retarded as fuelling is reduced, since the contact between the actuating rollers and the cams occurs progressively later in the cycle.

Advance with Increasing Speed :

The device illustrated in Fig. D13 provides progressive advancement of injection timing as engine speed is increased.

The piston (B) is free to slide in a cylinder machined in the body of the device (E). Movement of this piston is transmitted to the cam ring (C) by the ball-ended lever (A), causing the cam ring to rotate within the pump housing (D).

Pressure exerted on the piston by the springs, tends to hold the piston and the cam ring in the fully retarded position.

Fuel oil at transfer pressure enters the device through a fuel passage in the screw which secures the device to the pump housing. Transfer pressure acts upon the piston and tends to move the cam ring towards the fully advanced position.

Transfer pressure increases progressively as the engine speed is raised, and the piston is moved along the cylinder to compress the springs and move the cam ring towards the fully advanced position. When engine speed is decreased, transfer pressure falls, and the piston and cam ring are moved towards the retarded position by spring pressure.

The impact of the actuating rollers on the cam lobes at commencement of injection tends to move the cam ring towards the retarded position. Such movement is prevented by a non-return valve situated in the fuel passage in the screw securing the device to the pump housing. Normal leakage between the piston and the cylinder permits the device to return to the retarded position when the engine speed falls.

Light Load Advance :

When the load is removed from an engine, the metering valve is moved towards the closed position by governor action. This reduces fuelling in order to maintain the selected engine speed within close limits.

SERVICE

IMPORTANT NOTE : Unless the necessary equipment and experienced personnel are available, dismantling of the fuel pump should not be attempted.

To Remove the Fuel Pump :

1. Disconnect the stop and throttle controls from the pump and remove the stop return spring.
2. Remove the high and low pressure pipes from the fuel pump and blank off all ports to prevent the ingress of dirt.
3. Remove the timing case front cover inspection plate.
4. Remove the three setscrews which secure the fuel pump gear to the fuel pump.
5. Remove the fuel pump from the timing case, ensuring that when the fuel pump gear leaves the shaft it stays in mesh with the idler gear, otherwise the fuel pump timing will be affected.

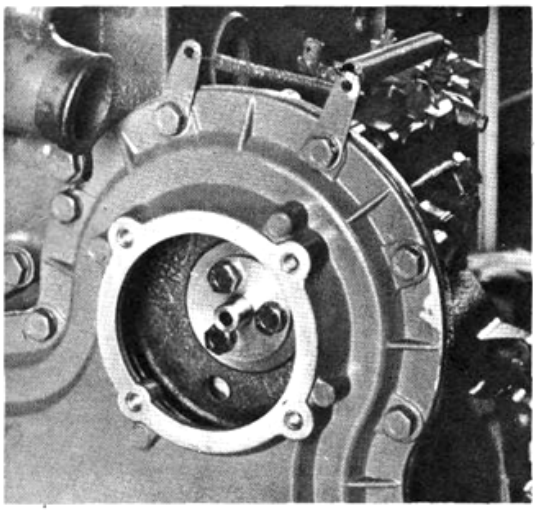


Fig. D16 — Inspection Cover Removed to Disclose Fuel Pump Gear Setscrews

To Refit the Fuel Pump :

1. Replace the fuel pump ensuring that the slot in the pump hub is aligned with the dowel in the gear.
2. Position the pump so that the scribed line on the pump flange aligns with the mark on the timing case. Secure the pump to the timing case.
3. Secure the driving gear to the fuel pump shaft with the three setscrews and spring washers, ensuring the dowel is properly located in its slot.
4. Refit the timing case inspection cover.
5. Refit the high and low pressure pipes to the fuel pump.
6. Re-connect the throttle and stop lever controls and attach the return springs.
7. Vent the air from the fuel system.
8. Adjust the maximum and idling speeds.

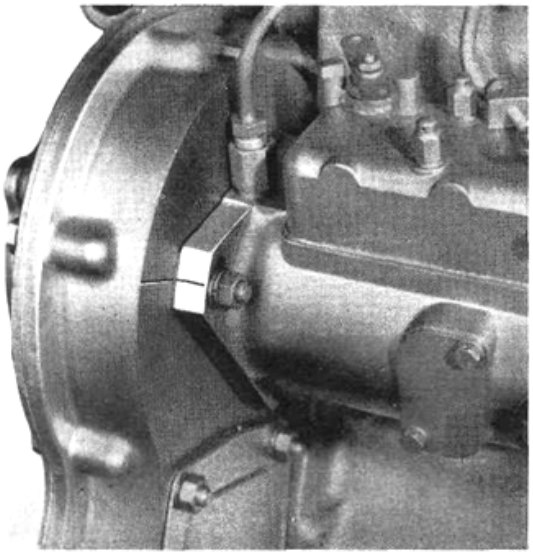


Fig. D17 — Scribed Line on Fuel Pump and Timing Case

To Re-set the Fuel Pump Timing :

On the fuel pump rotor, inside the fuel pump, are a number of scribed lines, each one bearing an individual letter. At the static timing point, the scribed line "C" on the rotor should be aligned with the end of the circlip which has a straight edge.

There are two methods of checking the fuel pump timing, the first can be used on both manual and torque converter model tractors, the second only on manual model tractors :—

1. (a) Ensure that the fuel pump is correctly fitted with the scribed line on the mounting flange coinciding with the mark on the timing case.

(b) Position the crankshaft so that No. 1 piston is at T.D.C. on compression stroke.

(c) Remove the collets, spring cap and spring from one of the valves on No. 1 cylinder and allow the valve to rest on top of the piston. Care is necessary with this operation as the consequences of a valve dropping into the cylinder need not be described.

(d) With the aid of a clock gauge in contact with the end of the valve now sitting on No. 1 piston, it will be necessary to position the crankshaft so that the piston will be 0.230" B.T.D.C., this being an equivalent of 22° B.T.D.C. on the flywheel. Ensure that timing gear backlash has been taken up.

(e) Remove the inspection plate on the fuel pump enabling the rotor to be seen.

(f) With No. 1 piston at the static timing point on its compression stroke, the scribed line on the fuel pump rotor marked "C" should align with the straight edge on the circlip. As there is no adjustable fuel pump drive plate, the adjustment is carried out by slackening the nuts on the pump mounting flange and rotating the pump body as necessary. If this is insufficient adjustment, suspect that the timing gear is incorrectly meshed.

2. (a) Ensure that the fuel pump is correctly fitted with the scribed line on the mounting flange coinciding with the mark on the timing case.

(b) Position the crankshaft so that No. 1 piston is at T.D.C. on compression stroke.

(c) Remove the cover plate from beneath the flywheel housing and position the crankshaft so that

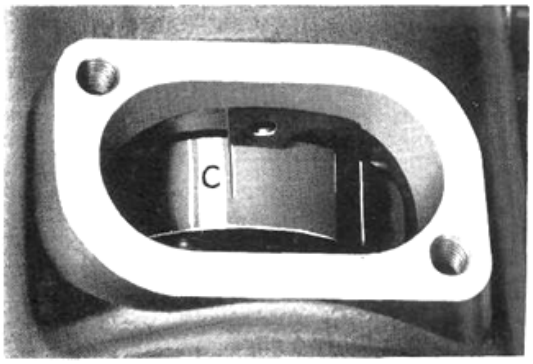


Fig. D18 — Static Timing Marks

the 22° mark on the flywheel is aligned with the mark on the flywheel housing. Ensure that timing gear backlash has been taken up.

(d) Remove the inspection plate on the fuel pump enabling the rotor to be seen.

(e) With No. 1 piston at the static timing point on its compression stroke, the scribed line on the fuel pump rotor marked "C" should align with the straight edge on the circlip. As there is no adjustable fuel pump drive plate, the adjustment is carried out by slackening the nuts on the pump mounting flange and rotating the pump body as necessary. If this is insufficient adjustment, suspect that the timing gear is incorrectly meshed.

Maximum Speed Setting :

IMPORTANT NOTE :

The maximum speed screw of original fuel pumps must not be broken or tampered with in any way unless factory authority is first obtained. Failure to do so may result in the guarantee becoming void.

When fitting a replacement pump, or in the event of the maximum speed screw having been moved for some reason, the maximum no load speed must be checked and reset as necessary.

The last four numbers in the fuel pump setting code indicate the speed required, in this case :—2160 r.p.m.

IMPORTANT : Under no circumstances should the engine be allowed to operate at a higher speed than specified or severe damage to the engine may result.

To set the maximum no load speed the following procedure should be adopted :—

1. Check the fuel system for leaks and rectify as necessary. Ensure no air is present in the fuel system.
2. Run the engine at part throttle until full operating temperature is reached.
3. Open the throttle fully and, using a tachometer, check the engine speed. To vary the maximum speed, turn the maximum speed screw anti-clockwise to increase the speed or clockwise to reduce the speed. Re-seal the maximum speed screw.

Idling Speed Setting :

The engine idling speed is adjusted by the idling screw. With the engine warm, turn the screw clockwise to increase the engine speed or anti-clockwise to decrease.

A minimum of 500 r.p.m. should be set.

Note : If the tractor is not working, shut it off. The injectors will quickly become fouled if the engine is allowed to idle at a slow speed.

INJECTORS

General :

Each injector body consists of a steel body held to the cylinder head by means of a flange and two studs.

The joint between the injector and cylinder head is made by a copper washer between the lower face of the nozzle cap and the cylinder head.

When preparing to fit the injector into place in the cylinder head, care should be taken that only the correct copper washer is used to make this joint. The metal of the cylinder head, the faces of the copper joint ring and the corresponding face on the nozzle holder cap should be perfectly clean if a leak-proof joint is to result.

It is advisable to fit a new or annealed joint washer when the injector is replaced after having been removed for any reason.

Ensure that the old washer has been removed from the injector or cylinder head.

This joint washer should be an easy, but not loose fit for the injector nozzle, and it is because this is such an important feature that the washers especially made for that purpose should be used and none other. On no account should ordinary sparking plug washers be used.

The injector can now be fitted in place, care being taken to see that it is an easy fit in the cylinder head and on the holding-down studs, so that it can be placed down on the copper joint without force of any kind. The nuts on the flange should then be tightened down evenly to 10 - 12 lbs./ft. in order to prevent the injector nozzle being canted and so "nipped" in the cylinder head.

When fitting the leak-off pipes make sure new washers are used, and before tightening the banjo bolt make sure the washers are a good fit and are placed centrally, and remain central when tightening the bolt.

Troubles in Service :

The first symptoms of injector troubles usually fall in one or more of the following headings :—

1. Misfiring.
2. Knocking in one (or more) cylinders.
3. Engine overheating.
4. Loss of power.
5. Smoky exhaust (black).
6. Increased fuel consumption.

Fig. D19 — Removing a Fuel Injector

Often the particular injector or injectors causing trouble may be determined by releasing the pipe union nut on each injector in turn, with the engine running at a fast "tick-over". This will prevent fuel being pumped through the nozzle to the engine cylinder, thereby altering the engine revolutions. If after slackening a pipe union nut the engine revolutions remain constant, this denotes a faulty injector.

After stopping the engine, the nuts from the flange of the doubtful injector should be removed and the complete unit withdrawn from the cylinder head and turned round, injector nozzle outwards and the unions retightened. After slackening the unions of the other injector pipes (to avoid the possibility of the engine starting), the engine should be turned until the nozzle sprays into the air, when it will be seen at once if the spray is in order. If the spray is unduly "wet" or "streaky" or obviously to one side, or the injectors nozzle "dribbles", remove from the fuel pipe; the faulty injector should then be securely wrapped, preferably in grease-proof paper for attention on the maintenance bench.

Note : Great care should be taken to prevent the hands or face from coming into contact with the spray, as the working pressure will cause the fuel oil to penetrate the skin with ease.

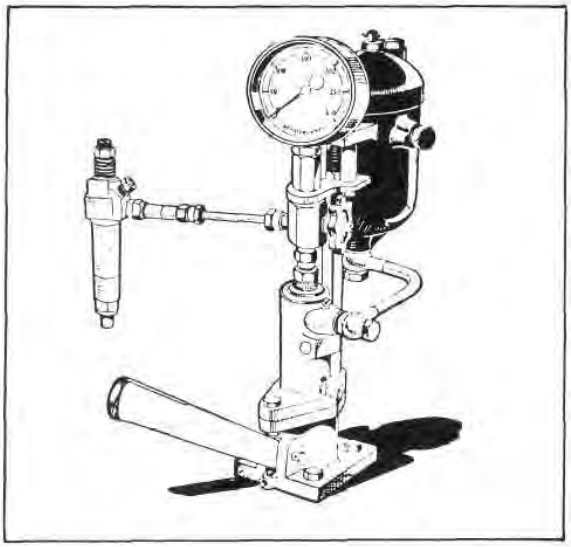


Fig. D20 — Injector Testing Pump

Maintenance :

The following information is given for the guidance of those who wish to carry out their own injector maintenance using the basic test equipment, which would include an Injector Testing Pump and kit of tools. (Refer Figs. D20 and D21).

Injectors should be taken out for examination at regular intervals. How long this interval should be is difficult to advise, because of the widely different conditions under which engines operate. When combustion conditions in the engine are good and the fuel tank and filtering system are maintained in first-class order, it is sufficient if the injectors are tested every 600 hours.

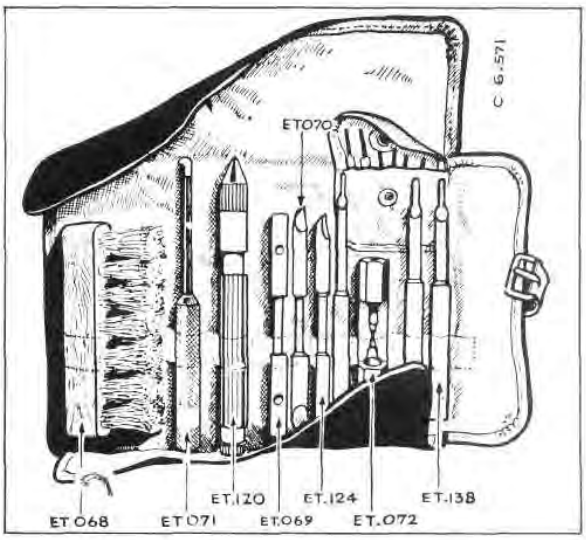


Fig. D21 — Injector Cleaning Kit

It is no use taking injectors out for attention unless the correct equipment is available, or spare injectors are at hand for substitution.

The nearer the ideal conditions of good fitting with adequate cooling and absolutely clean fuel are realised, the less attention the injectors will need, and so the longer their efficient life. In this connection, since there is no other item of the equipment upon which the performance of an engine depends so much, it pays the user handsomely to see that the engine never runs with any of its injectors out of order.

Preparation :

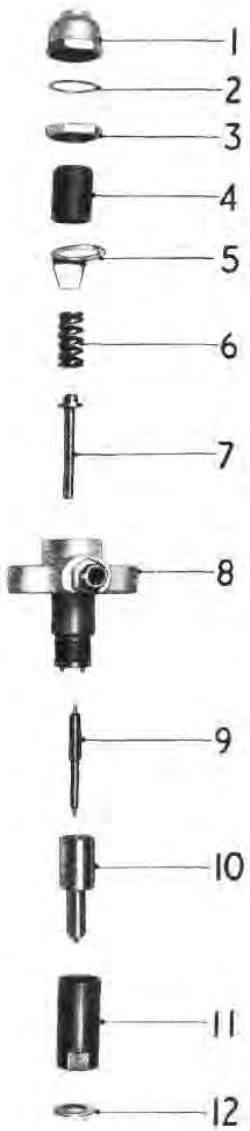
The most suitable bench for injector maintenance is one that is zinc, linoleum or plastic covered, absolutely free from dust, dirt, filings, grease or acids, where no other work is done and where the use of cotton waste or fluffy rags is forbidden. It should also be provided with a small vice (the jaws being protected with clean soft copper or aluminium shields) and a dust-proof drawer for holding the nozzle cleaning tools.

An injector is good for service if, when operating the Injector Testing Pump at the recommended rate, it gives four effective sprays, each breaking into a very fine mist and the breaking pressure is not less than the working pressure, then the injector may be put back into service.

An Injector requires attention if (a), when proceeding as above it throws out "solid" wet jets and not broken up spray or, (b), if any of the holes are choked or partially choked so that the spray issues only from one or two holes in the nozzle, or (c), an irregular spray pattern is formed.

Injector Dismantling :

The injector should be placed on a suitable holding plate, nozzle downwards, first remove the nozzle holder cap nut (1), slacken the locknut (3), release



1. Nozzle Holder Cap nut.
2. Cap Nut Washer.
3. Locknut.
4. Spring Cap.
5. Identification Tab Washer.
6. Spring.
7. Spindle
8. Body.
9. Nozzle Needle.
10. Nozzle.
11. Nozzle Cap Nut.
12. Copper Washer.

Fig. D22 — Exploded View of Injector

the nozzle spring tension by turning the spring cap (4) in an anti-clockwise direction. Reverse the position of the injector on the holding plate and remove the nozzle cap nut (11) and nozzle (10) taking care not to drop the nozzle needle onto the floor. Complete the dismantling by removing the spring cap, spring (6) and spindle (7). Inspect visually for signs of corrosion, distortion, etc. Keep all the dismantled parts together, if possible, in a tray to facilitate re-assembly after cleaning.

Note : Do not lose the small steel shim washer fitted between the top of the spring and the spring cap.

To hold the nozzle holder cap nut in a vice or to use badly worn or adjustable spanners is to invite trouble.

Inspection :

The nozzle needle should be free from all traces of damage, it is important that it is not "blued" at the tip due to overheating. If the nozzle is "blued" or the seating has a dull circumferential ring indicating wear or pitting, the complete unit (nozzle and needle) should be set aside for attention by a depot or agent with specialised equipment available and a replacement nozzle assembly used.

The stem of the nozzle needle should be clean and bright, free from high spots, bad scratches or dull patches, and the grooves free from foreign matter of any kind; similarly the nozzle needle bore in the nozzle body should be free from any of the above, the small drilled passages should be checked to see that they are clear.

Cleaning :

Starting with the nozzle assembly, remove the needle from the nozzle body and by using the soft brass seat scraper (ET070) any carbon which may be present on the nozzle body seat can be removed. The gallery should now be cleaned with the aid of the special soft brass scraper (ET071).

Brush all carbon from the nozzle tip using the brass wire brush contained in the recommended Nozzle Cleaning Kit shown in Fig. D21. The four holes in the nozzle tip should be cleared by means of the probing tool (ET120) fitted with the appropriate sized cleaning wire. Extreme care must be taken to obviate the danger of wire breaking off in the hole, as its removal is practically impossible and renders the nozzle unusable.

The cleaning wire should be fitted in the probe chuck so that there is approximately 1/16" protrusion, thus giving maximum resistance to bending.

Enter the wire into the hole, pushing and rotating gently until each hole in turn is cleared. Particular attention should be given to the nozzle needle seat. This and the smaller cylindrical portion above it, called the "stem" and "cone", can be cleaned with the fine brass wire brush. To ensure that the stem and cone in the nozzle body are free from carbon particles, the soft brass stem cleaner (ET072) should be applied with a rotary action pressing between the fingers. After ensuring that the exterior of the injector nozzle is clean and free from carbon, the nozzle needle and nozzle body may be thoroughly washed in clean fuel oil, or an approved alternative, assembled

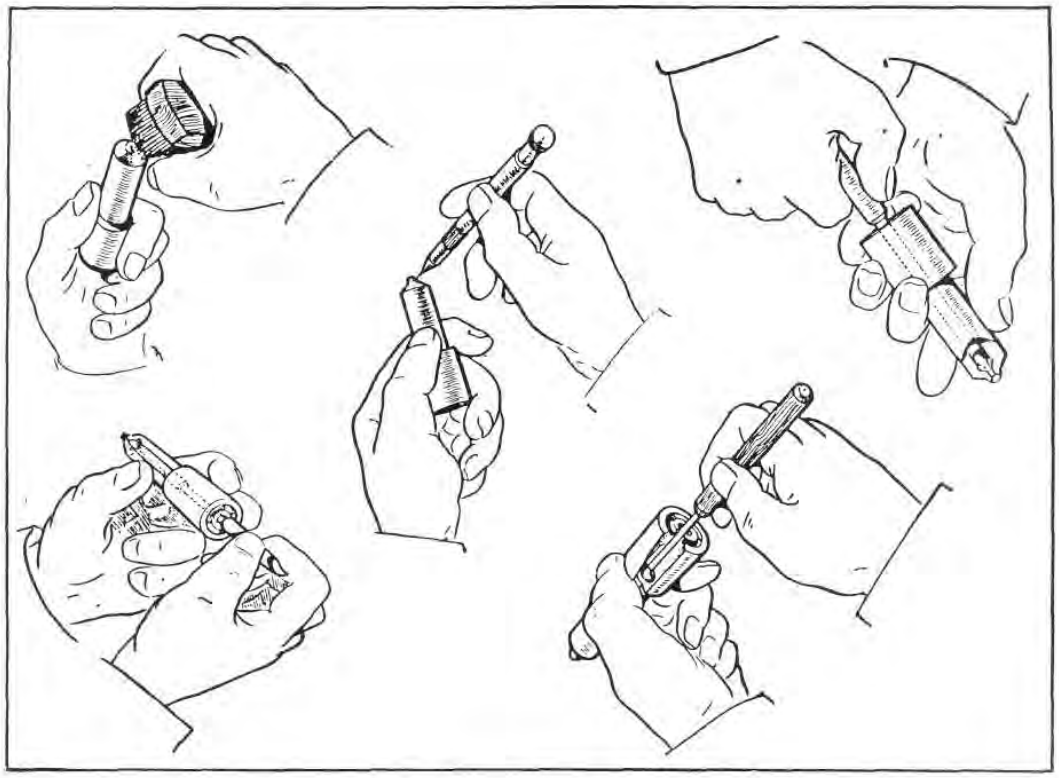


Fig. D23 — Cleaning the Nozzle

together whilst submerged in the clean oil and left immersed until it is intended to re-assemble the injector. Should it be desired to store the nozzle assembly for any period of time, then the needle and nozzle should be lightly smeared with grease and stored away, preferably in a dust-proof drawer.

The injector body should now receive attention, it should be washed in clean fuel oil or an approved alternative, care being taken to ensure that the highly ground face is clean and free from scratches. This face must register with the injector nozzle flange cleanly and squarely to form a high pressure joint and must, therefore, be handled in such a way as to avoid damage to the surface. The exterior of the injector body, of course, should be cleaned thoroughly.

Re-Assembly of Injector :

The injector body and nozzle assembly may now be assembled carefully, after having immersed the pressure faces of each in clean fuel or an approved alternative, to ensure that these faces are absolutely clean. Place the injector body on the holding plate, pressure face uppermost, place the nozzle assembly in position (located by the dowel) and fit the nozzle cap nut, tighten carefully. Excessive tightening of this cap may result in distortion of the nozzle and its consequent failure: care should be exercised that the leverage applied is not excessive. Reverse the injector on the plate and refit the spindle, spring and spring cap (ensure that the steel shim washer is correctly located in the top of the cap). Transfer the injector from the holding plate and fit to the Injector Testing Pump. Pump up slowly until fuel spurts out of the four nozzle holes and whilst still pumping slowly turn the spring cap, using a suitable screwdriver, in a clockwise direction increasing the spring tension until the breaking pressure is 175 atmospheres.

The injector is good for service if, as previously mentioned, when the Injector Testing Pump is operated at approximately twenty strokes per minute, four effective and even sprays breaking into a very fine mist are obtained.

Note : When testing injectors for spray formation, as opposed to setting the nozzle breaking pressure, always isolate the pressure gauge by means of the valve fitted, to prevent possible damage caused by rapid fluctuations in pressure.

Pressure Setting :

To set the pressure at which the nozzle should open, slowly move the hand lever downwards and carefully watch the pressure gauge for the highest recorded pressure before the needle "flicks", indicating the needle lifting off its seat. Any necessary adjustment is effected by loosening the locknut (3) and turning the spring cap (4) clockwise to increase or anti-clockwise to decrease the breaking pressure. Tighten the locknut and re-check the pressure before removing from the Injector Testing Pump.

When the injector has been cleaned, re-assembled, the breaking pressure set to the recommended figure and the spray formation found to be satisfactory, the following two checks may be carried out on the Injector Testing Pump before returning the injectors to service.

1. **Back Leakage :**

Pump up sufficient pressure to raise the nozzle needle from its seat, pump up again slowly to just below this pressure (approximately 160 - 165 atmospheres), then upon realising the hand lever and allowing the pressure to fall naturally, record the time (with the aid of a stop-watch) taken for the pressure shown on the gauge to fall from 150 to 100 atmospheres. For a nozzle in good condition this time should not be less than 6 seconds.

When carrying out this test observe that no leakage occurs at the lapped pressure faces of the nozzle holder and nozzle body. Leakage may be external when it is visable at the nozzle cap nut screw thread, or internal, in which case it cannot be readily distinguished from excessive leakage past the lapped portion of the needle. If leakage past the lapped portion is suspected, do not overtighten the cap nut in an effort to cure such leakage, but remove the nozzle and re-examine the pressure faces for signs of dirt or surface imperfections. Clean thoroughly, and if all appears in order, replace components and re-test.

If the pressure drop time is still low, this indicates excessive leakage past the lapped portion of the nozzle needle.

2. **Seat Tightness :**

Wipe the nozzle tip dry, pump up the pressure to approximately 10 atmospheres below the nozzle opening pressure, the nozzle tip must remain substantially dry and there must be no tendency for blobs of fuel to collect or drip. A slight dampness may be ignored.

Note : Should, after carrying out the forementioned injector maintenance, satisfactory results not be obtained, the nozzle assemblies concerned may still be fit for further service after reconditioning. This, however, requires specialised equipment, and the complete nozzle assemblies should be forwarded to the nearest depot or workshop capable of undertaking such work, or a replacement unit obtained.

A perfect injector, when tested by pumping fuel through it in the open air gives a short "pinging" sound as the fuel emerges from the holes. After the injector has been in service for some time, the "pinging" changes to a crackling sound. It is not until the injector sounds "dead" that its condition is likely to affect the running of the engine.

FUEL PIPES

No two of the pressure pipes, from the fuel pump to the injectors are alike. Keep this in mind when replacing.

Examine the olives at each end of the pipe. If the union nuts have at any time been over-tightened there is a risk that the olives will have cracked or been unduly compressed. If so, leakage will result and a new pipe should be fitted.

In this connection bear in mind that the working pressure which these joints must sustain is several thousand pounds per sq. in. Only a perfect joint is satisfactory.

Offer up the pipe to the fuel pump and injector unions to check that the pipe fits squarely at both ends. Do not fit one and then bend the pipe to square it with the other union.

When fitting the pipe tighten the unions alternately a little at a time, first one end and then the other.

If the olives are in good condition, and the pipe is square to the unions at each end as described previously, no force will be needed to make a good joint. Use only a standard open ended $\frac{5}{8}$" A.F. spanner.

If the union is tightened excessively the olive may collapse and split. The same danger exists if the pipe is not square to and central with the union.

When changing an injector always remove the pipe entirely. Never disconnect one end only, leaving the other end tight. Never bend the pipe.

PRIMING THE FUEL SYSTEM

The air must be vented from the fuel system whenever any part of the system between the fuel tank and injection pump has been disconnected for any reason, or when the system has been emptied of fuel.

No attempt must be made to start the engine until the injection pump has been filled and primed, as serious damage can be caused to the pump due to lack of lubrication.

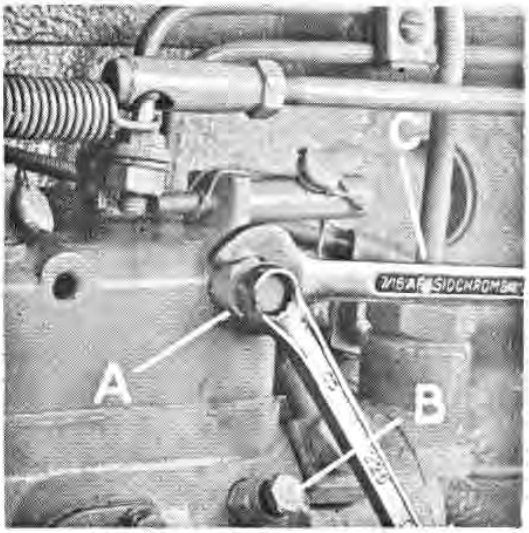


Fig. D24 — Venting the Fuel System

To Prime the System :

(a) Slacken the air vent screw (A) on the top of the governor control cover. (Fig. D24).

(b) Slacken the bleed screw (B) on the side of the fuel pump body .

(c) Operate the priming lever of the fuel feed pump, and when distillate, free from air bubbles, issues from each venting point, tighten the screws in the following order :—

1. The bleed screw (B).
2. The Governor vent screw (A).

(d) Slacken the pipe union nut (C) at the pump inlet, operate the priming device and re-tighten when distillate, free from air bubbles issues from around the threads.

(e) Slacken the unions at the injector ends of two of the high pressure pipes.

(f)) Set the throttle lever at the open position and ensure that the "stop" control is in the "run" position (push fully in).

(g) Turn the engine until distillate, free from air bubbles, issues from both fuel pipes.

(h) Tighten the unions on the fuel pipes, and the engine is ready for starting.

Note : If the cam driving the fuel lift pump is on maximum lift, it will not be possible to operate the hand primer. If such a condition arises, the engine should be turned until the hand primer can be operated.

SECTION **E**

THE ELECTRICAL SYSTEM

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

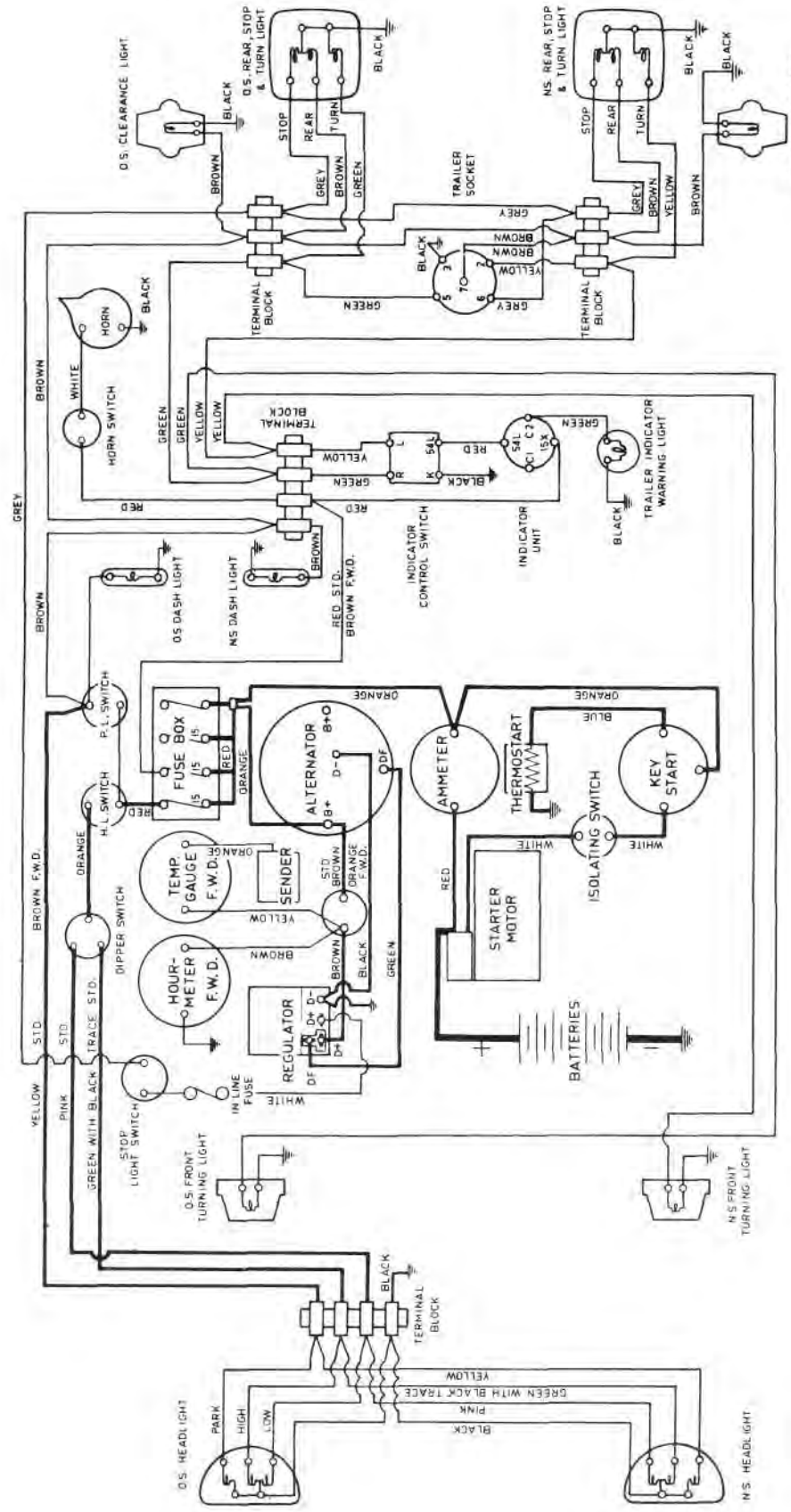


Fig. E1 — Electrical Wiring Diagram

THE ELECTRICAL SYSTEM

The tractors are fitted with a 12 volt basic starting and charging system, negative to earth.

WARNING : The alternator will be damaged instantly if the batteries are connected positive to earth at any time.

Two six volt batteries, connected in series, make up the twelve volt storage unit. They are charged by a battery excited aternator with in-built rectification, and the system voltage is controlled by a double contact, vibrating regulator unit, incorporating a positive temperature co-efficient resistor. The alternator and regulator are isolated from the system when the engine is stopped, by an engine oil pressure operated pressure switch.

The starter motor is engaged and switched on by a key switch on the panel, and is self-indexing to assist engagement. A safety switch is incorporated in the wiring to prevent operation unless the clutch is disengaged (manual models) or the forward/reverse control is in neutral (T.C. models).

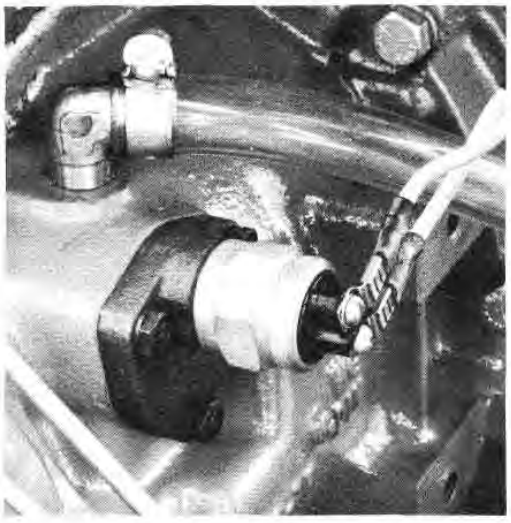


Fig. E2 — Safety Switch (T.C. Models)

Optional extra — Road licensing kit — is designed to comply as closely as possible with Police Traffic Regulations. Lighting equipment consists of two headlights, a stop and tail light, two instrument lights, clearance and flashing indicator lights. The head lights have dipping equipment operated by a foot button, and parking lights operated by a separate switch on the instrument panel.

SPECIFICATIONS

Voltage	— 12 volt — NEGATIVE TO EARTH
Battery	— Two, connected in series — 6v, 21 plate.
Starter Motor	— Type, JD, 12V, 4PS, screw push, self indexing.
Alternator	— Type, LJ series, battery excited.
Regulator	— Type, RS, double contact with temperature compensate.
Lamp Bulb Sizes :	
Head Light	— 45/60W twin beam with 4W parking.
Tail Light	— 18/5W stop/tail with 18W flasher.
Front Indicator lights	— 18W.
Clearance Lights	— 5W.
Instrument Lights,	— 3W.
Indicafor switch light	— 2W.
Indicator panel light	— 2W.
Fuses	— 15 amp.
Horn	— Low note air tone.

MAINTENANCE

Wiring : The entire tractor wiring is protected by heavy P.V.C. insulation, but all cables should be periodically examined for signs of chafing or loose connections.

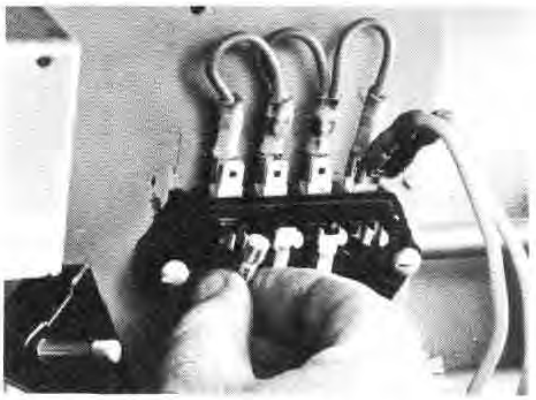


Fig. E3 — Changing Fuses

Fuses : The fuse holder is located below the instrument panel adjacent to the regulator. In the event of a fuse blowing, investigate the cause before fitting a replacement fuse. Under no circumstances fit fuses of larger capacity.

Batteries : The batteries are conveniently located under the top cowling to allow easy access for maintenance. It is important that the units be kept clean, the terminals kept tight, and the electrolyte maintained at the correct level ($\frac{1}{4}$" - $\frac{3}{8}$" above the plates). A sodium bi-carbonate (or ammonia) solution is an effective battery cleaning agent. If the terminals show a tendency to corrode, clean them and apply a coating of petroleum jelly. Keep the filler plug vents clear and maintain the fluid level above the surface of the plates. Use only distilled water for battery topping up.

Fig. E4 — Changing Headlight Globe

Fig. E5 — Changing Width Light Globe

A check on the battery condition may be made with a hydrometer. A reading of 1.250 - 1.270 indicates a fully charged battery. The battery should be at least half-charged.

To check that the battery will maintain a high discharge rate, as required by the starter motor, use a heavy discharge tester with a load resistance which will pass about 300 ampheres. Apply the tester for about 10 seconds and, with a fully charged battery, the voltage for each cell should not drop below 1.5 volts. A rapid fall-off of voltage below this figure would indicate a faulty cell and the battery will need to be re-conditioned or renewed.

Note : Fast charging of the batteries will affect the electrical system. Disconnect the battery leads during this operation.

Fig. E6 — Changing Rear Light Globe

Starter Motor : To ensure maximum life and trouble free starting, maintenance should be undertaken at regular intervals, the length of which are dependent on operating conditions.

Starter motor brushes must be free in their holders and replaced if broken or worn so far that the cable soldered into the brush is likely to butt against the brush holder, also replace if the soldered cable comes loose. When inserting a carbon brush, check that the spring does not hit the brush. With every major overhaul of the engine, the starter motor brushes should be renewed.

Alternator : To ensure maximum life and trouble free operation, maintenance should be undertaken at regular intervals, the length of which are dependent on operating conditions.

Checking of the alternator components requires the unit to be removed from the tractor. Brushes should be replaced when they reach a minimum length of 23/64", and worn or rough ball bearings replaced with new, approved bearings, lubricated with the recommended grease.

Regulator : Providing the electrical system is operating satifactorily, no maintenance is required to the regulator until the alternator is serviced. At this time, check the regulator point condition and renew or adjust as necessary.

Fan Belt : Maintain the belt tension of $\frac{3}{4}$" movement under heavy thumb pressure (15 - 20 lbs) midway between the alternator and crankshaft pulleys.

THE ALTERNATOR

The alternator is designed for charging 12 volt, negative earthed batteries. It comprises a rotating field winding excited from the battery through a pair of slip rings, and a stationary output winding with in-built rectification.

In the alternator, the frequency of the alternating current in the stator windings increases in proportion to the rotor speed. The resistance to current flow in the

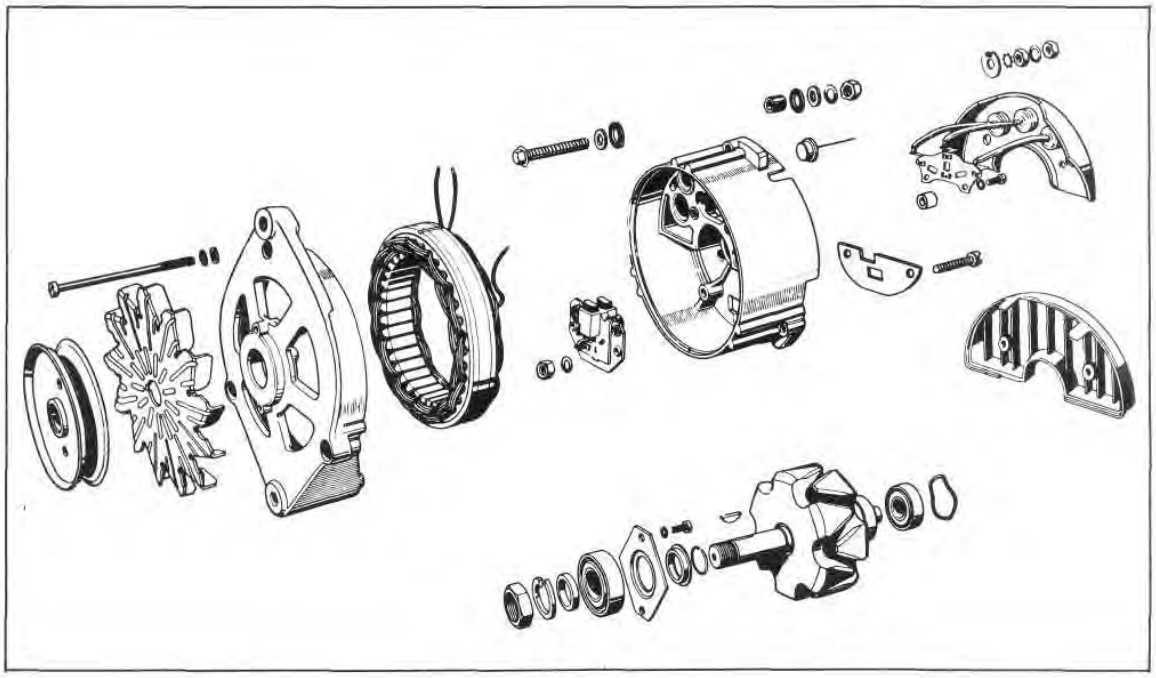


Fig. E7 — Exploded View of Alternator

stator windings also increases with the increase in rotor speed. Therefore, as the voltage increases and the current flow increases, inductive reactance increases and the alternator output is automatically limited. A voltage regulator alone is required to control the alternator output.

Excitation of the alternator is by means of an oil pressure switch connected between the regulator B+ terminal and the alternator B+ terminal. When the engine is started and engine oil pressure closes the switch at approximately 10 p.s.i., a positive connection is made between regulator and alternator and excitation of the rotor winding takes place.

Alternator Maintenance :

Brushes and Slip Rings :

1. Mark the relative positions of the stator and end plates.

2. Remove three drive end plate screws and withdraw the rotor, end plate and pulley assembly.

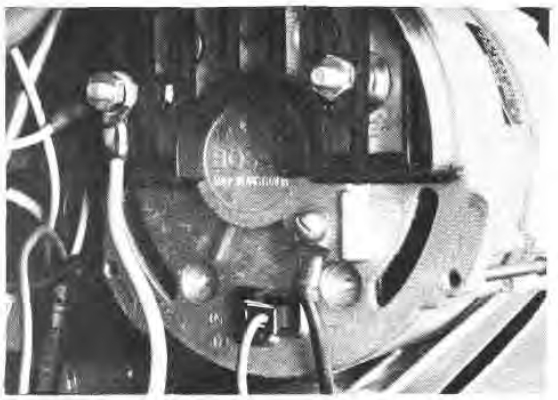


Fig. E8 — Alternator Terminals

Fig. E9 — Alternator Brush Holder Removal

3. Take two setscrews from the slip ring end plate and remove the brush holder assembly. Salvage the nuts and washers from inside the end plate.

4. Renew the brushes if their length is less than 23/64" by soldering the leads into the holder.

5. If the slip rings are worn, they should be turned in a lathe in the usual manner.

6. Replace the brush holder assembly in the slip ring end plate. Thread a piece of wire through the brush lower connections and the end plate (DF connection hole), and hold the brushes away from the slip rings.

7. Install the rotor, end plate and pulley assembly, carefully aligning the markings to ensure correct relative positioning. Tighten the three drive end plate screws.

Note : Ensure that the wave washer is installed prior to locating the rotor bearing on the end plate.

8. Remove the wire holding the brushes and ensure that the brushes are contacting the slip rings.

Rotor Bearings :

1. Mark the relative positions of the stator and end plates.

2. Remove the three drive end plate screws and withdraw the rotor, end plate and pulley assembly.

3. (a) Check the exposed slip ring end plate bearing for wear and roughness. If renewal is necessary, use a suitable puller for removal, and replace with a new bearing, ensuring that the shielded side is towards the slip rings.

(b) If renewal of the drive end bearing is necessary, remove the pulley and then the key. Separate the end plate from the rotor shaft, remove the screws from the end plate bearing cover and press out the bearing. Reverse this procedure for bearing replacement.

4. Thread a piece of wire through the brush lower connections and the end plate (DF connection hole), and hold the brushes away from the slip rings.

5. Install the rotor, end plate and pulley assembly, carefully aligning the markings to ensure correct relative positioning. Tighten the three end plate screws.

Note : Ensure that the wave washer is installed prior to locating the rotor bearing in the end plate.

6. Remove the wire holding the brushes and ensure that the brushes are contacting the slip rings.

THE VOLTAGE REGULATOR

The voltage regulator is a single element, double contact, vibrating unit. It has a resistor which possesses a high temperature co-efficient, meaning that its resistance gets considerably greater as its temperature increases. The regulator is also temperature compensated. A cutout is not required as reverse current cannot flow due to the action of the alternator diodes.

Precautions to be observed with Alternators :

1. **Always** check that the polarity of the batteries and cables are correct **before** connecting the other wires in the circuit.

The Negative terminal must be earthed, otherwise the regulator and/or alternator will be damaged. The positive lead battery terminal is painted RED to overcome the possibility of damage to the alternator and regulator due to batteries being fitted in reverse polarity.

2. When connecting slave batteries, observe correct polarity.

3. Do **not** run the engine with the alternator disconnected from the battery unless the **field** and **battery** wires are removed from the alternator.

4. Always disconnect the alternator output terminal before electric welding onto the tractor.

FIELD TEST PROCEDURE

No Charge :

1. Check that the **fan belt** is intact and adjusted.

2. Check **battery polarity** — must be **negative** to earth.

3. Check **battery connections** and **ammeter** — connect test lamp between fuse box orange wire terminal and earth. Lamp should light.

4. Check the **pressure switch.** Connect a 12 volt test lamp or voltmeter between earth and one and then the other terminal. Voltage should register on one but not the other. Start the engine. Both terminals should now be live. Stop the engine.

Fig. E10 — Checking the Pressure Switch

5. Check **alternator earthing.** Connect a voltmeter or 12 volt test lamp between the alternator B+ and D— terminals. Battery voltage should be registered. If no voltage, check connections and earthing.

6. Check **field circuit.** When the pressure switch is closed a current of 2 - 3 amps should flow through the regulator and alternator field. Disconnect the DF lead from the alternator and insert an accurate ammeter between the lead and the terminal. Bridge the pressure switch terminals to activate the regulator and a current of 2 - 3 amps should flow in the field circuit. If more than say 4 amps flow, the field is not providing enough resistance as it is partly shorted. The alternator must be repaired.

If no current flows, either the alternator field, the regulator, or the connections are open circuited. Thoroughly check the connections and check again. If still no current, leave the DF lead disconnected, but connect the ammeter between the alternator B+ and DF terminals.

If still no current, the alternator field is open circuit and the alternator must be repaired.

If 2 - 3 amps now flow, the regulator is defective.

Check regulator connections B+ to B+ on alternator, and DF to DF on alternator.

Note : Remove the pressure switch bridge at the end of this test.

7. If points 1 to 6 have been thoroughly checked and no defect has been found, the probable fault will be in the stator windings or the diodes in the alternator. A positive check can be made on the tractor using a variable load resistor and an accurate voltmeter as below. If this equipment is not available, the alternator and regulator should be removed and tester in an authorised electrical repair depot.

Remove field leads from terminal DF of alternator. Connect jumper lead from terminal DF to terminal B+ and ground. Shunt a carbon pile or load resistor across the battery. Start engine and gradually accelerate until a voltage of 14 V is recorded on the voltmeter. Gradually increase engine speed, but maintain a maximum of 14 V by constantly adjusting the load resistor. At approx. 2000 Engine R.P.M. the output should be at least 35 Amps.

Caution The load resistor must be adjusted to the no-load position as the engine speed is reduced.

Regulator Maintenance :

Remove the cover and visually inspect the regulator contacts. Clean oxidised or burnt contact surfaces with an approved contact cleaning tool.

CAUTION : The gold upper contacts must not be cleaned with abrasives which would remove the contact material. A piece of thin insulating paper can be used to remove any metal build up and to polish the gold contact surface.

Apply light finger pressure to the armature to relieve the contact pressure on the lower, or increase the pressure on the upper, contacts. After cleaning, the mechanical settings must be checked and adjustments made so that the clearances are within the specified tolerances.

Mechanical Settings (Fig. E12) :

(A) With the armature in the rest position, the gap between the electromagnetic core and the armature should be .032 - .050". Adjust by bending the lower contact bracket.

Fig. E11 — The Voltage Regulator (cover removed)

(B) The gap between the high speed contacts should be .008 - .016". Adjust by bending the upper contact bracket. The contacts **must** be correctly aligned one with the other.

(C) In the attracted position — when the upper contacts are closed — the gap between the electro magnetic core and the armature should be .012 - .028".

(D) The gap between the armature and bracket should be .008 - .028".

The pressure required to just open the lower contacts should not be less than 8 oz. Measure by placing a spring balance vertically on the tip of the armature. Adjust by bending the bimetal spring bracket.

Checking the Regulator :

Run the engine at maximum r.p.m., when the voltage reading should be 13.4 - 14.6 V. The regulator **must** be warm before the voltage is read, and this will be after approximately 15 minutes of engine operation. If the voltage reading requires adjustment, the regulator should be removed and reset, together with the alternator, on a test bench as follows :—

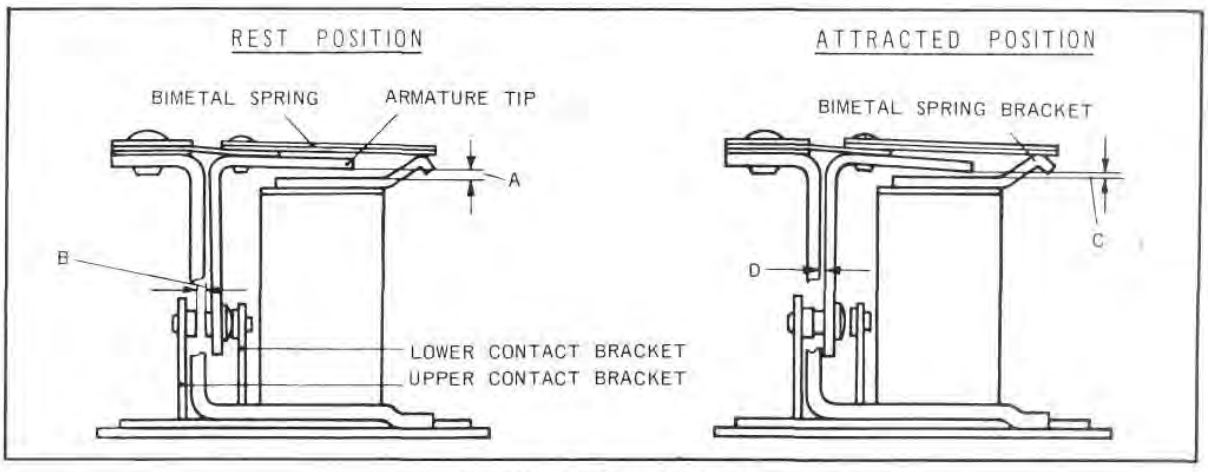


Fig. E12 — Regulator Adjustments

1. The main battery supply from the test bench ammeter must be connected to the alternator terminal B+.
2. Connect the DF terminal of the regulator to that of the alternator.
3. The test bench voltmeter must be connected to the alternator terminal B+ and ground.
4. Be sure that both regulator and alternator have good ground connections to the test bench. The test bench battery must be fully charged and have a load resistor connected across it if one is not already connected as part of the test bench.

Regulating Voltage :

1. Operate the alternator at 1700 r.p.m. and adjust the load resistor until a charging rate of 10 amps. is recorded. Reduce the speed to zero.
2. Increase speed again and adjust load resistor until a charging rate of 10 amps. is recorded but do **not** exceed the 1700 r.p.m. specified.

The regulating voltage should now be :—

Cold — 13.6 - 14.1 Volts.
Warm — 13.5 - 14.4 Volts.
(15 minutes continuous operation)

Regulating Range :

Increase the alternator speed to 7000 r.p.m. to ensure that the regulator is operating in the high range. The voltage reading with a load of 8 - 10 amps. should not vary from the regulating voltage by more than —0.2 to +0.4 volts. If the regulating range exceeds the permissable voltage increase (+0.4) reduce the air gap between the armature and core. If the regulating range exceeds the permissable voltage decrease (—0.2) enlarge the air gap.

When it has been found necessary to adjust the air gap to achieve the specified regulating range, the regulating voltage must be checked to ensure that it remains within the tolerance.

Note : It is important for the regulator electrical adjustments to be carried out within 2 minutes, commencing with a cold regulator. The figures are valid only if the cover is in place and the regulator is mounted in a vertical position, i.e. with the regulator base on a horizontal plane.

After the adjustments are completed, seal the cover with tape and apply a spot of adhesive at the start of the tape, underneath the overlap to prevent moisture ingress.

TROUBLE SHOOTING

Trouble	Possible Cause	Remedy
LOW CHARGE	1. Fan belt slipping.	Adjust as specified.
	2. Dirty or corroded battery terminals.	Clean.
	3. Battery sulphated.	Indicated by low terminal voltage — replace battery.
	4. Alternator open circuit in one or more diodes or a phase.	Replace or service regulator.
OVERCHARGE	1. Incorrect wiring connections to alternator or regulator.	Check against wiring diagram
	2. Regulator has open circuit in voltage winding.	Replace regulator.
	3. Regulator contacts frozen.	Replace or service regulator.

THE STARTER MOTOR

An isolating switch, connected between the key start switch and the starter motor, prevents starting until the clutch pedal is depressed (manual models) or the forward and reversing unit hand lever is in neutral (T.C. models).

When the solenoid is actuated by the starting switch, the starter motor shift lever is first moved against the pressure of a spring, without the field and armature coil being energised. The shift lever pushes, via a guide ring and the pressure of a helical spring located between the guide ring and over-running clutch, the driver and pinion towards the ring gear. At the same time, these parts rotate under the effect of the course threads on the shaft and internally on the pinion. If a tooth of the pinion meets a tooth space of the ring gear, the pinion will mesh instantly. Shortly before the end of the meshing travel the solenoid switch, mounted on the starting motor, is closed. The starting motor armature begins to rotate and, under the force of the course thread, the pinion is pushed further into the ring gear until it is stopped by a ring on the armature shaft. The pinion, not being able to move further, is now, via the over-running clutch and driver, positively coupled with the armature shaft so that the starting motor can crank the engine.

The shift lever stops as soon as the switch closes but, the driver continues to advance, and thereby compresses the helical spring located between the shift lever guide ring and the armature. The stop ring moves away from the guide ring located between the stop ring and the armature.

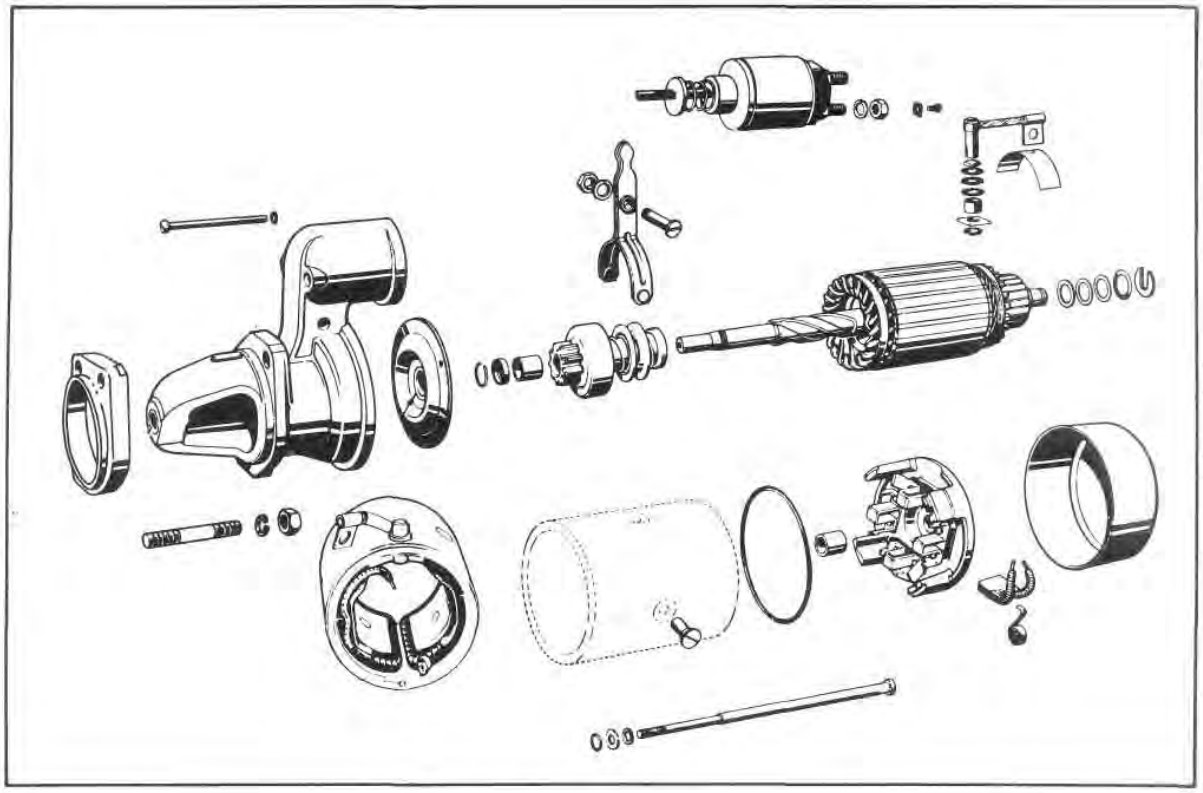


Fig. E13 — The Starter Motor

If the advancing pinion meets a ring gear tooth, the shift lever will compress the helical spring between the guide ring and overrunning clutch until the switch closes. The pinion will slide alongside the face of the ring gear and then engage the next following tooth space under the pressure of the pre-tensioned helical spring and most of all under the pressure of the coarse thread. Since the thread is very coarse, the screw action will not lead to jamming caused by axial force.

The solenoid switch has a pull-in and hold-in coil. When the plunger of the switch is drawn in, both coils are energised. After cutting in the starting motor current, the pull-in coil is short circuited, only the hold-in coil remaining energised.

After starting, the engine runs faster than the starting motor and, as a result, the pinion demeshes. The driver is relieved and pulled back by the tensioned helical spring located between the stop ring and armature. However, the pinion remains slightly in mesh as long as the shift lever is kept in the "on" position electromagnetically. Only when the starting motor is switched "off", thereby clearing the shift lever, the driver and the pinion return under the pull of a spring acting upon the shift lever to their rest position. This spring also holds the pinion in its rest position until a new start is attempted.

In order to protect the screw-push starter motor, an overrunning clutch is fitted. The clutch effects positive connection between pinion and drive so that the pinion is carried along providing the armature shaft drives. However, as soon as the pinion runs faster, the driver is disconnected, and the pinion runs free. To accomplish this, the internal rollers can move along a curved sliding surface until wedged in the narrower part of the space between the free wheeling ring and the cylindrically shaped part of the pinion. When the engine starts to fire, the overunning pinion moves the rollers, against spring pressure, into the enlarged part of the space where they only have slight contact with the freewheeling ring. While the rollers are in the rest position, springs act via guide pins upon them and push them into the narrow part of the space, thus ensuring positive connection between pinion and free wheeling ring while the starting motor begins to rotate.

In order to stop the starting motor as fast as possible after it has been cut off and to enable immediate re-starting if required, an armature brake is built into the starting motor.

The armature brake is designed as an axially acting disk brake, located at the drive. The brake disk, sitting behind the engagement ring, is pressed against the plane surface of the cup disk which is firmly connected with the armature shaft. However, this pressure takes effect only after the starting motor is cut off and slows down or is in rest position. There is no braking action during operation of the starting motor.

USING THE STARTER

The following points should rigidly be observed when starting the engine :—

1. Ensure that all engine controls are correctly adjusted.
2. Depress the clutch pedal (manual models) or place the forward and reversing lever in neutral (T.C. models).
3. Turn the starter switch firmly and **release it immediately the engine fires.**
4. If the engine does not fire at once, allow it to come to rest before turning the starter switch again.
5. Do not discharge the battery by turning the starter switch when the engine fails to start; ascertain the cause.
6. On **no** account should the starter be operated whilst the engine is running; damage to the pinion and ring gear will occur.

MAINTENANCE

Lubrication :

All bearings of the starter motor are self-lubricating and therefore do not have to be lubricated. These bearings must not be cleaned with grease-dissolving agents.

Brushgear :

The carbon brushes should be checked for good working order at regular intervals, the length of which is dependent on operating conditions.

Remove the starter motor from the tractor, remove the through bolts from the end cover, and remove the cover, ensuring that the unit remains together. Re-insert the through bolts.

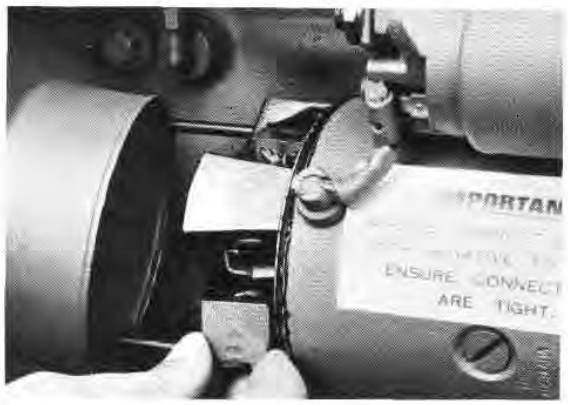


Fig. E14 — Starter Brush Checking

Lift the brush spring off the brush with a hook made of strong wire. When doing this do not bend the brush spring to the side nor lift it higher than necesary. Then check the brushes for free movement in their holders. The brushes and holders should be free from oil and grease. Should these parts jam or be soiled, wipe the dirt away with clean, non-fluffy rag soaked in gasoline and dry. Do **not** use wad or cotton for cleaning.

Use neither emery nor sandpaper, file or knife for cleaning the contact face of the brushes. Replace the brushes if broken or worn so far that the cable soldered into the brush is likely to butt against the brush holder, also replace if the soldered cable comes loose. When inserting the brush, check that the spring does not hit the brush.

With every major engine overhaul, the brushes should be renewed.

Commutator :

The commutator should have a uniform smooth dark grey surface, entirely free from dirt, oil or grease. Soiled commutators should be cleaned with a clean cloth dipped in gasoline (not with cotton waste) and well dried. Emery paper or file must never be used on the commutator. Worn commutators with grooves or out of round must be turned on a lathe in a properly equipped workshop.

Cables and Mounting Bolts :

The starter should be examined to ensure that its mounting bolts are securely fastened, and that all cable connections are clean and tight. The cables should also be inspected for fractures, particularly at the point where the cable enters the terminal lug. The cable insulation should be free from chafing or deterioration due to oil.

REMOVING THE STARTER

1. Disconect the batteries.
2. Remove all leads from the starter motor.
3. Remove the nuts holding the starter to the flywheel housing and lift the starter clear.

STARTER OVERHAUL

No attempt should be made to overhaul the starter unless all tooling and test equipment, mentioned in the following procedure, is available. Also ensure that the appropriate Test Instructions and Specification Sheet are available.

DISMANTLING

1. Clamp the starter in a V-vise and disconnect the connecting strap at the solenoid. Unscrew the pivot bolt for the engaging lever, unscrew the solenoid from the drive end frame, and remove, pulling the pinion forward.

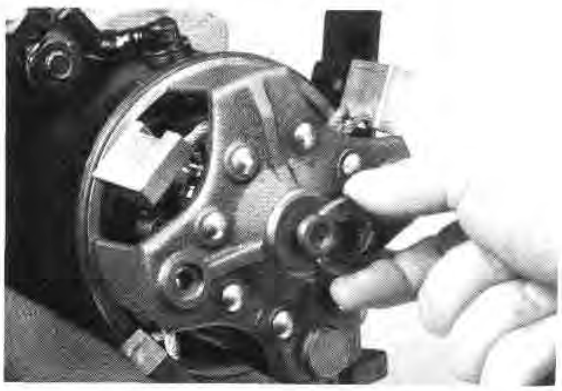


Fig. E15 — Removing the Retainer and Shims

2. Remove the cover from the commutator end, removing the through-screws and salvaging the rubber seals from between the cover and end plate.

3. Lift the brush springs with a hook and pull out the carbon brushes from the holders.

4. Remove the retainer and shims from the shaft end protruding from the end plate.

5. Pull out the commutator end plate, leaving two brushes attached to the field windings. Salvage the washers fitted between the end plate and commutator on the shaft end.

6. Pull out the armature with the drive end plate attached.

Fig. E16 — Pull the Drive End Plate Forward

7. Pull the drive end plate forward thus pulling out the engaging lever. Hold the armature slanted downwards, and slide the engaging lever upwards until the pins of the engaging lever can be lifted free of the guide ring. Pull the engaging lever towards the intermediate bearing, and at the same time tilt the armature further downwards. Take the engaging lever and armature shaft jointly out of the drive end plate.

8. Clamp the armature in a V-vise and drive the stop ring towards the armature exposing the snap ring. Bend out wide both ends of the snap ring to prevent damage to the groove. Fit a **new** split ring when re-assembling.

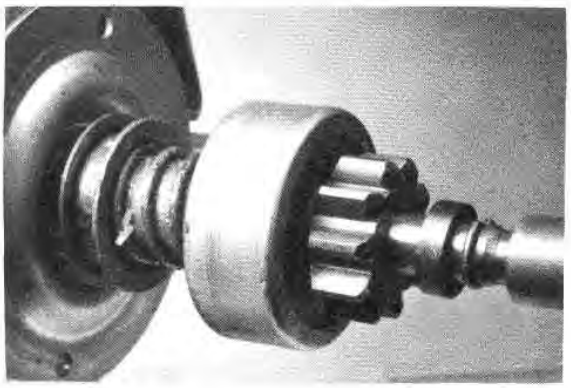


Fig. E17 — Drive the Stop Ring Back

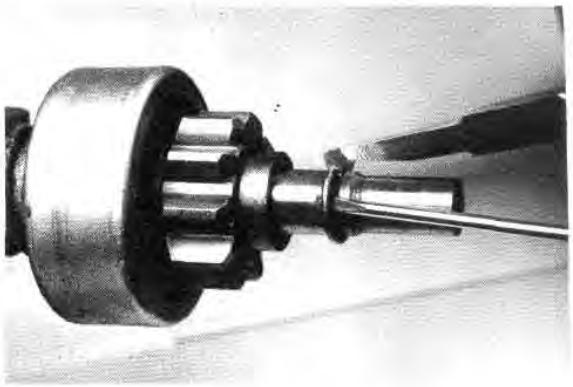


Fig. E18 — Removing the Snap Ring

9. To prevent damage to the drive self-lubricating bushing, remove any existing burrs at the edge of the split ring groove carefully with a fine file. Slide the stop ring, drive, intermediate bearing and armature brake off the armature shaft.

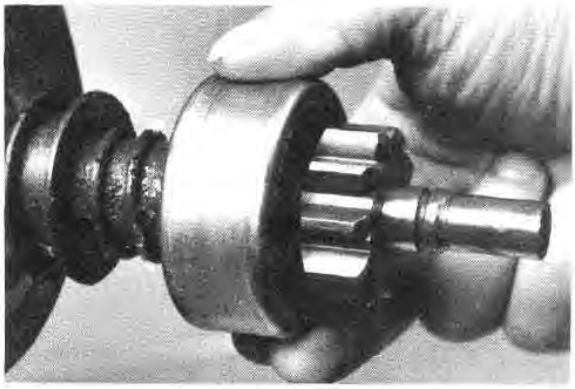


Fig. E19 — Sliding the Drive Assembly off the Armature Shaft

CLEANING THE COMPONENTS

The armature, windings and drive must not be immersed in solvents but the other components may be washed briefly in gasoline or Trichlorethylene and dried with compressed air at 71 p.s.i. maximum pressure.

INSPECTION AND TESTING COMPONENTS

1. Examine all components for mechanical damage and wear.

2. Oil polished parts lightly with rust preventative oil.

3. Test the armature for short to ground with test voltage of 40 V.a.c.

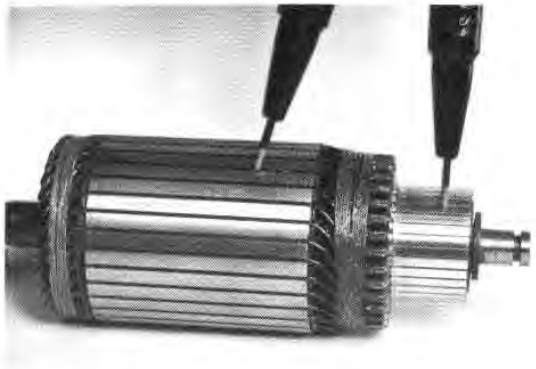


Fig. E20 — Test Armature for Short to Ground

Fig. E21 — Test Armature Windings for Shorts

4. Test the armature windings for shorts.

5. Test the commutator and armature for eccentricity. Maximum eccentricity allowable is 0.0012" for commutator and 0.0002" for armature. If the commutator requires machining the minimum allowable diameter is 1.5625" after turning.

When machining the commutator, undercut the segment insulation to a depth of 0.020" - 0.030" before finally finish cutting.

Check for good solder joints between the commutator bars and solder lugs and re-test the armature for ground and winding shorts.

6. Test the field windings for ground shorts with test voltage of 40 V.a.c.

7. Test the field winding for continuity with test voltage of 6 V.a.c. Pay particular attention to all connections. Replace burnt or damaged field windings.

8. Test the commutator and plate insulated brush holder for ground using test voltage of 40 V.a.c. The carbon brushes must move freely in their guides. When replacing the soldered-on brushes pay particular attention to the solder joints. Solder must not flow too far back into the brush cable as the cable may then break due to stiffness.

9. Replace damaged or annealed brush springs. Set them in correctly and test the pressure with a spring balance to 2.2 - 2.9 lb.

10. Replace the commutator end plate self-lubricating bushing.

11. Replace the self-lubricating bushings in the drive end housing and intermediate bearing.

Note: New bushings should be oil soaked for ½ hour minimum prior to installation.

12. Replace the drive if the over-running clutch is damaged or the pinion teeth are worn. Replace damaged self-lubricating bushings.

13. Replace the solenoid as a unit if any problems in operation have been experienced.

RE-ASSEMBLY

1. Clamp the armature in a V-vise and assemble the intermediate bearing, insulating and plate washers and helical spring onto the armature shaft, and screw the drive unit onto the shaft coarse thread.

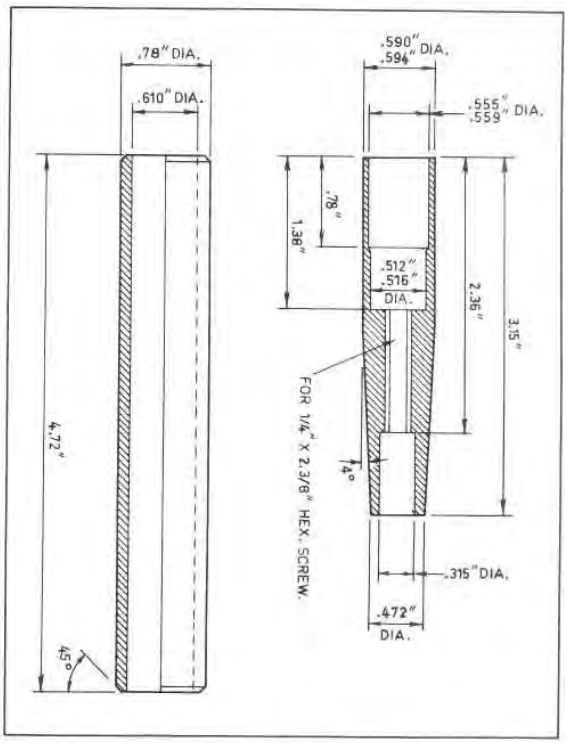


Fig. E22 — Snap Ring Expander Tool

2. Assemble the stop ring to the armature shaft and using the expanding tool shown in Fig. E22 fit a new snap ring. Fit the expander against the armature shaft and turn the expander screw in or out until the shaft ring groove is just exposed. Slide the snap ring over the expander and push it forward until it springs into the groove. Remove the tool, compress the snap ring and work the stop ring over the snap ring.

3. Slip the drive end housing over the drive unit and insert the engaging lever. The studs on the

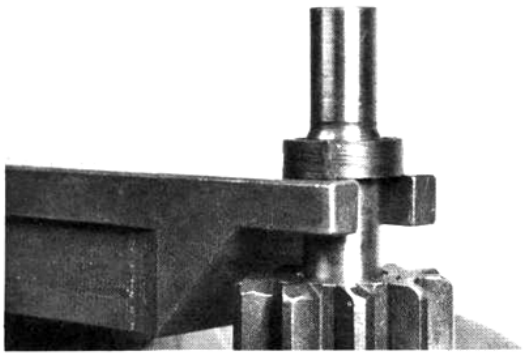


Fig. E23 — Working the Stop Ring Over the Snap Ring

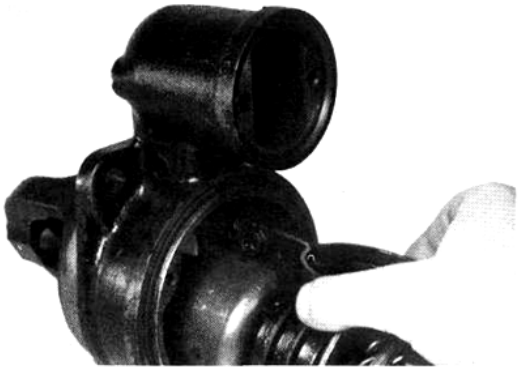


Fig. E24 — Refitting the Engaging Lever

engaging fork must grip into the two part guide ring of the drive unit. Position the fixing grooves in the drive end housing and intermediate bearing frame to coincide.

4. Slip the frame over the armature ensuring that the fixing groove and peg coincide.

5. Position the washers and shims on the commutator end of the shaft and screw on the commutator end plate. Test and adjust the armature axial play to 0.004 - 0.012".

6. Position the engaging lever and hook the forked link of the solenoid into the engaging lever. Secure the solenoid to the drive end housing, screw in the engaging lever pivot bolt and attach the winding terminal strap to the solenoid.

7. Insert the carbon brushes and check the brush spring pressure to 2.2 - 2.9 lb. Arrange the brush cables so that they do not touch the bearing plate.

8. Assemble the spacer and retainer to the protruding end of the shaft. Install the end cover seal, remove the fixing screws and install the end cover.

9. Test the starter operation using the appropriate Test Instructions and specifications sheet, and also check the following :—

Over-running torque	= 0.08 - 0.22 ft.lb.
Armature breaking torque	= 0.30 - 0.50 ft.lb.

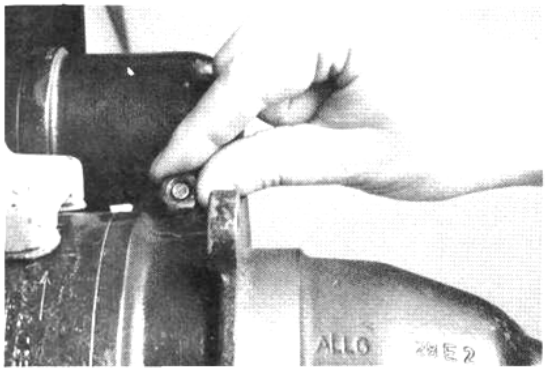


Fig. E25 — Refitting the Engaging Lever Pivot Bolt

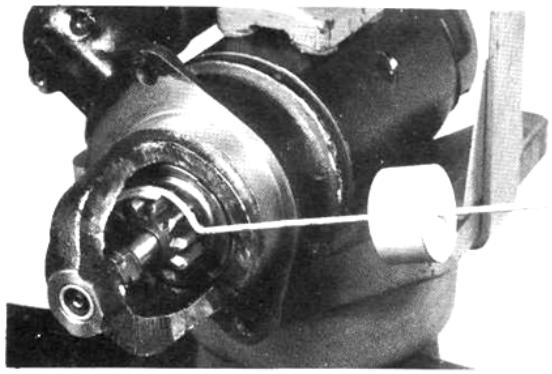


Fig. E26 — Testing the Starter

Starter Motor Trouble Shooting :

Trouble	Probable Cause	Remedy
ARMATURE FAILS TO ROTATE OR ROTATES TOO SLOWLY	Battery discharged.	Recharge battery.
	Battery defective.	Have checked.
	Battery terminals loose or oxidised.	Tighten terminals, clean pole heads with anti-acid grease.
	Starter terminals or carbon brushes short circuited.	Trace faulty ground connection and eliminate it.
	Carbon brushes of s/motor have unsatisfactory contact with commutator, jam in their holders, are worn, broken, fouled by dirt or oil.	Check and clean or renew brushes, clean brush holders.
	Starting switch damaged (burnt out or loose parts impeding switching action).	Replace switch.
	Starting solenoid switch damaged.	Have it repaired.
	Excessive voltage drop in circuit, wiring damaged, loose connection.	Check wiring and connections.
PINION FAILS TO MESH, THOUGH ARMATURE ROTATES	Pinion fouled.	Remove dirt.
	Pinion or ring gear teeth deformed, burr forming.	Deburr.
ARMATURE ROTATES UNTIL PINION IS CONNECTED THEN STOPS	Battery insufficiently charged.	Re-charge battery.
	Insufficient pressure on brushes.	Check and clean, or replace brushes.
	Starter solenoid switch faulty.	Have it repaired.
	Excessive voltage drop in starter circuit.	Check wiring and connections.
	Over-running clutch slips.	Repair or replace.
S/MOTOR CONTINUES ROTATING AFTER STARTING SWITCH IS RELEASED	Starting switch fails to cut out or solenoid switch sticks.	Disconnect cable immediately at battery or s/motor. Repair or replace switch.
PINION FAILS TO DEMESH WHEN ENGINE HAS STARTED	Pinion or ring gear fouled or damaged, return spring fatigued or broken.	Clean thoroughly or deburr ring gear. Replace return spring.

SECTION **F**

MAIN CLUTCH AND TORQUE CONVERTER

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

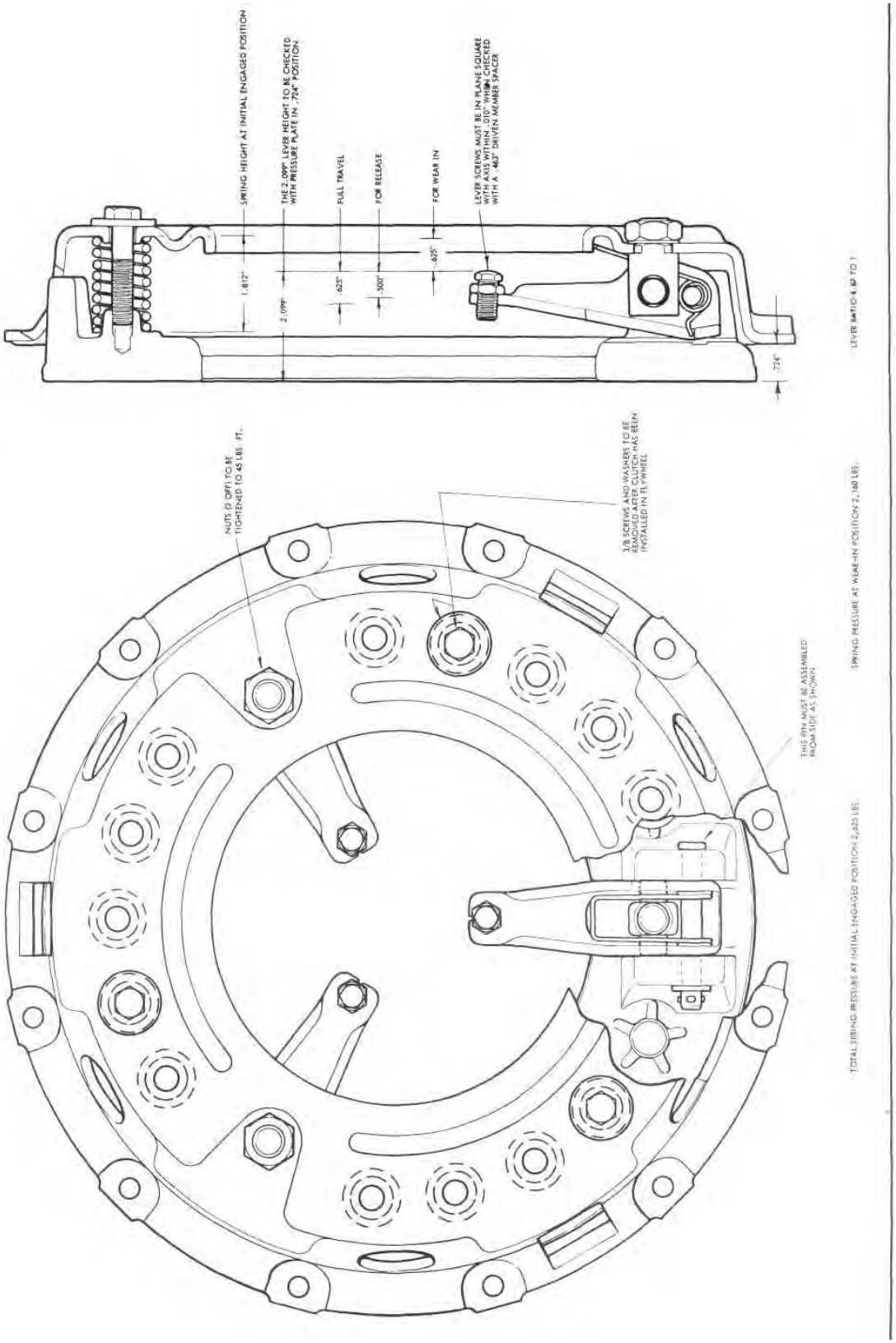


Fig. F1 — Main Clutch

MAIN CLUTCH

Std. Manual and F.W.D. Manual Models only.

DESCRIPTION

The clutch is a 14" single, dry plate type, self compensating for wear.

The pressed steel cover plate is located in and bolted to the flywheel, and drives the cast iron pressure plate by interlocking lugs. Pressure springs, seated on bosses on the pressure plate and around indentations in the cover plate, exert pressure on the plate to create the necessary friction in the driven plate. This pressure may be relieved from the driven plate by actuating the release levers.

The release levers, pinned to the pressure plate at the outer ends, operate through pivot blocks attached to the cover. Anti-rattle springs mounted on the release lever pins, bear on the levers and the cover.

The release mechanism consists of a sealed ball thrust bearing, with lubricator hose and fitting for greasing, fitted to a bearing carrier mounted on an extension of the gearbox mainshaft bearing retainer. Foot pressure transmitted through a cross-shaft and fork actuate the release mechanism which causes the thrust bearing to press on the levers, releasing the pressure from the driven plate, thus disengaging the drive. When the pedal is released, the levers allow the springs to re-engage the drive plate with the driven plate.

The clutch pedal is spring assisted for ease of operation.

SPECIFICATIONS

Make	— Repco-Rockford model 14 R.T.
Type	— Single dry plate.
Diameter	— 14".
Operation	— Foot control.
Torque Rating	— 300 lbs./ft.
Spring Code	— 505 - 2.
Spring Colour	— Yellow.
Lining — Material	— Asbestos Composition.
— Outside Diameter	— 14".
— Inside Diameter	— 8½".
— Thickness	— 3/16".
Release Mechanism	— Three adjustable release levers.
Adjustment	— Clutch, self compensating. Release mechanism, adjustable link under floorplate.
Permissable release lever misalignment	— .010".
Lubrication	— Grease nipples for cross-shaft and release bearing.

MAINTENANCE

Service the grease nipples on the clutch cross-shaft and the throw-out bearing every 50 operating hours. Do not over-lubricate the bearing.

Adjustment — Periodically check the pedal adjustment. Press the pedal downward by hand until the resistance to movement sharply increases, indicating that the throw-out bearing has made contact with the clutch release levers. The distance the pedal moves before contact is made should be 1" to 2" and must not be allowed to reduce to less than 1". If the measurement is reduced to zero severe wear and clutch slippage will result.

Fig. F2 — Clutch Pedal Adjustment

To Adjust the Pedal :

1. Slacken the clutch brake adjustment to prevent false impressions of the main clutch clearance.
2. Release the tension on the pedal helper spring.
3. Slacken the locknuts on either side of the pedal trunnion, adjust them as required, then re-tighten.
4. Disconnect the pedal return spring.
5. Adjust the helper spring tension so that a minimum effort is required to operate the pedal when the free travel has been taken up.
6. Reconnect the pedal return spring.

Note : If the pedal does not return hard up against the underside of the foot plate, ensure that the helper spring is not over-adjusted.

Fig. F3 — Adjusting Helper Spring Tension

Clutch Brake Adjustment :

As the lining wears, or if the main clutch is adjusted, it will become necessary to adjust the clutch brake. After adjusting the main clutch, check the clutch brake linkage. With the clutch engaged (pedal released) the small lever on the clutch brake screw (protruding from the side of the gearbox) should be at an angle of approximately 90° to the spring loaded link. If necessary, slacken the bolt in the cross-shaft lever slot and adjust to suit. Re-tighten the bolt and fully depress the clutch pedal.

In this position the cross-shaft lever should compress the springs on the link by moving ¼" to ⅜" away from the lower stop nut. If necessary, slacken the locknut on the brake adjusting screw and adjust the slotted screw to suit. Re-tighten the locknut and recheck the linkage movement.

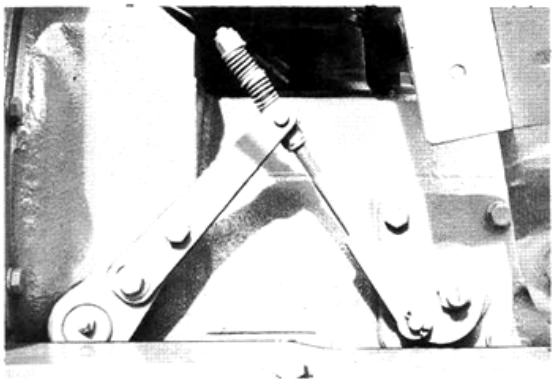


Fig. F4 — The Clutch Brake

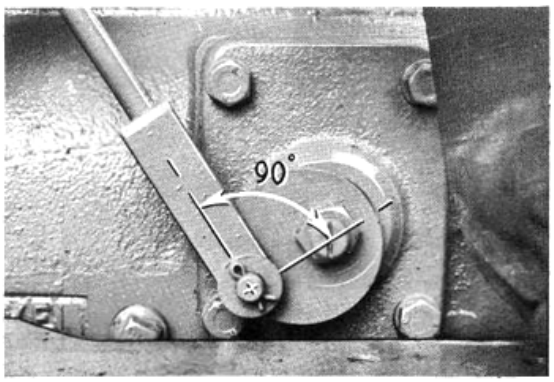


Fig. F5 — Angled approx. 90° to Spring Loaded Link

Note : As the clutch brake can be too effective if the linkage is incorrectly adjusted, preventing "on-the-move" primary gearbox changes, ensure that the clutch pedal must be depressed more than half its travel before the clutch lever starts to compress the springs on the link. An anti-rattle spring is fitted between the shoe and the screw to maintain a slight shoe drag against the reverse idler at all times. The screw is recessed to accommodate the spring.

CAUTION : When making "on-the-move" changes, do **not** depress the clutch fully, as this will actuate the clutch brake, stopping the reverse idler gear and cause "crashing" of the gears.

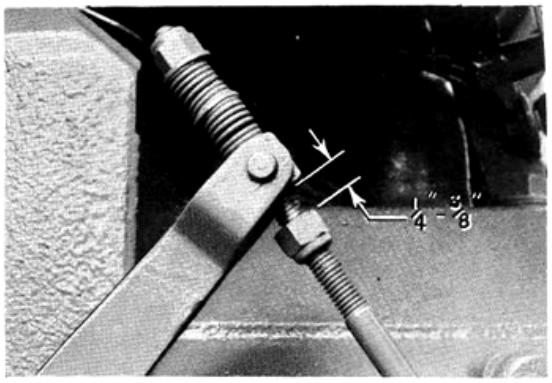


Fig. F6 — Link movement of approx. ¼" — ⅜"

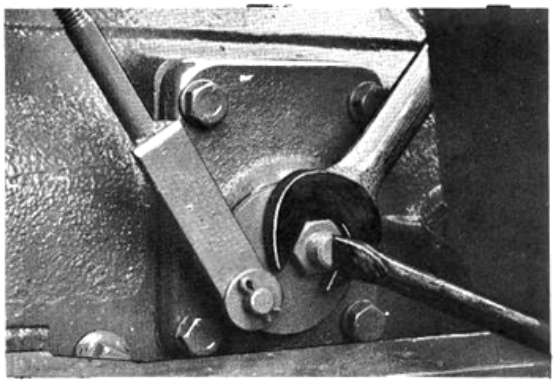


Fig. F7 — Clutch Brake Adjustment

TO DISMANTLE THE CLUTCH

1. Remove the primary gearbox (See Section G).
2. Fit three 'keeper' bolts and washers (P/N. 4224 and 26845) to hold the assembly compressed for easier removal and to prevent possible damage to the clutch.
3. Remove the clutch cover assembly by unscrewing the twelve retaining bolts.

Fig. F8 — "Keeper" Bolts Fitted

4. Remove the driven plate.

5. Centre punch mark the cover plate and the pressure plate to enable the same relative position to be maintained on re-assembly.

6. If the flywheel has been removed, bolt the pressure plate to its face and commence dismantling, otherwise, support the pressure plate on blocks, and with a suitable block arranged under a hydraulic press, or a jack placed under the tractor chassis, bear down evenly on the cover plate. When the spring pressure has been relieved, remove the lever block locknuts and the 'keeper' bolts.

7. Release the spring tension and lift the cover plate off the pressure springs.

8. Remove the pressure springs, release levers and lever pins.

9. The throw-out bearing and carrier may be removed by releasing the spring clips and sliding the carrier free, after disconnecting the lubricator hose.

Fig. F9 — Throw-out Bearing and Carrier Removal

10. The clutch pilot bearing may be removed from its retainer after removing the circlip. The fit of this bearing is such that it should be possible to prise it free. Should it be necessary to remove the retainer to drive the bearing free, it will be necessary to unlock and remove the flywheel bolts. When this is done, the flywheel is only supported on the crankshaft by a small spigot, and for this reason, it is advisable to remove an upper bolt first and replace it with a stud having ½" U.N.F. thread. This will support the flywheel whilst the retainer is removed and, if necessary, whilst the flywheel itself is removed. When replacing, tighten the bolts to 90 lbs./ft.

INSPECTION

Thoroughly clean and inspect all components for wear, paying particular attention to bearings, splines and the flywheel and pressure plate faces. Do not allow petrol or kerosene to contact the friction facings (linings), or the clutch pilot bearing.

The possibility of further use of the friction facings is sometimes raised, because they have a polished appearance after considerable service. It is natural to assume that a rough surface will give a higher frictional value against slipping, but this is not correct.

Since the introduction of non-metallic facings of the moulded asbestos type, in service, a polished surface is a common experience, but it must not be confused with a glazed surface which is sometimes encountered due to conditions discussed below.

The ideal smooth or polished condition will provide a normal contact, but a glazed surface may be due to a film or a condition introduced, which entirely alters the frictional value of the facings. These two conditions might be simply illustrated by the comparison between a polished wood, and a varnished surface. In the former the contact is still made by the original material, whereas in the latter instance, a film of dried varnish is interposed between the contact surfaces.

The following notes are issued with a view to giving useful information on this subject :—

(a) After the clutch has been in use for some little time, under perfect conditions (i.e., with the clutch facings working true and polished or ground surfaces of correct material, without the presence of oil, and with only that amount of slip which the clutch provides for under normal conditions) then the surface of the facings assumes a high polish, through which the grain of the material can be clearly seen. This polished facing is of a mid-brown colour and is then in a perfect condition, the co-efficient of friction and the capacity for transmitting power being up to standard.

(b) Should oil in small quantities gain access to the clutch in such a manner as to come in contact with the facings, it will burn off, due to the heat generated by slip which occurs under normal starting conditions. The burning off of this small amount of lubricant, has the effect of gradually darkening the facings, but, provided the polish on the facings remains such that the grain of the material can be clearly distinguished, it has very little effect on clutch performance.

(c) Should increased quantities of oil or grease obtain access to the facings, one or two conditions, or a combination of the two, may arise, depending upon the nature of oil, etc.

1. The oil may burn off and leave on the surface facings a carbon deposit which assumes a high glaze and causes slip. This is a very definite, though very thin deposit, and in general it hides the grain of the material.

2. The oil may partially burn and leave a resinous deposit on the facings, which frequently produces a fierce clutch, and may also cause a "spinning" clutch due to a tendency of the facings to adhere to the flywheel or pressure plate face.

3. There may be a combination of (1) and (2) conditions, which is likely to produce a judder during clutch engagement.

(d) Still greater quantities of oil produce a black soaked appearance of the facings, and the effect may be slip, fierceness, or judder in engagement, etc., according to the conditions. If the conditions under (c) or (d) are experienced, the clutch driven plate should be fitted with new facings, the cause of the presence of the oil removed and the clutch and flywheel face thoroughly cleaned.

Correction of oil leaks from either the engine or the primary gearbox is covered in the engine and primary gearbox sections.

It is advisable, if the clutch operation has been faulty, or if the flywheel has been removed, to check the flywheel alignment as described in the engine section.

To check the alignment of the three release levers, a gauge plate may be used to give accurate results. A reasonably accurate method of checking this alignment is to assemble the clutch unit to the engine, mount a scriber block on the chassis in line with the face of one of the lever screws, then rotate the engine to obtain a comparative reading on the other two levers. Mark the lever which lies furthest to the rear slacken the clutch unit, rotate the driven plate through approximately 90°, re-tighten and re-check. This latter procedure is to eliminate the possibility of incorrect readings due to inaccuracies in the driven plate. The alignment may be corrected by slackening the locknut and adjusting the screw as necessary.

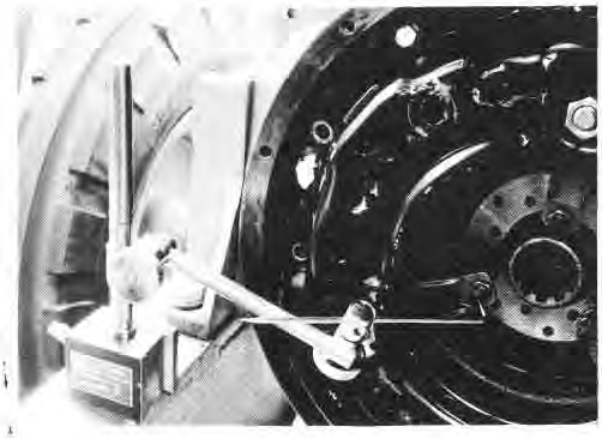


Fig. F10 — Checking Release Lever Alignment

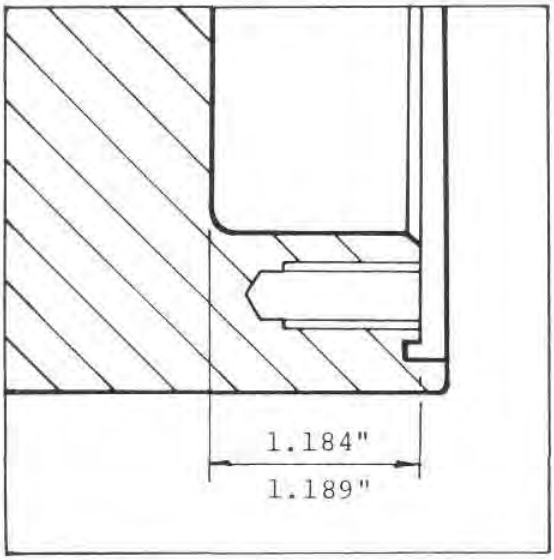


Fig. F11 — Flywheel Friction Face to Cover Mounting Measurement

Check both pressure plate and flywheel for concavity and convexity, a maximum of .006" being allowed. The friction face of the flywheel can be resurfaced to a maximum depth of .070" undersize. To maintain clutch spring pressure on the driven plate, the amount removed from the flywheel friction plate must also be removed from the clutch cover mounting face on the flywheel, the measurement between these two faces being 1.184 - 1.189".

Previous refacing of the flywheel can be checked by measuring the depth of the friction face from the outer edge of the flywheel — this measurement being 1 - 5/16" on a new unit.

Refacing of the clutch pressure plate to a maximum undersize thickness of .020" is permitted. Previous refacing of the plate can be checked by measuring from the edge of the springpin (pin fitted to hole) to the edge of the plate — this measurement is 1.8384 - 1.8497" on a new unit.

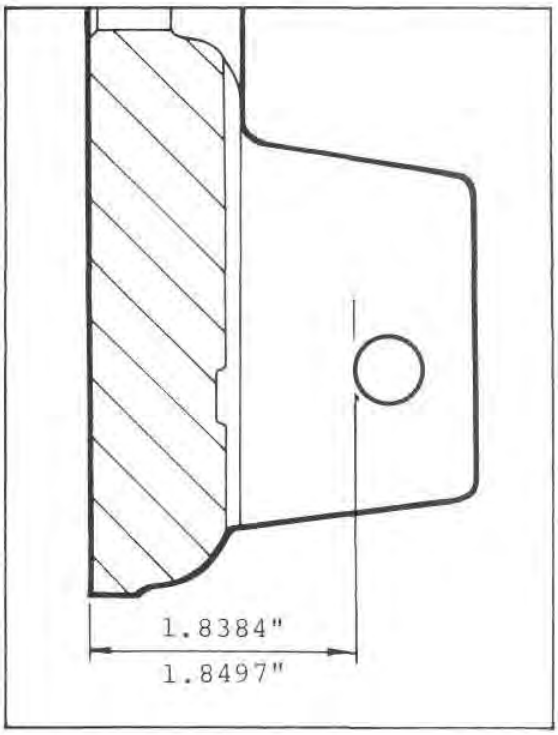


Fig. F12 — Checking Friction Plate for previous Re-facing

TO RE-ASSEMBLE THE CLUTCH

1. Mount the release lever assemblies on the pressure plate. Place the pressure plate with the assembled release levers on the blocks used for dismantling purposes.
2. Place the pressure springs in position on the pressure plate.
3. Lay the cover plate over the springs ensuring that the centre punch marks on the cover and pressure plate are lined up, and that the springs are seated on the bosses on the pressure plate and around the indentations on the top of the cover plate.
4. Compress the assembly, as under "Dismantling", line up the pivot block with the holes in the cover

plate, and replace the locknuts. Prior to releasing the tension on the assembly, replace the "keeper" bolts and washers.

5. Release the tension and the clutch assembly is ready to have the levers adjusted.

ADJUSTING THE LEVERS

1. Place the clutch assembly, pressure plate face down, on a clean surface plate, or similar flat surface.
2. Using the three 'keeper' bolts, adjust the tension so that the distance between the cover plate outer edge and the surface plate, is .724" measured in at least four separate places.
3. Using a depth micrometer, adjust the release lever screws to give a measurement of 2.099" to the surface plate. Lock the screws with the locknuts.

Note: With the clutch assembled on the flywheel lever screws must be aligned with a maximum of .010" between maximum and minimum reading using a scriber block mounted on the chassis. If the variation exceeds .010", investigate the cause.

TO RE-ASSEMBLE TO THE ENGINE

1. Fit the driven plate with the longer side of the splined boss towards the primary gearbox.
2. Fit the cover assembly, tightening the bolts evenly to just nip the driven plate, and centralise the driven plate with a dummy pilot shaft or a primary gearbox clutch shaft passed through the driven plate and into the pilot bearing. With the driven plate centralised in this manner, tighten the flange bolts with a torque wrench to 25 lbs./ft.

Fig. F13 — Centralising the Driven Plate

Note: The driven plate may be centralised by sighting or by using a suitably stepped straight edge but the dummy shaft or clutch shaft is recommended as, if the plate is not accurately centralised, difficulty will be experienced when re-assembling the gearbox.

3. When replacing the gearbox, lightly smear the splines with graphite grease and exercise care not to distort the driven plate by allowing the gearbox to move out of line after the clutch shaft spline has entered the plate.
4. Re-adjust the throw-out linkage.

TROUBLE SHOOTING

Trouble	Probable Cause	Remedy
SLIPPING	Incorrect pedal adjustment.	Adjust.
	Binding throw-out mechanism.	Lubricate.
	Worn or oil soaked linings.	Replace.
	Concave or convex flywheel and/or pressure plate. Maximum .006".	Reface flywheel. Max. .070". Reface pressure plate. Max. .020".
	Binding cover plate.	Ensure a minimum of .002" clearance between cover and lugs. File the cover, not the lugs.
	'Keeper' bolts not removed.	Remove bolts.
DRAGGING	Incorrect pedal adjustment.	Adjust.
	Badly worn linkage.	Replace.
	Distorted or oil soaked linings.	Replace.
	Driven plate splines sticking.	Clean. inspect and lubricate.
	Mal-adjustment of pressure plate.	Adjust.
	Pilot bearing failure.	Replace.

TROUBLE SHOOTING (Contd.)

Trouble	Probable Cause	Remedy
FIERCENESS OR GRAB	Binding throw-out mechanism.	Lubricate.
	Worn or oil soaked linings.	Replace.
	Mal-adjustment of pressure plate.	Adjust.
	Worn or scored flywheel and/or pressure plate.	Reface or replace.
	Incorrect clutch brake adjustment.	Adjust.
JUDDER OR CHATTER	Loose engine mountings.	Tighten.
	Worn or oil soaked linings.	Replace.
	Mal-adjustment of pressure plate.	Adjust.
	Flywheel mis-alignment.	Rectify.
	Distorted driven plate.	Replace.
	Bent clutch shaft.	Replace.
	Primary gearbox upper mainshaft forward bearing faulty.	Replace.
RATTLING OR SQUEAKING	Throw-out mechanism dry.	Lubricate.
	Throw-out mechanism worn.	Replace.
	Broken pressure springs.	Replace.
	Pilot bearing failure.	Replace.
	Worn driven plate splines.	Replace.
	Broken anti-rattle spring. (Release lever).	Replace.

TORQUE CONVERTER

T.C. Model Tractors Only

DESCRIPTION

The type 12W, welded steel, single stage, two phase, torque converter consists of three basic units — a pump (or impellor), turbine and stator. A cover, which is part of the pump, completely encloses the turbine and the whole case is charged with oil. The pump, turbine and stator are each fitted with curved blades.

OPERATION

When the engine is started, the pump (which is coupled directly to the engine) commences turning. If the engine R.P.M. is increased, the oil will be thrown :

A. Outwards by centrifugal force.
B. Forward by the shape of the housing.
C. In the direction of rotation by the pump blades.

The oil from the pump blades impinges on the turbine blades tending to turn it, and the oil is directed inwards towards the turbine inner circumference. As the turbine blades are curved, the oil is still pushing the blades when it reaches the outlet.

Thus, under heavy load conditions, the turbine speed will be very slow (stationary at full stall) and consequently there will be little, or no, centrifugal force retarding the flow of oil back towards the centre of the converter. The oil is discharged with considerable force from the inner ends of the turbine blades and, due to the shape of the blades, it leaves the turbine travelling in the opposite direction to the pump rotation.

As the load decreases, the turbine speed increases and centrifugal force retards the oil's return through the turbine blades and decreases the force of the discharged oil. As the blades are moving away from the oil entering the turbine, "turning back" of the oil

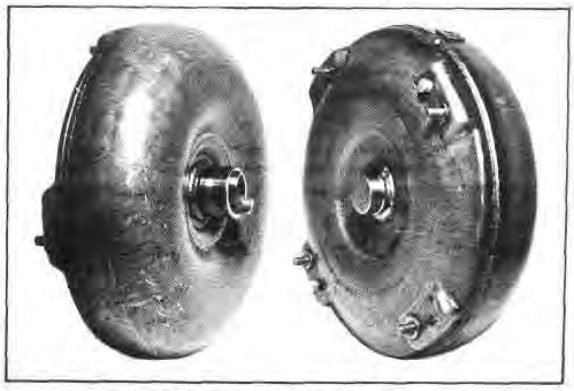


Fig. F14 — Type 12W Torque Converter

is reduced until at high turbine speeds the oil leaves the turbine still travelling in the pump direction of rotation.

From the turbine the oil impinges on the stator, its purpose being to turn the oil ejected from the turbine so that it re-enters the pump under force and in the right direction to assist the pump. As the load decreases and the angle of the turbine discharge decreases, oil will strike the reverse side of the stator blades but, as the stator is mounted on a sprag type over-running clutch, it turns and does not obstruct the flow of oil back to the pump inlet. Thus, the stator can "free wheel" to allow the converter to act as a fluid coupling at high ratio or, automatically "lock-up" at low ratios to provide the necessary re-action for torque multiplication.

As the cycle through the pump, turbine and stator is repeated, the oil will enter the pump with considerable initial energy to assist the pump action and the force exerted on the turbine will be greater than the original cycle. Theoretically, as the cycle is repeated, the forces would continue to rise until any load could be shifted (or the transmission collapse) but in practice fluid losses and blade shapes limit the torque multiplication.

Mounted on the front of the forward and reversing unit and coupled to the converter, is a pump which, whenever the engine is running, provides charging pressure for the converter and circulates the oil through a cooler and filter.

Advantages of Torque Converter Drive :

1. The engine always operates in the efficient speed range.
2. Torque multiplication is automatic.
3. Engine stall is prevented.
4. Smooth acceleration of the load is possible.
5. Shock loading is reduced.
6. The job cycle is faster.
7. Operator fatigue is reduced.

Disadvantages of Torque Converter Drive :

1. It has a lower overall efficiency.
2. The initial cost is higher.

SPECIFICATIONS

Make	— Borg and Beck.
Type	— 12W welded steel.
Model	— Single stage, two phase
Maximum Input Speed	— 4000 r.p.m.
Maximum Input Torque	— 280 lbs./ft.
Maximum Torque Multiplication Ratio	— 2.17 : 1.0.
Maximum Efficiency	— 90.5% @ 20 - 25% slip.
Maximum Efficiency @ 10% slip	— 89%.
Maximum Power, Engine Stall R.P.M.	— 1433 r.p.m.
Maximum Output Torque	— 376.5 lbs./ft.
Converter Charging Oil Pressure	— 50 - 60 p.s.i.

Term Definition :

Speed Ratio	Ratio of Input to Output Speed
Torque Ratio	Ratio of Input to Output Torque
% Slip	$\frac{(\text{Input Speed} - \text{Output Speed}) \times 100}{\text{Input Speed}}$
Efficiency	$\frac{\text{Output Horsepower} \times 100}{\text{Input Horsepower}}$

MAINTENANCE

Providing the oil level in the forward and reversing unit is maintained at the correct level and regular checks are made of the pressures, no maintenance is necessary to the converter unit.

SERVICE

The procedure for the detection of faulty converter performance is contained in Trouble Shooting at the rear of this section. As the converter is of the welded steel type, it must be serviced as a unit.

Torque Converter Removal :
Std. T.C.

1. Remove the blanking cover beneath the instrument panel.
2. Remove the main drive shaft tunnel.
3. Remove the centre floor plate.
4. Remove the main drive coupling shaft.
5. Drain the forward and reversing unit oil, and the torque converter oil. The torque converter drain plug is accessible when the flywheel housing bottom cover plate is removed. Turn the converter until the plug is disclosed.

Caution : If the oil is hot be careful when removing the drain plug.

Fig. F15 — Draining the Converter

6. Disconnect all controls, piping and wiring from the forward and reversing unit.
7. Remove the oil filter as an assembly.
8. Support the forward and reversing unit, remove the unit to bell housing bolts and move the unit out and clear of the tractor.
9. Remove the bell housing to flywheel housing bolts and remove the bell housing.
10. Remove the torque converter strap securing nuts and remove the converter. These nuts are accessible through the flywheel housing cover plate hole.

F.W.D. T.C.

1. Remove the forward and reversing unit control lever bell crank to cross-shaft link.
2. Remove the seat and support as an assembly.
3. Remove the main drive coupling shaft.
4. Remove the forward and reversing unit control cross-shaft.
5. Drain the forward and reversing unit oil, and the torque converter oil. The torque converter drain plug is accessible when the flywheel housing bottom cover plate is removed. Turn the converter until the plug is disclosed.

Caution : If the oil is hot be careful when removing the drain plug.

6. Disconnect all controls, piping and wiring from the forward and reversing unit.
7. Remove the oil filter as an assembly.
8. Support the forward and reversing unit, remove the unit to bell housing bolts and move the unit out and clear of the tractor.
9. Remove the bell housing to flywheel housing bolts and remove the bell housing.
10. Remove the torque converter strap securing nuts and remove the converter. These nuts are accessible through the flywheel housing cover plate hole.

RE-ASSEMBLY

Exercise extreme care to prevent the ingress of dirt into the torque converter, forward and reverse assembly and connections. Carefully examine the torque converter straps and if these have been removed, reassemble so that when the engine is running the converter will be pulled by the flywheel (not pushed).

1. Place the tab washer over the straps and under the bolt head with the turned down edge nearest the flywheel centreline and located against the edge of the straps. Position the hole in the straps over the centreline of the large hole in the flywheel and tighten the bolt to 28 lbs./ft. Turn up the long tab to contact at least two bolt head flats.
2. Fit the torque converter to the flywheel spigot and secure the converter straps with self locking nuts.
3. Mount a dial indicator gauge to measure the run-out of the converter pump drive sleeve. The maximum permissible run-out is .020". If the run-out exceeds this figure, the mounting straps require checking. To help control converter run-out, the spacer, P/No. 32494, tolerance is .604" - .600" and spacer sets of equal length should be fitted, if possible.

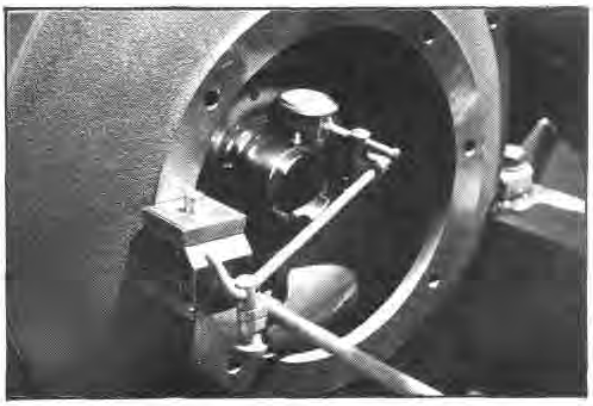


Fig. F16 — Checking the Converter Pump Drive Sleeve

4. Install the converter housing and tighten the flange bolts to 30 lbs./ft.
5. Carefully install the forward and reverse assembly. Support the unit securely and turn the drive as necessary to align the splines and dogs. Do not use force. Tighten the housing bolts to 40 lbs./ft.
6. The remainder of the assembly is the reversal of the dismantling procedure.
7. Refill the forward and reversing assembly with new Automatic Transmission Fluid Type "A" or Dexron, to the level indicated. The engine must be operated a sufficient time to ensure full charging of the converter and cooler and the steering column lever moved to forward, reverse and neutral before rechecking the level with the unit in forward. Move the secondary gearbox and drop box lever into the neutral position, **lock** the park brake, and then dismount from the tractor and remove and observe the dipstick.

TROUBLE SHOOTING

Trouble	Probable Cause	Remedy
NOISY OPERATION ALL GEARS	Misalignment of converter housing or converter with transmission or engine.	Align converter assembly and housing. Replace converter assembly.
NOISY OPERATION NEUTRAL ONLY	Worn sprag or sprag races in converter assembly.	Replace converter assembly.
TRANSMISSION OVERHEATING FORWARD AND REVERSING UNIT	Converter sprag clutch worn and slipping.	Replace converter assembly.
TRANSMISSION WILL NOT PULL ALL SPEEDS	Converter drive lugs sheared or not engaged in pump.	Replace converter.
	Pump gears seized and converter drive lugs sheared.	Replace pump assembly and converter.

CHAMBERLAIN

SECTION **G**

PRIMARY GEARBOX

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

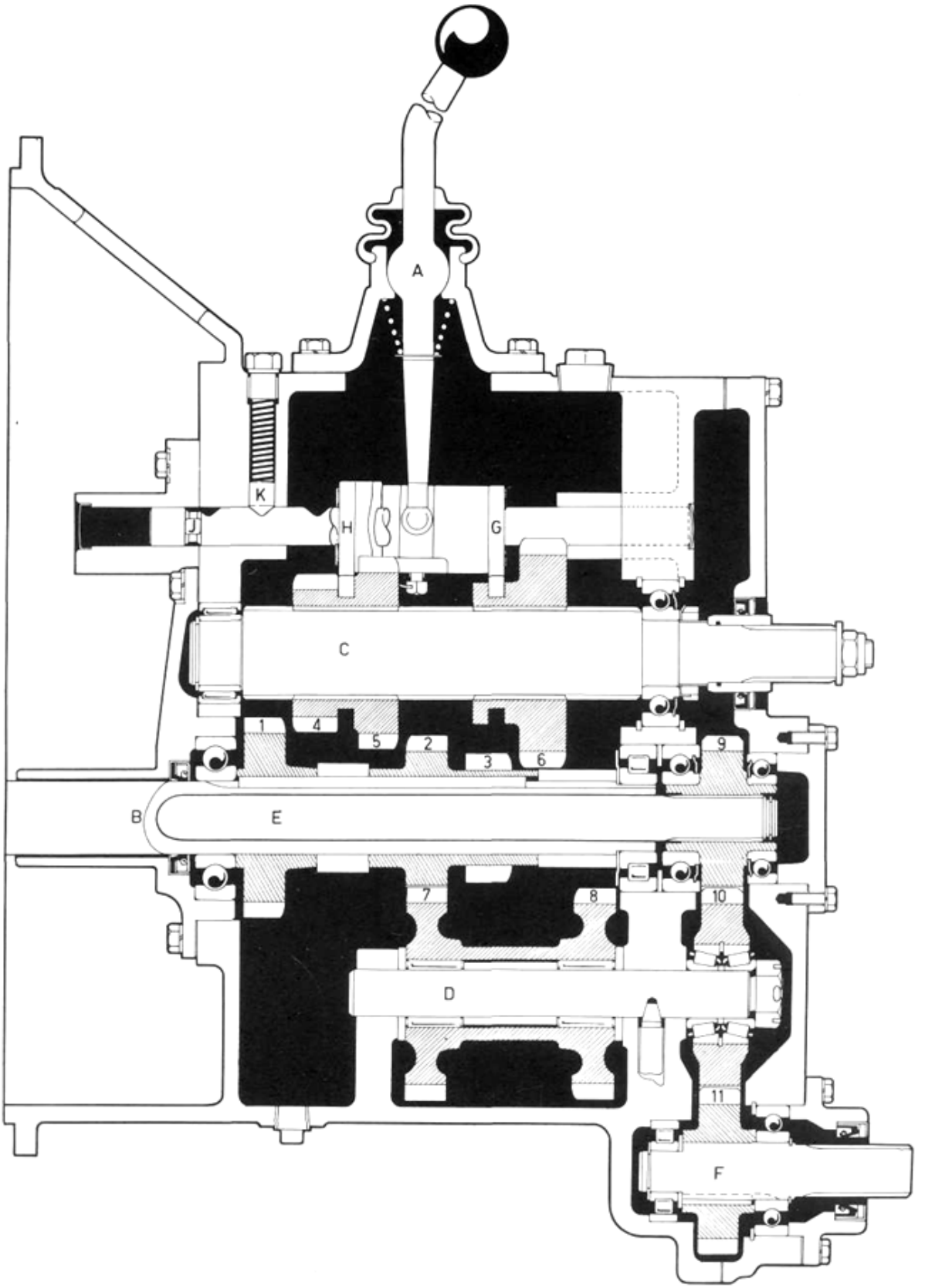


Fig. G1 — The Manual Primary Gearbox

PRIMARY GEARBOX (MANUAL)

Std. Manual and F.W.D. Manual Models only

DESCRIPTION

The housing of the primary gearbox bolts directly to the engine flywheel housing and also serves to enclose the clutch unit. The mechanism is a normal three speed and reverse, sliding spur gear assembly except for the provision of the "live" P.T.O. as an **optional extra.** To provide this, the primary shaft (B) is hollow and a shaft (E) passes through its centre to couple the engine flywheel directly to a train of three spur gears (9, 10 and 11) inside the rear cover. The third gear (11) of the train is keyed to a splined shaft (F) on to which is fitted a universal coupling shaft which transmits the drive to the rear P.T.O. assembly.

Power transmitted to the driven clutch plate by the main clutch is transmitted per medium of a shaft (B) to a cluster of gears (1, 2 and 3) keyed and shrunk to the shaft.

To engage first gear, slide gear 6 into mesh with gear 3.

To engage second gear, slide gear 5 into mesh with gear 2.

To engage third gear, slide gear 4 into mesh with gear 1.

To engage reverse gear, slide gear 6 into mesh with gear 8.

Gear 8 is integral with gear 7 which is in constant mesh with gear 2.

All shafts are arranged in a flat plane for clarity in the main diagram, but in practice, the splined shaft (C) lies behind the upper shaft (B) and the reverse idler shaft (D) so that gear 6 may mesh with the gear 8.

Gear selection is obtained by means of a gear lever (A) and selector forks (G and H). The selector forks are retained in their selected positions by means of two spring loaded plungers (K) which engage in grooves in the selector rails. As a preventive measure against both shifter forks being moved at once from the neutral position, thus engaging two gears at the same time, a shifter rail interlock (J) is fitted between the two rails.

Motion applied through any one of the selected gear ratios is transmitted by the splined shaft (C), via a universal coupling shaft to the rear assembly.

Lubrication is by oil bath and splash. Filler, level and drain plugs are provided.

SPECIFICATION

Make	— Own.
Type	— 3 speed and reverse, sliding spur gear with provision for a "live" P.T.O. or pump drive.
Control	— Lever with standard "H" action.
Speed Ratios	— 1st — 2 : 1. — 2nd — 1.181 : 1. — 3rd — 0.741 : 1. — Reverse — 1.506 : 1.
Gears	— Straight spur.
Bearings	— Ball, roller and needle roller.
Lubrication	— Oil bath.
Capacity	— 11 pints.
P.T.O. gear train (Optional Extra)	— Comprises a primary shaft from the flywheel, a train of 3 spur gears and an output shaft. A spun metal cover is fitted over the output shaft if this is not connected to external equipment.

MAINTENANCE

Lubrication is by oil bath and splash, and it is recommended that every 150 operating hours, the oil level should be checked at the plug situated on the nearside of the gearbox, inside the chassis. Every 1200 operating hours, while the gearbox is hot, drain and re-fill to the correct level with new oil.

Fig. G2 — Oil Level Plug

SERVICE

Oil Leakage :

The output shaft oil seal may be serviced by removing the universal coupling shaft. Leakage into the clutch compartment may be from either the engine or the primary gearbox. Engine seal leakage is covered in the engine section. Gearbox leakage could be caused by failure of the upper mainshaft oil seal, faulty gasket, faulty shifter rail interlock housing, or possibly failure of the pilot bearing sealing. To examine these components, the gearbox must be moved back and lowered to the floor.

TO REMOVE THE GEARBOX

Std. Manual Model :

1. Drain the gearbox oil.
2. Remove the centre floor plate.
3. Remove the main drive coupling shaft and, if fitted, the P.T.O. coupling shaft.
4. Disconnect the clutch link clevis from the clutch cross-shaft and remove the clutch pedal and helper

spring as an assembly. Include the helper spring bracket.

5. Disconnect the isolating switch from the clutch brake linkage and remove the switch from the chassis.

6. Remove the gear shift lever.

7. Suitably support the gearbox, remove the gearbox to flywheel housing bolts, and move the gearbox out and clear of the tractor. Care should be taken not to damage the pipes located inside the chassis members.

F.W.D. Manual Model :

1. Drain the gearbox oil.
2. Remove the seat cushion.
3. Remove the main drive coupling shaft and, if fitted, the P.T.O. coupling shaft.
4. Disconnect the clutch link clevis from the clutch cross-shaft.
5. Disconnect the isolating switch from the clutch brake linkage and remove the switch from inside the chassis.
6. Remove the gear shift lever assembly.
7. Suitably support the gearbox, remove the gearbox to flywheel housing bolts, and move the gearbox out and clear of the tractor. Care should be taken not to damage the pipes located inside the chassis members.

DISMANTLING

To Remove the P.T.O. Gear Train (if fitted) :

The gears can be dismantled without removing the gearbox from the tractor.

Note : On F.W.D. Manual Model, work from beneath the tractor unless the gearbox has been removed.

1. Remove the centre floor plate — Std. model only.
2. Drain the gearbox oil.
3. Remove the coupling shafts.
4. Remove the upper retaining plate from the rear cover, being careful not to damage the shims.
5. Remove the circlip from the protruding end of the P.T.O. drive shaft.
6. Remove the rear cover bolts and lift the cover clear. The P.T.O. driven shaft and gear will come away with the cover.

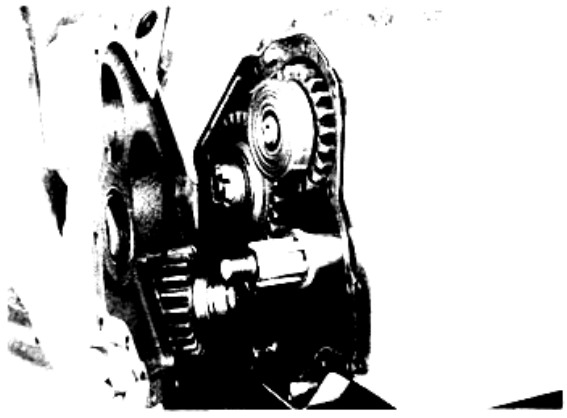


Fig. G3 — Rear Cover Removal

7. The driving gear and bearings may now be removed from the main gearbox housing.
8. To remove the P.T.O. intermediate gear, unpin and remove the slotted nut and slide the gear, bearings and spacer from the shaft.
9. The driven gear may be removed from the rear cover by removing the retainer plate, removing the circlip then exposed, and pressing the shaft and gear through towards the inside of the cover.

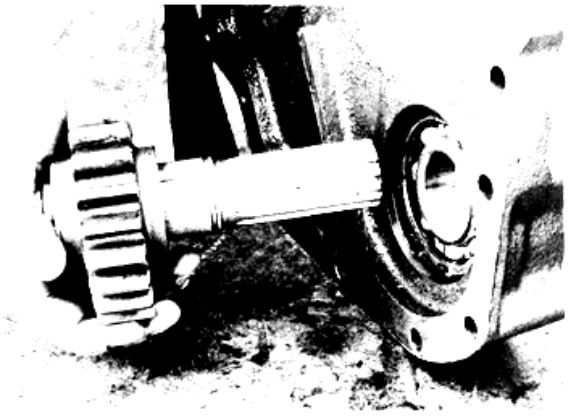


Fig. G4 — Removing P.T.O. Driven Gear (if fitted)

To Remove the Selector Mechanism :

This can be accomplished with the gearbox on the tractor, but it will be necessary to remove the centre footplate (Std. model only) and the side cowl for ease of working.

1. Drain the oil from the gearbox.
2. Remove the gearbox side cover.
3. Remove the gear lever assembly.
4. Remove the shifter rail core plugs at the rear of the gearbox.
5. Remove the detent plunger retaining plugs.
6. Unlock and remove the selector fork locking screws, push the rails out through the rear of the gearbox and remove the forks. Collect the detent plungers and springs.

If the gearbox has already been removed from the tractor, proceed as follows :—

1. Remove the gearbox side cover.
2. Unlock and remove the selector fork locking screws.
3. Remove the detent plunger retaining plugs.
4. Remove the shifter rail interlock housing and the interlock from the forward end of the gearbox housing.
5. Draw the shifter rails out through the front of the housing and collect the detent plungers and springs.

To Remove the Lower Mainshaft :

This procedure is the same if the gearbox is on or off the tractor :—

1. Remove the gearbox rear and side covers.
2. Remove the circlip from behind the shaft rear bearing.
3. Support the sliding gears and withdraw the shaft from the rear of the housing. The bearing, lock-

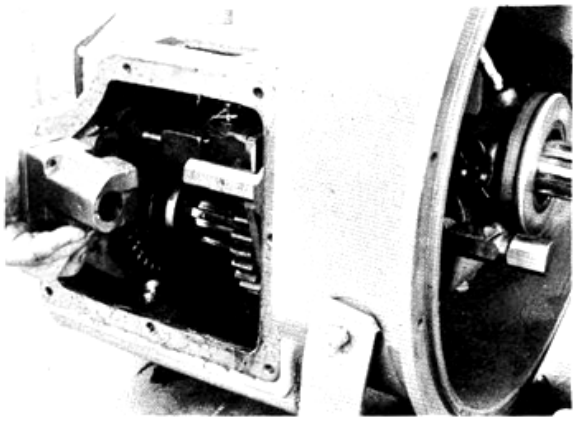


Fig. G5 — Removing Shifter Fork (gearbox removed)

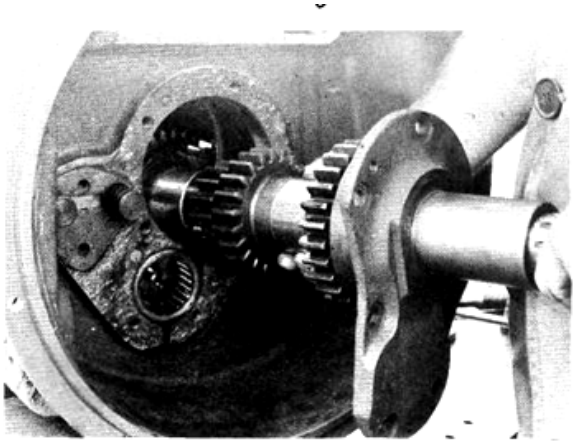


Fig. G7 — Removing the Upper Mainshaft

washer and locknut will be removed, attached to the shaft.

Note : If it is anticipated that the gears will require removal, dismantling will be facilitated if the selector mechanism is first removed.

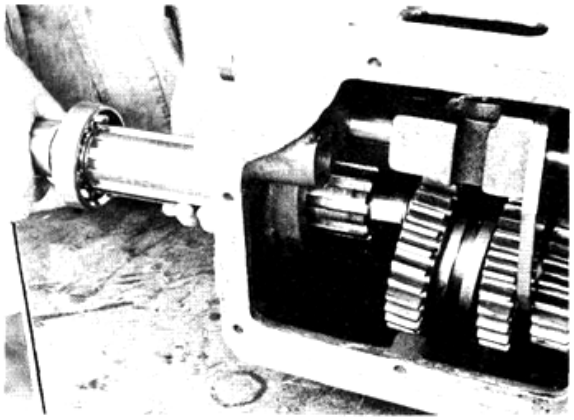


Fig. G6 — Withdrawing Lower Mainshaft (gearbox removed)

To Remove the Upper Mainshaft :

This requires the gearbox to be removed from the tractor and then removal of the rear cover, side cover and lower mainshaft.

1. Remove the spring clips and slide the throw-out bearing and carrier away from the front housing.
2. Disconnect the clutch brake linkage from the end of the clutch cross-shaft.
3. Unlock and remove the two setscrews from the throw-out fork, slide the cross-shaft out of the housing and collect the fork.
4. Remove the front bearing housing bolts and, using two jacking screws in the two tapped holes provided in the flange of the housing, withdraw the shaft, complete with bearings and front housing.

To Remove the Reverse Idler Gear :

Remove the gearbox from the tractor. Remove the gearbox cover, selector mechanism, lower mainshaft and gears, and the upper mainshaft. The clutch brake assembly and the idler shaft setscrew protruding through the nearside of the housing also require removal. The shaft, together with the intermediate P.T.O. gear (if fitted), may now be withdrawn through the rear of the housing. The reverse idler gear with two side spacers, two bearings and bearing spacer may now be removed through the side opening. Note the position of the thrust washers for re-assembly.

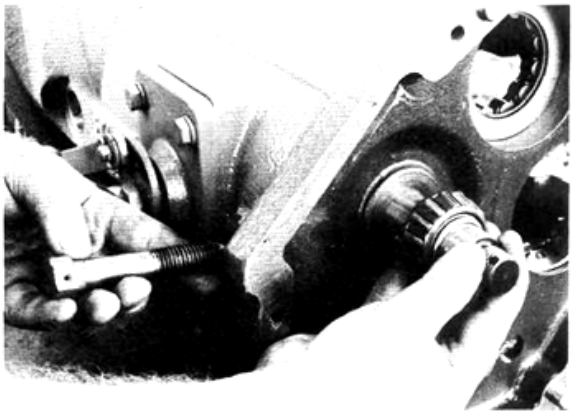


Fig. G8 — Reverse Idler Shaft Removal

To Dismantle the Gear Lever Assembly :
Std. Manual Model :

1. Free the rubber boot and remove it from the top of the selector housing.
2. Remove the spring retaining circlip from the lower end of the gear lever and lift the lever from the top of the selector housing. Collect two lever guide pins.

F.W.D. Manual Model :

1. Remove the locknut and washer from the top of the remote gear lever and free the lever from the link.
2. Free the rubber boot and remove it from the top of the selector housing.
3. Remove the spring retaining circlip from the lower end of the gear lever and lift the lever from the top of the selector housing. Collect two lever guide pins.

4. Remove the locknut and washer from the bottom of the gear shift lever and free the lever from the link.

5. Free the rubber boot and remove it from the top of the selector housing.

6. Remove the spring retaining circlip from the lower end of the gear lever and lift the lever from the top of the selector housing. Collect two lever guide pins.

To Reassemble the Gear Lever Assembly :

Reassembly is a reversal of the dismantling procedure with the following points being observed when working on the F.W.D. Manual Model lever :—

1. Ensure that the shortest section of the link is between the pivot pin and the remote gear lever.

2. When correctly positioned, the slot in the link is parallel to the centre line of the tractor and the pivot pin is in the centre of the slot when the gear lever selects neutral position in the gearbox.

INSPECTION

Thoroughly clean all components and examine shafts, gears and bearings for wear. Examine the oil seals and replace them if any doubt exists as to their serviceability.

Note any wear on the reverse idler spacer washers. Excess end float on this gear could result in noisy operation as it is in constant mesh with the upper mainshaft. Correct end float for this gear is .005" - .025" and excess clearance may be reduced by replacing either or both standard thrust washers P/N 20143 with .020" oversize thrust washers P/N 23294, or .060" oversize thrust washers P/N 42776.

If there are indications that the sliding gears have been inclined to work themselves out of mesh, use a dial gauge as illustrated to check the shaft and gear clearance. Replace the gear if the indicated clearance is .003" or more, and ensure that the replacement gear clearance on the worn shaft does not exceed .002". Gears and shafts are manufactured with .001" to .002" spline clearance but, if the clearance reaches .003", the gear can tilt under load, screw itself along the shaft and dis-engage.

Inspect the upper mainshaft gears for damage. Replace any that are severely damaged. Slight burrs on any of the gearbox gears can be removed by stoning and the operator should be instructed to correct gear changing technique.

Inspect the detent plungers for worn ends, and the springs for loss of tension (compare the original springs with each other or a new one).

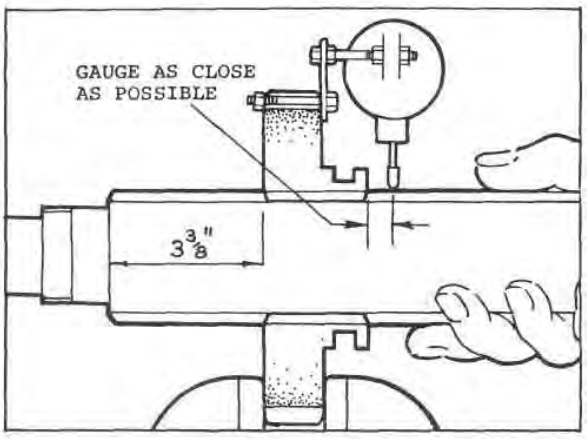


Fig. G9 —Checking Gear and Shaft Clearance

RE-ASSEMBLY

Re-assembly is a reversal of the dismantling procedure with the following points noted :—

1. Use new gaskets throughout.

2. Protect all oil seals from damage during installation.

3. Lightly lubricate all bearings immediately prior to installation.

4. Ensure that the smaller (or 28 tooth) gear is at the rear of the gearbox when the reverse idler is assembled. Adjust the end float to .005" - .025" using the thrust washers listed.

5. Fit the upper mainshaft oil thrower with the flange away from the bearing rollers.

6. Check that the front bearing is fully home in its housing before installing the upper mainshaft. Check that the reverse idler front gear teeth are correctly aligned with the upper mainshaft gear. It may be necessary to interchange the thrust washers to obtain this alignment.

7. Place the bearing spacer against the mainshaft rear bearing and ensure that the driving gear inner ball bearing shield is toward the rear of the gearbox prior to installing the P.T.O., driving gear assembly.

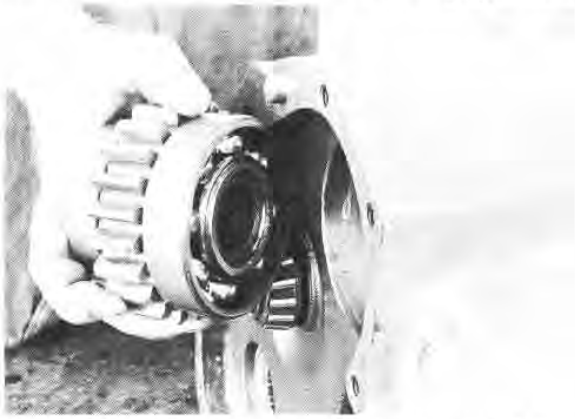


Fig. G10 — P.T.O. Driving Gear Inner Bearing Assembly (if fitted)

8. Adjust the P.T.O. intermediate gear taper roller bearings (if fitted), using spacers of various thickness as listed, to give no end float or pre-load with the bearings lightly lubricated with engine oil.

9. After the mainshafts, front bearing housing and rear cover are assembled, tap the rear P.T.O., driving gear bearing forward to remove any clearance and offer up the rear bearing retainer without shims. On tractors without a P.T.O. gear train, a spacer is used between the bearing retainer and the rear bearing on the upper mainshaft. Measure the clearance between the rear cover and the flange of the retainer, remove the retainer, then re-fit it with a shim pack .025" - .035" greater than the measured clearance to obtain the specified mainshaft end float.

Fig. G11 — Measuring Mainshaft Retainer Clearance

Note : Refer to paragraph 3 — under "Installation".

10. Check gear selection.

(a) If all gears are hard to change, a newly fitted interlock could be slightly too long.

(b) If 1st and 2nd gears only are hard to change, new forks could be rubbing together and require re-working to provide the necessary clearance.

11. Check that the 1st sliding gear over-runs the 1st gear on the upper mainshaft by at least 1/32". It may be necessary to remove metal from the fork boss to provide correct engagement.

12. Check that the 3rd sliding gear over-runs the 3rd gear on the upper mainshaft by at least 1/32", and that the teeth on the upper mainshaft gear do not contact the fork blade. Modify the fork as necessary to provide the fork blade clearance and correct gear run-through.

13. Tension the gearbox side and rear cover bolts to 27 lbs./ft.

GEARBOX INSTALLATION

Installation is a reversal of the instructions "To Remove the Gearbox" with the following points noted :—

1. Ensure that the P.T.O. spline shaft (if fitted) and the upper mainshaft are correctly aligned with the clutch drive plate and the pilot bearing retainer before forcing the gearbox into position. Two studs, fitted into the flywheel housing tapped holes, will facilitate gearbox alignment for installation.

2. Tighten the gearbox to flywheel housing bolts to 31 lbs./ft.

3. With the gearbox correctly positioned, remove the rear retainer shims and re-check the mainshaft end float. If the clearance has decreased, ensure that the upper mainshaft is pushed fully forward and re-adjust the retainer shims to obtain the correct end float.

4. Tighten the rear retainer bolts to 15 lbs/ft.

TROUBLE SHOOTING

Trouble	Probable Cause	Remedy
EXCESSIVE NOISE	Low oil level.	Replenish oil.
	Rough gear changing.	Repair damage and instruct in correct gear changing technique.
	1st and/or reverse only — reverse idler incorrectly assembled.	Check and adjust the end float as described in "Inspection", Page G - 6.
	Upper mainshaft end float excessive.	Check and adjust the end float as described in "Inspection", Page G - 6.
	2nd/3rd fork rubbing against 3rd gear on the upper mainshaft.	Check sliding gear run-through, and detent groove position on shifter rail. Modify the fork if detent and run-through correct.
OVER HEATING	Low oil level.	Replenish oil.
	Insufficient upper mainshaft end float.	Check and adjust end float as described in "Inspection, Page G - 6.

TROUBLE SHOOTING (Continued)

Trouble	Probable Cause	Remedy
HARD TO CHANGE GEARS	All gears — interlock too long.	Shorten interlock.
	Gear lever end insufficiently rounded.	Modify gear lever.
	1st and 2nd only — forks rubbing.	Modify forks.
	1st and/or reverse only — reverse idler incorrectly assembled.	Remove and correctly assemble.
GEAR JUMP OUT	Damaged gears.	Replace gears.
	Worn detent or weak spring.	Replace affected parts.
	Excessive clearance between sliding gear and shaft.	Replace affected gear or shaft.
	Fork contacting housing, before detent engaged.	Modify fork.
	Misaligned fork.	Replace fork.

PRIMARY GEARBOX (T.C.)

Std. T.C. and F.W.D. T.C. Models only.

DESCRIPTION

The above models incorporate the AS2 72N Velvet Drive which is a hydraulically operated forward and reversing unit.

With the use of the torque converter coupling between the engine and forward and reversing unit, it is possible to power shift the unit from forward to reverse or reverse to forward while the engine is in operation, and the tractor stationary.

The forward and reversing unit consists of a planetary gear set, a multiple disc forward clutch, and a multiple disc reverse clutch (which are connected coaxially and mounted in a cast iron housing), along with an oil pump and control valving to provide forward, neutral and reverse operation.

. Hydraulic pressure is supplied by the crescent type pump, the drive gear of which is connected to the converter and operates at engine R.P.M., to provide oil pressure directly to the rotary control valve and pressure regulator. Oil pressure is directed to the converter, as well as lubrication to the journals and bushings, from the rotary control valve through internal passages during engine operation. Converter charging pressure is maintained by means of a converter regulator valve. Also, a safety check and charging valve is provided to ensure correct charging of the converter.

Oil discharged from the mainline regulator and converter regulator valves is directed to the cooler through external piping, and cooled oil is returned to the housing sump.

Shifting is accomplished by movement of the forward and reverse control lever, which in turn rotates the control valve and directs oil pressure through internal passages to the forward and reverse clutches.

LUBRICATION

Several characteristics of the lubricant used are extremely important since it also serves as the working medium in the hydraulic system. Therefore, Automatic Transmission Fluid, Type "A", or Dexron is recommended. Use clean, fresh oil to fill. The oil level should be checked every 10 hours and maintained between the "L" and "F" indications on the filler cap bayonet gauge. The engine should be operated a sufficient time to ensure full charging of the converter

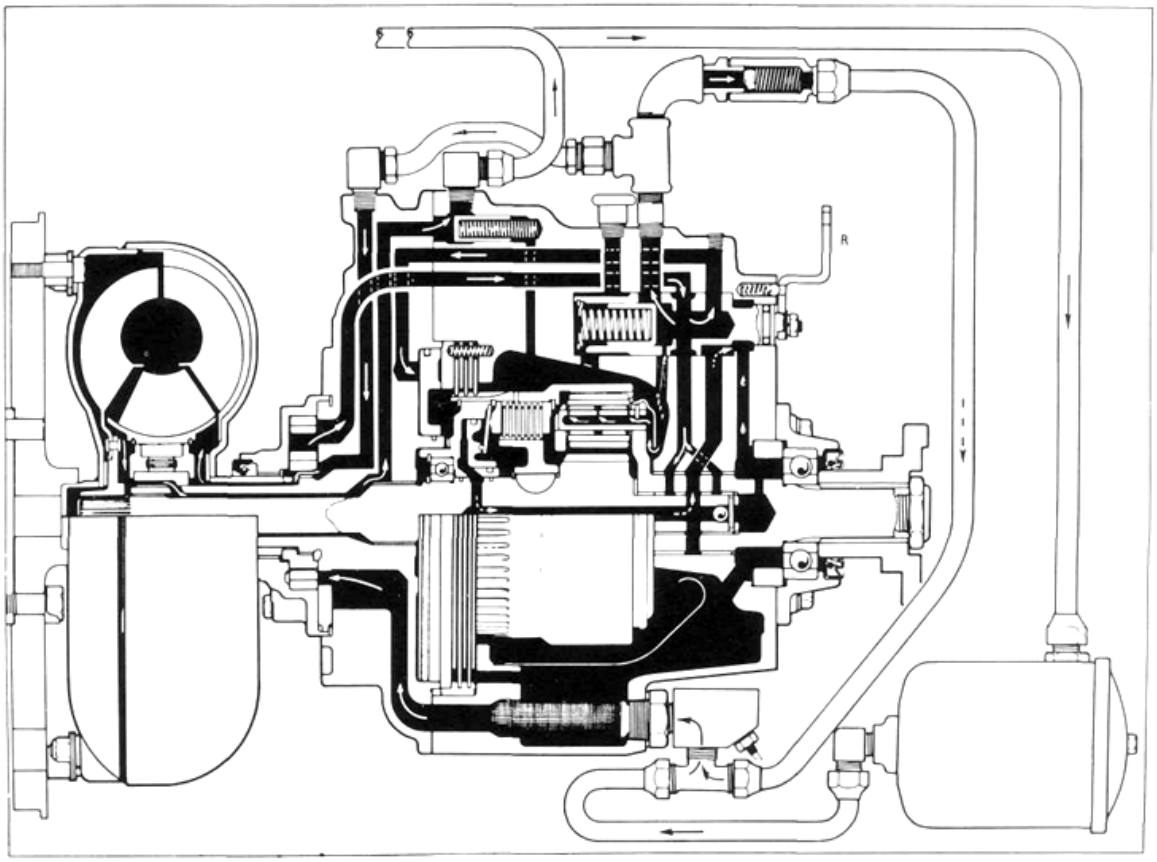


Fig. G12 — Torque Converter and Velvet Drive

and cooler, and the selector should be moved to forward, reverse, and neutral before checking the oil level with the unit in forward.

Fig. G13 — Checking Oil Level

OPERATION

When the forward and reverse unit is properly filled with oil and the engine is operating, the following conditions exist in all gear ranges :—

1. The oil pump operating at engine R.P.M. supplies oil to the main line circuits where pressure is controlled at 120 to 140 p.s.i.
2. Controlled mainline pressure is passed by the regulator valve through internal passages to the converter and also to bushings for lubrication.
3. Charging pressure of 50 to 60 p.s.i. is ensured by a safety check and charging pressure control valve.
4. Converter charge pressure of 15 to 25 p.s.i. is controlled by the converter regulator valve.
5. Oil flows from the converter regulator valve through external piping to the cooler.
6. All excess oil at the charging pressure and safety check valve is passed by the spring loaded ball in the valve through external piping to the cooler.

Forward :

Move the forward and reverse transmission shift lever to the extreme forward position where the spring-loaded ball enters the chamfered hole in the side of the lever and properly locates it in the 'forward" position. With the shift lever so located, oil at regulated pressure flows from the rotary control valve through porting in the case, output shaft, and drive gear into the forward clutch cylinder, actuating the forward clutch piston. The resulting movement of the forward clutch piston and the lever action of the clutch spring forces the forward clutch discs together.

As the inner discs of the forward clutch are secured to the forward clutch hub by their internal teeth and the outer discs are secured to the ring gear, the application of the forward clutch piston locks the input shaft to the ring gear. This in turn prevents rotation of the planetary pinions about their own axis and thus locks the input shaft, ring gear, and output shaft together, causing them to rotate as a solid concentric coupling. In this way the input shaft speed and direction of rotation is transmitted directly to the forward and reverse unit output shaft.

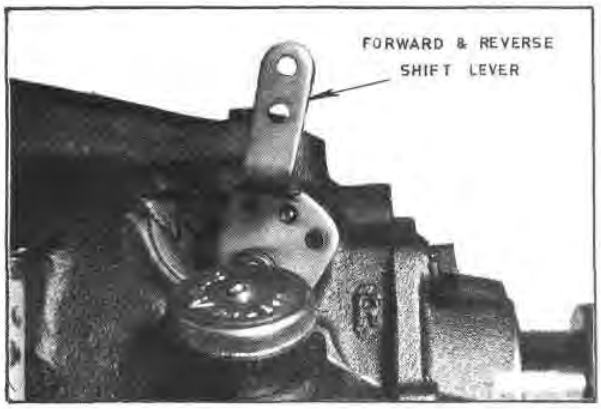


Fig. G14 — The Forward and Reverse Shift Lever

Reverse :

Move the forward and reverse transmission shift lever to the extreme rearward position where the spring-loaded ball enters the chamfered hole in the side of the shift lever and properly locates it in the "reverse" position. With the shift lever so located, oil at regulated pressure flows from the control valve into porting in the transmission case, thence to the front adaptor and into the reverse clutch cavity. The resulting movement of the reverse clutch piston and reverse clutch pressure plate locks the reverse clutch disc to the transmission case. The stationary reverse clutch plates and the inner clutch discs, through their splined connectors, prevent rotation of the ring gear. With the ring gear held and the sun gear on the input shaft operating at input speed, the pinions of the compound planetary gear set are free to rotate about their own axis and reverse the direction of rotation of the pinion carrier and output shaft.

Neutral :

Move the forward and reverse transmission shift lever to the centre position where the spring-loaded ball enters the chamfered hole in the side of the shift lever and properly locates it in neutral position. With the lever so located, flow of pressurized oil to the clutches is blocked at the rotary control valve. The clutches are also vented by the rotary control valve into the sump of the case. Thus, free running open clutches and complete interruption of power through the transmission is ensured.

DISASSEMBLY AND INSPECTION

To Remove the Forward and Reversing Unit :

Std. T.C. Model : Carry out instructions 1 to 8 under "Torque Converter Removal", Page F-9, Section F.

F.W.D. T.C. Model : Carry out instructions 1 to 8 under "Torque Converter Removal", Page F-9, Section F.

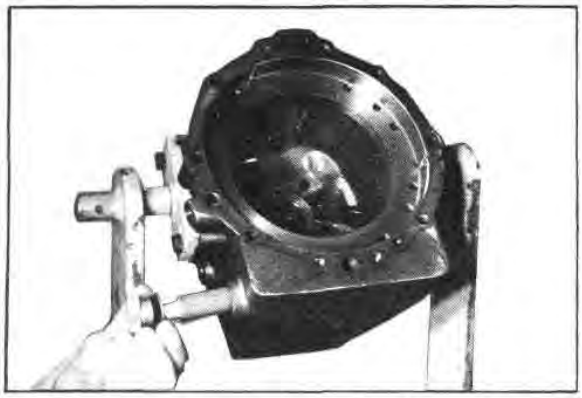


Fig. G15 — The Strainer Assembly

To Remove the Strainer Assembly :

1. Remove the oil lines from the adaptor block and remove the adaptor block and bush. Reach into the opening with a suitable tool and remove the strainer assembly (Figure G15). Check the strainer assembly for sediment and foreign material and clean it in solvent before re-assembling.

2. Stand the unit, rear face down, on a suitable tool with clearance for the output shaft.

To Remove the Pump Assembly :

3. Remove the bolts that attach the pump assembly to the front adaptor. Lift the pump assembly over the input shaft (Figure G16) and remove the pump gasket from the adaptor face.

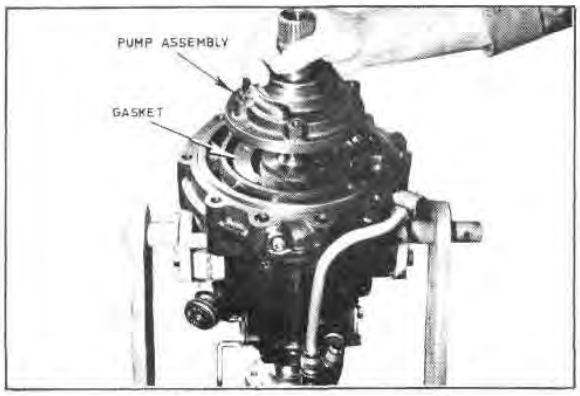


Fig. G16 — Removing the Pump Assembly

To Dis-assemble and Inspect the Pump Assembly :

4. Place the pump assembly on a bench or suitable work surface with the converter support down and remove the flat head screw (Figure G17).

5. Lower the housing and pump gears straight down over the stator support to avoid damaging the pump drive gear bushing. The pump gears can then be removed from the housing.

Note : It is good practice to mark the pump gears before dismantling to ensure proper mating during re-assembly.

6. Check the pump gears for nicks on teeth, excessive wear on faces, and drive gear bushing wear.

Fig. G17 — Removing the Pump Retainer Screw

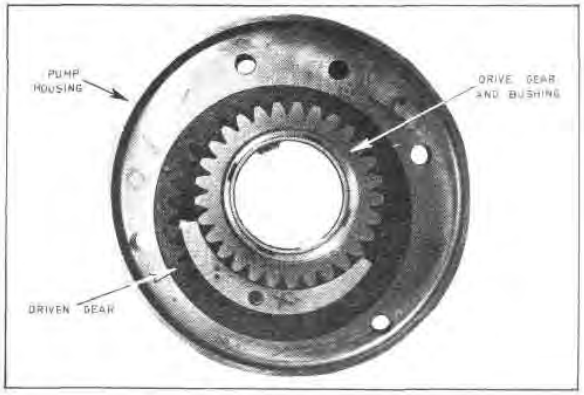


Fig. G18 — The Oil Pump Gears

Check the stator support for excessive wear or mutilation on the front face and the two (2) journals on the stem diameter. Check the housing for excessive wear in gear pockets, damaged or worn seal, and worn housing bushing.

Note : If the seal is damaged or worn, it can be replaced as a separate service item. Also, the converter support can be replaced as a separate service item. If the housing or gears are damaged, the complete pump assembly should be replaced as gears and housing are in matched sets.

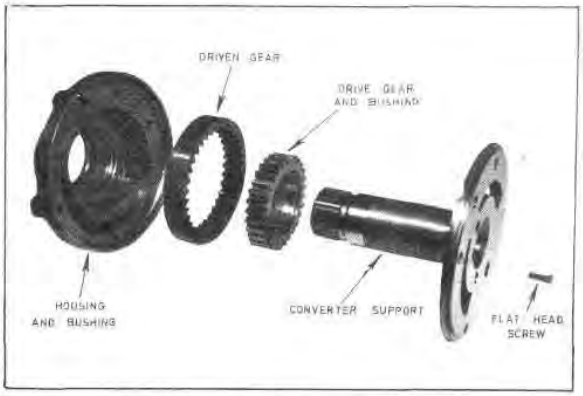


Fig. G19 — The Oil Pump Components

Disassembly and Inspection of the Forward and Reverse Adaptor (Front):

7. Remove the special cap screws which secure the front adaptor to the forward and reverse transmission housing (Figure G20). Lift the adaptor and reverse piston assembly over the drive gear. If necessary, tap the adaptor with a soft hammer to remove.

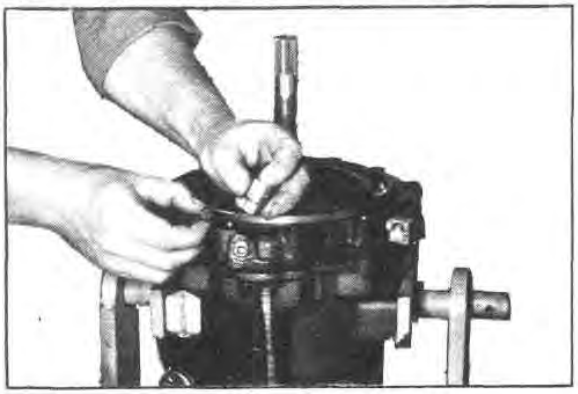


Fig. G20 — The Front Adaptor Capscrews

Caution: The reverse clutch pressure plate may stick momentarily to the reverse clutch piston. To avoid damage, prevent the pressure plate from dropping.

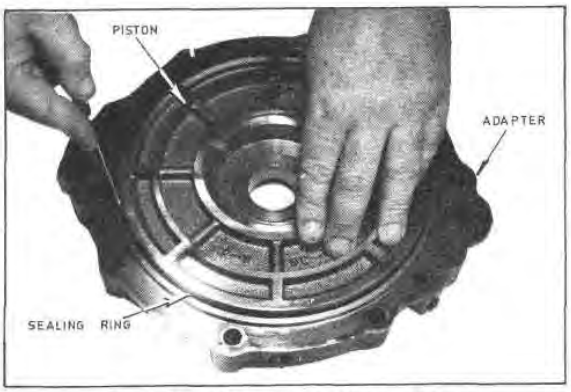


Fig. G21 — The Reverse Clutch Piston

8. Force compressed air into the reverse clutch apply hole to remove the reverse clutch piston (Figure G21). Remove sealing rings from the inner hub of the adaptor and from the reverse clutch piston (Figgures G22 and G23). Inspect the sealing rings for wear, mutilation, or brittleness, and replace if damaged. Inspect the reverse clutch piston for wear, scoring, or burrs on the inside and outside diameters. Inspect the adaptor for wear, scoring, and burrs at the clutch cavity outer wall and on the diameter of the internal hub. Examine the adaptor bushing for wear (Fig. G22). Examine the internal oil passages of the adaptor for burrs or foreign material.

Disassembly and Inspection of the Reverse Clutch Pressure Plate, Pressure Plate Springs, Dowel Pins, and Clutch Plates:

9. Remove the clutch pressure plate as shown in Figure G24. Check the pressure plate for wear, scoring, or burrs on the rear face. This surface should be smooth.

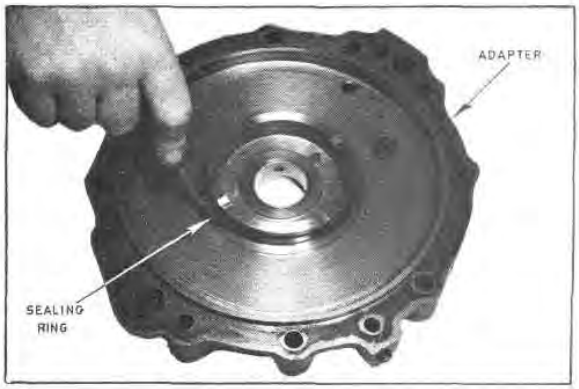


Fig. G22 — The Adaptor Inner Hub Seal Ring

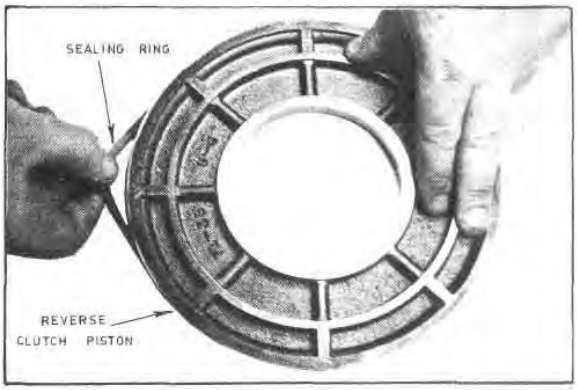


Fig. G23 — The Reverse Clutch Piston Seal Ring

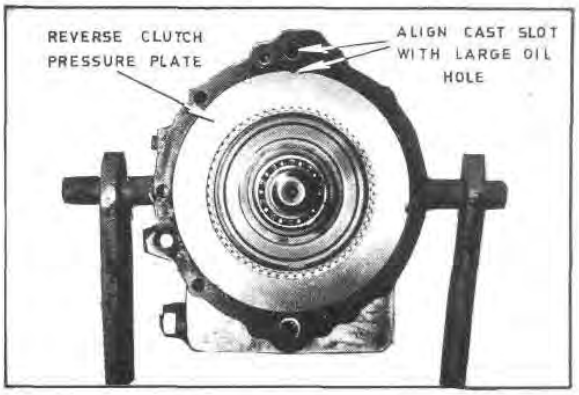


Fig. G24 — The Reverse Clutch Pressure Plate

10. Remove the twelve (12) pressure plate springs and three (3) dowel pins. Check the springs for being bent or mutilated.

11. Remove the three (3) inner clutch plates and two (2) outer clutch plates from the ring gear and housing clutch cavity (Figure G25). Inspect the clutch plates for wear on faces and inner teeth; also, check for warpage (.020" max.).

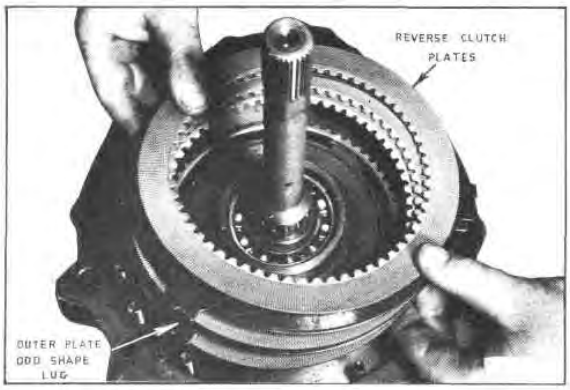


Fig. G25 — The Reverse Clutch Plates

Removing Converter Check Valve and Spring, Drive Gear, and Forward Clutch Assembly :

12. Before removing the converter regulator valve and spring from the forward and reverse housing (Figure G26), compress the valve and spring to ensure the valve has been operating freely, then lift the valve and spring from the housing.

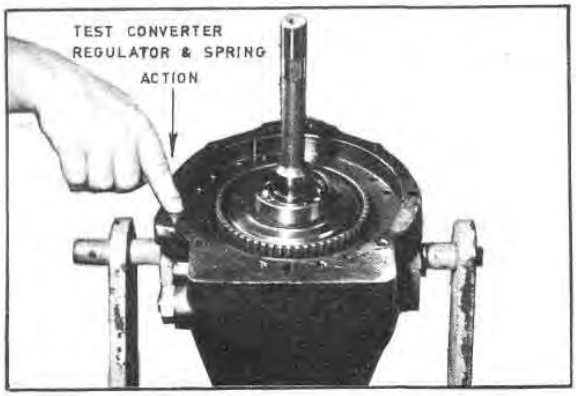


Fig. G26 — Compress the Converter Regulator Valve and Spring Action Prior to Removal

13. Remove the thrust washer from the thrust face of the clutch cylinder (Figure G27). Check the washer for wear, and replace if worn.

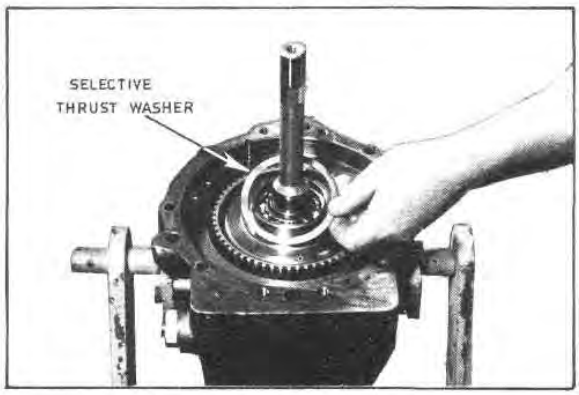


Fig. G27 — The Clutch Cylinder Thrust Washer

14. Lift the drive gear and clutch assembly from the housing (Figure G28).

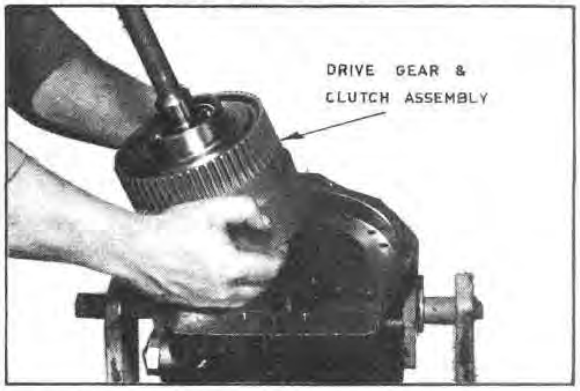


Fig. G28 — The Drive Gear and Clutch Assembly

15. Stand the drive gear and clutch assembly in a suitable fixture and remove the snap ring from the drive gear (Figure G30), and the snap ring from the

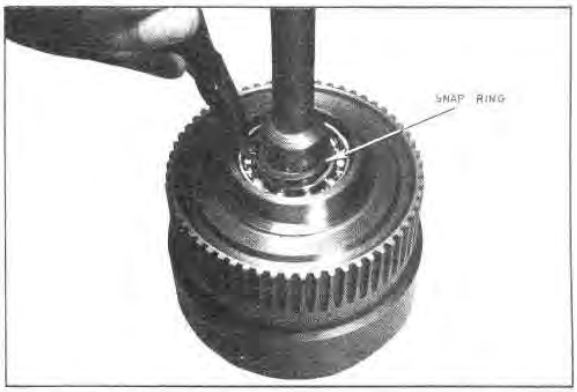


Fig. G29 — The Drive Gear Bearing Snap Ring

bearing cavity of the clutch cylinder (Figure G30). Do not lift the clutch assembly by the drive gear or permit the drive gear to move forward after the above snap rings are removed.

16. While holding the ring gear, tap the front end of the drive gear with a soft hammer. The drive

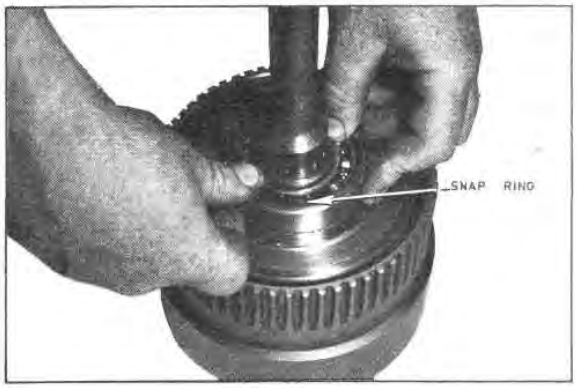


Fig. G30 — Clutch Cylinder Snap Ring

gear and forward clutch hub will pass through the ring gear and forward clutch assembly to come out of the rear end of the ring gear (Figure G31).

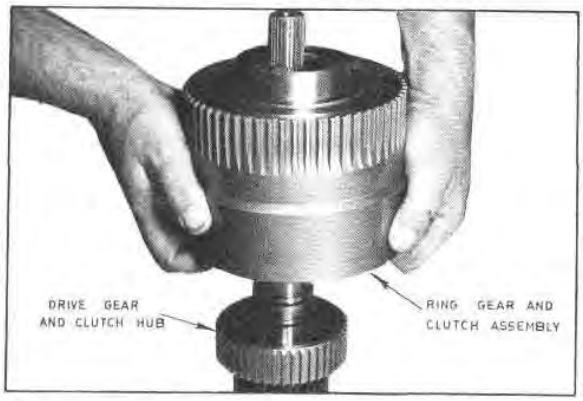


Fig. G31 — Removing the Ring Gear and Clutch Assembly

17. Remove the two (2) forward clutch sealing rings on the drive gear (Figure G32), and examine them for wear. Check the journals, thrust face, and teeth of the drive gear for wear.

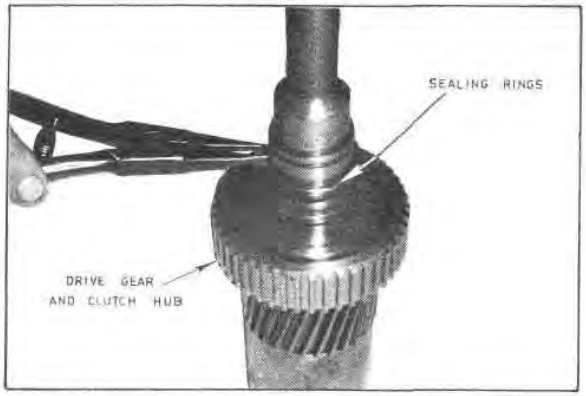


Fig. G32 — Removing the Forward Clutch Sealing Rings

18. If it is necessary to replace the drive gear or clutch hub, remove the clutch hub by removing the snap ring retaining the clutch hub on the drive gear (Figure G33); place the drive gear and clutch hub on an arbor press with the front end of the drive gear up, and press the drive gear through the clutch hub.

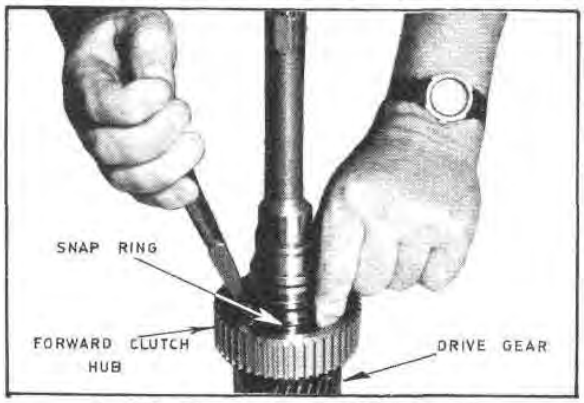


Fig. G33 — Removing the Clutch Hub Snap Ring

19. Remove the annular bearing in the clutch cylinder by tapping with a soft, blunt tool. Check the bearing for free roll, and replace if damaged.

20. Remove the ring gear snap ring (Figure G34).

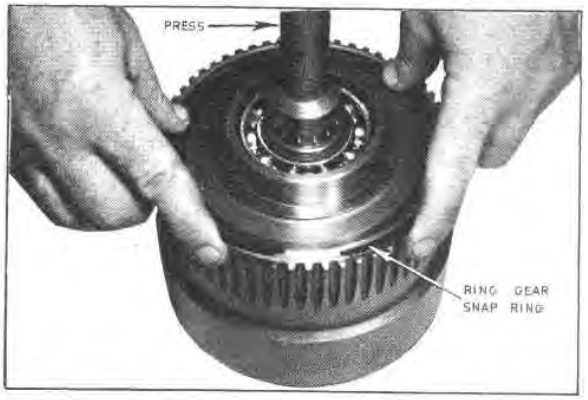


Fig. G34 — Removing the Ring Gear Snap Ring

21. Place the ring gear and clutch assembly, front face down, on a suitable ring or fixture which will clear the outside diameter of the forward clutch cylinder. Using a 2¼" diameter bar against the exposed inside hub of the clutch cylinder, press the clutch cylinder out of the ring gear. The remaining parts of the forward clutch can be removed in the order shown in Figure G36.

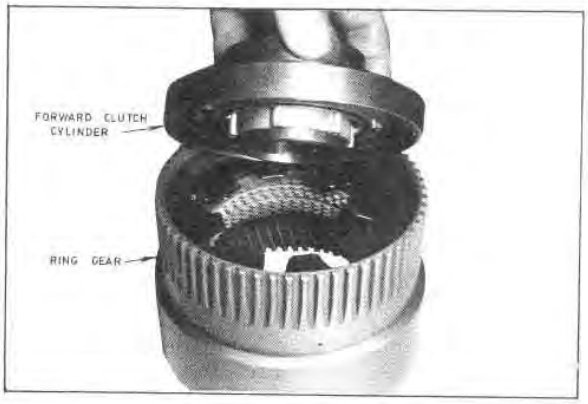


Fig. G35 — Clutch Cylinder Removed

22. Check the seven (7) inner clutch plates and six (6) outer clutch plates for wear, mutilation, and warpage. Any detectable buckle or wave renders the plate unserviceable.

23. Check for proper bevel on the piston return spring.

24. The piston can be removed from the forward clutch cylinder to the position shown in Figure G37, by applying compressed air to the clutch cavity through the three (3) holes in the inside diameter of the forward clutch cylinder. Check the inside diameters of the clutch cylinder for wear, scoring, or mutilation.

25. Remove the clutch sealing rings from the clutch cylinder and clutch piston (Figures G38 and G39).

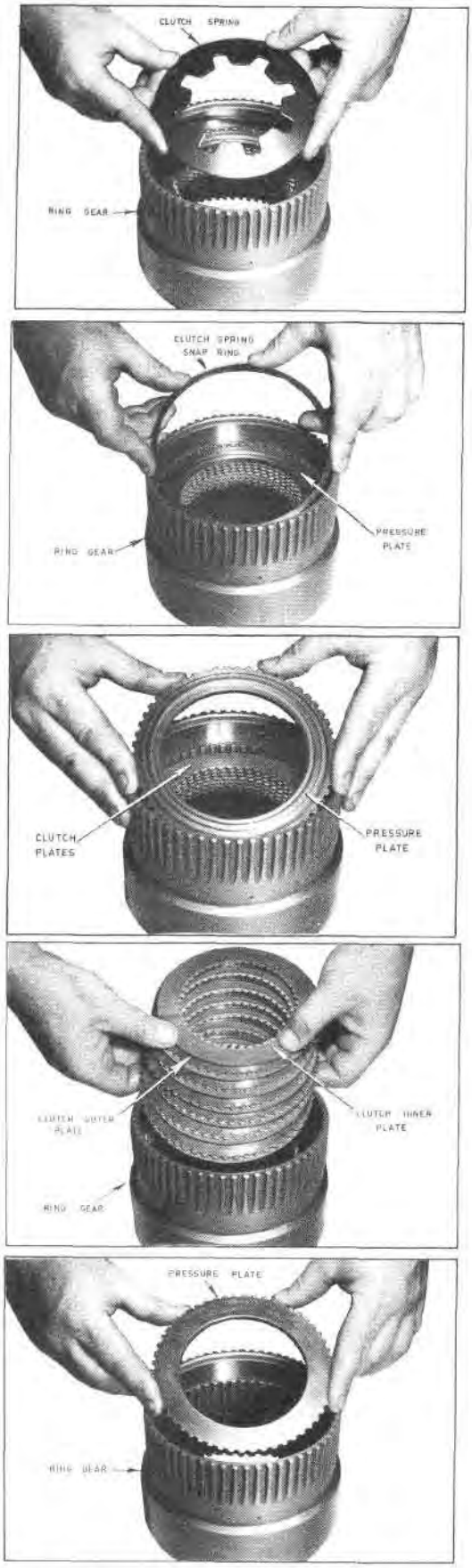


Fig. G36 — Forward Clutch Component Removal Sequence

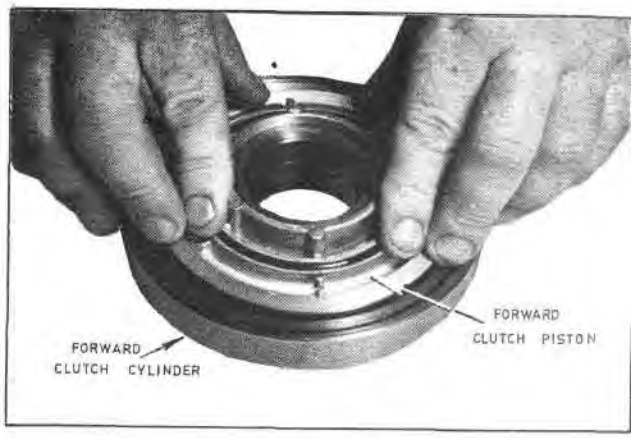


Fig. G37 — The Forward Clutch Piston

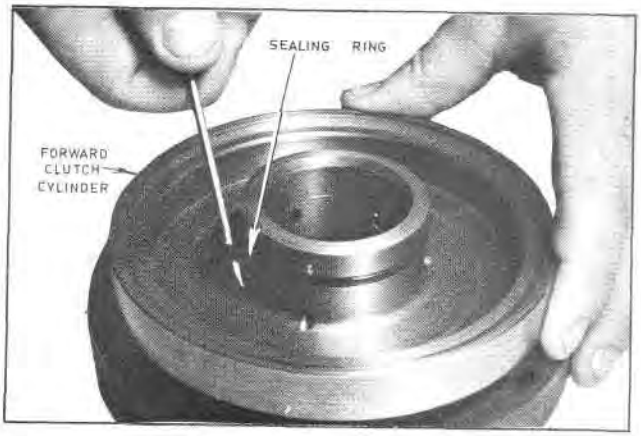


Fig. G38 — Forward Clutch Cylinder Seal Ring

Check sealing rings for wear, mutilation, and brittleness. Examine the inside and outside diameters of the forward clutch piston for burrs, wear or scoring.

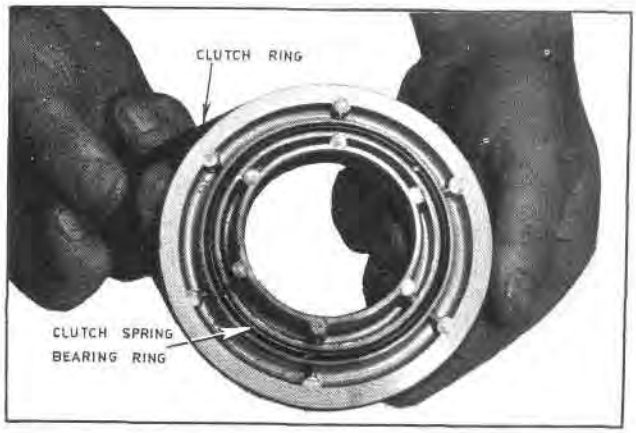


Fig. G39 — Clutch Piston Seal Ring

Removing the Pinion Cage and Output Shaft Assembly from the Case :

26. Place the forward and reverse transmission case in a vertical position with the front face down. Tap lightly with a soft hammer on the rear end of the output shaft and pinion cage and output shaft assembly. Protect the pinion cage and output shaft assembly from damage from fall during this operation.

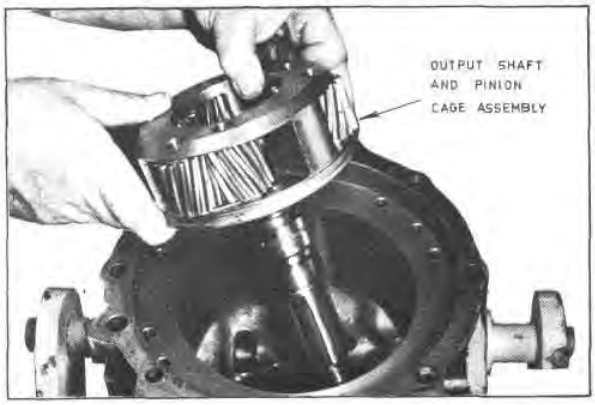


Fig. G40 — Removing the Pinion Cage and Output Shaft Assembly

27. Inspect the journals, drive pilot bushings, and planetary gears of the output shaft assembly for wear. If the bushings are worn, pre-sized service bushings are available for replacement.

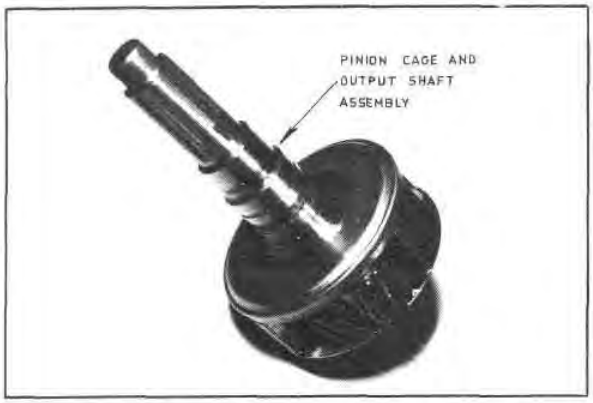


Fig. G41 — Pinion Cage and Output Shaft Assembly

Caution : If installing service pilot bushings in the output shaft, use a suitable puller which will not damage the output shaft. Press the service bushings into the output shaft with the oil holes of the bushings in alignment with the oil holes of the output shaft and in the order shown in the transmission assembly, with the small internal oil groove of the front bushing toward the front of the output shaft.

Removing the Rotary Control Valve and Spring Assembly *from the Transmission Housing* :

28. Remove the three (3) hex head bolts, lock washers, valve cover, and valve cover gasket, as shown in Figure G42.

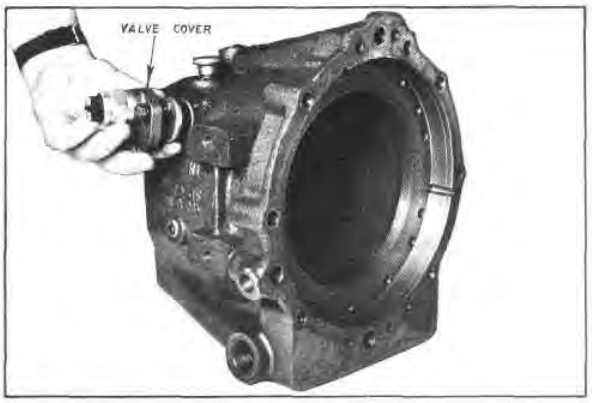


Fig. G42 — Valve Cover Removal

29. Remove the shift lever and associated parts (Figure G43).

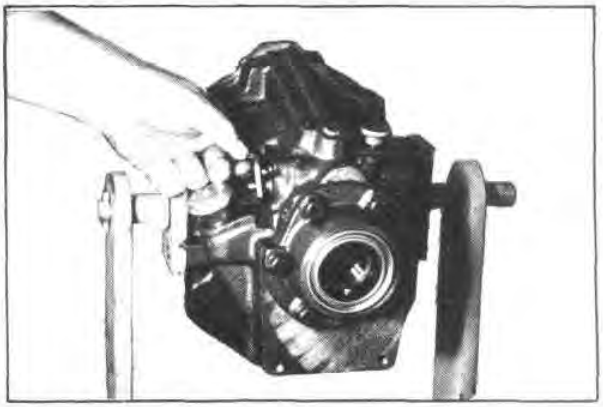


Fig. G43 — Shift Lever Removal

30. Tap with a soft hammer on the exposed thread end of the valve upon which the lever was mounted. Pull the valve and spring assembly out of the case from the right side.

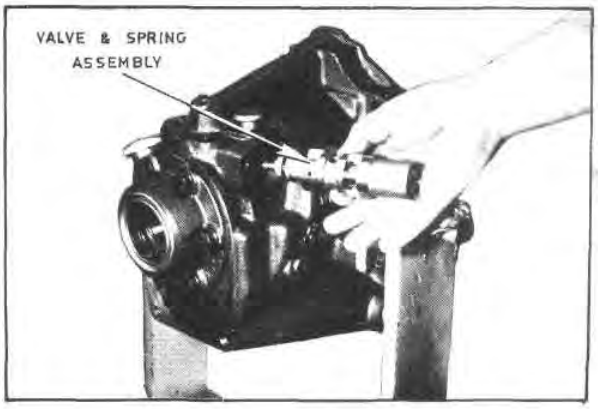


Fig. G44 — Valve and Spring Assembly

Disassembling the Valve and Spring Assembly :

31. Place the valve and spring assembly in a suitable holder so constructed to hold the assembly in a vertical position (Figure G45). Place the assembly and holder on an arbor press and, using a suitable tool, depress

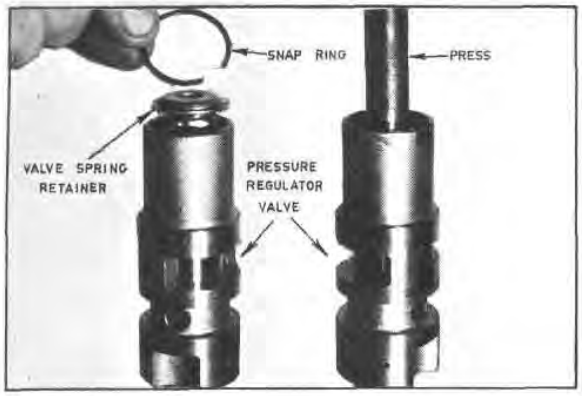


Fig. G45 — Valve Spring Depressed and Snap Ring Removed

the valve spring retainer and valve spring. The valve spring retainer snap ring can then be removed (Figure G45). Components of the valve and spring assembly can be removed in the order shown in Figure G46. Inspect the valves for burrs or nicks. Check to see that the regulator valve slides freely in the rotary control valve.

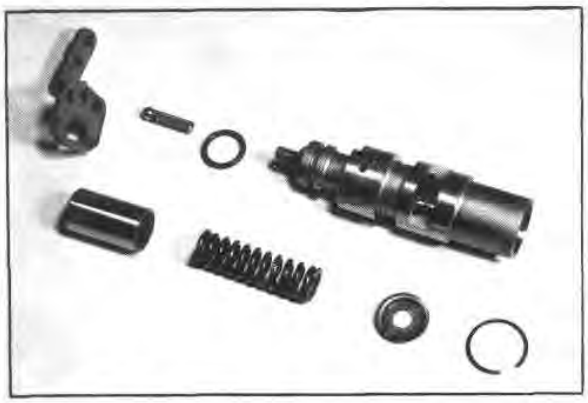


Fig. G46 — Valve and Spring Assembly Components

Removing the Oil Baffle from the Housing :

32. The oil baffle in the housing can be removed by depressing the front of the baffle towards the bottom of the housing, forcing the locating holes of the baffle off the spherical bosses of the housing. The baffle can then be removed through the front opening of the housing (Figure G47).

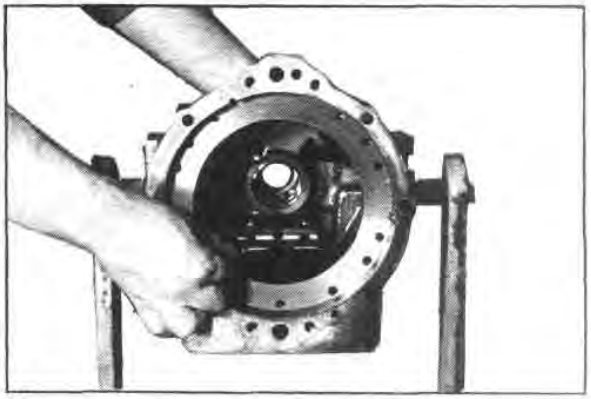


Fig. G47 — Oil Baffle Removal

ASSEMBLY

General Instructions :

Clean all parts thoroughly.

Replace all damaged or worn parts. Follow the inspection suggestions made through the disassembly procedure.

Always install new gaskets. If the transmission has had "Field Service", new clutch rings, sealing rings, and oil seals should be used.

Use a lint-free cloth such as rayon or nylon for wiping transmission parts. Lint or other foreign material can cause erratic operation of the pressure regulations in the forward and reverse transmission.

Use a low melting point petroleum jelly on gaskets for easier assembling.

When assembling the forward and reverse transmission, lubricate internal parts with Automatic Transmission Fluid Type "A", or Dexron.

When assembling oil seals or bearings, always use a suitable tool which will cover the face of the bearing or seal.

Replace all snap rings and lock washers which have been distorted.

Tighten all bolts and plugs to the recommended torque.

Installation of the Oil Baffle in the Transmission Case :

1. Place the oil baffle inside the transmission case with the curved portion below the cast spherical bosses in the case as shown in Figure G47.

2. Snap the baffle into position by lifting it up on the curved portion so that the two large holes are located firmly on the spherical bosses at the rear end of the case. (Figure G48).

Assembly of the Main Line Regulator Valve and Spring :

3. Collect the valve and spring assembly components, as shown in Figure G46. These components assemble in the order as shown. The valve spring assembles into the hollow portion of the pressure regulator valve and the pressure regulator valve assembles into the bore of the rotary control valve, with the spring toward the open end of the valve. The

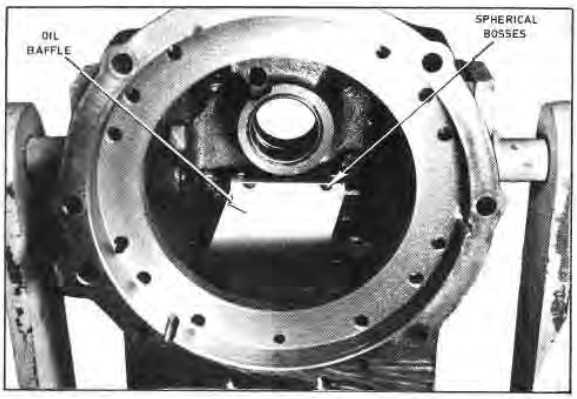


Fig. G48 — Oil Baffle in Position

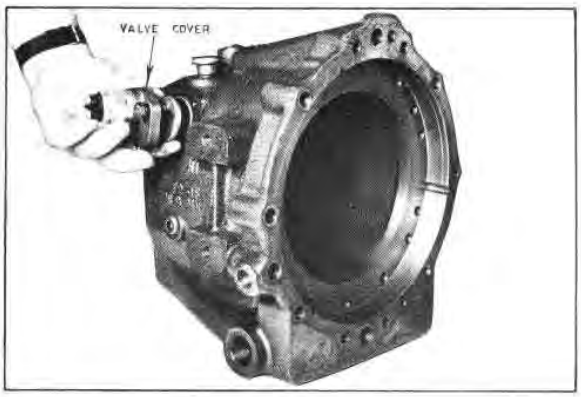


Fig. G50 — Assembly of Valve Cover

concave side of the valve spring retainer faces the valve spring.

4. Place the assembled parts described in step 3 in a suitable holding tool.

5. Using an arbor press and a suitable tool against the valve spring retainer, compress the valve spring until the internal snap ring groove in the rotary control valve is uncovered. Install the snap ring. After removing the completed assembly from the assembly tool, install the 'O' ring in the groove provided at the threaded end of the valve.

Installation of the Valve Assembly in the Case :

6. Place the forward and reverse transmission case and associated parts assembled in steps (1) to (5) on a flat work surface, bottom side down. Install the rotary control valve and regulator assembly threaded end first, into the bore provided at the right rear side of the transmission case (Figure G49). To ensure proper installation and neutral positioning of the valve, align the .369" - .376" wide slot in the spring end of the valve with the bottom tapped hole in the cover face of the housing (Figure G49).

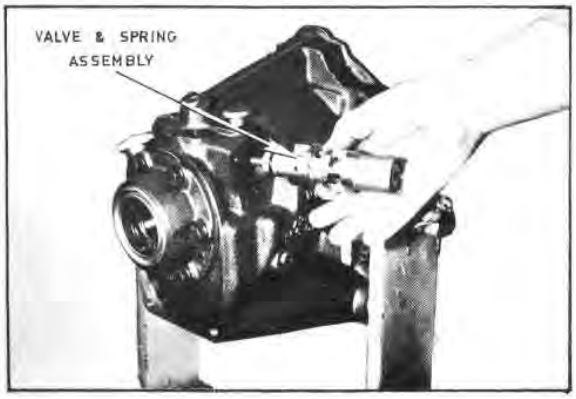


Fig. G49 — Installation of Valve and Spring Assembly

7. Assemble the valve cover gasket, valve cover, hex head bolts, and lockwashers, as shown in Figure G50. Torque the hex head bolts to 12 to 14 lbs./ft.

8. Assemble the shift lever and related parts in the order shown in Figure G51. Torque the hex nut to 12 to 14 lbs./ft. Rotation of the rotary control valve assembly through the forward, neutral, and reverse positions should require no more than finger tip effort. If the valve binds in rotation, remove and inspect for nicks and burrs.

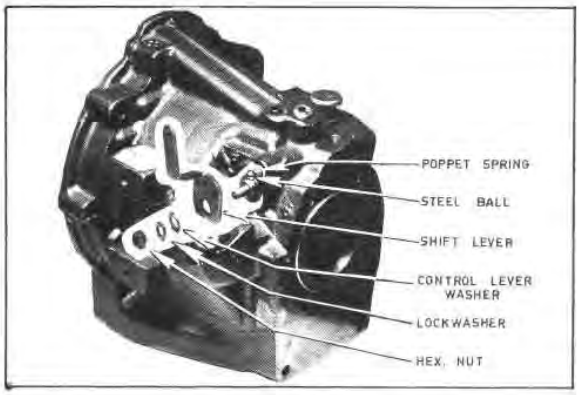


Fig. G51 — Assembly of Shift Lever and Related Parts

Installation of the Oil Strainer Assembly, Cooler Return, and Drain Bushing in the Case :

9. Using the oil strainer assembly and associated parts in the order shown in Figure G52, assemble as follows :—

(a) Insert the oil strainer assembly in the tapped hole provided in the lower right side of the transmission case. Insert the large end of the strainer first. The small end of the strainer will be approximately even with the outside machined surface of the case when inserted to its full depth.

(b) Mount the annular gasket on the cooler return bushing and screw into the case. Tighten the bushing to the recommended torque of 28 to 30 lbs./ft. Install the adaptor block in the $\frac{3}{8}$" fitting hole of the bushing.

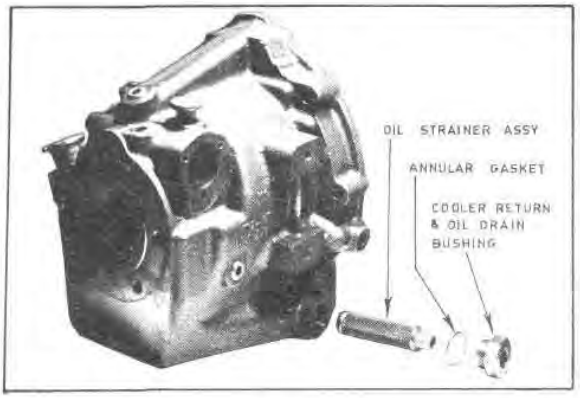


Fig G52 — Installation of Oil Strainer and Related Parts

Installation of Pinion Cage and Output Shaft Assembly in the Case :

10. Place the forward and reverse transmission case, rear face down, with parts assembled in steps (1) to (9) on a suitable ring or support which will clear the outside diameter of the output shaft.

11. Lower the pinion cage and output shaft assembly, into the output shaft bore of the housing (Figure G53). Care should be taken not to damage the output shaft bushings in the housing during this operation.

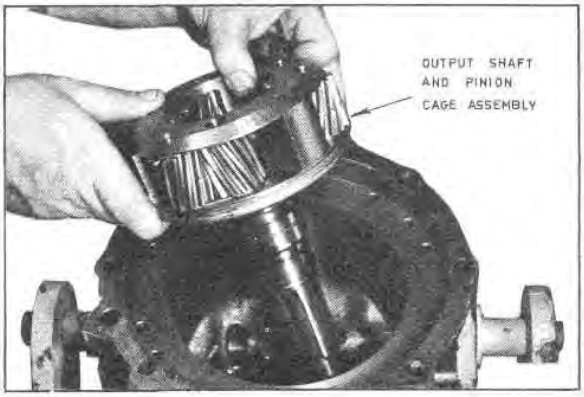


Fig. G53 — Installing Pinion Cage and Output Shaft Assembly

Assembling the Forward Clutch in the Ring Gear :

12. Place the ring gear on a clean surface, with the external teeth up. With the smoothly ground face up, install the clutch pressure plate in the ring gear, as shown in Figure G54. Assembly is complete when the clutch pressure plate is firmly and squarely seated on the shoulder at the bottom of the internal splines.

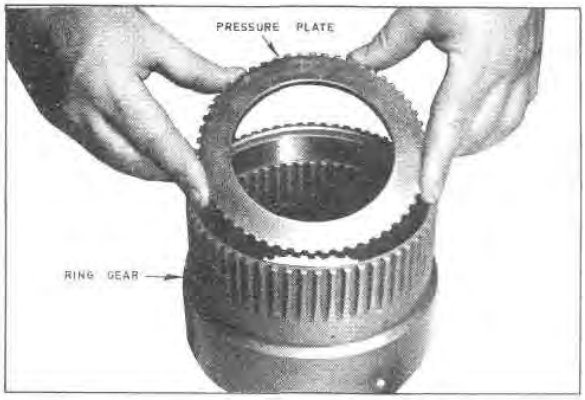


Fig. G54 — Install the Clutch Pressure Plate

13. Using seven (7) lubricated inner clutch plates and six (6) lubricated outer clutch plates, arrange and assemble as shown in Figure G55.

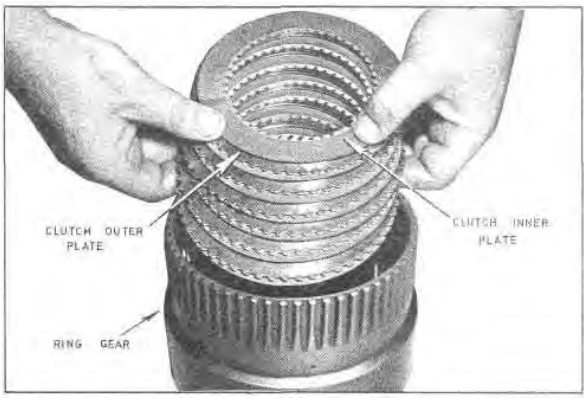


Fig. G55 — Install the Forward Clutch Plates

14. Install the clutch pressure plate with the smoothly ground face down in contact with the clutch plates, as shown in Figure G56.

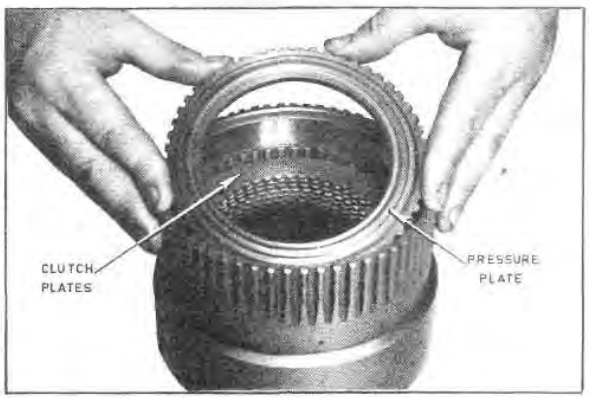


Fig. G56 — Install the Clutch Pressure Plate

15. Install the clutch snap ring squarely and firmly against the shoulder provided by the top of the internal splines (Figure G57).

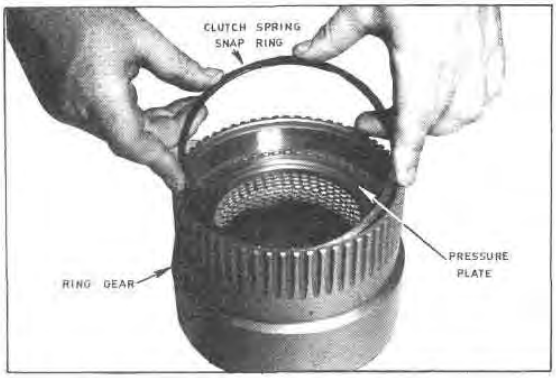


Fig. G57 — Install the Clutch Spring Snap Ring

16. With the concave side of the clutch spring down, install it in the ring gear squarely against the clutch snap ring (Figure G58).

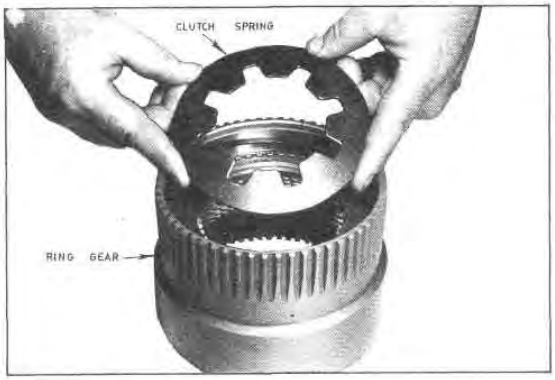


Fig. G58 — Install the Clutch Spring

17. Assemble the clutch spring bearing ring and a lubricated clutch ring on the forward clutch piston. (Figure G59).

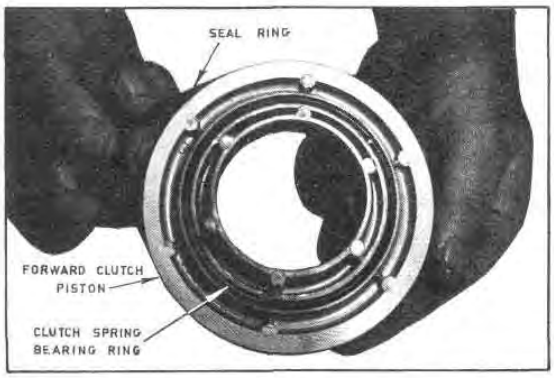


Fig. G59 — Forward Clutch Piston Components

18. Install a lubricated sealing ring in the groove provided in the inner hub of the forward clutch cylinder (Figure G60).

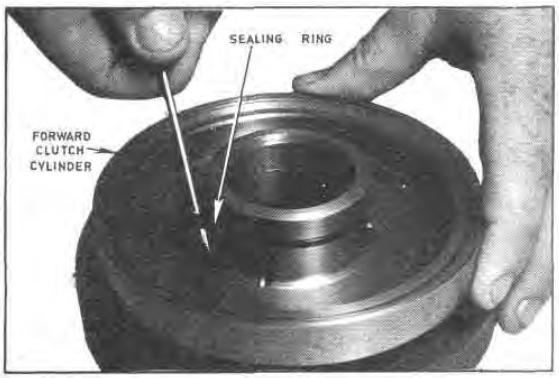


Fig G60 — Forward Clutch Cylinder Sealing Ring

19. Lubricate the forward clutch cylinder before assembling.

20. After aligning the forward clutch piston squarely on the assembled forward cylinder, press the piston into the forward clutch cylinder as shown in Figure G61. Assembly is complete when the piston bottoms in the forward clutch cylinder.

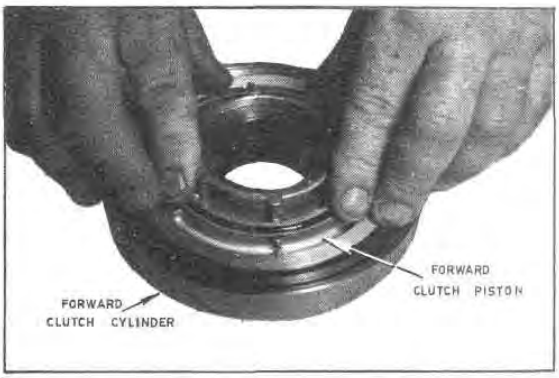


Fig. G61 — Install the Forward Clutch Piston

21. Place the ring gear and combined parts assembled in steps (12) to (16) on a suitable tool on an arbor press. Then place the forward clutch cylinder, with the combined parts assembled in steps (17) to (20), squarely into the open top of the ring gear. Using a suitable assembly tool, press the forward clutch cylinder into the ring gear until it is firmly seated against the internal clutch snap ring and the snap ring groove in the ring gear is fully exposed (Figure G62).

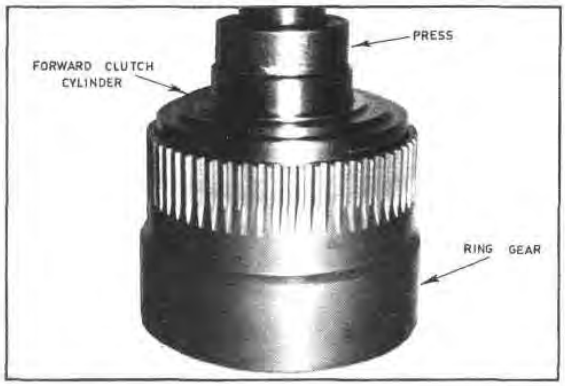


Fig. G62 — Pressing the Forward Clutch Cylinder into Position

22. While maintaining the load on the arbor press, assemble the ring gear snap ring (Figure G63). Tap with a soft tool to ensure the proper seating of the snap ring in the groove.

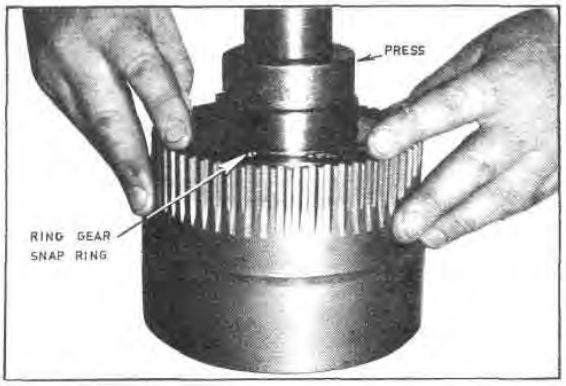


Fig. G63 — Installing the Ring Gear Snap Ring

23. Place the forward clutch and ring gear assembly, with combined parts assembled in steps (12) to (22), on an arbor press and an assembly tool which will support the front face of the ring gear (Figure G64). Using a suitable tool with which to apply force to the pressure plate, compress the clutch plates against the clutch snap ring (Figure G64).

24. The clearance between the clutch pressure plate and the shoulder of the snap ring groove in the ring gear can be measured with a feeler gauge as shown in Figure G64.

25. Install one of the selective snap rings, as shown in Figure G65, to obtain the proper clearance of .046" to .066". *The minimum clearance is recommended.*

Fig. G64 — Measuring the Gap for the Selective Snap Ring

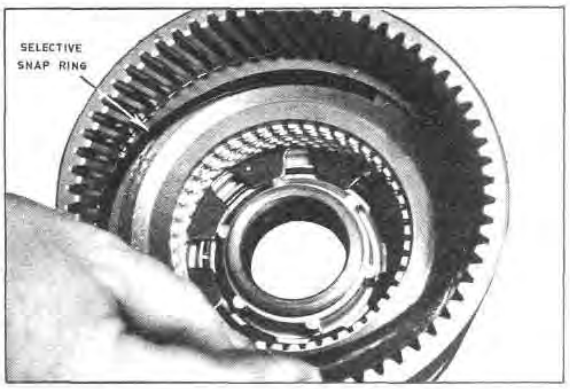


Fig. G65 — Installing the Selective Snap Ring

Assembly of the Forward Clutch Hub on the Drive Gear and Installing the Sealing Rings :

26. Place the forward clutch hub on an arbor press table.

27. Assemble the woodruff key in the keyway provided in the drive gear. Lubricate the outside diameter of the drive gear which presses into the forward clutch hub.

28. Align the woodruff key in the drive gear with the keyway in the forward clutch hub. Press the drive gear squarely into the clutch hub until the gear *"bottoms" on the face of the clutch hub and the* groove for the snap ring in the drive gear is fully uncovered.

29. Invert the drive gear and associated parts assembled in steps (26) to (28) and install the snap ring in the groove provided in the drive gear (Figure G66).

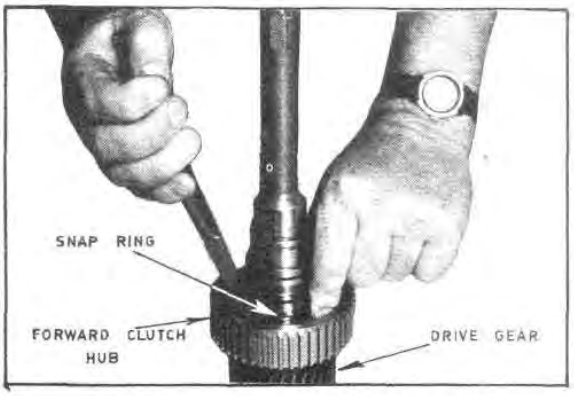


Fig. G66 — Installing the Clutch Hub Snap Ring

30. Install two (2) forward clutch sealing rings in the grooves provided in the drive gear (Figure G67). After installing the rings, hook the ends and turn the rings to ensure their freedom of rotation.

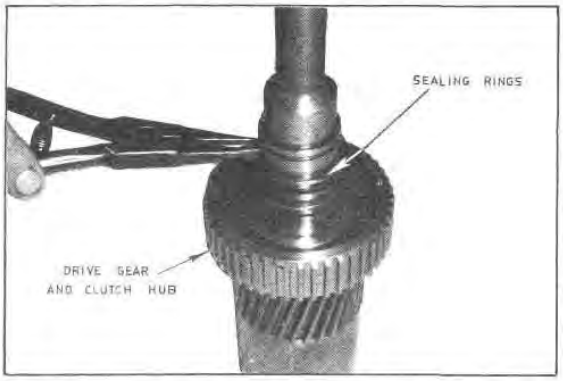


Fig. G67 — Installing the Forward Clutch Sealing Rings on the Drive Gear

Assembly of the Drive Gear in the Forward Clutch and Ring Gear Assembly :

31. With the drive gear and forward clutch hub in an assembly tool, as shown in Figure G68, place the ring gear and forward clutch assembly over the drive gear, as shown in Figure G68.

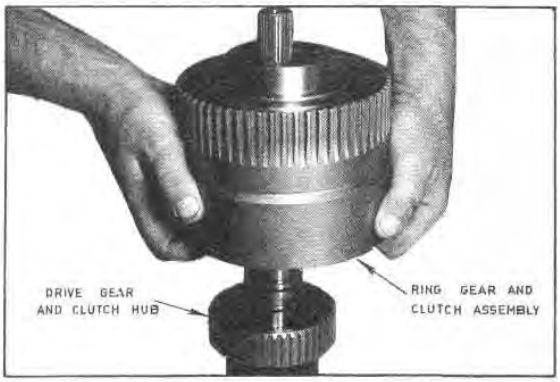


Fig. G68 — Installing the Ring Gear and Clutch Assembly on the Drive Gear

32. Lower the ring gear and clutch assembly until the internal teeth of the clutch plates begin to engage the teeth on the forward clutch hub. Rotate the ring gear to align the teeth of the clutch plates with the teeth on the clutch hub Do not force the ring gear, as damage to the teeth on the clutch plates will result. When the ring gear and clutch are in the correct position, the rear end of the ring gear should be against the assembly tool or "flush" with the rear thrust face of the drive gear. Do not remove the drive gear and clutch assembly from the assembly tool or move the drive gear forward until steps (33), (34) and (35) are completed. Any movement of the drive gear forward will result in the clutch plates becoming disengaged, with the clutch hub and sealing rings moving out of position.

33. Place the aligned parts and assembly tool on an arbor press. Place the annular clutch bearing over the protruding drive gear and squarely into the bore at the front end of the forward clutch cylinder. Using a suitable tool, press the clutch bearing down until the snap ring grooves on the drive gear and in the clutch cylinder are exposed (Figure G69).

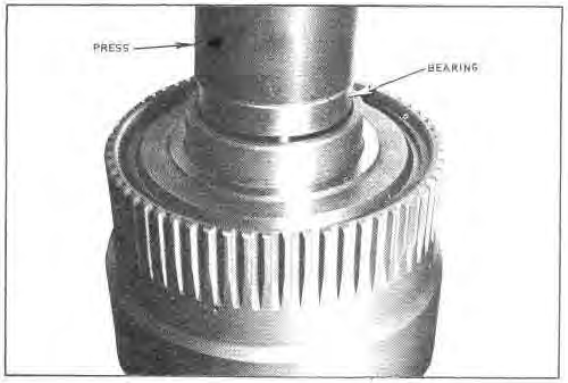


Fig. G69 — Pressing the Bearing into Position

34. Install the drive bearing snap ring (Figure G70).

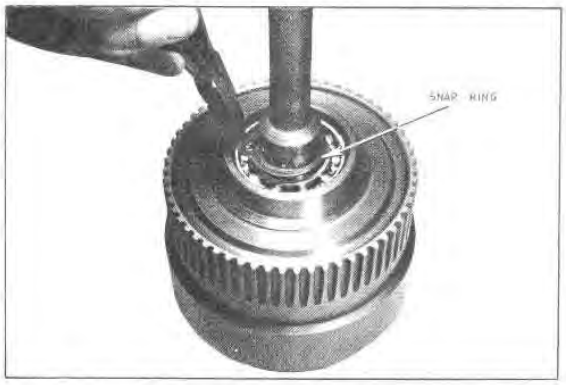


Fig .G70 — Installing the Drive Gear Bearing Snap Ring

35. Install the snap ring in the clutch cylinder (Figure G71).

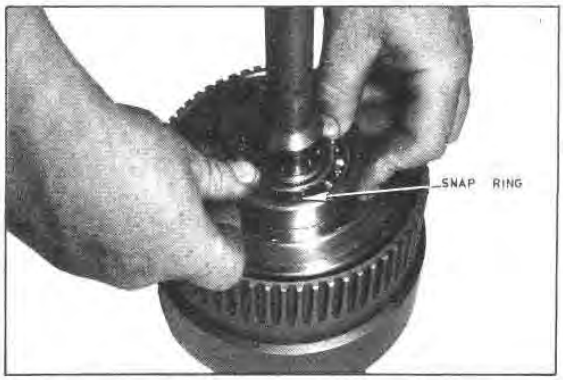


Fig. G71 — Installing the Clutch Cylinder Snap Ring

Assembly of the Drive Gear and Clutch Assembly in the Case :

36. With the forward and reverse case and parts assembled in steps (1) to (10) on a suitable support as described in step (10), place the forward clutch hub thrust washer on the front thrust face of the output shaft (Figure G72). Coat the thrust washer with petroleum jelly to facilitate positioning.

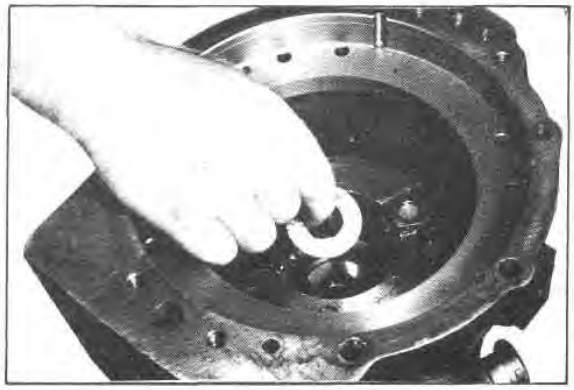


Fig. G72 — Installing the Forward Clutch Hub Thrust Washer

37. After lubricating the rear end of the drive gear and checking the centred position of the thrust washer install the drive gear and clutch assembly into the case and output shaft and the pinion cage assembly (Figure G72). Care should be taken not to damage the bushings in the output shaft when the rear diameter of the drive gear enters the output shaft.

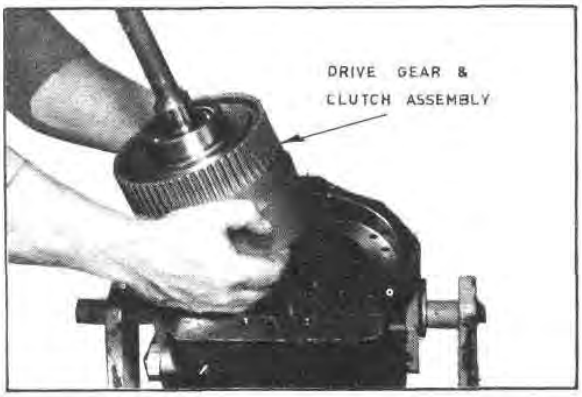


Fig. G73 — Installing the Drive Gear and Clutch Assembly

38. To make the proper selection of the front thrust washer, move the drive gear, output shaft, and associated parts (all tight) rearward. Take a measurement from the front face of the case to the thrust face on the forward clutch cylinder (Figure G74). If the measurement is .405" or under, use the .061" to .063" thick thrust washer. If the measurement is over .405", use the .085" to .087" thick washer. End clearance of the completely assembled forward and reverse unit should be .004" to .043".

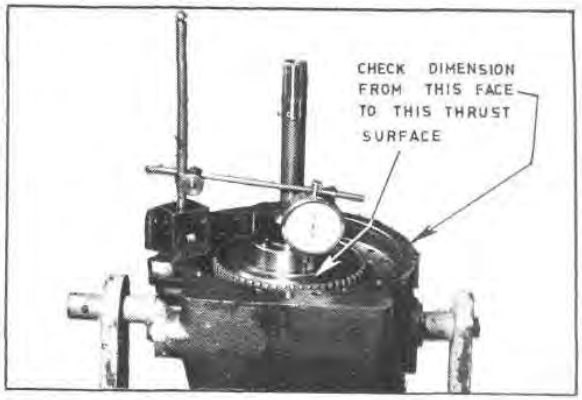


Fig. G74 — Checking for Selection of the Thrust Washer

Assembly of the Converter Regulator Valve and Spring, Reverse Clutch Pressure Plate Springs, and Dowel Pins :

39. Assemble the converter regulator valve spring and valve into the bore provided in the case at the lower right front (Figure G75). Assemble the hollow portion of the valve over the valve spring. The valve should move freely in the bore.

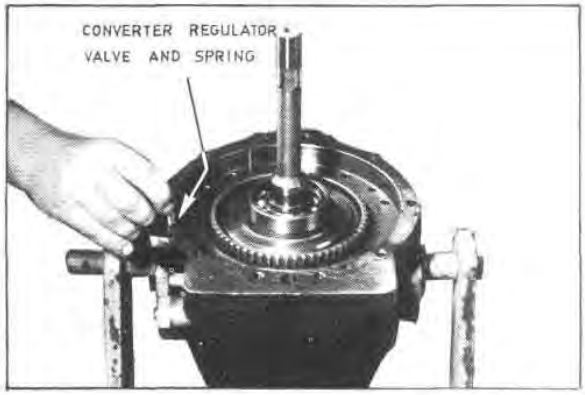


Fig. G75 — Assembling the Converter Regulator Valve and Spring

40. Assemble the twelve (12) clutch pressure plate springs in the holes provided in the reverse clutch cavity of the case, as shown in Figure G76.

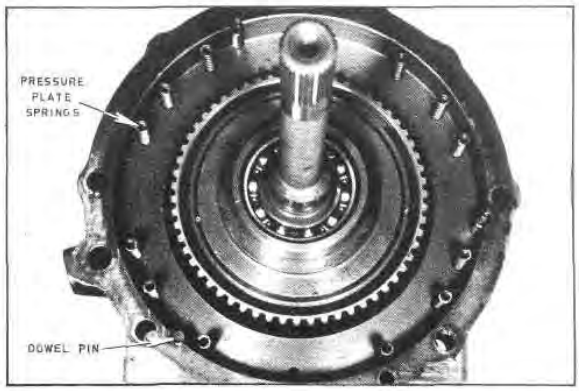


Fig. G76 — Assembly of the Pressure Plate Springs and Dowel Pins

41. Coat the three (3) dowel pins with petroleum jelly and assemble them in the three (3) grooves provided in the reverse clutch cavity of the case (Figure G76).

Assembly of the Reverse Clutch Plates, Pressure Plate, and Adaptor Gasket :

42. Assemble one of the reverse clutch plates over the exposed splined teeth on the ring gear. Assemble the outer clutch plate with the odd shaped lug positioned as shown in Figure G77 to obtain the proper spacing in relation to the pressure plate springs. Repeat this procedure to complete the assembly of the three (3) clutch plates and the two (2) outer plates in the order shown in Figure G77.

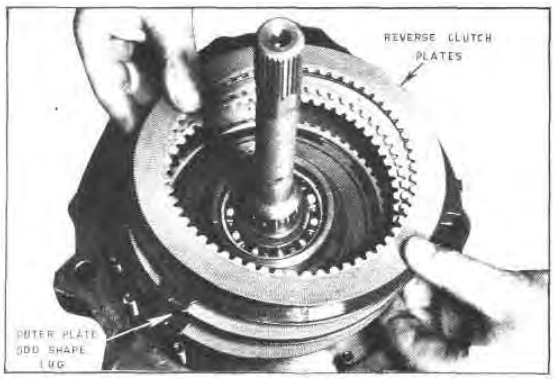


Fig. G77 — Assembling Reverse Clutch Plates

43. Install the reverse clutch pressure plate with the twelve (12) holes in the downward position. Align the cast slot in the pressure plate with the large hole in the front face of the transmission case (Figure G78). This is required to properly position the spring holes in the pressure plate with the springs and dowel pins. If the plate does not drop into position approximately flush with the case, check the three (3) dowel pins for misalignment.

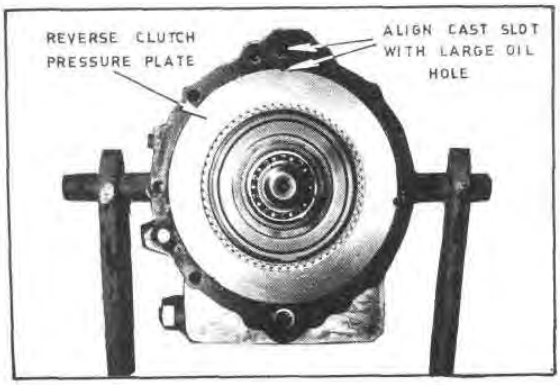


Fig. G78 — Reverse Clutch Pressure Plate Installed

44. Coat the front face of the transmission case lightly with petroleum jelly and assemble in place the adaptor gasket.

Assembly of the Reverse Clutch Piston and Mounting Adaptor Assembly on the Case :

45. Assemble a well lubricated sealing ring in the groove provided in the outside diameter of the reverse clutch piston (Figure G79).

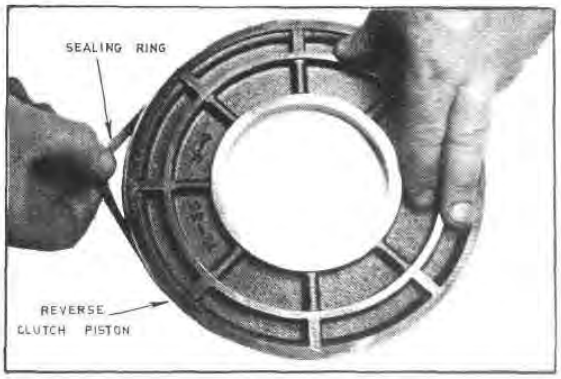


Fig. G79 — Assembling the Reverse Clutch Piston Sealing Ring

46. Assemble a well lubricated sealing ring in the groove provided in the diameter of the adaptor hub (Figure G80).

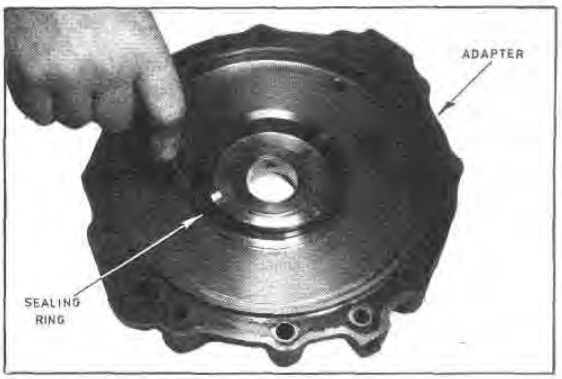


Fig. G80 — Assembling the Adaptor Hub Sealing Ring

47. Place the reverse clutch piston squarely over the piston bore of the adaptor, as shown in Figure G81. Press down on the reverse clutch piston while pulling a clean smooth screwdriver blade around the exposed portion of the sealing ring. This will aid the chamfered bore in the adaptor to compress the sealing ring in the groove in the outside diameter of the piston. The operation is complete when the piston "bottoms" in the adaptor.

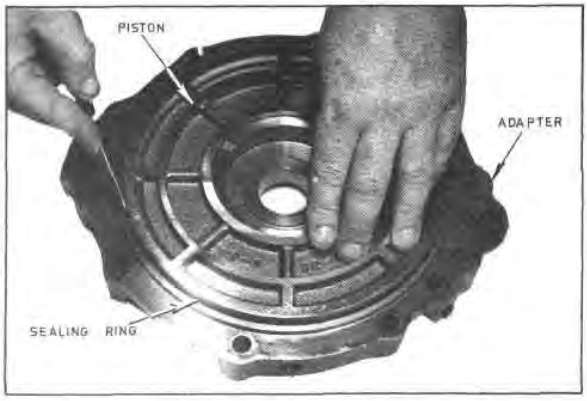


Fig. G81 — Assembling the Reverse Clutch Piston

48. Lift the adaptor and reverse clutch piston assembly over the drive gear and case with the parts assembled in steps (1) to (41). Lower the adaptor and reverse clutch piston assembly squarely onto the input shaft and transmission case. Align the holes in the adaptor with those in the case and gasket.

49. Avoid damaging the input shaft bushing in the adaptor during this operation.

50. When the pilot diameter on the rear end of the adaptor has entered the mating bore in the front end of the case, check the gap between the adaptor and case faces to ensure squareness.

51. Install the four (4) special cap screws and tighten them evenly to prevent binding. When the adaptor face has contacted the face of the case solidly, tighten the special cap screws to the specified torque of 28 to 30 lbs./ft. A 5/16" shakeproof washer, with the bore enlarged to suit the capscrew will prevent the capscrew loosening in service.

Assembly of the Front Pump and Installing on the Transmission :

52. After carefully checking and cleaning all the pump components (shown in Figure G82 and outlined in the disassembly procedure), place the housing rear face down on a clean smooth surface under an arbor press. Place the oil seal assembly squarely into the bore with the seal "lip" position toward the rear of the housing.

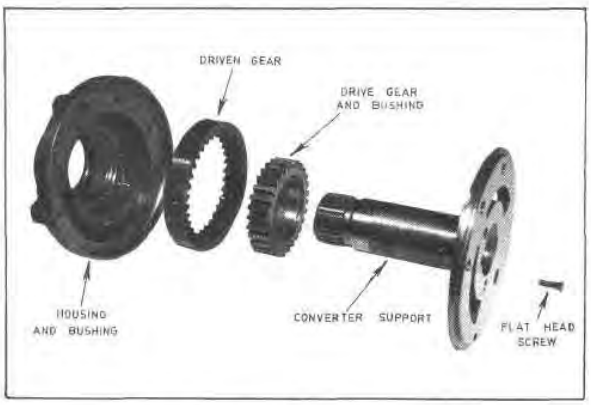


Fig. G82 — Front Pump Components

53. Using a suitable tool which will cover the complete seal assembly, press the seal squarely into the bore until it bottoms. The outer end of the oil seal should be approximately 3/16" from the front end of the pump housing when the seal is pressed to its full depth (Figure G83).

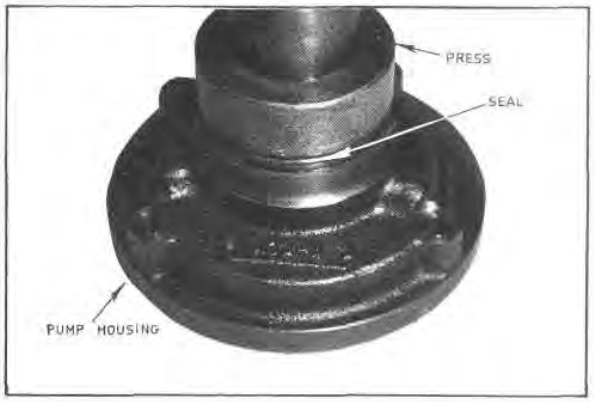


Fig. G83 — Assembling the Oil Seal

54. Invert the housing with the seal assembled and install the pump gears as shown in Figure G84.

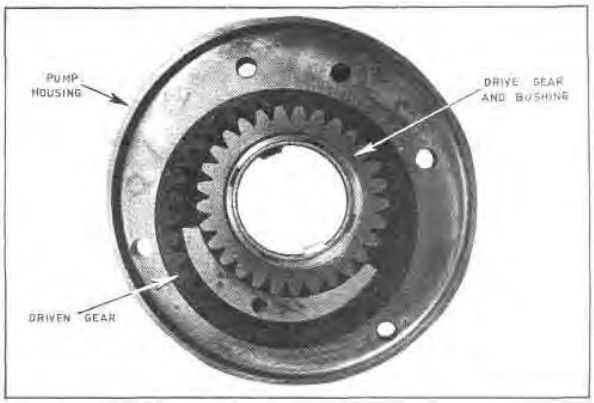


Fig. G84 — Pump Gear Installation

55. Lower the stem end of the converter support through the pump drive gear and into the housing until the large diameter enters the mating bore in the housing. Avoid damage to the pump drive gear bushing during this operation. Align the mounting bolt holes in the backing plate portion of the converter support with those in the housing and assemble the flat head screw and tighten to 17 to 22 lbs./ft. torque (Figure G85). The pump gears should turn freely after this assembly is completed. If the pump gears are tight or bind, disassemble the pump and re-check the gear faces, face of converter support, and gear pockets for burrs, nicks, or foreign material. Lubricate the pump assembly with Automatic Transmission Fluid Type "A", or Dexron when the assembly is completed.

Fig. G85 — Tightening the Backing Plate Retaining Screw

56. With the forward and reverse transmission case and associated parts, assembled in steps (1) to (49) position the pump gasket on the pump mounting face of the adaptor. Lower the pump assembly over the input shaft and onto the mounting face of the adaptor (Figure G86).

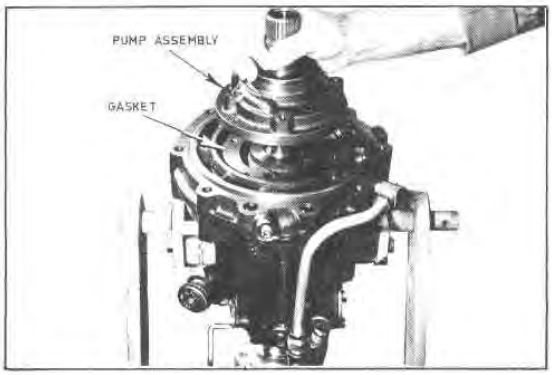


Fig. G86 — Installing the Pump Assembly

57. Align the mounting bolt holes in the pump assembly with those in the adaptor, and install the bolts in the pump assembly (Figure G87). Tighten the bolts to 17 to 22 lbs./ft. torque.

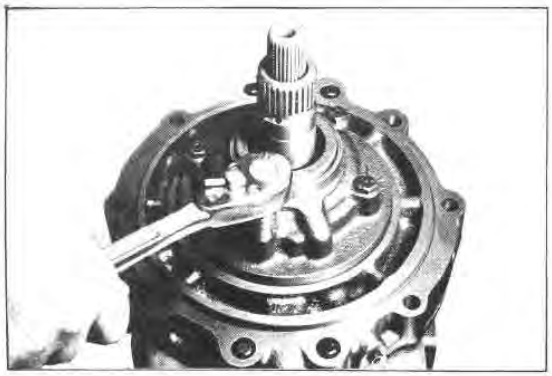


Fig. G87 — Mounting the Pump Assembly

Note : It is extremely important that the correct length bolts are used in the correct length bosses, otherwise malfunction of the pump can occur.

58. After installation of the pump assembly on the transmission is completed, check the rotation of the pump gears. If the gears bind or do not rotate freely, remove the pump assembly and inspect the mounting faces of the pump assembly and the adaptor for burrs, nicks, or foreign material.

Assembly and Installation of the Charge Pressure Control and Safety Check Valve :

59. Using the charge pressure control and safety check valve and associated parts, as shown in Figure G88, proceed with the assembly in the following sequence :—

(a) Insert the check valve spring, large end first, into the open end provided in the check valve body.

(b) Insert the 15/32" diameter steel ball into the valve body, against the small end of spring.

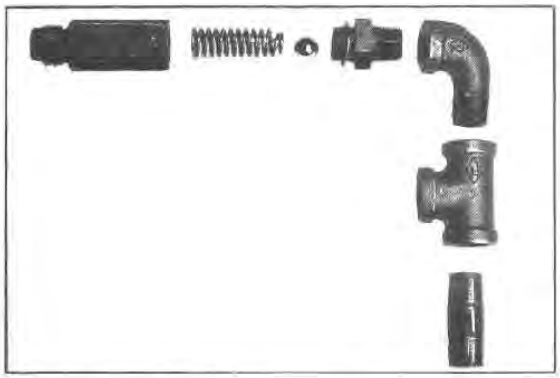


Fig. G88 — Charge Pressure Control and Safety Check Valve Components

(c) Install the metal gasket against the shoulder on the thread end of the check valve seat and screw the check valve seat into the body against the ball and spring. Tighten the check valve seat to 25 to 30 lbs./ft torque.

(d) Assemble the check valve seat and body assembly into the $\frac{3}{8}$" pipe elbow and onto the pipe nipple.

(e) Assemble the pipe nipple and the check valve assembly into the $\frac{3}{8}$" tapped opening of the forward and reverse case.

Assembly of the Rear Adaptor on the Forward and Reversing Transmission :

60. Place the rear adaptor, rear face down, on a suitable support on an arbor press. Place the oil seal assembly squarely on the oil seal bore of the adaptor with the "lip" of the seal positioned up.

61. Using a suitable tool which will completely cover the seal, press the seal into the bore until the assembly tool "bottoms" in the bearing bore of the adaptor. The rear end of the seal assembly should be "flush" to 3/64" below the bearing seat of the adaptor when pressed to the proper depth.

62. Position the annular bearing squarely in the bearing bore of the adaptor and with the use of a

suitable tool press it into the bore until it is seated squarely.

63. With the forward and reverse transmission case and components assembled in steps (1) to (59) in a horizontal position, as shown in Figure G89, and with the rear end overhanging a suitable work surface, install the rear adaptor gasket. Coat the gasket lightly with petroleum jelly to facilitate positioning.

64. Position the rear adaptor assembly over the output shaft and align the piloting bore of the adaptor with the piloting diameter provided by the rear sleeve (Figure G89).

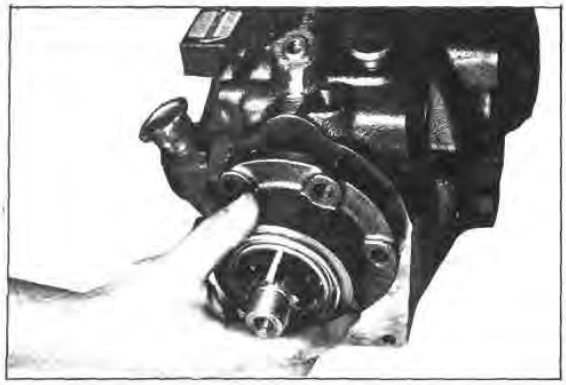


Fig. G89 — Positioning the Rear Adaptor

65. Align the mounting bolt holes of the adaptor with the mounting holes of the case and assemble the bolts and lock washers. Tighten the bolts evenly to pull the adaptor squarely on the piloting diameter and to the 40 to 45 lbs./ft. recommended torque (Figure G90).

Fig. G90 — Tightening the Adaptor Bolts

Assembly of Miscellaneous Plugs, Oil Filler Plug and Dip Stick Assembly and Breather Assembly :

66. Assemble three (3) $\frac{1}{8}$" dry seal plugs in the adaptor and case. Assemble one (1) $\frac{1}{4}$" dry seal plug in the forward and reverse adaptor. Assemble two (2) $\frac{3}{8}$" dry seal plugs in the forward and reverse case.

67. Place the oil filler plug and dip stick assembly into the hole provided in the rear left side of the forward and reverse case.

68. Install the surge tank hose elbow in the hole at the rear end of the case.

To Install the Forward and Reversing Unit :

69. Reverse the removal procedure and ensure that the unit is correctly filled with oil prior to attempting operation.

TROUBLE SHOOTING CHART

NOISY OPERATION

Trouble	Probable Cause	Remedy
ALL GEARS	Misalignment of converter housing or converter with transmission or engine.	Align converter assembly and housing.
	Worn universal joints.	Inspect and service as necessary.
NEUTRAL ONLY	Worn bushings in pump assembly.	Inspect pump assembly and replace if necessary.
	Worn sprag or sprag races in converter assembly.	Replace converter assembly.
	Oil level low in forward and reversing unit.	Fill to correct oil level.
REVERSE ONLY	Worn or rough planetary gears in forward and reversing unit.	Replace planetary gears (set).

TRANSMISSION OVERHEATING

Trouble	Probable Cause	Remedy
FORWARD AND REVERSING UNIT	Oil level low.	Fill to correct level.
	Cooler oil passages restricted.	Cooler must permit free flow of oil from regulator valves. Clean as necessary. All external oil lines should have minimum inside diameter of 13/32".
	Pump pressure low, worn or damaged pump.	Check transmission pressures. Inspect pump assembly if pressures are low. Replace pump assembly if worn or damaged.
	Converter sprag clutch worn and slipping.	Replace converter.

TRANSMISSION WILL NOT PULL

Trouble	Probable Cause	Remedy
ALL SPEEDS	Converter drive lugs sheared or not engaged in pump.	Replace converter.
	Pump gears seized and converter drive lugs sheared.	Replace pump assembly and converter.
	Insufficient oil in forward and reversing unit.	Fill to correct level.
	Worn or damaged bushings in forward and reversing unit.	Disassemble and inspect. Replace worn parts.
FORWARD ONLY	Worn or broken sealing rings in forward clutch of forward and reversing unit.	Disassemble and inspect clutch assembly. Replace parts as necessary.
	Clutch plates worn or broken in forward clutch assembly.	
REVERSE ONLY	Worn or broken sealing rings in reverse clutch piston.	Disassemble and replace damaged or worn parts as necessary.
	Broken or worn reverse clutch plates.	

HARD SHIFTING

Trouble	Probable Cause	Remedy
FORWARD AND REVERSING UNIT	Rotary control valve burred or nicked.	Disassemble valve and remove nicks or burrs.
	Forward and reversing lever bent or interfering on housing.	Remove and replace as necessary.

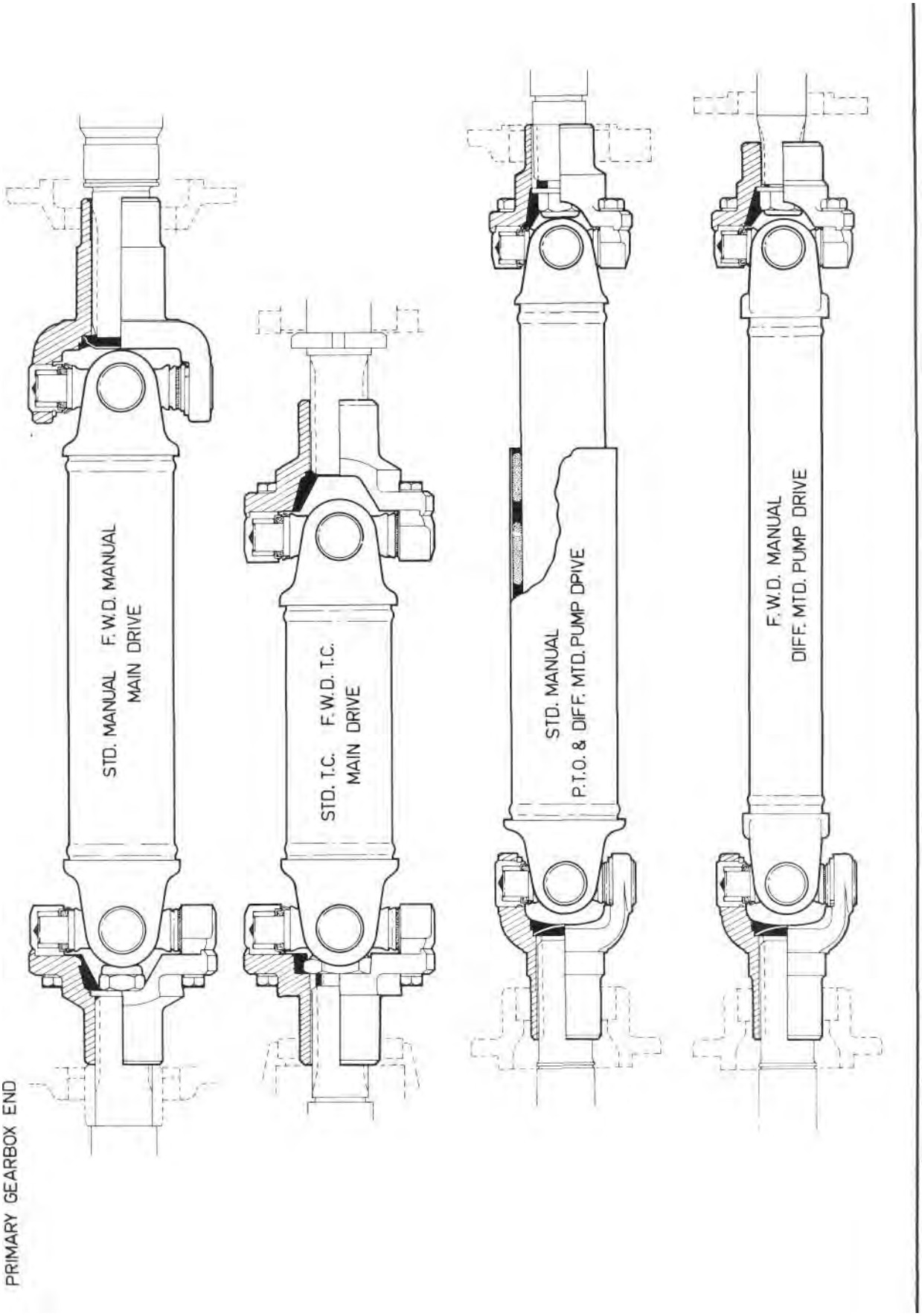
CHAMBERLAIN

SECTION **H**

COUPLING SHAFTS

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT


PRIMARY GEARBOX END
STD. MANUAL F.W.D. MANUAL
MAIN DRIVE
STD. T.C. F.W.D. T.C.
MAIN DRIVE
STD. MANUAL
P.T.O. & DIFF. MTD. PUMP DPIVE
F.W.D. MANUAL
DIFF. MTD. PUMP DRIVE

COUPLING SHAFTS

DESCRIPTION

Universally jointed coupling shafts connect the primary gearbox (or forward and reversing unit) to the secondary gearbox (or drop box), and the primary gearbox to the P.T.O. unit (if fitted) or the differential pump drive (if fitted). They are of the open propellor type and the shafts and universals are balanced as assemblies to prevent vibration. The universal joints are fitted with needle bearings, protected by cork seals.

The main drive coupling shaft is splined to the output shaft of the primary gearbox (or forward and reversing unit) and the input shaft of the secondary gearbox (or drop box), carrying the controlled drive to the rear wheels. The split yoke is nut retained to the secondary gearbox (or forward and reversing unit) output shaft, and the fixed yoke acts as a wet spline coupling through an oil seal in the drive gear bearing retainer of the secondary gearbox (or drop box).

Note : T.C. model tractor coupling shaft has two split yokes fitted.

The P.T.O., or pump drive, coupling shaft (when fitted), connects the splined P.T.O. output shaft of the primary gearbox with the splined clutch shaft protruding through the differential housing. The split yoke is nut retained on the clutch shaft and the fixed yoke acts as a wet spline coupling through an oil seal in the primary gearbox retainer.

Fig. H2 — P.T.O. Wet Spline Arrangement

The F.W.D. model pump drive coupling shaft (when fitted) is constructed of straight tubing whilst the Std. model P.T.O., or pump drive coupling shaft (when fitted) is constructed with a rubber muff connection in the tube section to reduce shock loadings caused by mis-alignment of universal joints in the P.T.O. hitch.

SPECIFICATIONS

Type	— Main drive — open propellor. — P.T.O. drive (if fitted) open propellor with rubber muff. — F.W.D. Diff. pump drive (if fitted) — open propellor.
Bearings	— Needle roller.
Flange Bolt Torque	— 16 - 20 lbs./ft.
Shaft Retaining Nut Torque	— 150 lbs./ft.

MAINTENANCE

The main drive coupling shaft universal joints are fitted with grease nipples and should be serviced every 150 hours.

The P.T.O. or pump drive coupling shaft bearings are pre-packed and should not require further service for at least 2,000 operating hours under normal conditions.

Periodically check that the yoke retaining nuts and flange bolts are tight.

SERVICE

Excessive Vibration :

This can be caused by worn universal joints, loose yoke retaining nut, bent shaft or worn shaft or yoke splines. To service either the joints or splines, it is necessary to remove the shaft.

To Remove the Shafts :

1. Remove the centre floorplate, or work from underneath. On T.C. models, it is necessary to remove the floorplate tunnel.
2. If the P.T.O. or pump drive coupling shaft is to be removed, drain the primary gearbox oil.
3. Remove the trunnion bolts from the split universal yoke and tap the trunnions lightly with a soft hammer to separate the driving lugs, or prise them apart with a screwdriver or similar tool. The loose trunnions are wire tied to the spider assembly to prevent them falling off during dismantling.

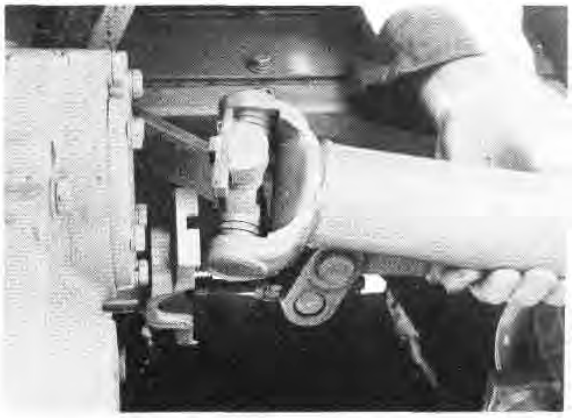


Fig. H3 — Main Drive Coupling Removal (Manual Model)

4. The shafts may now be moved to clear the split yoke end away from the gearbox spline shaft.
5. If the split yoke or spline shaft is to be serviced, removal of the retaining nut enables the yoke to be removed from the splined shaft.

To Dismantle the Universal Joints :

1. Remove the trunnion lockwire and the trunnions from the spider.

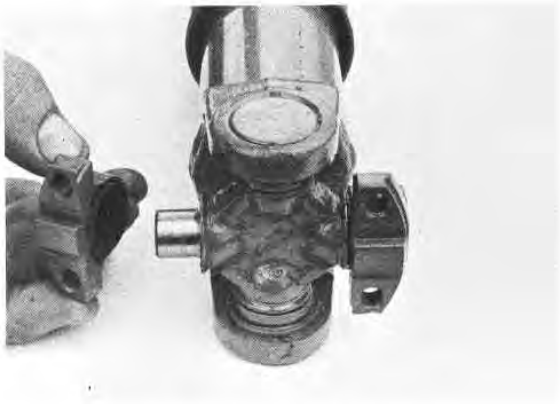


Fig. H4 — Removing the Trunnion

2. Remove the retainer lockrings from the machined grooves at the inner end of each bearing (other than the trunnion blocks).

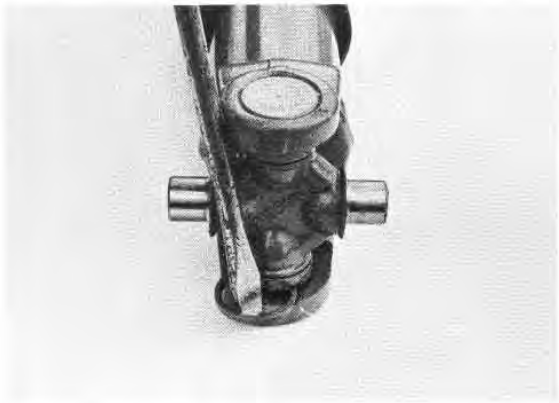


Fig. H5 — Removing the Lock Ring

3. Support the shaft, or splined yoke, on blocks and use a piece of 1" pipe or similar tool to apply force to the yoke around the bearing to be forced out. This will cause the spider to drive the bearing out.

4. After the bearings opposite each other are forced out as far as possible with the spider as described, insert four or five small washers between the end of the spider and one bearing. The spider will now drive this bearing out and the spider can be removed.

5. The opposite bearing may now be drifted free.

6. The procedure is repeated for the second pair of bearings by supporting the exposed ends of the spider on blocks.

Fig. H6 — Drifting the Bearing

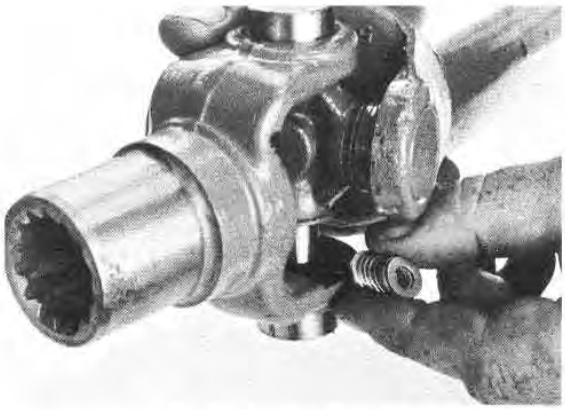


Fig. H7 - Inserting Washers

Fig. H8 — Removing the Opposite Bearing

Fig. H9 - Drifting Second Pair of Bearings

INSPECTION

1. Thoroughly clean all the component parts in petrol or solvent and probe the holes in the ends of the spider to remove hardened lubricant.

2. Examine the bearing surfaces on the spider and inside the outer races for signs of wear. Also inspect the needles. The outer races should be a neat fit in the yoke ends. If this is not the case, their slackness will have been noticed when dismantling. Replace worn or damaged parts.

3. Examine the cork seals and retainers for wear or damage. The seals should be smooth and flexible. If brittle or charred, replace with new seals.

4. Check the fit of the yokes on to the splined shafts. Excessive backlash will result in noisy operation and undue wear on the universal joint assemblies.

5. Examine the fixed yoke oil seal bearing surface. Ensure that it is in good condition or oil leakage will result. Check that the core plug seal is effective.

RE-ASSEMBLY

Re-assembly is a reversal of the dismantling procedure with the following points noted :—

1. Repack the bearings of the P.T.O. coupling shaft (if fitted) and lubricate the main coupling shaft.

2. Check that the spider pilot diameters are clean and free from nicks and re-assemble the universal joint assemblies. Re-wire the separate trunnion assemblies.

3. Re-fit the split yokes to their respective shafts and torque the retaining nuts to 150 lbs./ft.

4. Re-fit the shafts to the tractor and tighten the trunnion bolts to 16 - 20 lbs./ft.

CHAMBERLAIN

SECTION **J**

DROP BOX AND SECONDARY GEARBOX

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

J

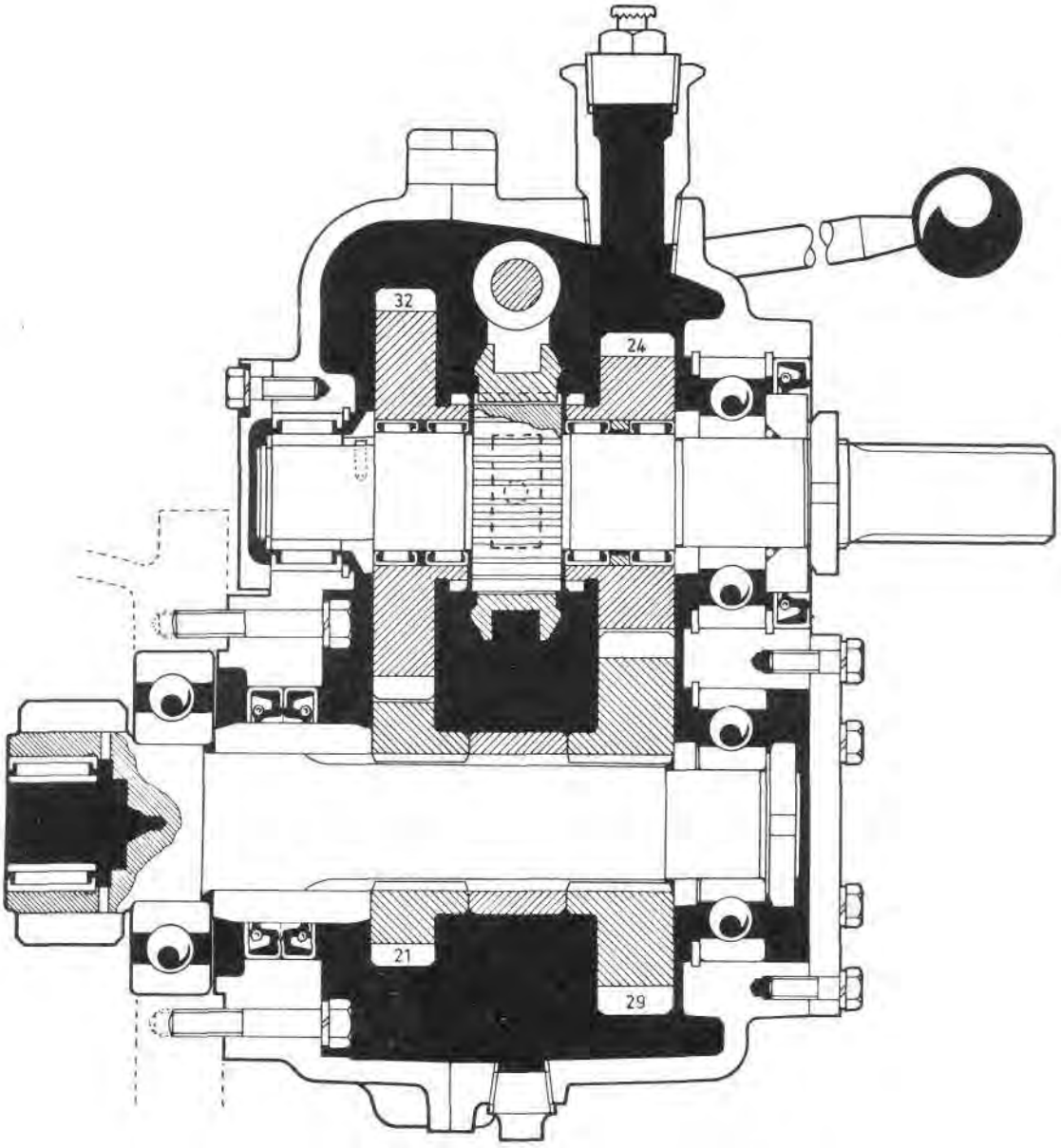


Fig. J1 — Drop Box — Std. T.C. and F.W.D. T.C. Models

DROP BOX

Std. T.C. and F.W.D. T.C. Models only.

DESCRIPTION

The two speed drop box is mounted on the secondary gearbox over the input shaft, and incorporates an upper and lower shaft with a pair of high and low ratio, constant mesh, gears. The driven gears are splined to the lower shaft and the driving gears are mounted on needle rollers on the upper shaft, with a sliding dog splined to the shaft between them.

The sliding dog is held in position by a detent ball, spring and plug in the side of the drop box housing. The ball locates in the detents in the selector fork to provide high range, neutral, or low range. Ball and roller bearings are used throughout.

OPERATION

Movement of the selector to either high or low range causes the sliding dog to engage the external side teeth of the selected gear, giving a direct drive from the upper shaft, through the appropriate gears to the lower shaft. Do **not** change on the move.

SPECIFICATIONS

Make	— Own.
Gear Ratios	— 1.208 : 1 reduction.
	— .656 : 1 -overdrive.
Lubrication	— Oil bath and splash.

MAINTENANCE

Check the oil level in the drop box every 150 hours and drain while hot after working, every 1200 hours. Refill with clean, fresh oil as specified for the differential.

SERVICING

Dismantling :

1. (a) Std. T.C. Model : Remove the coupling shaft cover, the coupling shaft, centre floor plate and the fuel tank shield.

(b) F.W.D. T.C. Model : Drain and remove the fuel tank, remove the floor plate, brake pedal cross-shaft and support, and the coupling shaft.

2. Drain the drop box oil. *The drain plug is at the* bottom of the housing.

3. Remove the secondary gearbox lever link pin and then the drop box lower cover.

4. Move the drop box into high or low ratio, then unlock and remove the circular nuts from the upper and lower shafts. Use the correct shape spanner.

5. Remove the gear change lever. On F.W.D. T.C. models, it is also necessary to remove the shift lever shaft support bearing.

6. Remove the drop box housing cover bolts, insert two jacking screws into the tapped holes and jack clear the housing cover complete with upper shaft and gears.

7. From the lower shaft remove the shim, outer spacer, 29 tooth gear, inner spacer and 21 tooth gear. Remove six retaining bolts and remove the housing from the secondary gearbox, taking care not to damage the two seals. Remove the collar from the lower shaft.

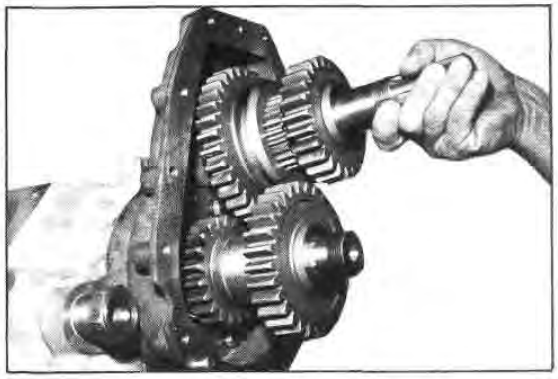


Fig. J2 — The Outer Cover Removed

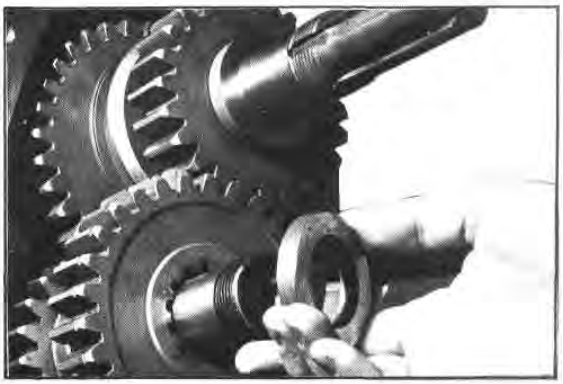


Fig. J3 — Removing a Lower Shaft Spacer

8. Remove the small circlip from the gearbox end of the upper shaft. Using a puller from the same end, connected to the large 32 tooth driving gear, remove the bearing inner race, collar and large driving gear.

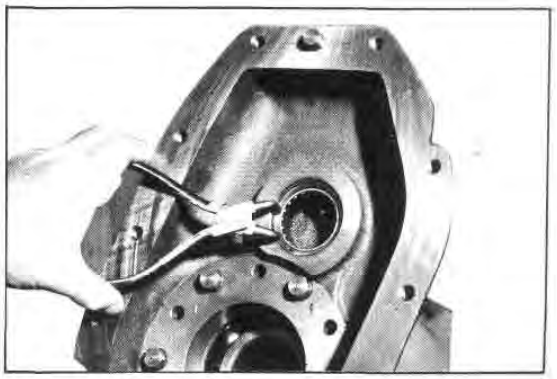


Fig. J4 — Removing the Housing Upper Bearing Circlip

9. Remove the detent plug, spring and ball. Movement in the selector fork will then allow the dog clutch to be taken off the gearbox end of the shaft.

10. Withdraw the two bolts attaching the selector fork and remove the selector shaft and fork.

11. Support the small 24 tooth driving gear and carefully press the upper shaft through the bearing and gear from the coupling shaft side of the housing. Care must be taken to avoid loading the bearing inner circlip.

INSPECTION

Thoroughly clean all the components and examine them for wear to the shafts, gears, bearings and the selector fork. Examine the oil seals and 'O' ring and, if any doubt exists as to their serviceability, they should be replaced.

Note : The 'O' ring is fitted under the locknut spacer on the upper shaft.

If removal of the driving gear needle bearings is necessary, ensure that the gear bores are not scored by the removal tool. A press **must** be used to replace these bearings and they **must** be fitted with their thin flanges toward the centre of the gear.

RE-ASSEMBLY

Re-assembly is a reversal of the dismantling procedure but the following points should be noted :—

Fig. J5 — Replacing the Driving Gear Needle Bearing

1. The use of new gaskets throughout is recommended.
2. Exercise care with all oil seals.
3. The two seals must be fitted back to back with the lips facing outwards.
4. When installing the lower shaft bearing P/No. 32436, ensure that a shim P/No. 43998 is fitted between the bearing and the spacer P/No. 32434.
5. Do not replace the detent ball, spring and plug until the drop box has been completely re-assembled.
6. Re-fill the drop box with the correct oil to the bottom of the level plug hole.

SECONDARY GEARBOX

All Models

DESCRIPTION

The secondary gearbox, mounted on the differential housing, enables the drive to be transmitted to the differential unit. The two-speed gearbox gives a direct drive, or alternatively, a four-to-one reduction through a train of gears. The change is by a sliding gear clutch, operated through linkage by a lever adjacent to the seat.

There are four shafts included in the gearbox; the input shaft which includes the main drive gear, the countershaft, the pinion shaft and the selector shaft.

The input shaft is supported by two small bearings, one bearing being mounted in the gearbox bore whilst a spigot located bearing housing carries the other bearing, which is located by a spigotted retainer. A circlip adjacent to the bearing prevents shaft movement, and an oil seal is fitted in the bearing retainer.

A setscrew retained lockplate locates the countershaft which is fitted with an 'O' ring seal to prevent oil leakage. The cluster gear revolves on the shaft and contains three, circlip retained, needle roller bearings and ejector rings, and gear end float is controlled by thrust washers at either end.

The pinion shaft is supported by two pre-loaded, taper roller bearings, contained in a housing at one end, and by a needle roller bearing, inside the main drive gear, at the other end. The taper roller bearings are retained by a locked circular nut. The bushed driven gear, mounted on the pinion shaft, is positioned by a lockwasher and circlip.

A fork that operates in a groove in the sliding clutch is fitted to the detent located selector shaft, and an oil seal, carried in an extension plug in the gearbox housing, prevents oil leakage.

Lubrication of the gearbox is by oil bath common to the differential housing, the level being equalised by a transfer hole.

The gearbox is ventilated through the differential vent, and the drain plug, adjacent to the lockplate setscrew, serves both the gearbox and the differential unit.

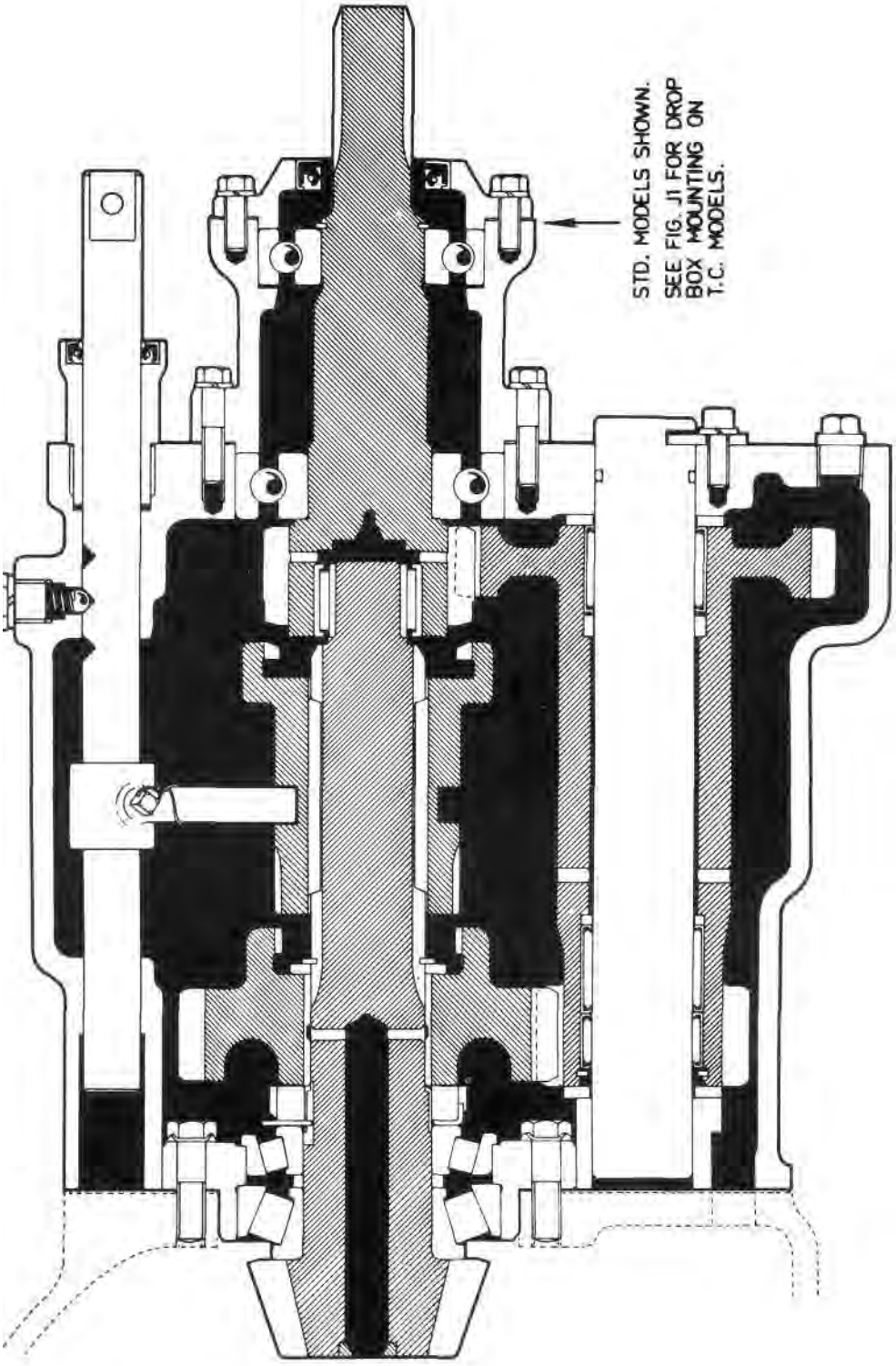


Fig. J6 — Secondary Gearbox

OPERATION

With the selector in the "high" ratio position, the sliding clutch, which is splined to the pinion shaft, is moved so that its internal teeth mesh with the extended teeth on the main driving gear. The driving gear, sliding clutch and the pinion are thus locked together to give a direct drive.

In "low" range, the sliding clutch is moved to engage its external teeth with the internal teeth in the driven gear. This locks the driven gear to the pinion shaft and allows the drive to be transmitted by the cluster gear.

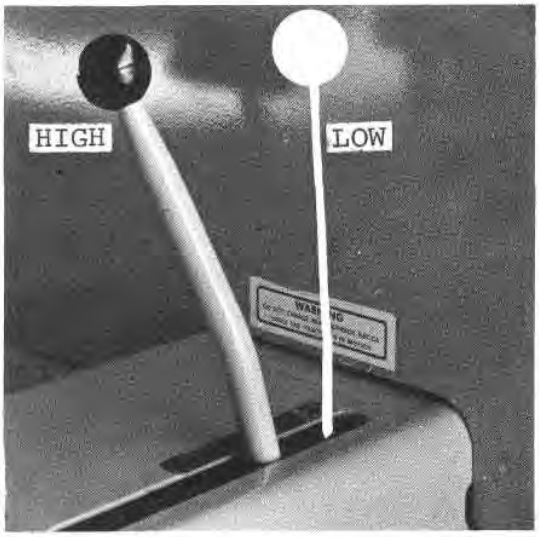


Fig. J7 — Gearbox Lever (Std. Models)

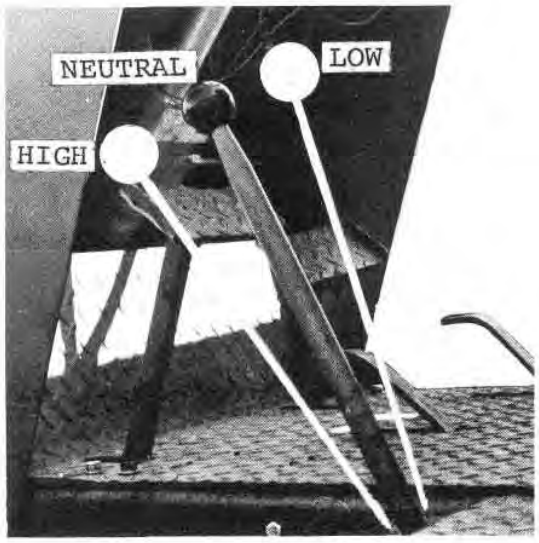


Fig. J8 — Gearbox Lever (F.W.D. Models)

SPECIFICATIONS

Ratios	— High 1 : 1.
	— Low 4 : 1.
Change Method	— Sliding gear clutch.
Lubrication	— Oil bath and splash.
Bolt Torque	— Housing to differential — 27 lbs./ft.
	— Pinion bearing housing — 70 lbs./ft.
Pinion Bearing pre-load	— 20 - 26 lbs./inches (new bearings).

MAINTENANCE

Check the oil level every 150 operating hours.

Every 1200 operating hours, while the tractor is hot after working, drain the oil from the plugs under the differential housing and in the gearbox, and re-fill with new recommended oil, to the correct level. Allow time for the oil to equalise in the gearbox and differential housing before reading the level.

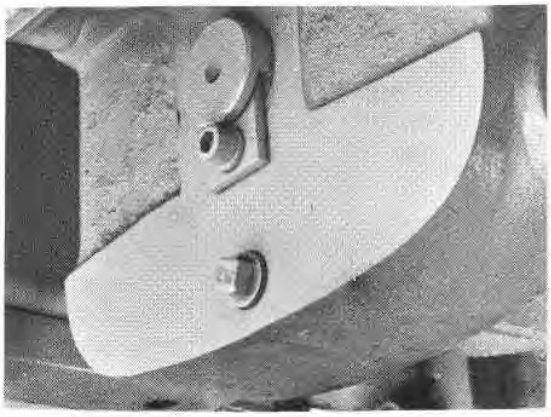


Fig. J9 — Secondary Gearbox Oil Drain Plug

The correct oil level is indicated by a dipstick fitted into the centre pad on the differential housing on Std. manual and T.C. model tractors, or to the bottom threads of the filler elbow on F.W.D. manual and T.C. model tractors. The filler elbow is fitted into the

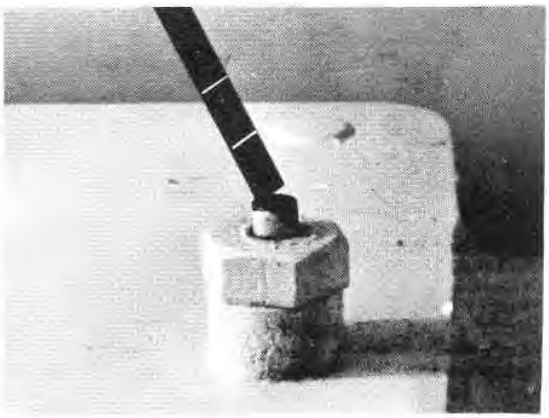


Fig. J10 — Differential Dipstick

differential cover plate except where P.T.O. units are fitted, the filler on these units being a large screwed plug hole on the top of the P.T.O. housing.

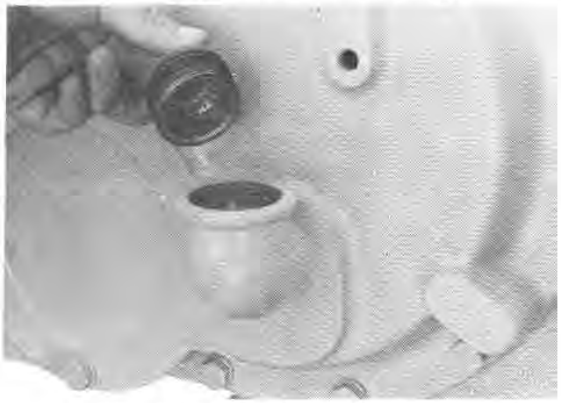


Fig. J11 — Filler Elbow Oil Level Plug

SERVICING

Secondary Gearbox Removal :

(T.C. Models — See also drop box Page J 3)

1. Drain the differential and gearbox oil.
2. Remove the centre floor plate (Std. model) or the main footplate (F.W.D. model) for ease of working.
3. On Std. model tractors, remove the fuel tank shield-to-footplate bolts and the seat frame-to-mud-guard bolts. Lift the shield and seat frame as an assembly from the tractor.
4. On Std. model tractors, turn off the fuel taps, disconnect the pipe to tank fittings (drain some fuel if it overflows the return elbow), remove the cradle straps and lift the tank from the tractor.
5. Disconnect the shifter rail to lever link pin.
6. Thoroughly clean around and then remove, the gearbox inspection cover.
7. Remove the wire and the fork locating setscrew.
8. Remove the detent plug, spring and ball. The ball can be recovered after the shaft is removed if care is taken to ensure that it does not fall into the gearbox.
9. Withdraw the shifter rail, and then the fork from the gearbox.
10. Remove the main drive, and, if fitted, the P.T.O. or pump drive coupling shafts.

Note : The P.T.O. or pump drive coupling shaft is removed to facilitate manoeuvring the gearbox during removal and replacing. This shaft removal requires the primary gearbox to be drained of oil.

11. Remove the gearbox to differential housing bolts, move the gearbox away from the differential and clear of the tractor.

Secondary Gearbox Dismantling :

1. Remove the main drive gear bearing housing flange bolts and remove the assembly from the gearbox. It may be necessary to apply pressure from inside the gearbox if the bearing is tight in the gearbox bore.
2. Remove the bearing housing retainer, the circlip from the shaft, and press the shaft out of the bearing.
3. Remove the countershaft retaining setscrew and lockplate, push the shaft out of the gearbox and cluster gear, then recover the cluster gear and thrust washers from the gearbox. Note the position of the thrust washers for re-assembly.
4. Remove the driven gear lockwasher retaining circlip from the pinion shaft and slide the washer and gear from the shaft.

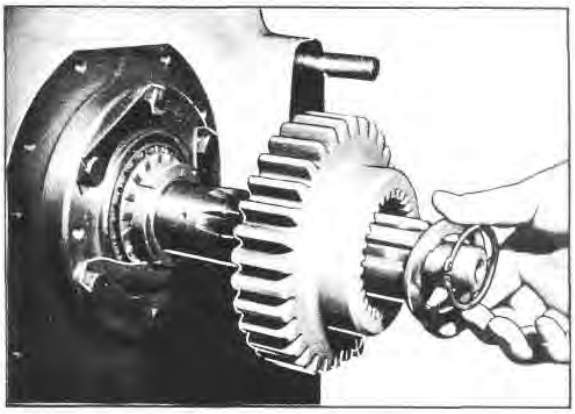


Fig. J12 — Removing Driven Gear Retainers

Pinion Removal and Dismantling :

1. Unlock and remove the bolts retaining the pinion bearing housing and prise it free of the differential housing. Take care not to damage, and note, the number of pinion shims.
2. Unlock the pinion nut lockwasher, hold the pinion shaft firmly in a soft jawed vice, and remove the circular locknut.
3. Press the pinion from the housing.

Inspection :

Thoroughly clean all parts and inspect all shafts, bearings and gears for signs of excessive wear. Replace parts as necessary. Check the condition of the oil seals and 'O' rings.

Pinion Assembly :

1. Re-assemble the pinion to the bearing housing with a new bearing pre-load of 20 - 26 lbs./inches (bearings clean and lightly lubricated).

The usual checking method is to attach a spring scale to a lever arm, measuring 6" from the centre of the shaft to the attachment point, and slowly increase the pull until the shaft commences to turn.

After the shaft inertia has been overcome, a reading on the scale of approximately 4 lbs. should be recorded. Shims must be removed, or added, between the bearings to obtain the correct reading (.001" shim variation changes bearing pre-load approximately 4 lb. inches).

Note : Ensure that the locknut holds the bearing against the spacing shims and not against the bearing cup. Grease the rear face of the nut when assembling and securely tighten the nut before checking the pre-load.

Caution : Serviceable bearings should be set to a reduced pre-load of 10 - 13 lbs./inches on re-assembly.

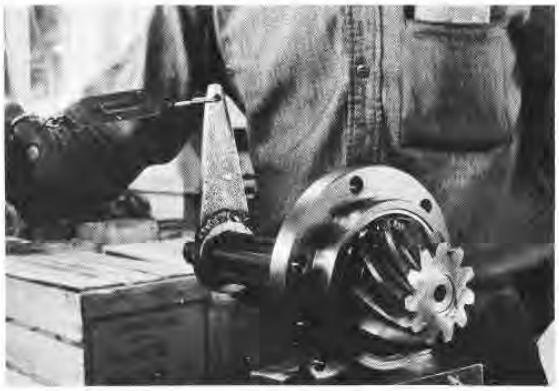


Fig. J13 — Checking Pinion Pre-Load

Pinion bearings are not serviceable unless they are in good condition and a moderate press fit on the pinion shaft.

2. Insert the bearing housing into the differential housing, aligning the oil holes in the flange and adjusting shims with the hole in the differential housing, and tension the retaining bolts to 70 lbs./ft. Lock the bolt tabwashers, ensuring that the tabs will not interfere with the gearbox housing as it is being installed.

Note : If the pinion bearings have been replaced, it will be necessary to check the mating of the pinion with the crownwheel as described in Section K.

Secondary Gearbox Re-Assembly :

(T.C. Models — See also drop box Page J 3)

1. Ensure that the cluster gear bearing knock-out rings are correctly fitted, narrow ring in the two bearing end, that the bearings are fitted with the numbers facing outwards, and the short bearing is fitted outside the long bearing.

2. Install the cluster gear and thrust washers on the countershaft in the gearbox and check the endfloat at .010" - .020". .010" oversize thrust washers P/No. 37438 and .060" oversize thrust washers P/No. 37440 are available to correct excessive endfloat. Ensure that the washers are correctly fitted to preserve the alignment of the mating gears.

3. Press the large ball bearing onto the main drive gear, install the bearing housing and press the small ball bearing into position. Install the circlip and, using a new gasket, fit the bearing retainer. Re-assemble the unit to the gearbox housing using a new gasket.

4. Install the driven gear on the pinion shaft, assemble the lockwasher and fit the circlip, ensuring that it is correctly seated.

5. Position the sliding gear on the pinion shaft.

6. Use a new gasket and assemble the gearbox to the differential.

7. Replace the fork and shifter rail and assemble the detent. Install the rail to lever link pin and ensure that all gears can be obtained, then wire lock the fork locating screw. Replace the inspection cover using a new gasket.

8. Replace all other parts removed.

9. Fill the differential, primary and secondary gearboxes with the recommended oil.

CHAMBERLAIN

SECTION **K**

DIFFERENTIAL

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

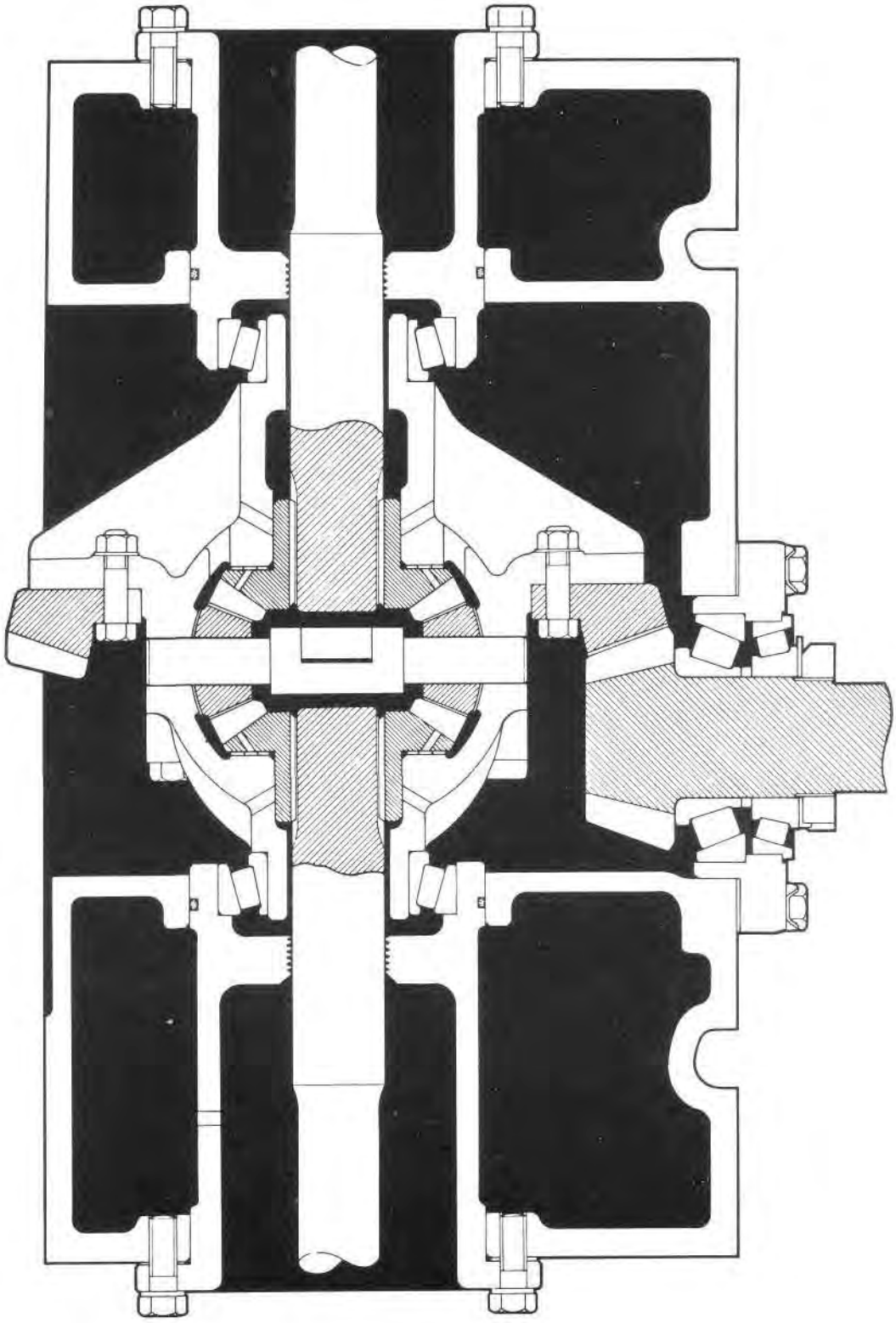


Fig. K1 — Differential Assembly

DIFFERENTIAL

All Models

DESCRIPTION

The differential assembly is contained within a housing which is attached by studs and nuts directly to the tractor chassis. Also supported by the housing is the pinion bearing housing and secondary gearbox and, if fitted, the live P.T.O. unit. The drive of this unit is carried through the housing by a splined shaft.

Taper roller bearings mounted in two removeable insert housings support the differential unit, and lateral position and bearing adjustment is achieved by shimming behind the flanges of these housings. The pinion position, relative to the crownwheel, is adjusted by shimming between the pinion bearing housing and the differential housing.

A four-star bevel gear assembly provides the compensating action of the differential, and the crownwheel and pinion are of the mated spiral bevel type. From the crownwheel, the drive is carried by the differential casing to the differential pinions, these pinions being mounted on two half-lapping cross-shafts. The four pinions mesh with two gears supported in the differential case and into which are splined two half shafts that carry the drive through the insert housings to the final drive units.

Lubrication to the unit is by oil bath and splash, the oil bath being inter-connected with the secondary gearbox and P.T.O. unit. An oil trap ensures adequate lubrication of the pinion bearings. A drain plug is located beneath the housing, the dipstick level is in the top of the housing or to the bottom threads in the tiller elbow and the filler is a large, screwed plug in the top of the P.T.O. unit, or an elbow in the differential cover. The differential housing vent also serves the secondary gearbox and P.T.O. unit.

SPECIFICATIONS

Make	— Own.
Type	— *Spiral Bevel, 4-star bevel.*
Ratio	— 11 : 40.
Backlash	— .008" - .014". — .008" - .013" side gear and pinion.
Bearing Pre-load	— Pinion bearings — 20 - 26 lbs./in. (New bearings). — Side carrier bearings — 15 lbs./in. (New bearings).
Adjustment	— Shims — pinion and differential.
Bolt Torque	— Pinion bearing housing — 70 lbs./ft. — Differential case — 70 lbs./ft. — Crownwheel to carrier — 50 lbs./ft. (black bolts) — 45 lbs./ft (cadium plated). — Carrier bearing inserts — 70 lbs./ft.
Oil Change	— 1200 operating hours.

MAINTENANCE

Check the oil level every 150 operating hours. At every 1200 operating hours, while the tractor is hot after working, drain the oil and re-fill with new, recommended oil, to the correct level. Allow time for the oil to equalise in the gearbox and differential before reading the level.

SERVICING

Differential Removal and Dismantling :

1. Drain the differential oil.
2. Remove the P.T.O. unit (if fitted) or the differential cover.
3. Support the rear of the tractor with jacking stands for safety, and remove the rear wheels and final drives (Section L).
4. Use a $\frac{3}{8}$" Inhex socket spanner to remove the bearing housing insert Allen setscrews, then remove the housings, move the differential assembly to the left and manoeuvre it out the back of the housing. On F.W.D. models, it is necessary to first remove the pinion assembly.

Note : A piece of wood used under the crownwheel will prevent the assembly dropping when the inserts are removed, and prevent damage to the bearings.

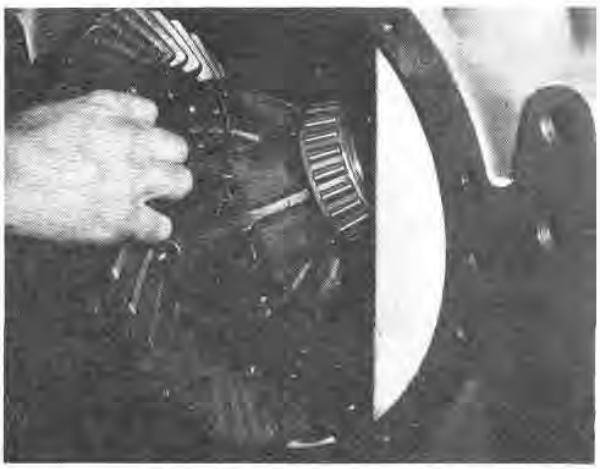


Fig. K2 — Removing the Differential

5. Remove the secondary gearbox and pinion assembly if necessary (Section J).
6. To ensure that the differential carrier is re-assembled correctly, check that it is marked on adjacent points on each half of the casing then unlock and remove the bolts coupling the two halves together. Part the casing and remove the internal components, arranging them so that they can be re-assembled in the same positions. The side carrier bearings can be removed with the aid of suitable bearing pullers, if required.

Inspection :

Thoroughly clean and inspect all parts of the differential, crownwheel and pinion gear. If one of the differential gears or pinions is found to be faulty carefully examine the remainder as these may also have been affected. Should the gear or pinion thrust washers show appreciable wear, replace the set (4 pinion or 2 gear washers) to ensure an even distribution of loads when the unit is re-assembled.

If any doubt exists regarding the serviceability of an inspected part, replace it as this may prevent a premature expensive overhaul.

Note : The crownwheel and pinion are only available as a mated pair, so that, in the event of failure of either component, both must be replaced.

Note : The pinion assembly can be removed and serviced as described in Section J.

Differential Re-assembly :

1. Re-assemble the differential casing (with marks matching) and, when new gears or thrust washers are fitted, check that the gears have .008 - .013" backlash after the casing bolts have been tightened to 70 lbs./ft. Two sizes in thrust washers are listed to enable an adjustment to be made, if necessary.
2. Install the crownwheel, if it was removed, and tighten the bolts to tension given in specifications. Use the tab washers to lock the bolts.

Note : Due to tolerance allowance of .002", a crownwheel on low limit may be matched with a casing on the high limit and be an interference fit. In this case, it will be necessary to heat the crownwheel in an oven or oil bath to a temperature of 100° - 120°C (212° - 248°F) before assembling.

3. Install the assembly by manoeuvring it towards the left and then centralising it in the housing. A piece of wood under the crownwheel will prevent bearing damage. Assemble the insert housings, with two opposite setscrews in each, to the differential housing using the original flange shims but without the "O" rings seals. Rotate the differential assembly and check for pre-load. If the assembly has new bearings, the pre-load should be 15 lbs./ins. whilst used serviceable bearing pre-load is 7 - 8 lbs./ins. Add or subtract insert housing shims to adjust the pre-load.

A spring scale pulling on a piece of string wrapped around the carrier adjacent to the crownwheel teeth, should give a reading of approximately 4¼ lbs. for new bearings after the initial inertia of the carrier has been overcome.

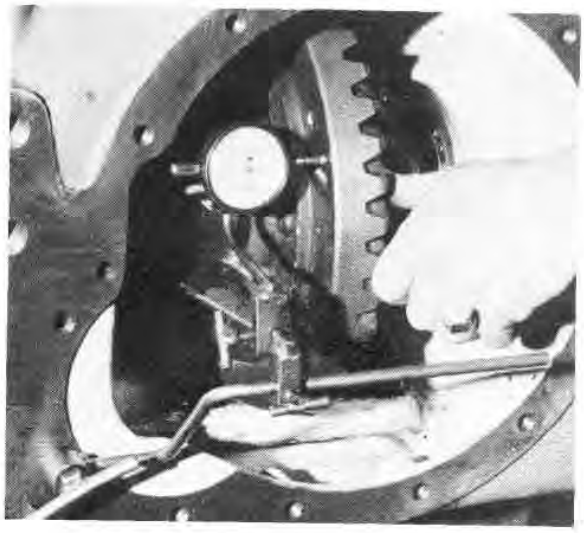


Fig. K3 — Checking Crownwheel Run-out

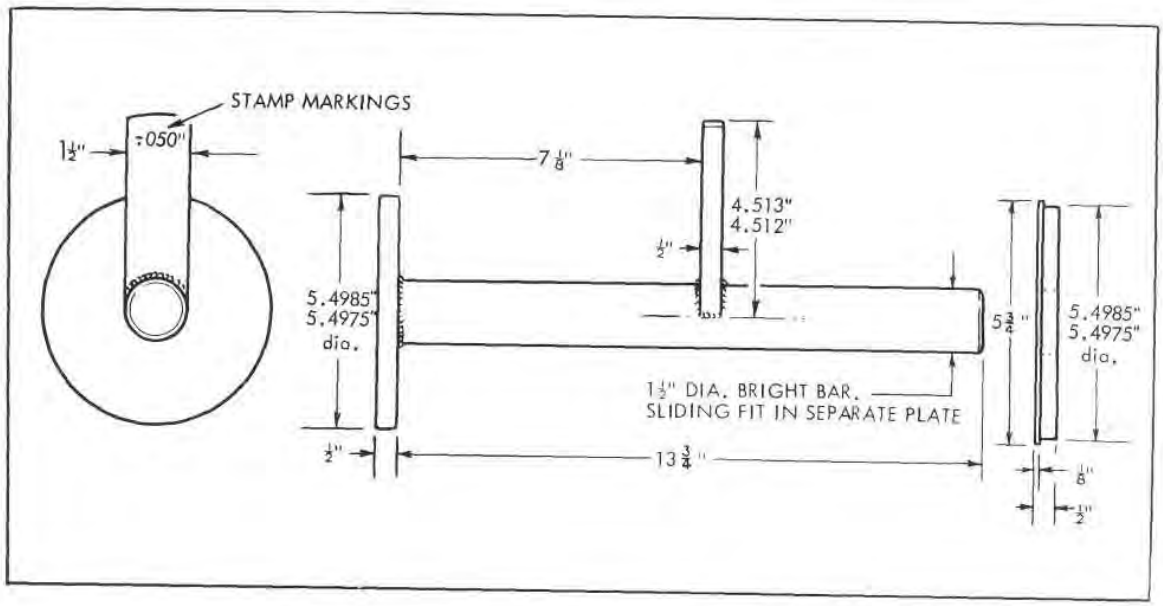


Fig. K4 — Differential Setting Gauge

Note : Bearings should be clean and lightly lubricated with S.A.E. 20 engine oil when pre-load readings are taken.

4. With a dial indicator gauge applied to the back of the crownwheel check that run-out does not exceed .003" total indicator reading. Check for dirt or burrs under the crownwheel, or machine the carrier flange if this is the cause of the run-out.

5. When the differential assembly pre-load is satisfactory and run-out is within the specified limit, remove the assembly and insert housings, ensuring that the shims are kept matched to the housings.

6. Install the pinion assembly in the differential housing. A gauge, as shown in Fig. K4 may be used to adjust the pinion to the cone centre distance from the crownwheel centre line.

Note : The differential setting gauge **cannot** be used on F.W.D. model differentials. At this stage, on these models install the pinion assembly and continue on from paragraph No. 7 Page K - 6.

CAUTION : The gauge is used to obtain a reasonably accurate setting of the pinion **but,** due to machining tolerances of the various parts making up the complete assembly, the final setting **must** be made from a reading of the tooth markings as indicated on Page K - 6.

Reference to the pinion head core plug shown in Fig. K5 shows that the pinion head marking details have been calculated and stamped on the plug. The sign prior to the plug number indicates the direction in which the gap between the pinion head and gauge should be varied from the standard .050" — a minus sign indicating a reduction of the gap, and a plus sign an increase of the gap. Variations are made by moving the position of the pinion mounting plate.

Fig. K5 — Pinion Head Core Plug Marking

The number behind the sign indicates the amount of variation in thousands of an inch. If the core plug becomes displaced and lost, the alternative calculation method described on this page should be used.

Using the gauge, set the assembly as follows :

(a) Check the pinion head for assembly details and establish the necessary gauge gap from the examples shown in Fig. K6.

(b) Place the pinion assembly, with the original shims, in the differential housing. Install three setscrews and tension them to 70 lbs./ft.

Note : Ensure that the shims are clean and the edges are not folded.

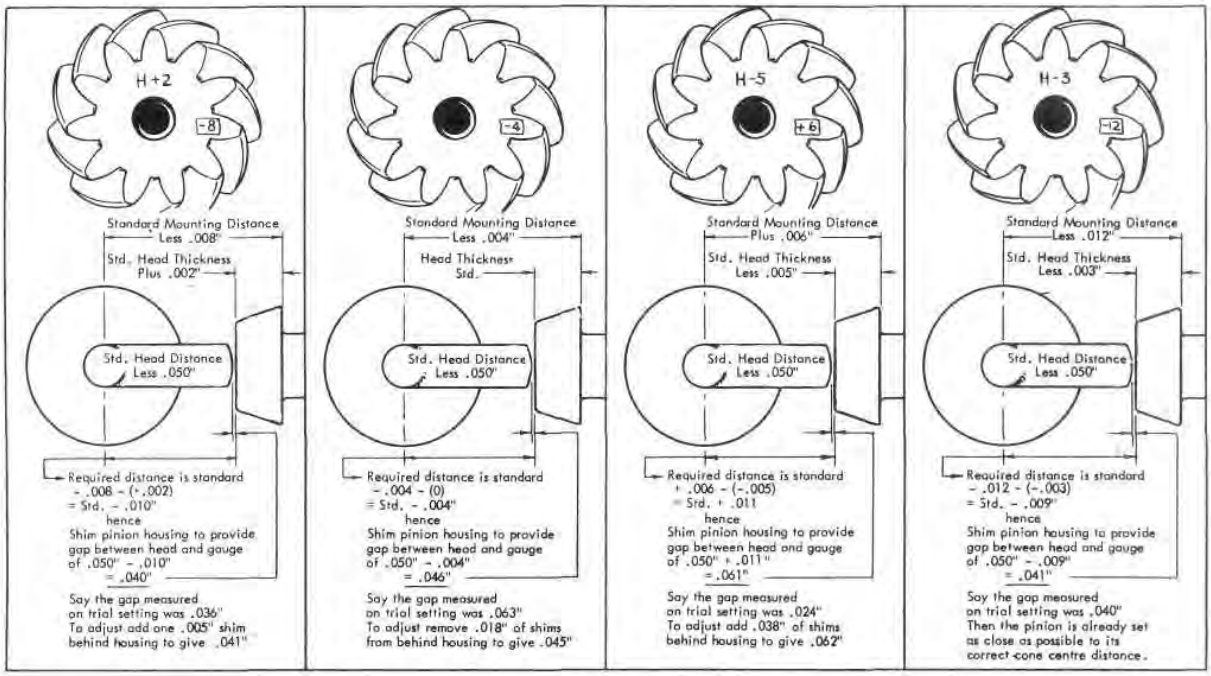


Fig. K6 — Calculation of Pinion Head Housing Shim Thickness

(c) Manipulate the gauge into position with the circular plates located in the bores of the differential housing. Swing the bar into line with the pinion head and measure the gap between the bar and the pinion head machined face with feeler gauges. Taking into account the fact that the gauge is made .050" undersize, calculate from the markings on the pinion head the shimming required under the pinion bearing housing to correctly position the pinion head in relation to the crownwheel.

(d) Remove the pinion assembly, adjust the pinion bearing housing shims as required and re-install the pinion assembly. Re-check the setting and adjust the shims, if necessary. Remove the gauge when the setting is correct.

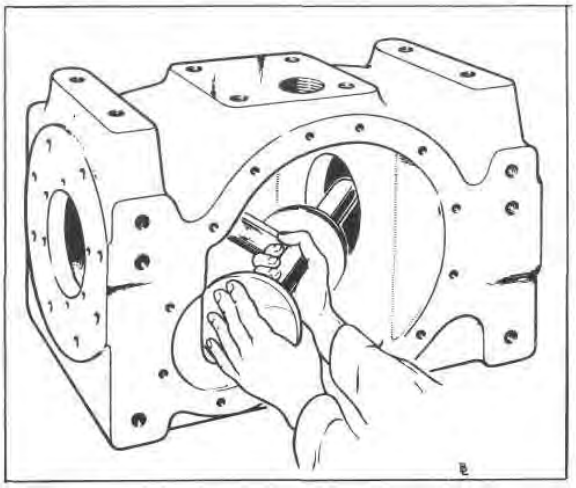


Fig. K7 — Positioning the Gauge

7. Assemble the differential assembly and insert housings, complete with shims, to the housing and, using a dial indicator gauge, check the crownwheel backlash of .008" - .014". Backlash may be increased by moving shims from the right side to the left side insert housing, or decreased by moving shims from the left side to the right side insert housing.

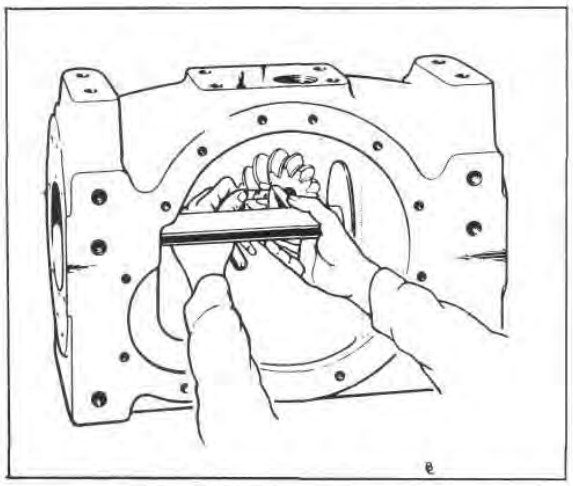


Fig. K8 — Measuring Pinion Head to Bar Gap

8. Mark with red lead or bearing blue 3 or 4 consecutive crownwheel teeth in 3 or 4 different places around the crownwheel and, with an assistant applying a crownwheel load with a piece of wood, obtain crownwheel and pinion tooth markings in forward and reverse directions. Compare the markings with those shown on Page K - 7 and, if necessary, adjust the backlash or pinion position to improve the markings. Concentrate on the driving sides of the teeth as if these are correct the coasting sides will usually be satisfactory. The driving sides of the crownwheel teeth at the rear are the upper sides (std. models) or the under sides (F.W.D. models).

Fig. K9 — Checking Crownwheel Backlash

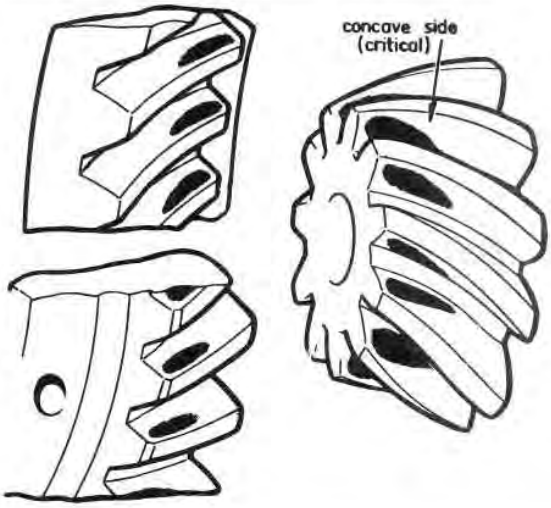
9. When the tooth markings are satisfactory, remove the pinion bearing housing bolts, assemble the tabwashers and oil trough, and tension the bolts to 70 lbs./ft. Ensure that the oil hole in the differential housing, shims and pinion bearing housing are lined-up, and that the tabwashers will not interfere with the gearbox installation.

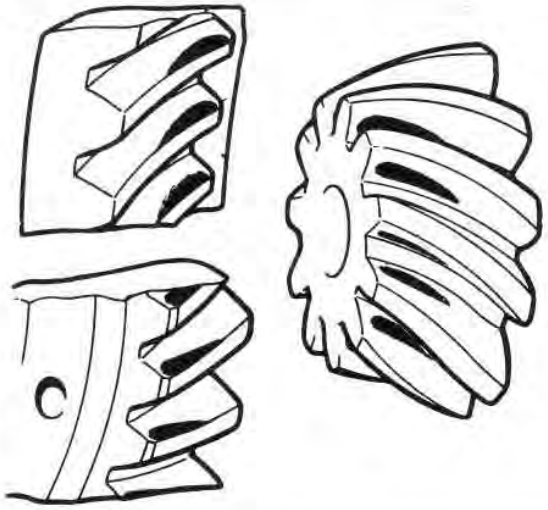
10. Remove the insert housings and install the "O" ring seals. Do not stretch the "O" rings as they will not return to their original size. Check the differential housing bores to ensure that there are no sharp edges to damage the "O" rings, lubricate the "O" rings to facilitate assembly and assemble the insert housing to the differential housing. With the insert flange groove towards the bottom of the housing, install the setscrews, tighten them to 70 lbs./ft.

11. Using new gaskets, re-assemble to the tractor by reversing Paragraphs 1, 2, 3 and 5 of "Removal" instructions Page K - 3.

IDEAL MARKING

With correct backlash the crownwheel and pinion tooth contact should be as shown with the markings ½" - ¾" in length. The best marking obtained should be from the concave side of the pinion tooth which is the most critical.





INCORRECT MARKING

With correct backlash the pinion shown is .015" too far **out** of mesh which is indicated by the marking at the top of the crownwheel tooth.

INCORRECT MARKING

With correct backlash the pinion shown is .015" too far **into** mesh which is indicated by the marking at the base of the crownwheel tooth.

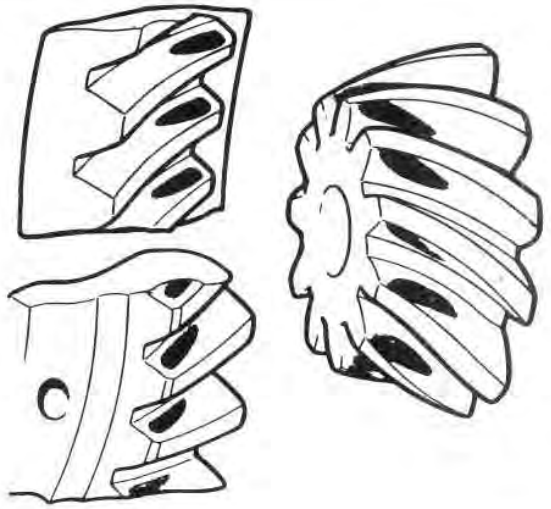


Fig. K10 — Crownwheel Tooth Markings

CHAMBERLAIN

SECTION **L**

FINAL DRIVES

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

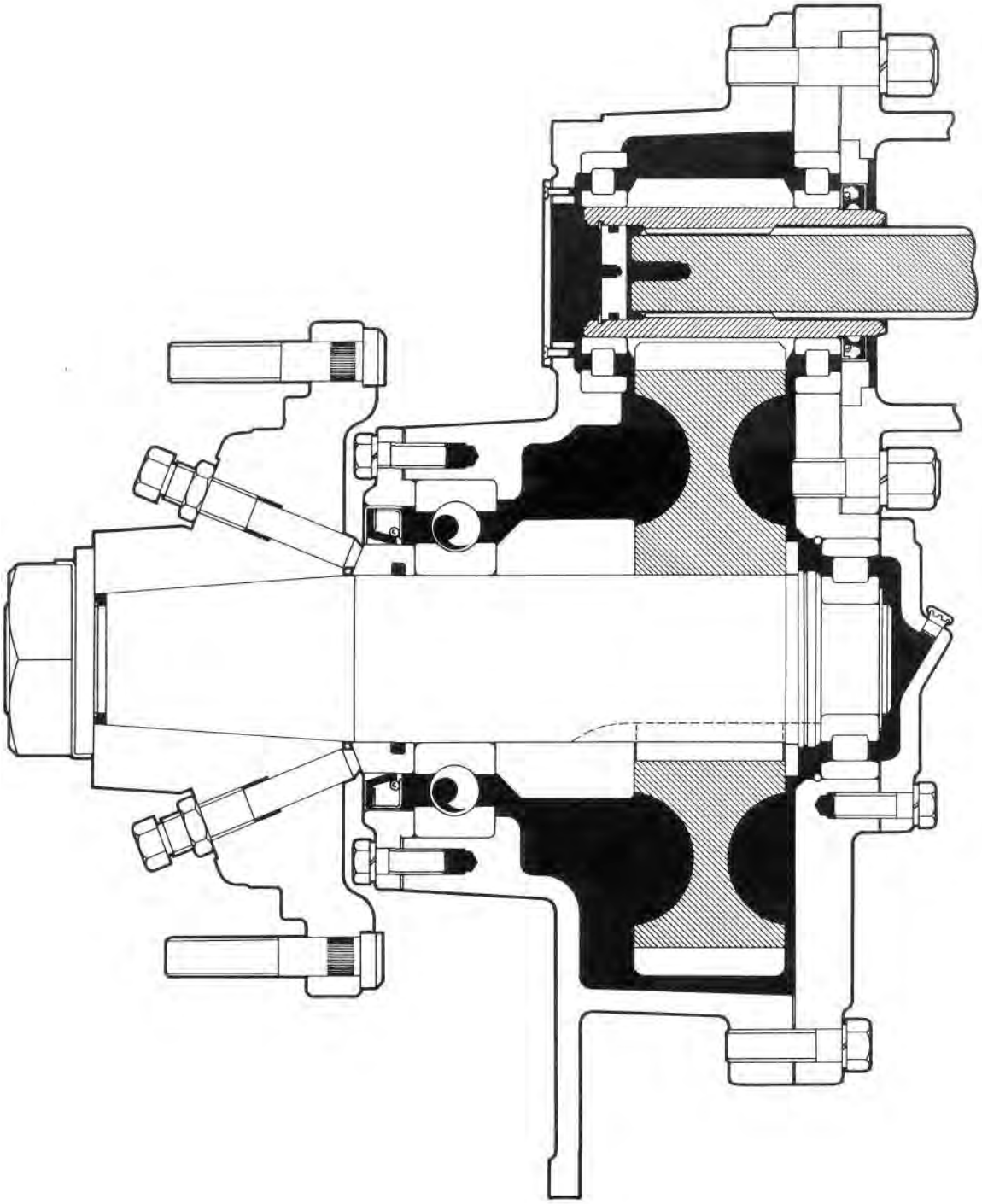


Fig. L1 — Final Drive Assembly

FINAL DRIVES

DESCRIPTION

The final drive units are self contained assemblies attached to the differential unit by two extensions through which pass the two half shafts. The half shafts are splined into the differential and also the final drive pinions. The pinions engage the bullgears which are shrunk and keyed onto the rear axles. The driving wheel hubs are retained on a taper and key on the axle and to the wheel hubs are attached the brake drums. The brake shoes are attached to the final drive housings.

The axle and bullgears are mounted on heavy duty ball bearings on the outer mounting and roller bearings on the inner ends. The side thrusts are taken by the ball bearings. The pinions are mounted on roller bearings.

Large hexagon nuts retain the hubs on the axles, and four setscrews serve the dual purpose of retaining the axle in position, and to jack the hub from the axle. If, for any reason, a hub is removed, care must be taken to ensure that these screws are well backed off until the hub is firmly installed on the axle taper by the large hexagon nut. The screws may then be retightened and locked. Failure to observe this precaution will result in the wheel and hub working loose on the axle.

Lubrication of the units is by oil bath and splash, each unit being fitted with a filler, level and drain plug. A seal is fitted in the outer end of each differential extension and works on an extension of the pinion boss. Oil leakage inward along the half shaft is prevented by an 'O' ring and housing, retained by a circlip in the outer bore of the pinion. Breathers are fitted to the centre of the axle inner bearing cap.

SPECIFICATION

Make	— Own.
Type	— Straight spur gear.
Bullgear	— 49 teeth.
Bullpinion	— 12 teeth.
Axle bearings	— Straight roller and ball.

MAINTENANCE

Check the oil level at 150 operating hours and top-up as necessary.

At 1200 operating hours drain the oil while the tractor is hot from working and refill with new oil as specified.

SERVICING

Final Drive Removal :

1. Slacken, but do not remove, the wheel to hub nuts, and the axle nut.
2. Jack under the differential housing, remove the wheel to hub nuts and, by manipulating the jack up and down, remove the wheel and roll it clear of the working area. Place jacking stands under the differential housing, or other suitable support areas for safety.
3. If the final drive is to be dismantled, remove the hub and brake drum. Remove the hub nut, suitably support the brake drum and back-off the hub jacking screw locknuts. Tighten the jacking screws evenly until the hub is free of the taper, and move the assembly clear of the tractor.
4. Drain the oil from the final drive.
5. Disconnect the brake linkage at the camshaft and remove the lever grubscrew.
6. Remove the mudguard to final drive holding setscrews, support the final drive on a suitable lifting gear and remove the final drive housing to extension nuts. Separate the final drive from the extension, leaving the half shaft in the differential housing, and remove the final drive to a suitable working area.

Note : If both final drives are to be removed, remove the necessary bolts and lift the mudguard and seat frame assembly from the tractor as a unit.

Fig. L2 — Final Drive Oil Level Plug

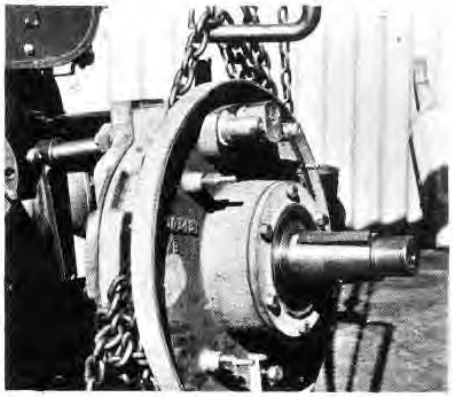


Fig. L3 — Removing the Final Drive

To Dismantle the Final Drive :

1. Remove the brake camshaft as follows :—

(a) Remove the lever and key from the inboard end of the camshaft.

(b) Use circlip pliers to remove the inboard seal retaining circlip and remove the seal and components from the shaft.

(c) Remove the keeper plate circlips and the keeper plate from the brake anchor pins.

(d) Turn the camshaft to the minimum brake position, lever each brake shoe away from the camshaft and remove the shoe actuating pins. Withdraw the camshaft and nylon bush halves from the housing.

2. Remove the anchor pin locknuts and spacers.

3. Remove the brake centralising eccentric locknut.

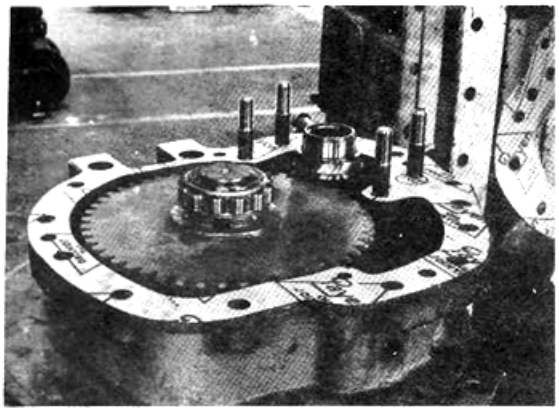


Fig. L4 — Cover Removed

4. Remove the cover to housing bolts, press the dowels through the cover into the housing and separate the housing and cover. Exercise care to ensure that the mating face of the two components is not damaged.

5. Remove the axle outer bearing retainer to expose the oil seal, bearing, and 'O' ring when the collar is also removed.

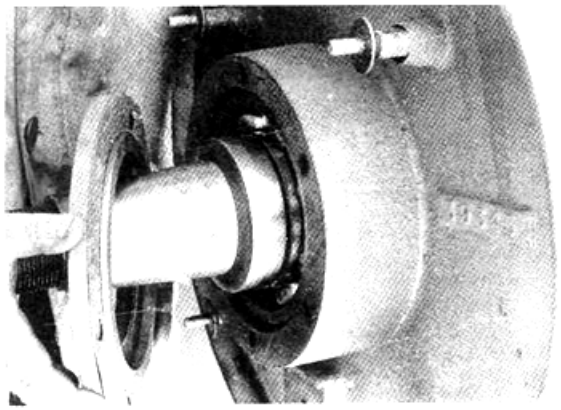


Fig. L5 — Removing Retainer and Seal

6. At this stage all parts may now be visually inspected except the outer pinion bearing. Inspection of this bearing necessitates the removal of the bullgear and pinion before an inspection can be made. An indication of its condition can be obtained by manipulating the pinion and noting any roughness or excess free movement.

7. After the circlip is removed the axle roller race can be removed with the aid of a bearing puller. The outer race removal from the cover requires the bearing cap to be removed.

8. Mount the housing in a press, support it adequately on blocks, and press the axle and bullgear from the housing. As the pinion should be freed as the bullgear is removed, ensure that the pinion does not foul during the pressing operation.

9. The axle ball bearing can be presed or drifted from the housing.

10. Jacking screw holes are provided in the housing to enable the pinion roller bearing outer race to be removed.

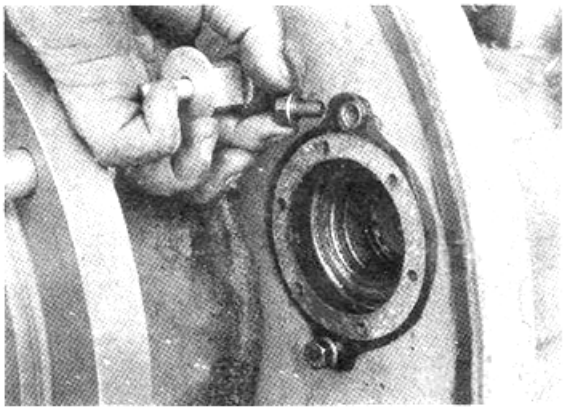


Fig. L6 — Pinion Bearing Jacking Screw Holes

11. Use a bearing puller to remove the bearings from the pinion.

Inspection :

Thoroughly clean and examine all components including the 'O' ring in the pinion bore and, if any doubt exists as to the serviceability of any part, replace it.

To Re-assemble the Final Drive :

1. Install the axle ball bearing in the final drive housing and assemble the retainer without the oil seal.

Note : Matched housings and covers only are available as replacement parts to ensure correct alignment. It is necessary to ream the holes for bolts 39733 and dowel 23270 if replacing the assembly in the field.

2. Install the pinion roller bearing outer race in the final drive housing, ensuring that the jacking screws are first removed.

3. Fit the housing, 'O' ring, and circlip to the pinion outer bore and assemble the roller bearing inner races.

4. Support the final drive housing under the press, outer face downwards, with the axle ball bearing inner race also supported. Install the bullgear collar and position the bullgear in the housing. Prior to pressing the bullgear into position, engage the pinion with the bullgear so that during the pressing operation

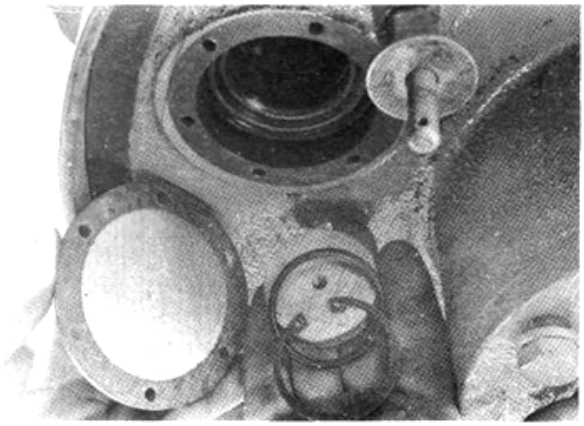


Fig. L7 — Pinion Bore Sealing

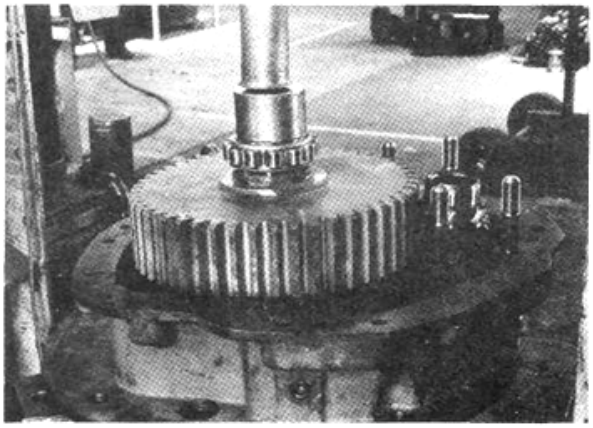


Fig. L8 — Pressing the Bullgear into the Housing

the outer pinion bearing is located in the outer race. Ensure that the bearing is not jammed as the bullgear is pressed into place.

5. Install the axle inner bearing and fit the circlip.

6. Install the axle and pinion bearing outer races in the cover, position a new cover to housing gasket and, using guide studs, assemble the cover to the housing. Install the dowels before the cover to housing bolts are finally tightened.

7. Fit the axle inner bearing cap, using a new gasket.

8. Turn the assembly over, remove the axle bearing retainer and fit the oil seal. Install the 'O' ring in the axle collar and position the collar on the axle. Assemble the retainer to the housing, using a new gasket.

9. If it was removed, refit the pinion bore cover plate and gasket, and fit the bearing knock-out setscrews or Allen screws.

10. Replace the brake centralising eccentric locknut and the anchor pin spacers and locknuts.

11. Replace the brake camshaft as follows :—

(a) Install the camshaft and nylon bush halves in the housing, using a clay based, non-melting grease suitable for high temperature operation in disc brakes, on the inner and outer surfaces of the bush, turn the camshaft to the minimum brake position, lever each brake shoe away from the camshaft and install the shoe actuating pins.

(b) Install the keeper plate and circlips on the anchor pins.

(c) Install the seal components on the camshaft and position the circlip.

(d) Replace the key, lever and lever grubscrews.

Final Drive Replacement :

1. Suitably support the final drive, align the half shaft splines with the pinion and position the assembly on the extension, carefully entering the pinion in the seal. Tension the housing to extension stud nuts to 220 - 240 lbs./ft.

Note : If a new assembly has been fitted, ream the holes for the bolts 393733 and dowel 23270.

2. Replace the mudguard to final drive holding setscrews.

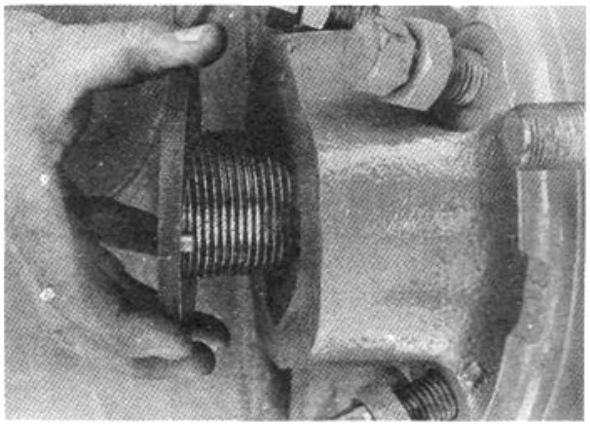


Fig. L9 — Correct Assembly of Washer and Peg

3. Replace the key, hub and brake drum. Ensure that the hub jacking screws are backed well off so that they will not engage the axle 'O' ring collar and prevent correct seating of the hub on the axle. The axle nut should be flogged up tight and the jacking screws turned in until they all contact the collar solidly then, as an added insurance, back them off ⅛ turn to provide a slight clearance, before tightening the locknuts. A slight clearance is acceptable as oil leakage is prevented by the collar 'O' ring.

Note : If the hub is held clamped between the collar and the nut, it will appear to be tight, but will in fact be loose on the taper. It will move in service, fretting the axle, and apply concentrated loads where the hub contacts the axle. Axle failure or cracking of the hubs can result. If a hub has been allowed to move as described, the bore of the hub will be slightly belled and it will be necessary to lap the hub onto the axle to obtain a good seating.

4. Connect the brake linkage and camshaft lever.

5. Re-adjust the brakes, if necessary (Section N).

6. Replace the wheels and, after the tractor has been taken off the jack, refill the final drive to the correct level with new, clean recommended oil.

7. Re-tighten the wheel nuts when the wheel is resting on the ground.

CHAMBERLAIN

SECTION **M**

MULTI-PLATE P.T.O. AND BELT PULLEY

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

M

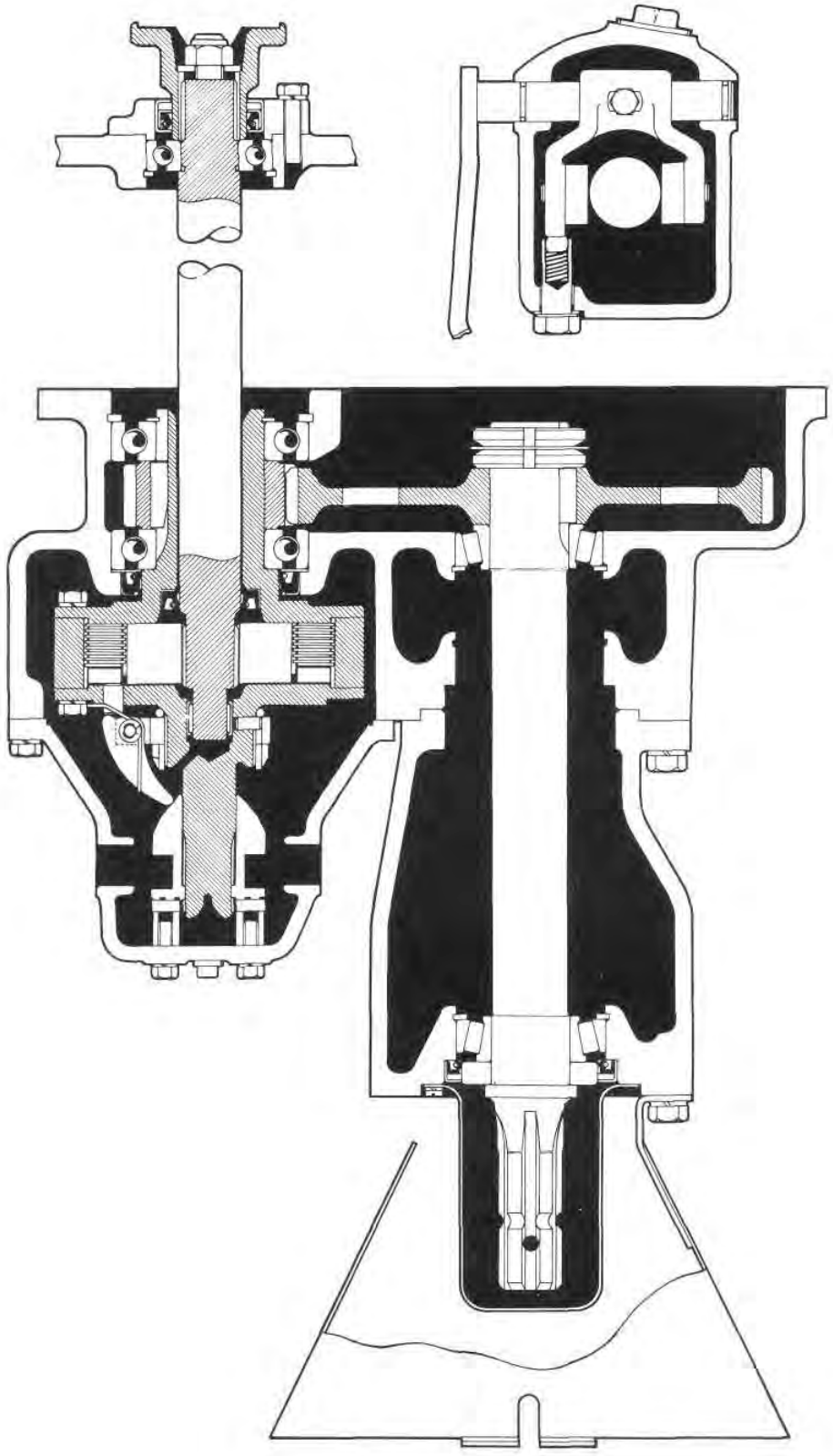


Fig. M1 — Power Take-Off Assembly

MULTI-PLATE P.T.O.

Optional on Std. Manual Model only

DESCRIPTION

The power take-off unit is mounted on the differential housing.It is coupled to the engine by a splined shaft fitted into the engine flywheel and passing through the main clutch and primary gearbox upper mainshaft to drive a train of three spur gears in the rear of the primary gearbox.

Onto the shaft of the lowest gear is coupled a universally jointed tail shaft which carries the drive to the differential housing. A further splined shaft passes through the differential housing into the clutch driving hub of the multi-plate P.T.O. mounted on the unit.

The P.T.O. operating lever, adjacent to the dirver's seat, compresses the clutch through a fork controlled cone and pawl arrangement and transmits the drive through a gear train to the out-put shaft. The lever is retained in the engaged position by the action of the moveable cone on the three clutch pawls and in the disengaged position by a detent ball and spring.

To provide a positive output shaft stop, the clutch cone is splined to the end plate pin and, when disengaged, contacts a friction disc attached to the shifter fork housing.

The drive gears and bearings are splash lubricated from the differential unit, and the P.T.O. clutch is lubricated with high quality A.S.D., P.T.O. clutch oil. A large filler plug, fitted in the top of the housing above the output shaft, enables the differential oil to lubricate the bearings as the differential is being filled and the P.T.O. shifter fork housing is fitted with a filler and level plug for the clutch.

SPECIFICATION

Input shaft speed	— Engine R.P.M.
P.T.O. shaft Speed	— 540 R.P.M. @ 1600 engine R.P.M.
Spline	— A.S.A.E. standard 1⅜" 6B.
P.T.O. Torque	— 152 lbs./ft. @ 2000 engine r.p.m.
Rotation	— Clockwise, viewed from rear.
Clutch Type	— Multi-Plate.
Clutch Control	— Fork-controlled cone and pawl arrangement.
Clutch adjustment	— Depitched locknut.

MAINTENANCE

The P.T.O. clutch is lubricated with a low viscocity, high index, anti-foam oil, and the level should be checked every 50 operating hours, using the plug provided in the shifter fork housing. The oil must be changed every 600 hours of operation or more often if the oil shows signs of contamination. A plug is fitted on top of the cover for filling purposes and the drain plug is under the main P.T.O. housing.

Transmission oil from the differential unit splash lubricates the drive gears and bearings.

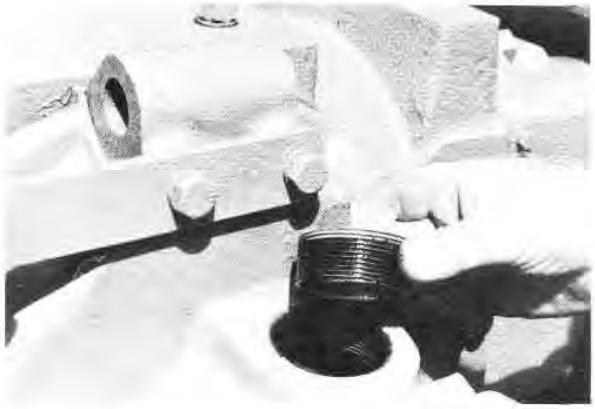


Fig. M2 — P.T.O. Transmission Filler Plug

CLUTCH ADJUSTMENT

The control rod is positioned on assembly and should not require further adjustment. Clutch slippage is an indication that plate wear has occurred and an internal adjustment is provided to increase the pressure exerted by the pawls to compress the clutch plates. Remove the large plug in the top of the fork housing and, using a hammer and large screwdriver, tighten the locknut position. A force of 40 lbs. on the handlever knob when the engine is running is adequate. Check that the pawls are moving well onto the cone parallel area in the engaged position.

Note : Over-tightening when cold can result in only partial engagement when the plates are heated and expanded, with the clutch tending to slip and "jump-out".

Fig. M3 — Clutch Adjustment

If any trouble is experienced with the clutch operation, ensure that the handlever does not foul the footplate slot in either the engaged or disengaged position before proceeding with further investigations.

Adjust the operating rod as necessary to overcome the condition.

To ensure that the weight of the P.T.O. lever, when the tractor is operating over rough ground, cannot jerk the P.T.O. out of engagement. a lever support mechanism is fitted. With the operating rod removed, the lever should snap into the engaged and disengaged positions. The spring exerts only enough force to hold the lever and no attempt should be made to increase this force.

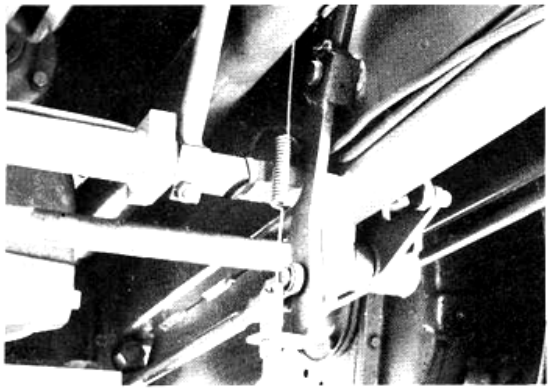


Fig. M4 — P.T.O. Lever Support Mechanism

SERVICING

Clutch Slippage :

This condition should not occur if the clutch is correctly adjusted but, if it is still evident after the adjustment has been made, it will be necessary to drain the clutch housing oil, remove the shifter fork housing and thoroughly inspect the internal mechanism.

Clutch Failing to Disengage Correctly (dragging) :

If this condition exists, proceed as follows :—

1. Ensure that the clutch lever is not restricted by the handlever hitting the end of the footplate slot, or by the operating rod or fork lever contacting the drawbar track (if fitted).
2. Ensure that the correct oil is being used and that it is to the correct level.
3. Check the clutch for correct adjustment (Page M3).
4. Check the clutch brake for correct adjustment (Page M6).
5. Drain the oil and remove the fork housing. Check the condition of the oil. Some evidence of bronze sheddings and blackening of the oil is to be expected but, the presence of steel or iron sheddings indicates a mechanical fault. Noticeable thickening is detrimental and could be due to entry of transmission oil caused by a leaking front end plate seal.
6. Check for fouling between the fork yoke and the cone.
7. Check that there is a minimum of .010" clearance between the pressure plate and the clutch plates with the clutch disengaged.
8. Dismantle the clutch and check these points :—

(a) That the thrust pins are free sliding fit in the rear end plate. Dirt can cause jamming with resultant drag.

(b) That the dished steel outer plates are fitted in the correct sequence (Page M6).

(c) That all the plates are free in their splines and that the front plate is not trapped between the hub and the front end plate.

Clutch Dismantling :

1. Disconnect the hand lever operating rod by removing the circlip and clevis pin from the clevis and fork lever.
2. Drain the clutch housing oil from the plug beneath the P.T.O. housing.
3. Remove the shifter fork housing bolts and lift the housing from the unit. Support the clutch operating cone to avoid dropping when removing the housing.

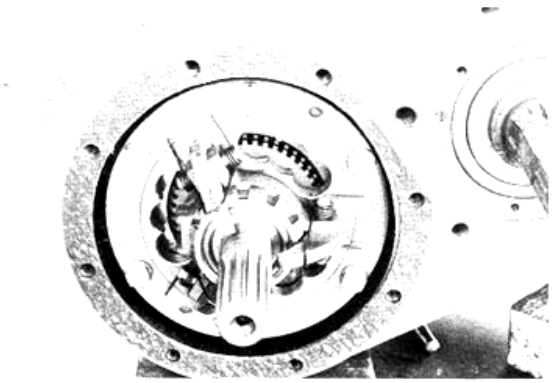


Fig. M5 — Shifter Fork Housing Removed

4. Remove the setscrews retaining the rear end plate to the driven ring gear and lift the plate off as an assembly. Two jacking screw holes are provided to be used if the plate is tight on its spigot. Do not use levers.

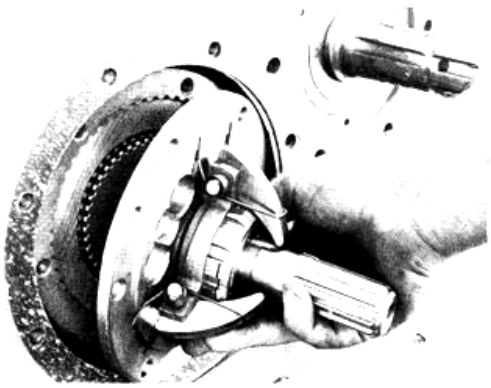


Fig. M6 — Rear End Plate Removed

5. Lift the clutch driving hub from the unit, then the pressure plate and clutch plates. Note the order in which the plates are assembled.

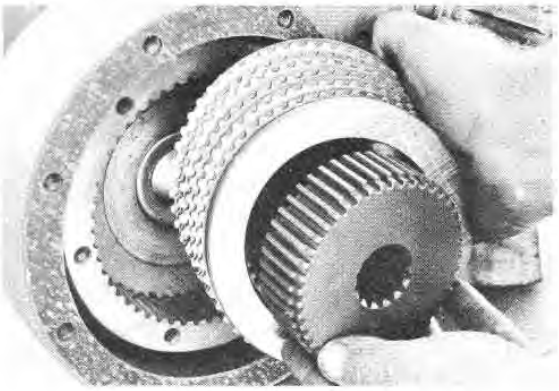


Fig. M7 — Clutch Driving Hub and Clutch Plates

6. The front end plate inner oil seal is now accessible if the clutch shaft is removed (Page M6 paragraph 3) and the seal can be replaced using a standard seal remover but, the end plate outer seal requires removal of the unit from the tractor.

7. The pawl assembly on the rear end plate can be dismantled by unscrewing the clutch adjusting locknut and lifting the collar from the rear plate. Removal of the pawl release springs and the pawl pivot pin circlips will enable the pawls and pivot pins to be disassembled. The thrust pins can be removed from the front or rear of the end plate.

Fig. M8 — Pawl Assembly and Thrust Pins

8. The shaft and lever assembly 'O' rings can be exposed by removal of the ball and spring retaining plug under the fork housing, removing the fitted fork bolt and sliding the shaft and lever from the fork housing. If a new fork is required it will be necessary to ream the bolt hole in the replacement to the correct size.

9. The clutch brake friction disc can be renewed by removing the two screws attaching it to the brake plate bolted inside the fork housing.

Fig. M9 — Clutch Brake Friction Disc

Clutch Inspection :

1. Thoroughly inspect all parts including the end plates 'O' ring and collar stop pin and, if any doubt exists regarding the serviceability of a component, replace it.

2. Examine the clutch plates for spline and face wear, and for distortion. Most wear will be evident on the splines of the inner plates but the plates do not require replacement unless the splines are worn to half their original width.

3. Replace any clutch plates which have a detectable buckle or wave. Buckled or wavy plates can cause loss of clearance when the clutch is disengaged, resulting in drag.

4. To provide a smooth clutch engagement, the steel outer plates have an initial "dish" set of .015" - .018" but wear and progressive settling will reduce this figure in service.

Plates with less than .014" dish will tend to drag but will not affect the clutch's ability to transmit full power.

5. Check the clutch driving hub and the clutch shaft for worn splines and replace, if required.

6. Check the condition of all oil seals and, if they are at all worn, replace, as the cost of subsequent dismantling to correct leakage would be much higher than the cost of the seals.

Clutch Re-Assembly :

1. Install the 'O' ring on the rear end plate. This 'O' ring restricts the forward movement of the collar during initial engagement which can result in a friction lock and "double engagement" action.

2. Assemble the pawl assembly and install it on the rear end plate, ensuring that the stop pin is correctly engaged and that the thrust pins are clean, lightly lubricated and a free fit in their position.

3. If the clutch shaft was removed, use a seal guide over the rear splines, install the clutch shaft through the front end plate oil seal and fix it in position so that the seal is not damaged by movement of the splines. Remove the seal guide.

4. Install the driving hub in the ring gear (shouldered edge to the rear) and assemble the clutch plates (Fig. M10).

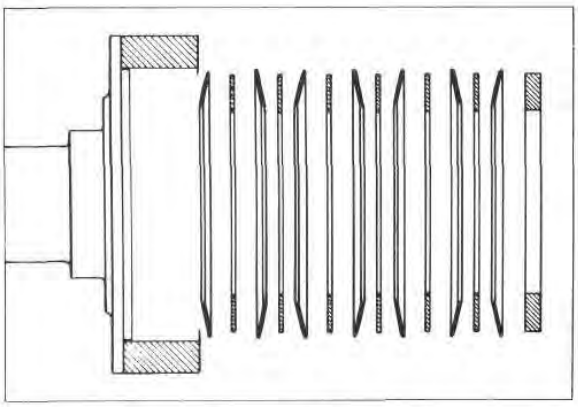


Fig. M10 — Assembly of Outer Clutch Plates

5. Re-assemble the rear end plate assembly to the ring gear, using any shims previously fitted, and tighten the setscrews evenly to 31 lbs./ft. Check that there is a minimum of .010" clearance between the pressure plate and the clutch plates. Adjust the rear end plate shims as necessary.

6. With the shifter fork housing removed from the unit, check that the lever detent holds the cone firmly against the brake disc. If it does not, add sufficient shims P/No. 43842 (.005") or P/No. 43843 (.010") between the housing and brake plate. Do not add more than necessary.

7. Replace the fork housing assembly, aligning the operating cone splines with the end plate and using the same thickness new gaskets as previously fitted. Tighten the bolts to 27 lbs./ft.

8. Remove the large plug in the top of the fork housing and check the clutch brake adjustment. With the clutch disengaged, there should be a gap of approximately 1/16" between the underside of the pawls and the adjusting nut chamfer. Adjust the fork housing gaskets as necessary to give correct brake adjustment.

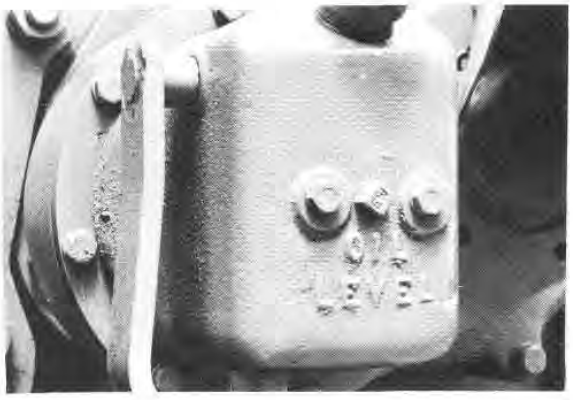


Fig. M11 — Clutch Housing Oil Level Plug

9. Fill the clutch housing with new, recommended oil to the correct level and connect the operation rod and fork lever. Test the operation of the P.T.O. and adjust as necessary.

To Remove the P.T.O. Unit :

1. Drain the transmission oil from the plug beneath the differential housing.

2. Disconnect the handlever operating rod at the fork lever clevis.

3. As the clutch shaft is fitted through an oil seal and locates in a needle roller bearing at its rear end, it is recommended that the shaft be removed with the P.T.O. unit. Prepare for the shaft removal as follows :—

(a) Remove the P.T.O. coupling shaft (Section H).

(b) Unscrew the self-locking nut from the forward end of the clutch shaft and remove the P.T.O. coupling split yoke.

(c) Remove the setscrews holding the retaining plate to the differential housing and remove the plate and seal.

4. Support the unit and remove the P.T.O. housing to transmission bolts. A pin through the T.P.L. top link pivot point, used in conjunction with lifting tackle is the ideal method of support. The unit may now be moved back from the differential housing, taking the P.T.O. clutch shaft with it.

Note : If it is necessary to use a drift to remove the shaft from the front bearing, avoid damaging the shaft thread.

Output Shaft and Collar Removal :

With the P.T.O. unit removed from the tractor :

1. Unlock and remove the circular nuts on the forward end of the P.T.O. shaft, using a suitable "C" spanner.

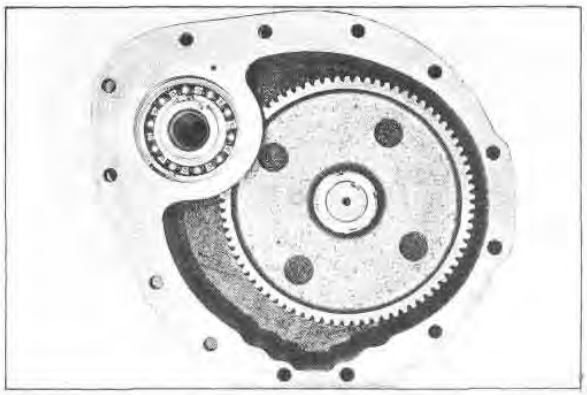


Fig. M12 — P.T.O. Gears

2. Suitably support the unit and press the shaft from the rear of the housing. If a press is not available two methods of removal are listed :

(a) Bridge the housing with a plate bolted through the housing-to-transmission bolt holes and, using a large threaded bolt, tapped through the bridging

piece, engage the end of the shaft and push it out through the housing, or

(b) Use a large hammer and drift to shock the shaft from the housing. This method is definitely not recommended, but if used as a last resort the large gear must be clamped against the bearing cone to prevent brinelling of the bearing cup whilst the shaft is removed. Two 8" "G" clamps can be used to hold the gear in position by clamping against the housing.

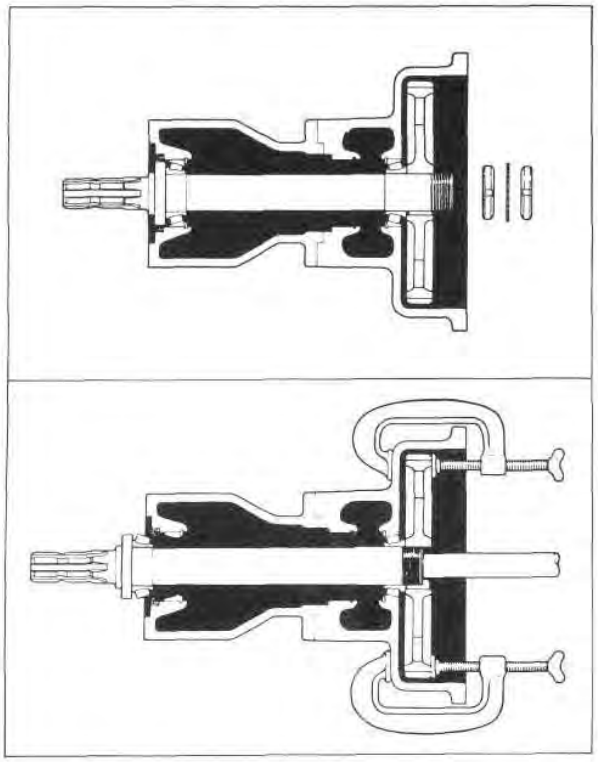


Fig. M13 — P.T.O. Shaft Removal

3. The bearing cups and the rear oil seal are now accessible and may be removed, if necessary.

4. If the collar, fitted to the shaft, is grooved in the seal seat it will require replacing. As the collar is shrunk onto the shaft, it is recommended that heat be applied for its removal, as damage to the shaft can occur if other means are employed and the replacement part may not then fit correctly.

Front End Plate Removal :

The clutch must be dismantled and the P.T.O. unit removed from the tractor :

1. If not already removed as under "Output shaft and Collar Removal" remove the output shaft and the large driven gear.

2. Remove the external circlip from the front of the end plate.

3. With a drift or press, force the front end plate through the bearings and into the clutch compartment.

4. Remove the internal circlip from the housing and drift the front bearing, gear and the rear bearing forward from the housing. It will be necessary to drive the rear bearing through both bearing bores

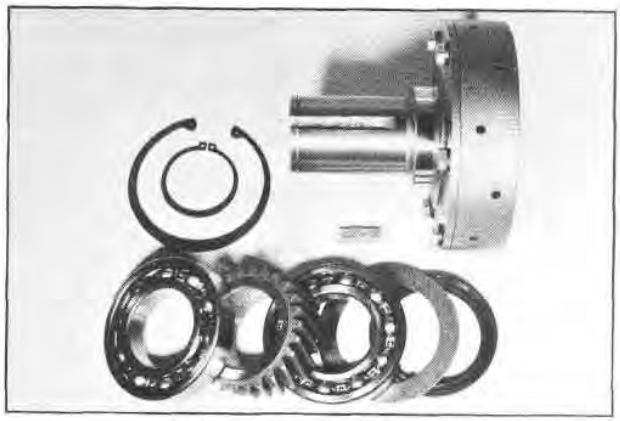


Fig. M14 — Front End Plate Components

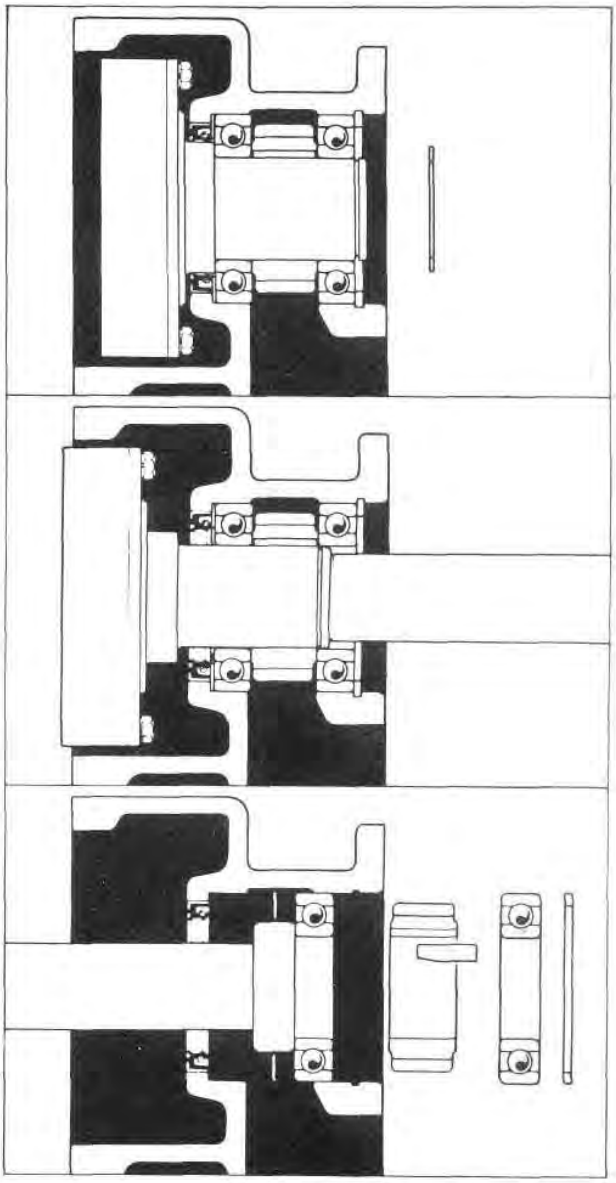


Fig. M15 — Front End Plate Removal

and care must be exercised when starting the bearing through the front bore to prevent jamming. Collect the bearing shield.

5. The oil seals may now be removed, if required.

P.T.O. Re-Assembly :

The procedure for re-assembly is virtually a reversal of the dismantling sequence given, but the following points should be noted.

(a) Use new gaskets throughout on thoroughly cleaned faces.

(b Exercise care with all oil seals when re-assembling the respective shafts. If a shaft with a tight spline or sharp shoulder is to be pushed through a seal, protect the seal lips with either a suitable seal guide or by wrapping shim brass around the shaft.

(c Front end plate re-assembly : It will be necessary to fit the outer seal, pass the end plate boss through the seal ,block the end plate to prevent it moving towards the rear, place the pinion bearing shield in position and drive the two bearings, gear and key onto the end plate boss from the front.

(d When re-assembling the P.T.O. shaft bearings ensure that the correct bearing is fitted onto the rear of the shaft. (The rear bearing is slightly larger in the bore to allow it to clear the front boss of the shaft during re-assembly). Heat the bearings in an oil bath to facilitate installation.

(e) After the rear bearing is installed on the P.T.O. shaft, place the heated front bearing in position with the driven gear and re-assemble the shaft through the bearing and gear using the locknut to draw the assembly into position. Allow the bearings to cool and use the locknut to obtain the condition where no end float or pre-load is apparent in the bearings.

If no oil heating facilities are available, press or bump the shaft into position. In either case, the gear must be clamped into position to enable the shaft to be pushed through and two 8" "G" clamps, placed over the housing and clamping the gear to the housing, can be used provided the gear is centrally located.

(f) Ensure that the clutch shaft is positioned prior to P.T.O. installation and that the end spigot is correctly located in the needle roller bearing.

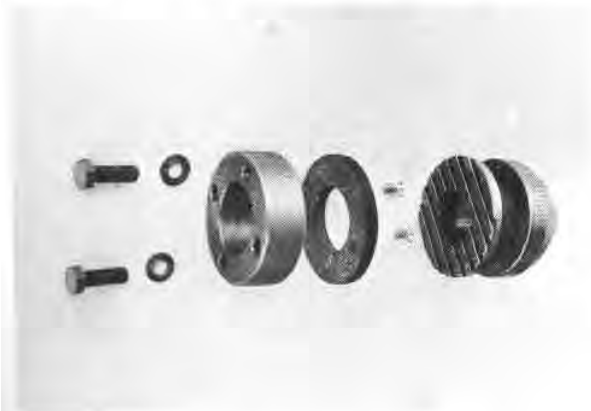


Fig. M16 — Clutch Brake Components

(g) Check the clutch for brake operation when disengaged.

COUPLING OF P.T.O. DRIVEN IMPLEMENTS

Although some early implements were fitted with constant velocity joints, most modern implements use the simple Hookes type joint with provision for adjustment, to provide a final output to the implement mechanism at a constant velocity, even though the intermediate shaft, or shafts, may have a considerable speed fluctuation.

The Chamberlain live P.T.O. drive will transmit more than 100 H.P. but it can be damaged when driving an implement using less than 30 H.P., if that implement incorporates a heavy revolving component having appreciable flywheel inertia and the joints are badly maladjusted.

Basically, the output shaft from a Hookes joint bent at an angle doesn't turn at a steady speed but flicks twice in every revolution as the forks pass over dead centre. This flick or jerk is mild if the joint is bent at only 5°or even 10°, but becomes violent at 20° or 30°.

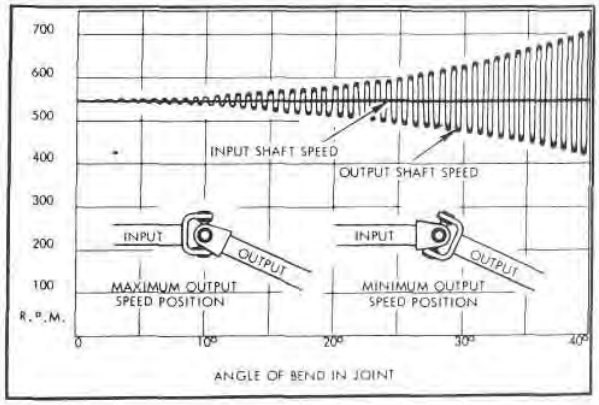


Fig. M17 — Shaft Fluctuation Graph

As an illustration of this, if a tractor P.T.O. shaft turning at 540 R.P.M. is coupled to a universal joint bent at 30°, the speed of the output shaft from the joint will fluctuate between 629 and 467 R.P.M. every 180°. (See Fig. M17).

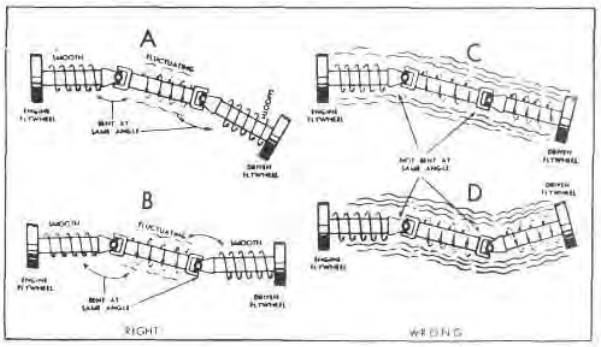


Fig. M18 — Coupling Shaft Action

This jerking motion can be corrected if the drive is taken through a second joint provided :

(a) Both joints are bent at the same angle and

(b) The yokes on the intermediate shaft connecting the two joints are in the same plane and not turned at 90° to each other.

If adjusted in this manner the shaft ends can safely be connected to heavy revolving parts without damage. (See Fig. M18).

Most implement manufacturers provide precise instructions to ensure that the tractor and implement are not damaged and provide adequate means of adjustment to ensure correct alignment, but the following is a general instruction :

With the tractor and implement in line, the joints directly in front and behind the hitch point must be —

(a) Straight or bent as (A) in Fig. M18, viewed from above and from the side.

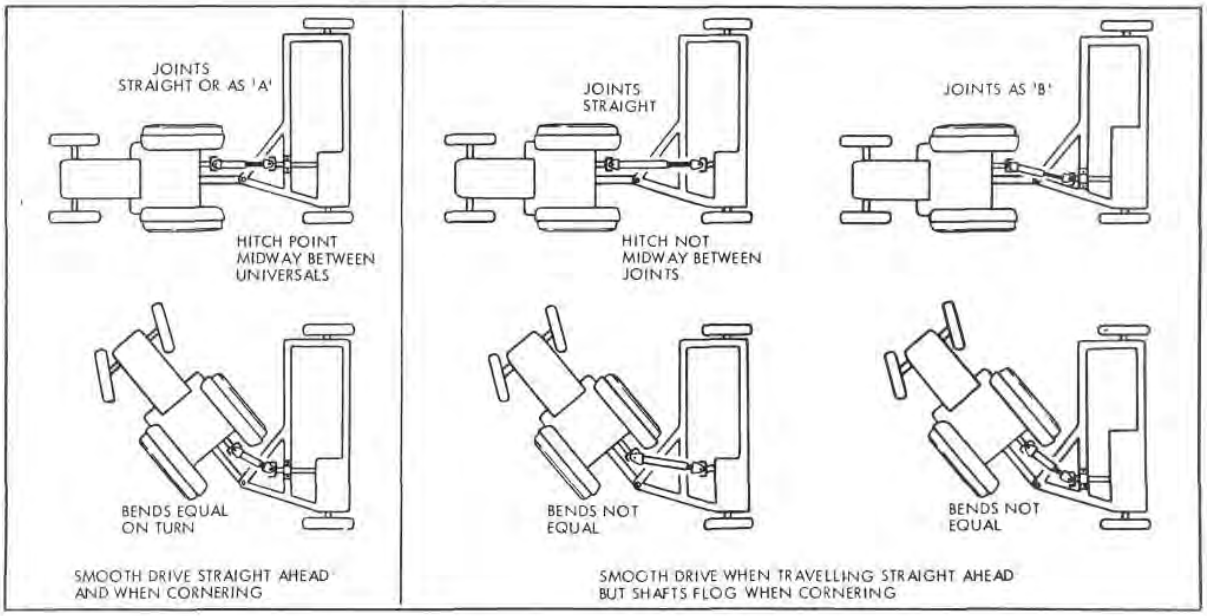


Fig. M19 — Correct and Incorrect Hitching

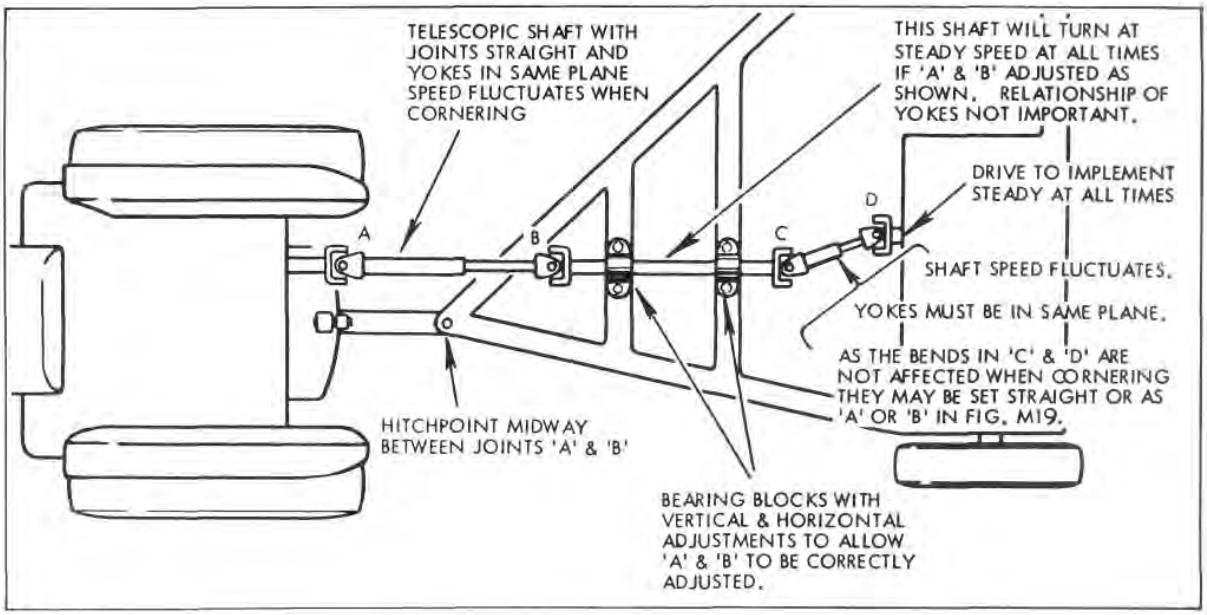


Fig. M20 — Correct Hitching and Two Additional Joints

(b) Eqi-distant from the hitch point. In other words, the hitch point must be half way between the two joints.

If connected in this manner the two joints will be bent at the same angle when the tractor and implement are turning a corner or crossing a rise or gully, and the implement mechanism will be driven at a constant speed. (See Fig. M19).

Some implements are fitted with either one or two additional joints to line up the implement drive.

If two additional joints are provided (making a total of four joints) they must be adjusted as A or B in Fig. M18. (See Fig. M20).

If only one additional joint is fitted however, its purpose is to provide only slight adjustment and must be kept as straight as possible, as any appreciable bend in this joint cannot be counteracted.

BELT PULLEY UNIT

DESCRIPTION

The Belt Pulley unit bolts onto the rear of the P.T.O. unit, and its drive shaft internal splines mesh with the protruding P.T.O. output shaft. The drive is transferred from the shaft bevel gear to the bevel pinion shaft on which is mounted the belt pulley with a taper and key, retained by a slotted nut and split pin. Taper roller bearings are used throughout the unit.

The P.T.O. operating lever, adjacent to the driver's seat, is used to engage or disengage the drive. Transmission oil is used to lubricate the gears and bearings.

When using the belt pulley, manoeuvre the tractor to align the pulleys, creep the tractor forward until the belt has sufficient tension to carry the load and engage the park brake. Put the primary gearbox lever in neutral and release the foot clutch pedal. With the governor control set at a required speed, gently engage the P.T.O. clutch to start up the belt. Keep clear of the belt and pulleys when they are operating.

SPECIFICATION

Shaft Speed	— 1188 R.P.M. @ 1600 engine R.P.M.
Belt Speed	— 3100 ft./min. @ 1600 engine R.P.M.
Pulley Size	— 10¼" dia. x 6¼" wide.
Gear Ratio	— Pinion Bevel — 15T. — Gear Bevel — 33T.

MAINTENANCE

The oil level should be checked every 50 operating hours, using the plug provided, and renewed every 1200 operating hours. A plug is fitted to the top of the housing for filling purposes.

SERVICING

Oil Leakage :

Three seals are incorporated in the unit and oil leakage necessitates the seals being replaced. The front seal can be replaced by removing the adjusting nut, but the pinion shaft seals require the pinion assembly to be dismantled. If oil becomes apparent in the internal bore of the drive shaft, the plug at the rear of the shaft requires replacement.

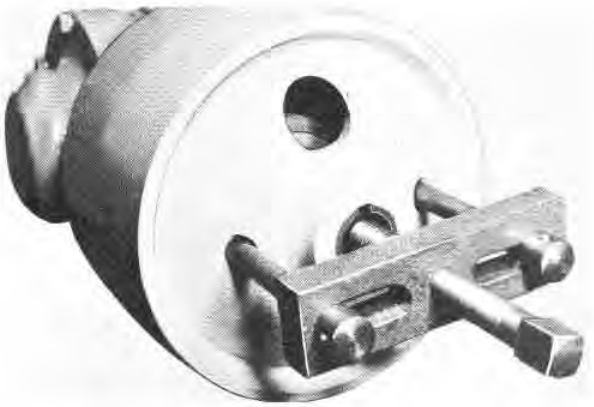


Fig. M22 Belt Pulley Removal

DISMANTLING

Pinion Assembly :

1. Drain the oil from the unit.
2. Remove the split pin, slotted nut and washer from the belt pulley shaft.
3. Using a suitable puller, remove the pulley. A sharp tap with a hammer against the centre screw of the puller may be necessary to free the pulley from the taper on the shaft. Remove the key.

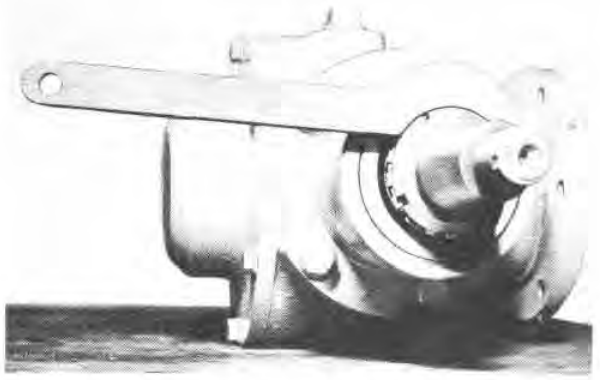


Fig. M23 — Circular Nut Removal

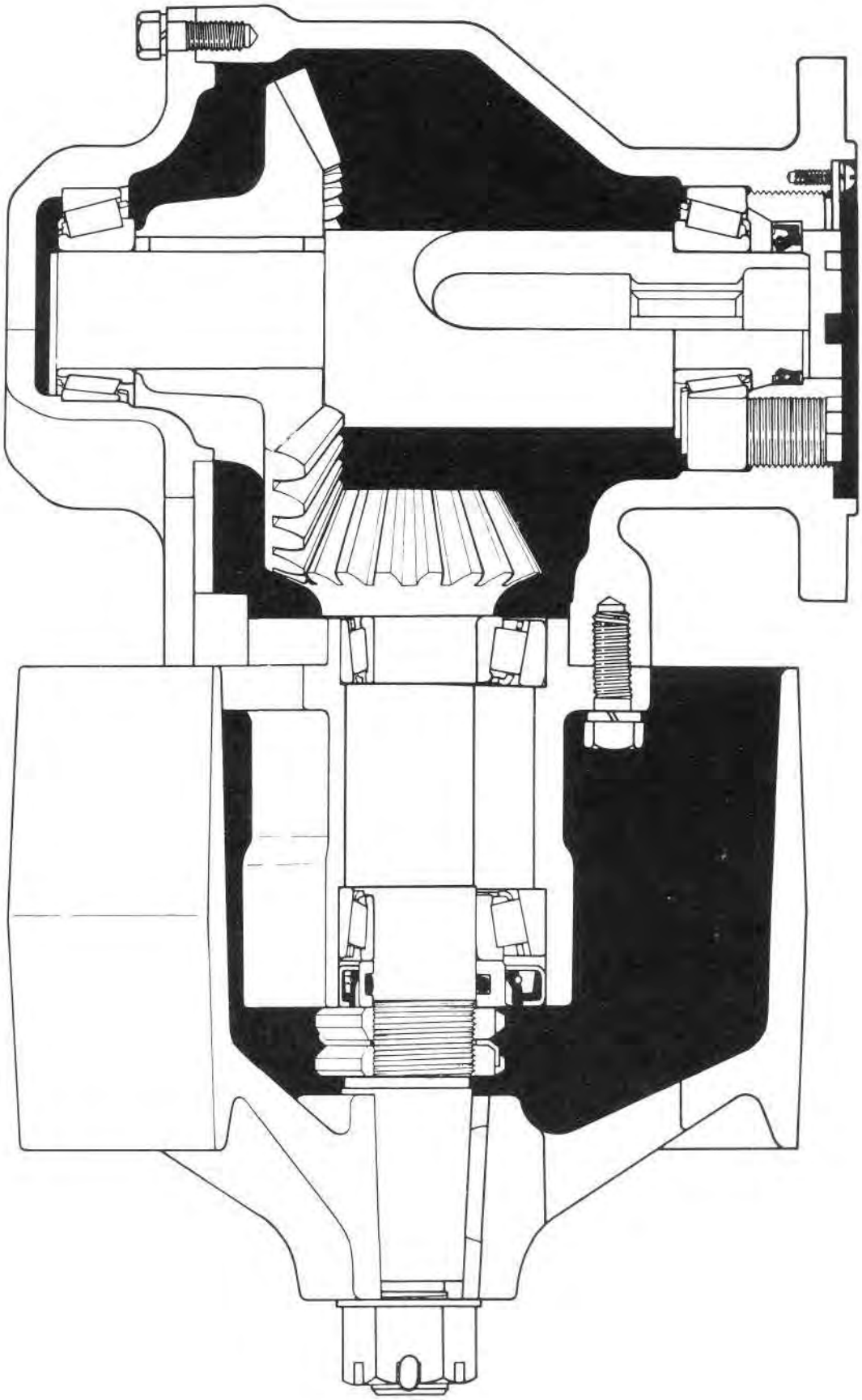


Fig. M21 — Belt Pulley Unit

4. Unlock and remove the two circular nuts on the shaft using a suitable "C" spanner.

5. Remove the five flange bolts and remove the pinion bearing housing complete with shaft, bearings and seals. Some prising may be neceessary, but care must be taken to avoid damage to the flange shims. Note the number of shims.

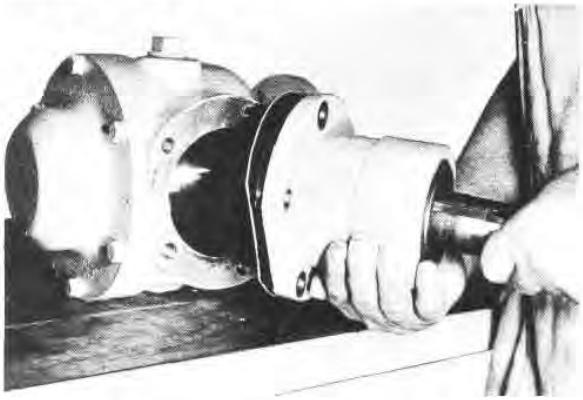


Fig. M24 — Pinion Bearing Housing Removal

6. The housing may now be supported and the shaft pressed or drifted from the bearings. If using a drift, care must be exercised to avoid damaging the threaded end of the shaft.

7. The bearings, seal and seal retainer may now be removed from the housing and the bearing removed from the shaft with a puller.

Fig. M25 — Pinion Assembly Components

Drive Shaft Assembly :

1. Remove the six flange bolts and remove the belt pulley housing complete with shaft, etc., from the P.T.O. housing.

2. Remove the lockplate screw and lockplate, and remove the adjusting nut.

3. Remove the six bolts and remove the housing cover. Note the number of shims.

4. Lift the drive shaft from the housing and, if required, the bevel gear and bearings can be removed.

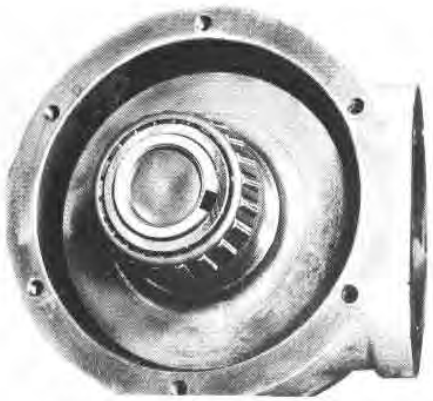


Fig. M26 — Housing Cover Removal

5. Remove the bearing cups from the housing and housing cover and the oil seal from the adjusting nut.

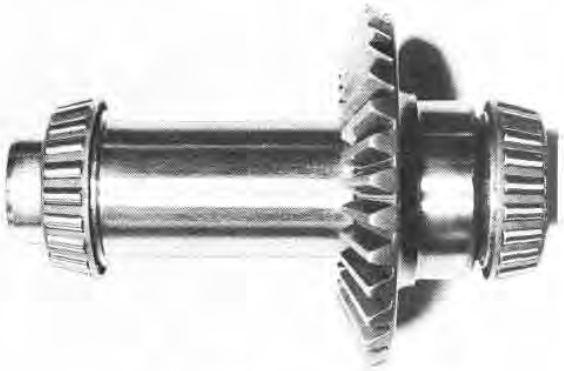


Fig. M27 — Drive Shaft Assembly

INSPECTION

Thoroughly clean all parts. Carefully examine shafts, bearings and gears for signs of wear and replace, if necessary. Check the condition of the oil seals and 'O' ring and if they are at all worn, replace them.

RE-ASSEMBLY

1. Install the key, bevel gear and bearings on the drive shaft.

2. Press the bearing cups into the belt pulley housing and cover.

3. Install the oil seal in the adjusting nut.

4. Place the drive shaft in position in the housing and fit the housing cover using the original shim pack. Use gasket cement between the shims, housing and cover.

5. Screw the adjusting nut into the housing over the drive shaft, carefully protecting the seal, until the bearings are adjusted to the position where no end float or pre-load exists. Install the nut locking tab.

6. Install the bearing cups in the pinion bearing housing.

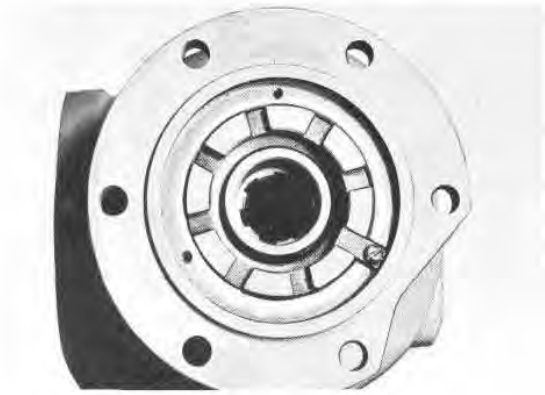


Fig. M28 — Adjusting Nut and Lockplate

7. Press the bearing onto the pinion shaft.
8. Place the pinion shaft in position through its housing and install the bearing, oil seal, 'O' ring collar complete with 'O' ring and one pinion locknut.
9. Adjust the locknut to give zero end float to the pinion bearings. Install the lock washer and the second locknut and lock the washer tabs.
10. Fit the pinion assembly to the belt pulley housing using the original shim pack. Use gasket cement between the two housings and the shims.
11. Check that the bevel pinion backlash is .012" - .015". This can be done by installing the belt pulley key and turning the shaft against a dial test indicator gauge.

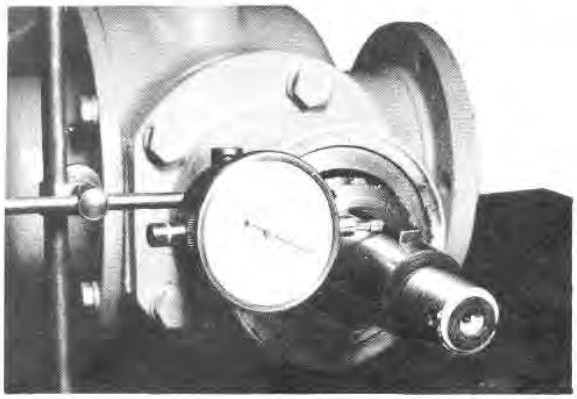


Fig. M29 — Checking Pinion Backlash

If the backlash is satisfactory, mount the unit on the P.T.O., refit the belt pulley and fill the housing with the correct oil to the level indicated.

If the backlash is not within the figures quoted and/or the unit is noisy in operation, it will be necessary to obtain gear tooth markings and to adjust the bevel gear and pinion relationship to each other in the direction that the markings indicate.

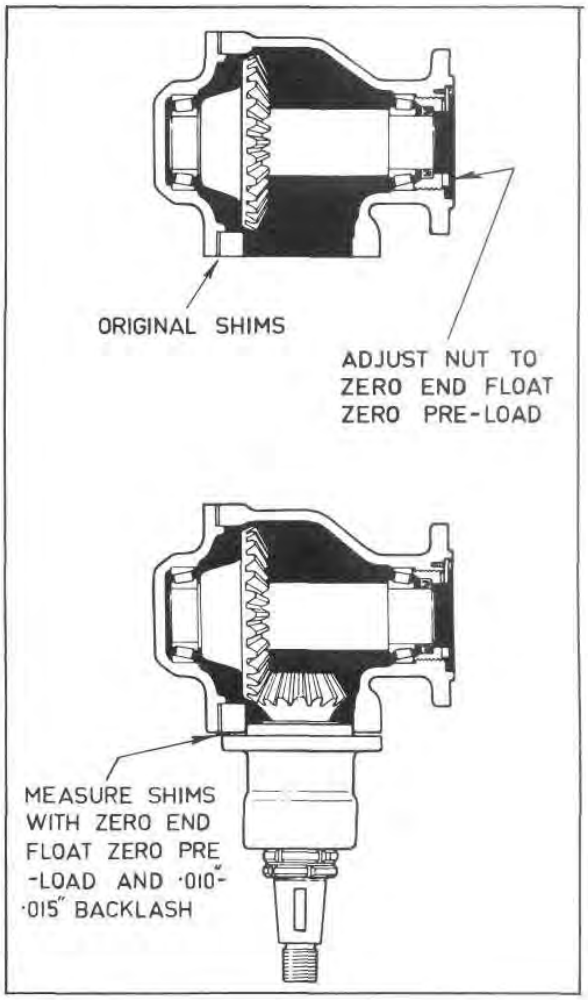


Fig. M30 — Belt Pulley Adjustments

CHAMBERLAIN

SECTION **N**

BRAKES

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

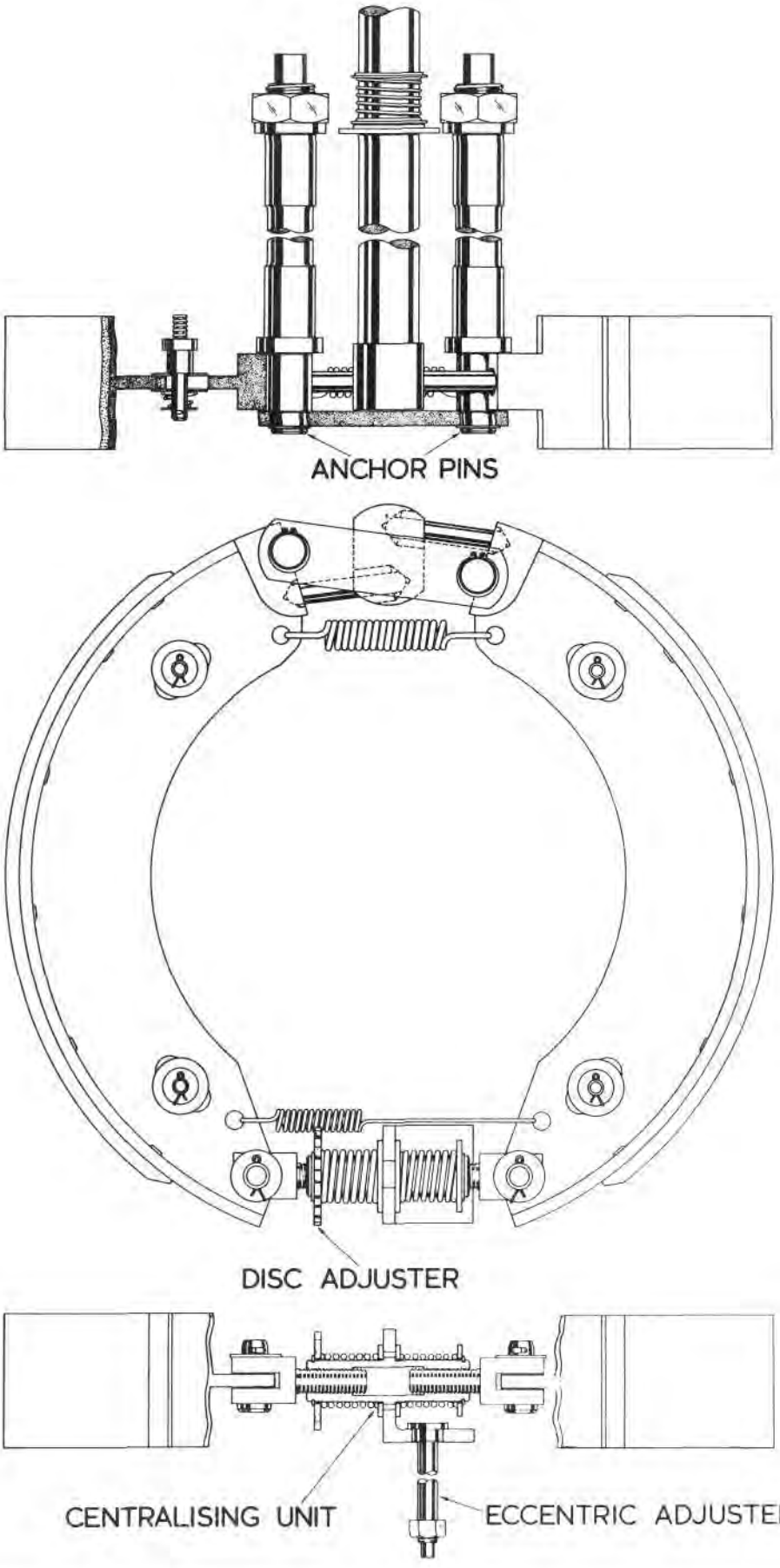


Fig. N1 — Driving Wheel Brakes

BRAKES - DRIVING WHEELS

DESCRIPTION

The tractor is provided with 19" heavy duty, Duo-Servo, mechanically operated brakes. Brake drums, mounted directly onto the driving wheel hubs are clamped between the wheel and hub on the wheel nut studs.

Each driving wheel has two brake shoes, pivoted at their upper ends on eccentric anchor pins, protruding from, and locknut retained to, the final drive housing. An anchor pin keeper plate prevents shoe side movement and retains the camshaft in position. The shoes are held against anti-chatter, spring loaded studs attached to the final drive housing, and a tension spring links the top of the shoes to hold them in contact with the anchor pins, and to prevent them rubbing against the drum when the brakes are disengaged.

The lower end of each shoe is connected by a clevis to a centralizing unit which is anchored to an adjustable eccentric pin protruding through the final drive housing. Shoe to brake drum clearance is obtained by moving the unit disc adjuster, and the shoes are centralized in the drum by turning the eccentric pin. The disc adjuster is held positioned by a spring engaging in the slots, the spring being over-ridden when making an adjustment.

Actuation is provided by a camshaft which passes through the final drive housing to operate the shoes through positively located actuating pins. The camshaft is mounted in two nylon bushes, the inner bush being contained in a bracket attached to the differential extension, whilst the outer split bush operates in a slide in the final drive housing. A circlip retained spring and seal is fitted to the shaft against the final drive housing, and a cover plate attached to the top of the housing assists in preventing dust accumulation around the camshaft.

Keyed to the camshaft is a lever which is coupled by tie-rods and a bellcrank to the brake pedal. The tie-rods are adjustable but should not require further attention after the tractor has been initially assembled. Return springs are provided for the brake pedal. A parking lock is attached to the linkage.

SPECIFICATIONS

Make	— Own.
Type	— Duo-Servo drum type.
Adjustment	— Disc adjuster and centralizing cams.
Operation	— Mechanical push rod actuation.
Control	— Foot pedal.
Diameter of Drum	— 19".
Length of Lining	— 18".
Width of Lining	— 3¼".
Effective Lining Area	— 117.5 square inches per wheel.

MAINTENANCE

No lubrication of the linkage pivot points is necessary as nylon or dri-lube bushes are fitted.

ADJUSTMENTS

There are three adjusting points for the brake.

1. The disc adjuster, accessible through a large hole at the bottom of the brake assembly mounting flange on the final drive. It is used to take up normal lining wear by expanding the lower ends of the brake shoes.
2. The eccentric adjuster, which protrudes through the final drive housing adjacent to the disc adjuster, is locknut retained and used to centralise the bottom of the brake shoes in the drum.
3. The two eccentric brake shoe anchor pins, located at the top of the final drive housing adjacent to the camshaft. They are used to position the top of the brake shoes in the drum.

The following procedure should be adopted when adjusting the brakes :—

Normal Wear Adjustment :

1. Disconnect the brake linkage by removing the camshaft lever clevis pin.
2. Expand the disc adjuster until the brakes drag slightly. (Wheels off the ground).
3. Back-off the disc adjuster until brake drag is eliminated.

Note : Minimum clearance is required for maximum brake efficiency.

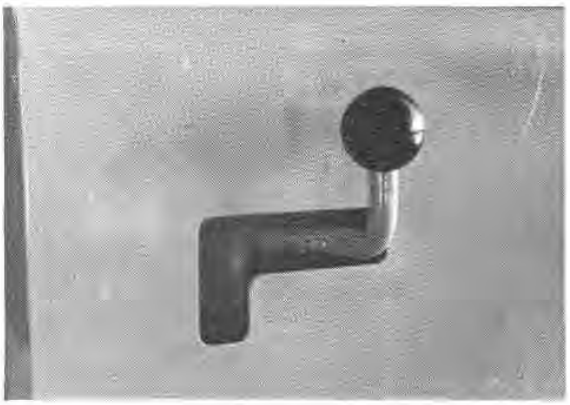


Fig. N2 — Parking Lock

Fig. N3 — Adjusting Brake Shoes

4. Attach the brake link clevis to the camshaft lever after adjusting the link length so that the pin can be inserted freely when the pedal is in the off position.
5. Road test the tractor. Correct any unbalanced braking by expanding or contracting the brakes with the disc adjusters, as necessary.

Re-adjustment for abnormal brake operation or lining replacement :

1. Disconnect the brake linkage by removing the camshaft lever clevis pin.
2. Expand the disc adjuster until contact is made with the drum, i.e., brake drag occurs. (Wheels off the ground).
3. Rotate each anchor pin in turn in both directions until the shoe contacts the drum, then by halving the amount of pin movement, the shoe will be centralised.

Note : The anchor pins require to be in the minimum brake expansion position before this operation commences. The pins are marked with an etched 'V' on the inner end and this 'V' should point away from the camshaft to indicate minimum expansion position. A 1⅛" Whitworth ring spanner is required to release the locknuts.

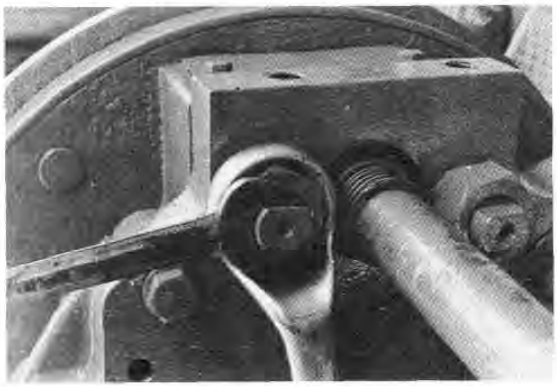


Fig. N4 — Rotating the Anchor Pins

4. Slacken the locknut on the eccentric adjuster and rotate the adjuster in both directions until it is centralised.

Note : Rotation of the adjuster in one direction will bring the shoe in contact with the drum; reversing the rotation will bring the opposite shoe in contact with the drum and halving the distance travelled during the second rotation should approximately centralise the shoes.

5. If the drum now rotates freely, expand the disc adjuster until dragging occurs.
6. Rotate each anchor pin in both directions until the drum ceases to drag.
7. Continue expanding the disc adjuster and moving the anchor pins until a point is reached where even slight rotation of the anchor pins in either direction causes the brake to drag.
8. Back-off the disc adjuster until drag is eliminated.

Note : Minimum clearance is required for maximum brake efficiency.

9. Re-check the centraliser and secure the locknut.
10. Firmly secure the anchor pin locknuts, ensuring that the pins do not rotate during the operation.
11. Attach the brake link clevis to the camshaft lever after adjusting the link length so that the pin can be inserted freely when the pedal is in the off position.

CAUTION : If the camshaft lever is pushed too far in the off direction, it is possible for the lower shoe actuating pin to become displaced and fall to the bottom of the brake drum. If this occurs, it is necessary to remove the drum to replace the pin.

12. Road test the tractor and correct any unbalanced braking by expanding or contracting the brakes with the disc adjuster, as necessary.

SERVICE

Should it be necessary to dismantle the brake mechanism, proceed as follows :—

1. Remove the wheel.
2. Remove the brake drum.
3. For ease of working, remove the hub. This reduces the possibility of over-stretching the tension spring during re-assembly.
4. Remove the splitpin, anti-rattle spring and washer from each of the four studs, the clevis pins and spring from the centralising unit and the circlips retaining the keeper link. The shoes can now be removed sideways off the anchor pins, taking the keeper link with them.
5. Removal of the centralising unit requires the removal of the eccentric adjuster locknut.

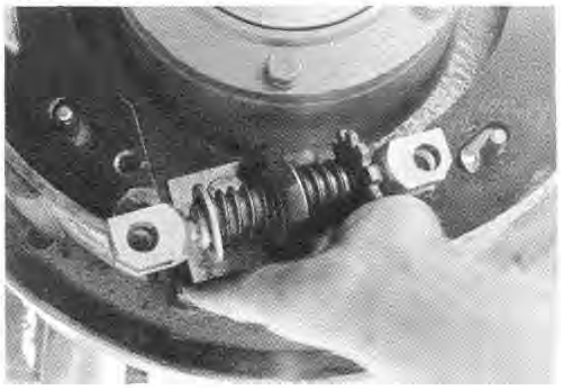


Fig. N5 — Removing the Centralising Unit

6. With the keeper link removed, the camshaft may be withdrawn if the seal retaining circlip and camshaft lever are now removed.
7. The anchor pins can be removed after the locknuts are removed.
8. Dismantling of the centralising unit involves unscrewing the clevis from each end and removal of the external spring retaining circlip.

Thoroughly examine the linings for wear, the anchor pins, camshaft, bushes, seals, push rods and springs for indications that replacement is necessary, and the drum for scoring.

Replacement linings should be rivetted and bonded.

Lightly lubricate the centralizing clevis threads,

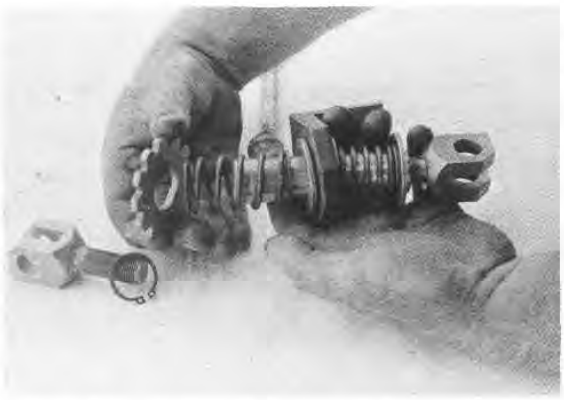


Fig. N6 — Dismantling the Centralising Unit

push rod ends, and all pivot pins with a clay based, non melting grease suitable for high temperature operation in disc brakes.

Re-assembly of the brakes is a reversal of the dismantling procedure with the following points noted :—

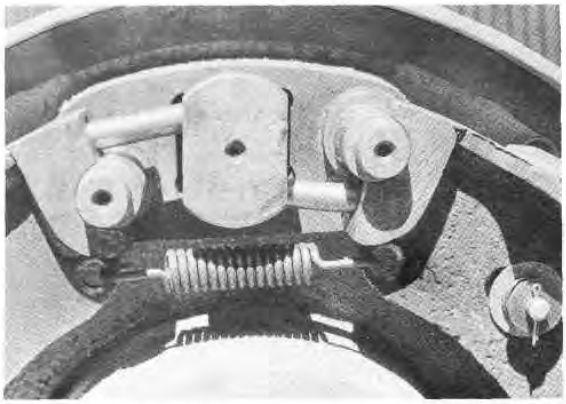


Fig. N7 — Anchor Pins in the Minimum Brake Position

1. Ensure that the camshaft will slide and turn when in the extreme slot positions in the final drive housing. Check that any binding is not caused by the inner bush.
2. Turn the cams of the centralising unit and the anchor pins to the minimum brake expansion position until the brake drums are installed.
3. When re-installing the centralising unit, ensure that the clevis's are screwed out equally.
4. Check that the brake shoes are free sliding on the four studs.
5. For ease of assembly, connect the brake shoe spring to the top of the shoes and spread the shoes over the anchor pins. Ensure that the correct shoe is fitted towards the radiator, this shoe being the one with the actuating pin hole above the anchor pin.

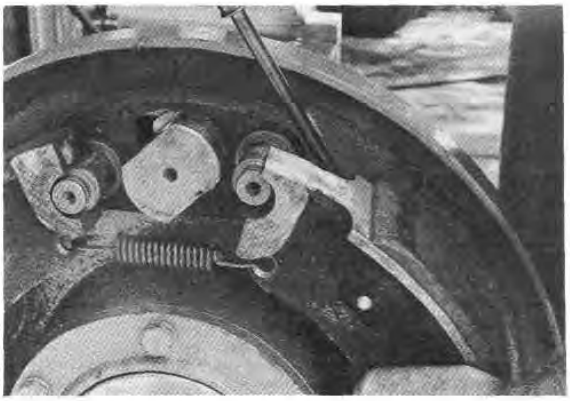


Fig. N8 — Assembling the Brake Shoes

6. When installing the adjuster spring, ensure that the coils engage with the adjuster grooves.
7. Firmly secure the anchor pin locknuts, ensuring that the pins do not rotate thus changing the setting.

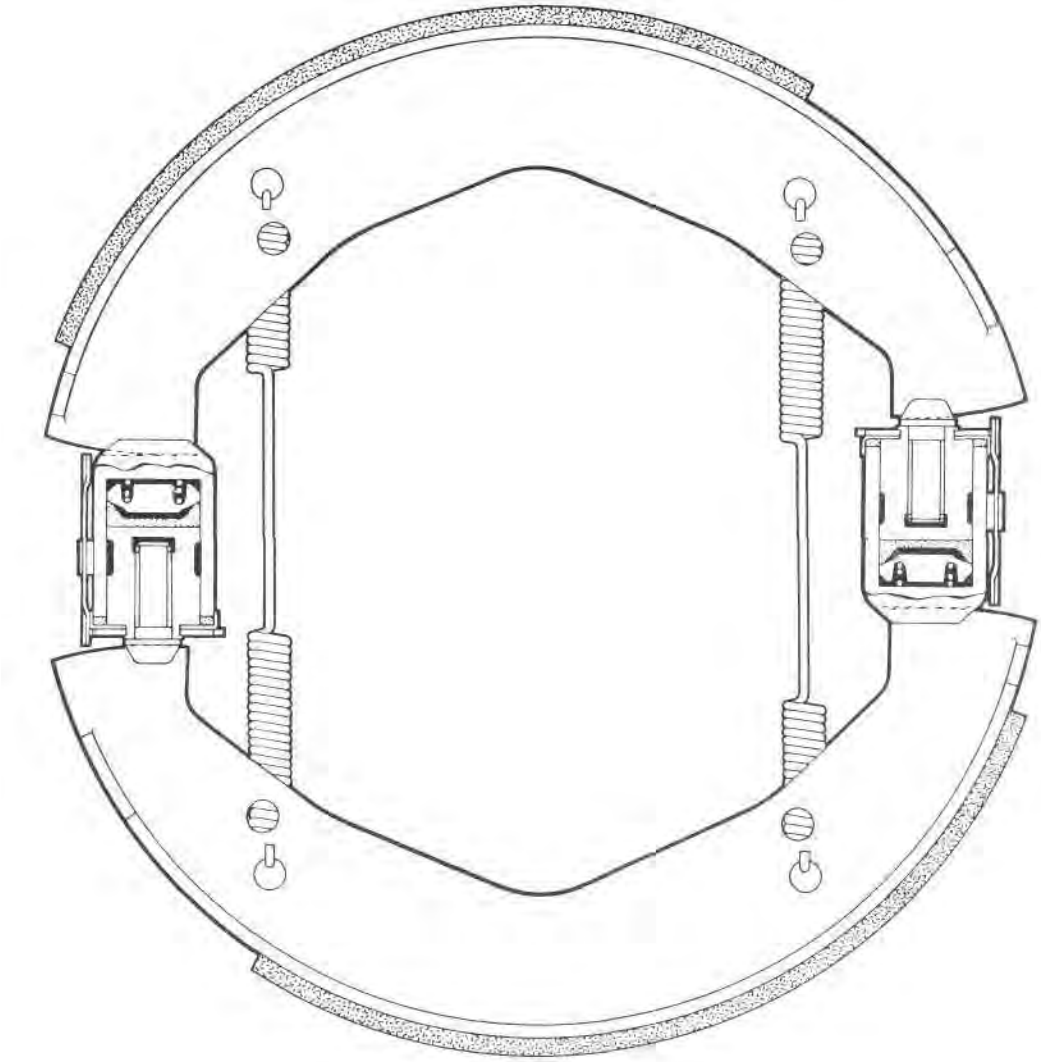


Fig. N9 — Steering Axle Wheel Brakes

BRAKES - STEERING AXLE WHEELS

(Cannot be Used with Flotation Steering Tyres)

These brake units are for use with the heavy duty steering axle only. The backing plates attach to flanges incorporated in the stub axle assembly, and support 14" shoe brakes of the two leading shoe type. The brake drums, mounted directly onto the steering axle wheel hubs, are clamped between the wheel and hub on the wheel nut studs.

Each wheel has a top and bottom shoe, spring retained together against the two wheel cylinders. Actuation is by a master cylinder mounted on the mechanical brake pedal, ensuring balanced braking effort between both sets of brakes.

The brake assemblies are connected to the master clyinder by means of metal tubing and flexible rubber hoses; the master cylinder and wheel cylinders being provided with rubber cups to maintain pressure and prevent any loss of the fluid.

When the brake pedal is depressed, the master cylinder piston applies a force to the brake fluid which, being incompressible, is displaced through the pipes, causing the pistons in the wheel cylinder to apply pressure to the tip of the respective brake shoes and so bring them into contact with the brake drums. All shoes are able to float in order that they may centralise themselves within the drums when applied.

In the event of a hydraulic failure, the end of the pedal will contact a stop on the equaliser unit and thus actuate the mechanical brakes. The F.W.D. model handbrake can also be used to stop the machine in an emergency.

Routine Maintenance :

Every 50 hours, check the master cylinder reservoir fluid level and top up with hydraulic brake fluid as necessary. The correct level is to within half an inch of the upper shoulder of the reservoir. Thoroughly clean around the cap prior to removal to prevent dirt entering the system.

The addition of fluid should be required only at extremely long intervals, and a considerable fall in the fluid level would indicate a leak at some point in the system which should be traced and rectified **immediately.** To check for leaks, apply firm pressure to the brake pedal whilst an assistant examines the units, pipes, hoses and fittings.

Fig. N10 — Checking Reservoir Oil Level

Ensure that the air vent in the filler cap is not blocked; blockage at this point would cause the brakes to drag.

Check the mechanical brake adjustment, as, if this adjustment is neglected and the hydraulic system fails, the brakes will be in-operative.

At 1200 hours, examine the brake linings and renew if worn to less than one half of their original thickness of $\frac{1}{4}$". Check brake drums for excessive wear and ensure that linings are not contaminated by oil or grease. Check also for wheel cylinder and master cylinder leakage.

Also at 1200 hours, inspect the brake hoses for signs of leakage, chafing or general deterioration. If there is any doubt, renew the hoses. When checking hoses, also inspect pipes for corrosion, chafing, looseness or general condition.

It is also recommended that at intervals of approximately eighteen months, the fluid should be completely drained from the system and refilled with new hydraulic brake fluid. It is most important that extreme care is taken to exclude dirt or dust of any kind from the system during the filling operation, and that great care is taken to see that any containers or dispensers used for filling purposes are completely free of water. Brake fluid absorbs water from the atmosphere and it is, therefore, essential that fluid is only exposed to atmosphere during the time it takes to fill the system:

Flushing the System :

Should the fluid in the system become thick or "gummy" after considerable service, or after the tractor has been laid up for some time, the system should be drained, flushed and refilled. It is recommended that this should be carried out at least every three years. The system should also be flushed if it has been contaminated by the use of spurious fluid.

Pump all the fluid out of the system through the bleeder screw of each wheel cylinder in turn. Connect one end of a rubber tube to the bleeder screw, allowing the other end to fall into a container, unscrew one complete turn and pump the pedal by depressing it quickly and allowing it to return without resistance. Repeat, with a pause between each operation, until no more fluid is expelled. Discard the fluid extracted.

Fill the reservoir with hydraulic brake fluid and flush the system as described. Keep the reservoir replenished until the fluid runs clean from each wheel cylinder. Refill with clean hydraulic fluid and "bleed" the system.

Note : If the system has become contaminated by the use of mineral oil, etc., this process may not prove effective. All parts, including the pipes, should be dismantled and thoroughly cleaned, and all rubber parts, including flexible hoses, should be renewed. The contaminated fluid should be destroyed immediately.

Bleeding the System :

"Bleeding" the system — or expelling air is not a routine operation and should be necessary only when some portion of the hydraulic equipment has been disconnected or when fluid has been drained off.

1. Fill the reservoir with hydraulic brake fluid and keep it at least one quarter full throughout the operation, otherwise air will be drawn in, necessitating a fresh start.

2. Attach a rubber tube to the bleeder screw on one of the wheel cylinders and allow the free end to be submerged in a little fluid in a clean glass jar. Open the bleeder screw one complete turn.

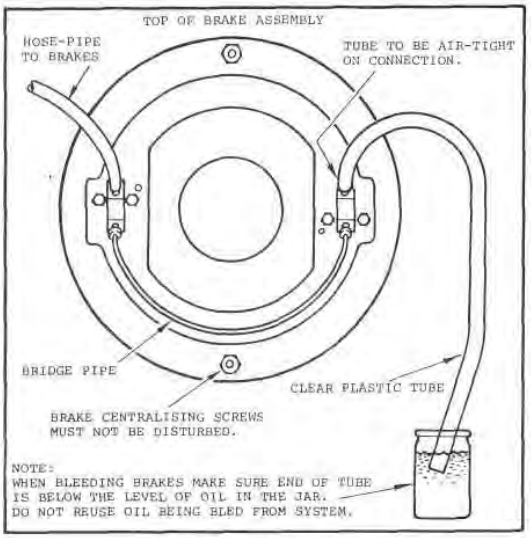


Fig. N11 — Bleeding the Brakes

3. Depress the brake pedal slowly, allowng it to return unassisted, repeating this pumping action with a slight pause between each operation. Watch the flow of fluid in the jar, when all the bubbles cease to appear, hold the pedal down firmly and securely tighten the bleeder screw.

Note : Ensure that the end of the bleeder tube is below the level of the oil in the jar during bleeding operation.

4. Repeat the operation for the other wheel cylinder.

5. **Do not** re-use oil that has been bled from the system.

Brake Adjustment :

Two adjustments can be made to the brakes, the first being an initial adjustment only of the free movement between the master cylinder and push rod, and the second is the normal wear adjustment to compensate for lining wear.

1. (a) Free movement between the master cylinder and push rod is necessary to ensure the master cylinder piston returns to its stop when the brakes are released. This is an **initial** adjustment only unless the adjustment has been disturbed.

(b) Block the rear section of the pedal assembly (equaliser housing) in the released position.

(c) Operate the brake pedal and adjust the push rod clevis to give ¼" to 3/16" pedal free movement prior to the push rod contacting the master cylinder piston. This provides nominal free movement of 0.020" between these two components.

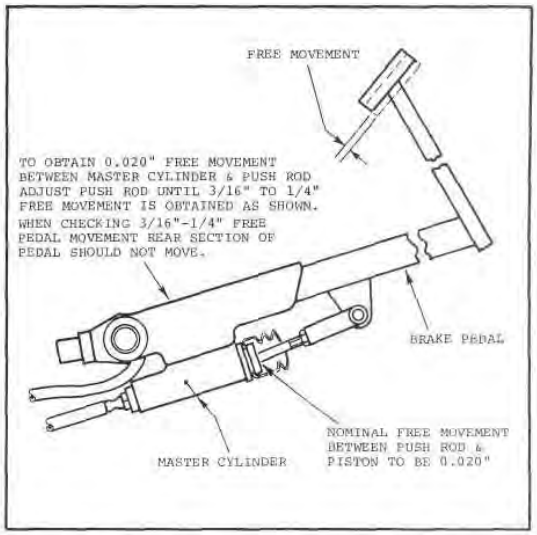


Fig. N12 — Pedal Movement (initial adjustment)

2. (a) This is normal wear adjustment.

(b) Jack up the wheel and remove the wheel cylinder dust covers.

(c) Use an adjusting tool not exceeding 6" in length to turn the adjuster end cap in a clockwise direction, relative to the wheel cylinder, until the shoe bears hard against the drum.

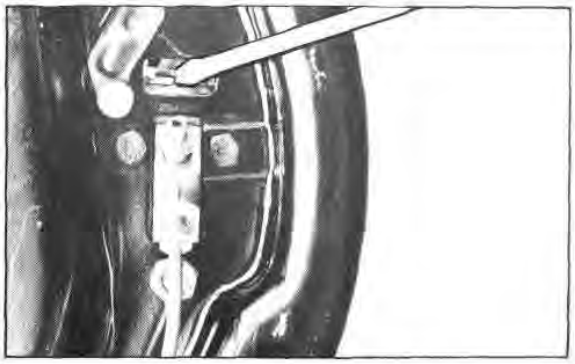


Fig. N13 — Adjusting the Brake Shoes

(d) Back-off the adjustment the least possible amount to enable the wheel to revolve freely and apply the brake sharply to centralise the shoes.

(e) Re-check the adjustment and repeat the operation on the second wheel cylinder.

(f) Adjust the opposite wheel brake shoes in the same manner. **Close the dust covers.**

TROUBLE SHOOTING

Trouble	Possible Cause	Remedy
PEDAL FEELS SPONGY	Brakes not properly bled. Leak at one or more points in the system.	Bleed the system. Rectify leaks.
BRAKES INEFFICIENT	Linings not "bedded-in". Linings greasy.	Bed-in operation. Renew linings.
BRAKES DRAG	Shoes over-adjusted. Shoe pull-off springs weak or broken. Pedal spring weak or broken. Pedal to push rod adjustment incorrect. Wheel cylinder piston seized. Blocked reservoir cap orifice. Master cylinder by-pass port blocked.	Re-adjust. Renew springs. Renew spring. Re-adjust. Overhaul cylinder. Clear blockage. Clear blockage.
BRAKES REMAIN ON	Shoes over-adjusted. Master cylinder and/or wheel cylinder cups swollen due to contamination with mineral oil or spurious fluid.	Re-adjust. Overhaul cylinders and thoroughly clean brake system.
UNBALANCED BRAKING	Greasy linings. Tyres unevenly inflated. Brake backplate loose.	Renew. Check and adjust. Re-tighten backplate.

CHAMBERLAIN

SECTION **0**

THREE POINT LINKAGE AND HYDRAULICS

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

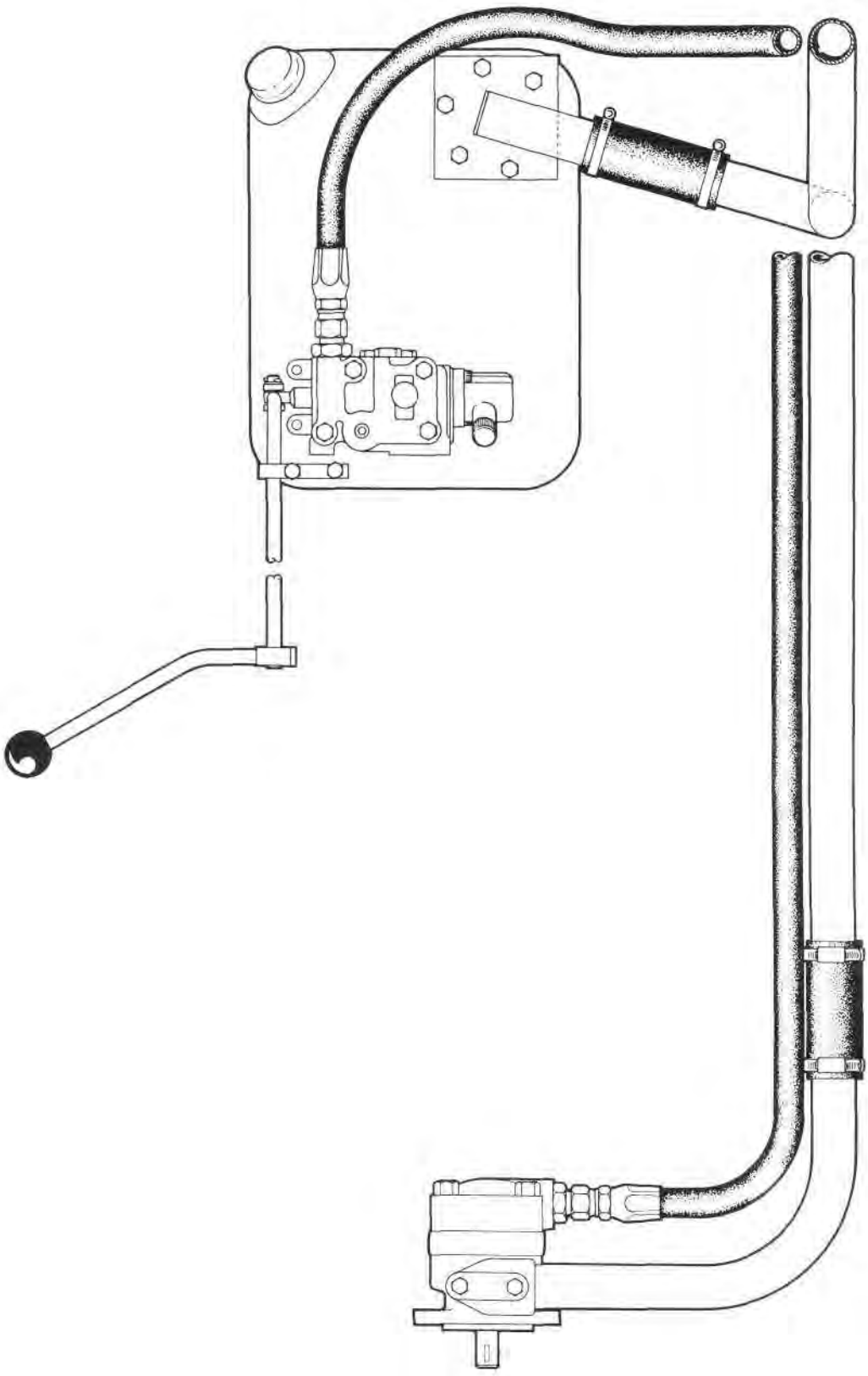


Fig. 01 — Three Point Linkage Hydraulics

HYDRAULICS FOR THREE POINT LINKAGE

DESCRIPTION

The hydraulic system includes an engine driven vane pump, a reservoir beneath the driver's seat, a reservoir mounted control valve with hydrostatic relief valve, and the necessary hose and piping from the reservoir to the pump, and from the pump to the control valve.

The balanced vane type pump is gear driven from the engine gear train and, at 2000 engine r.p.m. the output is 10.7 imperial gallons per minute with a maximum system pressure of 1900 p.s.i.

The three position (raise, hold and float) control valve incorporates three additional valves, a hydrostatic relief and flow control valve, a check valve, and a single-double acting valve that enables the control to be adapted to provide :—

(a) Single acting three-point linkage hydraulics, with the valve retained in the "float" position by screwing in the spool detent adjustment.

(b) Double acting hydraulics with both lines blocked when the valve is in the "hold" position. The spool detent adjustment **must** be released for this operation. Parts are not supplied for continuing double acting hydraulics from the control valve to an attachment.

Selection of double or single acting operation is provided by a spring-loaded, knurled knob protruding from the front of the valve. Screw in with finger pressure for double acting, or screw out for single acting operation.

CAUTION : The valve **must** be screwed out for linkage operation.

SPECIFICATION

Make of unit	— Vickers V200 (special) series pump: — Vickers (special) CM11-20 control valve.
Pump output	— 10.7 g.p.m. @ 2000 engine r.p.m.
Max. operating pressure	— 1900 p.s.i.
Rotation	— Clockwise (viewed from radiator of tractor).
Oil recommendation	— Refer to chart.
Reservoir oil level	— Dipstick level.

MAINTENANCE

Fill the hydraulic reservoir to the marked level of the dipstick. Check the level at 10 hours or daily, and top-up as necessary.

It is recommended that the reservoir be drained and cleaned after the first 300 hours of operation and thereafter every 600 hours. At this time the suction filter should be removed and cleaned by sluicing thoroughly in clean distillate and allowing to dry in a dust-free position before re-fitting. Carefully examine the filter and gasket and replace, if showing signs of deterioration. If the oil shows signs of contamination before these hours are reached, it should be drained and replaced with clean, new oil.

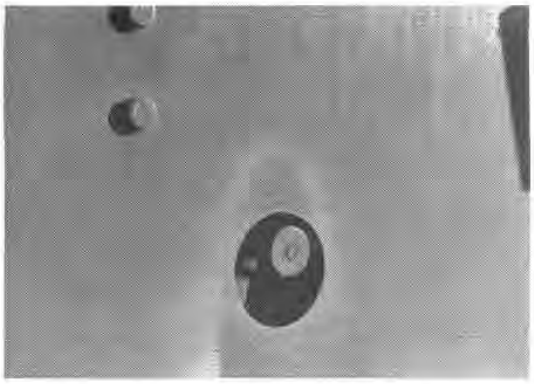


Fig. O2 — Single or Double Acting Valve

Never Run the Engine Without Oil in the Hydraulic Reservoir.

Do Not Use Hydraulic Brake Fluid.

To Renew the Filter :

1. Drain the reservoir of oil.
2. Remove the seat apron.
3. Remove the filter carrier plate setscrews and remove the plate and filter.

THE PUMP

The unit consists principally of a ported body and cover, a drive shaft supported by two ball bearings, a pumping cartridge and a pressure plate. The components of the cartridge are an elliptical ring (or cam), a slotted rotor splined to the drive shaft and twelve vanes fitted to the rotor slots.

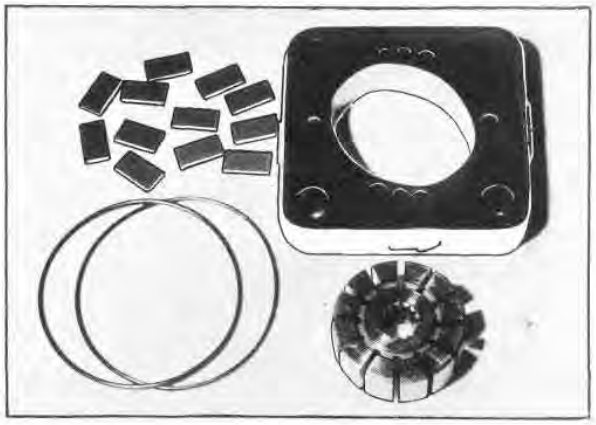


Fig. O3 — The Pump Cartridge

The vanes generate fluid flow within the pumping cartridge by carrying fluid around the elliptical ring contour. Fluid enters the cartridge through the inlet port in the body and is discharged through the pres-

sure plate to the outlet port in the cover. The rotor is driven within the ring by the drive shaft which is coupled to the engine through a gear. As the rotor turns, centrifugal force on the vanes causes them to follow the elliptical inner surface of the ring.

Radial movement of the vanes and turning of the rotor cause the chamber between the vanes to increase as the vanes pass the inlet sections of the ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. (Fluid outside the inlet is at atmospheric pressure or higher).

This fluid is trapped between the vanes and carried past the larger diameter or dwell section of the ring.

As the outlet section is approached, the ring diameter decreases and the fluid is forced out into the system. System pressure is fed under the vanes assuring their sealing contact against the ring during normal operation.

The pump ring is shaped so that the two pumping chambers are formed diametrically opposed. Thus hydraulic forces which would impose side loads on the shaft cancel each other out.

The pressure plate seals the pumping chamber. A light spring holds the plate against the cartridge until pressure builds up in the system. System pressure is effective against the area at the back of the plate which is larger than the area exposed to the pumping cartridge. Thus, the unbalanced force holds the plate against the cartridge, sealing the cartridge and providing the proper running clearance for the rotor and vanes.

PUMP OVERHAUL

To Remove :

1. Drain the oil.
2. Remove the hose and the pump inlet pipe (2 bolts).
3. Remove the pump to mounting bracket bolts (2) and lift the pump from the tractor.

To Dismantle :

1. Remove the setscrews from the end of the shaft and, using a puller, remove the drive gear.

Fig. O4 — Pump Cover Removed

2. Remove the four bolts holding the pump cover. Carefully remove the cover and the pressure plate spring.
3. Remove the pressure plate and note the position of the ring for correct re-assembly. Lift off the ring and remove the locating pins. Separate the vanes from the rotor and remove the rotor from the shaft.
4. Turn the pump body over and remove the shaft key and circlip which retains the outer bearing. Tap with a soft hammer on the splined end of the shaft to force the shaft out of the body. Support the bearing inner race and press the shaft out of the bearing. Pull the shaft seal out of the body with a suitable hooked tool and press out the inner bearing.

Inspection and Repair :

1. Discard the used shaft seal and all 'O' rings. Wash the metal parts in mineral oil solvent, blow them dry with filtered compressed air and place them on a clean surface for inspection.
2. Check the wearing surfaces of the body pressure plate, ring and rotor for scoring and excessive wear. Remove light score marks by lapping. Replace any heavily scored or badly worn parts.
3. Inspect the vanes for burrs, wear and excessive play in the rotor slots. Replace the rotor if the slots are worn.
4. Check the bearings for wear and looseness. Rotate the bearings while applying pressure to check for pitted or cracked races.
5. Inspect the oil seal mating surface on the shaft for scoring or wear. If marks on the shaft cannot be removed by light polishing, replace the shaft.

Re-assembly :

Coat all parts with hydraulic fluid to facilitate re-assembly and provide initial lubrication. Use small amounts of petroleum jelly to hold 'O' rings in place during assembly.

Note : It is possible that raised burrs may be apparent on the sharp edges of the machined cartridge parts and these should be lightly stoned prior to installation.

Begin re-assembly by pressing the shaft into the front bearing while supporting the bearing inner race. Next, press the inner bearing into the body, using a driver which contacts the outer race only. Be certain both bearings are firmly seated.

The double lip seal is assembled with the spring toward the pumping cartridge. Press the seal firmly in place and lubricate the lip with petroleum jelly or other grease compatible with the system fluid. Slide the drive shaft into the body until the bearing is seated. Tap lightly on the end of the shaft if necessary. Install the snap ring.

Install the new 'O' ring in the body and cover. Insert the ring locating pins in the body and assemble the ring so that the arrow on the perimeter points toward the left hand side. Install the rotor on the shaft and insert the vanes in the rotor slots. Be certain the radius edges of the vanes are toward the cam ring. Place the pressure plate on the locating pins and flat against the ring.

Assemble the cover to the pump, exercising care to prevent the ingress of dirt or water and damage to the components. Hold the pressure plate spring and 'O'

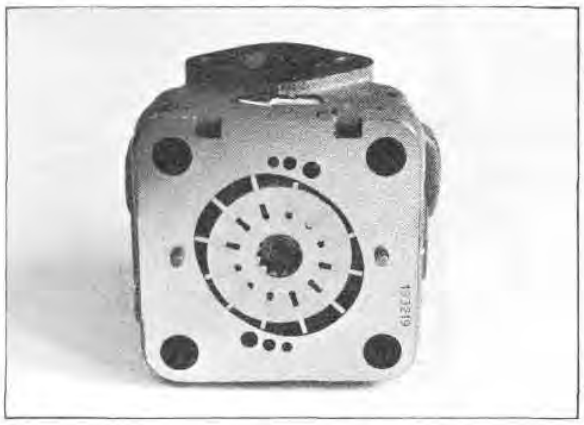


Fig. O5 — Cam Ring Correctly Assembled

ring in place with petroleum jelly, face the delivery port to the nearside and install the four bolts, tensioning them to 65/75 lbs./ft.

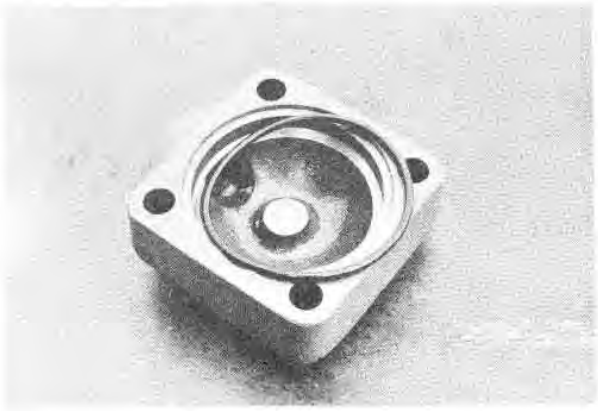


Fig. O6 — 'O' Ring and Cover

To replace pump, reverse the pump removal instructions.

Refill the system with oil, test the hydraulic operation and then re-check the reservoir oil level. Top-up, if necessary.

THE CONTROL VALVE

The valve includes principally, a valve spool, a body with internal passages for oil flow, a check valve, a valve to change operation from single to double acting, a spring-loaded detent, and a relief valve.

Pump oil flow is directed by the valve spool to obtain the selected work operation with the body oil passages allowing the flow of oil. The check valve prevents back flow or release of oil under pressure from the cylinder when the spool is actuated, and the relief valve protects the system from excessive pressure build-up. The detent holds the spool in the "float" position to allow an implement connected to the system to rise or fall without hydraulic assistance.

The spool is spring-loaded to return to "hold" from "raise". It normally rests in either "hold" or "float" positions which act as "neutral", the oil flow from the pump being directed to the tank discharge port ("hold") or the single acting valve port ("float") and back to tank.

Raise :

Oil under pressure from the pump is directed to the rear of the cylinder piston to contract the cylinder and raise the linkage. Air fom the front of the piston is expelled through the cylinder return hose.

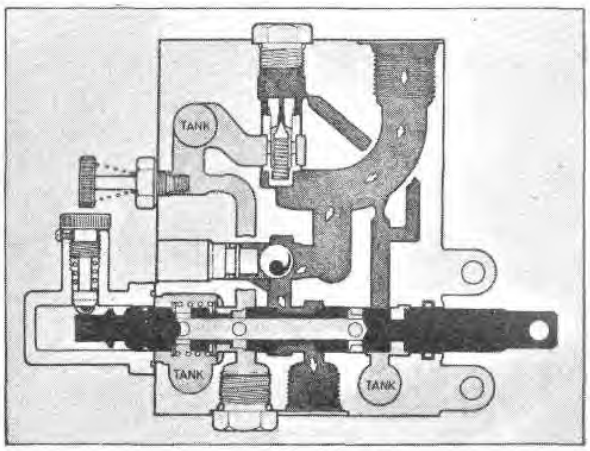


Fig. 07 — Valve in "Raise"

Hold :

In this position oil is prevented from entering or leaving the cylinder and the linkage will not lower unless leakage occurs in either the piston or gland seals, the hose or the valve spool. However, an upward thrust on the linkage of only 25 lbs., (in addition to that required to overcome friction) will reduce the pressure on the oil in the cylinder sufficiently to vaporise it and allow the cylinder to contract and the linkage to lift, this preventing severe loss of traction or damage to the linkage and implement.

Note : If the above situation is encountered, air will be introduced into the system causing aeration problems. To prevent this, operate the linkage in the "float" position of the control valve.

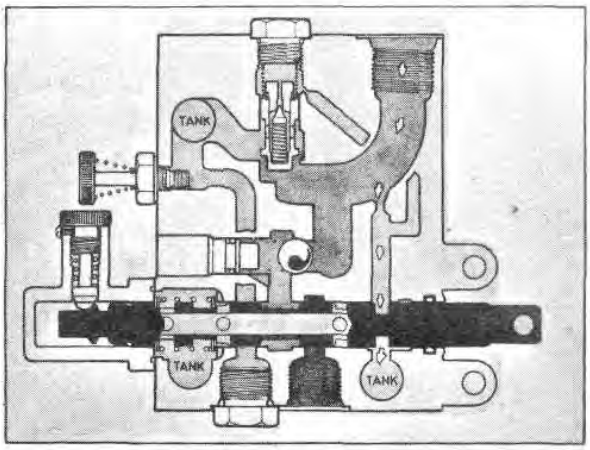


Fig. O8 — Valve in "Hold"

Float :

In this position oil is able to flow freely between the cylinder and the reservoir, and the weight of the implement, combined with the suction of the tillage tools, keeps the implement at a working level controlled by the implement depth setting. In the event of the tractor rear wheels dropping into a depression, the resultant upward thrust on the linkage allows oil to enter the cylinder and enables the implement to lift.

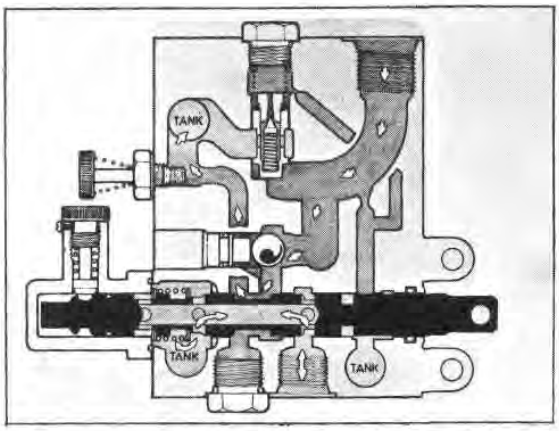


Fig. O9 — Valve in "Float"

The Check Valve :

The spool valve glands are dimensioned to ensure that the pump supply is not completely blocked when the spool valve is moving to "pressure raise". To prevent oil escaping from the cylinder connection and returning to the tank during this period (resulting in the implement dropping when moving the control to the "pressure raise" position), the ball check valve has been incorporated. This valve opens against a light spring to allow oil from the pump to flow to the cylinder, but is held against its seat by the pressure in the cylinder line until the spool valve has restricted the flow of pump oil to the tank sufficiently to exceed the line pressure.

The Relief Valve :

The hydrostatic relief and flow control valve is used to prevent excessive pressure build up when the spool is in the "pressure raise" position, and to allow the direct return to tank, of oil not required when the spool is in the "hold" position.

It consists of a spring loaded spool fitted internally with a poppet valve set at 1900 p.s.i. The spool is installed in an internal passage and has full pump oil flow feed to its upper surface and a restricted flow to its lower surface in which is seated the poppet valve.

When pressure in the system exceeds the relief valve setting, the poppet valve is forced off its seat and fluid in the main valve spring cavity flows past the poppet valve and to the reservoir. This flow causes a pressure differential on the main valve, shifting it against the spring. Pump delivery is thus permitted to flow to the reservoir past the main valve. As the pressure returns to relief valve setting, the poppet valve closes and the spring returns the main valve to the closed position.

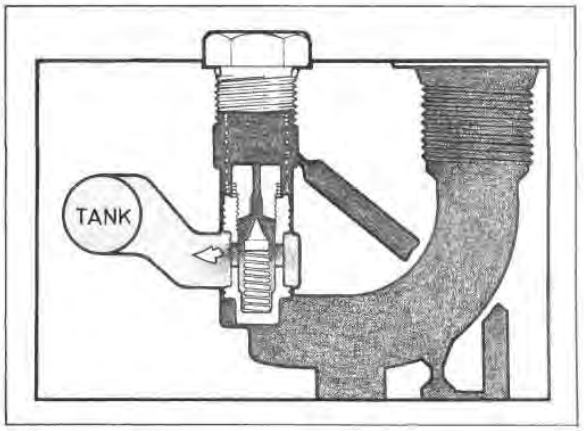


Fig. O10 — Excess Pressure Opening Poppet Valve

Fig. O8 shows the valve operating as a flow control valve when the control spool is in "hold". When the control spool is in this position, 5 to 6 g.p.m. can escape through the by-pass passage. Should the flow rate exceed this, a pressure build-up occurs behind the by-pass orifice. Pressures on either end of the valve are consequently unbalanced and the valve assembly is opened to allow free discharge of surplus oil. This feature allows the use of high volume pumps without back-pressure, over-heating and necessary horse-power drain.

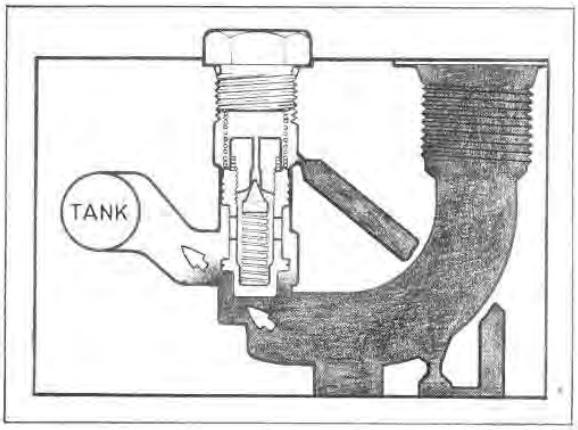


Fig. O11 — Main Valve Open

The valve design ensures a stable system pressure (it will be noted that the oil controlling the maximum relief pressure is relatively static). Operation is quiet and the wear rate is low.

VALVE OVERHAUL

1. Drain the reservoir of oil.
2. Disconnect the control rod clevis.
3. Remove the seat apron, or the complete seat frame.
4. Disconnect the pipes from the valve.
5. Remove the valve to reservoir bolts and lift the valve clear of the tractor.
6. Remove the detent knurled knob, then the detent and spring. Remove the detent housing allen screws and lift off the housing.
7. Withdraw the spool from the detent housing end.
8. Compress the spool centring spring and separate the retaining washers. Remove the spring and the other washers.
9. Unscrew the relief valve retaining nut and collect the nut, spring and relief valve, noting the position of the relief valve for re-asssembly.
10. Remove the check valve retainer, spring and ball.

Fig. 012 — Removing Check Valve Components

11. Discard all 'O' rings, including the spool quadring and back-up ring, wash all parts clean and inspect thoroughly.
12. Check the surface of the spool for scoring. If considerable scoring is noticed, it is an indication that the mating surfaces of the spool bore is similarly scored. Never touch-up the spool to remove scoring. Due to selective fit size, spool repairs in any form may result in excessive oil leakage and pressure loss at operation. Replacement of defective or damaged spool necessitates the replacement of the valve body also.
13. Replace any defective centring, relief or check valve springs. Check the relief and check valve plunger or ball and the contact surfaces for damage or wear that will affect proper closing of these integral valves. Replace all defective valve parts.
14. Prior to assembly, immerse all parts, including 'O' rings in clean hydraulic oil to facilitate re-assembly and provide initial lubrication to the parts.
15. Assemble 'O' rings and ensure that they are correctly seated. Cutting and tearing of seals can be avoided by ample lubrication and careful insertion in metal retaining grooves or bores possessing sharp edges. The spool quadring and back-up ring assembly will be facilitated by the use of grease lubricant, the quadring to be inserted first, then the back-up ring. Locate one end of the back-up ring between the quadring and body in the retaining groove, and feed the remainder into the groove around the body, **carefully** using a small screw driver to compress the quadring while inserting the back-up ring.
16. Insert a new single-double acting valve 'O' ring. Re-assemble the spindle and knurled knob, and install the valve body.
17. Install the relief valve in the valve body, ensuring that it is the correct way up, that is, with the hexagon head section facing toward the spring and plug.

Caution : Any adjustment to the relief valve setting must be checked with a gauge inserted in the lines immediately the system is re-assembled.

Fig. 013 — Correct Relief Valve Installation

18. Assemble the centring spring and washers before returning the spool to its body bore.
19. Re-assemble the detent housing to the valve body, and the detent and spring to the housing.
20. Install the check valve, spring and retainer.
21. Install the valve and sealing rings on the reservoir, and tighten the mounting bolts to 15 lbs./ft.
22. Reconnect the hose and spool clevis, fill the reservoir with the correct oil to the marked level and check the hydraulic operation. Re-check the reservoir and top-up, if necessary.
23. Replace the seat apron, or seat frame assembly.

TROUBLE SHOOTING

Trouble	Possible Cause	Remedy
PUMP NOT DELIVERING FLUID	Driven in wrong direction of rotation.	Change drive direction immediately to prevent pump seizure.
	Shaft sheared.	Disassemble the pump and check for damage. Replace necessary parts.
	Fluid intake pipe in reservoir restricted.	Check filter for dirt and sludge. Clean if necessary.
	Fluid viscosity too heavy to pick up prime.	Completely drain the system. Add new filtered fluid of the proper viscosity.
	Air leaks at intake, pump not priming.	Check the inlet connections to determine where air is being drawn in. Tighten any loose connections. See that the fluid in the reservoir is above the intake pipe opening.
	Vane(s) stuck in the rotor slot(s).	Dismantle the pump. Check for dirt or metal chips. Clean the parts thoroughly and replace any damaged pieces. If necessary flush the system and re-fill it with clean fluid.
INSUFFICIENT PRESSURE BUILD-UP	System relief valve set too low.	Use a pressure gauge to correctly check the relief valve.
	Dirt in the relief valve.	Dismantle, clean and re-assemble.
	Worn parts causing internal leakage of pump delivery.	Replace necessary pump parts.
	Relief valve upside down.	Correct condition.
PUMP NOISY	Pump intake partially blocked.	Service the intake filter. Check the fluid condition and, if necessary, drain and flush the system. Refill with clean fluid.
	Air leaks at the intake or shaft seal (oil in reservoir would probably be foamy).	Check the inlet connections and seal to determine where air is being drawn in. Tighten any loose connections and replace the seal, if necessary. See that the fluid in the reservoir is above the intake pipe opening.
OIL OVER-HEATING	Insufficient or incorrect oil in system.	Top-up or change to correct oil.
	Valve spool not centring.	Adjust linkage to centralise the spool.
	Continuous operation of relief valve.	Check for excess loading or dirt, in the relief valve.

THREE POINT LINKAGE

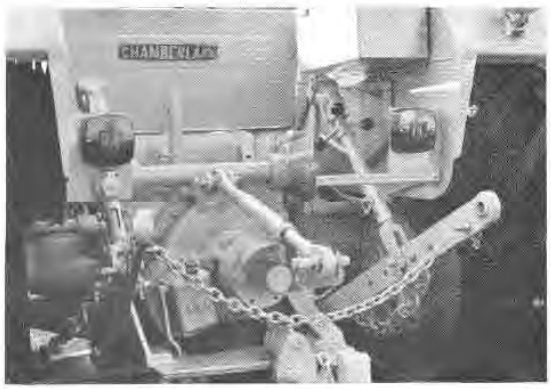


Fig. 014 — Three Point Linkage

DESCRIPTION

The assembly consists basically of three links, the single upper link incorporating a turnbuckle, and the two lower links coupled by adjustable lift arms to the rockshaft mounted above the differential housing. Levelling of the implement is by adjusting the lift arms, or the top link as required.

The linkage incorporates only slotted lift arm holes as float provision, as the hydraulic system prevents damage or appreciable loss of traction due to the linkage resisting an upward thrust from the attached implement.

Sway chains connect the lower links to the final drive housings and are adjusted so that they have a constant tension throughout the lift range. A locking pin is provided to hold the linkage in the fully raised position for transport, or for trailing implement hydraulic operation, and safety chains are provided to couple the lower links when no implement is attached .

Linkage actuation is by an 8" stroke x 3" bore external hydraulic cylinder which is anchored by a bracket to the chassis member, and is connected to a rockshaft lever.

The linkage hydraulic system has three positions : raise, hold and float.

Raise :

Oil under pressure from the pump is directed to the rear of the cylinder piston to contract the cylinder and raise the linkage. Air from the front of the piston is expelled through the cylinder return hose.

Hold :

In this position oil is prevented from entering or leaving the cylinder and the linkage will not lower unless leakage occurs in either the piston or gland seals, the hose or the valve spool. However, an upward thrust on the linkage of only 25 lbs., (in addition to that required to overcome friction) will reduce the pressure on the oil in the cylinder sufficiently to vaporise it and allow the cylinder to contract and the linkage to lift, thus preventing severe loss of traction or damage to the linkage and implement.

Note : If the above situation is encountered, air will be introduced into the system, causing aeration problems. To prevent this, operate the linkage in the "Float" position of the control valve.

Float :

In this position oil is able to flow freely between the cylinder and the reservoir and the weight of the implement, combined with the suction of the tillage tools, keeps the implement at a working level controlled by the implement depth setting. In the event of the tractor rear wheels dropping into a depression, the resultant upward thrust on the linkage allows oil to enter the cylinder and enables the implement to lift.

SPECIFICATION

Lift capacity (hitch point with arms lowered, 6" above ground)	— 3200 lbs.
Max. vertical height of hitch point above ground	
18.4 x 26 tyres	— 38".
14.00 x 28 tyres	— 37".
Min. vertical height of hitch point from ground level	
18.4 x 26 tyres	— 9/16" below.
14.00 x 28 tyres	— 1 - 9/16" below.
Power Range :	
Lift link extended	— 29 - 1/6".
Lift link closed	— 24 - 15/16".
Mechanical Height Adjustment :	
Lower link raised	— 10 - 3/8".
Lower link lowered	— 13 - 5/8".
Rockshaft lever bolt tension	— 230 lbs./ft.
Rocklever cross-shaft end float	— 1/32" maximum.

MAINTENANCE

Lubricate the linkage with grease at 50 operating hours. Seven nipples are provided on the rockshaft bearings, lift links and cylinder-to-rocklever pivot pin.

Hydraulic Cylinder :

The linkage cylinder has a hose connection in each end piece, one hole being fitted with a breather nose to the reservoir for single acting operation. Four tie rods clamp the cylinder body between the ends, and 'O' rings make the seal. The piston is clamped to the piston rod by a nut, with an 'O' ring sealing between the rod and piston, and a neoprene ring and two back-up rings sealing between the piston and cylinder body. The protruding piston rod is fitted with a screwed fork and locknut, and the gland cap is fitted with an oil seal and rod wiper seal.

Cylinder Maintenance :

The cylinder should be removed and flushed out each time the hydraulic system oil is renewed. Any oil leaks must be repaired immediately they become apparent.

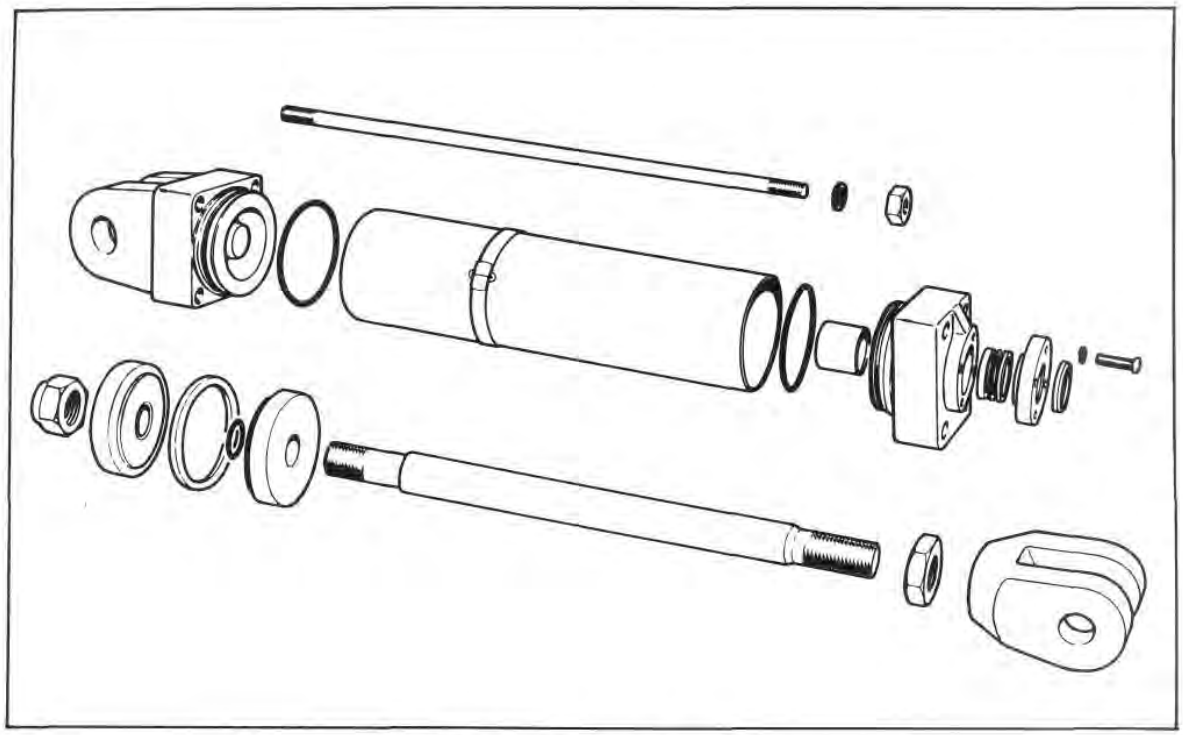


Fig. O15 — Hydraulic Cylinder (exploded view)

When re-filling and checking the hydraulic system oil, the linkage should be in the lowered position.

Cylinder Overhaul :

1. Prepare a clean working area and thoroughly clean the outside of the cylinder.
2. Remove the hose connections and ensure that all cylinder oil is completely drained.
3. Slacken the locknut and remove the fork.
4. Remove the tie rod nuts and the gland cap.
5. Withdraw the piston and remove the cylinder body from the hinge cap.
6. Thoroughly clean all parts and inspect. Check the cylinder bore and piston for scoring. If any doubt exists regarding the serviceability of any part, renew. It is recommended that all seals be replaced at overhaul.
7. The piston seal can be re-newed by removing the nyloc locknut and separating the piston halves.
8. Insert the piston in the cylinder body. The new piston assembly is a tight fit when installing in the cylinder tube and care is necessary to avoid seal damage. The lead-in chamfer on the cylinder body must be free of nicks or burrs prior to assembling the piston. The piston friction decreases after the linkage has been raised and lowered a few times.
9. Fit the 'O' rings to the end pieces and assemble the body to them, ensuring that the seals remain correctly positioned. Tighten the tie-rod nuts to 120 lbs./ft.
10. Install the piston rod seal in the gland cap, the wiper seal in the seal housing and assemble the housing to the gland cap. Fit the locknut and fork.
11. Install the cylinder on the tractor and operate the hydraulic system, checking for cylinder oil leaks.

CRANKSHAFT OR GEARBOX DRIVEN HYDRAULIC PUMP

These positive displacement pumps are used to develop hydraulic fluid for the operation of hydraulic equipment. The pump operation is basically the same as for the pump for the three point linkage hydraulics, and the overhaul procedures described on Pages O4 and O5 can also be applied, when necessary.

SPECIFICATION

Make of unit	— Vickers V30 series pump.
Pump output	— 34 (U.S.) g.p.m. @ 1400 p.s.i.
Rotation, (C'shaft)	— Anti-clockwise (viewed from shaft end).
Gearbox	— Clockwise (viewed from shaft end).
Pump fixing	— 2 bolt "B" flange.
Pump ports, (C'shaft)	— Inlet and outlet ports in line.
Gearbox	— Inlet and outlet ports at 90°.
Pump drive rating (continual)	— 30.5 H.P. max.
Pump drive rating (30 sec. intermittent)	— 61 H.P. max.
Dry weight	— 30 lbs. approx.
Oil recommendation	— Refer to chart.

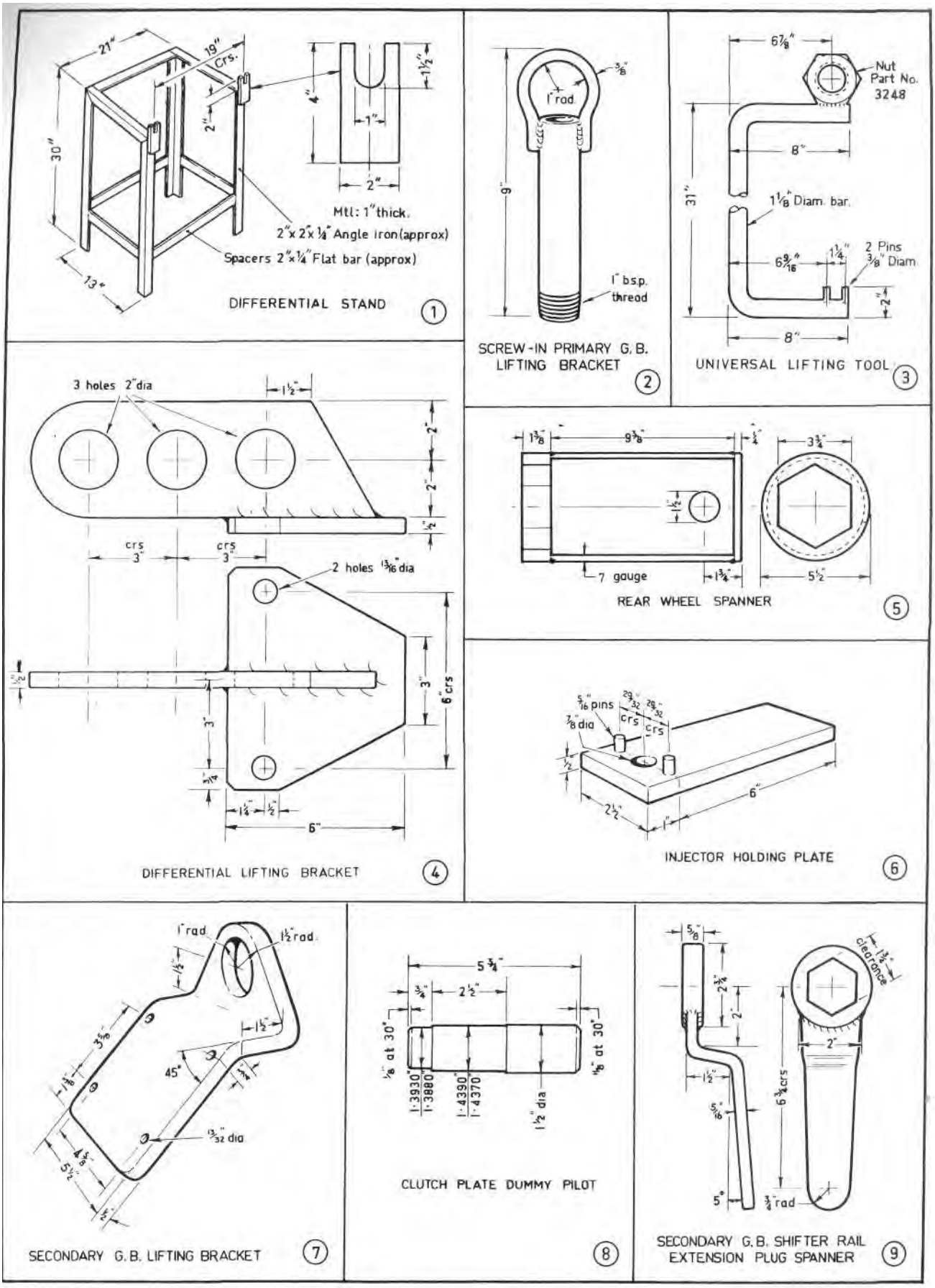
SECTION **P**

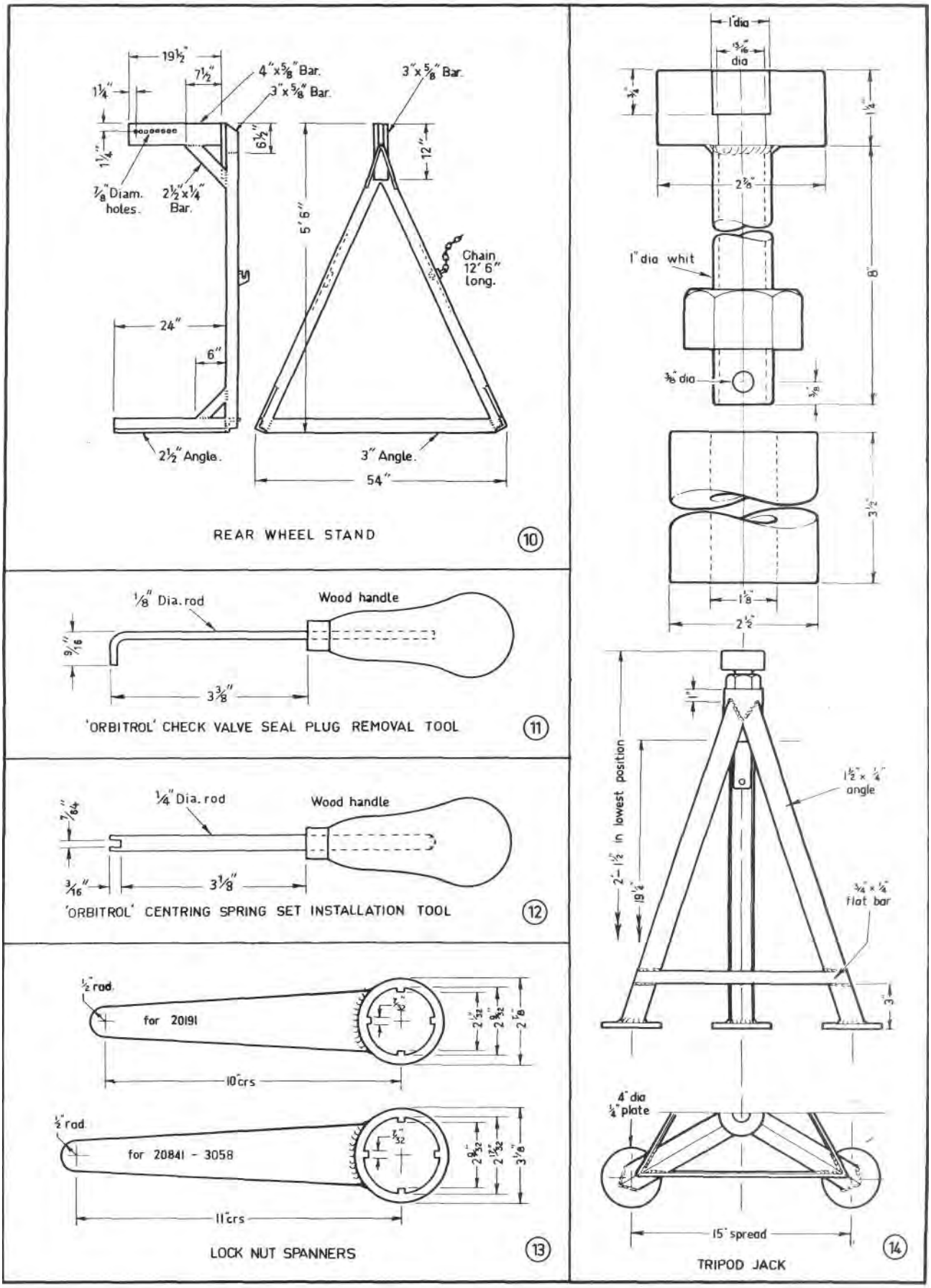
MISCELLANEOUS

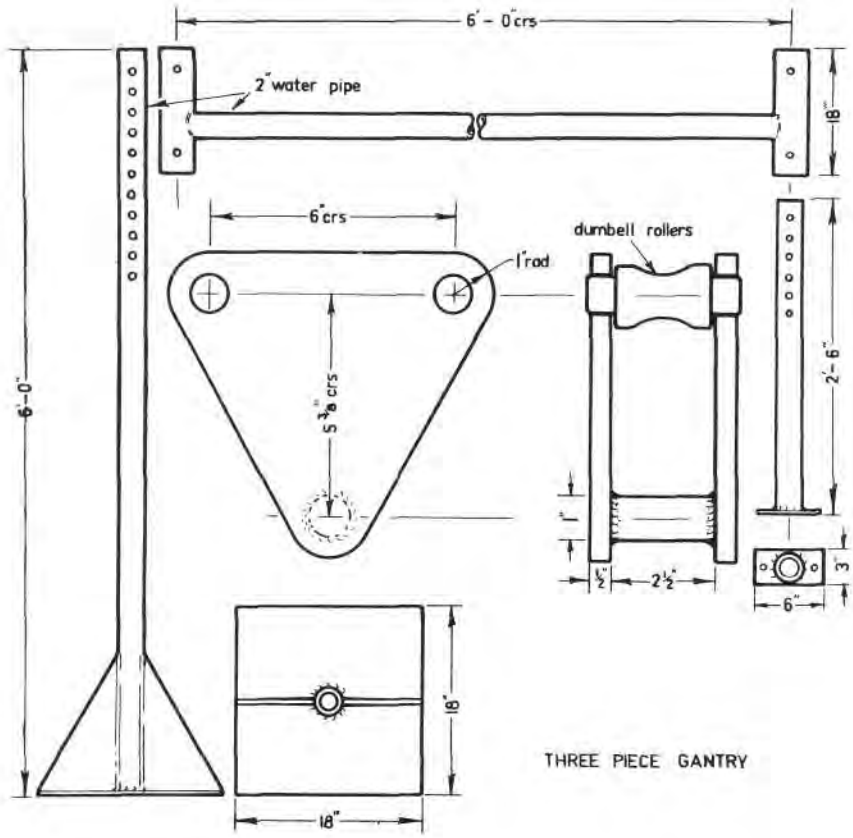
SERVICE TOOLS, MAINTENANCE CHART, LUBRICANTS

SERVICE BULLETIN REFERENCE

S.B. No.	TRACTOR	SUBJECT

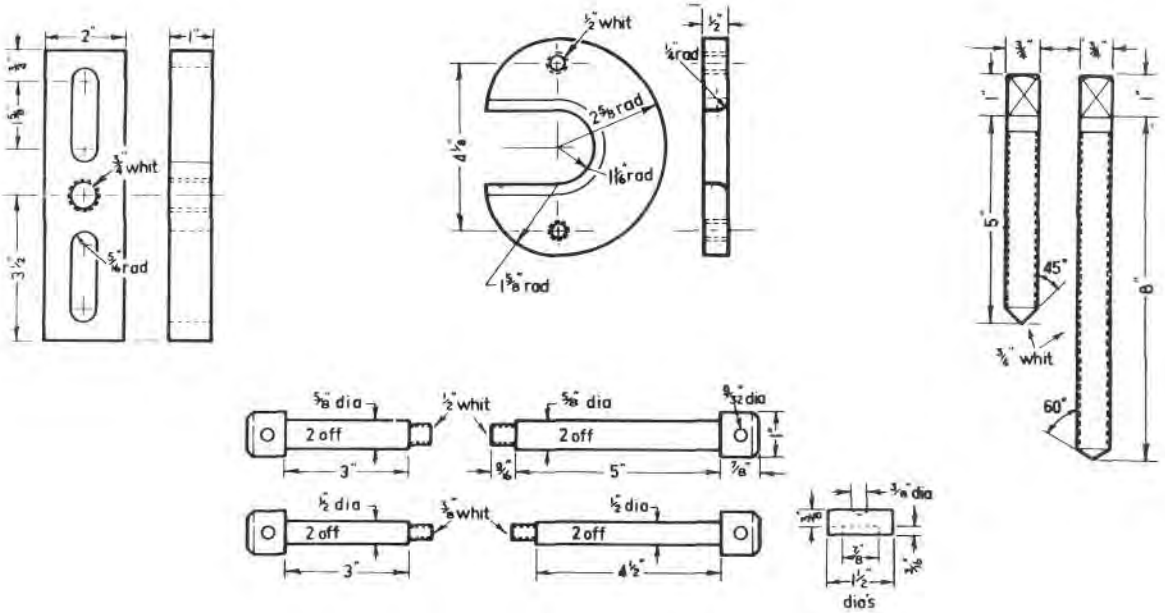






THREE PIECE GANTRY

15



UNIVERSAL PULLER SET

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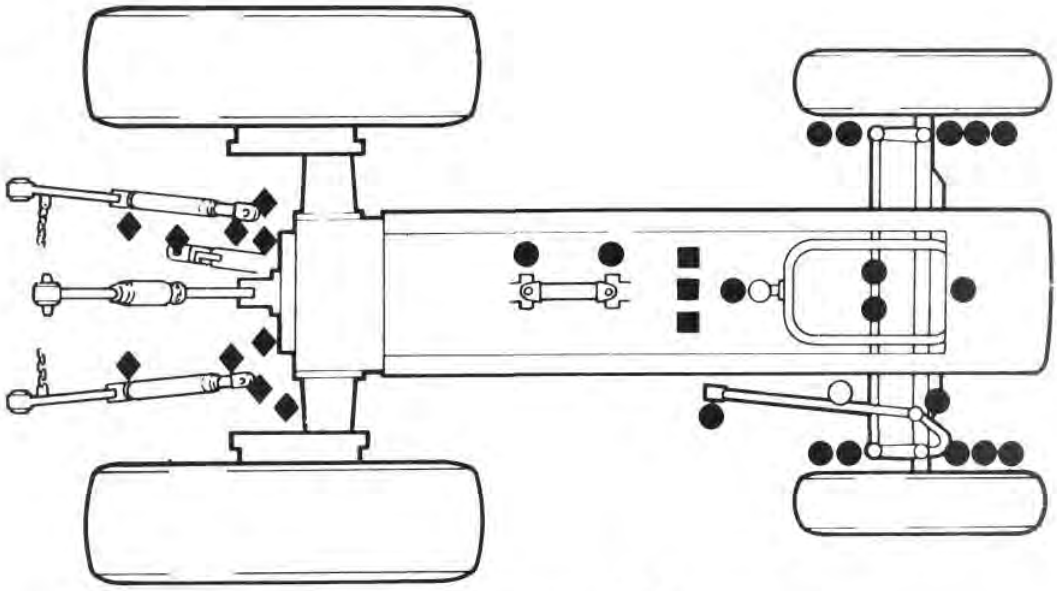
TRACTOR LUBRICATION GREASE POINTS



● STD. & F.W.D. CHASSIS ■ MANUAL GEARBOX
○ POWER STEERING CYL. ◆ T.P. LINKAGE & ROLLER D.B.

PERIODICAL MAINTENANCE REQUIREMENTS

EVERY 10 HRS.	RADIATOR	- check level
	ENGINE OIL	- check level
	PRE-CLEANER	- check dust level
	AIR CLEANER (oil bath)	- check oil
	* AIR CLEANER (dry type)	- check dust level
	* HYDRAULICS	- check level
	* TORQUE CONVERTER	- check level
	FUEL SYSTEM	- check for dirt/water
	STEERING AXLE AND LINKAGE	- lubricate
	* DRAWBAR ROLLER	- lubricate
	* FRONT AND REAR TYRES	- check pressure
EVERY 50 HRS.	FAN BELT	- check tension
	BATTERIES	- check water
	ENGINE AND * HYDRAULIC CONTROLS	- lubricate
	* CLUTCH AND CLUTCH BRAKE	- lubricate and adjust
	BRAKES (std.)	- check adjustment
	* BRAKES (steering axle)	- check oil and adjustment
EVERY 150 HRS.	ENGINE OIL	- change oil
	* AIR CLEANER (dry type	- clean element
	COUPLING SHAFT	- lubricate
	PRIMARY GEARBOX, * DROP BOX, SECONDARY GEARBOX	- check level
	DIFF., FINAL DRIVES, * P.T.O. (clutch)	- check level
EVERY 300 HRS.	ENGINE OIL FILTER	- change filter
	TAPPETS	- adjust if necessary
	FUEL SYSTEM	- change agglom. filter
	INJECTORS	- test & re-set if necessary
	* TORQUE CONVERTER	- change oil and filter
	STEERING BOX (manual)	- check level
	* P.T.O. (clutch)	- change oil
	COOLING SYSTEM	- drain and flush
EVERY 600 HRS.	PRIMARY GEARBOX, * DROP BOX, SECONDARY GEARBOX	- change oil
	DIFF., FINAL DRIVES	- change oil
	* HYDRAULICS, * POWER STEERING, * BELT PULLEY	- change oil
	AIR CLEANER (oil bath)	- clean body
	* AIR CLEANER (dry type)	- re-new element
	FUEL SYSTEM	- re-new final filter
EVERY 1200 HRS.	SPARK ARRESTOR	- clean out ash

* If applicable

RECOMMENDED LUBRICANTS — See over.

RECOMMENDED LUBRICANTS

COMPARTMENT	LUBRICANT	VISCOSITY OR GRADE
ENGINE AND OIL BATH CLEANER	Heavy duty oil conforming to MIL-L-2104A or MIL-L-2104B and suitable for API Service DG. **Note :** Series 3 oils are NOT recommended.	Below 30°F — SAE 10W 30° to 80°F — SAE 20W Above 80°F — SAE 30 All temps. above 30°F SAE 20W/40
PRIMARY GEARBOX SECONDARY GEARBOX DIFFERENTIAL FINAL DRIVES MANUAL STEERING BOX * DROP BOX (TORQUE CONVERTER) * BELT PULLEY	Multi-purpose Extreme Pressure gear lubricant conforming to MIL-L-2105B and suitable for API service GL1 to GL5.	SAE 90 or 90/140
* TORQUE CONVERTER	Automatic transmission fluid type A or Dexron.	
* POWER STEERING * POWER STEERING (F.W.D.)	Automatic transmission fluid type A or Automatic transmission fluid type F or Dexron.	
* 3 P.L. HYDRAULIC SYSTEM	Motor oils meeting ASTM G 1VMS requirements. **Note :** Many HD oils also meet MS requirements and standardisation of engine and hydraulic systems is recommended.	20°F to 80°F — SAE 20W Above 40°F — SAE 30 Multigrade oils are NOT recommended
* POWER TAKE-OFF (CLUTCH)	Chamberlain ASD PTO oil only (Part No. 39760).	
ALL GREASE POINTS	Lithium base multi-purpose grease.	N.L.G.I. No. 2

Confirm with your lubricant supplier that lubricants supplied meet ALL requirements listed above. Special additives for fuel and lubricants are not recommended unless endorsed by the manufacturer of the fuel and oil in use.

* Optional Extra