Fiat Trattori
FIAT

480-480 DT
500-500 DT and models "Special"
540-540 DT and models "Special"
640-640 DT

WORKSHOP MANUAL

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D I R E Z I O N E   C O M M E R C I A L E

IMPORTANT

The original design and official dimensions are given in metric units.
Dimensions are also given in imperial units only for prompt reference.
In the "Service Tools" section two catalog numbers are reported, the previous one (letters and digits) and the present one (digits), while in the text the previous numbers have been largely reported and the new ones appear in a few cases.

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MODEL 640

See Appendix page 210 for:

- engine with Bosch injection pump;
- subsidiary reduction unit;
- models 640 DT e 640 DT 3;
- power steering.

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ENGINE

0 - SPECIFICATIONS - REMOVAL - INSTALLATION

DESCRIPTION

The FIAT engine installed on wheel tractor model 640 is a high-speed Diesel unit with a four-stroke cycle and four cylinders in line.

The engine crankcase is a cast iron unibloc with dry, replaceable cylinder liners and with the housings for the crankshaft and camshaft bearings and for valve tappets.

Helical-teeth timing gears, camshaft located in crankcase and overhead valves; intake valves are shielded to increase turbulence of aspirated air.

The power chain is driven by the crankshaft which revolves in five thin-shell main bearings and includes; light-weight pistons with toroidal combustion chambers built in top, three piston rings (two oil scrapers and one compression ring), forged-steel connecting rods with an oil drill for piston pin and liners lubrication and a second one through the small end for piston cooling.

Engine vibrations are dampened by a counter-rotating weight type unit located in the oil sump.

Aspirated air is filtered through an oil-bath cleaner with wire-mesh element, preceded by a centrifugal-type self-cleaning unit.

Direct injection in the high-turbulence combustion chamber built in piston tops.

Double-diaphragm fuel lift pump, double filters connected in series and water depuration.

Injection pump of the single plunger type with all-speed governor and automatic timing device:

— type C.A.V., with fly-weight mechanical governor

Three-hole nozzles clamped to the cylinder head.

Forced feed lubrication by camshaft-driven gear-type pump with incorporated relief valve.

Full-flow filter bolted to the crankcase and provided with an internal relief valve which by-passes the oil flow when filter is clogged.

Circulating water and radiator cooling system. A centrifugal pump, belt-driven by a crankshaft-mounted drive pulley, activates the water flow which enters the radiator when the temperature reaches up to the thermostat setting.

The cold air drawn in by the fan, which is secured to the water pump hub, activates water circulation inside the radiator.

Direct electric starting with solenoid-engagement 12 V motor and starting aid for low temperatures.

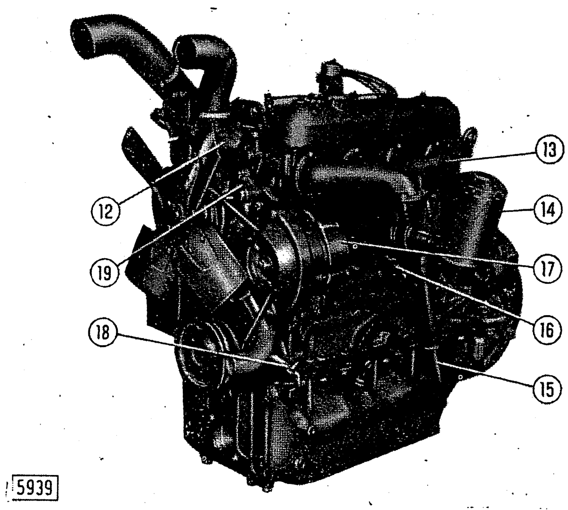


Fig.0/2 - Three-quarter left front view of engine
12. Thermostat housing pipe - 13. Exhaust manifold - 14. Oil filter - 15. Breather - 16. Crankcase water drain cock - 17. Alternator - 18. Radiator water drain cock - 19. Water pump.

SPECIFICATIONS

Engine type	FIAT	8045.02.300 with Ferodo clutch 8045.02.307 with Luk clutch

Cycle	Diesel
Strokes	4
Number of cylinders	4
Bore and stroke	100 × 110 mm (3.93 × 4.33 in)
Capacity	3456 cm³ (210 in³)
Number of main bearings	5
Injection sequence	1-3-4-2
Governor setting:	
— Max. power speed	2400 r.p.m.
— High idling	2600 r.p.m.
— Low idling	650 r.p.m.
Compression ratio	17 : 1
Crankshaft rotation (as seen from fan end)	clockwise
Starter pinion and flywheel ring gear tooth ratio	9/110
Engine and alternator speed ratio	1 : 1.827
Lube pressure	3 ÷ 4 kg/cm² (42.7 ÷ 56.9 p.s.i.)
Engine and oil pump speed ratio	1 : 0.500
Engine and water pump speed ratio	1 : 1.423
Hourmeter calibration (1 hour)	96.000 engine revs.
Engine weight (without air cleaner and lube oil)	370 kg (816 Lb)

TEST RIG DATA (WITH CAV INJECTION PUMP) (°)

Brake test.

Test conditions: engine installed on test rig without fan, air cleaner and exhaust muffler.
pressure: 740 ± 5 mm of mercury (Turin altitude);
— temperature: 20 ± 3° C;
— relative humidity: 70% ± 5;
fuel specific weight: 830 ± 10 gr/liter;
- temperature of fuel backleakage at pump outlet : 54±2°C (129±4°F);
- fixed injection advance before T.D.C. in cylinder no. 1 in compression : 18°±1°

(°) For test rig data of the engine equipped with BOSCH injection pump, see table page 212.

Throttle lever setting	Engine speed r.p.m.	Power output of engine runned-in for a total of 2 hours HP	Power output of engine runned-in for a total of 50 hours HP	Fuel consumption time (250 cu.cm) sec.
Max. (under load)	2400	⩾ 60	⩾ 62	⩾ 63,5
Max. (max. torque)	1400	⩾ 38,5	⩾ 40	⩾ 97
Max. idle	⩽ 2600	—	—	—
Min. idle	650	—	—	—

Belt pulley test.

The test is carried on under the same ambient conditions specified for the engine installed on test rig. Besides, the belt must be adequately stretched and slip must not exceed 3 percent.

Throttle lever setting	Speed engine r.p.m.	Speed belt pulley r.p.m.	Power output of engine runned-in for a total of 2 hours HP	Power output of engine runned-in for a total of 50 hours HP	Fuel consumption time (250 cu.cm) sec.
Max. (under load)	2400	1248	⩾ 55,5	⩾ 58,2	⩾ 63,5
Max. (max. torque) . . .	1400	728	⩾ 36,2	⩾ 37,6	⩾ 97
Max. idle	⩽ 2600	⩽ 1351	—	-	—
Min. idle	650	338	—	—	—

FAULT-FINDING IN CASE OF POOR ENGINE PERFORMANCE

If test specifications cannot be met:

— check, by excluding one cylinder at a time, that the pressure drop is constant in order to ascertain the functional efficiency and uniformity of nozzles. Replace defective nozzles or try once again using a set of calibrated test nozzles;

— replace injection pump or try again using a properly calibrated and reliable pump;

— look for the causes of poor engine performance. Use the recording compression tester **A 711150**, applying it in succession to each cylinder, to which the present test data and procedure refer.

Test the engine when temperature has reached 70° C (158° F), corresponding almost to the limit of the white band of the panel-mounted temperature gauge, and stop the engine:

- remove the injectors from the cylinders ;

- install the test injector 645N in place of the injector corresponding to the cylinder to be tested and, in order to obtain a good seal, place a copper washer on seat ;

- hold the injection pump in "stop" position and take the readings, turning the engine with the starter motor.

The pressure reading for a normally operating engine, recorded at temperature of about 40°C (104°F) and at sea level (760 mm of mercury), and for a speed of about 250 r.p.m. is from 26 to 28 kg/cm^2 (370 to 398 p.s.i.).

The minimum permissible pressure reading for a worn engine is 22 Kg/cm^2 (313 p.s.i.).

It must be kept in mind that pressure drops of 1 percent for every 100 m increments of altitude.

The maximum permissible pressure difference between the various cylinders is 3 Kg/cm^2 (42.7 p.s.i.).

Compression faults can be traced to : valves and seats, pistons and their rings, cylinder liners, cylinder head gasket.

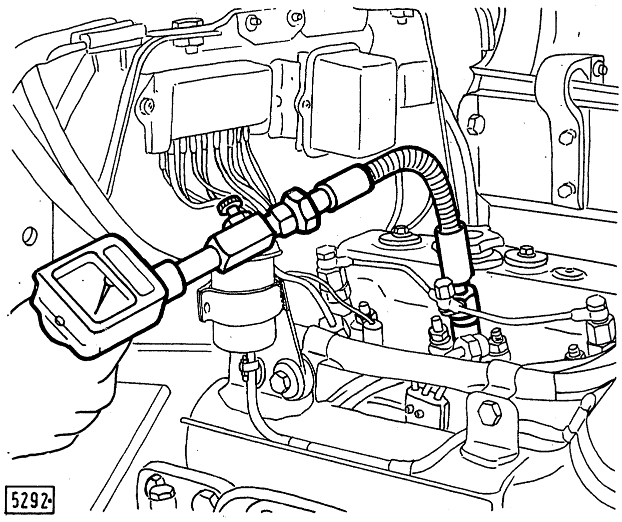


Fig. 0/3 - Checking engine compression with tester A 711150.

Caution - *Pressure test data are reliable only if the gauge* **A 711150** *is functionally efficient and correctly installed and if temperature and speed conditions requirements have been met.*
Do not start overhauling or repairing an engine following a single low compression reading, or if the gauge is not the one indicated or if the test has not been carried on as specified.

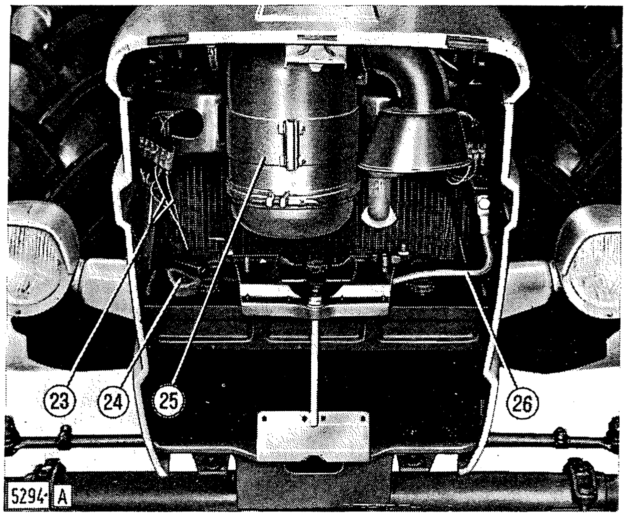


Fig. 0/5 - *Front view of tractor without cowling.*
23. Headlamp connection cables. - 24. Battery positive cable. - 25. Air cleaner band clamp. - 26. Battery ground cable.

REMOVING THE ENGINE FROM TRACTOR

Proceed according to the following sequence:

1. *Front axle.* Remove radiator grille (Fig. 0/4) after rotating the upper stop (**21**) in either direction indicated by the arrows, disconnect the ground cable (**26**, Fig. 0/5) and then the battery. Disconnect the headlamp cables from the front connections (**23**) and remove the headlamps, then remove the nuts securing the front hood to the side panels, and, finally, remove the front hood. Withdraw from the intake hose the two band clamps securing both hose and headlamp cable strap and then remove the positive cable (**24**) attaching plate.
Drain radiator water through the cock (**18**, Fig. 0/2) and slacken the water inlet and outlet hose band clamps.
Detach the drag link (**27**, Fig. 0/6), place a shop stand or wooden blocks under the oil sump and insert two wedge blocks, between traverse and axle support. Remove the screws and detach the axle from engine being careful to avoid upsetting the assembly or damaging the fan blades with the air shroud.

2. *Hood and cowling (Fig. 0/7).* Remove all the fastenings and starter switch (**35**, Fig. 0/8), disconnect the instrument connections on the panel (**32**) and then remove the same panel.

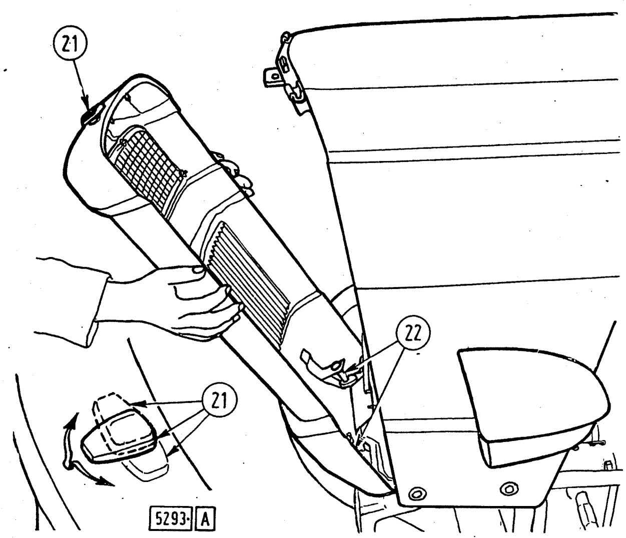


Fig. 0/4 - *Removing the cowling after turning upper lock pin (21) and withdrawing the pins (22) from the lower support.*

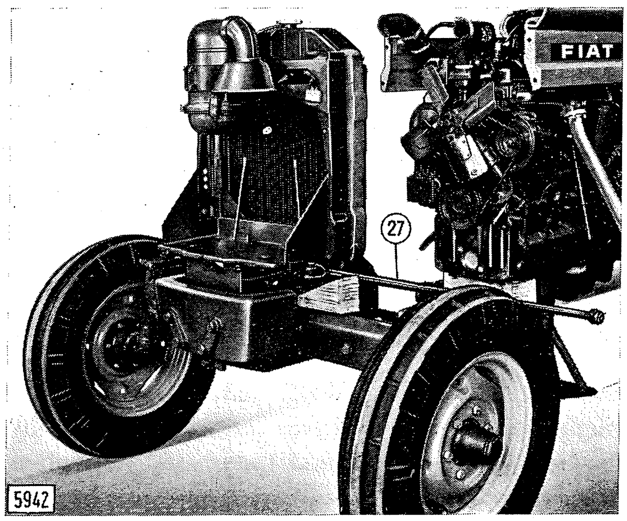


Fig. 0/6 - *Removing front axle from engine.*
27. Steering tie-rod.

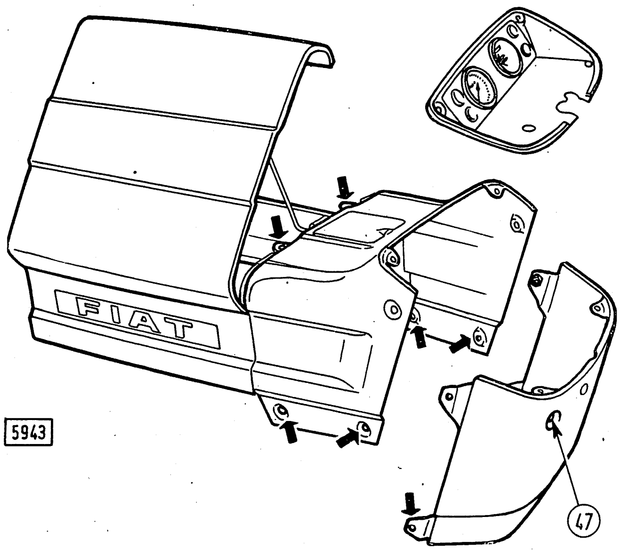


Fig. 0/7 *- Removing body parts.*
(Arrows indicate holes of screws securing body parts to tractor. All other holes are for screws securing body darts to each other).
47. Radiator curtain chain hole.

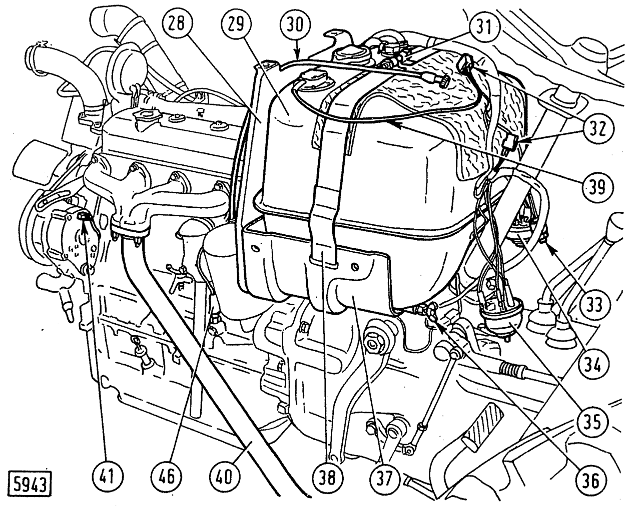


Fig. 0/8 *- View of engine without hood.*
28. Control valve mounting. - 29. Fuel tank. - 30. Tractormeter flexible cable. - 31. Fuel tank (29) clamp (38) tie bolt. - 32. Panel indicators connections. - 33. Electric horn push-button. - 34. Lighting and starting switch. - 35. Starting switch. - 36. Fuel-cock. - 37. Fuel tank mounting. - 38. Fuel tank (29) straps. - 39. Floating cable. - 40. Exhaust muffler. - 41. Alternator cable. - 46. Low lube pressure cable connection.

Remove the master switch (**34**), horn button (**33**), rear panel and the remaining body parts (Fig. 0/7).

3. *Fuel tank and mounting.* Close the fuel tap (**36**, Fig. 0/8), detach the float wire (**39**) of the fuel level indicator and the starting safety cable, slacken the band clamps of the injection backflow lines and second fuel filter, and, finally, remove the straps and then the fuel tank.

Remove the temperature gauge bulb, cables and wires of the alternator, electric horn, starting aid and starting motor, then remove the brackets on the intake manifold so as to free the headlamp cable.

Remove the throttle links (**42**, Fig. 0/9) and shut-off links (**43**), the capscrews securing the mounting to the engine and transmission and, finally, remove the tank mounting with electrical control box.

4. *The engine (Fig. 0/10).* Drain crankcase water through cock (**16**, Fig. 0/2) and oil through the sump bottom plug, remove the exhaust muffler (**40**, Fig. 0/8) and disconnect the input and output piping (**45** and **44**, Fig. 0/9) from the oil pump of the hydraulic lift.

Arrange the lifting hook **ARR 117105** on the engine, unscrew the engine and transmission attaching capscrews (**C_1**) and then, with the aid of a crowbar used to free the crankcase from locating dowels, move the engine forward as smoothly as possible to ease the clutch shaft out.

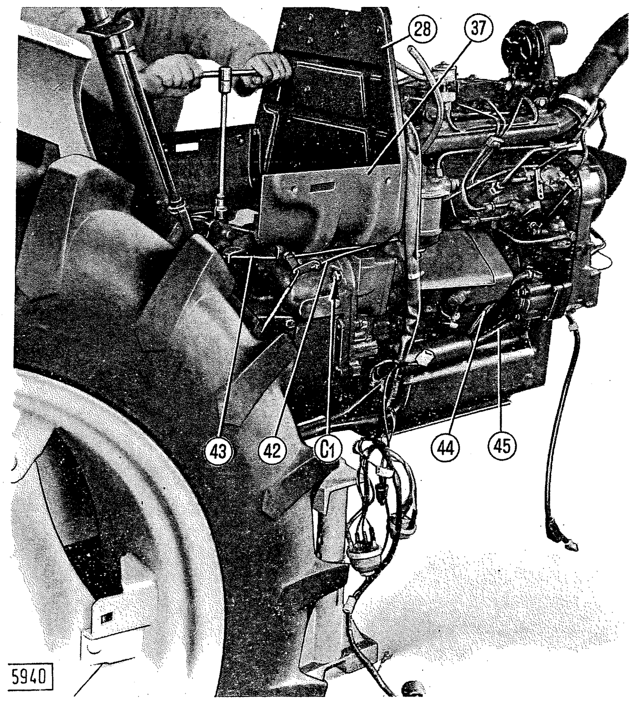


Fig. 0/9 *- Removing fuel tank mounting (37) with electric control box mounting plate (28).*
C_1. Capscrews securing engine to trasmission case. - 42. Engine throttle rod. - 43. Engine shut-off rod. - 44. Oil delivery line to hydraulic lift. - 45. Oil suction of hydraulic pump.

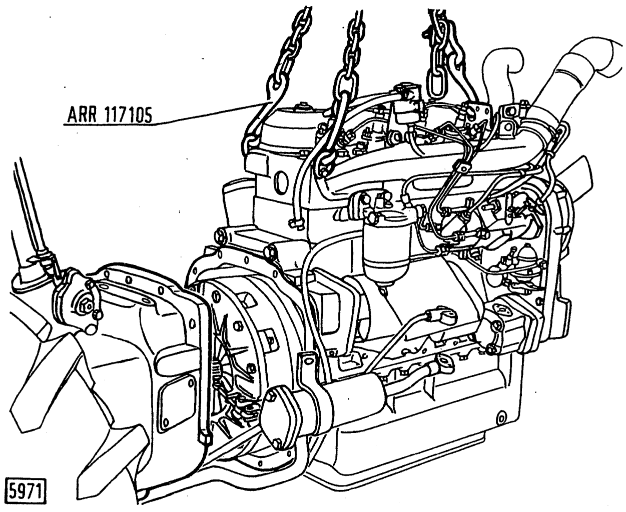


Fig. 0/10 - Removing engine from tractor with lifting hook ARR 117105.

DISASSEMBLY AND REASSEMBLY

Attach the engine on turnover stand **ARR 2216** using the bearer brackets **ARR 117204/A/B** at front and bracket **ARR 117204/C** at rear.
Before securing the right front bracket to crankcase mounting, remove the starting motor and hydraulic lift pump.
Attach the front brackets to crankcase using M 10 × 1.25 × 25 mm long capscrew and the rear bracket to the engine mounting by means of M 12 × 1.25 × 80 mm long capscrews, paying attention to the assembly mark stamped on the upper surface (Fig. 0/11).

Refer then to the disassembly and reassembly outlines reported in the chapters covering the major overhauling of the various groups and sub-assemblies.

INSTALLATION

Prior to re-installating the engine on tractor free it from the turnover stand bearer brackets and fit cork plugs to the tapped holes to prevent thread damage.
Reverse the removal sequence and refer to the following points:

— fill the clutch shaft bearing seating in the flywheel with FIAT G 9 (multi-purpose) grease;

— when attaching the engine to the transmission case be sure to locate the clutch splines on their respective gearbox and P.T.O. shaft section properly so to avoid jamming or spline damage;

— torque tighten to tabulated values.

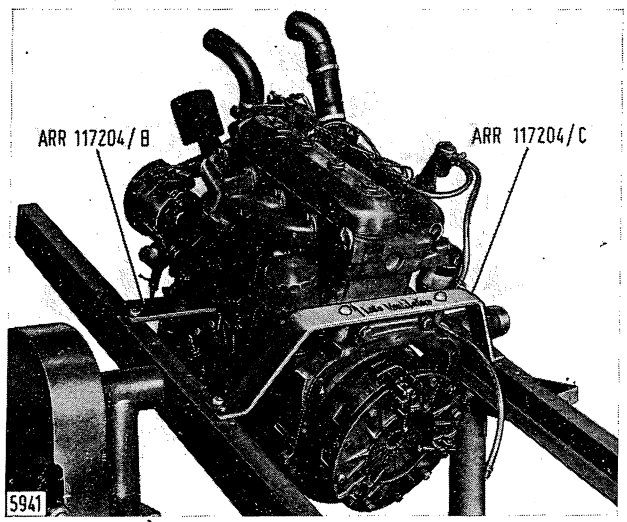


Fig. 0/11 - Installing engine on turnover stand ARR 2216 with front bearer brackets ARR 117204/A/B and rear bracket ARR 117204/C.

I - CRANKCASE - CYLINDER HEAD - OIL SUMP

For a general overall inspection of the crankcase components remove engine from tractor as indicated on page 15.

CRANKCASE AND CYLINDER LINERS

The cast iron crankcase and cylinder block unit construction comprises the cylinder liner bores, crankshaft main bearings, camshaft bearing bores, and the valve tappet bores. Cylinders liners, of the dry-type, are inserted by cold press fitting.

CHECKING AND CLEANING THE CRANKCASE

At overhauls check for failures of oil and water leaks and seepage.
Proceed then as follows:

— wash the crankcase with a hot soda and water solution, and flush it repeteadly with cold water;

— degrease the lubrication passages with a jet of pressurized air and gasoline mixture and remove sludge from the inside of elbows;

— check sealing tightness of threaded and expansion plugs, and replace unreliable ones;

— check the cylinder head attaching capscrews and replace them if stretched because of faulty tightening;

— check the face parallelism of the cylinder head mating surface using a comparator gauge and, if necessary, re-face it with a hand scraper or surface grinder;

— to avoid fluid leaks or seepage, make sure both crankcase and cylinder head mating surfaces are clean, before installing the gasket.

CYLINDER LINER RE-BORING AND REPLACEMENT

Check the liner inside diameter by placing a dial gauge successively on two axes perpendicular to

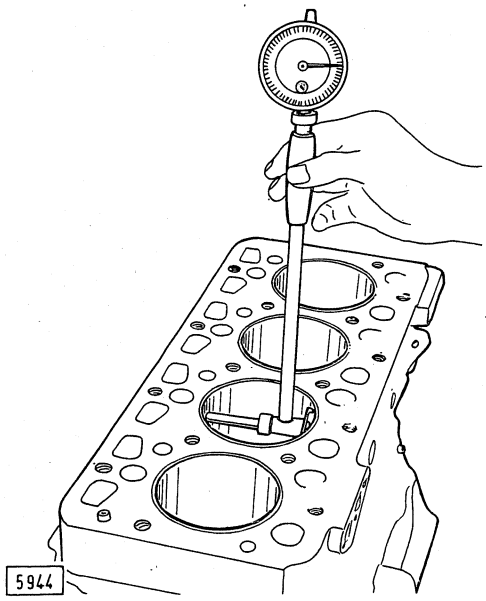


Fig. I/1 - Checking cylinder liner bore with a dial indicator gauge.

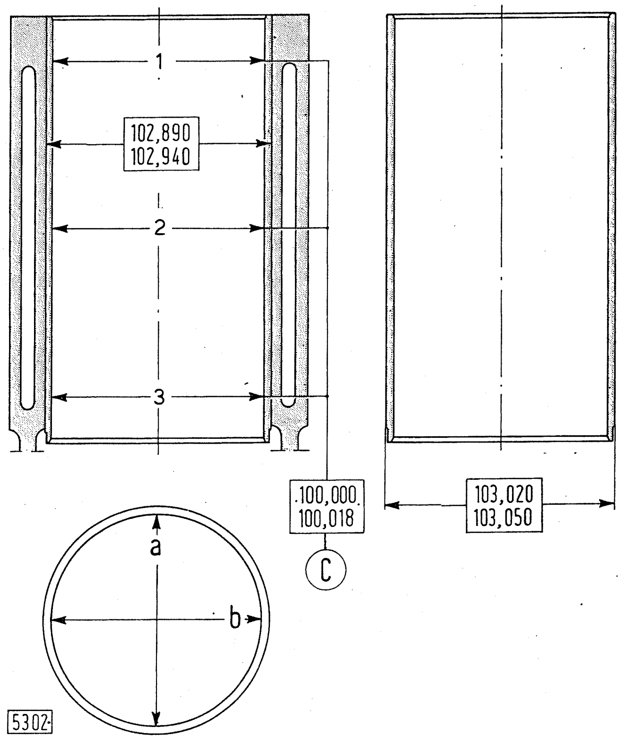


Fig. I/2 - Standard liner and crankcase bore dimensions (mm - See conversions in Section VIII).
a-b. Liner measuring locations. - C. Final dimension after press-fitting.-1,2 and 3.Bore measuring planes.

each other (Fig. I/1) and take these readings at three different heights (Fig. I/2) so to make sure to locate ovalisation or excessive wear.

If necessary, re-bore the liners to the next oversize diameter, the values of which are reported in the table of data of Section VIII; if, on the other hand, the liners which require re-boring are already oversized of 0.8 mm (0.032 in), which is the maximum permissible oversize, replace them.

To replace the cylinder liners, drive them out from the bottom of crankcase with a press, using the removal plate 292507 and install new liners from top of crankcase using a press and the installation plate **A 917072/A** (Fig. I/3).

Caution - *If the dowel with lube oil flow constriction is removed also, make sure to refit it with the smaller hole uppermost.*

CYLINDER HEAD

Special alloy cast-iron cylinder head with hardened valve seats and nozzle mounting holes.

To remove the cylinder head from a tractor-installed engine proceed as follows:

— remove right-and left-hand side panels with central hood panel;

— disconnect the fuel delivery pipes from both injectors and pump (Fig. I/4) considering that the pipe for the cylinder 4 injector is indipendent whilst the others are bracketed together;

— disconnect the injector backleakage tube and remove injectors; this operation is not required for disassembly but it is necessary to prevent nozzle damage following head removal;

— remove the termometer bulb (**10**) and electric horn cables and the headlamp connection cable from the brackets (**7**) on the intake manifold;

— drain cooling water and disconnect the water outlet hose from the radiator and the air suction hose from the intake manifold;

— remove the screws securing the exhaust manifold and intake manifold and be sure to refit immediately the eyelet for lifting hook;

— remove the capscrews securing the second fuel filter to its mounting;

— remove the tappet cover after withdrawing the screws (**4**) securing it to rocker arms;

— remove rocker arms assembly and push rods;

— arrange the lifting hook **ARR 117105** on the head;

— unscrew the attaching capscrews from the crankcase and split the head away without wedging in with tools inserted between mating surfaces to avoid damaging them.

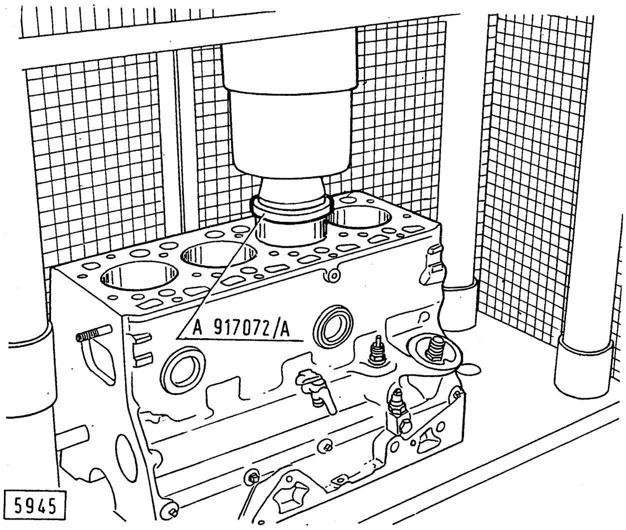


Fig. I/3 - Press-pulling the liners with plate A 917072/A.

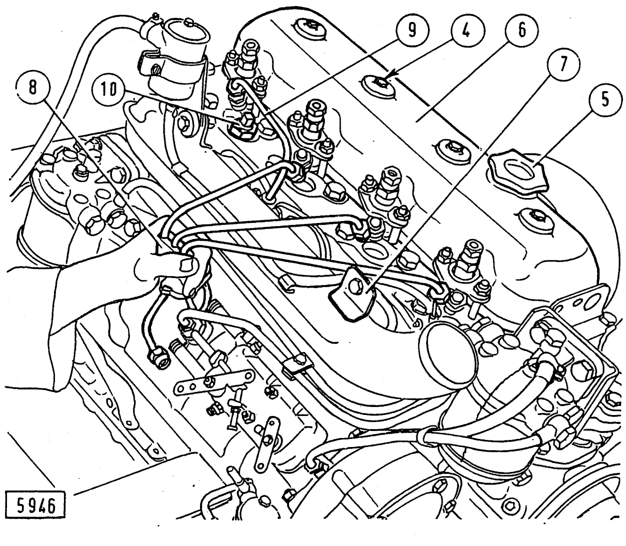


Fig. I/4 - Removing injector piping.
4. Tappet cover nut (6). - 5. Oil filler plug. - 6. Tappet cover. - 7. Cable clamping brackets. - 8. Bracket retaining injector piping of cylinders no. 1, 2 and 3. - 9. Injector pipe of cylinder 4. - 10. Thermometer bulb.

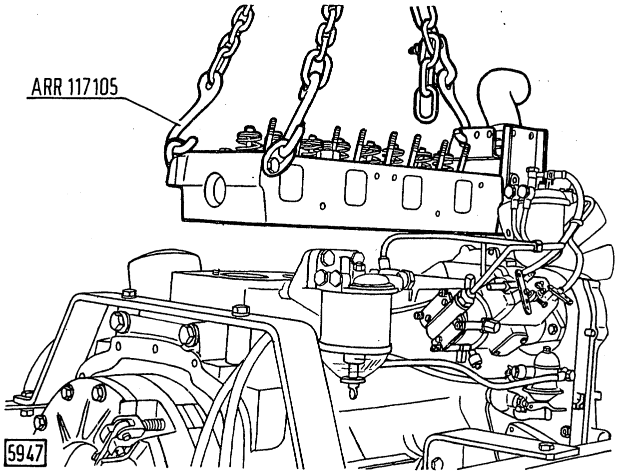


Fig. I/5 - Removing cylinder head from engine installed on turnover stand.

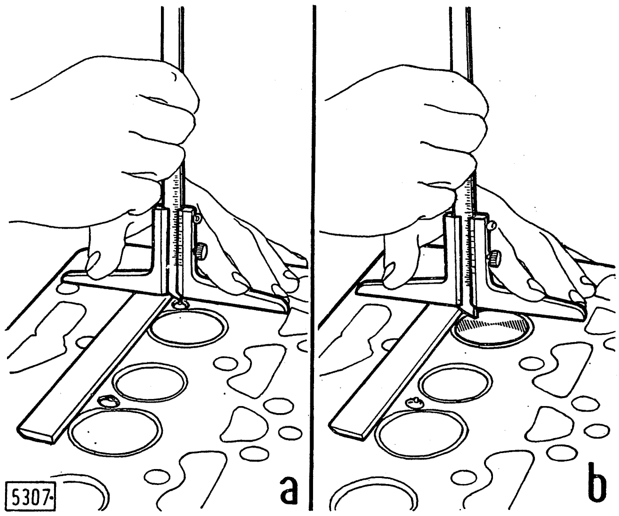


Fig. I/6 - Mesauring nozzle projection above cylinder head plane (a) and valve recessing (b).
(Nozzle projection: 2 ÷ 2.5 mm = 0.08 ÷ 0.10 in. Valve recessing: 0.7 ÷ 1.1 mm = 0.03 ÷ 0.04 in).

Generally speaking, the cylinder head gasket cannot be recovered for successive use, as it is smeared with a jointing compound which makes it stick to the mating surfaces under the effect of heat.

In case of major engine overhaul, the cylinder head is removed from the engine once the latter is suitably installed on the shop turnover stand (Fig. I/5).

Checking the cylinder head.

For complete inspection and checking of the cylinder head it is best to remove valves, valve springs and nozzles and to clean the mating surface, valve seat and passages.

Check the cylinder head mating plane by moving it over a surface plate smeared with lampblack or blue until the high spots show up; smooth them down with a hand scraper if warping is very slight, otherwise re-face it with a surface grinder.

If valve seats are to be re-cut, the cylinder head mating plane can be ground to a depth not exceeding 0.5 mm (0.020 in).

In case of grinding we suggest that a copper washer of suitable thickness be placed inside the nozzle seat so to maintain the nozzle projection above the cylinder head at the same value as before; also, make sure the valve recessing from the cylinder head plane does not exceed 0.7 ÷ 1.1 mm (0.03 ÷ 0.04 in) (Fig. I/6). The height of a new cylinder head is 92 mm (3.662 in).

Check the expansion cups and threaded plug for water and oil tightness and replace them if unreliable.

Following checks, inspections, and grinding, wash cylinder head in kerosene to remove even the slightest trace of abrasive matter.

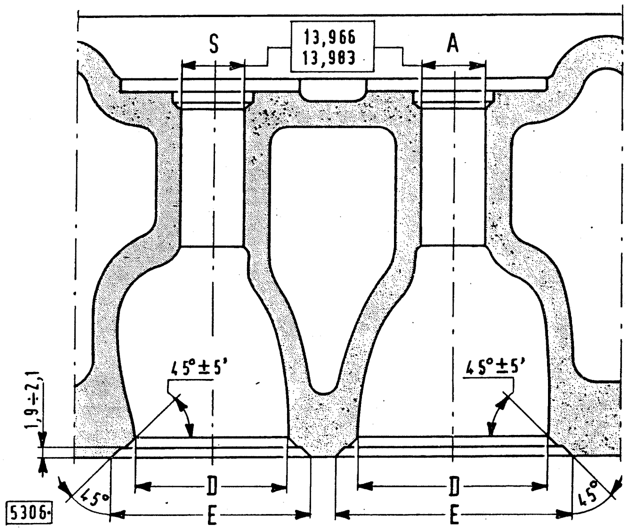
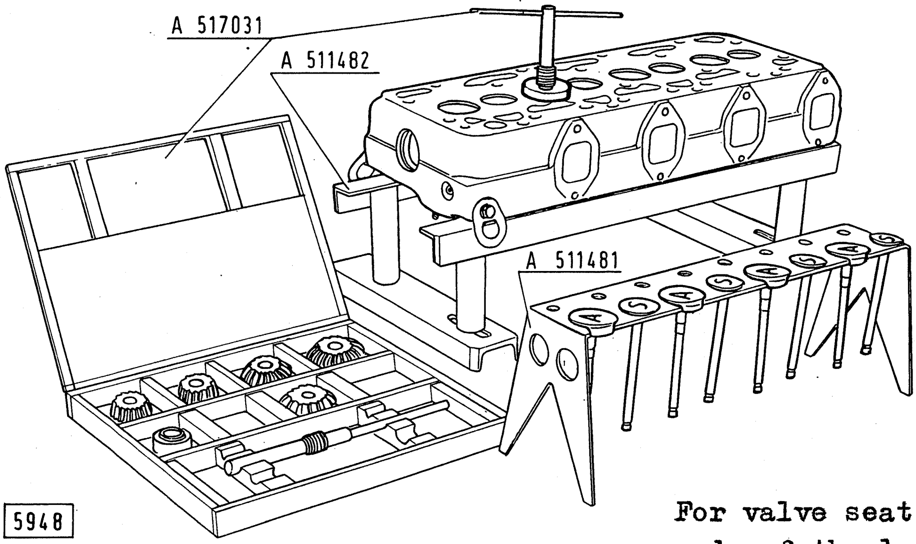


Fig. I/7 - Dimensions of intake and exhaust valve seats and of valve guides in cylinder head.

Valves	(A) Intake		(S) Exhaust	
	mm	in	mm	in
dia. D	40	1.575	33	1.299
dia. E	48.6	1.913	41.6	1.637

Fig. I/8 - Valve seat grinding.



For valve seat regrinding use can be made of the lathe A 60419.

Re-cutting the valve seats.

Place the cylinder head on support **A 511482** and use the cutter and mandrel kit contained in the box **A 517039** (Fig. I/8), as follows:

— grinding wheel **U 511139/7** to descale the exhaust valve seats;

— cutter **U 511139/10**, 45°, for exhaust and intake valve seat grinding.

To reduce the width of the seat use the following cutters and respective mandrels:

— 45° and 20° cutter **U 511139/22 quater** for intake valve seats;

— 45° and 20° cutter **U 511139/22/5** for exhaust valve seats;

— 75° cutter **U 511139/25** for intake valve seats;

— 75° cutter **U 511139/24** for exhaust valve seats.

Depending on the amount of wear of the valve guides use one among the following mandrels:

— mandrel **A 511139/2A** for standard valve guides

— mandrel **A 511139/2B**, 0.08 mm oversized, for worn valve guides.

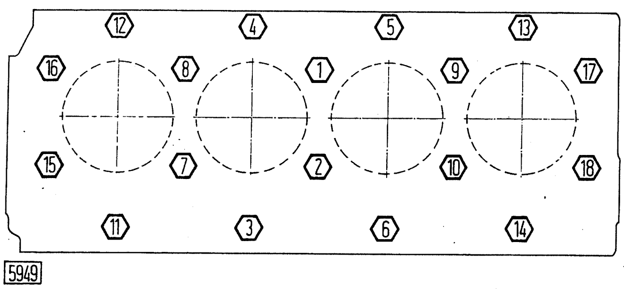


Fig. I/9 - Cylinder head tightening sequence.

Cylinder head and gasket installation.

Reverse the sequence of removal and take good note of the following:

— thoroughly clean both crankcase and cylinder head mating planes to remove gasket particles which have remained stuck to the surfaces at removal;

— arrange gasket with the « ALTO » mark on the cylinder head side;

— do not apply any sealing compound to the gasket, as its surfaces have already been treated with a suitable adhesive compound over the areas requiring the greatest sealing performance; this will adhere to the crankcase and cylinder head surfaces under the effect of heat as the engine gets progressively hot;

— place the cylinder head with the crankcase locating dowel fitting in the head hole;

— arrange the capscrews and torque tighten them following the sequence illustrated in Fig. I/9 and to the values given in the table of Section VIII.

OIL SUMP

The cast iron oil sump houses the counterotating-weight vibration damper (Fig. I/10).

At overhauls, wash the sump with a hot water and soda solution, and then rinse it with cold water.

Disassemble it with engine installed on tractor, after removing the front axle and draining the lube oil through the plug (**12**). Proceed then as follows:

— disconnect oil input and output pipes from the hydraulic lift pump;

— remove the sump cover (**11**) with oil drain plug (**12**);

— remove the oil strainer (**13**) after unscrewing the capscrews (**C_2**) securing it to the damper weights support and oil pump;

— arrange a wooden block under the sump to support it once free, and then remove all capscrews securing it to the engine block and the transmission case.

The operations is easier if the engine is installed on the turnover stand, as it will be sufficient, to free the pump, to remove the attaching screws to the crankcase.

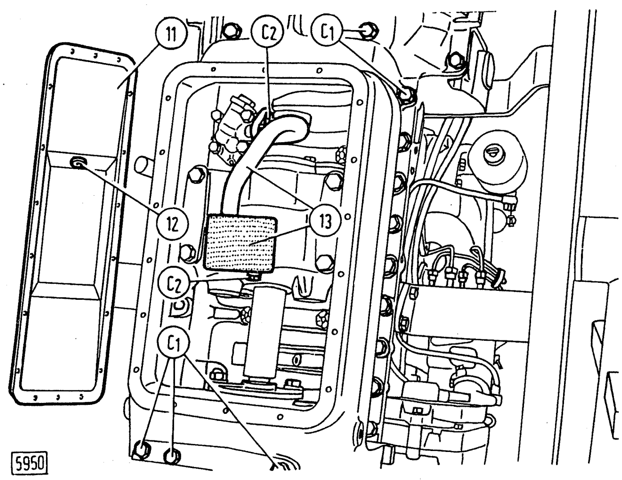


***Fig. I/10** - Bottom view of oil sump without cover (11).*
C_1. Capscrews securing oil sump to crankcase. - C_2. Capscrews securing suction end strainer to damper case and oil pump. - 12. Oil drain plug. - 13. Strainer.

II - VALVES AND TIMING MECHANISM

GENERAL

Over-head valves actuated by the camshaft which is driven from the engine through the timing gears. The camshaft motion is transmitted to the valves through tappets, push rods and rocker arms (Fig. II/1).

Each valve is fitted with one spring and one guide, the length of the latter inside the cylinder head being limited by a stop ring. The intake valves are shielded to favour turbulence and their correct assembly is made fool-proof by allowing only one possible arrangement.

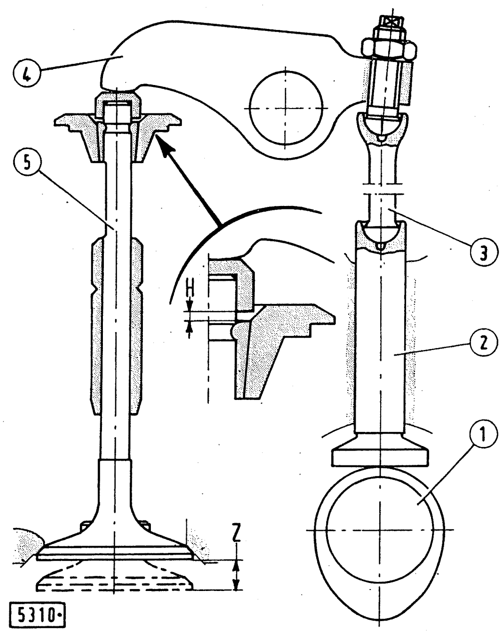


Fig. II/1 - Valve drive and control mechanism.
H. Clearance between cup retaining cap and locks. - Z = 10 mm (0.394 in). Maximum valve down stroke. - 1. Camshaft. - 2. Tappet. - 3. Push rod. - 4. Rocker arm. - 5. Valve.

TIMING DATA

Valve opening and closing angles, with respect to crankshaft rotation, are as follows:

intake valves

— opening advance . . . . 3° before T.D.C.

— closing retard . . . . . 23° after B.D.C.

exhaust valves

— opening advance . . . . 48° 30' before B.D.C.

— closing retard . . . . . 6° after T.D.C.

Valve gap (intake and exhaust for timing check) 0.45 mm (0.018 in)

Valve service gap for engine:

- intake .... 0.25 mm (0.010 in)

- exhaust .... 0.35 " (0.014 in)

Total valve down stroke inside cylinders in the opening phase . . . . 10 mm (0.394 in)

Install engine on the turnover stand then remove the rocker arms and push rods so to relieve pressure from the cams.

If necessary, losen the rocker arms screws, but it is best to remove the complete unit.

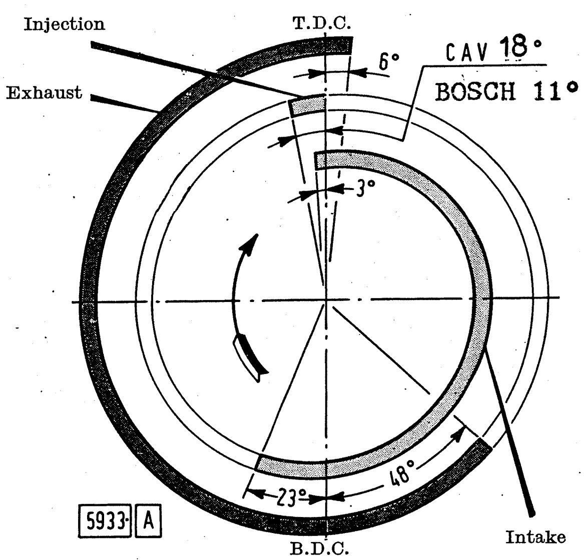


Fig. II/2 - Timing diagram.
Note - Permissible angular allowance is ± 5° of indicated values.

CAMSHAFT

Crankcase-mounted camshaft revolving in three steel bearings with friction metal lining and force-fitted in their respective crankcase housing bores. The shaft (8, Fig. II/3) is retained at front by means of a stop flange (7) and carries a driving gear (6) press fitted hot and keyed to its front end. Remove the camshaft only after the engine has been removed from the tractor.

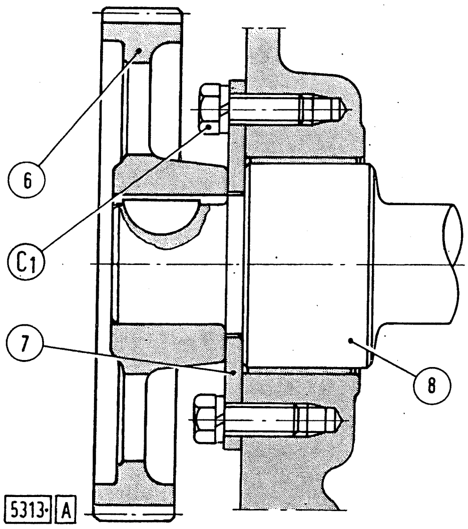


Fig. II/3 - Section view of the camshaft drive (8).
C_1. Capscrews securing the gear and camshaft assembly to the crankcase. - 6. Driving gear. - 7. Stop plate.

Turn the engine 180° on turnover stand, remove the oil sump and disassemble the oil pump as its driving gear is driven from the camshaft helical gear teeth.

Remove the access cover of the timing gears following the instructions reported on page 29, then unscrew the capscrews (C_1, Fig. II/3) securing the back-up plate to the timing gear case and withdraw by hand the shaft complete with its drive gear (Fig. II/4).

Replacing the camshaft sleeve bearings.

In case of bearing replacement we recommend the following sequence:

— remove the timing gear case, if necessary, to ease the job;

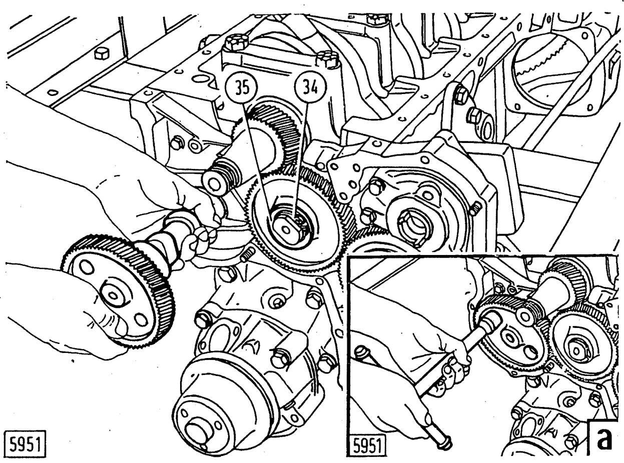


Fig. II/4 - Removing the camshaft after withdrawing the screw securing stop plate to crankcase (a).
34. Retaining ring. - 35. Washer.

— use the universal puller **A 537105** on the front bearing (Fig. II/5) and the same puller with extension for the intermediate one;

— remove the rear crankcase mount;

— drive out the expansion plug located at the rear sleeve bearing using a suitable bar through the crankcase;

— remove the rear bearing with the same pullers used on front and intermediate ones.

At installation, be sure to:

— arrange bushings so that lube passages are aligned with the crankcase one;

— drive in the intermediate bushing with the installation tool **A 95543**;

— use installation tool **A 95058** for the front and rear bushings;

— ream the bushing with the reamer **U 517090** to the diameter specified in Fig. II/6;

— when fitting the crankshaft rearmost bearing, be sure to see if this is in the modified version i.e., with curved uppermost surface so to shield the expansion cup on the crankcase from the outside; if otherwise, fit a rubber plug with replacement inside the cup, to avoid ingress of water in the clutch compartment.

Camshaft and bearing checks.

Measure journal and bearing wear and check service clearance (see table of data).

Sleeve bearings are not available with undersized bores; if necessary, replace both bearings and camshaft.

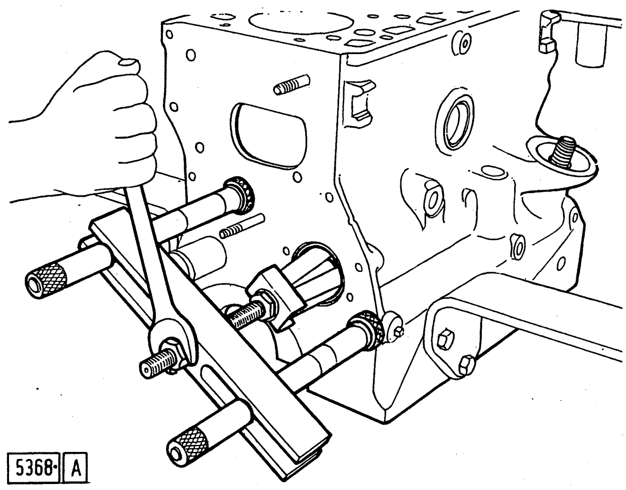
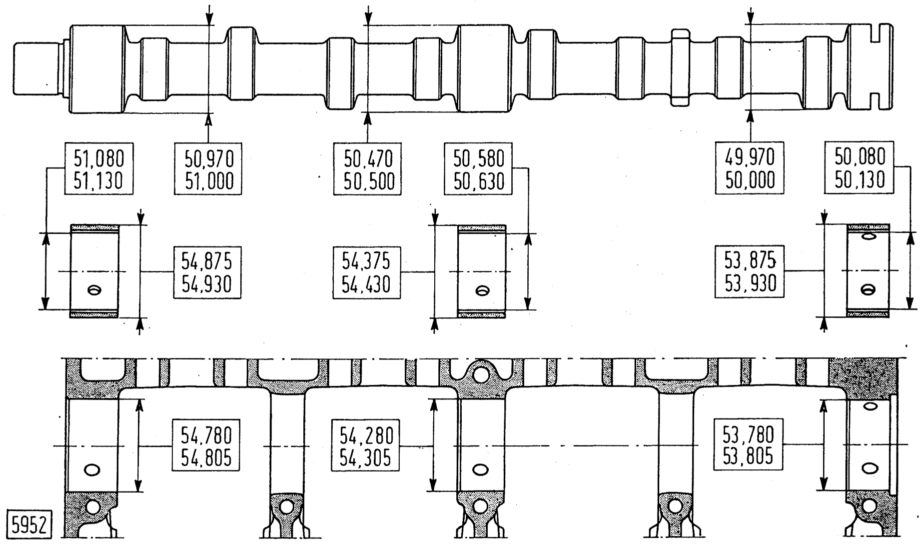


Fig. II/5 - Removing the camshaft front-end sleeve bearing by means of the universal puller A 537105.

Fig. II/6 - *Dimensions of camshaft journals and sleeve bearings (mm - See conversions in Sect. VIII).*

Note - I. D. refers to fitted bearings.



VALVES AND THEIR GUIDES AND SPRINGS

Many a trouble occurring to engines are due to faulty valve operation.

For satisfactory engine performance, the valves must seat tightly and move freely.

Remove valves as follows:

— remove cylinder head from crankcase (see page **20**);

— remove cap (9) from valve rod;

— compress springs with tool **A 511028** (Fig. II/8), then remove the upper cup (**11**) locks (**10**).

If valves, following a thorough cleaning, do not ensure perfect tightness on their seats, grind both valves and seats together (Fig. II/9), then wash each part thoroughly to remove all traces of abrasive matter.

Extract the valve-guides (**16**, Fig. II/8) using the removal tool **A 511009** from the underside of the cylinder head and withdrawing them with retaining snap ring.

Install them using the same tool **A 511009** but from the top of cylinder head and stopping when the outer ring prevents further introduction.

Inspect and check valve guides noticing that:

— the surface of the hole of each guide, should be absolutely smooth and free of scoring or seizure marks;

— the guides must be assembled in their cylinder head locations to a force fit; if not, replace them with oversized ones (see table of data in Sect. VIII);

— following installation always ream guides with reamer **U 413030**.

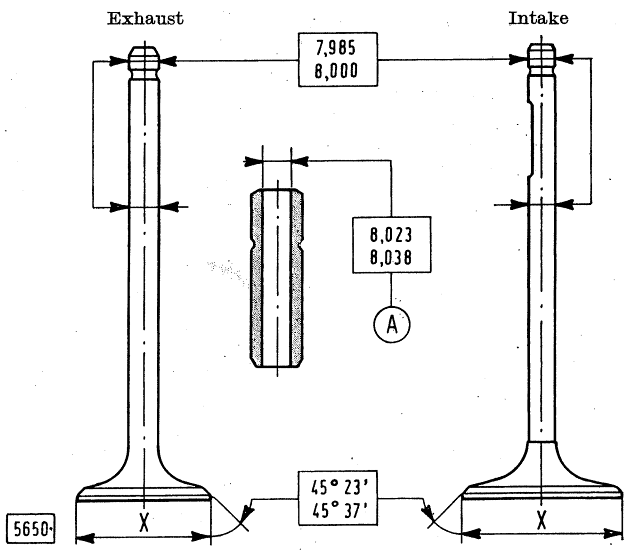


Fig. II/7 - *Major dimensions of intake and exhaust valves and their guides.*

A. Final dimension following boring of valve guide after press-fitting.

Valves	Intake mm (in)	Exhaust mm (in)
dia. X	43.750 ÷ 44.000 (1.7224 ÷ 1.7323)	36.750 ÷ 37.000 (1.4469 ÷ 1.4567)

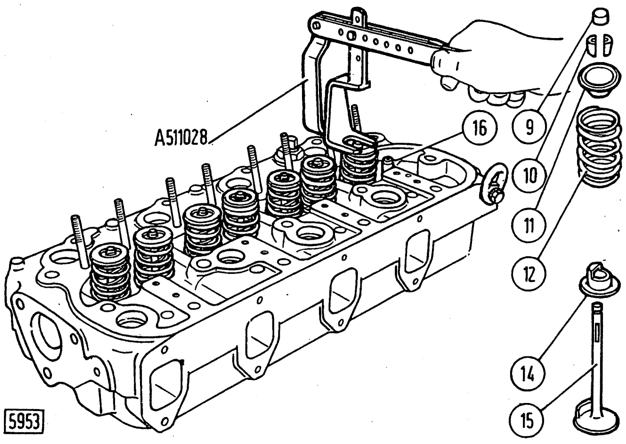


***Fig. II/8** - Removing (installing) valves and springs with tool A 511028.*

9. Valve lock cap. - 10. Cup (11) loks. - 11. Upper spring cup. - 12. Valve spring - 14. Intake valve lower cup. - 15. Intake valve. - 16. Valve guide.

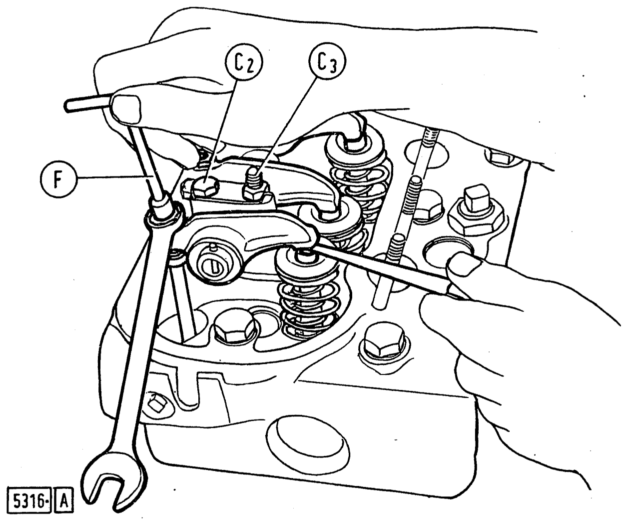


***Fig. II/10** - Measuring the valve gap with a feeler gauge.*

C_2. Capscrew securing the rocker arm support to the cylinder head. - C_3. Attaching stud, rocker arm support to cylinder head, and valve cover. - F. Wrench A 313046.

Springs, the specifications of which are reported in the Section VIII, can be taken down without removing cylinder head from crankcase, in which case care must be taken not to let the valves fall inside cylinders with lowered pistons.

At assembly, always make sure the smaller pitched coils are towards the cylinder head mating plane.

After assembly, make sure that:

— the valves are recessed below the cylinder head lower surface as specified (Fig. I/6);

— the upper spring cup (**11**, Fig. II/8) locks (**10**) seat perfectly in their seats;

— valve rod ends are fitted with caps (9).

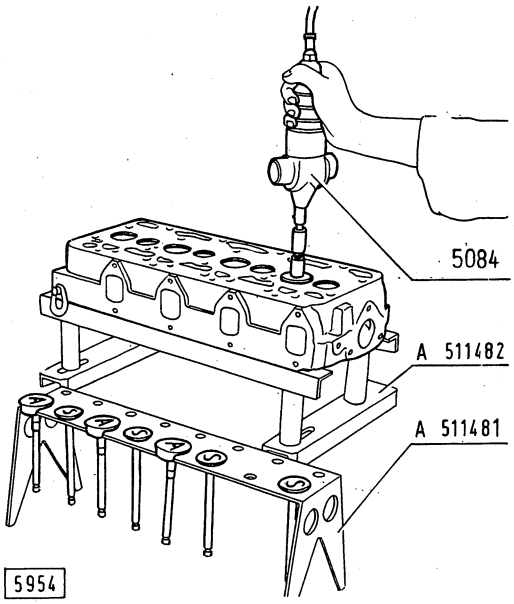


***Fig. II/9** - Grinding a valve with pneumatic grinder* 5084.

VALVE GAP ADJUSTMENT

Adjustment of the gap between valves and rocker arms can be effected indifferently, following timing gears installation on engines installed or removed from tractor.

Cylinder firing order is 1-3-4-2 and rocker arms shall be adjusted in the same sequence.

Turn the crankshaft until the first piston is at T.D.C. in compression and valves of cylinder 4 are in balanced position; this position of piston 1 is set when the mark « P.M.S. 1 » stamped on the flywheel rim is in register with the pointer (Fig. II/14).

Set the intake and exhaust valve gap on cylinder 1 using the special wrench **A 313046** and a feeler gauge (Fig. II/10).

Repeat for all remaining pairs of valves, holding in mind that when setting the cylinder 3 the valves of cylinder 2 must balance, and viceversa, and when setting cylinder 4, balancing of the valves of cylinder 1 should be noticed.

TAPPETS, PUSH RODS AND ROCKER ARMS

Tappets and push rods are located in the left side of crankcase. Removal of tappets must be preceded by the removal of the camshaft and of the oil sump. Inspections and checks are the following:

— inspect finish of surfaces contacting the shaft cams; smooth out scoring, if any, with a fine-grained carborundum stone;

— running clearance; if necessary, replace existing tappets with oversized ones and ream bores to suit.

At assembly, always lubricate the surface of tappets.

The rocker arms are pivoted on their shafts (**25**, Fig. II/11) which is attached to the cylinder head through four supports (**19**).

The lubrication oil enters the hole drilled through the fourth support, accumulates inside shaft from which lubricates the bushes, each provided with suitable scrolls, through the holes (**20**) located in each rocker arm.

To remove the rocker arms take the tappet cover (**6**, Fig. I/4) down and remove the screws (C_2 and C_3, Fig. II/10) which secure it to the cylinder head through the four supports.

To check rocker arms and shafts accurately, disassemble them as follows:

— first act on the pair of rocker arms for the valves of the first cylinder, pushing them manually inwards to overcome the spring force;

— remove the split dowel (**24**, Fig. II/11) from the shaft hole and withdraw end cup (**23**) rocker arm and support.

Before removing the fourth cylinder rocker arm support be sure to withdraw the screw (C_4, Fig. II/11) which secures it to the shaft.

This screw (C_4) is of a particular importance as it prevents the shaft from sliding on a running engine, so to ensure there is no end play.

Check clearance and wear of rocker arm shaft in bushes; the latter are installed in alternative types: steel and anti-friction metal lining (type Vandervell) or copper-tin alloy.

Inspect contact surfaces of adjusting screws and rods which should be glass-smooth, with no seizure marks.

Check the rocker arm spacer springs (**17**, Fig. II/11) and measure their strain values (see table of data of Section VIII).

Refit the rocker arms and make sure that:

— lubrication passages are free and unobstructed;

— end cups (**23**) are 0.9 ÷ 1.1 mm (0.03 ÷ 0.04 in) thick;

— spring end spacers (**18**) are 1 mm (.040 in) thick.

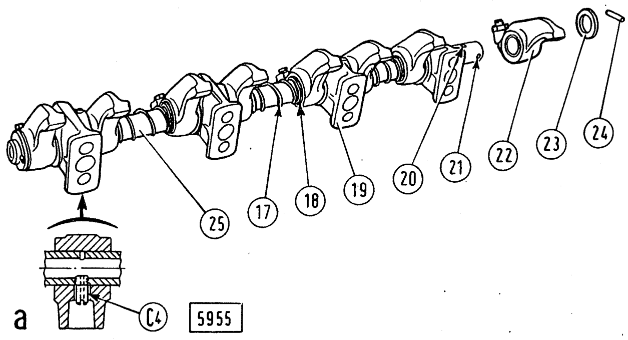


Fig. II/11 - *Rocker arms and their supports, springs and shafts.*

C_4. Screw with lube hole, securing rocker arm support to axle. - 17. Spring. - 18. Thrust washer. - 19. Rocker arm axle support. - 20. Lube hole. - 21. Pin (24) hole. - 22. Rocker arm. - 23. End cup. - 24. Pin. - 25. Rocker arm axle.

a. Fourth cylinder rocker arm support.

TIMING GEARS AND CASE

The timing gears, installed on their respective shaft, are housed inside the timing gear case (Fig. II/12) and are lubricated through an oil duct in the case; make sure this duct is free and descale it by poking through with a metal wire of suitable diameter.

Remove cover to reach the gears; this cannot be done unless the front axle assembly and oil sump are removed first, as reported on pages 15 and 22 Remove then the cover (**27**, Fig. II/13) to gain access to the injection pump drive gear, withdraw the drive belt and then remove both alternator and drive pulley.

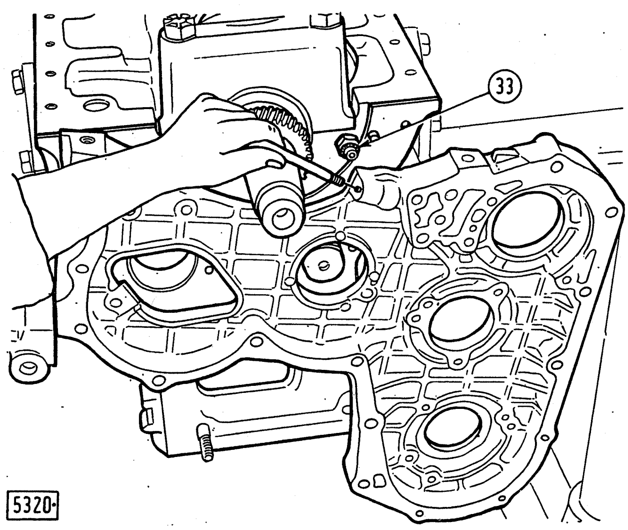


Fig. II/12 - *Cleaning the lubrication duct through the timing gear case.*

33. Rubber sealing ring.

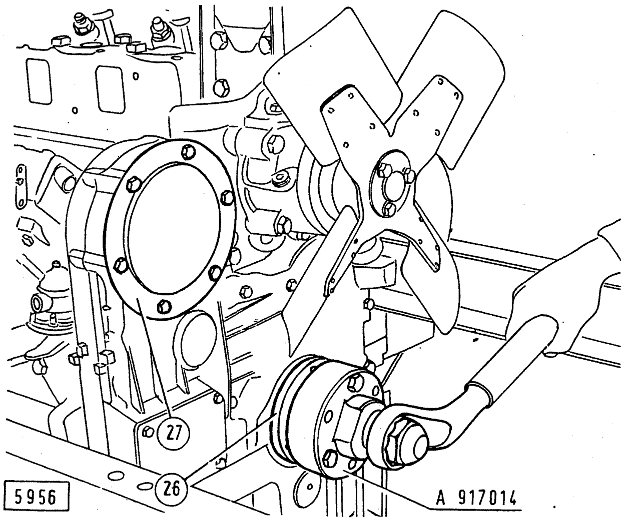


Fig. II/13 - *Removing the pulley hub (26) from crankshaft with the tool A 917014.*
27. Access cover to injection pump drive gear.

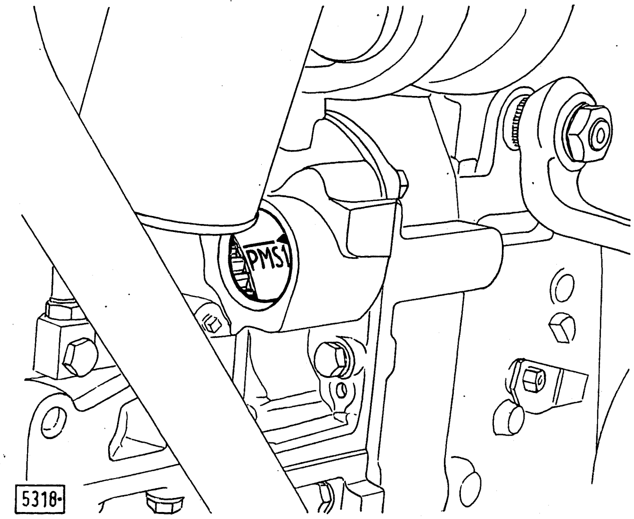


Fig. II/14 - *P.M.S. 1 mark on engine flywheel.*

Remove the nut (C_1, Fig. III/4) securing the crankshaft hub, the hub using the tool **A 917014** (Fig. II/13), the key from the shaft (as it may damage the front end seal installed in the cover) and then unscrew the gear case capscrews.

Disassemble the gear case as follows:

— camshaft drive gear (**8**, Fig. II/15), follow the instructions reported on page 26 ;

— idler gear (**29**), first withdraw the retaining ring (**34**, Fig. II/4) and thrust washer (**35**);

— transfer pump drive gear (**31**), first remove the pump with shaft support (**2**, Fig. IV/2), then withdraw the shaft retaining ring and the shaft with its gear (**1**);

— injector pump drive gear (**32**), unscrew the attacching nut (C_6) which also works as a puller.

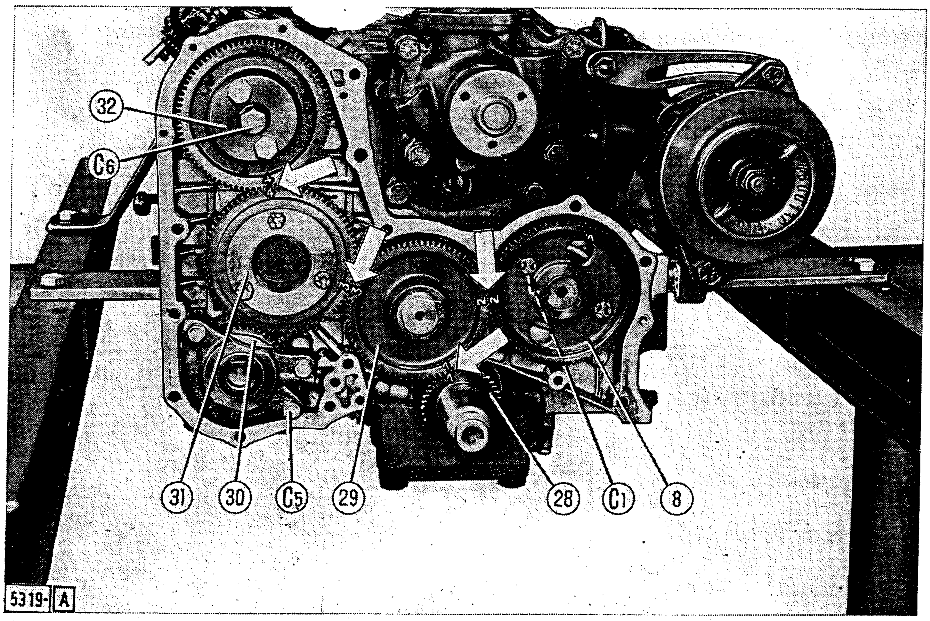


Fig. II/15 - *Phasing the timing gears.*

C_1. Gear and camshaft attaching capscrews. - C_5. Capscrews securing the hydraulic pump support. - C_6. Fuel injection pump attaching nut. - 8. Timing drive gear. - 28. Timing drive driving gear. - 29. Idler gear. - 30. Hydraulic lift pump driving gear. - 31. Fuel transfer pump driving gear. - 32. Fuel injection pump driving gear.

TIMING GEAR ASSEMBLY

Fig. II/15 illustrates the correct position of assembly of the camshaft driving gear (**8**) and of the other fuel injection pump (**32**) and transfer pump (**31**) gears. The injection pump gear is marked with the engine model designation (8045) and the angular position of the number 4 indicating the mesh with respect to the shaft key: 174° 24' ± 15'.

Notice that before installing the camshaft with gear the tappets must be fitted and that the idler gear (**29**) must be arranged with the more protruding part of the hub against the timing gear case.
Install the timing gears as follows:

— bring piston 1 to T.D.C. and turn the crankshaft until the pointer is in register with the «P.M.S. 1» (Fig. II/14) mark stamped on the flywheel rim;

— arrange feed and injection pump driving gears on respective shaft so to line up the assembly marks 4-4;

— install then idler and timing gears and line up the pairs 1-1, 2-2, 3-3;

TRACTORMETER

The tractormeter is applied to the instrument panel and is driven directly from the upper end of the oil pump.
It gives three readings: engine r.p.m., rear P.T.O. speed in r.p.m's and work hours.
The hourmeter is set for a constant engine speed of 1600 r.p.m., and totals 1 hour for every 96.000 revolutions.
The transmission ratios are:

— drive unit fitted on to the end of lube pump, and engine speed . 1 : 2

— angular drive unit (between drive flex-cable and instrument) . . . . 1 : 1

III - CRANK GEAR ASSEMBLY

GENERAL

The normalized steel crankshaft has its counterweights integral with the crank arms, revolves in thin-shell type bearings with anti-friction metal lining (type Vandervell) and is supported by four main bearings.

Pistons are made of a aluminium alloy possessing high resistance to both mechanical and heat stresses. Their combustion chambers are internal and offset, and the truncated-cone shaped skirt has an elliptical base with the major diameter at 90° from the pin axis.

Each piston is fitted with three rings type GOETZE arranged, from top down, as follows:

— first compression ring, with convex, chrome-plated outside surface;

— second ring, oil scraper, with step;

— third ring, oil scraper, backbone type, chrome-plated and with inside coil spring.

The forged steel channel-shaped connecting rods are drilled along the length for cylinder liner lubrication and are provided with thin shell bearings with anti-friction metal lining (type Vandervell) on big end and sleeve bearings (type Vandervell) on small end.

CRANKSHAFT

The crankshaft can be removed from the engine only after removing the latter from the tractor, then install the engine on the shop turnover stand, and remove the cylinder head (in case pistons also are to be removed), the oil sump and the timing gear case cover according to directions of respective topics on pages 20,22 and 29.

Remove the oil pump and the rear seal, the crankshaft main and crankpin bearings, after unscrewing the self-locking screws (C_4 and C_5. Fig. III/15), and the thrust washers which are arranged on the fourth main bearing to set the end float of the crankshaft.

Wash the crankshaft with kerosene and inspect it thoroughly; damages of any kind, however slight, require that the shaft be replaced. Examine wear on connecting rod and main bearing journals and make sure that:

— journal out-of-round does not exceed 0.008 mm (0.0003 in);

— journal taper is less than 0.012 mm (0.0005 in);

— journal alignment is within tolerance of 0.05 mm (0.002 in) (Fig. III/2);

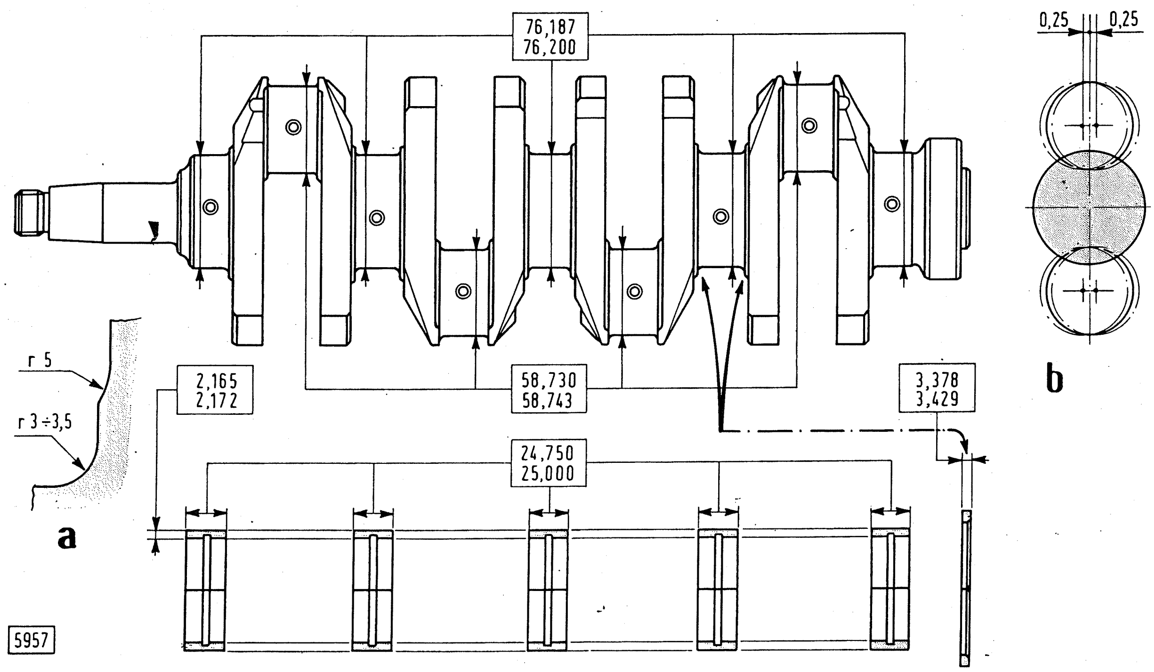
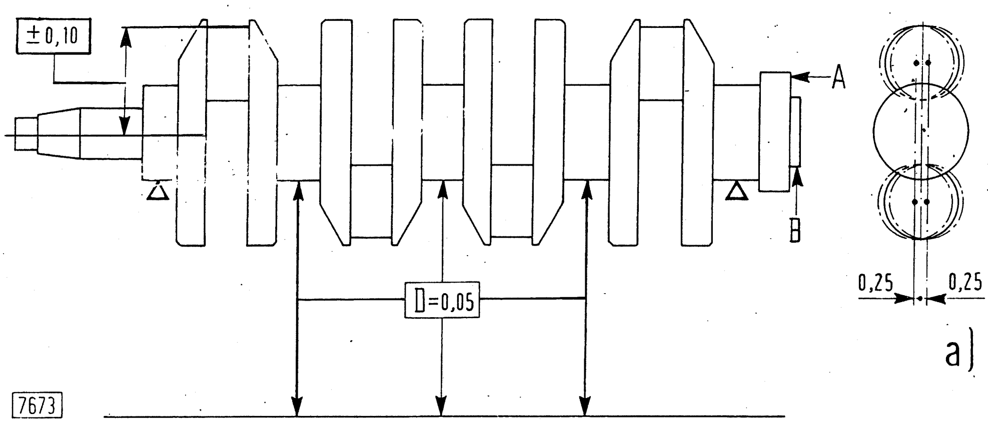


Fig. III/1 - Dimensions of crankshaft journals and main bearings and of standard thrust washers.
a. Journals fillets. - b. Detail drwg. showing tolerance on connecting rod journal alignment.

Fig. III/2-Checking Main Journal and Crankpin Alignment
(a) Detail of maximum misalignment of crakpins with respect to the main journals - A and B. Flange run-out stylus position - D. Maximum main journal misalignment.



— axes of connecting rod and main bearing journals are on the same plane with a max. permissible difference of 0.25 mm (0.010 in) on both directions (**b**, Fig. III/1);

cup-shaped plugs seal properly (test with oil at 15 kg/cm² = 213 p.s.i.); should the test show defective or unreliable sealing tightness, replace the plugs and repeat the test with new plugs installed.

If necessary, grind all crankshaft journals to one of the undersize specified in the table of Section VIII; make sure, after grinding, to machine proper radii and fillets on journals and to chamfer the lubrication holes.

Front and rear end seal installation.

Fluid tightness at front end of crankshaft is ensured by a metal-reinforced rubber seal (**a**, Fig. III/4)

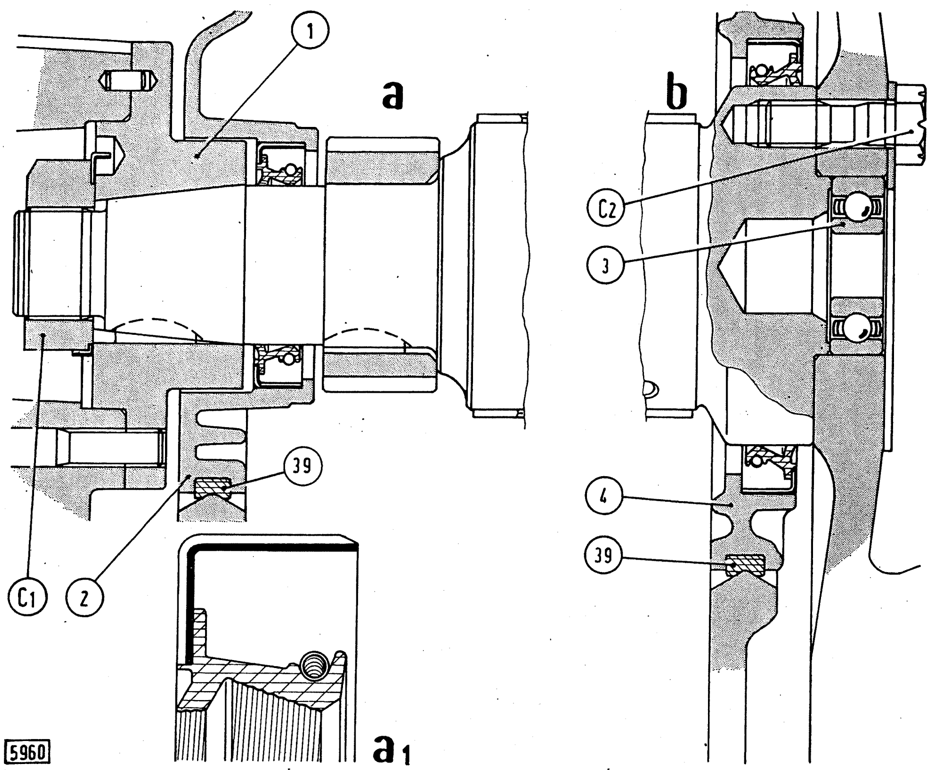


***Fig. III/4** - Cut-outs of crankshaft front and rear end seals (a and b, respectively).*

C_1. Crankshaft hub (1) nut. - C_2. Flywheel self-locking screws. - 1. Crankshaft hub. - 2. Timing gear case cover. - 3. Clutch P.T.O. shaft bearing. - 4. Seal housing flange. - 39. Oil sump gasket. - a_1. Detail of crankshaft oil seal.

with coil spring which is force fitted in the timing gear case cover.

The fundamental feature of this seal is the spiral rifling of the sealing lip in the direction opposite to that of rotation of the hub; this will throw back inside any fluid leaking out.

In case of oil leakage, excluding the running-in period during which parts may require adjustment of their final position of assembly, remove the timing gear case cover see page 29 and check:

— the working surface of the seal for wear, breakage of the rifling coil or of the sealing lip;

— the sealing surface in contact with the crankshaft for roughness or out-of-round exceeding 0.3 mm (0.012 in).

The seal cover must be removed first if the seal is to be replaced. Take good note of the following points to avoid assembly trouble:

— wipe off all traces of oil and dry the seal seat in the cover thoroughly;

— fit the seal in its seat without using lubricants and apply a uniform pressure over the entire seal ring by means of the plug **A 96553** so that the seal will bottom in its seat, normally to the shaft axis;

— lubricate the seal lip with a film of grease or thick oil to avoid dry contact with the crankshaft surface at the start, then secure the cover and its gasket to the crankcase.

Fluid tightness at rear end of crankshaft is ensured by a rubber seal with coil spring.

The seal is fitted in a metallic cage (**b**, Fig. III/4) fixed to the engine crankcase; the lower side of this cage has a semicircular rubber strip gasket (**39**) which ensure fluid tightness on the oil sump. These packings or seals can be considered as reliable up to a crankshaft speed of 3000 ± 10% r.p.m., and up to a service temperature of the oil of 120° ÷ 130° C (248° ÷ 266° F).

If the seal is to be replaced because of defective performance, remove the flywheel as reported in the chapter on page 40 and remove it together with its support as illustrated in Fig. III/5, following the removal of the capscrews securing it to the crankcase.

Remove the seal from its support and fit a new one using the installation bar a **9130115**.

Examine the seal (**39**, Fig. III/4) and replace it if worn then re-install the housing with rear seal

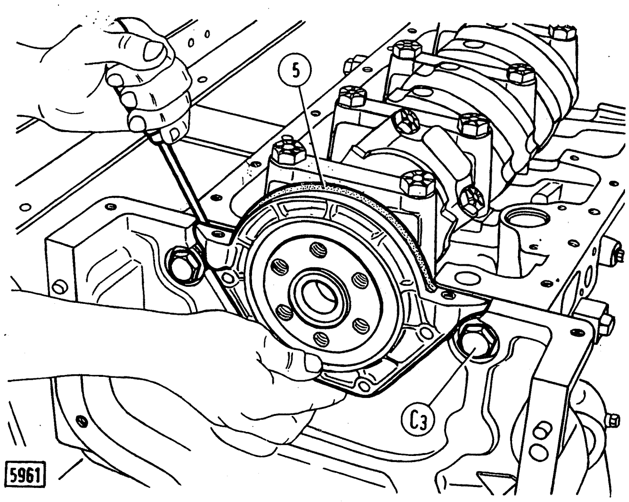


***Fig. III/5** - Removing the crankshaft rear seal.*
C_3. Rear main bearing mounting capscrews. - 5. Oil sump sealing strip.

after applying a suitable jointing compound to the surface abutting with the crankcase.

Prior to installation, lubricate the surface of the seal which comes in contact with the crankshaft and fill the seal space between lips with grease.

CRANKSHAFT BEARINGS

The thin-shell bearings with anti-friction metal lining are of the Vandervell type. They require no bedding in or adjustment but must be replaced when the working surface is worn or scored beyond the permissible limits.

Check the clearance with the crankshaft journals as follows:

— thoroughly clean with gasoline the journals, bearing shells and bearing bores;

— use a segment of « Perfect Circle Plastigage » type **PR-1** of the same length as the bearing cap and place it lengthwise on the bearing shell about 6 mm (1/4") off center (Fig. III/6);

— install the cap with wire and torque tighten to the value specified in the table of data;

— rock the shaft through a small arc, back and forth;

— remove the cap and measure the wire flat with the graduated scale (in mm or inches) drawn on the envelope containing the wire (Fig. III/6) considering that:

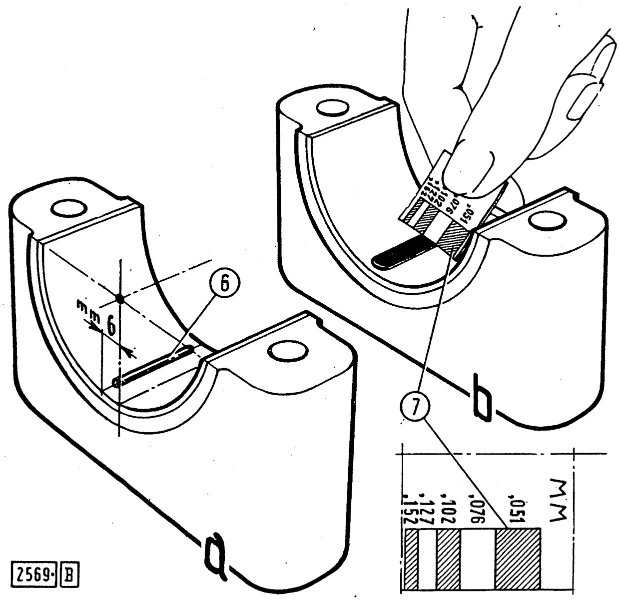


Fig. III/6 - Checking running clearance of crankshaft journals in bearings.

a. Arrangement of wire for cap installation. - b. Measure of wire flatting after cap removal. - 6. Perfect Circle Plastigage type PR-1. - 7. Graduated scale stamped on the wire envelope.

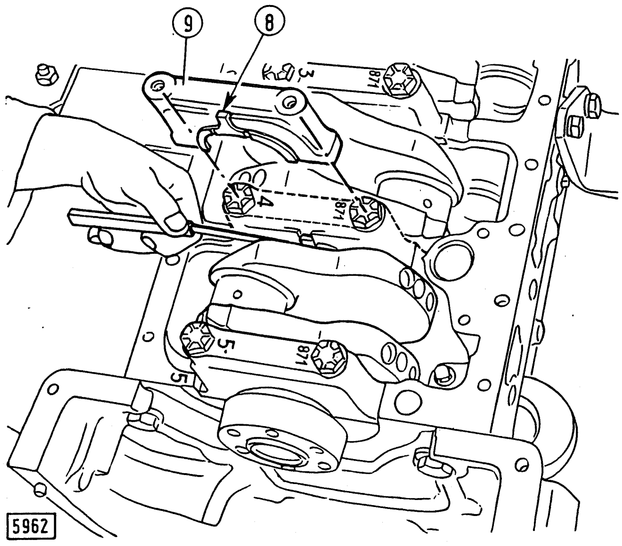


Fig. III/7 - Checking end float of crankshaft on the fourth main bearing (9) and arrangement of thrust washers (8).

— the flattened wire may stick to the shaft;

— the reading is the clearance;

— if one end of the wire is more flattened than the other, then taper is present; if so, measure the two ends, the difference being the approximate amount of taper.

If no wire gauge is available then check the play with cigarette paper.

When assembling the main bearings and their caps make sure to:

— arrange bearing shells in their original locations as they are not interchangeable, and align lubricating oil grooves;

— fit the thrust washers (**8**, Fig. III/7) to the fourth bearing and cap (**9**) with the lubricating oil grooves towards the central shaft journal shoulders;

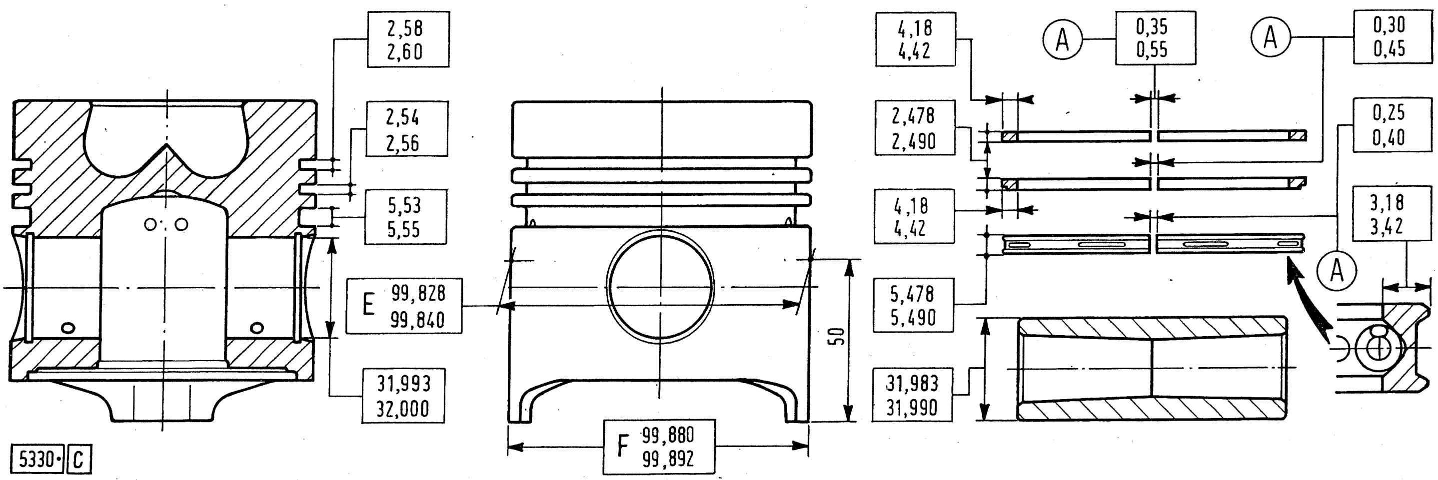


Fig. III/8 - Dimensions of standard-size pistons and of their pins and oil rings (mm. - See conversions in Section VIII).

A. Measurement to be taken with rings installed inside cylinder liners. - E. Major dia. at 50 mm. from skirt. - F. Major dia. at base of skirt.

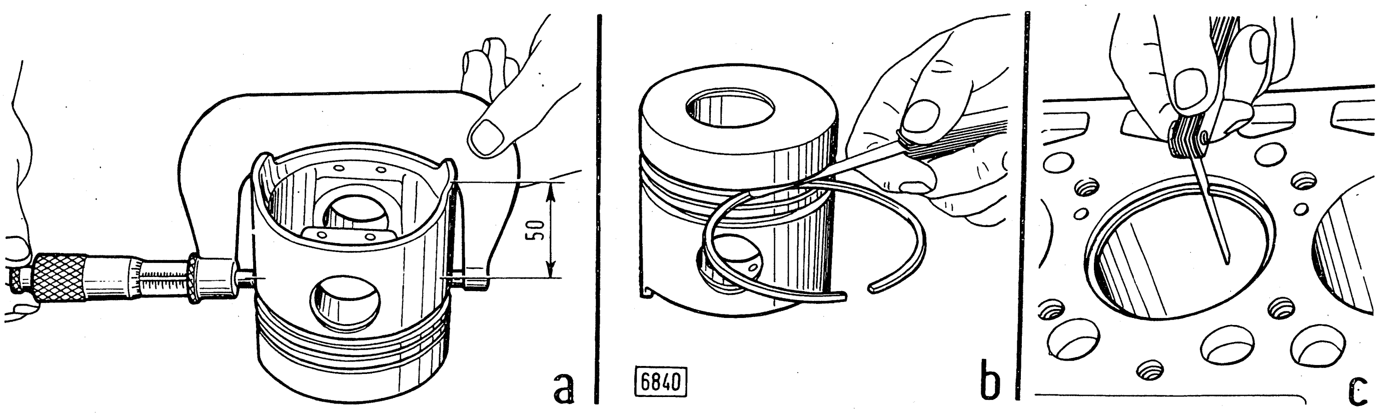


Fig. III/10 - Checking the piston and its rings.
a. Checking the diameter of a piston at 50 mm from the base of its skirt - b. Checking the assembly clearance of the ring in its piston groove - c. Checking the end gap on a piston ring installed in the cylinder liner.

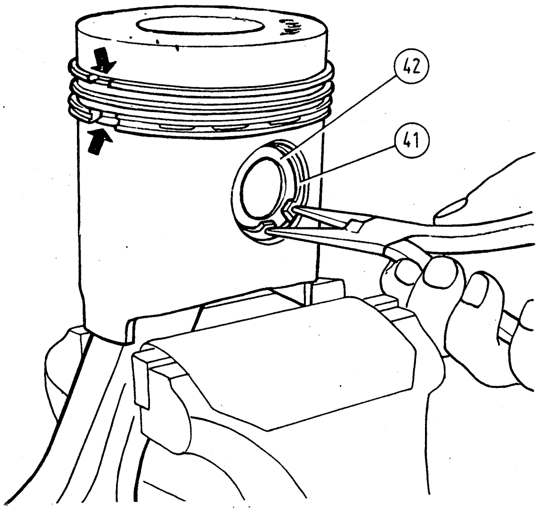


Fig. III/9 - *Removing the piston pin (42) retaining rings (41).*
(Arrows indicate assembly arrangement of piston rings).

Clamp unit in a bench vise, disassemble each piston by removing the piston rings first with pliers A 511801 (Fig. III/11), then the pin (42) retaining rings (41, Fig. III/9) and remove the former.

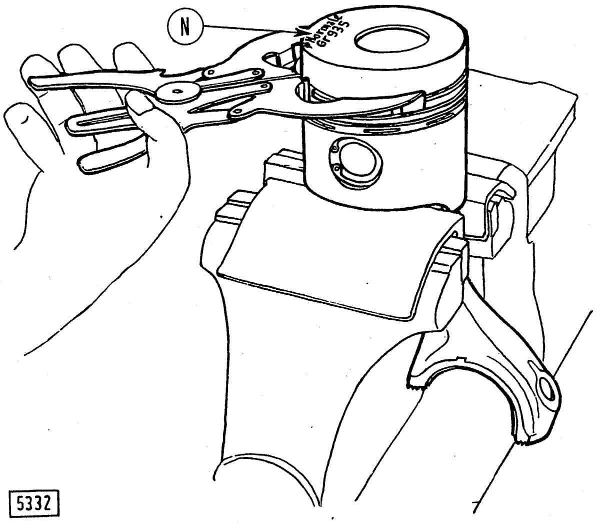


Fig. III/ 11 - *Installation (removal) of snap rings with pliers A 511801.*

N. Weight of piston in grams.

— the identification figures stamped on the connecting rod bearing caps must be on the crankcase side stamped with their respective bearing identification marks (Fig. III/15);

— before installing the connecting rod-piston assemblies, check the end float of crankshaft at the fourth main bearing (Fig. III/7).

PISTONS AND RINGS

Remove the piston by first removing the front axle, cylinder head and oil sump, as reported on topics of pages 15, 20 e 22. Then remove the oil pump, the self-locking screws (C_4, Fig. III/15) securing the connecting rod bearing caps after turning the shaft with the crank spanner **A 517062** applied to the driving pulley, and, finally, push the piston upwards and out, being careful not to score the cylinder liner with the connecting rod end.

Clean the pistons by scraping off all combustion deposits and wash them with gasoline, kerosene or solvent.

Calculate piston wear by measuring their diameter at 50 mm (~ 2 in) off the base of the skirt on the axis perpendicular to the piston pin (**E**, Fig. III/8).

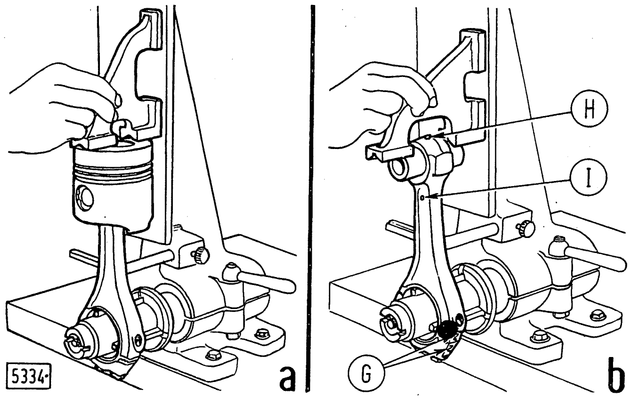


Fig. III/12 - Checking squareness of piston-connecting rod assembly (a) and parallelism of a connecting rod axis (b).

G. Number of corresponding cylinder. - H. Piston top lubrication hole. - I. Liner and piston lubrication hole.

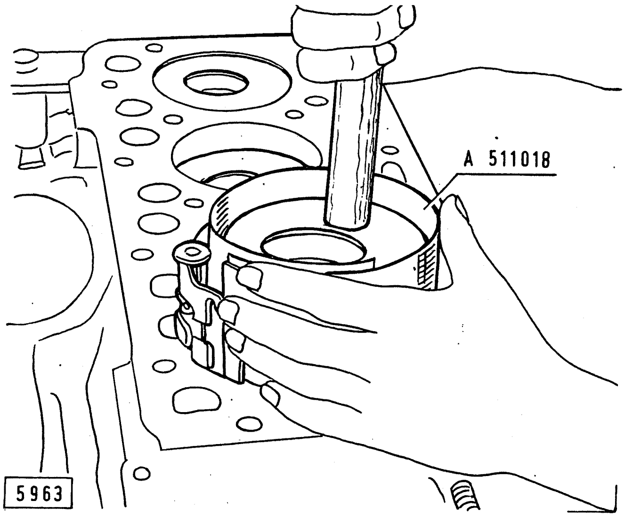


Fig. III/14 - Fitting a piston inside its cylinder liner with piston ring band A 511018.

Find then the difference between the measures taken on cylinder liners and pistons, the difference being the running clearance; when the clearance exceeds the permissible service limits (see table of data of Section VIII) the liners must be re-bored and new oversized pistons and rings installed.

Should it become necessary to replace the pistons, make sure the weight of the new ones is within a tolerance of ± 10 gr (0.36 oz).

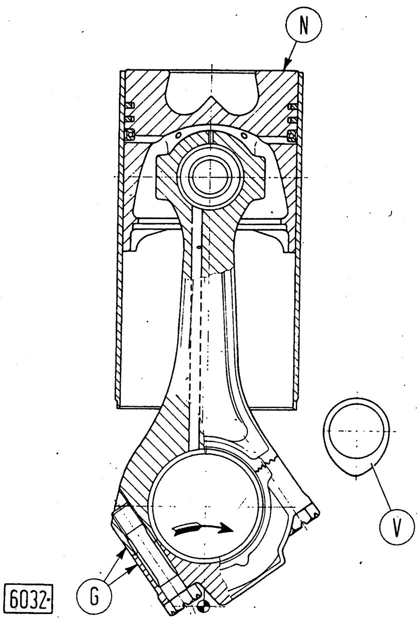


Fig. III/13 - Cross-sectional view of one connecting rod-piston unit with assembly reference with respect to the camshaft (V).

G. Number of corresponding cylinder - N. Weight of piston, in grams.

Piston pin bores should not be out-of-round; if so, re-bore them with an expansion-blade type reamer to one of the oversizes reported in the table of data of Section VIII.

Install (and remove) piston rings with the pliers **A 511801** (Fig. III/11) and arrange them with ends staggered 180° from each other; the second ring (oil scraper) should be placed with the step down as oil is scraped off the cylinder liner walls during the bottoming stroke of the piston; to make assembly fool-proof, the word « TOP » has been stamped over the face which is to be placed uppermost. At assembly, the end gap must meet specification requirements (see table of data); should the gap be less than specified, grind the ends, and if greater, replace the ring and install a new one of the same type.

Using a feeler gauge check if the ring side clearance in its groove meets specification requirements.

NOTE - Piston protrusion above engine block should be 0.46 to 0.78 mm (0.018 to 0.030 in).

CONNECTING RODS

To remove the connecting rods proceed as outlined for the pistons. Check connecting rod squareness with the gauge **C 517023** (**b**, Fig. III/12). The max permissible misalignment between connecting rod big and small end axes, checked at 125 mm (4.921 in) away from the rod center line, should not exceed 0.05 mm (0.010 in) in either direction. Slight bending can be corrected in a shop press; if not, it is best to replace the rods.

In case of replacement, make sure that the weight of new connecting rods is within the ± 15 gr 0.54 oz) limits.

Besides, the new rods must be stamped with the number of their locating cylinder; the figure is stamped on both the body and bearing cap of the connecting rod (**G**, Figs. III/12 and III/13).

If new bearing bushings are to be fitted into the rod small end, then re-bore it with an expansion-blade type reamer to the diameter indicated in the table of data of Section VIII.

Lubricating oil flows inside a lengthwise passage drilled through the rod and connecting the big and small ends.

Two small holes are drilled though the rod perpendicularly to the central passage (**I**, Fig. III/12) for the purpose of improving lubrication between cylinder liners and pistons. Another oil hole (**H**) which is drilled through the top of the small end provides a spray of oil which contributes to cool the piston.

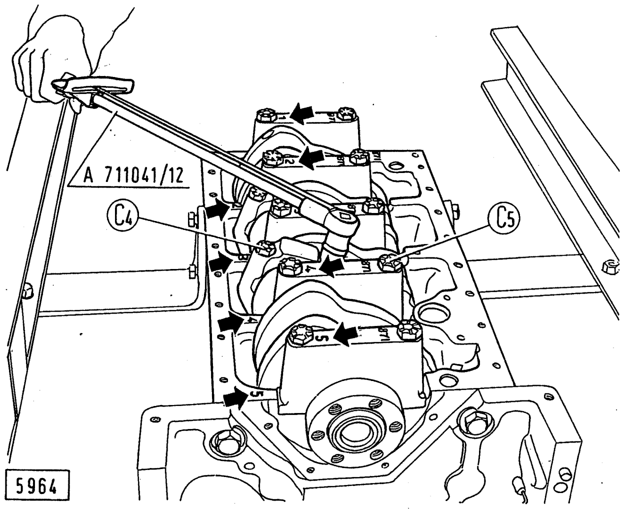


Fig. III/15 - *Tightening the connecting rod bearing cap self-locking screws (C_4) with the torque wrench A 711041/12.*

(Arrows indicate alignment of assembly marks for main bearing caps). - C_5. Main bearing caps self-locking screws.

Installing the connecting rod-piston assemblies.

Assemble the control rod and piston units so that the connecting rod identification number corresponds to the number of the cylinder in which the piston is to be installed and is located on the same side of class mark stamped in the piston (Fig. III/13); check squareness of the assembly whith the gauge **C 517023** (**a**, Fig. III/12).

Make sure that the oil holes drilled through the rod stem are free from scales which whould endanger the proper lubrication of the cylinder; if so, poke through them with a steel wire of a suitable diameter and blow with compressed air.

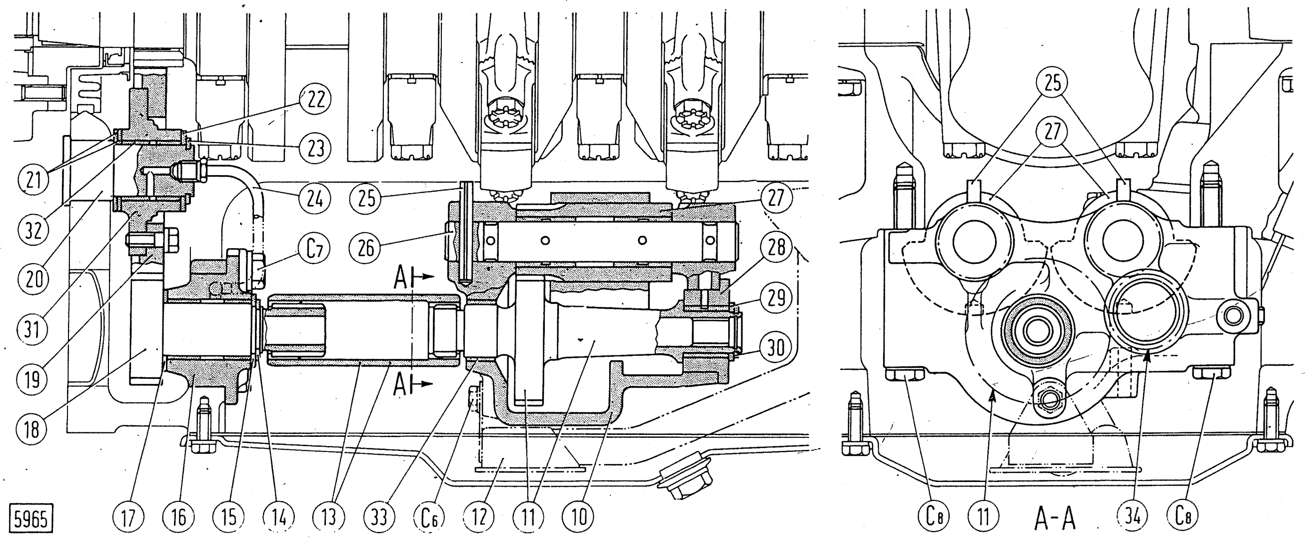


Fig. III/16 - *Sectional views of vibration damper unit.*

C_6. Capscrews securing oil strainer to weights housing (10). - C_7. Capscrews securing support (16) to sump. - C_8. Capscrews securing weights housing to oil sump. - 10. Weights housing. - 11. Weights driving gear. - 12. Strainer. - 13. Sleeve coupling. - 14. Retaining snap ring. - 15. Washer. - 16. Gear (18) support. - 17. Washer. - 18. Gear with weights driving unit. - 19. Transmission gear. - 20. Gear (19) axle. - 21 and 22. Washers. - 23. Retaining snap ring. - 24. Bushing (32) lubrication line. - 25. Axle (26) split dowel pin. - 26. Weights axle. - 27. Weights. - 28. Gear (11) supporting flange. - 29. Washer. - 30. Retaining snap ring. - 31. Gear (19) supporting flange. - 32 and 33. Bearing bushings. - 34. Weights drive idler gear.

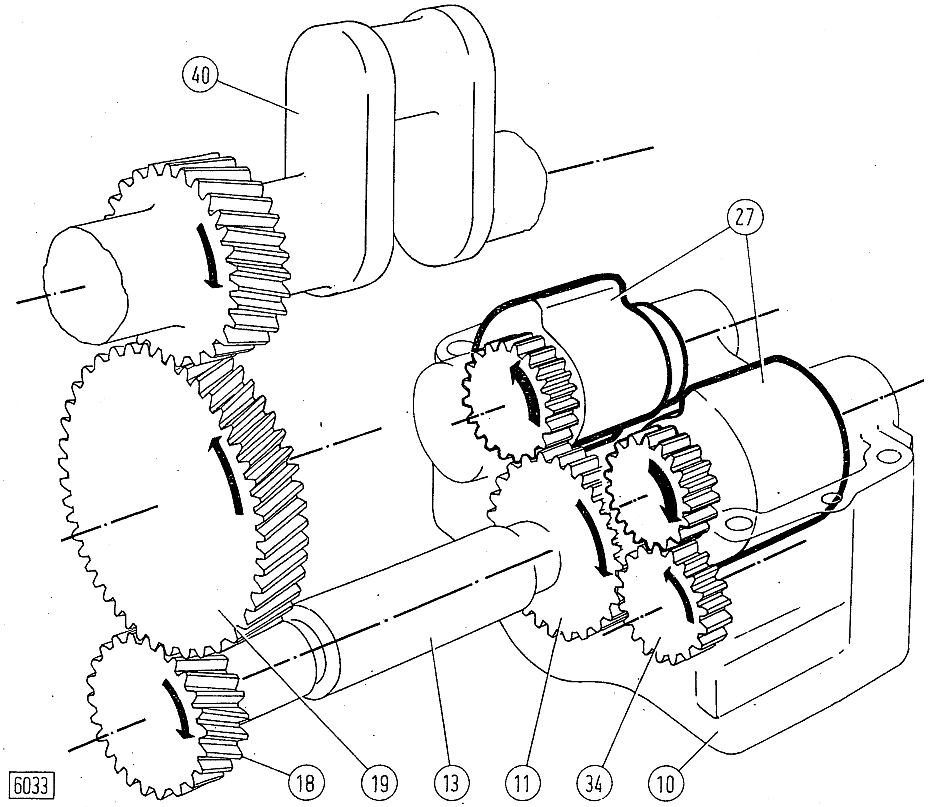


Fig. III/17 - Layout drawing of the vibration damper unit.

10. Weights housing box. - 11. Weights driving gear. - 13. Sleeve coupling. - 18. Gear with weights driving unit. - 19. Idler gear. - 27. Weights. - 34. Weights drive idler gear. - 40. Drive shaft.

Following all preliminary checks, install the connecting rod-piston unit assemblies into their respective cylinder liners using the piston ring band **A 511018** (Fig. III/14) to hold the rings tight. Make sure that the connecting rod identification number is on the side apposite to that of the camshaft (Fig. III/13). Secure the connecting rod bearing caps by torque tightening to the values given in Section VIII.

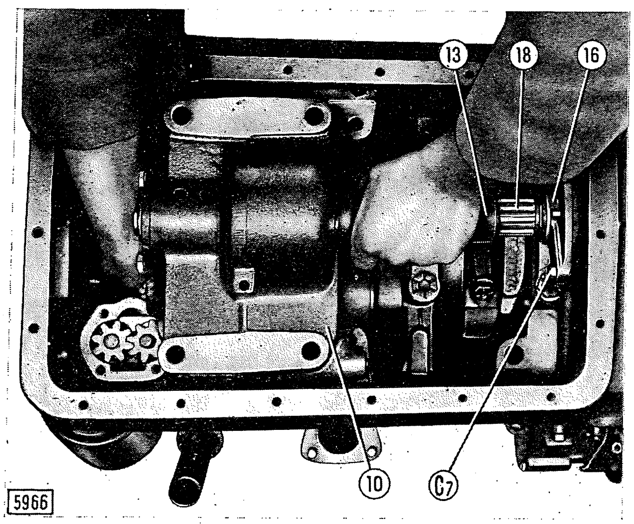


Fig. III/18 - Removing the weights housing box (10) with sleeve coupling (13) installed.

C_7. Capscrews securing support (16) to box. - 16. Gear (18) supporting flange. - 18. Gear with drive unit.

ENGINE FLYWHEEL

The flywheel is secured to the crankshaft by means of self-locking screws (C_2, Fig. III/4) and carries the starting ring gear press-fitted hot onto the inner rim.

To remove the flywheel, split the engine with front axle off the transmission, then remove the clutch as reported **on the page 102 .**

The flywheel is balanced together with the crankshaft at the production plant, within 300 gmm (0.42 in-oz).

If necessary, replace the ring gear by fitting a new one pre-heated in oil at 80° C (176° F) and with the 60° chamfer facing inside.

All these operations apply also whenever the crankshaft rear seal is to be checked or changed.

ENGINE VIBRATION DAMPER

Reciprocating engines in operation are subject to forces of various origins differing as to magnitude, direction and sense, which impart a vibrating motion that is trasmitted to the tractor through the engine mountings.

When these vibrations exceed the permissible limits they cause various troubles to the engine and tractor units and, above all, become extremely tiresome for the operator.

The contrarotating weights type vibration damper unit is housed in a box (**10**, Fig. III/16 and 17) which is bolted to the inside of the crankcase oil sump and includes: two contrarotating weights (**27**) turning on their axes (**26**) and driven by the gears (**11** and **34**). Externally, the splined sleeve coupling (**13**) connects the weights driving gear (**11**) to the drive unit (**18**) which is attached to the oil sump by means of a bracket (**16**) and is driven from the crankshaft through a transmission gear (**19**).

Removal.

At overhauls, remove the vibration damper unit from the tractor as follows:

— drain sump oil and remove sump cover (**11**, Fig. I/10);

— remove the oil pump strainer (**12**, Fig. III/16) by removing the capscrews (C_6) securing it to both pump and damper box;

— remove the capscrews (C_8) securing the weights box to the oil sump, move it away from the support to allow extraction of the seat locating dowel and then move it towards the rear end of engine to free the solid sleeve (**13**, Fig. III/18) from the drive spline (**18**) thus allowing its removal;

— remove the drive spline separately, complete with gear (**18**) and support (**16**), after removing the lube tubelet (**24**, Fig. III/22) and the attaching capscrews (C_7, Fig. III/16) securing it to the engine oil sump.

If the vibration damper is to be disassembled with the oil sump removed from the engine, then the drive unit and support may be removed together with the sleeve coupling and weights, following the removal of the lube tubelet (**24**, Fig. III/22) and capscrews (C_7 and C_8, Fig. III/16).

The transmission gear (**19**) which transmits motion from engine crankshaft to the drive unit (**18**), revolves about an axle (**20**) press-fitted in the oil sump.

It can be removed either before or after the removal of the vibration damping unit as follows:

— remove the gear bushing (**32**) lubrication tubelet (**24**);

— remove the first main bearing cap to free the way;

— remove the retaining snap ring (**23**), washer (**22**) and then withdraw the gear and its support (**31**).

Disassembly.

Particular care is required for the extraction of the split dowel pins (**25**, Fig. III/16 of the axles (**26**) as they are fitted into blind holes.

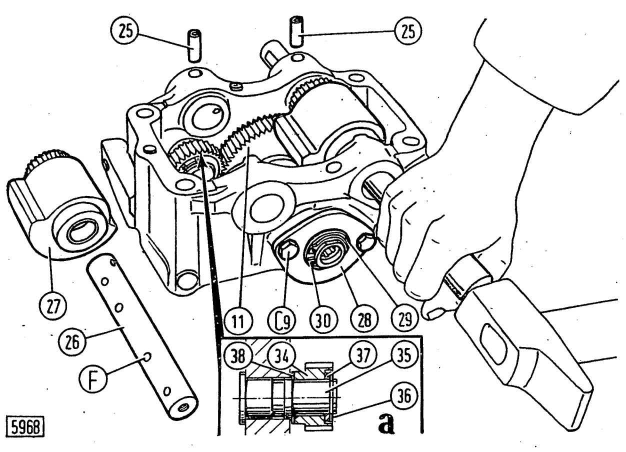


Fig. III/20 - *Removing the weight axles.*
C_9. Flange (28) screws. - F. Lube drills. - 11. Weights driving gear. - 25. Split pins. - 26. Weights axle. - 27. Weight. - 28. Gear supporting flange. - 29. Washer. - 30. Retaining snap ring.
a. Cut-out through idler gear (34).
35. Gear (34) axle. - 36. Retaining snap ring. - 37 and 38. Washers.

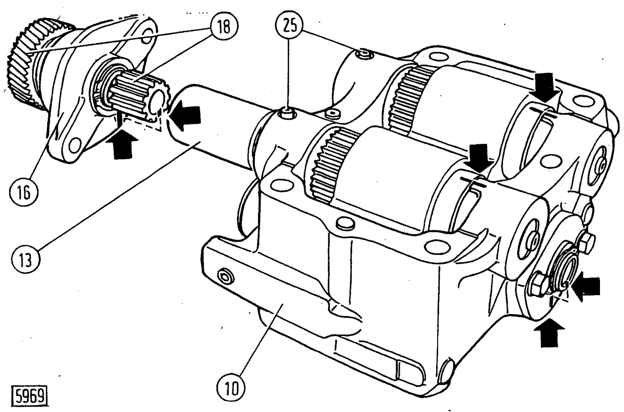


Fig. III/21 - *Arrangement and alignment of assembly marks for damper phasing.*
10. Weights housing box. - 13. Sleeve coupling. - 16. Support. - 18. Gear weights driving unit. - 25. Split pins.

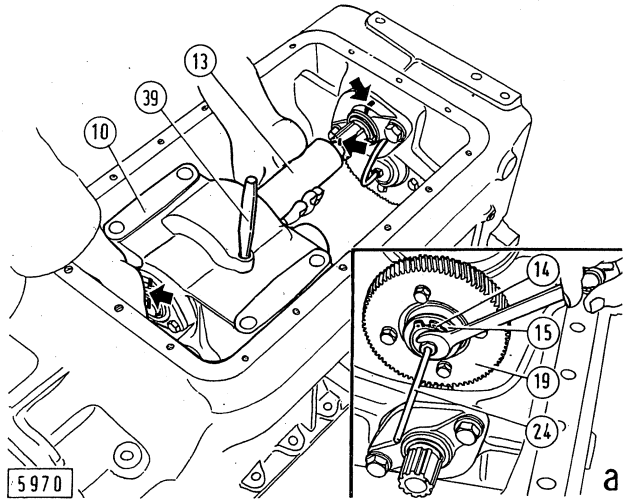


Fig. III/22 - *Assembling the weights housing box (10) with sleeve coupling (13) in oil sump removed from engine.*
(Arrows indicate assembly marks arrangement for correct phasing).
39. Weights lock pin at assembly.
a. Lubrication line (24) installation.
14. Retaining ring. - 15. Washer. - 19. Intermediate gear.

The pins, can be clamped directly in a vise and are also extracted by blowing on the case with a lead hammer.

Drive out each axle from its location (Fig. III/20) using a drive bar and hammer, and recovering the weight (**27**).

The weights driving gear (**11**) is withdrawn from the inside of the housing following the removal of the retaining snap ring (**30**), washer (**29**) and be ing cap (**28**), the latter secured to the box by th capscrews (C_9).

The weights drive idler gear (**34**, Fig. III/20) is withdrawn following the removal of the retaining snap ring, whilst the gear axle is removed afterward.

Inspections and assembly.

Following a thorough inspection apt to verify wear of bushings and gears, re-assemble the unit replacing defective parts and proceeding in accordance whith the following directions:

- bore all new bushing replacement using the expansion blade reamers **U 0321** and **U 611915**; the two weight bushings (**27**) are fitted after pre-heating the weights in hot oil at 140° ÷ 160° C (284° ÷ 320° F);
- arrange the washers and retaining snap rings in the position marked before disassembly, referring to Fig. III/16;
- install the weights drive idler gear (**34**, Fig. III/20) whith the longer end oriented towards the housing wall;
- fit the weights axles (**26**) with the split pin holes (**25**) aligned with those in the housing.

Installation.

Neither adjustement nor lubrication is needed in service, being the unit installed inside the engine oil sump.

However, to ensure effective performance, the vibration damper installation must be arranged as follows:

- bring cylinder 1 to T.D.C. and secure the drive unit (**18**) with its support (**16**) to the oil sump with the assembly marks aligned, as shown in Figs. III/21 and III/22;

— make sure that all assembly marks on the weights housing are lined up, as pointed out by the arrows of Fig. III/21;

— fit the coupling to the weights housing and block the unit with a split pin (**39**, Fig. III/22) which prevents offsetting of assembly marks in case of jolting or blows;

— introduce the coupling (**13**) into the drive unit (**18**) arrange the housing (**16**) on its supporting surface and tighten the attaching capscrews (**C**$_8$, Fig. III/16) to the specified torque (see table of data of Section VIII).

IV - FUEL SYSTEM

SPECIFICATIONS

Bowl capacity of oil-type air cleaner	**0.85 kg (3/4 qts)**
Cleaner oil type and grade	**FIAT Ambra 20 W - 40 (SAE 20 W - 40 multigrade motor oil)**
Fuel tank capacity	**54 liters (12 Imp. gal)**
Fuel transfer pump	**Double-diaphragm**
Cartridge-type fuel filters (2 in series)	**impregnated paper elements**
Injection pump	CAV DPA 3249 F 650 - 770537 (°)
Pump setting on engine: when cylinder no. 1 is away from T.D.C. of	17° ÷ 19°
Pump pressure outlet corresponding to cylinder no. 1	X mark
Sense of pump rotation (as seen from drive end)	counter-clockwise
Three hole injectors:	
— nozzle	DLL 140S 64F
— nozzle holder	KB 70 S1 F10
— pressure setting	225 ÷ 235 kg/cm^2 (3200 ÷ 3342 p.s.i.)
Pressure pipes from injection pump to injectors	1.5 x 6 x 480 mm

AIR SUPPLY

The air aspirated into the cylinders is previously filtered through an oil-bath oil cleaner (Fig. IV/1), with wire-mesh element and fitted on top of the central duct with a centrifugal pre-cleaner (**9**) with automatic dust discharge (**8**).

AIR CLEANER

The filter is strapped to the battery frame and it can be easily reached after removing the front cowling.

Tightness is ensured by a gasket between oil bowl and filter body and by the bands clamping the rubber hoses to the air inlet and outlet ducts.

The correct oil level in the bowl is indicated by the rim.

A periodic and thorough cleaning of the unit is a must if good performance is to be obtained of the engine.

After every 50 working hours remove the oil cup (**6**, Fig. IV/1), make sure oil reaches up to the rim on the bowl and top up if necessary.

The oil is changed if dirty or if deposits on the bottom of cup are 1 cm (3.8″) thick, or over. Following removal of the cup (**6**) clean the filter central air duct (**3**).

All these operations are to be done after at least 15 minutes the engine has been stopped.

At every 200 work hours remove the snap ring (**5**), then withdraw the filtering element (**4**); and wash

(°) For Bosch injection pump see page 212.

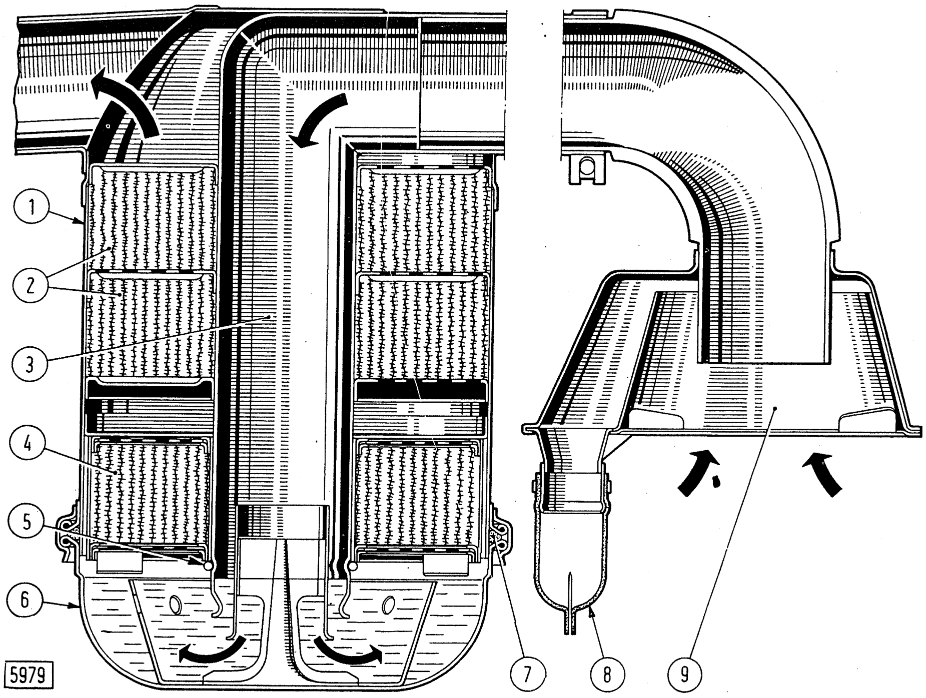


Fig. IV/1 - *Sectional view of air cleaner.*

1. Air cleaner body. - 2. Fixed element. - 3. Air duct. - 4. Filtering mesh. - 5. Mesh (4) retaining ring. - 6. Oil bowl. - 7. Ring seal. - 8. Disc drain valve. - 9. Centrifugal pre-cleaner.

it in kerosene. Prior to re-assembly, moisten the surfaces of the elements with oil.

To remove the air cleaner, first remove the front hood as reported on page 15, disconnect hose (2, Fig. 0/11) from the intake manifold and slacken the band clamp (25, Fig. 0/5), then dismantle the air cleaner and wash parts in kerosene; do it after every 400 hours of work.

Before reassembling the cleaner let it dry and moisten outer surfaces of elements with oil.

Check lightness of band clamps securing the cleaner to the pre-cleaner and intake manifold to prevent unfiltered air from being drawn into the engine.

FUEL SUPPLY

The fuel supply system consists of the following units:

— fuel tank (S, Fig. IV/5), 54 liter (12 imp. gal, approx.) capacity, located at the back of the engine and provided with a fuel level gauge directly connected to a panel mounted warning light;

— double-diaphragm fuel transfer pump (**Pa**, Fig. IV/5), cam driven from the injection pump drive intermediate gear and provided with hand control lever;

— two fuel filters (F_1 and F_2, Fig. IV/51) with impregnated paper cartridge and connected in series; the former is provided with water drain screw;

— C.A.V. injection pump with incorporated mechanical governor and automatic advance device. See specifications in the « Calibration Data » topic of each pump;

— 3-hole nozzles;

— starting aid for cold starts fed by nozzle spill fuel collected in a reservoir

FUEL TANK

Clean the engine thoroughly at engine overhauls. From time to time, drain water condensation and deposits by removing the bottom plug. Be sure the tank is almost empty when draining it, and repeat more often in wet, cold or unstable climates. See that the vent hole on the fuel filler plug is open through and that the cloth dampeners located on the mounting and under the fastening straps are not worn out, and replace them if necessary.

FUEL PRIMING PUMP

The double diaphragm fuel priming pump is actuated by a cam which is driven by the injection pump drive intermediate gear (Fig. IV/2) and incorporates one fuel intake and one outlet valve. At pump overhaul see that the two valves and the screen filter (**4**, Fig. IV/3) are unclogged and the diaphragm (**10**) unbroken. At pump disassembly make the double diaphragm axle rotate 1/4 turn either in a clockwise or counter clockwise direction so to disengage the control lever (**8**) tip end.
Fuel priming pump test specifications :

— min. output . . . 100 liters/hr (22 gal/hr.)

— pressure head (height of water column) . 5 ± 0.5 mm (0.177 ÷ 0.216 in)

— speed of cylindrical driving pin (22 mm dia. and 3 mm excentricity) . . . . 1600 r.p.m.

Test the pump on the test machine by driving the pump attached to the bench test **A 127041** using the same tractor attachment and driving parts.

NOTE - At assembly apply a sealing compound to the studs (V, fig.IV/2).

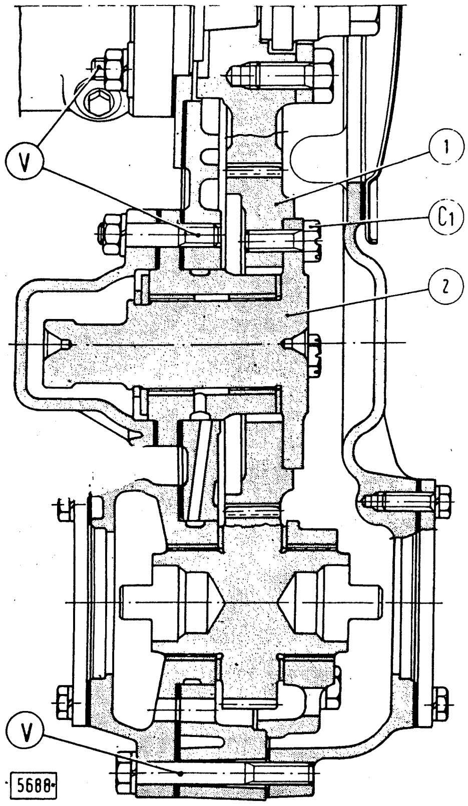


Fig. IV/2 - *Cross-section of fuel transfer pump.*
C_1. Self locking screws attaching shaft (1) to gear (2). - 1. Fuel transfer pump drive gear. - 2. Excentric drive shafts.

FUEL FILTERS

Major causes of trouble for good engine performance are water and fuel contaminants. A high percentage of damage to the fuel injection system is due to corrosion and excessive wear caused by the presence of water and abrasive matter in the fuel.

The water, in solution or condensed in droplets and the solid contaminants in suspension are eliminated through two filters arranged in series (Fig. IV/4).

The first filter separates the water and the solid contaminants. The water droplets, passing through the filtering element, are grouped into larger drops and are easily eliminated by sedimentation in the lower part of the filter where they are visible through the transparent wall of the container. The sediments are removed weekly by backing out the screw (**10**). The solid particles which pass through the filter are trapped in the same way as in other filters.

The fuel, free from water and solid particles, flows up the element central duct to a point sufficiently far from the bottom and completes its

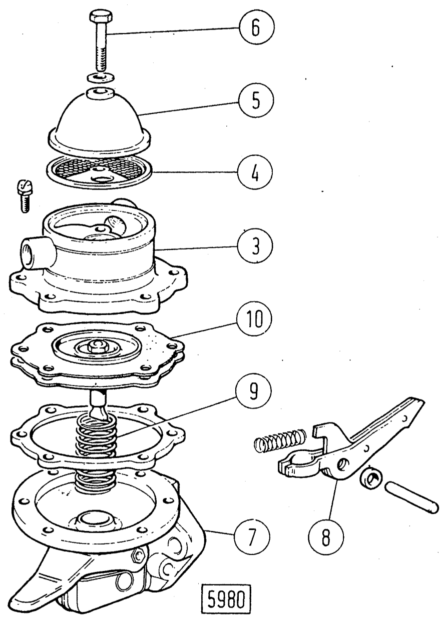


Fig. IV/3 - *Fuel transfer pump parts.*
3. Upper pump body with intake and outlet valves. - 4. Screen-and-seal unit. - 5. Cover. - 6. Cover (5) screw. - 7. Lower pump body. - 8. Control lever. - 9. Diaphragm (10) return spring. - 10. Draphragm with control link.

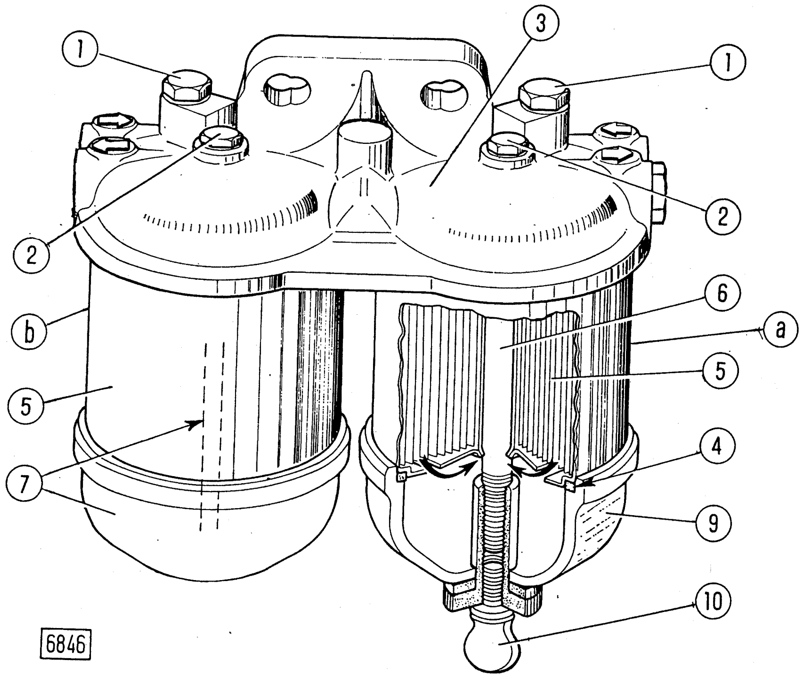


Fig. IV/4 - *Fuel filters.*
a. First fuel filter. - b. Second fuel filter. - 1. Vent. - 2. Control screw. - 3. Cover with fuel inlet and outlet valves. - 4. Rubber seal. - 5. Filtering element. - 6. Rod. - 7. Sediment bowl and rod. - - 9. Transparent bowl. - 10. Bowl (9) attaching screw.

cleaning through the second filter, which acts as a safety unit.

If, because of lack of maintenance, the water level rises in the bowl of the first filter, the same is trapped in the bowl of the second filter, where, however, it is not visible and may pass into the pump.

To ensure the filters the longest possible service life and the efficient operation of the fuel system this should be previously filtered while supplying the tank and, before that, decanted inside the container or barrel.

Caution - *Should the water be left to sediment in the bowl of the first filter, its level may rise and submerge the cartridge which swallows and cannot further trap the solid impurities. The second filter, replacing the functions of the former, can no longer function properly as a safety element and consequently water and impurities may enter the pump.*

After every 200 hours of work clean the first fuel filter (**a**, Fig. IV/4), as follows:

— back out the screw (**2**, Fig. IV/4);

— replace filtering element (**5**) and sealing rings (**4** and **8**).

After every 800 hours of work, proceding in the same way as for the first filter, replace the cartridge of the second filter (**b**) also.

During the warranty period this filter is sealed and is removed by authorized people only.

Bleed air after each service operation effected on filters to permit starting the engine.

FUEL SYSTEM BLEEDING

Every 50 working hours drain out the water condensate that collects at the bottom of the first filter transparent bowl (1, Fig.IV/5) by slackening the lower screw a few turns.
Every 200 working hours it is instead necessary to wash the transparent bowl itself in kerosene and to replace the paper cartridge (2) of this filter and sealings ring.
After every 800 hours of work, proceding in the same way as for the first filter, replace the cartridge of the second filter (6) also.
During the warranty period this filter is sealed and is removed by authorized personnel only.
It is advisable to avoid the contemporary substitution of both filtering elements, by delaying the substitution of the second cartridge 40 to 50 hours with respect to the first cartridge.
After every filter cartridge substitution it is necessary to bleed the fuel system with fuel tank replenished and relevant cock open.

Proceed as follows :

- turn back of a few turn the plug (3)of the first filter and actuate the lever (11) of the fuel transfer pump until the fuel spilled from the hole drilled through the plug is free from air bubbles. Then screw up the plug ;

- bleed as described above on plug (7)of the second filter.

For engines fitted with Bosch injection pump only the two above described operation are necessary, while for engines with C.A.V. injection pump is also necessary to :

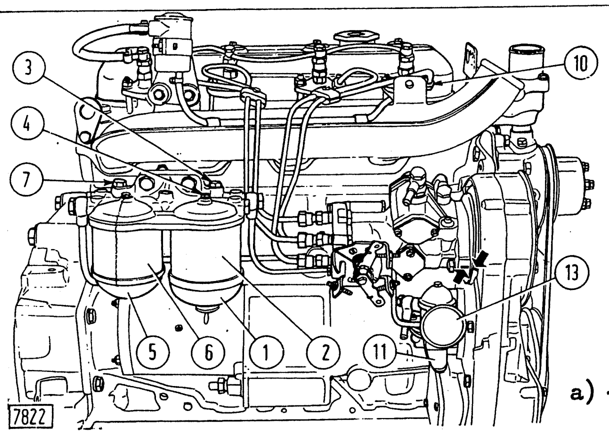
- bleed the air from the hydraulic head by loosening lower screw (8) and proceeding as for the filters ;

- turn back about two turn the upper screw (9), slacken fully the injector connections(10) and crank the engine with the starter motor until fuel without air bubbles issues from the lines ;

- screw back injector connections (10) and leave screw (9) loose ;

- start the engine and when bubble-free fuel spills out of the screw (9), tighten in the screw.

NOTE - The descriptions regarding the figures from no.IV/6 to no.IV/40 have been suppressed in this edition.



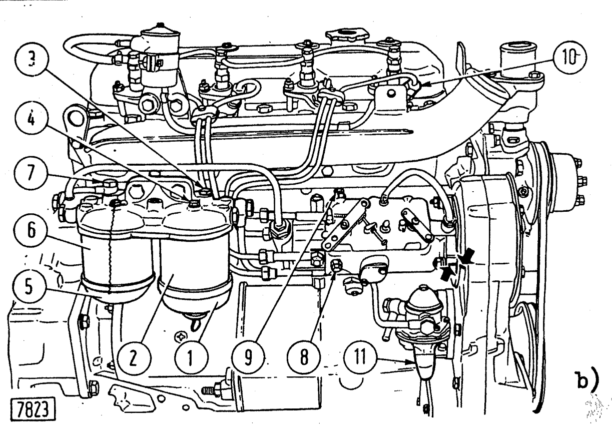


Fig. IV/5 - Bleeding the fuel system of engines fitted with Bosch (a) and CAV (b) injection pumps.
(arrows show pump and crank case marks to be lined up at assembly).
1. Transparent bowl complete with lower screw for discharging condensed water from 1st fuel filter - 2. First filter element - 3. First filter air bleed plug - 4. Filter element and bowl securing screw - 5. Second filter bowl (non-transparent and without lower screw) - 6. Second filter element - 7. Second filter air bleed plug - 8. Hydraulic head (CAV injection pump) air bleed screw - 9. Governor housing air bleed screw (CAV injection pump) - 10. Injector connections - 11. Fuel pump actuating lever - 13. Pressure equalizer installed on fuel pump (Bosch injection pump only).

C.A.V. INJECTION PUMP

GENERAL

The C.A.V. injection pump mod. DPA features the following major components:

— integrated vane-type transfer pump (**27**, Fig. IV/42) which pumps fuel under pressure to the distributing rotor (**46**) via the hydraulic head ports;

— a transfer pressure regulating valve (**49**, Fig. IV/39) serving a dual purpose i.e., regulating the transfer pressure of the vane-type pump (**27**) and filling the same pump with engine stopped in the priming stage;

— a hydraulic head (**23**) feeds the pumping chamber of the rotor with a metered quantity of fuel and is crossed at the very instant of injection by the fuel ducted to the high pressure pipe of the nozzle;

— a distributing rotor (**46**, Fig. IV/44) crossed transversally by the fuel pumping chamber, distributes the high-pressure fuel to the engine cylinders via the hydraulic head ports;

— a pumping element consisting of two opposed plungers (**13**, Fig. IV/44), located in the pumping chamber bored through the rotor, which move inwards and outwards and are actuated by cam followers or rollers (**12**) rotating inside the stationary cam ring (**10**);

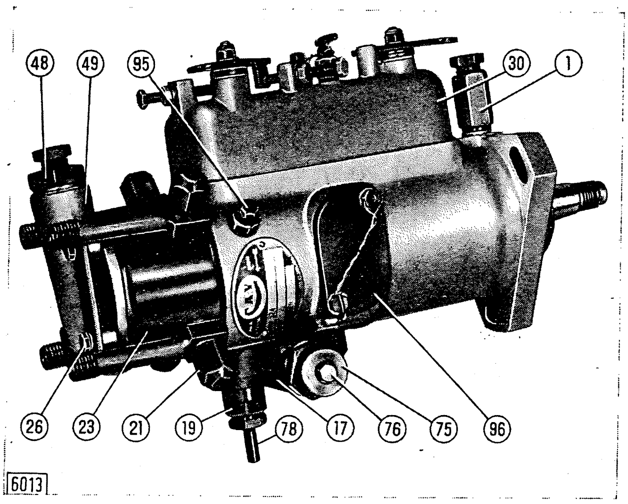
— a metering valve (**42**, Fig. IV/50) which ducts the correct volume of fuel to the high-pressure chamber (injection deliveries); this valve, which is housed inside the hydraulic head, is subjected to control by both the speed governor and throttle;

— a fly-weight, all-speed type mechanical governor (Fig. IV/50), with the drive shaft connected to the rotor (**46**) through a splined drive plate, which controls the metering valve (**42**);

— an auto advance device of the plunger type (**17**, Fig. IV/50), hydraulically-actuated by the transfer pressure, controls the angular position of the cam ring (**10**) where the rollers (**12**) and pumping plungers are located. The auto advance unit (**17**) is also provided with a manual retard mechanism (**20**) which excludes it at cold starts;

— air vent screws on the pump body (**95**, Fig. IV/41), control cover (**95a**), and side inspection cover (**96**) for phasing mark and output adjustment.

A design feature of the pump is the absence of such mechanical parts as roller bearing, gears, and highly stressed springs.
Lubrication is not necessary as the pump housing is completely filled with fuel oil under pressure which prevents airlocks and keeps out dust, water



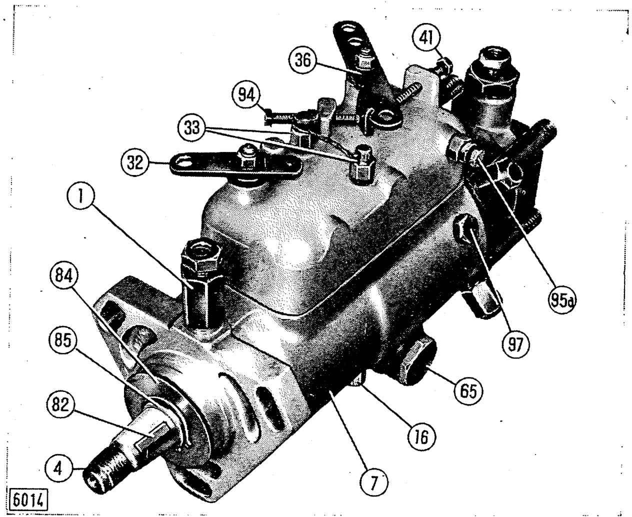


***Fig. IV/41** - C.A.V. fuel injection pump.*

1. Leak-off connection. - 4. Drive shaft. - 7. Pump housing. - 16. Auto advance device stud. - 17. Advance device housing. - 19. Hydraulic head locating fitting. - 21. High-pressure connection valve. - 23. Hydraulic head. - 26. End plate cap screw. - 30. Control cover. - 32. Shut-off lever. - 33. Cover stud nuts. - 36. Throttle arm. - 41. Maximum speed adjustment screw. - 48. Fuel inlet connection. - 49. End plate with transfer pressure regulating valve. - 65. End plug. 75. Piston cap. - 76. Piston cap screw (test machine advance check gauge application). - 78. Manual retard device pin. - 82. Key. - 84. Thrust washer. - 85. Circlip. - 94. Idling speed adjustment screw. - 95. Hydraulic bleed screw. - 95a. Governor bleed screw. - 96. Control cover. - 97. Hydraulic head attachment screw.

or other foreign matter which would lower the efficiency of the unit and shorten its service life.

The employment of a single pumping element obviates the need to balance the deliveries to each injector as the quantity fo fuel intended for injection is regulated before reaching the pumping chamber of the distributing rotor from which it is distributed to the individual engine cylinders through the hydraulic head porting.

The pump is flange-mounted on the crankcase, is driven by a tapered shaft and key and revolves in a counterclockwise direction.

Note - *The same figure or letter designates the same port or unit throughout this manual.*

The «front» and «rear» denominations refer to the assembly position of pump installed on the engine.

OPERATION

The functions and operation of every unit as previously described are hereby outlined and illustrated.

a) *Vane-type fuel transfer pump.* The pump rotor (**27**, Fig. IV/42) is screwed into the end of the distributing rotor (**46**) by means of a left-hand thread and serves as end spacer for the hydraulic head.

The bore stationary liner (stator **25**) inside which the two vanes of rotor (**28**) revolve, is excentric and the liner is located by means of a pin (**58**), fitted in the end plate which blocks it in its compartment inside the hydraulic head.

The blades revolve with the rotor and at the same time move radially inside their slots to follow the internal contour of the liner. A rubber seal (**24**) ensures sealing tightness with respect to the end plate surface.

Clean, filtered fuel enters the pump via the connection (**48**, Figs. IV/43 and 50), flows through the pressure regulating valve the function of which will be illustrated in the following paragraph, and flows out through the upper curved slot visible on the end plate. The fuel under transfer pressure is ducted from the transfer pump into the hydraulic head via the port (**92**, Fig. IV/42).

The capacity of the transfer pump is a multiple of the total maximum delivery quantity of the injection pump, excess fuel being dumped via the pressure regulating valve, returned to the suction side of the same pump and ducted through outlet connecting to the final (2nd) filter.

The inside of the pump is completely filled with fuel under slight pressure the advantage being that the same provides for cooling and lubrication of parts and prevents the ingress of air and dust and condensed water.

b) *Transfer pump pressure regulating valve.* This valve is housed inside the end plate which secures the vane-type pump to its hydraulic head location.

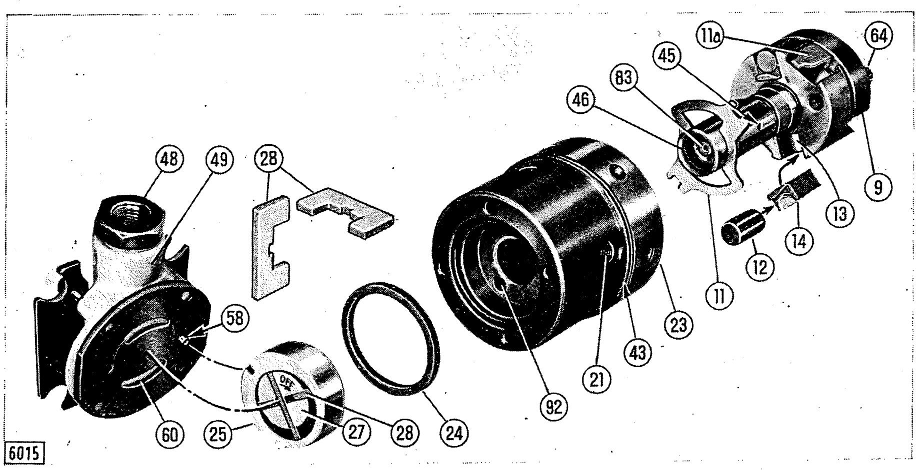


Fig. IV/42 - *Vane-type pump, hydraulic head (23), rotor (46) and transfer pressure regulating valve (49).*
9. Splined drive plate. - 11. Rear adjusting plate. - 11a. Front adjusting platd. - 12. Roller. - 13. Plunger. - 14. Roller shoe. - 21. High-pressure connection valve. - 23. Hydraulic head. - 24. Seal between hydraulic head and pressure regulating valve. - 25. Transfer pump liner. - 27. Transfer pump rotor. - 28. Transfer pump vanes. - 43. Hydraulic head seal ring. - 45. Inlet port. - 46. Rotor. - 48. Fuel inlet connection. - 49. End plate with transfer pressure regulating valve. - 58. Transfer pump liner locating dowel. - 60. Fuel outlet (priming) and inlet (transfer). - 64. Lockscrew location. - 83. Rotor central bore nut. - 92. Fuel port to metering valve from transfer pump.

The three diagrams of Fig. IV/43 illustrate the three basic operation features whilst parts can best be seen in Fig. IV/57.

Diagram *a* shows the position of rest (engine stopped). Diagram *b* illustrates pump priming, an operation which is required following the removal of components for maintenance or overhauling to bleed the transfer circuit and to fill it with fuel.

At priming, the fuel which is circulated by means of the hand priming pump enters via the connection (**48**), flows through the nylon filter (**56**), pushes the piston (**54**) down, compressing the spring (**55**) which prevents the piston from dropping, enters via the lower duct (**60**) — pump outlet — and is directed straight through the port (**92**, Fig. IV/42) which allows filling the whole system avoiding the pump vanes.

Diagram *c* illustrates the regulation of the transfer pressure, which the valve tends to adjust as much as possible in a direct ratio to speed variations.

In fact, with engine running, the vane-type pump is fed via the upper valve port (upper curved slot of end plate - **57**, Fig. IV/42 and 43) and the delivery pressure forces the plunger (**54**) upwards to compress the regulating spring (**53**). The fuel flows out through the regulating port (**59**), joins the fuel entering the inlet connection and re-enters the pump via the inlet port (**57**).

The opening of this port depends upon fuel pressure and consequently on engine speed as the plunger supports the load of the regulating spring (**53**) which in turn is supported at the opposite end by the plug (**51**) that is loaded by the spring (**50**).

To re-establish the calibration of the valve within the test specification limits, replace the plug (**51**) which modifies with its protrusion the load of spring (**53**). Plugs are marked with a number of grooves from zero (normal plug) to four.

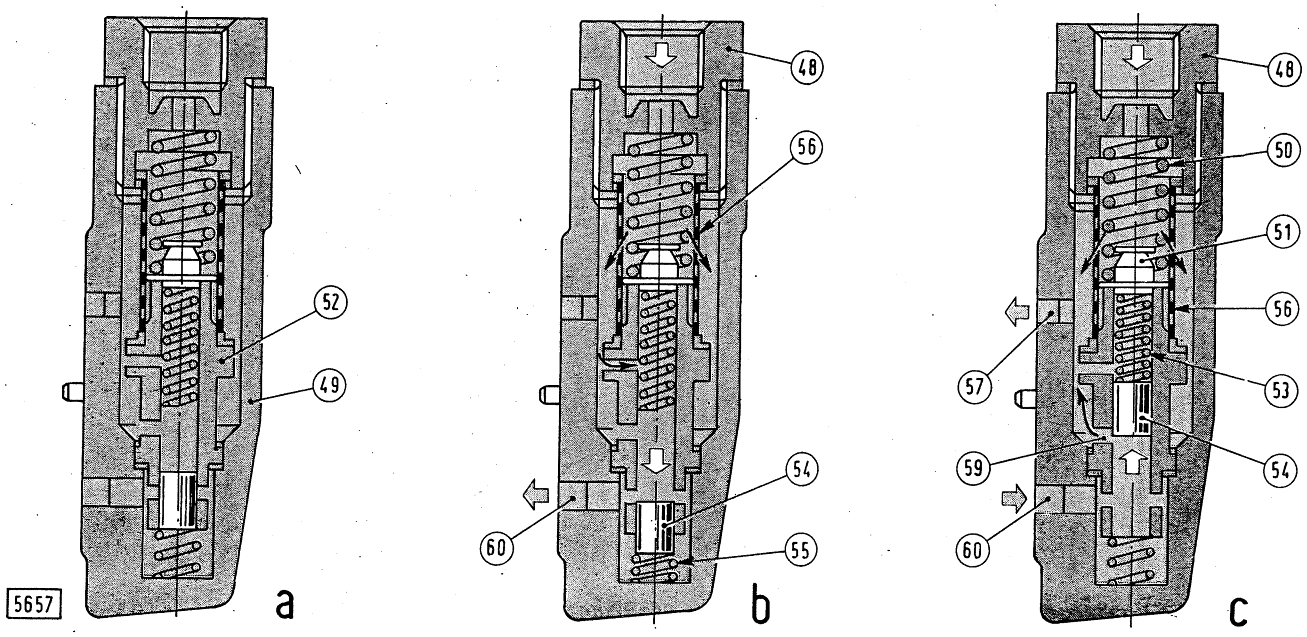
The pressure regulating valve (**49**), threfore, carries on two different tasks:

— regulates the fuel pressure maintaining a definite relationship between transfer pump delivery pressure and speed;

— fills the pump with fuel, at priming, excluding the cavities of stationary vanes (**28**), so that the fuel reaches the hydraulic head directly.

c) *Hydraulic head.* This section of the pump housing the distributor rotor is secured to the main body at three points: by the vent screw (**95**, Fig. IV/41), and by the nut of stud (**19**) securing the auto advance device.

In addition to the rotor (**46**, Fig. IV/42), the hydraulic head houses the vane-type pump liner (**25**) and the metering valve, and, externally, the high pressure connections and the pressure re-



a) At rest (stop). b) Priming. c) Regulation.

***Fig. IV/43** - Transfer pressure regulating valve (49).*

48. Fuel inlet connection. - 50. Retaining spring. - 51. Sleeve plug. - 52. Valve sleeve. - 53. Regulating spring. - 54. Piston. - 55. Priming spring. - 56. Nylon filter. - 57. Fuel inlet. - 59. Regulating port. - 60. Fuel outlet.

gulating valve. Sealing tightness is taken care of by the two seals (**43** and **24**).

Internally, the hydraulic head is crossed by a delivery duct from transfer pump to metering valve (**42**, Fig. IV/50) and by the high pressure connection outlet ports (**22**).

Further information concerning the hydraulic head ducts are given in the following topic.

d) *Pumping and distibuting rotor*. The rotor (**46**, Fig. IV/44) revolves inside the hydraulic head which feeds the pressure chamber with the volume of fuel determined by the metering valve. At the instant of injection in each one of the engine cylinders, high pressure fuel is distributed via the rotor and hydraulic head ports to the nozzle pipes.

One end of the rotor is fitted with the transfer pump impeller (27, fig. IV/42) and the other carries the pumping mechanism. The movement is transmitted to the rotor by the governor weight shaft to which it is connected through the splined drive plate (**9**) with which it makes a single revolving element.

The pumping element consists of two opposed plungers (**13**, Fig. IV/44) moving radially inside the rotor, actuated through rollers (**12**) and pads (**14**) by the contour of the cam ring (**10**) located in the pump body.

The two functions of the pumping element, fuel charging and injection, are illustred in Fig. IV/44.

Notice that for the charging operation the hydraulic head port (**44**), controlled by the metering valve, registers with the fuel inlet port (**45**) to the rotor; the fuel fills up the pressure chamber comprised between the two opposed plungers which move apart under the effect of pressure. In this phase the distributor port (**47**) is covered. As the rotor turns, the supply of fuel terminates, and as the rollers (**12**) meet the profiled contour of the cam ring (**10**) the plungers move back inwards on their working stroke and therefore commences the compression of the fuel; then, as soon as the distributor port (**47**) registers with one of the pressure outlets, the injection takes place.

The figure shows that there are as many inlet ports (**45**) in the distributor as there are engine cylinders.

All these fuel inlet ports are supplied via the duct (**44**) of the hydraulic head, and there is a single distributor duct (**47**) in the rotor for all the high-pressure outlets.

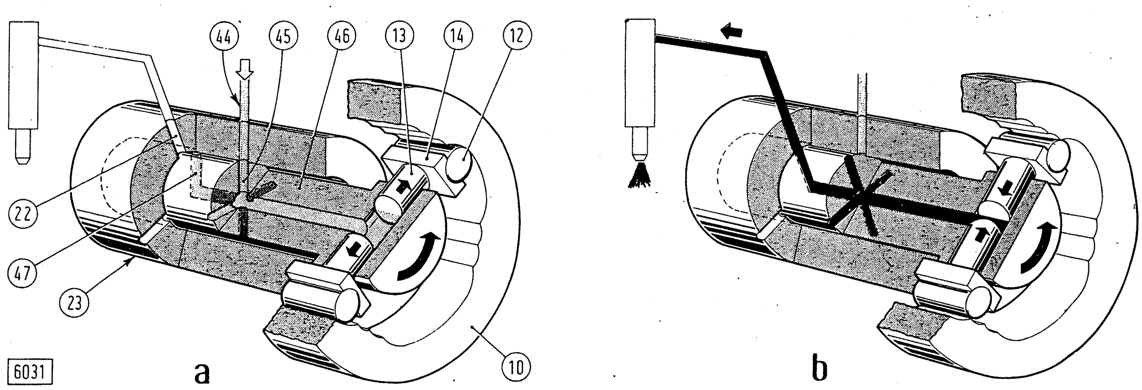
Notice that:

— the pumping plungers have no return spring as they are kept separate by the fuel pressure;

— the cam ring lobes are 4, just as many as the engine cylinders;

e) *Automatic advance device*. This device (**17**, Fig. IV/41) is located on the underside of the pump body to which it is bolted by means of the stud (**16**) and locating fitting (**19**); the latter is screwed onto the hydraulic head for branching off the pressure fuel from the transfer pump (**19**, Fig. IV/47).

This device is hydraulically-actuated and varies the injection advance in accordance with the speed of the engine. It consists of a plunger (**67**, Fig. IV/45) which, through the cam advance screw (**18**), makes the cam ring (**10**) rotate with respect to the pump body. The pressure of the fuel entering through the locating fitting (**19**) acts upon one plunger face and is opposed at opposite end by the force cf



a) Fuel inlet phase. b) Fuel injection phase.

***Fig. IV/44** - Hydraulic head and distributing rotor.*

10. Cam ring. - 12. Cam roller. - 13. Pumping plungers. - 14. Roller shoe. - 22. Outlet port. - 23. Hydraulic head. - 44. Metering port. - 45. Inlet port. - 46. Rotor. - 47. Distributor port.

the springs (**68**, **72** and **73**) which tend to hold it in the position of maximum retard.

With engine stopped or running at low speed, when the transfer pump pressure is not sufficient to overcome the opposing spring (**68**) force, the cam ring is in position of max. retard; when speed rises and the fuel pressure overcomes spring resistance, then the piston is displaced and the advance increase. As the pressure rises with engine speed, the plunger abuts against the cup (**70**), compresses both springs (**72** and **73**) and displaces the cam ring towards maximum advance.

The impact of the rollers (**12**) against the flanks of the cams might cause the ring to displace the plunger and consequently to expel the fuel which acts upon it, thus retarding injection. But this is prevented by the ball check valve (**81**, Fig. IV/46) located on the the fuel inlet fitting (**19**). As the engine speed drops (or stops) and the transfer pump pressure also drops, the plunger and the cam ring are displaced by the springs and the fuel leaks into the pump body seeping through the running clearance existing between piston and cylinder.

A pin (**78**, Fig. IV/46) manually actuated, facilitates cold starting by preventing the ball (**81**) to move off its seating to avoid fuel pressure action upon the plunger, thus maintaining the max retard of injection.

It should be pointed out a feature concerning the contact of the rollers (**12**, Fig. IV/45) with the lobes of the cam ring (**10**): the contact point with the cam contour varies as a function of the filling of transfer fuel. Besides, the contour of the cam is asymmetrical, being the rising profile shorter than the descent profile.

As to the latter, notice the first length (**K**) which determines a quick end to injection, thus avoiding dribbling at the nozzles, by making the pressure of the fuel trapped in the pumping chamber between plungers (13 ,fig.IV/44)to drop sharply. There is then a second length in which backing out starts again.

f) *Speed governor and metering valve.* The mechanical governor is of the all-speed and all-load type.

The fly weights are located on the pump drive shaft whilst the control spring (**38**, Fig. IV/48) and the linkage, from thrust sleeve (**5**) to metering valve (**42**) are closed in by a cover which is installed on top of the pump body. The shut-off and throttle control levers (**36** and **32**) are fitted to the shafts protruding out of the cover.

The speed governor consists of:

— the drive shaft with a double seal and connected through the splined drive plate (**9**) to the distributing rotor (**46**, Fig. IV/50);

— a cage (**6**, Fig. IV/64) containing four fly weights (**2**) connected to the drive shaft through a cushdrive made up of rubber inserts (**86**) which dampens vibrations;

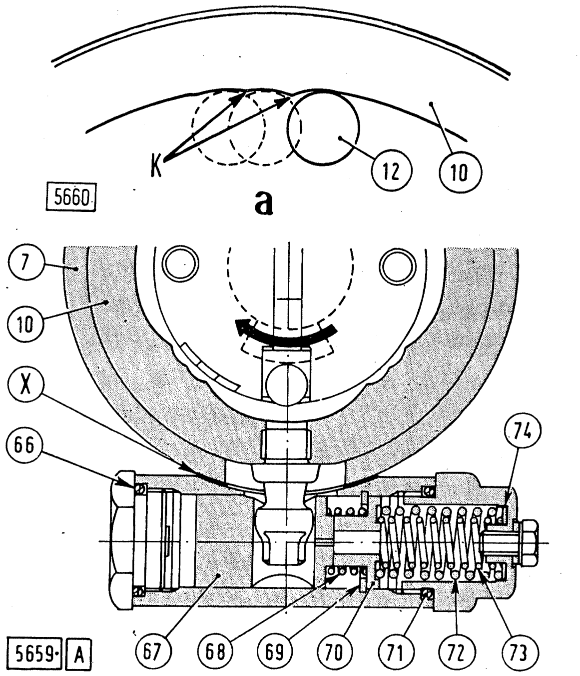


Fig. IV/45 - *Automatic advance mechanism.*
X. Gasket. - 7. Pump housing. - 10. Cam ring. - 66. O-ring. - 67. Plunger. - 68. Spring. - 69. Circlip. - 70. Spring plate. - 71. O-ring. - 72. Outer spring. - 73. Inner spring. - 74. Shims.
a. Profile of one cam on ring (10).
12. Roller.

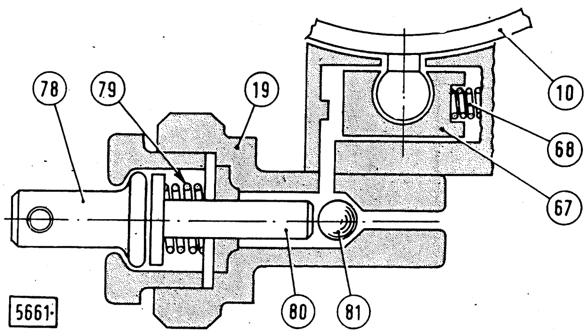


Fig. IV/46 - *Automatic advance inlet connection (19) and manual retard device (78) for cold starting.*
10. Cam ring. - 67. Piston. - 68. Advance device spring. - 79. Return spring. - 80. Plunger. - 81. Nonreturn valve ball.

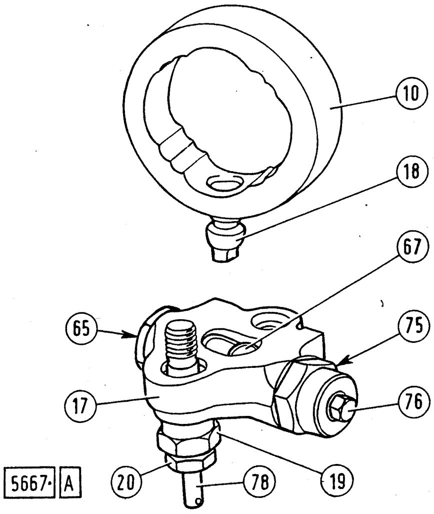


Fig. IV/47 - *Automatic advance mechanism (17) with cam ring (10).*

18. Cam advance screw. - 19. Hydraulic head locating fitting. - 20. Manual retard device. - 65. Piston end plug. - 67. Piston. - 75. Spring end plug. - 76. Screw for advance test gauge pin hole.

— the weight-controlled thrust sleeve (**5**, Fig. IV/64) with thrust washer (**88**) and max. travel stop circlip (**89**);

— a control arm (**8**, Fig. IV/48), working as a rocker arm, with one end in contact with the thrust sleeve (**5**) from which it receives the movement and the other end connected with the control spring (**38**) and governor link (**34**). A bracket (**29**) fixed to the pump body functions as the fulcrum of the control arm (**8**).

— the metering valve (**42**), which functions as the regulation valve for the transfer fuel delivery from vane-type pump to the pressure chamber between plungers (**13**), is controlled by the governor fly weights or by shut-off lever (**37**). To allow this double possibility of control, the end of the link (**34**) passes freely through the plate, kept in contact by a pre-loader spring, in order to act upon the shut-off without stressing the governor weights;

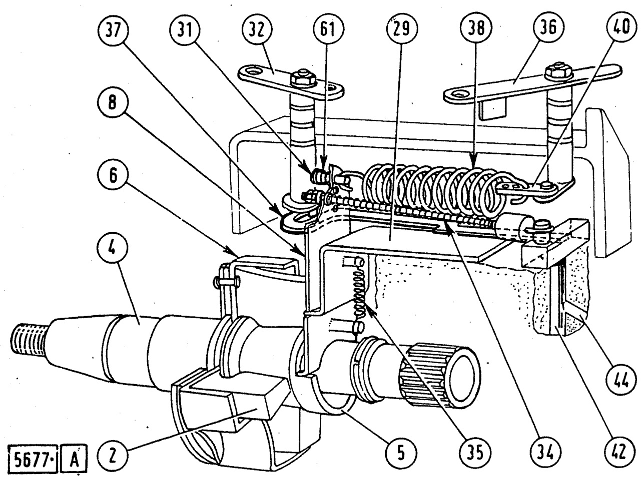
— the control valve (**38**) linked at one end with the control valve (**8**) and with the other to the throttle lever shaft;

— a spring-loaded link (**34**) connecting the control arm (**8**) to metering valve (**42**);

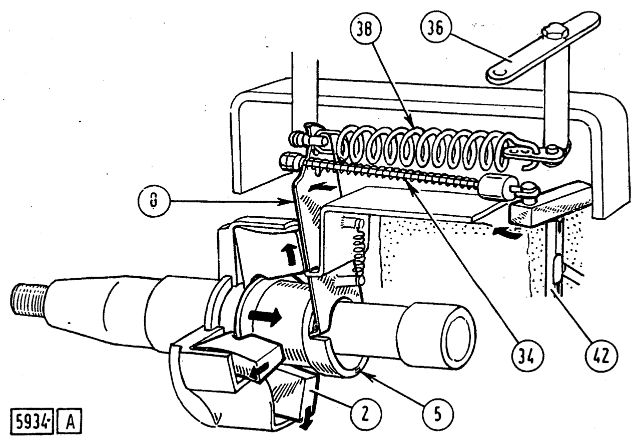
— the shut-off control consisting of an outside shut-off lever (**32**) and an inside bar (**37**); the latter acts directly on the metering valve to cut fuel delivery.

Engine speed is selected through the throttle control lever (**36**) which acts upon the control spring (**38**).

The latter, in turn, connects the guide (**31**) passing clear through the control arm (**8**) on which is located the idling spring (**61**). When the throttle lever moves to speed up the engine then the idling spring is compressed and the control spring is pulled under tension, and this force is trasmitted through the control arm (**8**) and thrust sleeve (**5**) to the fly-weights setting up a resistance to opening.



a) Schematic drawing



b) Operation following a load drop.

Fig. IV/48 - *Mechanical speed governor.*

2. Weight. - 4. Drive shaft. - 5. Thrust sleeve. - 6. Weights retainer. - 8. Control arm. - 29. Fulcrum. - 31. Idling spring guide. - 32. Shut-off lever. - 34. Governor link. - 35. Governor arm spring. - 36. Throttle. - 37. Shut-off bar. - 38. Control spring. - 40. Throttle arm. - 42. Metering valve. - 44. Metering port. - 61. Idling spring.

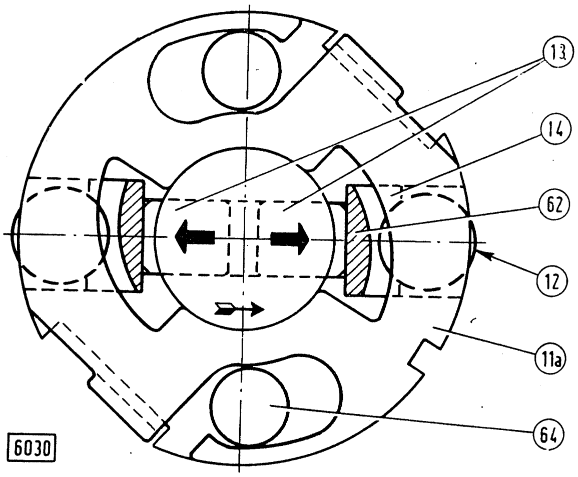


Fig. IV/49 - *Maximum fuel adjustment device.*
11a. Front adjusting plate. - 12. Roller. - 13. Plungers. - 14. Roller shoe. - 62. Shoe lugs. - 64. Drive plate bolts.

The correct assembly position of the control spring with respect to the control arm (**8**) and throttle lever is indicated in the assembly data on page 71 and in the Fig. IV/76, and can be derived from the information given on the pump identification plate, if post-modification.

The metering valve is a rotary-type of valve consisting of a shaft splined on one end and placed in the hydraulic head for the purpose of controlling the transfer pump fuel delivery to the supply chamber between pumping plungers. The regulation consists in the variation of pressure in the metering duct (**44**, Fig. IV/48). At starting, the throttle lever is moved all the way forward and the metering valve is in position of maximum fuel delivery; once started, the throttle lever is moved back and

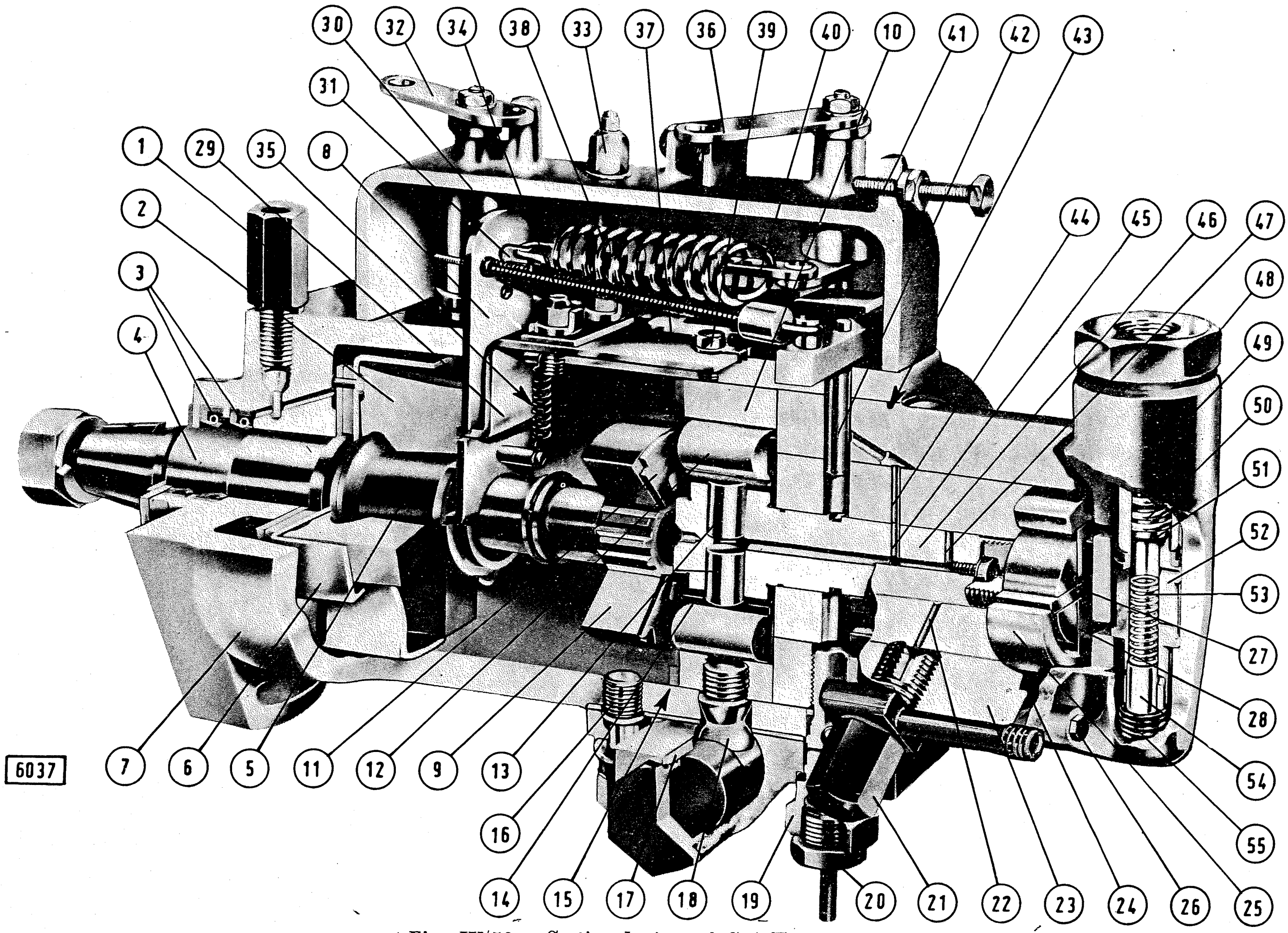


Fig. IV/50 - *Sectional view of C.A.V. pump.*
1. Leak-off connection. - 2. Governor weight. - 3. Shaft seals. - 4. Drive shaft. - 5. Thrust sleeve. - 6. Weights retainer. - 7. Pump housing. - 8. Control arm. - 9. Splined drive plate. - 10. Cam ring. - 11. Maximum fuel setting adjusting plate. - 12. Roller. - 13. Plungers. - 14. Roller shoe. - 15. Timing circlip. - 16. Auto advance device stud. - 17. Advance device housing. - 18. Cam advance screw. - 19. Hydraulic head locating fitting. - 20. Manual retard device. - 21. High-pressure connection. - 22. Outlet port. - 23. Hydraulic head. - 24. Seal. - 25. Transfer pump liner. - 26. End plate screw. - 27. Transfer pump rotor. - 28. Transfer pump. - 29. Governor control bracket. - 30. Control cover. - 31. Idling spring guide. - 32. Shut-off lever. - 33. Cover nut. - 34. Governor link. - 35. Governor arm spring. - 36. Throttle arm. - 37. Shut-off bar. - 38. Control spring. - 39. Governor bracket screw. - 40. Throttle arm. - 41. Maximum speed adjustment screw. - 42. Metering valve. - 43. Hydraulic head sealing rubber ring. - 44. Metering port. - 45. Inlet port. - 46. Rotor. - 47. Distributor port. - 48. Fuel inlet connection. - 49. End plate with transfer pressure regulating valve. - 50. Retaining spring. - 51. Sleeve plug. - 52. Valve sleeve. - 53. Regulating spring. - 54. Piston. - 55. Priming spring.

the metering valve is in position of minimum fuel delivery (spring **61** compressed between control arm **8** and guide **31**).

When the selected speed has been reached, the governor will hold it with a minimum of fluctuations.

A speed rise due to a lower load will cause an outward movement of the flyweights and consequently a restriction of the metering valve which will result in a lower engine speed deriving from a reduced supply of fuel. If, on the other hand, the engine speed drops the fly weights will close inwards increasing the opening of the metering valve and consequently a greater supply of fuel.

g) *Maximum fuel adjustment.* The volume of the pressure chamber housing the pumping plungers is set at pump assembly and checked on the test machine for final adjustment.

The adjustment device includes:

— two roller shoes (**14**, Fig. IV/49) with an end projection (**62**) for stop;

— two plates (**11** and **11a**) interconnected and attached to the rotor with two screws (**64**) and two eccentrically profiled slots allowing a stop for the shoe projections.

Increased fuel delivery is obtained by backing out temporarily the two screws (**64**) securing the adjusting plates (following removal of the timing index inspection cover **96**) and then moving the two plates (**11-11a**) to suit, and in the same direction of pump rotation.

The maximum pumping plunger travel is obtained when the curved surfaces of both pads and adjusting plates come in contact with each other.

Aside from the small fuel losses occurring at injection the whole volume of fuel introduced into the pumping element is ducted to the nozzle. Fuel delivery, therefore, depends upon the regulation of the volume of fuel supplied to the pumping element.

This quantity depends on two major factors:

— fuel pressure inside the filling duct from transfer pump to rotor;

— length of time the inlet port of the hydraulic head (**44**, Fig. IV/44) remains in register with the corresponding inlet port (**45**) on the distributing rotor.

The correct fuel delivery is obtained by regulating the pressure inside the inlet duct (**44**) by means of the metering valve.

PUMP OVERHAUL

Disassembly, re-assembly, testing and calibration of the pump are operations requiring specialized servicemen and the availability of special testing and measuring equipment. Thorough ambient cleanliness is a must as even the smallest of abrasive particles may damage the pump, lower its efficiency and shorten its service life.

Keep parts in FIAT CFB oil up to re-assembly.

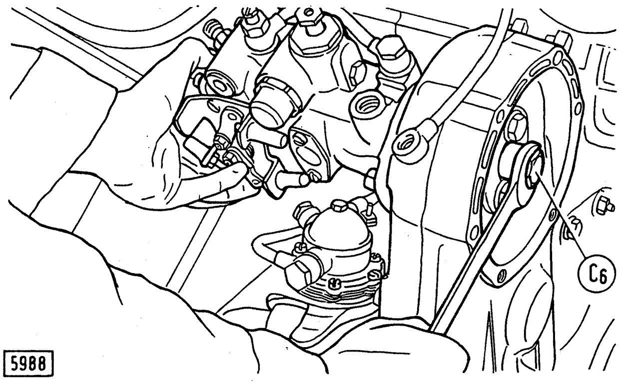


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Fig. IV/50 bis. Removing pump from engine.
C_6. Pump shaft attachment screw.

PUMP REMOVAL

Firstly prepare the pump by cleaning the adjacent area to prevent ingress of dirt through the open connection bores following removal of the pipes. Disconnect the control lever linkage and fuel pipes from the pump.

Remove the inspection cover and gasket from the timing gear cover and the nuts (Fig. IV/50bis) securing the pump flange from the timing gear case.

Remove the pump shaft central nut (**C_6**) which serves also as puller then withdraw the pump from its driving gear.

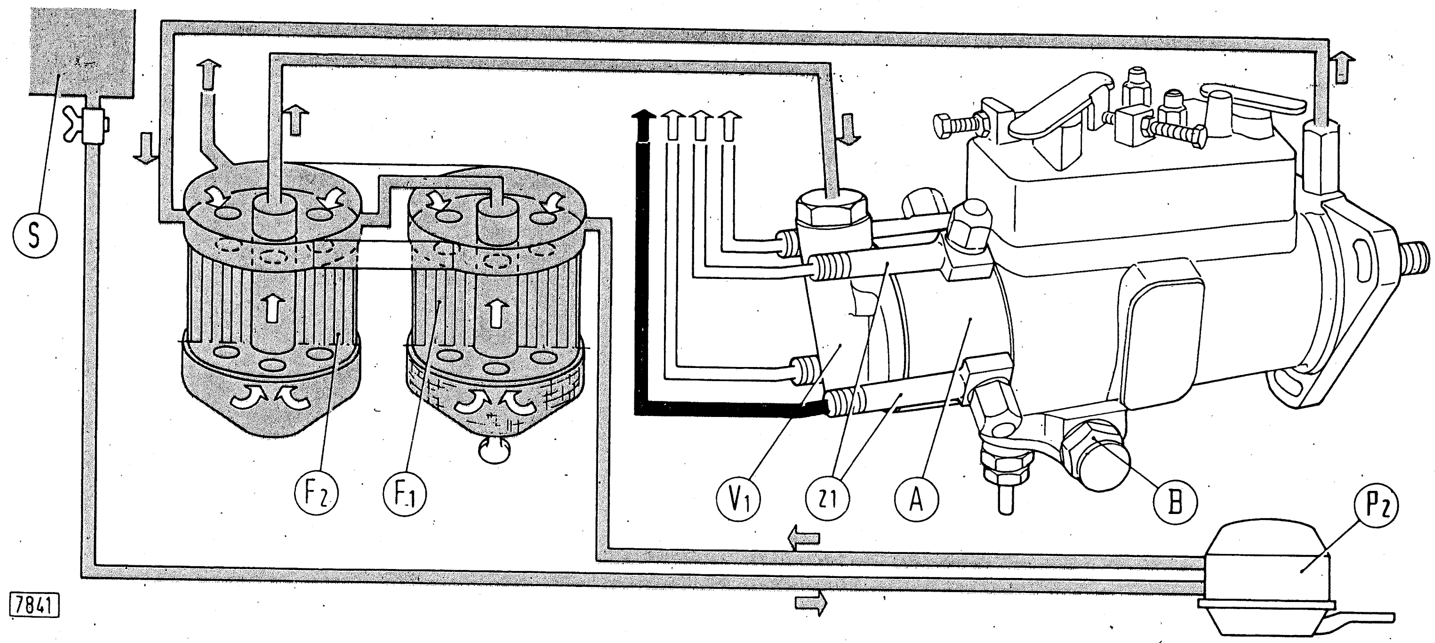
DISASSEMBLY

Before disassembly: drain fuel through side cover and secure it to the swivel stand **A 5717** by means of support **A 127013**.

Notice arrangement of pressure pipes to injectors, remove fittings, remove parts as indicated and keep specified parts in a bath of FIAT CFB protective oil.

1. *Governor cover* (**30**, Fig. IV/52). Remove the shut-off and throttle control levers (**32** and **36**) from their respective shaft, the nuts and washers from the cover studs (**33**) and the dust seals from the shafts.

Install the protection **A 127001** on the throttle control lever shaft and push on end to withdraw if from below, lifting, simultaneously, the governor cover (**30**).



▭ Priming pump suction and delivery fuel, fuel returning to the second filter (injection pump leakages) and fuel returning to the main tank.

▬ High pressure fuel to the actuated injector.

Fig. IV/51 - CAV injection pump fuel circuit diagram.

A. Hydraulic head - B. Automatic advance device - F_1 and F_2. First and second filter in series - P_2. Diaphragm fuel priming pump - S. Fuel tank - V_1. Transfer pressure regulating valve - 21.High pressure connections to the injectors.

NOTE - For the pump internal fuel flow,see page 270.

Disconnect both ends of control spring (**38**) and remove the idling spring with its guide (**31**) which remain loose.

Install the protection **A 127001** on the shut-off lever shaft and push down to split the shaft from the cover.

Remove the two studs and the governor bracket screw (**39**, Fig. IV/53) freeing them from their plates, after which all governor parts will remain free.

Lift from the pump the complete governor control linkage with the metering valve (**42**, Fig. IV/54).

Remove the metering valve and keep it in clean oil to avoid scratches or rust on finished surfaces, dismantle the linkage and remove the governor cover gasket.

2. Automatic advance device (Fig. IV/55). Turn pump on its support so that the device is uppermost, then slacken the two plugs (**65** and **75**) of the hydraulic control and the plug (**20**) of the manual retard device.

Remove the complete device body and gasket after unscrewing the nut of stud (**16**) and the hydraulic head locating fitting (**19**).

Strip the automatic device by removing altogether the two nuts (**65** and **75**), previously slackened, to free all internal parts, except for the stop ring which is better left installed.

When stripping the manual retard device make sure not to turn it upside down to avoid losing or damaging the ball and spring as loose spares are not available.

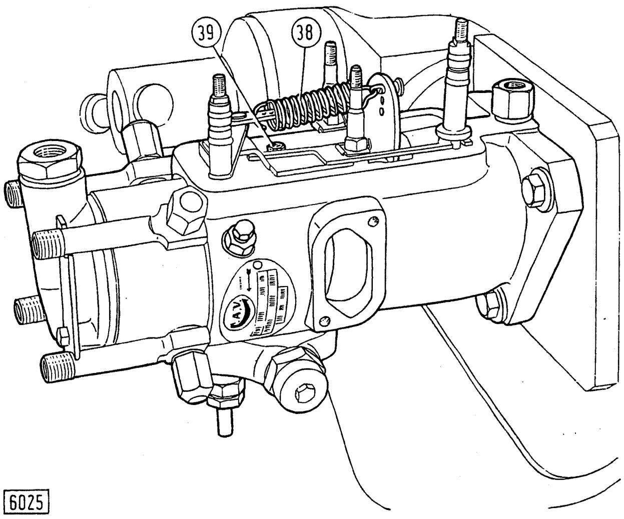


Fig. IV/53 - *Speed governor without cover.*
38. Control spring. - 39. Screw securing plate to pump body.

3. Pressure regulating valve and fuel transfer pump (Fig. IV/56). Turn the pump over on the mounting plate then slacken the fuel inlet connection (**48**) and remove the capscrews securing the pressure regulation valve (**49**) to the hydraulic head.

The latter is dismantled by removing connection (**48**), and turning it upside down.

Remove the rubber seal (**24**) from the hydraulic head, the pump liner (**25**) and vanes (**28**).

Fit to the end of the drive shaft the test machine drive coupling to block rotation when the pump rotor (**a**, Fig. IV/56) is slackened with a wrench and adaptor **A 127004**.

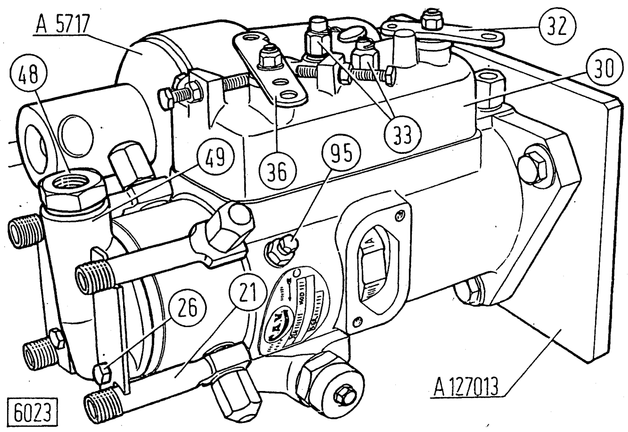


Fig. IV/52 - *Pump mounted on dismantling and assembly fixture A 5717 with plate A 127013.*
21. High pressure connection. - 26. End plate cap screw. - 30. Control cover. - 32. Shut-off lever. - 33. Cover nut. - 36. Throttle arm. - 48. Fuel inlet connection. - 49. End plate with transfer pressure regulating valve. - 95. Bleed screw.

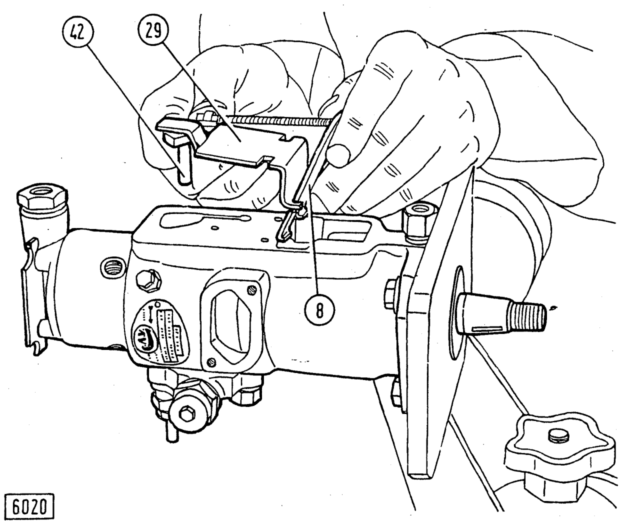


Fig. IV/54 - *Removing (installing) governor control assembly and metering valve (42).*
8. Governor control arm. - 29. Fulcrum.

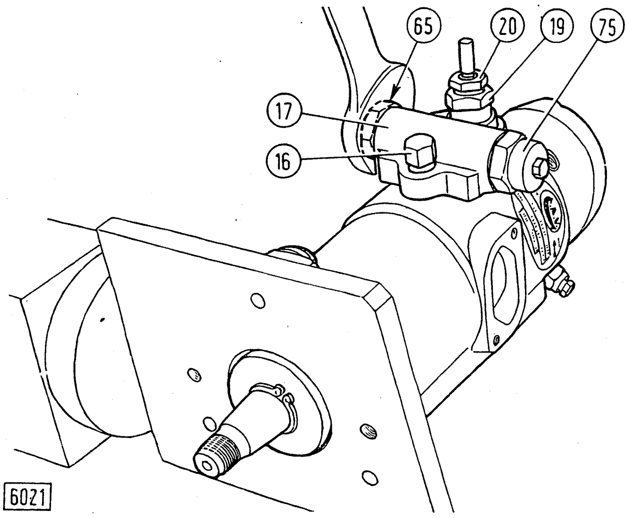


Fig. IV/55 - *Removing the plunger end plug (65) of the automatic advance device (17).*
16. Auto advance device stud. - 19. Hydraulic head locating fitting. - 20. Manual retard device. - 75. End plug and piston cap.

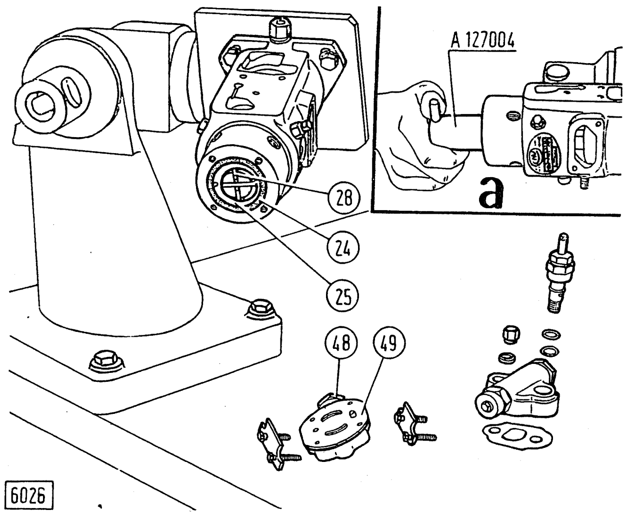


Fig. IV/56 - *View of the supply pump following the removal of the pressure regulating valve (49).*
24. Seal. - 25. Transfer pump liner. - 28. Transfer pump vane. - 48. Fuel inlet connection.
a. Loosening the rotor using the adaptor A 127004.

Notice that the thread is left-hand like the rotation of the pump and the arrow marked on the front surface with the word « OFF » indicates the direction of rotation for disassembly which is to be completed only after the removal of the hydraulic head.

4. Hydraulic head and distributing rotor (Fig. IV/42). Remove the vent screws (**95** and **97**, Fig. IV/41) which also serve to fix the head to the pump body then pull out the hydraulic head and rotor as an assembly.

Remove the rubber ring seal (**24**) from the hydraulic head. Block the rotor flange by means of tool **A 127007** and loosen the attaching screws (**64**) unscrew the pump rotor from the shaft and withdraw the rotor making sure the cam rollers (**12**, Fig. IV/58) do not fall out.

Unscrew the flange securing screws previously slackened, remove the two adjusting plates (**11** and **11a**), pull out rollers (**12**) and shoes (**14**) and put them in a protective oil bath.

To avoid exchanging places to the pumping plungers (**13**) plug them inside the rotor, lubricate the latter with protective oil and then fit it in the hydraulic head.

Unscrew with the adaptor **A 127028** the cam advance screw (**18**) after checking the cam ring for free rotation in its location out of which it is removed by hand.

5. Speed governor. Remove the inner snap ring (Fig. IV/59) and the key from the projecting end of shaft, if still installed. Remove snap ring and washer and finally the drive shaft and governor as an assembly by pushing it inside the pump. To remove the fly weights from their cage be sure to remove first the circlip (**89**, Fig. IV/60) thrust sleeve (**5**) and end washer.

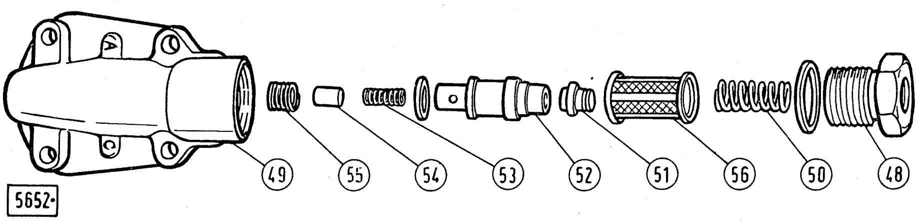


Fig. IV/57 - *Transfer pressure regulating valve parts located in end plate (49).*
48. Fuel inlet connection. - 49. End plate. - 50. Retaining spring. - 51. Sleeve plug. - 52. Valve sleeve. - 53. Regulating spring. - 54. Piston. - 55. Priming spring. - 56. Screen filter.

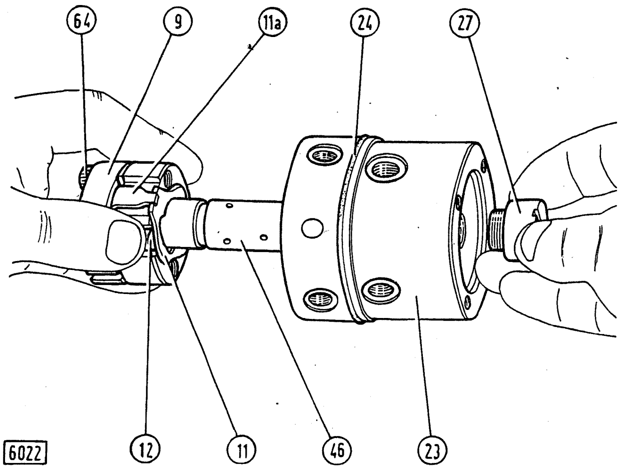


***Fig. IV/58** - Removing (installing) the transfer pump. rotor from hydraulic head.*

9. Drive plate. - 11 and 11a. Front and rear control plates. - 12. Cam ring roller. - 23. Hydraulic head. - 24. O-ring. - 27. Transfer pump (2) rotor. - 46. Rotor. - 64. Drive plate bolts.

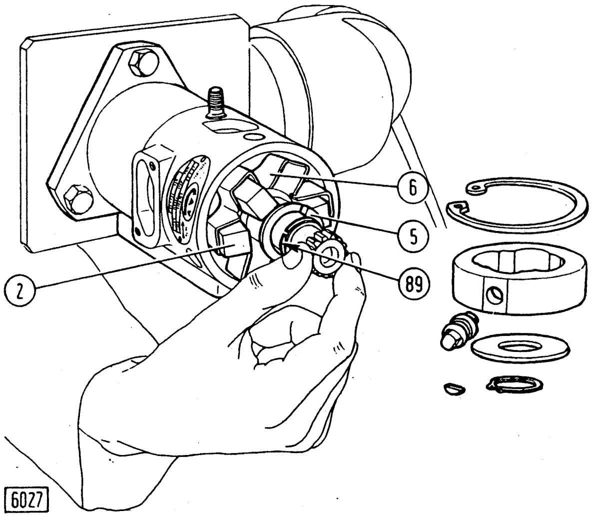


***Fig. IV/60** - Withdrawing (introducing) the governor drive shaft.*

2. Fly weights. - 5. Thrust sleeve. - 6. Weights retainer. - 89. Sleeve retaining ring.

6. Drive shaft oil seals (**3**, Fig. IV/61): remove them with a screwdriver backing it up against a suitable block put on the pump and used as fulcrum instead of the pump itself.

INSPECTIONS

Wash the parts in oil then check them for:

— damaged threads, particularly on studs, inlet and outlet connections, and on those screws which are repeteadly handled in the course of the pump service life;

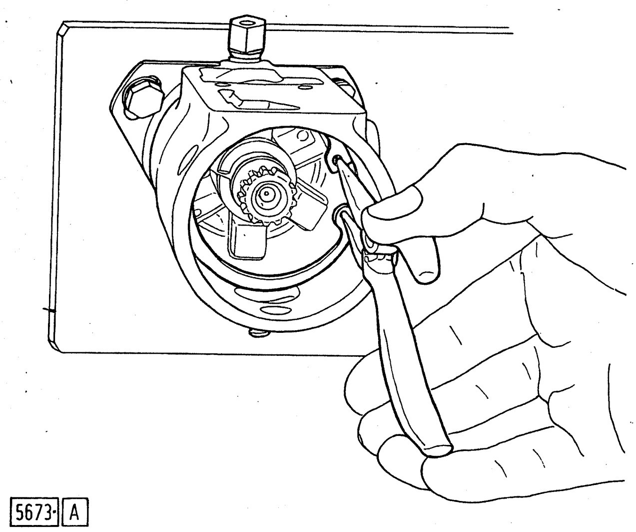


***Fig. IV/59** - Removing the cam ring retaining circlip.*

— broken or damaged springs;

— defective high pressure connection valves (**21**). Check valve for free movement by pushing on the cotter pin from the outside;

— damaged O-rings and other oil seals. At reassembly, renew all oil seals being careful not to damage them. After assembly, check their sealing efficiency to make sure of perfect fluid tightness.

A special inspection should be made of the following parts, following an accurate washing, to check for:

— scoring, wear or other damages of the metering valve and seat, play between metering valve upper pin and control lever. If the metering valve is to be replaced consider that an oversize

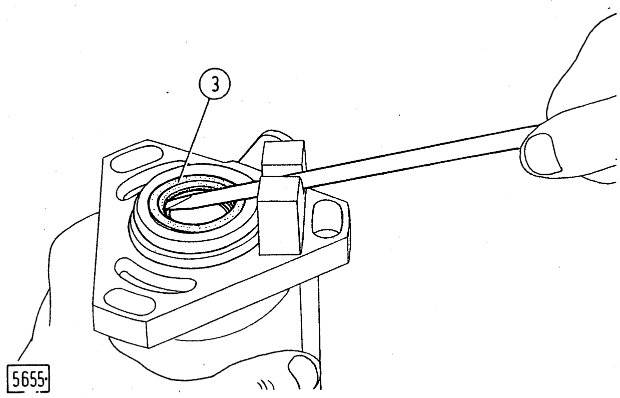


***Fig. IV/61** - Removing the drive shaft oil seals (3) with a screwdriver.*

spare (0.025 mm = 0.0010 in) also is available which is identified by a groove cut all around the circumference.
The oversize of the head is etched on its outer surface by the number 6.375. Wear of governor and control leverage pivots;

— dents, scoring or other signs of damage of the pumping plunger (**13**) surface finish. Do not exchange them in place; plungers are furnished already fitted to the hydraulic head and rotor unit;
— excessive wear, signs of corrosion, surface damage and failure of rotor, threads, hydraulic head, rollers (**12**, Fig. IV/66) and shoes (**14**). Make sure the surface finish of internal ducts in the rotor are perfectly smooth;
— chipped, broken or excessively worn pump vanes Make sure they are both made of synthetic resin, a feature which is identified by means of a rectangular cavity in the side of the vane in contact with the groove in the rotor, which distinguishes them from carbon blades which do not bear this identification and cannot be installed in this type of pump (Fig. IV/42);
— scoring, signs of-wear or other damages of the finished surfaces of hydraulic head, rotor location, automatic advance device location, mounting flange, and the cam ring;
— surface wear or failures of drive shaft (4, Fig. IV/50) splines and drive plate (**9**), and wear between thrust sleeve (**5**) and its shaft location. The governor drive shaft, the weight cage (**6**, Fig. IV/64)and the cush drive (**87**) make up a single assembly with the rubber inserts (**86**) and the drive plate (**9**, Fig. IV/50) so that if one part is faulty the whole assembly is replaced.
Fly weights, sleeve and thrust washer (**88**,fig. IV/64)are available separately;
— damaged or excessively worn surfaces of mating parts not mentioned above require the renewal of the same parts, whilst slight or isolated defects are thoroughly eliminated unless the area is a critical one. All seals of any kind are renewed at reassembly.

ASSEMBLY

It is best to dip the parts of the pump in oil of the same type as specified for the test to refit them properly lubricated and tighten to the torque specifications reported in Section VIII.

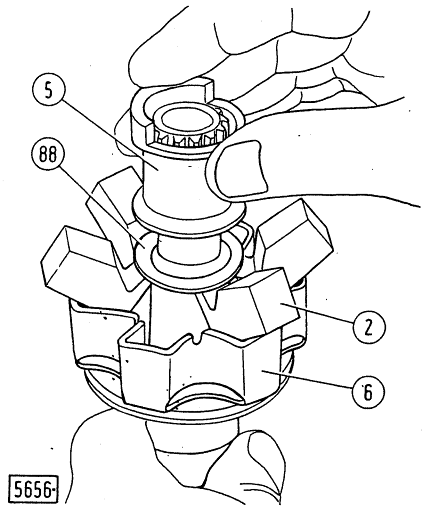


Fig. IV/62 *- Assembling the governor weights.*
2. Weight. - 5. Thrust sleeve. - 6. Weights retainer. - 88. Thrust washer.

Assemble components as follows:

1. Shaft oil seals in pump body. Install in the pump body the first seal with the lip on the inside and bed it properly, then fit the spacer circlip and the second seal arranged as the previous one (Fig. IV/64).

Install the pump body on the support A 5717 through the plate A 127013.

2. Speed governor. Hold the shaft upright (Fig. IV/62), arrange the four governor weights in diametrically opposed positions on the edge of their cage, introduce the thrust washer (**88**) and sleeve (**5**). When pressing on the thrust sleeve the weights will occupy their locations where they are held by the retaining ring.
Install the protection **A 127030** on the threaded end of the drive shaft (Fig. IV/63), lubricate it externally with FIAT G 9 (multi-purpose) grease

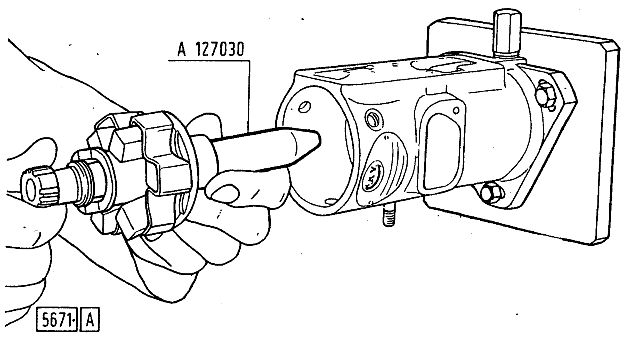


Fig. IV/63 *- Fitting the drive shaft with protection cap.*

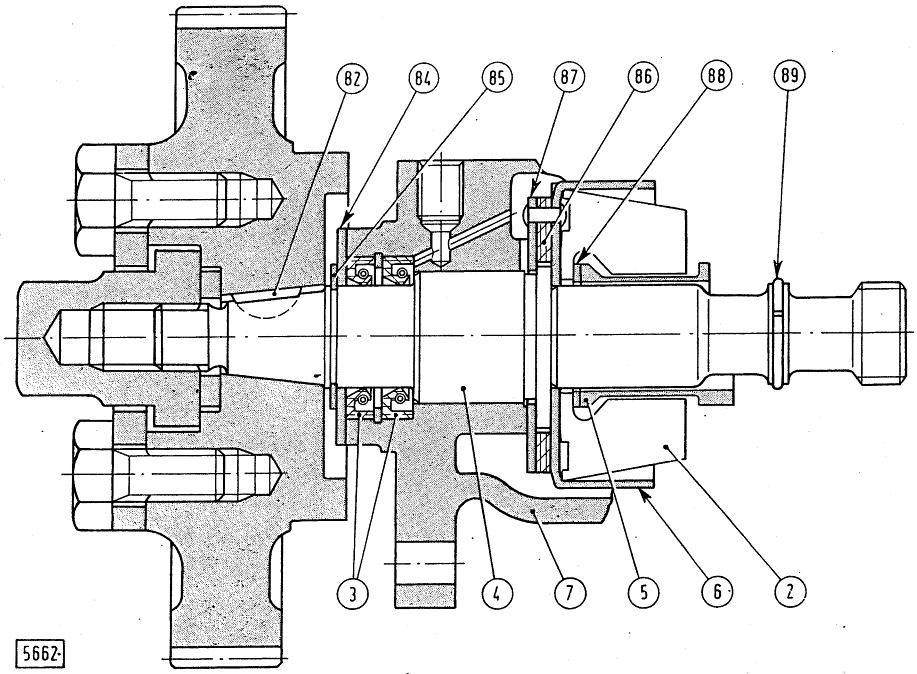


***Fig. IV/64** - Governor drive shaft and pump driving gear.*

2. Weights. - 3. Oil seals. - 4. Drive shaft. - 5. Thrust sleeve. - 6. Governor weights. - 7. Pump housing. - 82. Woodruff key. - 84. Thrust washer. - 85. Circlip. - 86. Cush drive rubber inserts. - 87. Cush drive damper plate. - 88. Thrust washer. - 89. Circlip.

and install the shaft with weights making sure not to damage the seals installed in the point 1.
Remove the protection from shaft end, hold it still and fit the thrust washer (**84**) to the outer surface of the pump securing it with the circlip (**85**).
Check with a feeler gauge (Fig. IV/65) the end float of the shaft measuring the clearance between thrust washer and pump body which should not exceed 0.05 ÷ 0.19 mm (0.002 ÷ 0.007 in); if it does, replace the thrust washer which is available in three different thicknesses: 2.05-2.18-2.31 mm (0.081-0.086-0.091 in).

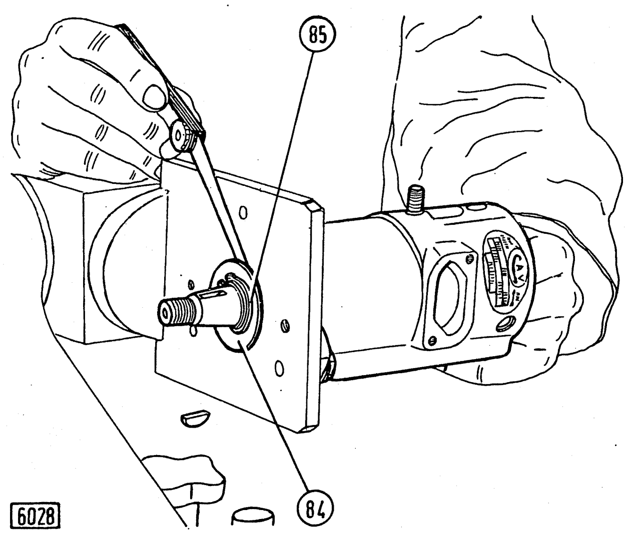


***Fig. IV/65** - Adjusting the end float using a feeler gauge.*
84. Thrust washer. - 85. Retaining circlip.

Turn the pump upside down with the governor uppermost, fit the circlip (15) in the pump with the pliers, arranging the two ends approximately at center of the side inspection cover and with the sharp corner end used as pump timing index, facing up.

3. Hydraulic head. Install on the shaft of the rotor (**46**, Fig. IV/66) the rear fuel adjusting plate (**11**) with the outside surface slots aligned with the rotor ones (not the cam roller locations).
Install the rotor in the hydraulic head and secure it by screwing up by hand the transfer pump rotor (Fig. IV/58).
Remove the plugs from the pumping plunger holes, fitted at disassembly, and introduce the cam shoes and rollers (**14** and **12**) locating them in the eccentric seats on the front fuel adjusting plate (**11**) against which the shoe projections stop.
Install the front fuel adjusting plate (**11a**) with the wings fitting in the two slots on the rear plate, apply the rotor drive plate (**9**) to the governor drive shaft and locate the two fuel adjusting plates with the assembly slot in register with the line mark (Fig. IV/67), then tighten the two screws of the drive plate by hand.
Check the distance between the two rollers (49.70 = 1.956 in) to allow some slight movement to the adjusting plates not requiring further pump disassembly; therefore, at this point, test under a pressure not exceeding 30 atm. (427 p.s.i.) and using FIAT CFB oil.

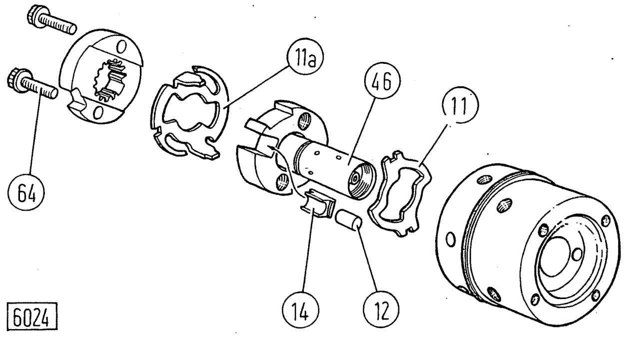


Fig. IV/66 - *Assembly arrangement of the maximum fuel adjustment device on distributor rotor (46).*
11 and 11a. Front and back adjusting plates. - 12. Roller. - 14. Roller shoe. - 64. Drive plate bolts.

Connect the adaptor **A 127021** (with pressure relief valve) to the end of the tube from the hand pump **A 12131** connecting one end to a high-pressure outlet of the hydraulic head (3-cylinder engines) and plugging up the opposite end (Fig. IV/68).

As the pressure of 30 atm. is reached, turn the rotor by hand until the pistons are fully apart and apply in corrispondence of the two rollers a micrometer opened to the aforementioned distance: if the distance does not correspond, correct it through adjusting plates (**11** and **11a**).

Tighten the locks screws (**64**) to the specified torque value and after blocking the rotation by means of the stop **A 127007.**

Disconnect the test connection from the hydraulic head and fit the rubber sealing ring.

Fit the cam ring (**10**) in the pump body and against the circlip; one of the two faces is marked with an arrow which at assembly is arranged like the arrow reported on the pump identification plate, and in any case counterclockwise looking from the outside end of the drive shaft. Install the cam advance screw and tighten it with adaptor **A 127028** and wrench to the specified torque value. Try then the shaft for free movement; if necessary, tap the advance screw with a plastic hammer.

Lubricate the part of hydraulic head contacting the pump body and install the head; notice that the installation is fool-proof, it being possible in only one position of the shaft spline with the drive plate and with the untapped metering valve hole uppermost.

Fix hydraulic head to body with the pressure damper and air vent screw slack, as they will be tightened following the installation of the automatic advance device.

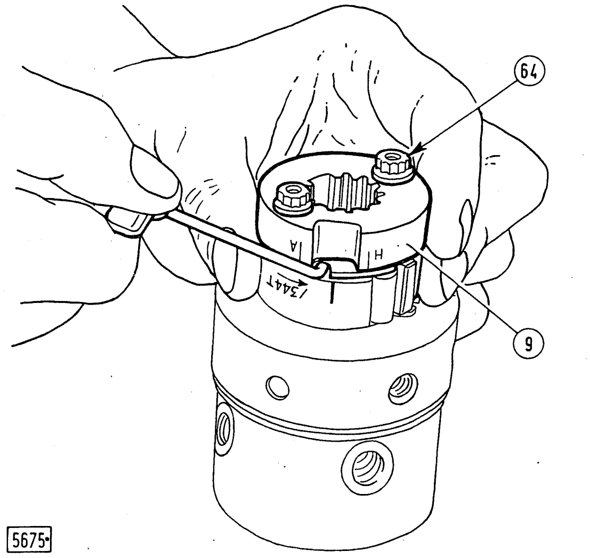


Fig. IV/67 - *Arrangement of the adjusting plates with respect to the rotor assembly mark.*
9. Splined drive plate. - 64. Drive plate bolts.

4. Automatic advance device. Turn the pump over on the supporting plate with the device location uppermost, then proceed as follows:

— fit new rubber rings to the threaded plugs using protection tool **A 127006;**

— install in the advance device body the plunger with the drilled side facing inwards, then check for free movement and screw up the pressure side plug (**65**, Fig. IV/69);

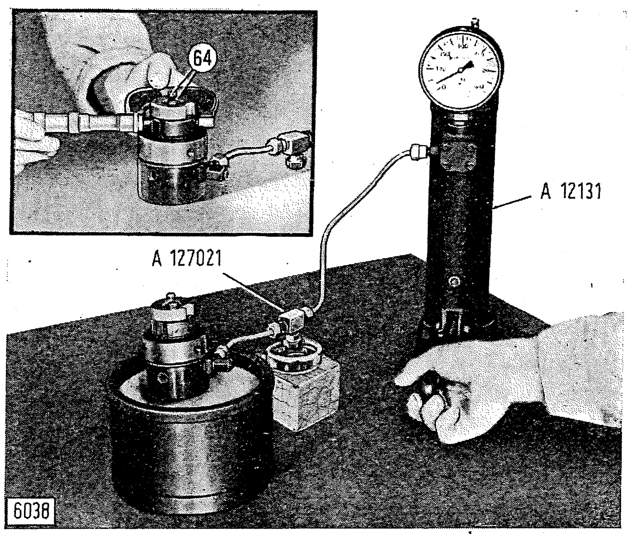


Fig. IV/68 - *Checking the maximum outward roller stroke under a pressure of 30 atm (427 p.s.i.).*
64. Drive plate bolts.

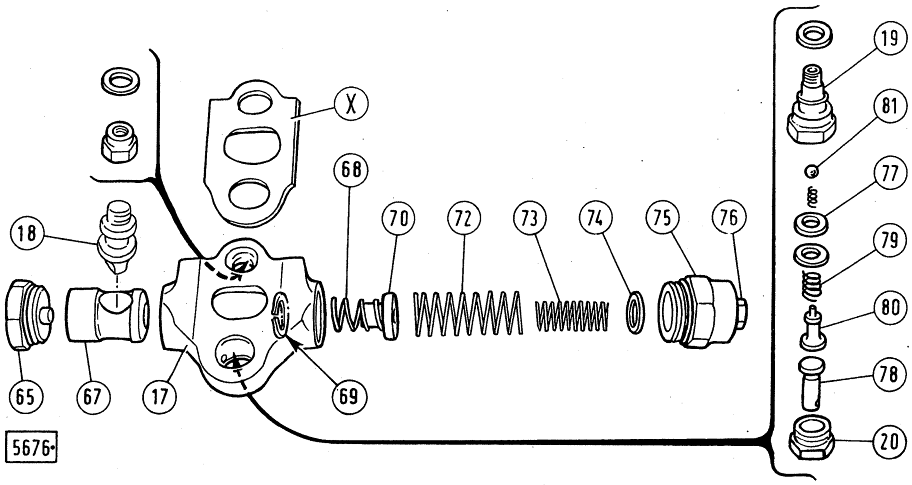


***Fig. IV/69** - Parts of the auto advance mechanism and manual retard device.*

X. Gasket. - 17. Body. - 18. Cam advance screw. - 19. Hydraulic head locating fitting. - 20. Nut. - 65. End plug. - 67. Piston. - 68. Spring. - 69. Circlip. - 70. Spring plate. - 72 and 73. Outer and inner springs. - 74. Shims (0,5 mm = 0.020 in). - 75. Piston cap. - 76. Piston cap screw. - 77. Seal. - 78. Pin. - 79. Return spring. - 80. Plunger. - 81. Non-return valve ball.

— re-install the manual retard device components (Fig. IV/69), fit the rubber sealing ring with protection **A 127005** and arrange the assembly inside the auto advance body hole;

— install the gasket on the pump body and then the advance device body, fitting the tip of the advance screw (**18**) of the cam ring (**10**) in the plunger.

Check the pump drive shaft for free rotation and torque tighten to specifications the auto advance and head screws.

We suggest unscrewing temporarily the end plug (**65**) to make sure the cam ring moves when the advance device plunger is actuated;

— introduce at the opposite end of the advance device the spring (**68**), circlip and plate (**70**).

Arrange, inside the end plug, the shim (**74**) and the two springs (**72** and **73**) and fix it, introduce then the screw (**76**) with washer and finally torque tighten the screw and the two end nuts.

5. Fuel transfer pump. Tighten the impeller on the rotor using the adaptor **A 127004**, applied to the torque wrench, hold the shaft with test bench coupling and torque tighten to specified value in the direction opposite to that shown by the arrow.

Install pump liner and vanes; then turn the shaft to make sure the latter do not drag the liner along when putting the finger on it.

Fit on the hydraulic head a new sealing ring for the pressure regulation valve.

6. Transfer pressure regulating valve. Arrange the pump body on the mounting support with governor location uppermost and assemble the regulating valve in its body separately refer to Fig. IV/57 and to the following outline:

— place the spring (**55**) at bottom of location;

— fit a new seal outside the regulating sleeve and the plunger inside. Arrange the valve with the larger diameter uppermost, introduce the spring (**53**), place on top of sleeve plug (**51**) the retaining spring (**50**), the filter and introduce the whole in the valve body, making sure the plunger is retained by spring (**55**);

— renew the seal before torque tightening the fuel inlet connection to specification;

— fix the regulating valve to the hydraulic head arranging the split dowel hole in the pump liner aligned with the dowel protruding from the valve inner face. Should doubts arise as to the position of the dowel, notice the letter « **A** » embossed at the outer surface of the assembly location (pump with counterclockwise rotation).

Cross-tighten the valve attaching screws gradually up to torque requirement.

7. Speed governor. Assemble it as follows:

— arrange bracket (**29**, Fig. IV/50) on the control arm (**8**) and block it with spring (**35**);

— fit the lower and upper O-rings to the accelerator and shut-off lever shaft using the protection **A 127002**, then fill the cavity between the two rings with FIAT G 9 (multi-purpose, NLGI No. 2) grease;

— install on the governor link (**34**) the larger spring stop first, then the spring and washer and insert it on arm (**8**) securing the threaded

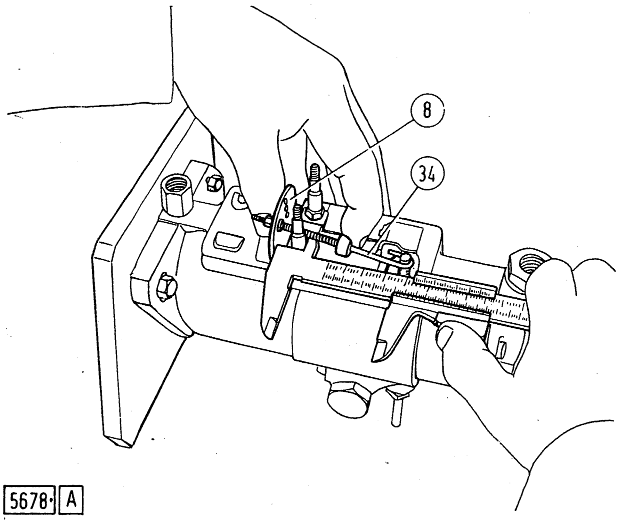


Fig. IV/70 - *Setting the mechanical governor control linkage.*
8. Control arm. - 34. Governor link.

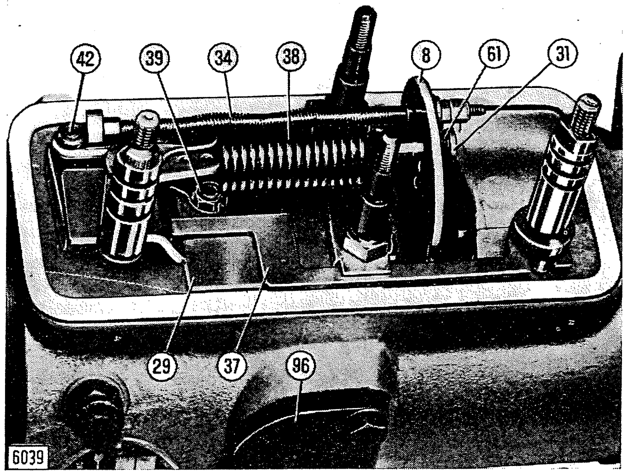


Fig. IV/71 - *Speed governor assembly without cover.*
8. Control arm. - 29. Fulcrum. - 31. Idling spring guide. - 34. Governor link with spring. - 37. Shut-off bar. - 38. Control spring. - 39. Fulcrum (29) screw. - 42. Metering valve. - 61. Idling spring. - 96. Inspection cover (timing marks).

end by the tapered washer, and nuts. Insert in the hooked end of the link the pin of metering valve (**42**) and arrange the shorter bent side towards the interior of the governor;

— arrange all governor controls and linkage in the pump body, then insert the control arm (**8**, Fig. IV/50) on the governor thrust sleeve (**5**) and the metering valve in its hydraulic head location;

— fix on control arm (**8**, Fig. IV/71) the stop plate to pump body using new safety plates to lock the governor cover studs, arranging them with the rectangular torque facing the shut-off bar (**37**).
Fit the arm attaching screw (**39**) with safety plate together with the studs, then torque tighten them to specification;

— set the internal distance between one of the governor cover studs and metering valve pin at 53 ÷ 54 mm = 2.09 ÷ 2.13 in (Fig. IV/70), by screwing up or unscrewing the governor link (**34**) nut to allow a slight pressure on the governor control arm (**8**) for holding the metering valve fully opened. This distance is measured in parallel with the pump axis;

— fit a new governor cover gasket and the shut-off bar (**37**);

— attach the governor control spring (**38**, Fig. IV/71) to the hole no. 3 of the control linkage and to the guide (**31**) fitted with the idling spring (**61**) in the hole no. 1 of the governor drive plate;

— fit the shut-off lever shaft in governor cover using the protection tool no. **A 127001** to prevent O-ring damage, remove the protection and refit it to the throttle shaft and, at the same time, fit cover over the studs. Check that the shut-off bar (**37**) is properly connected with the shaft, then remove the protection **A 127001**;

— install the stud plain washers and tighten the nuts at the specified torque value, install the dust shields to the shaft and fit the levers, safety washers and nuts, then torque tighten them to the specification given in Section VIII.

8. *Miscellaneous parts.* Re-fit the inspection cover (**96**) renewing the gasket and secure it by its capscrews torque tightened to specifications; tighten connections to the specified torque values after arranging them in their original positions and renew copper gasket.

PUMP TESTS

General.

To obtain reliable test data make sure to meet the following general requirements:

— use for test purpose oil type FIAT CFB;

— the data appearing in the table of deliveries (see page 72) have been obtained at an oil temperature of 30° ÷ 35° C (86° ÷ 95° F) and with a test machine pressure of 0.2 kg/cm² (2.8 p.s.i.);

— the tests can be carried on under two different conditions of injector pressure setting and, precisely, test **A** (175 kg/cm²) and test **B** (with engine injectors calibrated for 225 ÷ 235 kg/cm² pressure), both requiring different pressure pipes.

— counterclockwise pump rotation, looking from drive shaft end;

— do not run the pump at high speed and low delivery condition, nor actuate the shut-off lever for long time intervals.

— prime the pump before starting the tests and bleed if following installation or removal of any pressure fitting connected to test equipment or gauges.

Test specifications.

The correct test sequence is that appearing with progressive numbers in the « Master Test Schedule » and cannot be altered.

The following equipment must be available to make pump connection on the test machine (Fig. IV/72):

— a set of pressure pipes **A 127045** (for test **A**) to connect pump pressure outlets to the nozzles;

— nozzle holders **EFEP 182**;

— pump mounting support **A 127041** bis and flexible drive coupling **A 127022**;

— test machine speed reduction **A 127100** (1/2, 2/1 ratios), if it does not reach 100 r.p.m., in which case use the support **A 127041** instead of **A 127041 bis**;

— adaptors with threaded ends (metric and in mm), connecting pump to the measuring instruments and gauge **A 127040**, with copper washers, **A 127010** and **A 127011** for inlet and outlet caps and **A 127009** for hydraulic head vent screw;

— gauge **A 127040** with pressure lines ;

— auto advance angular test gauge **A 127003** (see tests 3 to 6) to be set at zero setting by the screw in the back of the quadrant before starting the test.

Equipment application, when necessary, is reported further on in the introduction to the tests.

Pump priming.

After installing the pump on the test machine and after arranging all the instruments which are required for the test, prime and bleed the pump as follows:

— slacken the two-bleed screws located on the governor and on the pump body;

— connect the fuel supply line to the pump outlet, if the latter is without ball valve; if not, remove the valve before turning on the fuel tap to fill the pump;
disconnect the test machine fuel supply line and connect it to the inlet of the pump, also, connect the pump leak-off connection to the test machine line;

— loosen injector pressure pipe fittings;

— run the pump at 100 r.p.m. Tighten the bleed screws and the injector pressure fittings as soon as the fuel flows out without air bubbles;

— as the pump is primed, check for fuel leaks from mating surfaces, pressure fittings and seals with pump both stopped and running.

Checking the vacuum at suction and the internal pressure of the fuel transfer pump.

The vacuum test consists in checking, by means of a pressure gauge applied to the oil inlet connection (**A 127010**), that a vacuum of 406 mm. Hg is reached within a time interval of 60 seconds and at a pump speed of 100 r.p.m.
For this test, the lever located on instrument **A 127040** is turned towards the vacuum gauge.

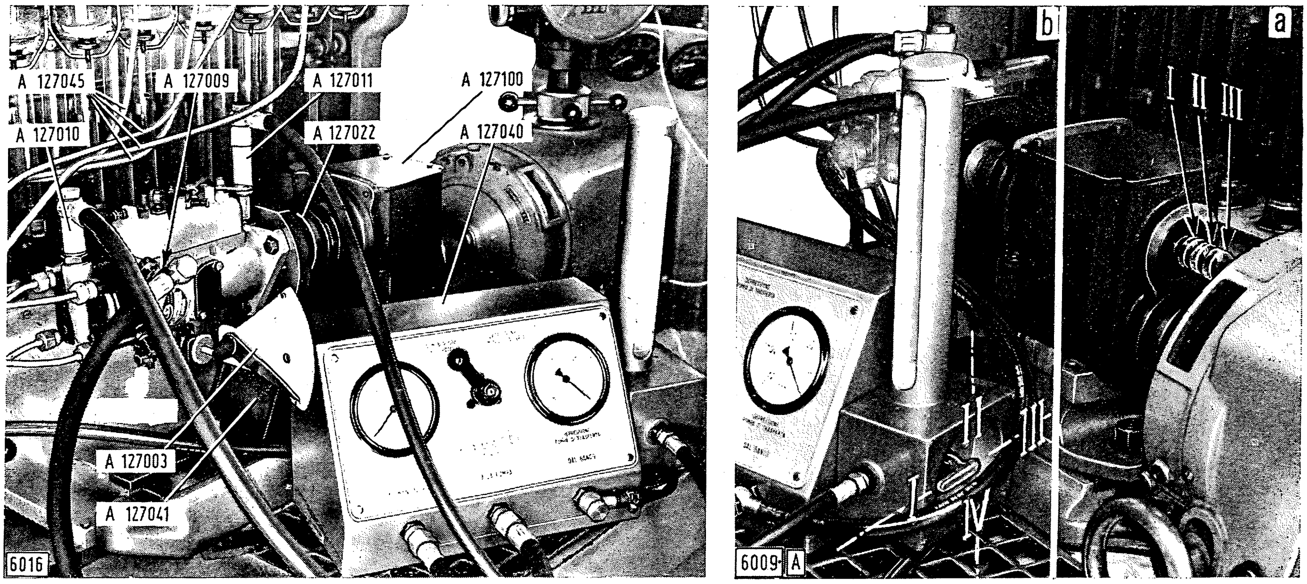


***Fig. IV/72** - Injection pump installed on test stand for calibration.*

a) Position of the speed variator control (ratio: 1 : 2, 2 : 1).
I - Reducer engaged.
II - Reducer in neutral (pump stopped).
III - Multiplier engaged.
b) Positions of fuel drain control lever:
I - Connection to draining.
II - Test glass filling (drain closed).
III - Connection to drain for emptying the test glass.
IV - Connection of test glass to drain (position to be avoided with oil in circulation).

Priming may need to be repeated following the vacuum test.

To check the internal pressure of the fuel transfer pump at the specified speeds (oper. 2-7-10) replace the screw attaching the hydraulic head to the pump body (**95**) by the adaptor **A 12709** for the pipe connecting to the test machine pressure gauge **A 127040.**

In this case, the lever should be turned to the left.

Pressure equivalents for different speeds are given in the « Master Test Schedule » on page **71** .

Through these two tests it is possible to ascertain the functional efficiency, wear and sealing tightness of the vane-type fuel transfer pump and of the pressure regulating valve.

It is possible to adjust the pre-load of the valve spring (**53**) by replacing the plug (**51**, Fig. IV/57) available in four extra sizes besides the basic one (1.1 mm = 0.043"), each identified by means of a letter having the following projections on spring end:

A = 1.3 mm (0.050 in); B = 1.5 mm (0.060 in);

C = 1.7 mm (0.067 in); D = 1.9 mm (0.075 in).

Checking the automatic advance timing.

The test consists in checking the functional efficiency of the device (Fig. IV/72) at the various speeds by reading the corresponding values on the graduated scale of the gauge **A 127003**, which is controlled by the advance control plunger (oper. 3-4-5).

The installation of the test gauge **A 127003** needs some explanations; proceed as follows:

— remove the screw (**76**, Fig. IV/69) from the plug (**75**) on the spring side of the automatic timing device and fit the pick-up end, integral with the threaded sleeve, in the hole inside the graduated scale support;

— introduce the pick-up end in the hole inside the disassembled screw up to the cup bore (**70**),

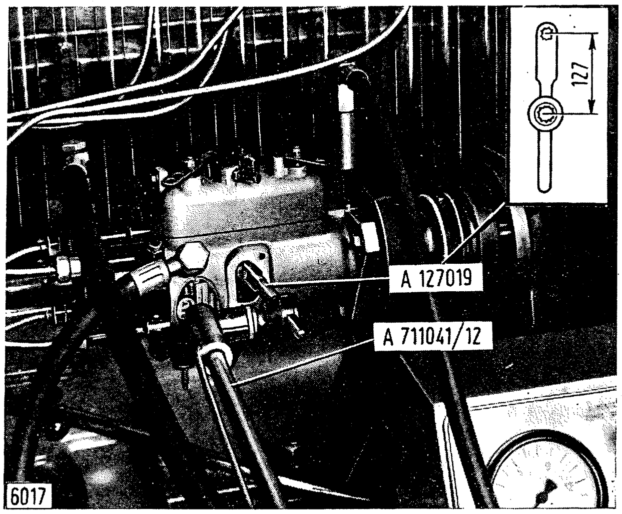


Fig. IV/73 - Torque tightening the splined drive plate bolts.
(Note - Hold the tools A 127019 and A 711041/12 in line to avoid damaging the inspection compartment edges).

then screw the sleeve up the threaded hole inside the plug (**75**). The scale of the tool is thus fixed between plug and threaded sleeve;

— with the pump stopped, zero the dial scale and set the indicator contact in line with the pick-up shaft by adjusting the screw located at the back of the quadrant.

To carry on these tests, make the pump run at the speeds specified in the « Master Test Schedule » (oper. 3-4-5) and make sure the instrument readings are within specified limits; if not, remove the plug (**75**) and vary the shims (**74**) or replace the springs (**72** and **73**). The shim, 0.5 mm (0.020″) thick, installed at the factory, must not be removed and the overall thickness cannot exceed 3 mm (0.118″). Should precise reading be difficult because of the pointer oscillation, stabilize it by putting a finger on it.

Calibration check.

Deliveries are checked at various pump speeds with the throttle lever in maximum fuel position (except for idling speed delivery) and with the shut-off lever not in stop position, as specified in the « Master Test Schedule » (oper. 9-11-12-14) where deliveries are given in c.c. per 1000 strokes.

A spread of 4 c.c. is anticipated among the injectors at the maximum power and torque speeds. The power speed delivery (oper. 9) is checked with the max. fuel stop (**41**) completely unscrewed and throttle in full-load position, and if it exceeds the limits, then:

— first slacken the pump inspection cover screws to let the pump drain, then remove screws and cover;

— slacken the two drive plate bolts (**64**) and, using the special wrench **A 127019**, turn the adjusting plate by tapping it on end so as to achieve the desired value, considering that to each 0.5 mm movement corresponds 1 c.c. of fuel delivery;

— cross-tighten the screws (**64**) gradually to the specified torque value, using the tool **A 127019** and torque wrench **A 711041/12** (Fig. IV/73);

Note - *In the end of tool* **A 127019** *is fitted the screw* (**64**) *and in the central hub, which is adjusted to the type of pump by slackening the recessed hexagon (in this case 127 mm = 5 in off the screw hole center line), is fitted the torque wrench. Tool and torque wrench are reciprocally arranged so as to be kept in line without touching the edges of the inspection compartment.*

— refit the inspection cover, refill the pump body with oil and check the maximum fuel system. Repeat the tests until deliveries are within specification limits.

Stop control check.

Run the pump (oper. 13) with throttle lever in maximum setting and shut off lever in position of stop. Permissible max. delivery is 4 c.c. of fuel, corresponding to normal at nozzle spill.
Run the pump with shut-off lever in stop position for short intervals of time only.

Governor check and maximum fuel stop setting.

Following the performance test at maximum power speed (oper. 9) with the maximum fuel stop completely screwed back, the speed is lowered to check intermediate fuel deliveries at various speeds (oper. 11-12 and 14).

Bring the speed up to (governed speed range) (oper. 15) and calibrate delivery by the stop screw.

Re-check (oper. 16) to make sure pump performance is unaffected, then lock tighthen the stop screw with the jam nut. The stop screw setting can be altered once more when timing the pump to the engine or to the test bench before final sealing.

The low idling speed stop setting must be adjusted on the tractor with engine installed.

Pump timing check (internal).

All tests completed, remove the pump from the test machine and drain the fuel by removing the inspection cover.

Connect the outlet pressure fitting marked **X** to the injector testing pump equipped with a pressure relief valve calibrated to 30 atm (427 p.s.i.) and (Fig. IV/74) incorporated in the adaptor **A 127021**.

Prime the hand pump and turn the injection pump shaft anti-clockwise until resistance is felt when rollers come in contact with cams.

At this point, the sharp edge of the circlip is made to register with the latter **A** (for this engine model) stamped on the drive plate (Fig. IV/74).

Scribe the assembly mark on the outer flange of the pump body fitting the tool **A 127027** (Fig. IV/75) to the shaft with key and setting the plate at 253°.

This mark must be in register with the assembly mark on the timing gear case when installing the pump on the engine.

CALIBRATION DATA FOR FUEL INJECTION SYSTEM C.A.V.

General test conditions.

Test oil: type FIAT CFB

Oil temperature: 30 ÷ 35° C (86° ÷ 95° F).

Test machine supply pressure: 0.2 kg/cm² (2.8 p.s.i.).

Specific test conditions.

Arrange the test rig for the tests **A** and **B** as follows:

Test **A** - Bosch test rig equipped with injectors with pressure spring **WSF 2044/4X** and nozzles **EFEP 182.**

- Rabotti test rig type Atmo **700F** equipped with standard rig graduated ring, pressure spring FIAT **656829** and nozzles **EFEP 182.**

Injector pressure setting: 175 kg/cm² (2485 p.s.i.).

Pressure pipes: 2 × 6 × 865 mm.

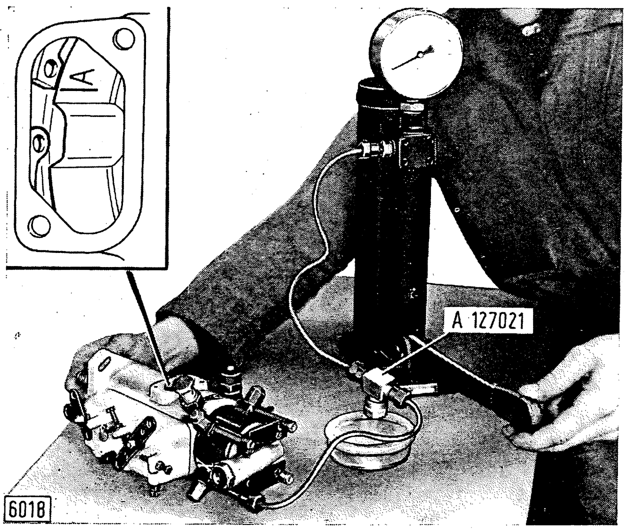


***Fig. IV/74** - Internal phasing of pump under 30 atm. (427 p.s.i.) from pressure fitting X.*

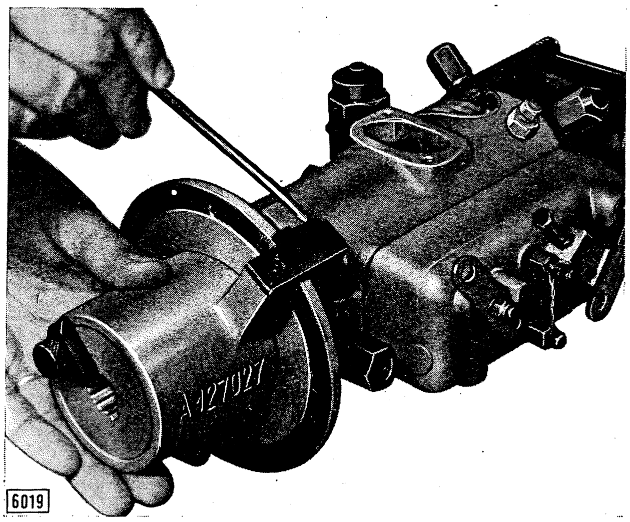


***Fig. IV/75** - Scribing the outside timing mark.*

Test **B** - Test rig equipped with nozzle holders type **KB 70 S1 F10** and nozzles type **DLL 140S 64F.**

Injector pressure setting: 225 ÷ 235 kg/cm² (3200 ÷ 3342 p.s.i.).

Pressure pipes: 1.5 × 6 × 700 mm.

Pump rotation looking from drive end: counterclockwise.

Assembly data.

Distance measured between governor cover stud and metering valve pin (Fig. IV/70): 53.00 ÷ 54.00 mm (2.087 ÷ 2.126 in).

Control spring (**38,** Fig. IV/76) mounting holes: hole no. 1 in control arm and hole no. 3 in throttle arm.

Distance between cam ring rollers (Fig. IV/68): 49.70 mm = 1.956 in.

Diameter of pumping plungers: 9.0 mm (0.354 in).

Timing arrangement of pump on the engine: mark **A** of drive plate in register with the flat end of the ring (Fig. IV/74);

outlet port of distributing rotor in register with the outlet pressure fitting marked with the letter **X**;

beginning of delivery to cylinder no. 1 in compression: 17° ÷ 19° before T.D.C.

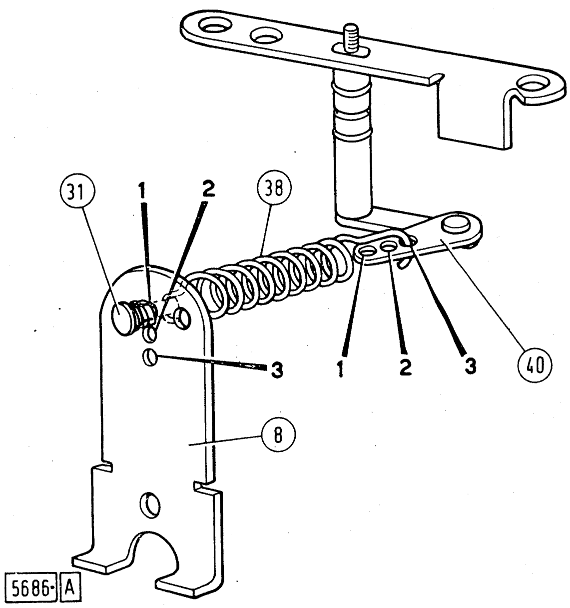


Fig. IV/76 - *Attaching holes of control spring (38) in throttle arm (40) and control arm (8) through the spring guide (31).*

Order of operations.

See the directions covering specialized tool use given in the topic dealing with the testing procedure. Starting from a primed and bled pump, go an as follows.

Note - *Fit a connecting clamp to prevent pressure pipes to injectors from bursting.*

MASTER TEST SCHEDULE FOR FUEL INJECTION SYSTEM C.A.V. 3249 F650

Order No.	TEST	Pump r. p. m.	REQUIREMENTS AND REMARKS
1	Vacuum at transfer pump suction . . .	100	406 mm of mercury within 60 seconds or less.
2	Transfer pump internal pressure (²) .	100	0.8 ÷ 1.4 kg/cm² (11.4 ÷ 20 p.s.i.)
3	Auto advance at max. torque speed (³)	800	5.5÷6.5 degrees of advance; if necessary, vary shims (74, fig. IV/69), never reduce them less than 0.5 mm (0.020") and more than 3 mm (0.118") in thickness.
4	Auto advance at max. power speed .	1200	7÷7.5 deg. of advance.
5	Auto advance at starting	180	1.5÷2 deg. of advance.
6	Disengagement of the auto advance at cold starts	300	0 deg. advance. Actuate the manual retard device.
7	Max. fuel transfer pressure (²)	1180 ÷ 1200	4 ÷ 5 kg/cm² (57 ÷ 64 p.s.i.) with throttle lever max. setting and stop control excluded.
8	Backleakage fuel (× 100 strokes)	1180 ÷ 1200	⩾14 c.c. or more. Control lever setting of test 7.
9	Maximum power speed delivery per injector (× 1000 strokes)	1180 ÷ 1200	Test A: 47.5 ÷ 50 c.c. Test B: 52.5 ÷ 55 c.c. Max. spread between any two deliveries (Tests A and B) not to exceed 4 c.c. Throttle lever stop (41) completely unscrewed.
10-11	Maximum delivery per injector (× 1000 strokes)	795 ÷ 805	Test A: 51 ÷ 54 c.c. Test B: 51.5 ÷ 54.5 c.c. Max. spread between any two deliveries (Tests A and B) not to exceed 4 c.c. Throttle lever max. setting. Fuel transfer pressure: 3.2 ÷ 4 kg/cm² (45.5 ÷ 56.9 p.s.i.)
12	Delivery per injector (× 1000 strokes) at low speed	100	Max throttle lever setting, actuate the manual retard device. Test A: 40 cc. or more.
13	Stop control check (delivery per injector at 1000 strokes)	200	Test A: 4 c.c. or less. Shut-off lever on and speed control lever in max. setting.
14	Delivery per injector at low idling speed (× 1000 strokes)	200	Test A: 5 c.c. or less. Throttle lever all closed with screw backed out.
15	Governed fuel delivery and max. fuel stop setting (per injector and 1000 strokes) . .	1270	Test A: 9 c.c. or less. Max. throttle lever
16	Final injector delivery check (× 1000 strokes)	1180 ÷ 1200	Test A: 47.5 ÷ 50 c.c. Max. speed control lever setting.

(²) Fit adaptor A 127009 in place of the screw securing the hydraulic head to the pump body for connecting to the test pressure gauge line.
(³) Read on dial of test gauge A 127031 fitted on the auto advance device plug in place of the small screw (Fig. IV/72).

Continued: « *Master test schedule* ».

Order No.	TEST	Pump r. p. m.	REQUIREMENTS AND REMARKS
17	Pump timing	—	Prime with hand pump (at 30 atm = 427 p.s.i.) through outlet connection, arrange circlip with flat end in register with letter mark A on distributing rotor drive plate. Scribe outside mark on flange mounting to engine crankcase using the tool A 127027 at 253°.

TROUBLE-SHOOTING CHART

The chart reports the major troubles and their causes which may occur when testing a fuel injection pump.

TROUBLE	CAUSE	REMEDY
A. Vacuum does not reach rig figure at 100 r.p.m.	1. Poorly made connections between pump and gauge, missing or defective seals.	Re-do the connections to the vacuum gauge, renew or fit copper washers and tighten connections.
	2. Defective seals on pump inlet connection.	Replace them.
	3. Air inside fuel supply circuit.	Bleed it (refer to page 67 priming).
	4. Broken or defective transfer pump valve spring (53, Fig. IV/57).	Inspect the pressure regulating valve.
	5. The end plate housing the pressure regulation valve is misplaced with respect to the hydraulic head.	Remove it, then cross-tighten the screws gradually to torque specification value.
	6. Damaged transfer pump seal (24)	Replace it.
	7. Broken or worn vanes (28).	Replace them installing new ones of the right type (see 28, Fig. IV/42).
	8. Transfer pump liner (25) is turned the other way around.	Remove the pressure regulating valve and see that the pin is fitted in the hole marked at the back with the letter A indicating counterclockwise rotation of pump.

Continued: « Trouble-Shooting Chart ».

TROUBLE	CAUSE	REMEDY
B. Low transfer pressure at 100 r.p.m.	1. Hydraulic head locating screw sealing washers are missing or defective, including the ones for auto advance and pressure equalizer locating screws.	Check them, and renew if necessary.
	2. Damaged pump impeller (27).	Check it.
	3. Metering valve (42), pressure valve plunger (54) or auto advance plunger (67) are worn or damaged. See trouble A - causes 4-5-7-8 also.	Inspect the quoted parts.
C. Pressure higher than quoted value at the high speeds.	1. The pressure relief valve plunger (54,Fig. IV/57) tends to bind in its location (52).	Remove the parts, then wash and inspeet them.
	2. Pressure regulating valve spring (53,Fig. IV/57) is too stiff.	Check it versus a new spring.
	3. High rig pressure.	Check the rig pressure gauge.
	4. Sealing plug (51) of pressure valve is too high.	Renew it. Consider that plugs are available in several dimensions, identified by a number of grooves, from one to four; the basic size only has no groove.
	5. Unsuitable valve sleeve (52).	Check it.
D. Pressure is too low and fluctuating.	1. Damaged sleeve (52) seal.	Renev it.
	2. Sealing plug (51) of pressure valve is too low.	See trouble C-4.
	3. Unsuitable pressure regulation spring (53) (too flexible).	Check it versus a new spring.
E. Scarce injection advance.	1. Shim (74, Fig, IV/45) under the springs is too thisk.	Max. permissible 3 mm (0.118″), minimum 0.5 mm (0.020″).
	2. Auto advance plunger tends to seize or seat is worn out.	Wash and inspect it.
	3. Cam ring is blocked inside pump body. See trouble C.2 also.	Remove the complete auto advance timing device and turn it by hand until free movement is re-established.
F. Excessive advance timing.	1. Insufficient thickness of shim (74, Fig. IV/69). See trouble D.3 also.	See remedy for trouble E-1 also.
G. Wrong maximum fuel setting (throttle screw backed all out).	1. Max. delivery figure different from specifications.	Adjust it to the data quoted on page 72.
	2. Metering valve is stuck.	Replace it and check seat on hydraulic head and linkage.
	3. Stuck pumping plungers (13) or roller shoes (14, Fig. IV/49).	Check damaged parts and replace them with rotor and hydraulic head as an assembly.
	4. Damaged pressure outlet connection washers.	Renew them.
	5. Wrong governor link measure (Fig. IV/70).	See governor assembly instructions.
	6. Wrong control valve assembly.	Ditto.

Continued: « *Trouble-Shooting Chart* ».

TROUBLE	CAUSE	REMEDY
	7. Cam ring position reversed with respect to pump rotation.	Ring arrow to have same direction of rotation indicated by the pump plate arrow.
H. Insufficient fuel delivery at 100 r.p.m.	1. Washer of distributing rotor shaft screw is damaged or screw is loose.	Replace washer and tighten screw with wrench A 4000 3/32″.
	2. Distributing rotor plungers are worn.	Replace hydraulic head and distributing rotor as an assembly.
	3. Hydraulic head outlet ports are damaged.	Ditto.
	4. Distributing rotor and hydraulic head wear.	Ditto.
	5. Basic size metering valve fitted to oversized head.	Replace it and check the metering valve stem for groove indicating oversize.
	See also troubles G.3-4.	
I. Damaged shut-off control.	1. Worn shut-off bar (37, Fig. IV/71).	Check it versus a new bar and replace if necessary.
	2. Stuck shut-off bar (37). See troubles G.2 and H-4-5.	Check to assembly (Fig. IV/71).
L. Difficulties encontered in adjusting the max. speed screw.	1. Broken or damaged control spring (38) because unsuitable or due to wrong assemblage.	Inspect it.
	2. Wrong adjustment of governor link (Fig. IV/70).	Check it.
	3. 3. Difficult sliding of governor thrust sleeve (5).	Inspect it.
M. Scarce test delivery at 1200 r.p.m.	See troubles L.1-2 and, if necessary, screw up the governor link (34) nut.	

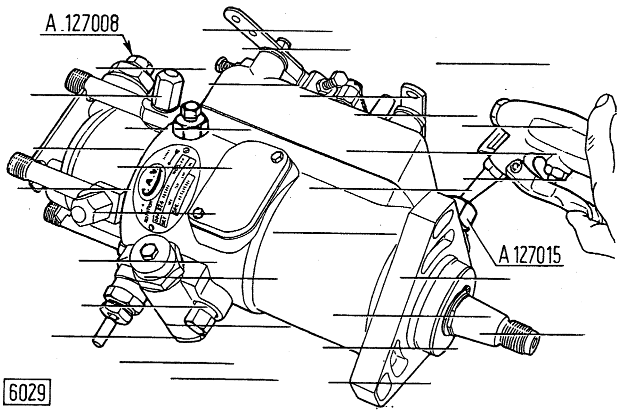


Fig. IV/77 - *Sealing tightness check of pump immersed in fuel oil with compressed air at 1.5 atm. (21.3 p.s.i.) pressure.*

Final operations for pump approval.

Following testing and timing, the pump is immersed into clean fuel oil for the tightness check; the fuel inlet connection is plugged up with the adaptor **A 127008** and pump is fed from the outlet connection. If the latter has no check valve, do not remove the connection, apply the gun **A 127015** and blow in compressed air at 1.5 atm (21.3 p.s.i.) (Fig. IV/77). Eliminate leaks, if any, where air seeps out, then seal the maximum setting and the inspection lid. If necessary, refer to the pump laying-up and storage recommendations.

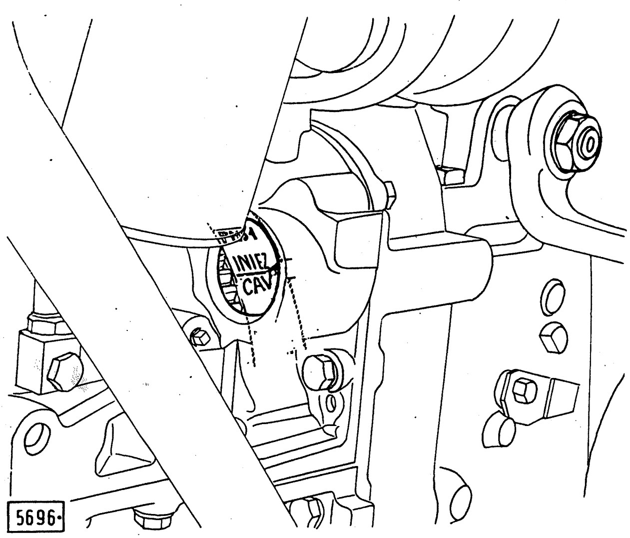


Fig. IV/78 - *Timing indew (INIEZ) for correct pump-engine phasing.*

Laying up.

The test oil contains oxidation and wear inhibiting additives adapt to good pump conservation for a limited period, therefore, we recommend not to drain it completely through the inspection cover.

When the pump is to be stored for long intervals of time be sure to fill the pump with oil type FIAT CFB, plug up the open ports, protect the outside parts and surfaces with grease and put it inside a nylon envelope.

During the seasonal periods of inactivity protect the pump and the whole injection system as follows:

— close the cock and disconnect from the tank the end of the pipe to the supply pump connecting it instead to a tank containing oil type FIAT CFB;

— make the engine run for about 15 minutes at 500 ÷ 800 r.p.m. and stop it as soon as smoke with oil comes out of the exhaust pipe;

— disconnect the tube from the protective oil tank and re-connect it to the fuel tank.

PUMP INSTALLATION AND TIMING

C.A.V. pump is installed on the engine following the assemblage of the timing gears with their mark in register as indicated and illustrated in the topic « Timing gear assembly » on page 31 of this manual.

To re-install the pump:

— fit the pump shaft with key and safety washer in its drive gear location and start the studs in the elongated holes of the drive plate;

— screw up the nut on the drive shaft, turn the pump to make the crankcase and drive plate marks register, install plain and taper washer and, finally, tighten all nuts up to torque specifications;

— fit the inspection cover with gasket to the engine timing gear case cover and the attaching capscrews and their washers;

— install and connect the fuel lines and bleed the pump (see instructions on page 48);

Shoud the assembly marks which are scribed on the timing gear case be deleted or unreliable, remake them as follows:

— set the piston of cylinder 1 at T.D.C. (end of compression) and check that the timing index is in register with the assembly mark (Fig. IV/78);

— turn the engine flywheel back to find the mark « Iniez. » with the indication of the type of pump C.A.V., remove the inspection cover of the pump and turn the drive shaft onto the phase of starting of injection to cylinder 1; bring the sharp edge at circlip end with the letter **A** scribed on the splined drive plate (C.A.V. pumps), see Fig. IV/74;

— fit the pump drive shaft with key and washer in the gear location, being careful to hold the gear still, then tighten the central nut on the pump shaft to the quoted torque figure. To facilitate the installation of the shaft, this nut can also be removed by removing the attaching screws (Fig. IV/19);

- bring the circlip sharp edge with the letter **A** (Fig. IV/74) which is marked on the shaft drive plate (C.A.V.), by suitably moving the pump along its mounting slots. Scribe the assembly mark on the crankcase, fit the pump inspection cover and tighten the nuts securing the pump to the timing gear case.

SPEED CHECKS AFTER PUMP INSTALLATION ON THE ENGINE.

With engine running idle and speed control lever at minimum setting check that the low idling speed quoted in the test tables is maintained: if not so, adjust the position of the stop screw. The speed is checked with either the tachometer or the tractormeter installed in the instrument panel.

A similar check is required for the high idling speed of the engine — particulary for new replacement units — by making the pump run idle and holding the speed control lever in the maximum speed setting.
If the quoted high idling speed cannot be maintained, adjust the position of the maximum speed adjusting screw and seal it.
Refit the other components as indicated in the pump installation topic.

INJECTORS

Injectors consist of a nozzle with three holes and with a spray pattern of 140° (Fig. IV/79).

Before removing the injectors out of their bores, clean the projecting length and adjacent surfaces on cylinder head thoroughly to avoid ingress of dust or dirt into the engine cylinders, then proceed as follows:

— unscrew the pressure pipe connections;

— unscrew the nuts securing the injector bracket to the cylinder head;

— pull injectors out of their bores.

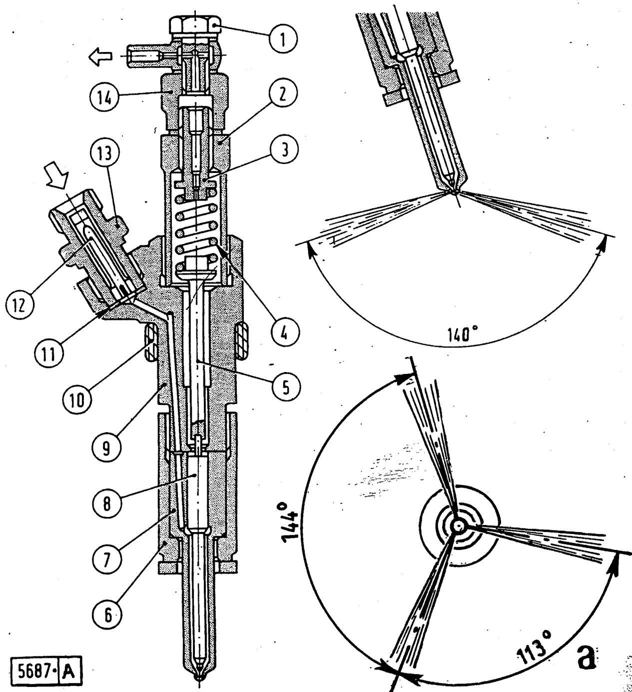


Fig. IV/79 - Injector cross-section and spray pattern.
a. Nozzle spray pattern.
1. Leak-off connection and plug. - 2. Fitting. - 3. Spring adjusting screw. - 4. Spring. - 5. Pressure rod. - 6. Nozzle nut. - 7. Nozzle. - 8. Nozzle rod. - 9. Nozzle body. 10. Outer sealing ring. - 11. Sealing washer. - 12. Bar filter. - 13. Union. - 14. Nut.

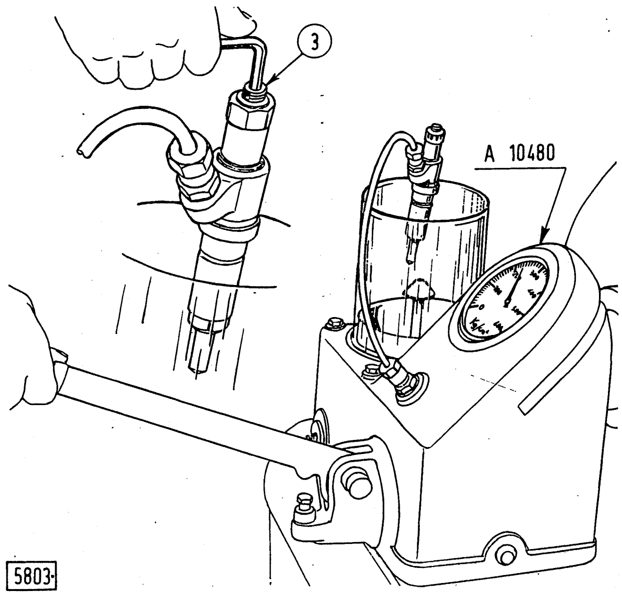


Fig. IV/80 - *Nozzle testing with hand pump and adjusting the spring-loading adjusting screw (3).*

Remove carbon deposits from injector tops with a metal brush.

Disassemble the single injectors as follows:

— arrange the injector on the fixture **A 323023 bis** clamped in a vise;

— unscrew the nut (**14**) and the plug (**2**) using the wrenches **A 721016** and **721018**, respectively;

— withdraw the spring (**4**) and pin (**5**);

— secure the holder **A 323023 bis** to a vise, install the nozzle in it, then, using the wrench **A 721020** unscrew the nut (**6**) to let the parts free.

Pull the rod filter (**12**, Fig. IV/79) out of the inlet connection, then wash all the parts of the nozzle in gasoline.

Calibration.

After cleaning the components assemble the injectors, then check and calibrate them, if necessary, on the RABOTTI test machine equipped with test set **A 10480**. Proceed as follows:

— actuate the lever (Fig. IV/80) to supply the injector and read on the quadrant if the spray pressure is within 225 and 235 kg/cm² (3200 ÷ 3342 p.s.i.);

— screw up the adjusting screw (**3**) if the pressure setting is lower than the quoted value, and unscrew it if higher;

— re-check the spray pressure following each adjustment of the screw.

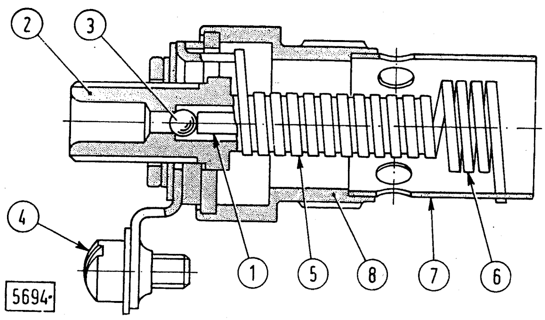


Fig. IV/81 - *Starting aid cross-section.*
1. Push rod. - 2. Valve body. - 3. Ball valve. - 4. End screw. - 5. Heating coil. - 6. Ignition coil. - 7. Shield. - 8. Valve holder.

STARTING AID

The engine is fitted with a glow plug for cold starting contained in a valve holder (Fig. IV/81) which is screwed up into the initial part of the intake manifold; the plug is fed from a special reservoir which in turn is supplied from the injector backleakage fuel (see diagrams on Figs. IV/51).

The starting aid unit consists of a valve body (**8**, Fig. IV/81) which is surrounded by a heating coil (**5**) the end of which (**6**) is designed to allow igniting fuel vapours.

The valve body contains a push rod which holds the ball (**3**) tight against its seat; this ball prevents the fuel from entering the valve.

When the starting switch is turned clockwise up to the first position it closes the electric circuit. The current flows to the resistance (**5**) of the starting aid which is heated and expands towards the inside of the manifold causing the movement of the push rod; consequently, the ball is released off its seat and the fuel can flow into the valve body where it comes in contact with the hot resistance and vaporizes.

After 15 ÷ 20 seconds, the end (**6**) of the resistance gets incandescent through the passage of current, and the developed heat determines a temperacture rise of the air inside the manifold.

As the switch is turned further it closes the contact of the starting motor which starts cranking the engine.

Once starting has taken place, the released switch lever returns automatically to the original position, the electric circuit is interrupted and the air flowing through the manifold cools the valve rapidly.

The push rod blocks the ball again on its seat and the fuel is kept out of the starting aid.

When engine is hot, starting aid operation is excluded by turning the switch counterclockwise.

V - LUBRICATION

GENERAL

Forced feed engine lubrication by camshaft driven gear-type oil pump.

Pressure regulating valve incorporated in the pump body and set for an opening pressure of 3.6 kg/cm² (51.2 p.s.i.).

The oil is kept clean by:

— one screen filter attached on the suction pipe inside the oil sump;

— a full-flow, integral cartridge type oil filter inserted in the pump delivery circuit and provided with a by-pass valve operating when filter is clogged.

The system is supplied with a detergent type multigrade motor oil (FIAT AMBRA see lubrication chart data), with SAE viscosity no. **10 W-30** for temperatures below 0° C (32° F) and **20 W-40** above 0° C which is to be changed after every 200 work hours. If the fuel sulphur content exceeds 1 percent, change the oil twice as often to avoid a more rapid wear of engine parts.

The oil dry capacity is 10.5 kg (10-1/4 imp. qt). After the specified interval, replenish with 9.5 kg (9-¼ imp. qt) of fresh oil to reach the max. mark on the dipstick.

The oil filler plug (**T**, Fig. V/3) is installed on the valve cover and the oil level dipstick gauge on the left side of the crankcase sump. Normal lube pressure reading at tapping on crankcase should be:

— at low idling . $\geqslant$ **0.7 kg/cm² (10 p.s.i.)**

— at max. speed . **3 ÷ 4 kg/cm²** (**43 ÷ 56 p.s.i.**)

Low oil pressure is signalled by the panel mounted warning light.

The camshaft/oil pump speed ratio is 1:1.

OIL PUMP

Pump removal is preceded by the removal of the oil sump, as reported ou page 22, and by the removal of the attaching capscrews to crankcase.

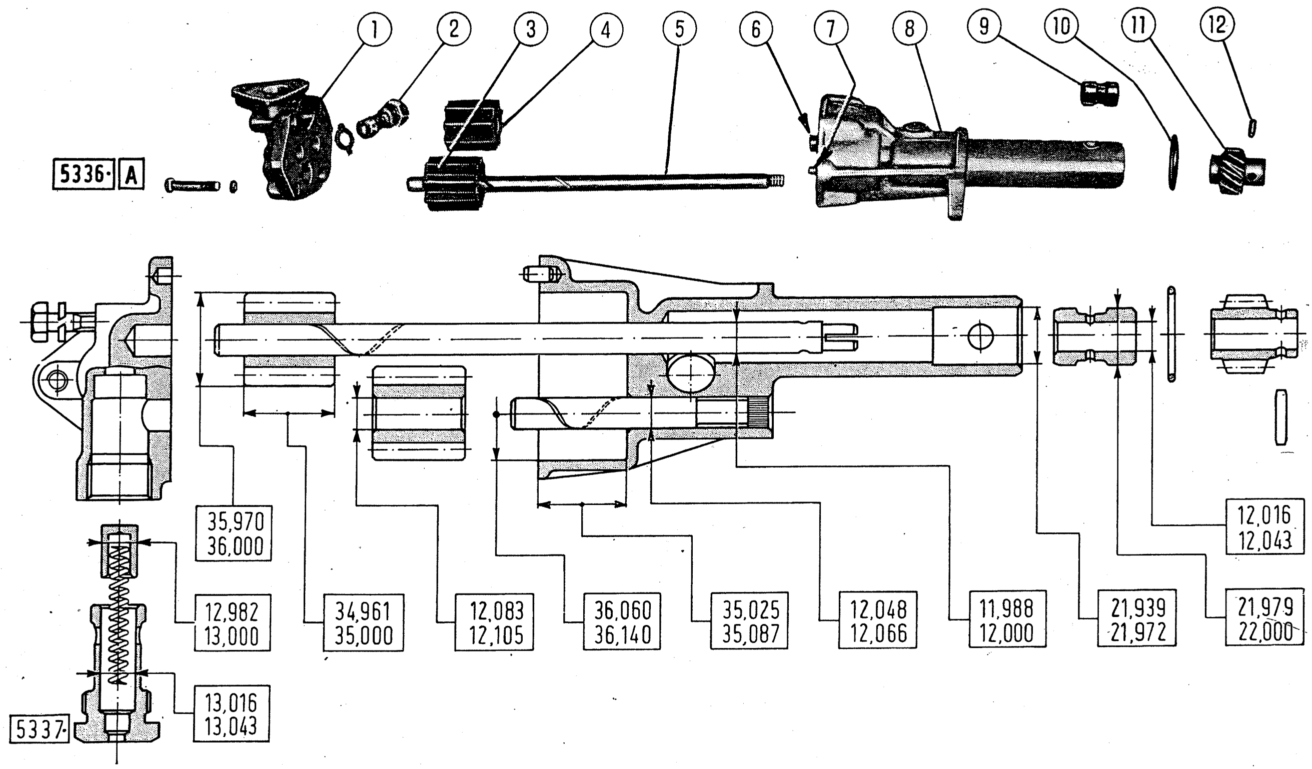


***Fig. V/1** - Oil pump parts and assembly data (mm - See conversions in Section VIII).*
1. Cover. - 2. Valve. - 3. Driving gear. - 4. Driven gear. - 5. Pump drive shaft. - 6. Driven gear shaft. - 7. Dowel. - 8. Pump body. - 9. Bushing. - 10. Sealing ring. - 11. Driven gear of oil pump drive. - 12. Hollow pin.

Pump disassembly (Fig. V/1) does not entail any difficulties:

— cover (1) is removed after its four capscrews securing it to pump body;

— shaft (5) with gear (3) is withdrawn after removing dowel pin (12) securing it to its drive gear (11).

Check assembly data and fits versus limits reported in Section VIII and replace worn out parts whenever necessary.

Notice that spares of gear (3) include shaft (5), and viceversa, as they are force fitted hot.

When assembling and installing the pump, mke sure to:

— install cover (1) correctly (see dowel 7 on pump body);

— check conditions of the O-ring (10);

— meet torque specification requirements reported in Section VIII.

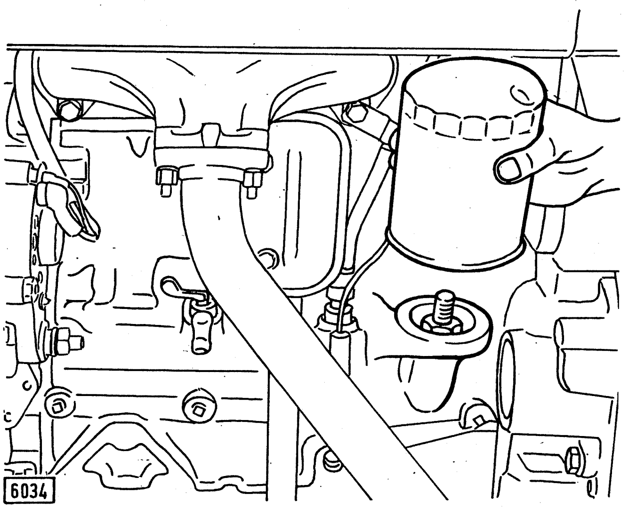


Fig. V/2 - Disassembly (reassembly) of oil filter.

OIL FILTER

The oil filter is furnished complete with the container, which comprises the cartridge and its outer seal and is bolted to the crankcase.

Replace the filter after the first 60 working hours and then at every second oil change, not over 400 working hours in any case, to avoid clogging.

If the filter gets clogged up, the by-pass valve (set at 0.9 ÷ 1.1 kg/cm² = 12.8 ÷ 15.6 p.s.i.) automatically cuts the flow off the filter, thus allowing the lubricating oil to reach the engine anyway but in this case by-passed oil would obviously be unfiltered.

The filter is removed by unscrewing it by hand from its support on the crankcase (Fig. V/2).

The filter is of the full-flow type, consequently efficient performance is a must. It must therefore be regularly replaced at the specified intervals, as the integral body constriction offers no possibility of checking or replacing components.

LOW OIL PRESSURE WARNING LIGHT

The warning indicator is a panel-mounted red bulb lamp which goes on in the following cases:

1) low oil pressure at cold starts or with engine stopped and the key inserted in the switch in a position different from zero;

2) transmitter (46, Fig. 0/8) inoperative;

3) broken ground cable.

If, in case 1) the red lamp does not light up, check the following:

— warning light bulb;

— fuse;

— transmitter;

— wires.

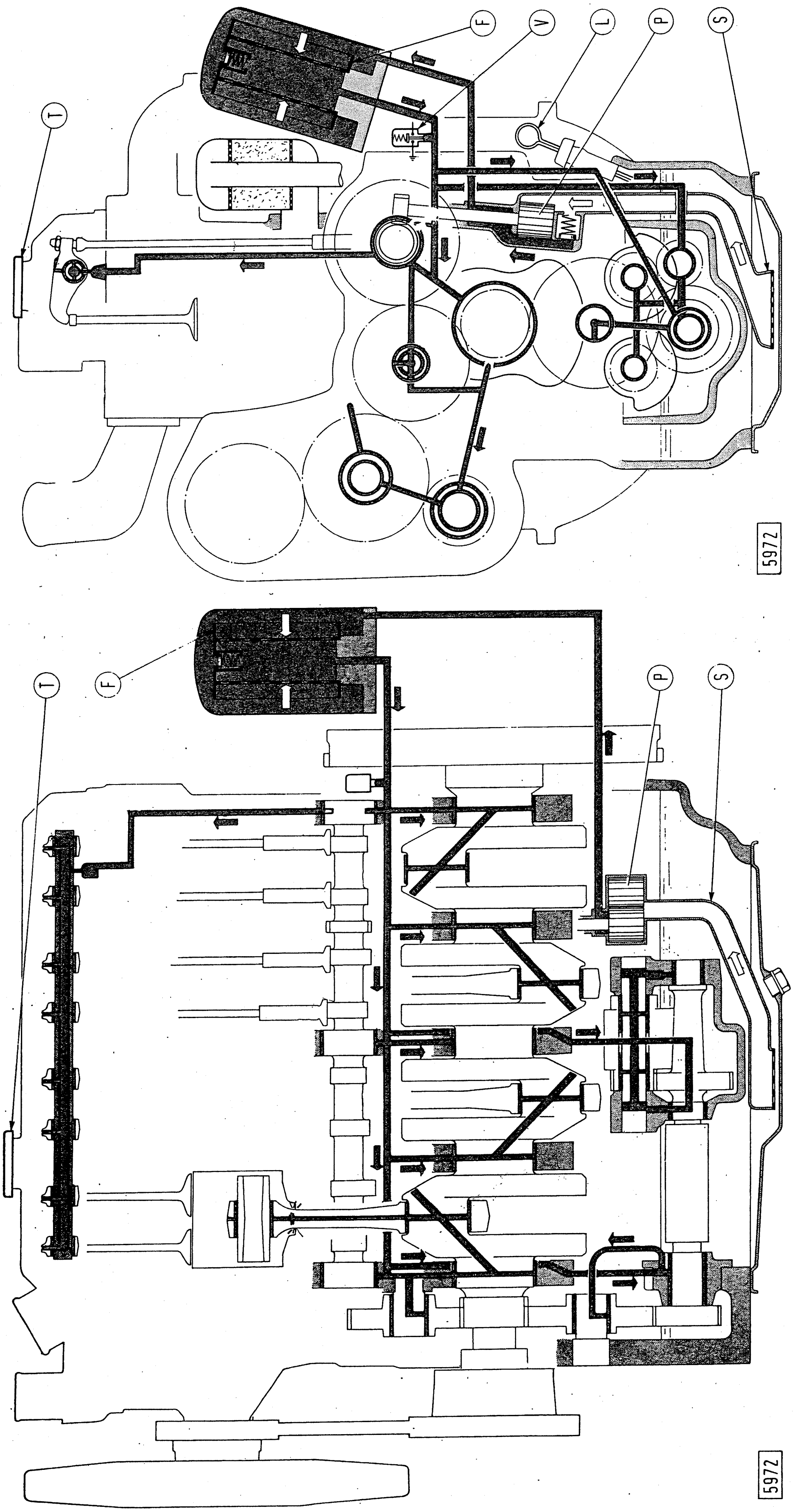


Fig. V/3 - Engine lubrication diagram.
F. Filter - L. Dipstick gauge - P. Gear-type pump - S. Oil sump bell - T. Oil filler plug - V. Pressure switch for insufficient oil pressure indicator (on panel).

ENGINE LUBE SCHEDULE AND CAPACITIES

Fill point	Level check intervals hours	Change intervals hours	LUBRICANT FIAT	LUBRICANT International	LUBRICANT Q.ty kg
Engine — Complete lube circuit	—	—	Ambra 20 W-40 (1)	Multigrade motor oil (MIL-L-2104 B) for all engine applications	10.5 kg (10-1/4 qts)
Engine — Oil sump only . . .	10	200			9.5 kg (9-1/4 qts)
Air cleaner cup	50	(2)			1 kg (1 qt.)

Capacities:
- — cooling system . . . . 14 liters (3 imp. gal)
- — fuel tank . . . . 54 liters (~ 12 imp. gal)

(1) Use 20 W-40 grade for ambient temperatures above 0° C (32° F) and 10 W-30 below 0° C.
(2) Change the oil if contaminated or if deposits are about 1 cm (~ 3/8″) thick.

VI - COOLING

GENERAL

Forced feed cooling water system with vane-type centrifugal pump and thermostat regulated (Fig. VI/1).
The water flow is cooled through an upright-tubelet type radiator core and an aspirating fan pulls cooling air through the core.
The cylinder head water outlet pipe houses the fixed-setting thermostat which, when the water is cold, blocks the flow of water to the radiator until the water warms up to correct operating temperature, as follows:

— with the thermostat closed (**b**, Fig. VI/1) the water circulates only between pump and engine (by-pass circuit), excluding the radiator;

— with the termostat open (**a**), the water flows through the radiator also, thus excluding, partially or in full, the by-pass circuit.

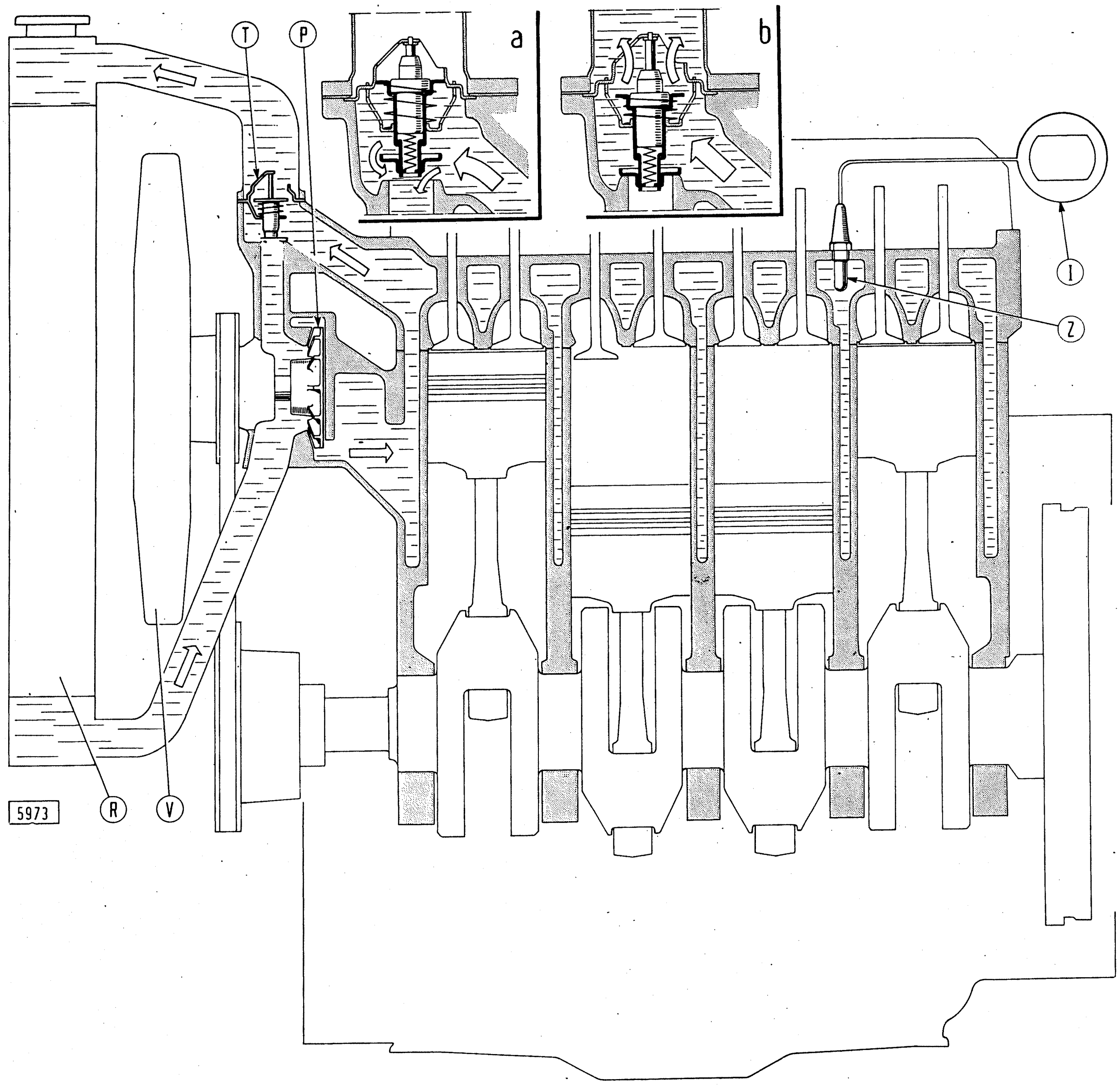


Fig. VI/1 - *Engine cooling diagram.*
I. Water temperature indicator. - P. Water pump. - R. Upright tubelet type radiator. - T. Thermostat. - V. Fan. - Z. Thermometer gauge bulb.
a. Water circulation with thermostat closed.
b. Water circulation with thermostat open.

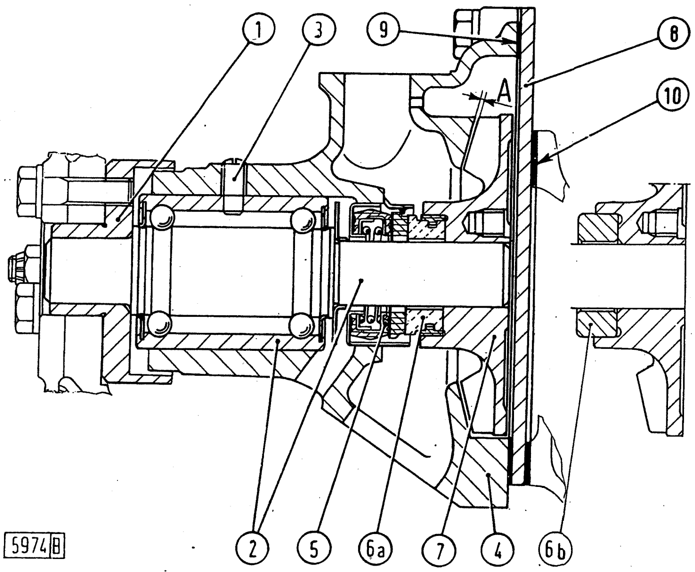


Fig.VI/2 - Sectional view of water pump.
A = 1 to 1.25 mm (0.039 to 0.049 in). Clearance between impeller vanes and pump body - 1. Fan and pump drive hub - 2. Pump shaft with sealed bearing - 3. Pump bearing retaining capscrew - 4. Pump body - 5. Pump shaft seal - 6a. Front sealing sleeve (seal solution) - 6b. Front sealing sleeve (pressed solution) - 7. Impeller - 8. Pump cover - 9 and 10. Gasket.

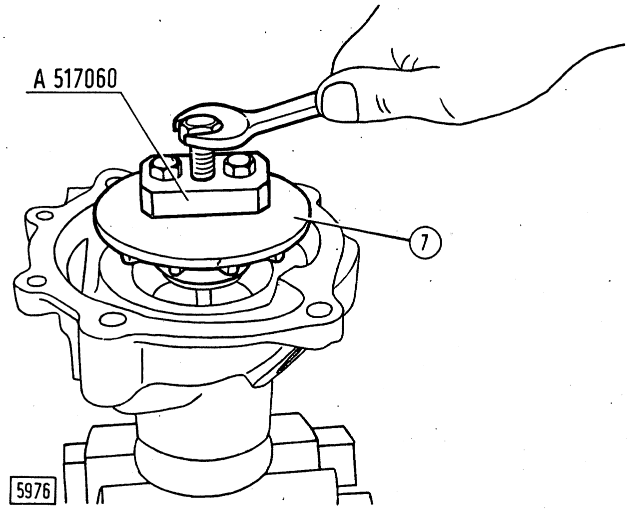


Fig. VI/4 - Removing the impeller (7) with puller A 517060.

WATER PUMP

The water pump is a cast-iron body with a double row ball bearing and shaft and protective centrifuge disc (Fig. VI/2).

The pump is mounted to the front end of crankcase by means of a support.

To remove it from the tractor, drain cooling circuit of water by opening the cocks (**16** and **18**, Fig. 0/2);

then remove the radiator (as indicated in the relevant topic on following page), fan, pulley, and fan and alternator drive belt, disconnect the pump from the tubing, remove the attaching capscrews and withdraw the pump with cover.

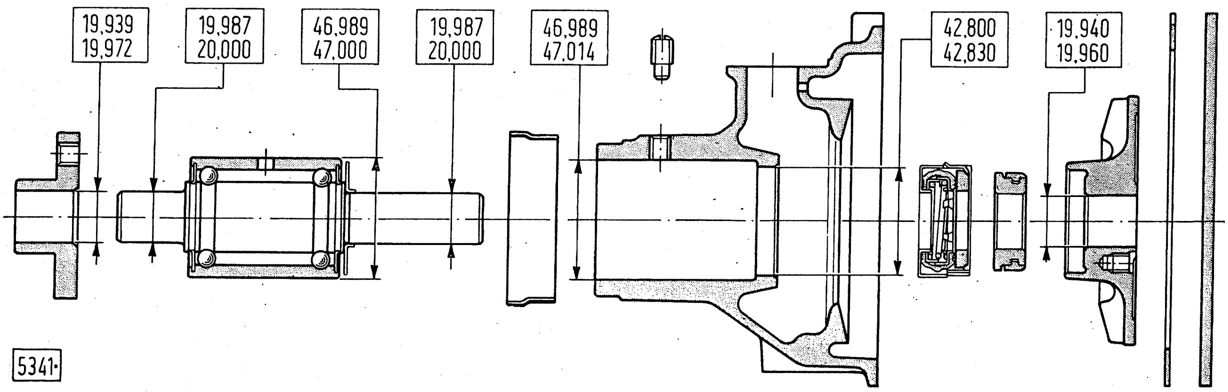


Fig.VI/3 - Main water pump data in millimeters.

Disassemble the pump (Fig. VI/3) as follows:

— remove screws and cover (**8**);

— remove the bearing (**2**) retaining capscrews (C_1) and tap the shaft lightly to break the oxidation film between shaft and impeller;

— remove the impeller using the tool **A 517060** (Fig. VI/4);

— apply a drive punch to shaft end (**2**), impeller side, and withdraw it with bearing and fan hub.

Remove the pump shaft seal (**5**, Fig. VI/2) in case of replacement only. Replace it when the graphite surface contacting the shaft is no longer smooth and sealing tightness unreliable.

Check the pump cover and mounting plate gaskets and replace them if excessively worn.

Check conditions of the seal for front sealing bushing (**6**) on those pumps which are provided with this supplementary seal.

Re-assemble by reversing the disassemble sequence and considering the following points:

— the bearing (**2**) is sealed and consequently does not require lubrication in service.

After fitting it in the pump body, lock punch the screw in its hole;

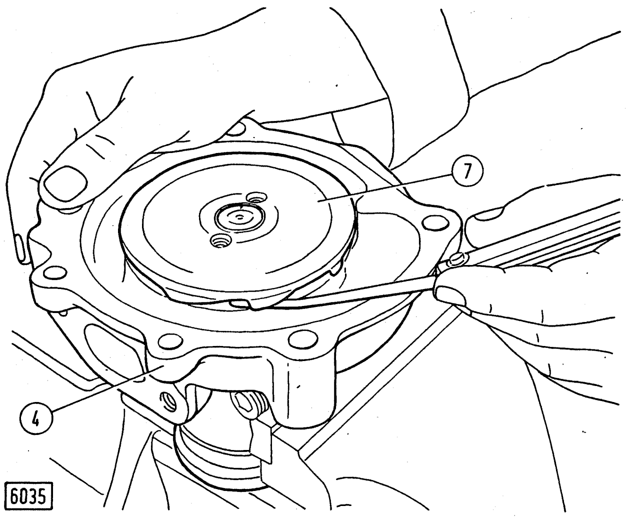


Fig. VI/5 - Checking clearance between impeller (7) and water pump body (4).

— fit the impeller flush with the shaft end surface using the drive punch **A 92532** and check that clearance between vanes and pump does not exceed 1.06 ÷ 1.25 mm (0.042 ÷ 0.049 in), Fig. VI/5;

— apply jointing compound to the pump cover and mounting gaskets (**9** and **10**, Fig. VI/2) to improve tightness;

— torque specification requirements are reported in Section VIII.

RADIATOR

The radiator core has three rows of upright tubelets with copper fins.

Two strips of spongy material are glued to the outer side of the radiator (**15**, Fig. VI/6); their purpose being to block the warm air produced by the cooling of the water from flowing back into circulation.

The outflow of water vapor which accumulates inside the radiator is provided by a plastic tube (**16**) connected to a hole which is drilled through the water filler cap.

Two valves are incorporated in the radiator cap: one compression (**17**) and one vacuum valve (**18**). The compression valve tends to open when, with the tractor in motion, the water temperature rise inside the circuit sets up internal pressure exceeding 0.5 atm; at this point the valve tends to lift off allowing the excess vapour to flow out along the plastic tubelet (**16**).

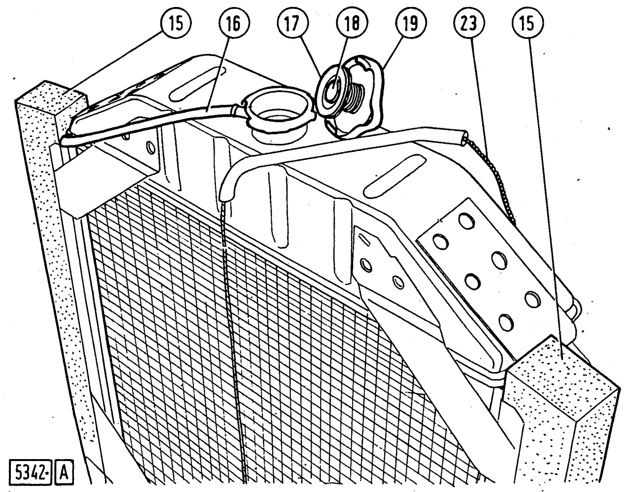


***Fig. VI/6** - Radiator.*

15. Air sealing sponge rubber elements. - 16. Water vapor vent tube. - 17. Compression valve. - 18. Vacuum valve. - 19. Plug. - 23. Curtain control chain.

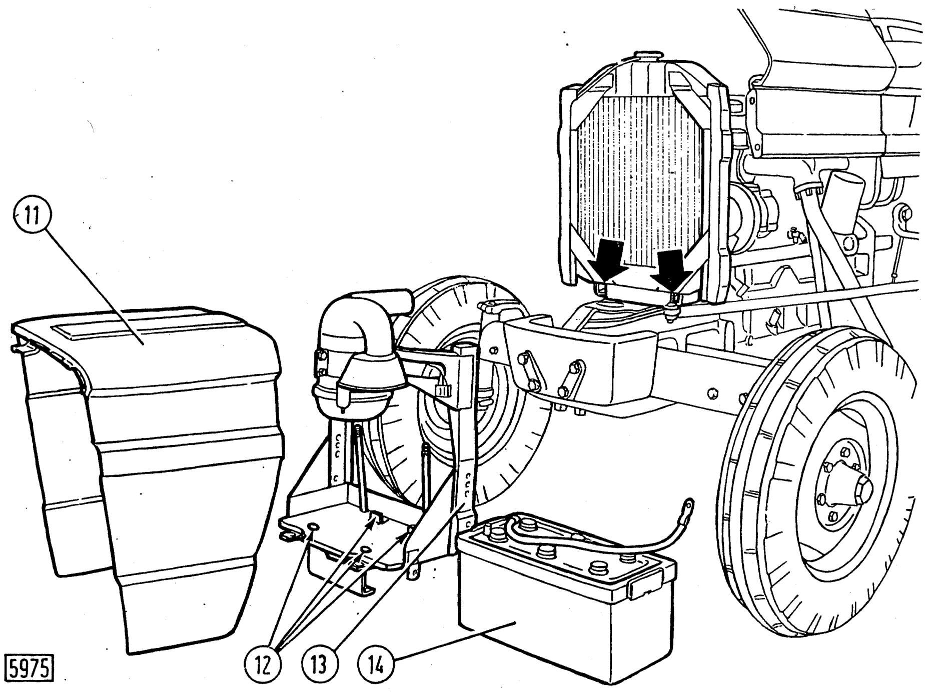


Fig. VI/7 - Parts to be removed before removal of radiator.

(Arrows indicate locations of capscrews securing radiator to front axle support).
11. Front hood. - 12. Locations of capscrews securing the mounting bracket (13). - 13. Battery and air cleaner mounting bracket. - 14. Battery.

The vacuum valve starts working by effect of the decreased water temperature which results in a pressure drop inside the circuit; the valve lowers and lets air in to re-establish the pressure balance.
A radiator curtain for the winter season is fitted on request. This curtain is controlled from the driver's compartment by means of a chain (**23**, Fig. VI/6).
First drain the water then remove the radiator as follows:

— remove the grille (Fig. 0/4);

— remove the battery (**14**, Fig. VI/7) after disconnecting the ground and positive cables;

— remove the headlamps after disconnecting the wires from the front connections, then remove the grille (**11**);

— remove the frame (**13**) together with air cleaner after slackening the air suction hose band clamps, disconnecting the electric wiring and removing the four attaching screws to the axle support;

— disconnect the radiator water inlet and outlet lines, remove the screws indicated in Fig. VI/7 and, finally, remove the radiator with air shroud.

Make sure of the radiator functional efficiency by checking for obstructions or clogging inside and outside the radiator core.

Descale the system as follows;

— make a solution of 30 gram per liter of sodium bicarbonate in warm water;

— filter it through a cloth;

— pour it in the radiator, drain it and flush thoroughly;

— check radiator tightness, in case of leakage, by immersion inside a tank filled with water at $30 \pm 10°$ C ($68° \div 104°$ F) and blowing compressed air into it at approx. 1 kg/cm^2 (14.2 p.s.i.) for about two minutes. Check for air bubbles, and repeat three times at least.

We do not recommend limiting the washing to the radiator alone as it should always be extended to the entire cooling system supplying the engine with the type of solution and in the manners previously indicated. Make the tractor work for about one hour before draining the coolant, with engine stopped.
The circuit should always be washed when the ambient temperature approaches 0° C (32° F) and before filling with anti-freeze.
In particular, we recommend the use of the FIAT special anti-freeze for which we give the percentage required to meet different temperature requirements

Freezing temperature	—8° C (18° F)	—15° C (5° F)	—25° C (—13° F)	—35° C (—31° F)
% of anti-freeze	20	30	40	50

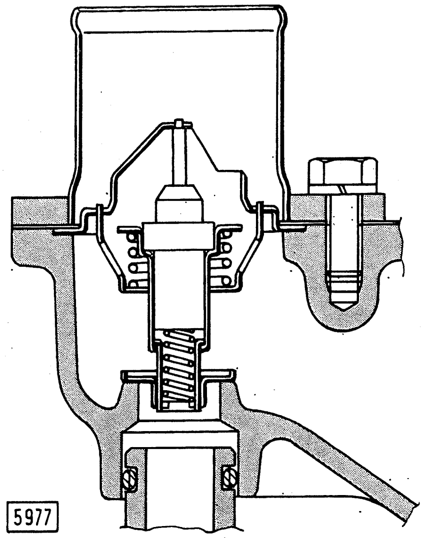


Fig. VI/8 - *Thermostat cut-out.*

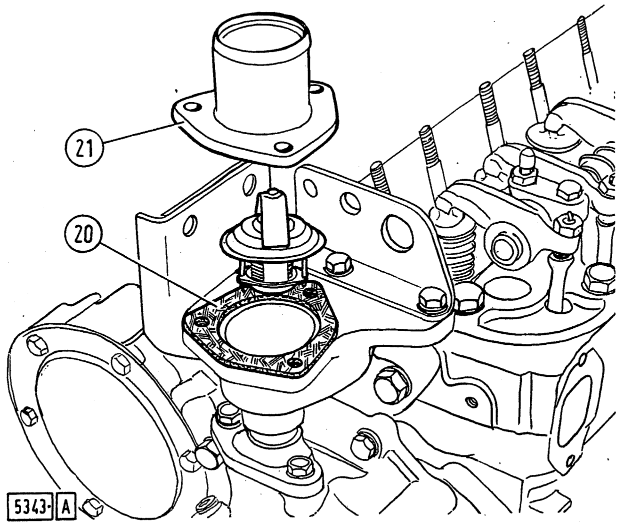


Fig. VI/9 - *Thermostat removal (installation).*
20. Gasket. - 21. Cover.

Fill the radiator up to about 2 cm (3/4″) below the vapour exhaust hole (**16**, Fig. VI/6).

THERMOSTAT

The thermostat (Fig. VI/8) is located inside the cylinder head water outlet pipe terminal.
To remove it, slacken the band clamps, disconnect the hose and remove the cover (**21**, Fig. VI/9). The termostat has a fixed setting which requires no adjustment. Check it by dipping it into the water contained in the tank **A 711149**. The latter is fitted with the temperature gauge of the kit **A 711148**, necessary to check the water temperature.
Two types of thermostats are available to be installed in alternative, all possessing the same characteristics as valve opening and closing temperatures but different lengths of valve opening travel, as follows:

Thermostat begins to open at (corresponding to a valve run of up to 0.10 mm = 0.004″)	78° to 81° C (170° to 178° F)
Full-open travel	95° C (203° F)
Valve operating travel (corresponding to a temperature of ≤ 95° C) (203° F): — SAVARA . . . . — CITMF BOA	 7.5 mm (0.295″) 7.5 mm (0.295″)

REPLACING THE FAN AND ALTERNATOR DRIVE BELTS

No tractor part needs to be removed first. Proceed as follows:

— loosen the take up bracket stop nut (C_3, Fig. VI/10;

— move the alternator away on the bracket so as to annull the belt tension;

— withdraw the belt through the opening in the air shroud.

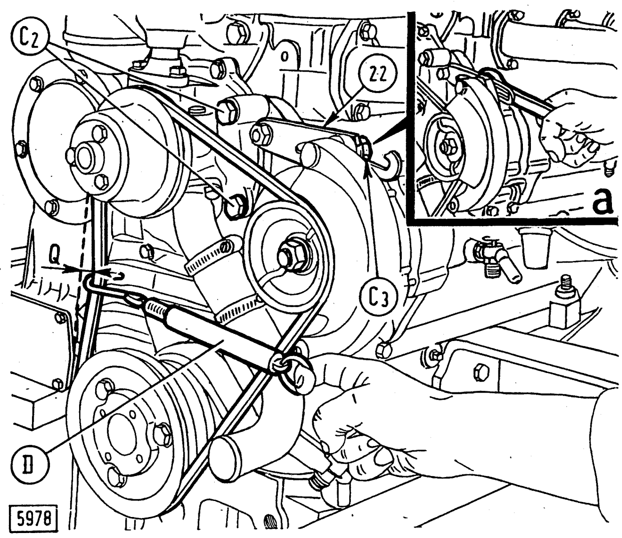


Fig. VI/10 - *Checking and adjusting belt tension.*
C_2. Water pump mounting screws. - C_3. Alternator mounting bolt on take up bracket. - D. Dynamometer. - Q = 1 ÷ 1.5 cm (3/4″ ÷ 9/16″). Max. give-in under a load of 5 ÷ 6 kg (11 ÷ 13 lb). - 22. Belt take up bracket.
a. Belt adjustment.

Checking and setting belt tension.

Apply a load on the belt between drive pulley and alternator (Fig. VI/10).
No adjustment is necessary if the resulting belt slack is within 1 ÷ 1.5 cm (3/8" ÷ 9/16") under a load of 5 ÷ 7 kg (11 ÷ 15 lb); if not, proceed as follows:

— loosen the adjusting bolt (C_3);

— move the alternator on the take up bracket in either direction so as to take up the excessive belt slack;

— tighten the adjusting bolt (a, Fig. VI/10).

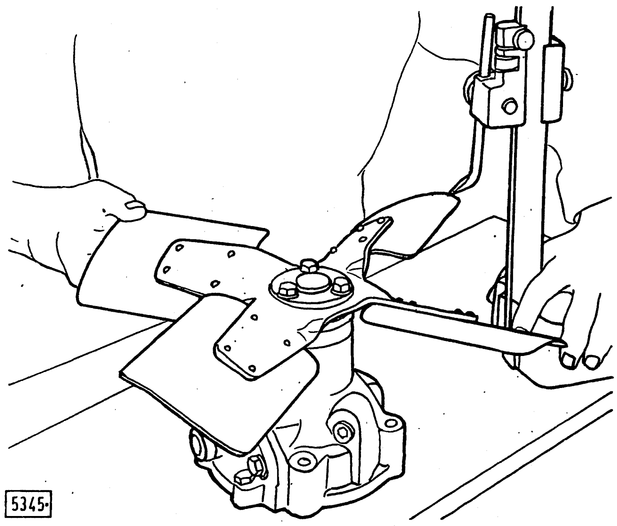


***Fig. VI/11** - Checking the fan blade face alignment with a surface gauge.*

FAN

The fan, like all other rotating parts, is statically balanced to prevent trouble due to its high speed (45 percent higher than engine speed) which might result in blade failure.
Two types of fans are installed in alternative: one pre-modification 4-blade steel fan, and a post-modification 9-blade plastic fan.
The maximum permissible out-of-balance is 400 gr.mm (0.555 in-oz.).

Always check blades for bending and for face aligment (Fig. VI/11) using a surface gauge.
Some bends can be straightened out with a fork bar, provided that they do not alter the radial shape and do not endanger the strength of the fan.

WATER TEMPERATURE GAUGE

Colored-band type gauge, the band being made up of three sectors, as follows:

— white sector . . **30° ÷ 75° C (86° ÷ 167° F)**

— central green . **75° ÷ 105° C (167° ÷ 221° F)**

— red sector . . . **105° ÷ 115° C (221° ÷ 239° F)**

The dial is within the green central sector under normal operating conditions.
Test the gauge, should any doubt arise about its reliability, by dipping the bulb in water and then ckecking the scale graduation versus a test calibrated gauge. Repeat test for greater safety.

Note - The description regarding the section VII have been suppressed in this edition.

VIII - FITS AND TOLERANCES - TORQUE SPECIFICATIONS SERVICE TOOLS

FITS AND TOLERANCES FOR ENGINE

DESCRIPTION	Size of new parts and wear limits	
	mm	in
I - Crankcase - Cylinder head - Oil sump.		
O.D. of cylinder liners 0.2 mm (0.008) oversize	103.220÷103.250	4.0637÷4.0649
Diameter of crankcase bores 0.2 mm (0.008) oversize	103.090÷103.140	4.0586÷4.0606
Interference fit of cylinder liners in crankcase bores	0.080 ÷ 0.160	0.0031÷0.0063
I.D. of standard liners (press-fitted)	100.000÷100.018	3.9370÷3.9441
— Oversizes 0.2 mm (0.008 in)	100.200÷100.218	3.9448÷3.9519
— Oversizes 0.4 mm (0.016 in)	100.400÷100.418	3.9527÷3.9598
— Oversizes 0.6 mm (0.024 in)	100.600÷100.618	3.9606÷3.9677
— Oversizes 0.8 mm (0.032 in)	100.800÷100.818	3.9684÷3.9755
Dia of crankcase bores for valve tappets:		
— standard	14.000 ÷ 14.018	0.5512 ÷ 0.5519
— 0.10 mm (0.004 in) oversize	14.100 ÷ 14.118	0.5551 ÷ 0.5558
— 0.20 mm (0.008 in) oversize	14.200 ÷ 14.218	0.5590 ÷ 0.5598
— 0.30 mm (0.012 in) oversize	14.300 ÷ 14.318	0.5630 ÷ 0.5637
Dia. of crankcase main bearing locations	80.587 ÷ 80.607	3.1727 ÷ 3.1735
Dia. of cylinder head locating bores for valve guides	13.966 ÷ 13.983	0.5498 ÷ 0.5505
II - Timing.		
Assembly clearance between camshaft and bearings:		
— front	0.080 ÷ 0.160	0.0031 ÷ 0.0063
— middle,	0.080 ÷ 0.160	0.0031 ÷ 0.0063
— rear	0.080 ÷ 0.160	0.0031 ÷ 0.0063
Interference fit of camshaft bearings in crankcase bores:		
— front	0.070 ÷ 0.150	0.0027 ÷ 0.0059
— middle	0.070 ÷ 0.150	0.0027 ÷ 0.0059
— rear	0.070 ÷ 0.150	0.0027 ÷ 0.0059
Assembly clearance between valve stems and guides	0.023 ÷ 0.053	0.0009 ÷ 0.0021
O.D. of valve guides:		
— standard	13.988 ÷ 14.016	0.5507 ÷ 0.5518
— 0.20 mm (0.008 in) oversize	14.188 ÷ 14.216	0.5586 ÷ 0.5597

Continued: " Engine fits and tolerance "

DESCRIPTIONS	Size of new parts and wear limits	
	mm	in
Interference fit of valve guides and their seats in the cylinder head	0.005 ÷ 0.050	0.0002 ÷ 0.0020
Max. O.D. (intermediate) of valve tappets:		
— standard	13.950 ÷ 13.970	0.5492 ÷ 0.5500
— 0.10 mm (0.004 in) oversize	14.050 ÷ 14.070	0.5571 ÷ 0.5579
— 0.20 mm (0.008 in) oversize	14.150 ÷ 14.170	0.5571 ÷ 0.5579
— 0.30 mm (0.012 in) oversize	14.250 ÷ 14.270	0.5610 ÷ 0.5618
Assembly clearance between tappets and crankcase bores . . .	0.030 ÷ 0.068	0.0012 ÷ 0.0026
O.D. of rocker arm bushings	21.030 ÷ 21.060	0.8279 ÷ 0.8291
Dia. of rocker arm bushing locations	20.939 ÷ 20.972	0.8244 ÷ 0.8257
Interference fit between bushings and rocker arm locating holes	0.058 ÷ 0.121	0.0023 ÷ 0.0048
I.D. of rocker arm bushings	18.016 ÷ 18.034	0.7093 ÷ 0.7100
Assembly clearance between rocker arm shaft and bushings (fitted)	0.016 ÷ 0.052	0.0006 ÷ 0.0020
Dia. of timing idler gear axle	31.975 ÷ 32.000	1.2588 ÷ 1.2598
I.D. of timing idler gear bushing	32.050 ÷ 32.075	1.2618 ÷ 1.2628
Assembly clearance between idler gear axle and bushing . . .	0.050 ÷ 0.100	0.0020 ÷ 0.0040
Thickness of idler gear thrust washer	1.450 ÷ 1.500	0.0571 ÷ 0.0591
Inner (premodification) valve spring:		
— free length	51	2.01
— closed-valve length (6.55 ÷ 7.55 kg = 14.4 ÷ 16.6 lb loading)	37.5 ÷ 38.5	1.476 ÷ 1.516
— open-valve length (15.4 ÷ 16.7 kg = 33.9 ÷ 36.8 lb loading)	26.8 ÷ 28.8	1.055 ÷ 1.134
Outer (premodification) valve spring:		
— free length	63	2.48
— closed-valve length (19.3 ÷ 21.7 kg = 42.5 ÷ 47.08 lb loading)	40.5 ÷ 41.5	1.59 ÷ 1.63
— open-valve length (36.4 ÷ 39.4 kg = 80.2 ÷ 86.9 lb loading)	29.8 ÷ 31.8	1.17 ÷ 1.25
Rocker-arm spacing spring specifications:		
— free length	59.5	2.34
— test length (4.7 ÷ 5.3 kg = 10.4 ÷ 11.7 lb test load) . . .	44	1.73
Modified valve spring specifications :		
- free length	66.5	2.62
- closed valve length (30.1÷33.9 Kg-66.3÷74.7 lb)	40.5÷41.5	1.59÷1.63
- open valve length (48.1÷52.1 Kg -106÷114.8 lb)	29.8÷31.8	1.17÷1.25
III - CRANK GEAR		
Dia.of standard size pistons,measured at a point 50 mm(1.968 in)above the base of the skirt (Fig.III/10)	99.828÷99.840	3.9302÷3.9307
Piston-liner clearance measured at a point 50 mm(1.968 in)above the base of the skirt normally to the pin axis	0.166÷0.190	0.0065÷0.0074

Continued " Engine fits and tolerance "

DESCRIPTION	Size of new parts and wear limits	
	mm	in
Oversizes of standard pistons.		
— 0.2 mm (0.008 in)	100.028÷100.040	3.9379÷3.9386
— 0.4 mm (0.016 in)	100.228÷100.240	3.9458÷3.9464
— 0.6 mm (0.020 in)	100.428÷100.440	3.9537÷3.9543
— 0.8 mm (0.032 in)	100.628÷100.640	3.9615÷3.9622
Dia. of piston pin 0.20 mm (0.008 in) oversize	32.183 ÷ 32.190	1.2670 ÷ 1.2673
I.D. of connecting rod small end bushings (fitted):		
— standard size	32.005 ÷ 32.012	1.2600 ÷ 1.2603
— 0.20 mm (0.008 in) oversize	32.205 ÷ 32.212	1.2679 ÷ 1.2682
Assembly clearance between piston pin and small end bushings	0.015 ÷ 0.029	0.0006 ÷ 0.0011
O.D. of connecting rod small end bushings	35.979÷36.017	1.4165÷1.4179
Dia. of small end bushing bore locations	35.877 ÷ 35.916	1.4125 ÷ 1.4140
Interference fit between small end bushings and their locations	-0.063 ÷ -0.140	-0.0025 ÷ -0.0055
I.D. of piston bosses:		
— standard size	31.993÷32.000	1.2595÷1.2598
— 0.20 mm (0.008 in) oversize	32.193÷32.200	1.2673÷1.2676
Assembly clearance of piston rings in grooves:		
— 1st ring	0.090 ÷ 0.122	0.0035 ÷ 0.0048
— 2nd ring	0.050 ÷ 0.082	0.0020 ÷ 0.0032
— 3rd ring	0.040 ÷ 0.072	0.0016 ÷ 0.0028
End gap (with piston and rings installed in cylinder liner):		
— 1st ring	0.350 ÷ 0.550	0.014 ÷ 0.022
— 2nd ring	0.300 ÷ 0.450	0.012 ÷ 0.018
— 3rd ring	0.250 ÷ 0.400	0.010 ÷ 0.016
Dia. of crankshaft main journals (undersizes):		
— 0.254 mm (0.010 in)	75.933 ÷ 75.946	2.9895 ÷ 2.9900
— 0.508 mm (0.020 in)	75.679 ÷ 75.692	2.9795 ÷ 2.9800
— 0.762 mm (0.030 in)	75.425 ÷ 75.438	2.9695 ÷ 2.9700
— 1.016 mm (0.040 in)	75.171 ÷ 75.184	2.9595 ÷ 2.9600
Thickness of main bearings (undersizes):		
— 0.254 mm (0.010 in)	2.292 ÷ 2.299	0.0902 ÷ 0.0905
— 0.508 mm (0.020 in)	2.419 ÷ 2.426	0.0952 ÷ 0.0955

Continued " Engine fits and tolerance "

DESCRIPTION	Size of new parts and wear limits	
	mm	in
— 0.762 mm (0.030 in)	2.546 ÷ 2.553	0.1002 ÷ 0.1005
— 1.016 mm (0.040 in)	2.673 ÷ 2.680	0.1052 ÷ 0.1055
Assembly clearance between main bearings and their journals	0.043 ÷ 0.090	0.0016 ÷ 0.0035
Dia. of crankshaft connecting rod bearing journals (undersizes):		
— 0.254 mm (0.010 in)	58.476 ÷ 58.489	2.3022 ÷ 2.3027
— 0.508 mm (0.020 in)	58.222 ÷ 58.235	2.2922 ÷ 2.2927
— 0.762 mm (0.030 in)	57.968 ÷ 57.981	2.2822 ÷ 2.2827
— 1.016 mm (0.040 in)	57.714 ÷ 57.727	2.2722 ÷ 2.2727
Thickness of connecting rod bearings:		
— standard size	1.816 ÷ 1.822	0.0715 ÷ 0.0717
— 0.254 mm (0.010 in) undersize	1.943 ÷ 1.949	0.0765 ÷ 0.0767
— 0.508 mm (0.020 in) undersize	2.070 ÷ 2.076	0.0815 ÷ 0.0817
— 0.762 mm (0.030 in) undersize	2.197 ÷ 2.203	0.0865 ÷ 0.0867
— 1.016 mm (0.040 in) undersize	2.324 ÷ 2.330	0.0915 ÷ 0.0917
Assembly clearance between connecting rod journals and bearings	0.021 ÷ 0.058	0.0008 ÷ 0.0023
Thickness of crankshaft thrust washers 0.127 mm (0.005 in) oversize	3.505 ÷ 3.556	0.1380 ÷ 0.1400
Length of crankshaft penultimate bearing journal	32.000 ÷ 32.100	1.2598 ÷ 1.2638
End floating of crankshaft	0.082 ÷ 0.334	0.0032 ÷ 0.0131
Vibration damper and drive unit for 4-cylinder engines:		
Interference fit of idler gear shaft in its oil sump location	0.009 ÷ 0.073	0.0004 ÷ 0.0029
Interference fit of idler and drive gear bushings in their respective locations	0.063 ÷ 0.140	0.0025 ÷ 0.0055
Clearance of idler and drive unit gear axle and shaft in respective bushings	0.050 ÷ 0.100	0.0020 ÷ 0.0039
Clearance between drive shaft flanks and splined sleeve	0.028 ÷ 0.106	0.0011 ÷ 0.0041
Interference fit of drive gear bushing and its damper box location	0.063 ÷ 0.140	0.0025 ÷ 0.0055
Interference fit of drive gear bushing in end support	0.037 ÷ 0.101	0.0015 ÷ 0.0039
Clearance between damper weights drive gear bushings and their hubs	0.050 ÷ 0.100	0.0020 ÷ 0.0039
Interfernce fit of bushings in damper weights	0.040 ÷ 0.100	0.0016 ÷ 0.0039
I.D. of damper weight bushings	25.020 ÷ 25.060	0.9851 ÷ 0.9867
Clearance of damper weights axles in bushings	0.020 ÷ 0.073	0.0008 ÷ 0.0029
Interference fit of weight drive idler gear axle in box location	0.007 ÷ 0.061	0.0003 ÷ 0.0024
Interference fit of bushing in weight drive idler gear	0.037 ÷ 0.101	0.0015 ÷ 0.0039
I.D. of weight drive idler gear bushing	25.013 ÷ 25.040	0.9848 ÷ 0.9859
Clearance of idler gear axle in bushing	0.013 ÷ 0.061	0.0005 ÷ 0.0024
Tooth backlash of meshing pairs of gears	0.080	0.0031

Continued " Engine fits and tolerance "

DESCRIPTION	Size of new parts and wear limits	
	mm	in
V - Lubrication system.		
Assembly clearance between oil pump driving shaft and bushing	0.016 ÷ 0.055	0.0006 ÷ 0.0021
Assembly clearance between oil pump driven shaft and gear . .	0.017 ÷ 0.057	0.0007 ÷ 0.0022
Tooth backlash, between oil pump drive and driven gears . .	0.100	0.004
Gear end clearance in pump body	0.025 ÷ 0.126	0.0010 ÷ 0.0050
Diametral clearance of drive and driven gears in pump body	0.060 ÷ 0.170	0.0024 ÷ 0.0067
Oil pressure valve spring specifications:		
— free length	45	1.77
— test length (4.6 ÷ 5 kg = 10.1 ÷ 11 lb) test load	37.5	1.48
— test length (9 ÷ 9.6 kg = 19.8 ÷ 21.2 lb) test load . . .	30.5	1.20

TORQUE SPECIFICATIONS

DESCRIPTION	Size and thread (metric)	Ultimate strength of material kg/mm²	TORQUE	
			kgm	ft.lb
0 - Data - Removal - Installation.				
Capscrews, engine to clutch case (C_1, Fig 0/9)	12 × 1.25	80-Zinc plate	10,5	75.9
Capscrews, front axle to oil sump	16 × 1.5	100-Zinc plate	25	180.8
I - Crankcase - Cylinder head - Oil sump.				
Capscrews, cylinder head (Fig. I/9)	12 × 1.25	120	15	108.5
Capscrews, oil sump (C_1. Fig. I/10)	10 × 1.25	80-Zinc plate	6	43.4
Stud nut injector	8 x 1.25	80 Zinc plate	2,3	16.6
II - Timing.				
Capscrews, rocker arm support to cylinder head (C_2 and C_3, Fig. II/10)	8 × 1.25	80-Zinc plate	2,3	16.6
Capscrews, timing gear case	8 × 1.25	80-Zinc plate	2,3	16.6
Stud nut timing case	8 x 1.25	50 Zinc plate	2,3	16.6
III - Crank gear.				
Capscrews, main bearing caps (C_5 Fig. III/15).	14 × 1.5	100	15	108.5
Capscrews, connecting rod bearing caps (C_4, Fig. III/ 15)	12 × 1.25	100	11,5	83.5
Capscrews, alternator and fan drive pulley . . .	10 × 1.25	80-Zinc plate	5	36.2
Capscrews, engine flywheel (C_2, Fig. III/4) . .	12 × 1.25	100	10,5	76
Nut, crankshaft hub (C_1, Fig. III/4)	30 × 1.50	50-Zinc plate	30	217
Capscrews, damper box (C_8, Fig. III/16). . . .	12 × 1.25	120	12	86.8

Continued " Torque specifications "

DESCRIPTION	Size and thread (metric)	Ultimate strength of material kg/mm²	TORQUE kgm	TORQUE ft.lb
IV — C.A.V. injection pump				
Capscrews securing the end plate containing the relief valve to the hydraulic head			0.50	3.5
Fuel inlet connection, (*48*, Fig. IV/41)			5.20	37.5
Fuel inlet connection pipe			1.40	10
Screw (*83*, Fig. IV/42) on distributing rotor axis			0.30 (²)	2.2
Transfer pump rotor (*27*)			0.75	5.5
Screws, hydraulic head (bleed screw included)			1.95	14
Locating fitting, hydraulic head (*19*, Fig. IV/41)			4.00	29
Stud nut, auto advance device (*16*)			1.50	11
Stud (*16*), auto advance device			0.70	5
Cam advance screw (18, Fig. IV/47)			5.20	37.5
Plugs, auto advance device (*65*, and *75*)			2.90	21
Screw, piston cap (*76*)			0.45	3.2
Drive plate screws (*64*, Fig. IV/42)			2.90 (³)	21
Ditto., with the wrench *A 711041/12* (Fig. IV/73) for torque wrench (4)			2.35 (³)	17
Studs, governor cover			0.70	5
Stud nuts, governor cover (33, Fig. IV/41)			0.45	3.2
Nuts, speed and stop control levers			0.35	2.5
Adjusting nut, governor link (*34*, Fig. IV/47)			0.25	1.8
Adjusting screw locknut, wide open throttle (*41*, Fig. IV/41)			0.25	1.8
Leak-off connection (*1*)			2.00	14.5
Vent screw thread, governor			0.75	5.5
Vent screw, governor			0.45	3.2
Nut, pump shaft			8.3 (⁵)	60
Pressure outlet connection (with copper washer)			3.00	21.7
Starting aid	½ Gas		5	36.2
V - Lubrication system.				
Capscrews, oil pump	8 x 1.25	80 Zinc plate	2.3	16.6
Capscrews oil pump cover	8 x 1.25	80 Zinc plate	2.3	16.6
Valve, pressure regulation (relief)	24 x 1.5	50	7.5	54.2
VI - Cooling				
Capscrews, water pump (C_2, Fig.VI/10)	10 x 1.25	80 Zinc plate	6	43.4
Capscrews, fan	8 x 1.25	80 Zinc plate	2.3	16.6
Nut, ventilator and alternator drive pulley hub.	30 x 1.5	30 Bon Zinc	34.5	249.5

(¹) Data apply to fasternings lubricated with crankcase oil.
(²) Seal with a suitable jointing compound (Araldite).
(³) After torque tightening to specified value, turn screws back and re-tighten them.
(⁴) Arrange the two screws in line with the hub of the first wrench 127 mm (5 in) away from the screw.
(⁵) Tighten first using a plain washer, then remove it and fit a safety washer.

SERVICE TOOLS

Tool No.	DESCRIPTION
	0 - Data - Removal - Installation.
293002/1 -	Universal bracket for engine installation on turnover stand.
292927 - A 147022/A	Puller, pivot shaft.
291274 - A711041/12	Torque wrench engine mounting capscrews.
291309 - A 711150	Recording pressure tester (Fig. 0/3).
290090 - 2216/F	Turnover stand, engine overhauling (Fig. 0/11).
290740 - ARR 117105	Engine lifting hook (Fig. 0/10).
290737 -ARR 117204/A 290738 -ARR 117204/B 290739 -ARR 117204/C	Bearer bracket set for engine installation on stand **ARR 2216** (Fig. 0/11).
	I - Crankcase - Cylinder head - Oil sump.
291112 - A 511481	Valve support (Fig. I/8).
291113 - A 511482	Cylinder head stand (Fig. I/8).
291179 - A 517039	Cutter and mandrel set, valve seat refacing (Fig. I/8).
292507 - 291501 - A917072/A	Plate set, cylinder liner removal-installation (Fig. I/3).
292913 - A 60419	Universal lathe for regrinding valve seat as on alternative to cutters A.517039.
	II - Timing.
290706 - A 95058	Installation tool, front and rear bushings.
290705 - A 95543	Installation tool, middle bushing.
290886 - A 313046	Wrench, rocker arm adjustment (Fig. II/10).
291046 - A 511009	Valve guide removal-installation tool.
291050 - A 511028	Valve installation-removal tool (Fig. II/8).
292911 - A 537105	Universal puller, camshaft bushing (Fig. II/5).
291504 - A 917014	Puller, crankshaft hub (Fig. II/13).
290064 - 5084	Pneumatic valve grinder (Fig. II/9).
291177 - U 517030	Valve guide reamers.
A90363 - 293269	Fixed-blade reamer for fitting bushings.
	III - Power chain.
290712 - A 96553	Installation tool, crankshaft front seal.
291048 - A 511018	Compressor band, piston rings (Fig. III/14).
291159 - A 511801	Pliers, piston ring removal-installation (Fig. III/11).
291274 - A711041/12 291276 - A711041/36	Torque wrenches, crankshaft journal bearings self-locking screws (Fig. III/15).
- - C 517023	Squareness set up, connecting rod and piston-connecting rod units (Fig. III/12).

Continued " Service tools "

Tool No.	DESCRIPTION
	IV - Injection pump C.A.V.
	Test rig equipment.
290761 – A 127040	Test instruments and gauges.
290764 - A 127044	Discharge fitting to be used during calibration.
290763 – A127041bis	Pump mounting on test machine without speed reduction unit.
290765 – A 127045	Pressure pipes to injectors (CAV) for test A.
	C.A.V. pump overhaul.
290741 – A 127001	Guide, throttle lever shaft removal.
290742 – A 127002	Guide, control lever shaft sealing ring installation.
290743 – A 127003	Checker, advance degrees.
290744 – A 127004	Adaptor (to be used with the torque wrench) for screwing and unscrewing the supply pump rotor.
290745 – A 127005	Installation guide, sealing rings for securing the hydraulic head on the manual retard device.
290746 – A 127006	Installation guide, automatic advance variator plug sealing rings.
290752 – A 127013	Plate securing the pump to revolving support 290239.
290747 – A 127007	Wrench, rotor flange stop.
290748 – A 127008	Plug, pump sealing tightness check.
290749 – A 127009	Connection, transfer pump pressure test.
290750 – A 127010	Connection, fuel return line.
290751 – A 127011	Connection, fuel supply lines.
290753 – A 127015	Connection, pump tightness check (with compressed air).
290754 – A 127019	Wrench, delivery adjusting screws (for torque wrench **A 711041/12**).
290755 – A 127021	Connection with relief valve, pumping plunger stroke check.
290756 – A 127022	Flexible coupling, pump drive on test machine.
290757 – A 127027	Graduated scribing tool, timing mark on pump flange.
290758 – A 127028	Connection, cam ring pin removal-installation.
290759 – A 127030	Installation guide, governor shaft in pump body.
290205 – A4000 3/32"	Wrench, central rotor screw head.
290760 - A 127031	Fitting, securing the advance variator (for three cylinder engines).
	VI - Cooling system.
292945 – –	Box containing the thermometer for checking temperature of vessel **A 711149**.
– – A 711149	Vessel, thermostat calibration check.
291182/1 – A 517060	Puller, water pump impeller (Fig. VI/4).
290694 – A 92532	Drive punch, water pump impeller.

POWER TRAIN AND ATTACHMENTS

GENERAL DESCRIPTION

The power train consists of the following major units :

- Ferodo or Luk or O.M.G. make dual-plate dry clutch with separate controls;

- transmission with epicyclic gear reduction: with eight forward (four with synchro mesh)and two reverse speeds;

- main drive bevel gear and two-gear differential with lock and pedal ;

- dry contracting band service brakes with mechanical control and indipendent pedals;

- single-reduction final drives ;

- telescoping front axle centrally pivoted with reversed U shaped section ;

- steering with wheel and worm gear and unit box.

The Controlmatic hydraulic lift is of the position and draft control type.The P.T.O. and drive are incorporated in the transmission housing rear cover and the belt pulley is optional.

TRANSMISSION RATIOS, PERFORMANCE, WEIGHT AND CONSUMPTION DATA

Speed gears	Transmission and epicyclic gear train speed reduction ratios 1 :	Overall speed reduction ratios from engine to drive wheels(1 wheel turn per engine revs) 1 :	Maximum speed (with engine running at 2400 r.p.m. and rear tyres 12.4/11-36) km/h	MPH
1st Low	10.575	256	2.4	(1.5)
2nd "	7.029	170.1	3.7	(2.3)
3rd "	4.799	116.2	5.4	(3.3)
4th "	3.716	89.9	7.0	(4.3)
1st High	2.938	71.1	8.8	(5.5)
2nd "	1.952	47.2	13.3	(8.3)
3rd "	1.333	32.2	19.5	(12)
4th "	1.032	24.9	25.2	(15.6)
1st Creeper(°)	32.6	790.2	0.80	(0.49)
2nd " "	21.7	525.5	1.20	(0.74)
3rd " "	14.8	358.9	1.76	(1.09)
4th " "	11.4	277.8	2.27	(1.40)
Low Reverse	7.359	178.2	3.5	(2.2)
High Reverse	2.044	49.5	12.7	(7.9)
Creeper Rev.(°)	22.7	550.3	1.15	(1.21)

Bevel gear speed reduction ratio 12/47 .... 1 : 3.917
Final drive speed reduction ratio 11/68 .... 1 : 6.181
Total speed reduction ratio (final drives-bevel gear). 1 : 24.212

Tractor weight (with standard fittings, oil, coolant and fuel, operator excluded) .... 2160 Kg (4762 lb)

(°) With subsidiary reduction unit (optional).

POWER TRAIN AND ATTACHMENT LUBRICANTS

Fill point	Inspection schedule hours	Change schedule hours	Lubricant FIAT	Lubricant International	Capacity kg	Capacity Imp. qts.
Transmission housing rear train housing and hydraulic lift unit (*)	400	1600	AMBRA 20 W - 40	MIL-L-2104B (1)	17,5	16
Final drives (each)	400	1600	AMBRA 20 W - 40	MIL-L-2104B (1)	3,9	3,5
Steering box	400	—	AMBRA 20 W - 40	MIL-L-2104B (1)	0.35	0.35
Drive pulley	50	1600	AMBRA 20 W - 40	MIL-L-2104B (1)	0.4	0.4
Front wheel hubs (each)	400	—	MR3 Grease	NLGI 3 (2)	0,25	0.25
Grease nipples	50	—	G9 Grease	NLGI 2 (3)		

(*) For temperatures below 0°C (32°F) use oliofiat AMBRA 10W/30.

(1) Multigrade motor oil, SAE viscosity no. 20 W-40, detergent to spec. MIL-L-2104 B and suitable for general lubrication purposes.
(2) Mineral grease, litium soap base, consistency NLGI no.3.
(3) Mineral grease, litium-calcium soap base, consistency NLGI no.2.

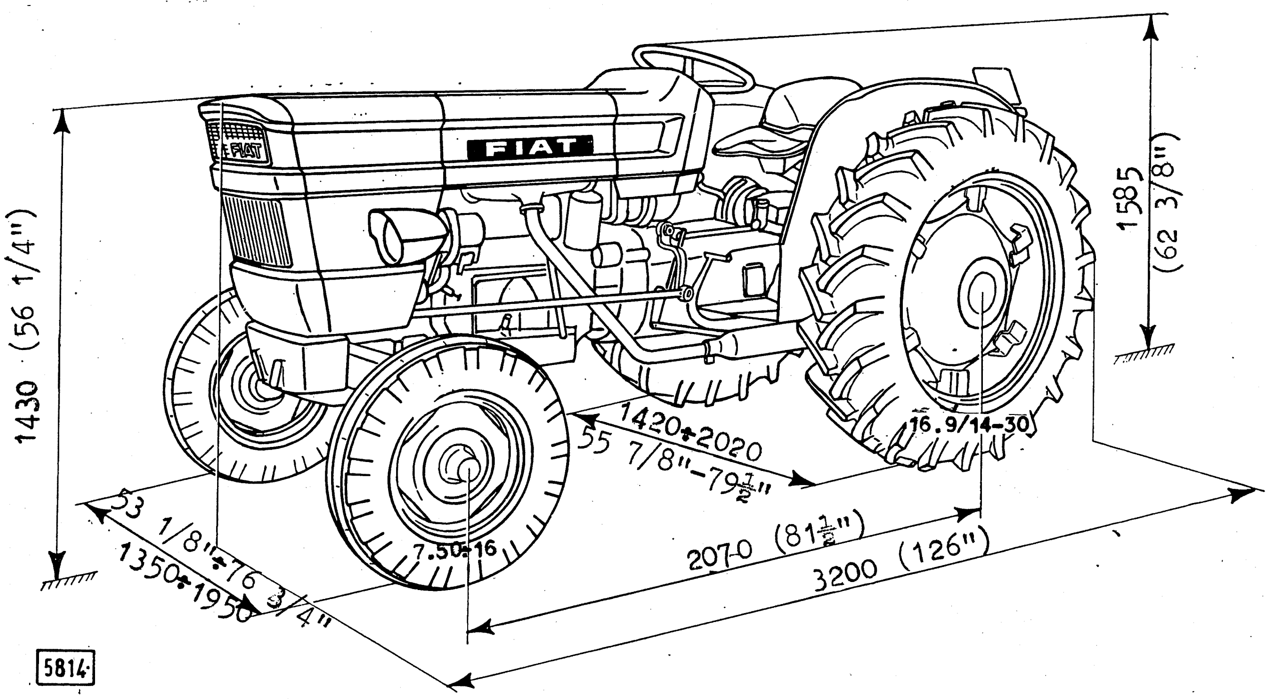


Fig.0/2 - Overall dimensions of the tractor Mod.640

I — CLUTCH

11" CLUTCH (FERODO) DESCRIPTION AND OPERATION

The clutch type **FERODO 280 D 2 B** groups into a single unit two 11" single-plate dry clutches one of which acts on the transmission and the other actuates the power take-off (Fig. I/1).
The two clutches are indipendent and are provided with separate controls: the clutch transmitting engine power to the transmission has a pedal control and the P.T.O. clutch a hand control lever.
When the pedal (**P**, Fig. I/13) is depressed, the transmission clutch throw-out collar (**12**, Fig. I/1) takes up the play (**A**, Fig. I/11) and abuts against the diaphragm spring (**8**, Fig. I/1). This is provided with radial cuts which increase its flexibility and is fixed to the clutch cover by means of the pins (**14**) and by the annular ring (**15**).
The release collar (**12**) thrust bearing compresses the diaphragm spring (**8**) internally and the latter, reacting on the ring (**15**) and relieving externally the load on the pressure plate (**7**) circumference causes the disengagement of the friction disc (**6**). The disengagement of the pressure plate is further facilitated by three intermediate return springs (**20**).
By actuating the hand lever (**L**, Fig. I/13), the P.T.O. clutch collar (**10**, Fig. I/1) takes up the play (**B**, Fig. I/11) and acts upon the release levers (**9**). These are pivoted on the clutch cover and are connected to the pressure plate (**2**) through the rods (**5**). The pressure by the collar (**10**) disengages the clutch disc (**1**) and compresses the dish spring (**3**), through the pressure plate (**2**) and clutch housing.
Both clutches are engaged by releasing the load on the diaphragm and dished springs (**8** and **3**).

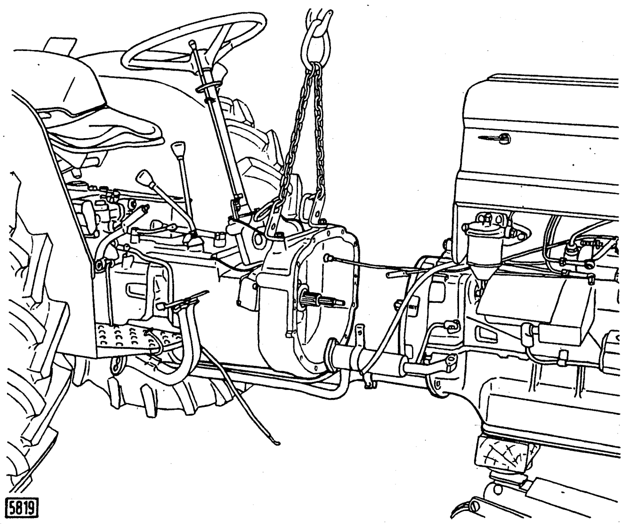
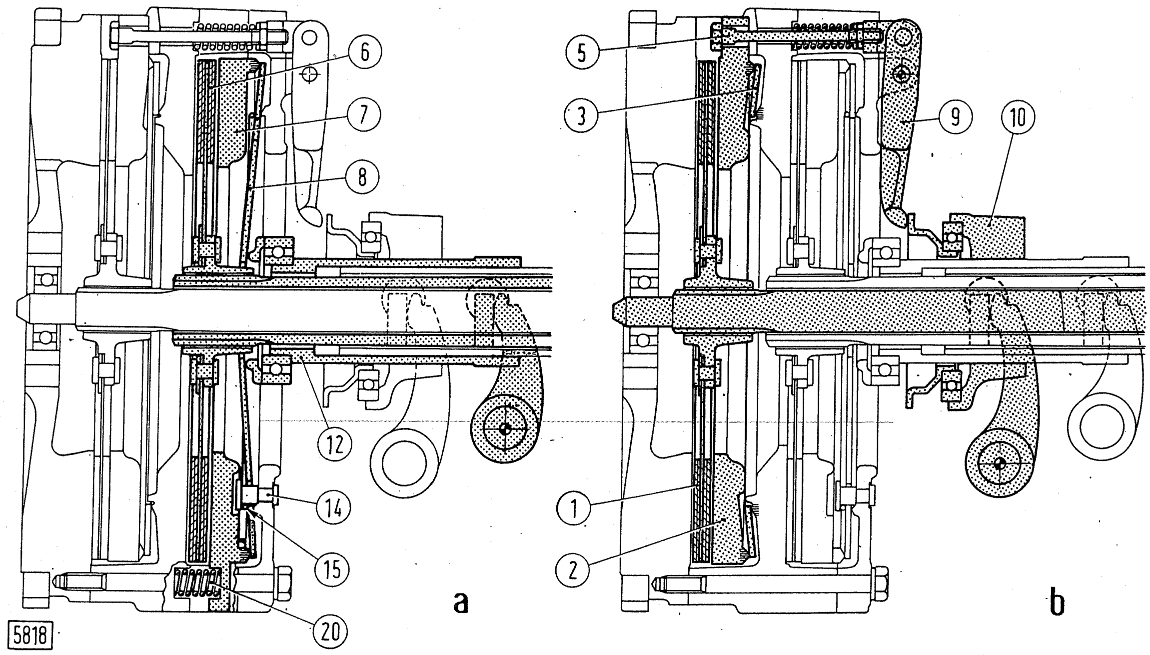


Fig. I/2 *- Removing (refitting) the engine-axle group with clutch from the power train*



a. Transmission clutch disengaged.

b. P.T.O. clutch disengaged.

Fig. I/1 *- Clutch (FERODO) operational diagrams.*
(The annotated parts are described in the text).

11" CLUTCH (FERODO) REMOVAL

Split the engine with front axle as an assembly from the tractor transmission housing (Fig. I/2) and then remove the clutch unit from the engine flywheel as follows:

1. Disconnect the battery ground cable and protect the terminal.

2. Remove, in the order:
— the hood back plate, and from this remove the lighting-starting switch, the electric horn pushbutton and the radiator curtain control on those tractors which are equipped with one;
— the rear hood after separating it from the side panels and dashboard;
— the dashboard, disconnecting the tractormeter cable, electrical connections and starting switch unit;
— the fuel tank after closing the cocks, disconnecting the fuel level indicator wires and fuel lines and removing the mounting brackets.

3. Disconnect the electric cables from the engine starting safety push-button and from the rear lighting connections and place the cable strap assembly on the engine (**Fc**, Fig. I/3).

4. Remove the fuel tank supports (**18**) by separating them from the central panel, disconnecting the throttle controls from the linkage and unscrewing the engine stop control knob.

5. Drain the transmission and rear train housing of lubricating oil and detach:
— hydraulic lift oil lines from the pump installed on the engine;
— the exhaust muffler from the left-hand side final drive, loosening then the stud nuts which secure it to the exhaust manifold;
— the drag link from the steering box arm.

6. Put on the hand brake, insert two wooden wedge blocks between the front axle and its support, attach a lifting chain to the transmission housing and to a shop hoist, then take the weight off and place a hydraulic jack under the engine oil sump.

7. Remove all attaching capscrews (**C_3** and **C_5**, Fig. I/11) and move the engine-front axle unit forward, separating it from the transmission housing and then placing it on a shop stand (Fig. I/2) after suitably wedging the front wheels.

8. Remove the clutch unit from the engine flywheel, as follows:
— cross-slacken and remove four of the six screws (**C_4**, Fig. I/14) securing the clutch to the flywheel;
— introduce the aligning spigot (**E**) of the fixture **291184** (was **A 517063/L**) in the clutch shaft locations;

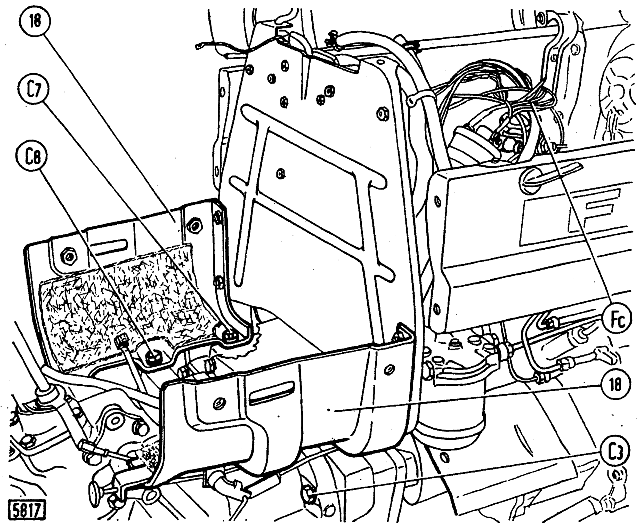


Fig. I/3 - *Right-side view of tractor without rear hood and fuel tank.*

C_3. Upper screws securing the clutch-transmission housing to the engine crankcase. - C_7. and C_8. Tank supports front and rear attaching capscrews. - Fc. Electric cable strap. - 18. Fuel tank supports.

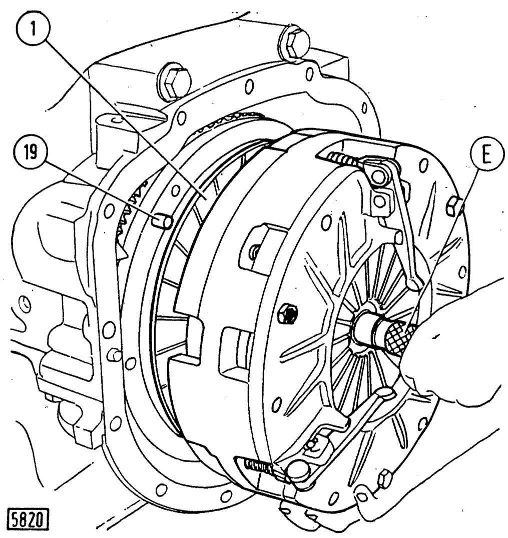


Fig. I/4 - *Removing (refitting) the 11" clutch unit from the engine flywheel.*

E. Spigot of tool 291184 (was A 517063/L.) - 1. P.T.O. clutch disc. - 19. Clutch cover alignment dowel.

— remove the two remaining screws and then the complete clutch unit (Fig. I/4) withdrawing it from the alignment dowels (**19**) and recovering the P.T.O. clutch disc (**1**).

11" CLUTCH (FERODO) DISASSEMBLY

Prior to disassembly, scribe assembly marks on clutch cover (**4**, Fig. I/5) and pressure plates (**2** and **7**), as illustrated, to make sure the parts are re-assembled in their respective original positions thus maintaining the dynamic balance of the unit as set at the factory.
To dismantle, reassemble and adjust the clutch use tool **291291/2** (Fig. I/8) or universal tool **293650** (Fig. I/9).
To fit the clutch to tool **291291/2** proceed as follows:

— Place spacer (B) on base plate (A, Fig. I/8) and three locaters (E) over a 241 mm (9.5 in) circumference.

— Rest the P.T.O. clutch assembly without the driven plate on the base plate and secure by means of three fasteners (F) provided with guide bushes (G).

To fit clutch to universal tool **293650** proceed as follows:

— Position spacer (B) on base plate (A, Fig. I/9) with register contact surface 124,5 mm (4.901 in) above base plate and tighten at this height using locknut (D).

— Position adjustable locators (E) on a 240 mm (9.4 in) circumference with the top surface 9 mm (.4 in) from base plate and tighten using hand wheels (M).

— Rest the P.T.O. clutch assembly without the driven plate on the base and secure by means of three fasteners (F) provided with guide bushes (G) and clamps (I).

— Remove cotter pins and withdraw the release lever (**9**) pivot pins (**21**, Fig. I/5) and turn the levers over towards the outside.

Remove the cover screws (**C_6**) and gradually unscrew fasteners (F, Figs. I/8 and I/9) to take the load off the springs for subsequent clutch dismantling as shown on Fig. I/6.

INSPECTION

Check wear of the friction linings of discs (**1** and **6**, Fig. I/7) vs. tabulated limits. If the discs are impregnated with oil we recommend replacing them as washing with gasoline and brushing are not enough.
Check the pressure plate and clutch casing contact surfaces; if necessary, these surfaces may be dressed according to the dimensions given in the illustration and noting the following instructions.

1. P.T.O. clutch pressure plate (**2**, Fig. I/15) - Grind contact surface down to a maximum depth of 1 mm. (.04 in). Subsequently, also grind the clutch casing surface (**C**) removing an equivalent amount of material.

2. Transmission clutch pressure plate (**3**) - Proceed as described above and remove the same amount of material from clutch casing (B).

3. Clutch casing (**4**) - Grind contact surface (A) to a maximum depth of .5 mm (.02 in).

If necessary, the flywheel face may be dressed noting that the .5 mm (.02 in) deep peripheral step must be restored.

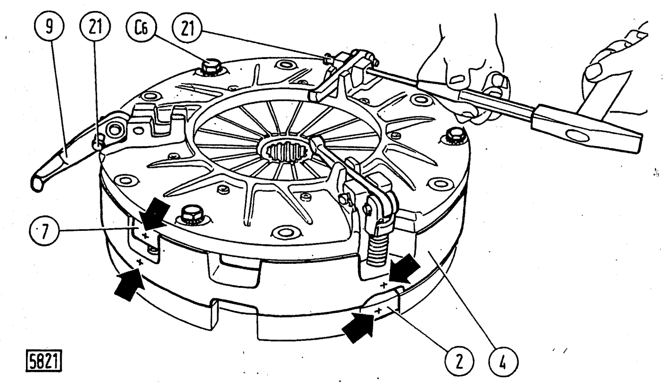


***Fig. I/5** - Removing the release levers (9) pivot pins (21) on the clutch cover.*

(Arrows indicate the assembly marks to be scribed prior to disassembly).
C_6. Clutch cover attaching capscrews. - 4. Clutch cover. - 2 and 7. Transmission and P.T.O. clutch pressure plates.

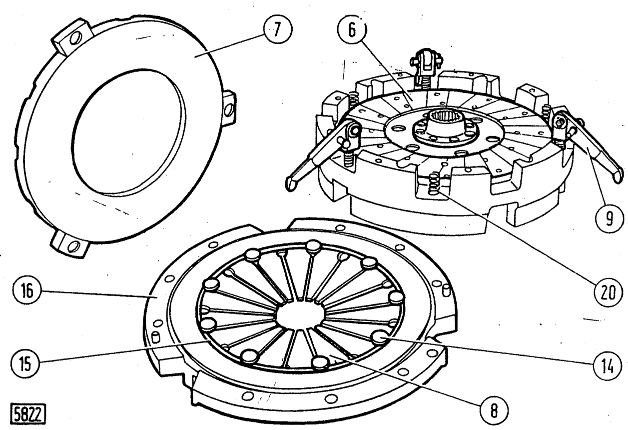


***Fig. I/6** - Removing (refitting) the transmission clutch.*

6. Clutch disc. - 7. Pressure plate. - 8. Diaphragm spring. - 9. P.T.O. clutch release levers. - 14 and 15. Spring (8) attaching pin and ring. - 16. Clutch cover. - 20. Pressure plate intermediate return springs.

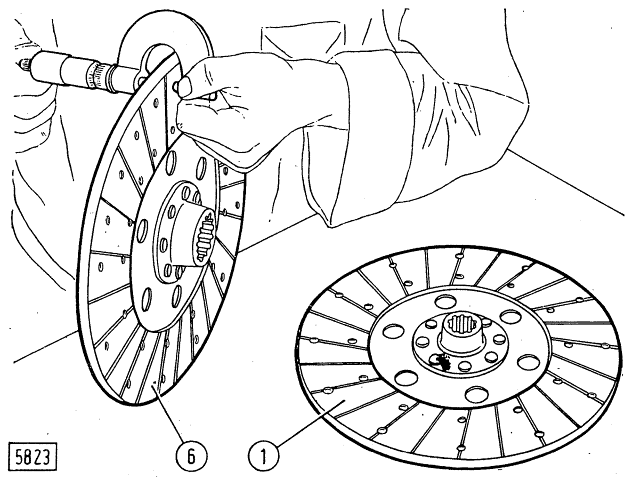


Fig. I/7 - Checking the 11" clutch discs.
1. P.T.O. clutch disc. - 6. Transmission clutch disc.

Examine the return springs (**20**, Fig. I/6) and (**22**, Fig. I/12) measuring their flexibility and cheching the values obtained vs. the specifications given in the table of data.
The diaphragm and dished springs (**8** and **3**, Fig. I/11) should not lose their flexibility even after long service periods. Should they need to be replaced notice that the diaphragm spring (**8**. Fig. I/6) spares are available only with the cover (**16**) as an assembly, being it ridigly fixed to the cover by the pins (**14**) and by the annular ring (**15**).

To reassemble the clutch use tool **291291/2** or universal tool **293650**, noting the following points:
— Reposition dished spring (3, Fig. I/11) over the P.T.O. clutch pressure plate with the convex side uppermost.
— Adjust the clutch as directed below.

11" CLUTCH (FERODO) ADJUSTMENTS

For a correct P.T.O. clutch adjustment, the release levers should be aligned at the same dimension from the flywheel surface.
Clutch adjustment may be carried out both on the bench and with the clutch fitted to the fywheel.

1. On-bench clutch adjustment

Position the clutch over the base plate of tool **291291/2** or universal tool **293650** and clamp using parts previously mentioned for dismantling.

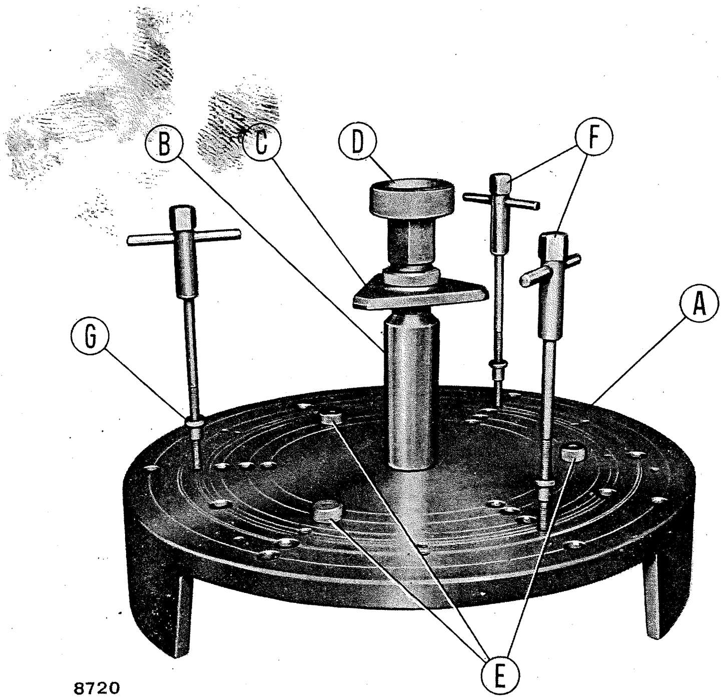


Fig. I/8 - Component Parts of Ferodo Clutch Adjuster 291291/2

A. Base plate **292598** - B. Spacer **292342.** - C. Register **292347** - D. Nut **292344** - E. Locators **293454** - F. Fasteners **291292/1** - G. Bushes **291293/1.**

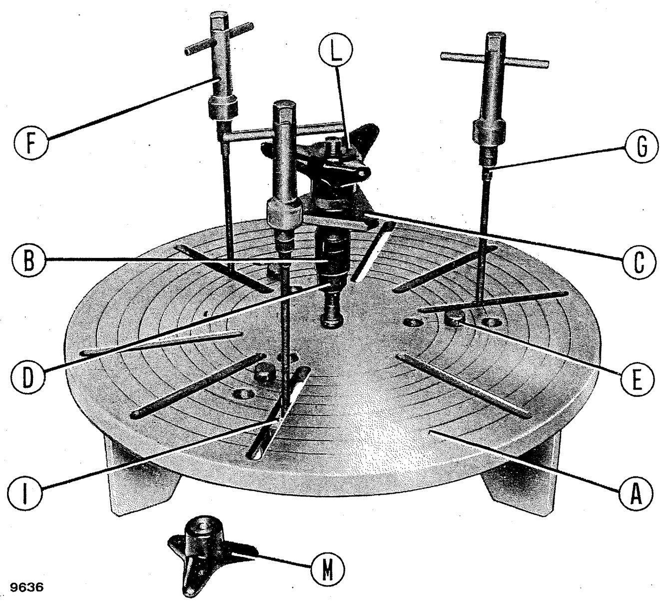
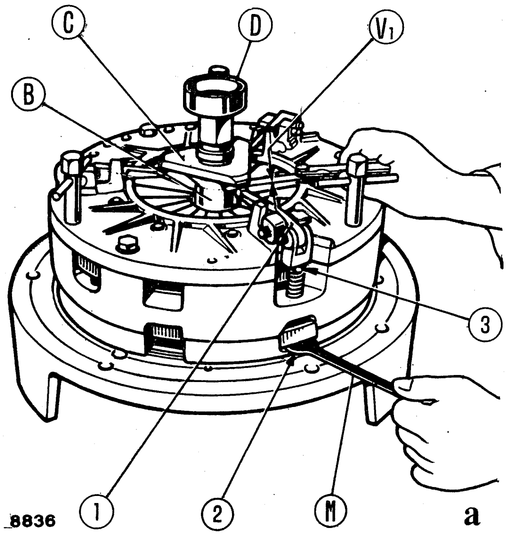
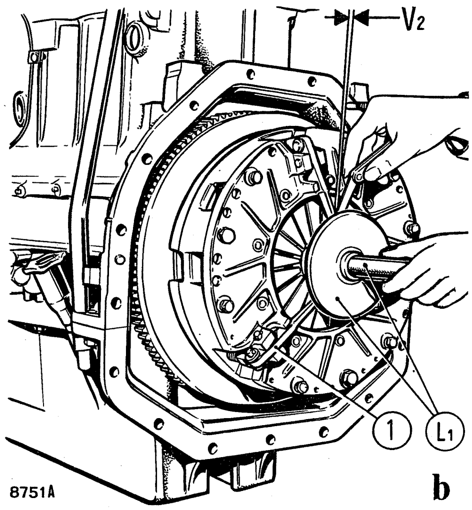


Fig. I/9 - Component Parts of FERODO Clutch Universal Adjuster 293650.
A. Base plate **293332/1** - B. Spacer **293728** - C. Register **293732** - D. Locknut **293730** - E. Locators **293726** - F. Fasteners **293725** - G. Bushes **293734** - I. Clamps **293755** - L. Handwheel **293730** - M. Handwheels **293740.**

Fig. I/10 - *Checking P.T.O. clutch release lever height*

a. On-bench adjustment using tool **291291/2**, or universal tool **292650** - b. On-flywheel adjustment - B. Spacer - C. Register - D. Nut **292344** (for tool **291291/2**) or handwheel **293739** (for universal tool **293650**)- L_1. Centralizer **291184** (was A 517063/L) - M. Wrench **291187** - V_1 = .1 mm (.004 in), release lever gap against register - V_2 = .1 mm (.004 in), release lever gap against clutch with unit fitted to flywheel - 1. Release levers - 2/3. Adjusting screw and nut.





Install register (**C**) and fasten with nut (**D**), tool **291291/2**, or handwheel (**L**, Fig. I/9), universal tool **293650.**

Using spanner (**M**), screw in or back off P.T.O. clutch release lever screws (**2**) to obtain a clearance (V_1) between the end of each release lever and register (**C**). Subsequently, tighten the screws using nuts (**3**)

2. On-Flywheel Clutch Adjustment

Insert centraliser (L_1) **291184 (was A517063/L)** in place of the clutch shaft ensuring that the end is in contact with bearing (**17**, Fig. I/11), and push the associated register against it.
Adjust cap (V_2) as directed above for (V_1) gap adjustment.

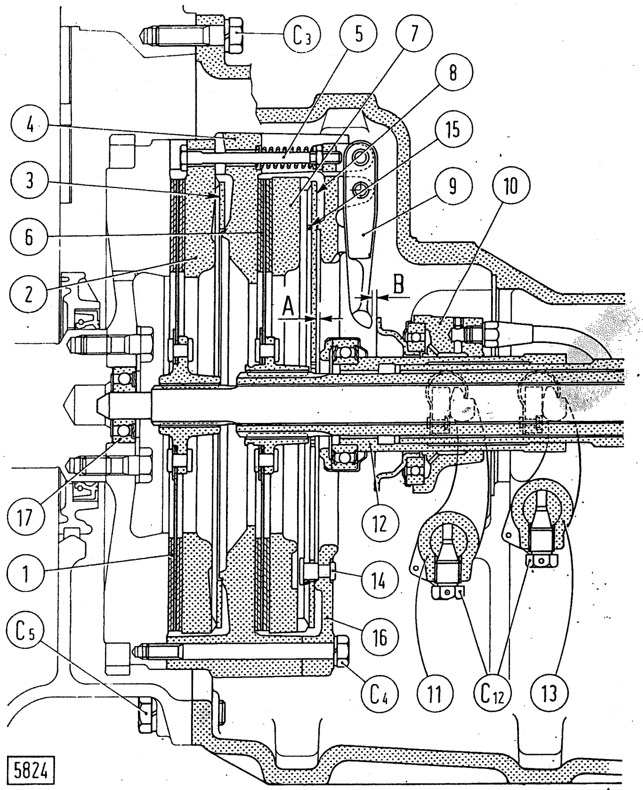


Fig. I/11 - *11" Clutch cross-section.*
A = 2.5 mm (0.098") Gap between release collar (12) and spring (8). - B = 2.5 mm (0.098"). Gap between collar (10) and release levers (9). - C_3 and C_5. Cap screws securing clutch-transmission housing to engine crankcase. - C_4. Cap screws securing clutch to engine flywheel. - C_{12}. Fork levers (11 and 13) setscrews. - 1,2 and 3. Disc, pressure plate and dished spring of the P.T.O. clutch. - 4. Clutch case - 5. Adjustable rod for release lever (9). - 6,7 and 8. Disc, pressure plate and diaphragm spring of the transmission clutch. - 9, 10 and 11. Release lever, collar and fork of the P.T.O. clutch. - 12 and 13. Transmission clutch release collar and fork. - 14 and 15. Diaphragm spring attaching pin and ring. - 16. Clutch cover. - 17. P.T.O. shaft ball bearing.

Note: On-bench and on-flywheel clutch adjustment may result in quite considerable differences in terms of positioning, a fact which does not affect clutch efficiency, being due to varying P.T.O. clutch plate thickness owing to machining tolerance build-up or wear, plus the magnification inherent in the high leverage ratio.

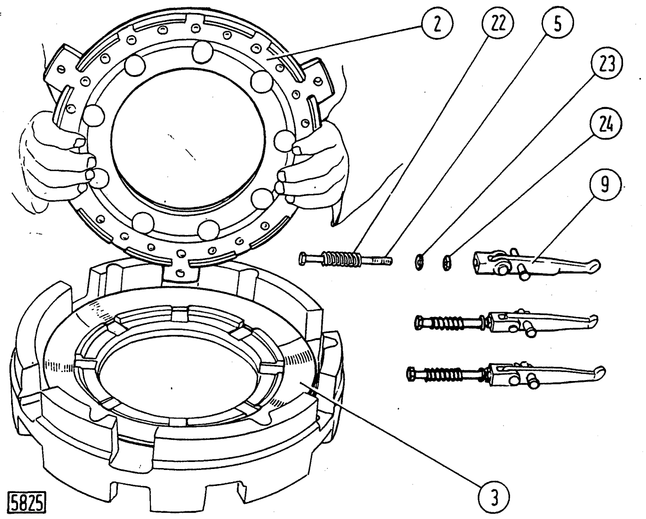


Fig. I/12 - Assembly (disassembly) of the P.T.O. clutch.

2. Pressure plate. - 3. Dished spring. - 5 and 9. Release rods and levers. - 22 Return springs. - 23. Spring washers. - 24 Tie-rods locknuts (5)

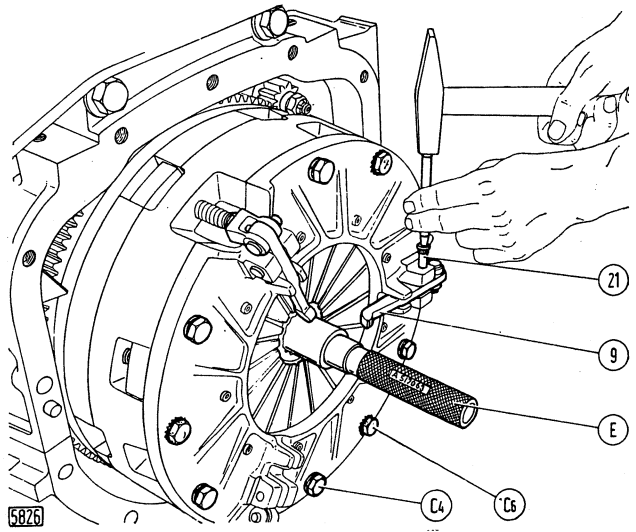


Fig. I/14 - Fitting the release levers (9) pivot pins (21) to the clutch installed on the engine.

C_4. Clutch attaching capscrews to the engine flywheel. - C_6. Clutch cover capscrews. - E. Alignment spigot of the fixture **291184** (was A **517063/L**).

3. Adjusting the free travel of the pedal (P, Fig. I/13) and of the hand control lever (L)

The free travel which the footrest of the pedal makes before commencing the disengagement of the transmission clutch, i.e., before the collar (**12**, Fig. I/11) after taking up clearance (**A**), acts on the diaphragm spring (**8**) is 35÷40 mm (1-3/8" ÷ 1-37/64") (**Z**, Fig. I/13).

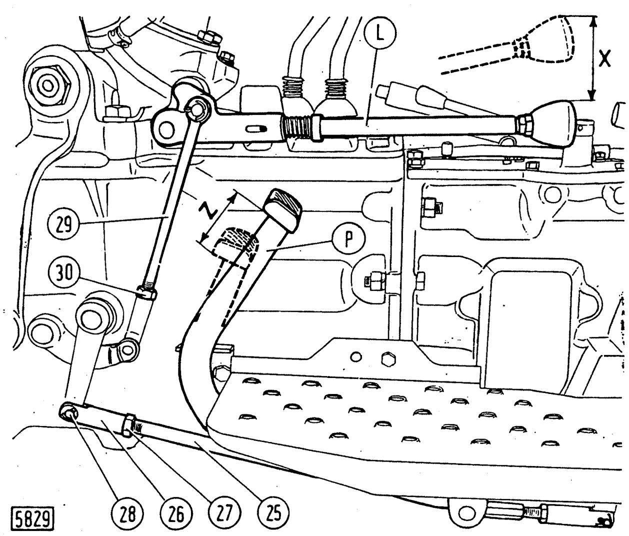


Fig. I/13 - Checking and adjusting the 11" clutch control.

L. P.T.O. clutch hand control lever. - P. Transmission clutch pedal. - Z = 35÷40 mm (I-3/8 ÷ 1-37/64"). Pedal free travel. - X = 40 m. (I-37/64"). Hand lever free travel. - 25 and 26. Adjustable rod and transmission control clevis. - 27. Clevis locknut. - 28. Clevis pivot pin. - 29 and 30. P.T.O. clutch adjustable rod and its drive nut.

When, because of disc lining wear, the free travel left is down to about 25 mm (~ 1"), adjust it as follows:

— slacken the locknut (**27**, Fig. I/13) and separate the clevis (**26**) from the outside arm by with-drawing the pin (**28**);

— screw back the clevis (**26**) to extend the rod (**25**) to suit, considering that the free travel varies by 10 mm (25/64") for each full turn;

— block the adjusting clevis with the locknut (**27**) and re-connect it to the outside disengagement arm;

— make sure the free travel (**Z**) measured on the pedal foot-rest, is about 35 mm (1-3/8").

The free travel which the hand lever grip makes before starting to disengage the P.T.O. clutch (i.e., before the collar **10**, Fig. I/11, after taking up the clearance **B**, acts upon the release levers (**9**) is about 40 mm = 1-37/64" (**X**, Fig. I/13).
When, because of disc lining wear, the free travel left is down to about 20 mm (25/32") adjust it as follows:

— slacken the locknut (**30**, Fig. I/13) and disconnect the link (**29**) from the hand control lever shaft;

— extend the link by screwing it back to suit, considering that the free travel veries by 20 mm (25/32") for each full turn;

— re-connect the link to the hand control lever shaft and tighten the locknut (**30**);

— make sure the free travel (**X**) measured at the lever hand grip, is about 40 mm (1-37/64").

11" CLUTCH (FERODO) INSTALLATION

Before refitting the clutch be sure to fill the flywheel housing of the pilot ball bearing (**17**, Fig. I/11) with FIAT G 9 (multi-purpose, NLGI 2) grease.

When the assembly has been carried out on the tool **291291/2** or on the universal tool **293650** refit the clutch to the engine flywheel as follows:

— Insert the P.T.O. clutch disc (**1**, Fig. I/11) arranging it as illustrated in the figure;

— line up the clutch unit and disc (**1**) by means of the spigot (**E**, Fig. I/4) of the fixture **291184 (was A 517063/L)**;

— make sure the alignment dowels (**19**) fit in the clutch cover, then tighten the attaching capscrews (**C**$_4$, Fig. I/14) gradually.

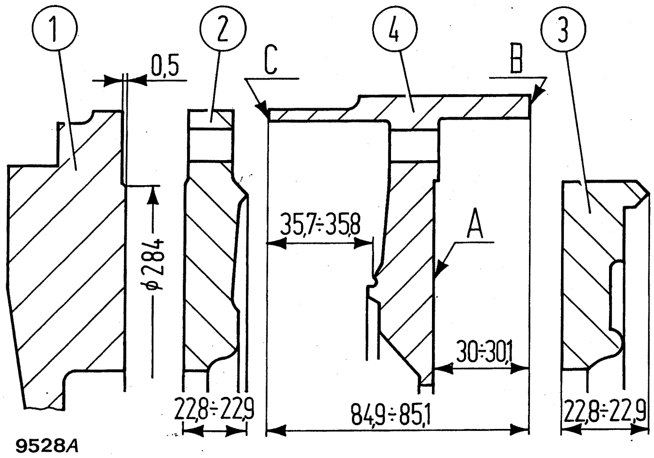


Fig. I/15 - Dimensional data in mm of pressure plates for P.T.O. clutch (2), transmission clutch (3) and clutch casing (4).
A/B/C See text - 1. Engine flywheel.

11" CLUTCH (LUK OR O.M.G.) DESCRIPTION AND OPERATION

The clutch type **LUK** or **OMG** installed as an alternative to the **FERODO** type groups into a single unit two 11" dry single-plate clutches, one of which acts on the tractor trasmission and the other controls the power take-off (Fig. I/16).

The two clutches are indipendent and are separately controlled, like the FERODO model, by a pedal which controls the clutch that transmits engine power to the transmission and by a hand lever which controls the P.T.O. clutch.
When the pedal (**P**, Fig. I/13) is depressed, the transmission clutch throw-out collar (**12**, Fig. I/16) takes up the gap (**A**, Fig. I/19) and acts upon the release levers (**14**). These are pivoted to the outside of the cover (**4**) and act through the push rods (**15**) on the pressure plate (**7**). The shifting collar (**12**) disengages the disc (**6**) and compresses the dished spring (**3**) through the peripheral rim of the pressure plate (**a**, Fig. I/16).
When the hand control lever (**L**, Fig. I/13) is shifted, the P.T.O. clutch release collar (**10**, Fig. I/16) takes up the gap (**B**, Fig. I/19) and acts on the release levers (**9**). These are pivoted to the inside of the cover (**4**) and are connected externally to the pressure plate (**2**) through the links (**5**). The shifting collar (**10**) disengages the clutch disc (**1**) and compresses the dished spring (**3**) through the inner peripheral rim of the pressure plate (**b**, Fig. I/16).
Both clutches are engaged by the extension of the dished spring (**3**).

11" CLUTCH (LUK OR O.M.G.) REMOVAL

Follow the directions given for the removal of the 11" (FERODO) clutch in the chapter on page 102.

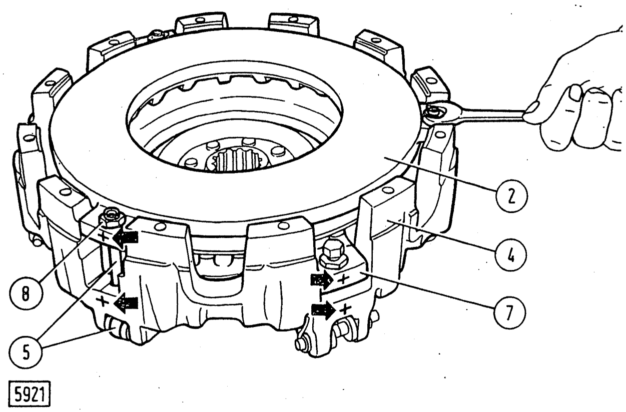
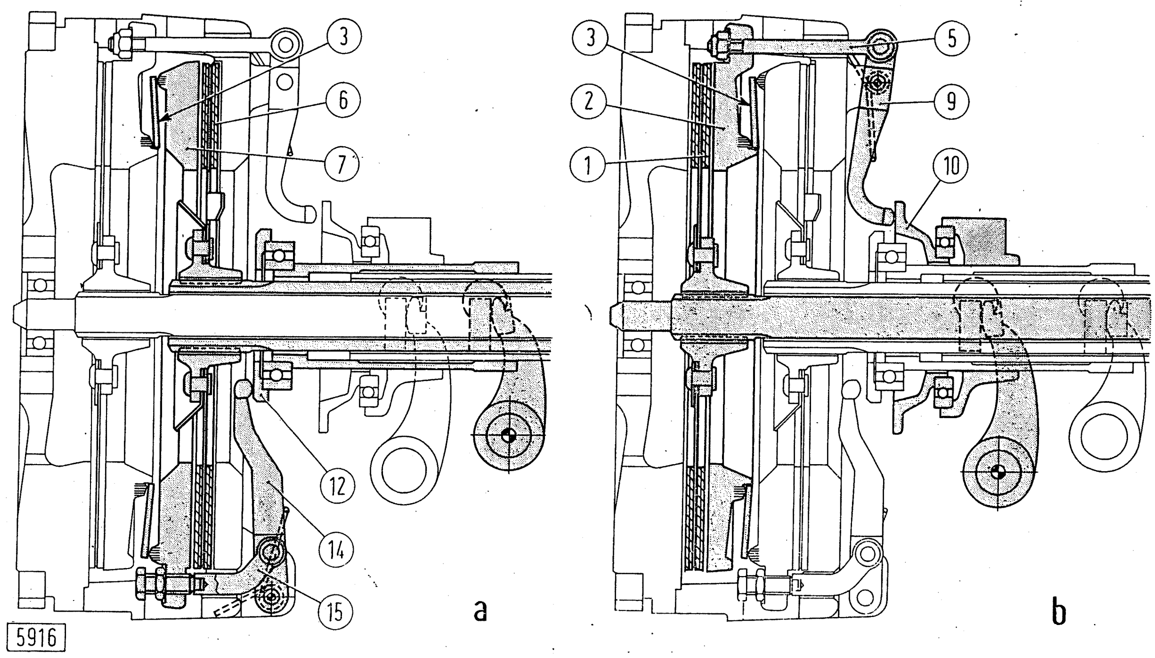


***Fig. I/17** - Removing (refitting) the nuts (8) for P.T.O. clutch release levers links (5).*
(Arrows indicate the assembly marks to be scribed prior to disassembly).
2 and 7. Transmission and P.T.O. clutch pressure plates. - 4. Clutch housing.



a. Disengaged transmission clutch.

b. Disengaged P.T.O. clutch.

***Fig. I/16** - Working diagrams of the LUK or O.M.G. 11" clutch.*
(The annotated parts are described in the text).

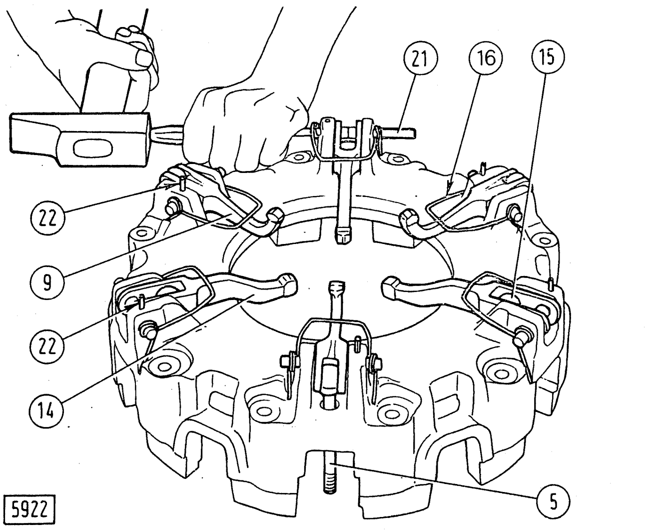


Fig. I/18 - Removing the release levers pivot pins (21).
5. Lever (9) links. - 9. P.T.O. clutch release levers. - 14. Transmission clutch release levers. - 15. Lever (14) push rods. - 16. Release lever return springs. - 22. Pin retaining split pins.

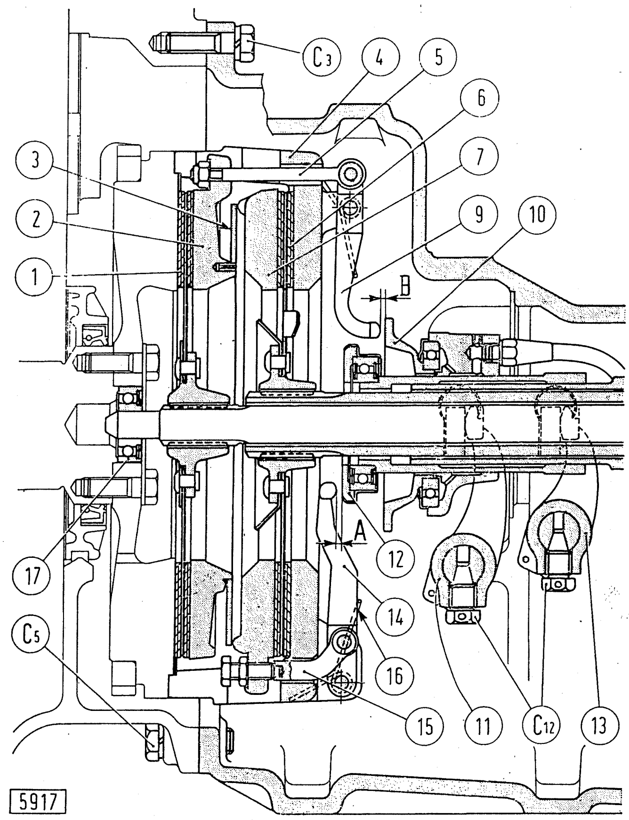


Fig. I/19 - 11" LUK or O.M.G. clutch cross-section.
A = 2.5 mm (0.098"). Gap between release collar (12) and levers (14). - B = 2.5 mm (0.098"). Gap between release collar (10) and levers (9). C_3 and C_5. Attaching cap screws securing clutch-transmission housing to engine crankcase - C_{12}. Fork levers (11 and 13) blocking screws. - 1 and 2. P.T.O. clutch disc and pressure plate. - 3. Clutch engagement dished spring. - 4. Clutch cover. - 5. Adjustable rod for lever (9). - 6 and 7. Transmission clutch disc and pressure plate. - 9.10 and 11. P.T.O. clutch release lever, collar and fork. - 12,13,14 and 15. Transmission clutch release collar, fork, lever and push rod. - 16. Release lever return springs. 17. P.T.O. shaft ball bearing.

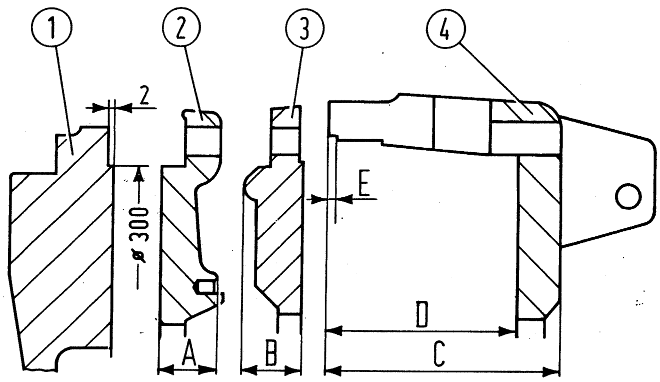
11" CLUTCH (LUK OR O.M.G.)DISASSEMBLY

Prior to disassembly, scribe assembly marks on clutch cover (**4**, Fig. I/17) and pressure plates (**2** and **7**) as illustrated to make sure the parts are re-assembled in their respective original positions thus maintaining the dynamic balance of the unit as set at the factory.

To dismantle, reassemble and adjust the clutch use tool **291291/2** (Fig. I/22) or universal tool **293650** (Fig. I/21).
To apply clutch to tool **291291/2** proceed as follows:
— Place spacer (**B**) on baseplate (**A**, Fig. I/22) and three locators (**E**) over a 241 mm (9.5 in) circumference.
— Rest P.T.O. clutch assembly without driven plate on baseplate and secure by means of three fasteners (**F**).

To apply clutch to universal tool **293650** proceed as follows:
— Place spacer (**B**) on baseplate (**A**, Fig. I/21) and position register at a height of 123 mm (4.8 in) and tighten at this height using locknut (**D**).
— Place adjustable locators (**E**) over 240 mm (9.4 in) circumference with top face at a height of 10.6 mm (0.417 in) and tighten through handwheels (**M**).
— Rest P.T.O. clutch assembly without driven plate on baseplate and secure by means of three fasteners (**F**) with pads (**I**) plus spacers (**N**).

Remove P.T.O. clutch release lever adjusting nuts (**8,** Fig. I/26) and gradually backoff studs (**F,** Figs. I/21 and I/22) to take the load off the dished spring and permit clutch disassembly.
Check wear of the friction linings of discs (**1** and **6,** Fig. I/19) vs. tabulated limits. The discs are also to be renewed if the organic facings are found to be soaked with oil.
Check friction faces of pressure plates and clutch casing. If necessary, dress noting that dimensions (**A, B, C** and **D**, Fig. I/20) of each part must not be reduced below the limits given in the illustrations. Renew as necessary.



9531B

Fig. I/20 - Minimum Dimensions After Wearing Part Dressing LUK or O.M.G. 11"/11" Clutch

A = 22 mm (.866 in) - B = 24 mm (.945 in) - C = 87 mm (3.425 in) - D = 70 ± .15 mm (2.756 ± .006 in) - E = 2.5 mm (.098 in) - 1. Flywheel - 2. P.T.O. clutch pressure plate - 3. Transmission clutch pressure plate - 4. Housing

Proceed as follows:

— Dress pressure plate surfaces.
— Replace damaged or worn plates.
— Dress clutch casing face.
— Calculate dimension (**D**) according to the following formula:

$$\mathbf{D = A + B + S_1 + S_2 + P + L}$$

where:

A and **B** = Measured dimension of two pressure plates after dressing.

S_1 and S_2 = Measured dimension of P.T.O. and master clutch plates.

P = 4 mm (.16 in) (O.M.G. clutch) or 4.5 mm (.18 in) (LUK clutch) Dimension of spring to restore original load.

L = 2 mm (.08 in). Undercut on flywheel.

— Check that distance (**D**) is at least equal to or greater than that given in the illustration and that in order for it to be reestablished, dimension (**C**) of casing is not reduced in excess of the indicated values. If necessary, replace one or both pressure plates adhering to the instructions given in the note below.

Note: Clutch casing width should not fall below 17 mm (.67 in); therefore, ensure that the following condition exists at all times:

C — D = 17 mm min.

Check that undercut (**E**) is higher than indicated in the illustration and restore as necessary.

If necessary, dress friction face on engine flywheel, and restore external undercut of 2 mm (.08 in).

Assemble clutch using tool kit **291291/2** or universal kit **293650,** noting the following points:

— Arrange the dished spring (**3**, Fig. I/19) as shown in the figure and fit it to the pressure plate (**2**) lining up to dowels with their spring locations as shown by the arrows in Fig. I/24.
— Adjust clutch as directed below.

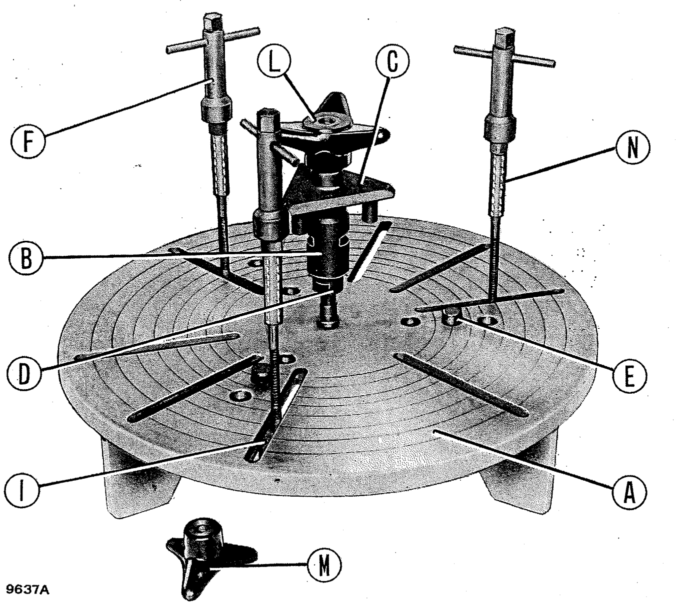


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Fig. I/21 - Component Parts of Universal tool 293650 for LUK or O.M.G. Clutch Adjustment

A. Base plate **293332/1** - B. Spacer **293728** - C. Register **293731** - D. Locknut **293730** - E. Locators **293726** - F. Studs **293725** - I. Pads **293755** - L. Handwheel **293739** - M. Locator handwheels **293740** - N. Spacers **293737.**

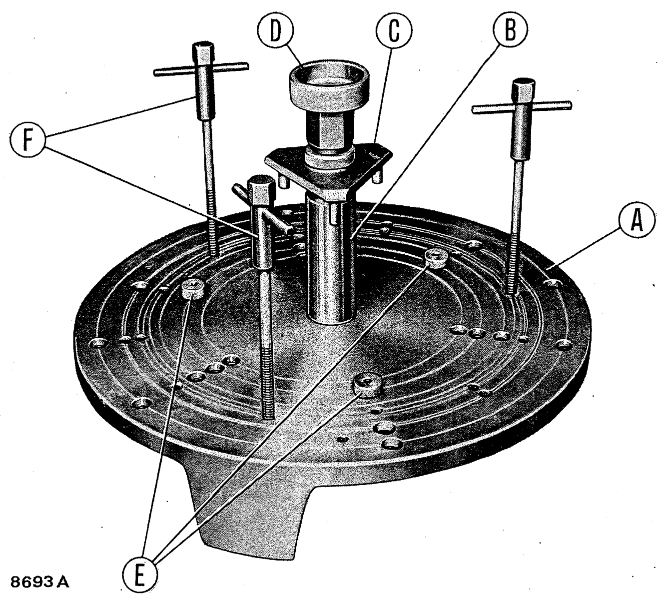

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Fig. I/22 - Component Parts of Tool 291291/2 for LUK or O.M.G. Clutch Adjustment

A. Baseplate **292598** - B. Spacer **292342** - C. Register **291299** - D. Nut **292344** - E. Locators **293454** - F. Studs **291292/1.**

11" CLUTCH (LUK OR O.M.G.) ADJUSTMENTS

For correct clutch adjustment the release levers must be correctly aligned at the same dimentions relative to flywheel face.
Clutch adjustment may be carried out both on the bench and with the clutch fitted to the flywheel.

1. On-bench clutch adjustment

Place the clutch over the baseplate of tool **291291/2** or universal tool **293650** and tighten by means of the fasteners provided as directed under dismantling (page 109).
Fit register (**C**) and tighten by means of nut (**D**), tool **291291/2**, or handwheel (**L**, Fig. I/21), for universal tool **293650.**
Screw in or back off the transmission clutch release lever screws (**19**, Fig. I/23) to obtain gap (**V_1**) between register (**C**) and release levers. Subsequently, retighten nuts (**20**).
Screw in or back off P.T.O. clutch nuts (**8**, fig. I/25) to obtain a gap (**V_2**) between each release lever and register (**C**).

2. On-flywheel clutch adjustment

Insert centraliser (**L_1**) **291184** (was **A 517063/L**) in place of clutch shafts, ensuring that the end is in contact with bearing (**17**, fig. I/19) and press against the associated register.
Adjust gaps (**V_1** and **V_2**) as indicated above.

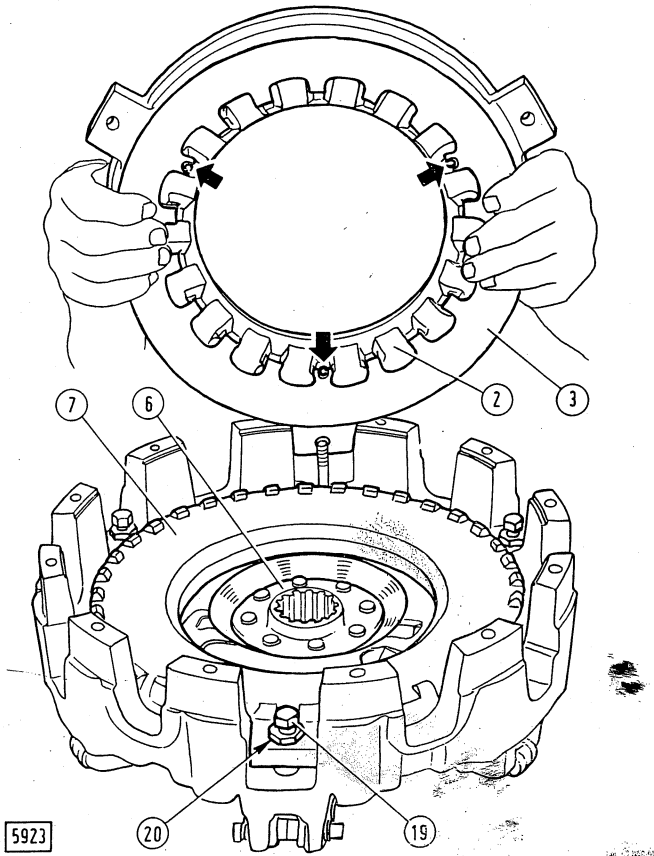


Fig. I/24 *- Fitting (removing) the P.T.O. clutch engagement dished spring (3) and pressure plate (2)*

(Arrows indicate alignment of dowel pins with respective spring locations).
6 and 7. Transmission clutch disc and pressure plate. - 19. Transmission clutch release lever adjusting screws. - 20. Screw locknuts (19).

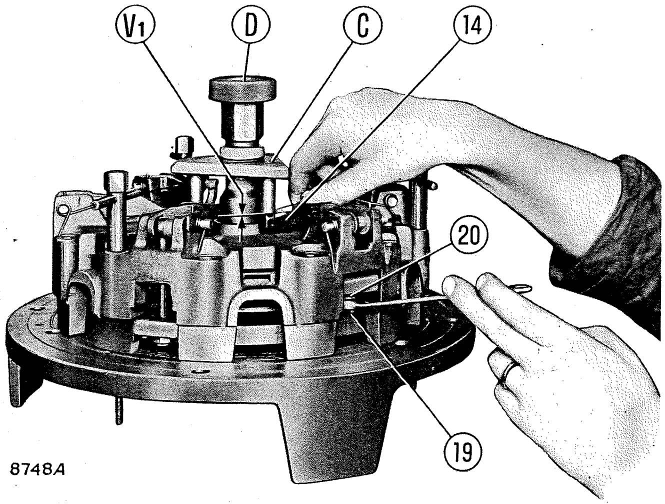


Fig. I/23 *- On-bench Inspection and Adjustment of Transmission Clutch Release Lever Height Using tool 291291/2 or Universal Tool 293650*

C. Register - D. Nut 292344 (tool 291291/2) or handwheel 293739 (universal tool 293650) - V_1 = .1 mm or .004 in, release lever gap - 14. Release levers - 19/20. Adjusting screw and nut.

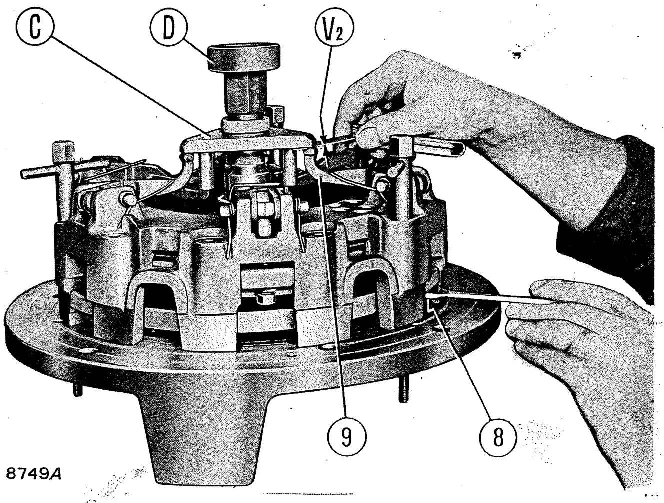


Fig. I/25 *- On-bench Inspection and Adjustment of P.T.O. Clutch Release Lever Height Using Tool 291291/2 or Universal Tool 293650*

C. Register - D. Nut 292344 (tool 291291/2) or handwheel 293739 (universal tool 293650) - V_2 = .1 mm or .004 in, release lever gap - 8. - Adjusting nut - 9. Release levers.

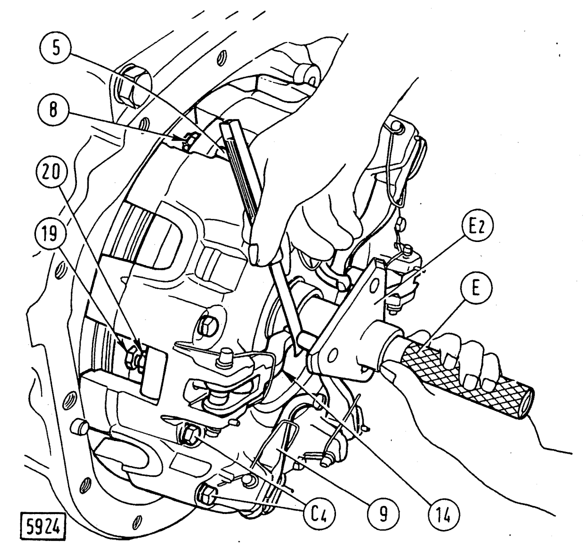


Fig. I/26 - Adjusting complanarity of the release levers with the 11" LUK or O.M.G. clutch installed on engine flywheel.
C_4. Clutch attaching cap screws. - E and E_2. Alignment spigot and gauge block of fixture 291184 (was A 517063/L). - 5 and 8. Lever (9) adjusting rods and nuts. - 9. P.T.O. clutch release levers. - 14. Transmission clutch release levers. - 19 and 20. Lever (14) screws and adjusting nuts.

Note: On-bench and on-flywheel clutch adjustment may result in quite considerable differences in terms of positioning, a fact which does not affect clutch efficiency, being due to varying P.T.O. clutch plate thickness owing to machining tolerance build-up or wear, plus the magnification inherent in the high leverage ratio.

2. Adjusting the free travel of the pedal (P, Fig. I/13) and of the hand control lever (L).

With the exception of the ends of collars (**10** and **12**, Fig. I/9), the release parts of the 11" LUK or O.M.G. clutch are the same as those of the similar 11" FERODO clutch. Consequently, being the plays (**A** and **B**) between release lever collars and levers equal, the para. **2** of the adjustment topic for the FERODO model applies as well to the free travel setting for the control pedal and lever of the LUK model.

11" CLUTCH (LUK OR O.M.G.) INSTALLATION

Before refitting the clutch be sure to fill the flywheel housing of the pilot ball bearing (**17**, Fig. 19) with FIAT G 9 (multipurpose, NLGI 2) grease.
Refit the clutch unit to the engine flywheel as follows:
— insert the P.T.O. clutch disc (**1**, Fig. I/19) arranging it as shown in the figure;
— line up the disc (**1**) with the clutch unit using the alignment spigot (**E**, Fig. I/26) of the fixture **291184** (was **A 517063/L**), then tighten the attaching capscrews (**C_4**).

II - TRANSMISSION

8-SPEED TRANSMISSION

The transmission (Fig. II/16) offers four speed reduction ratios in forward and one in reverse. The auxiliary gear speed reduction unit, which is arranged at the back end of the transmission driven shaft, doubles the speed range bringing it up to eight speed ratios in forward and two in reverse.

The gears, all with straight teeth, are constant mesh trains and the 1st and 2nd speeds and the epicyclic gear reduction are engaged through splined sliding collars, whilst the 3rd and 4th speeds are engaged with the aid of the synchromesh unit. This device, though being of the conventional free cone type is provided, in addition, with three outer flat springs (**60**, Fig. II/29), arranged in suitable holders (**61**) and applying a radial force upon the synchromesh tapered rings (**58**). Consequently, the axial mating of the cones (**58**) over their respective tapered surfaces of the driven gears (**65** and **66**) brakes down the speed of the latter thus synchronizing it with that of the fixed collar (**59**) so to facilitate the quick engagement of the sliding collar (**62**) with the tractor in motion at different engine speeds.
The reverse gears are engaged by shifting the trasfer gear (**37**, Fig. II/31) axially.
Speeds are subdivided into " high " and " low " speed gears and are controlled by means of two indipendent levers, one of which (**C**, Fig. II/17) selects the transmission speed gear and the other (**R**) controls the engagement of the epicyclic gear reduction unit.
The hand lever (**C**) is provided with a spring which returns it automatically to the central neutral setting indicated by the arrow in Fig. II/17.

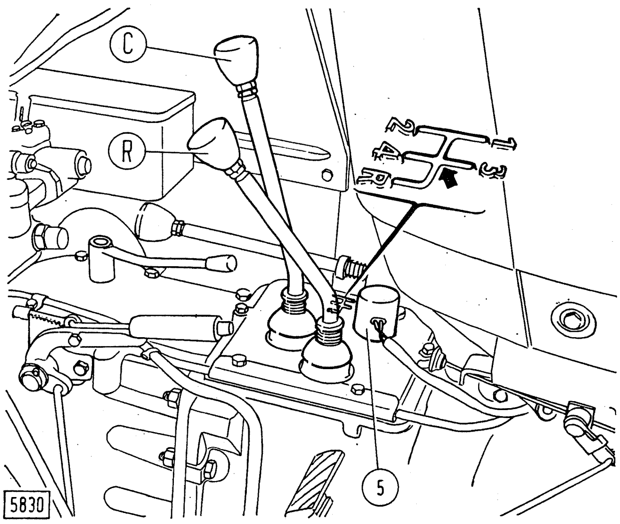


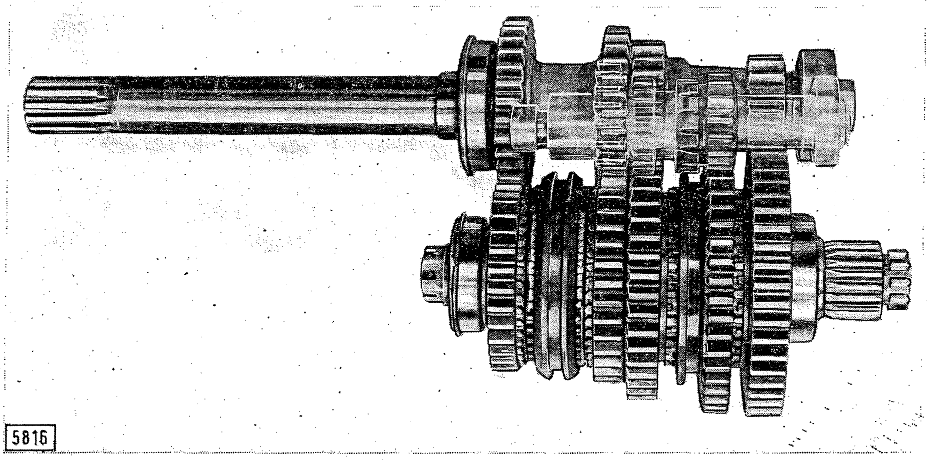
***Fig. II/17** - Right-side view of the 8-speed transmission.*
(The arrow indicates the neutral setting of gearshift lever C).
C. Gear shift lever. - R. Speed range selector lever. - 5. Engine starting safety push-button (optional).

The safety push-button (**5**) allows starting the engine only with the auxiliary reduction unit lever (**R**) in neutral. In fact, if either low-and high-speed gears are engaged, the push rod (**6**, Fig. II/22) will not close the contacts of the push rod (**5**), thus holding the electric starting motor interrupted.

REMOVING THE 8-SPEED TRANSMISSION

Split the engine-front axle assembly off the transmission housing by performing the operations specified for the removal of the 11" clutch, as follows:

— remove the floorplates after disconnecting the rear lighting cable sheaths and the steering box;



NOTE - The description regarding the figures from no.II/1 to no.II/15 have been suppressed in this edition.

***Fig. II/16** - 8-speed transmission gears and shafts.*
(The transmission is shown in reverse gear).

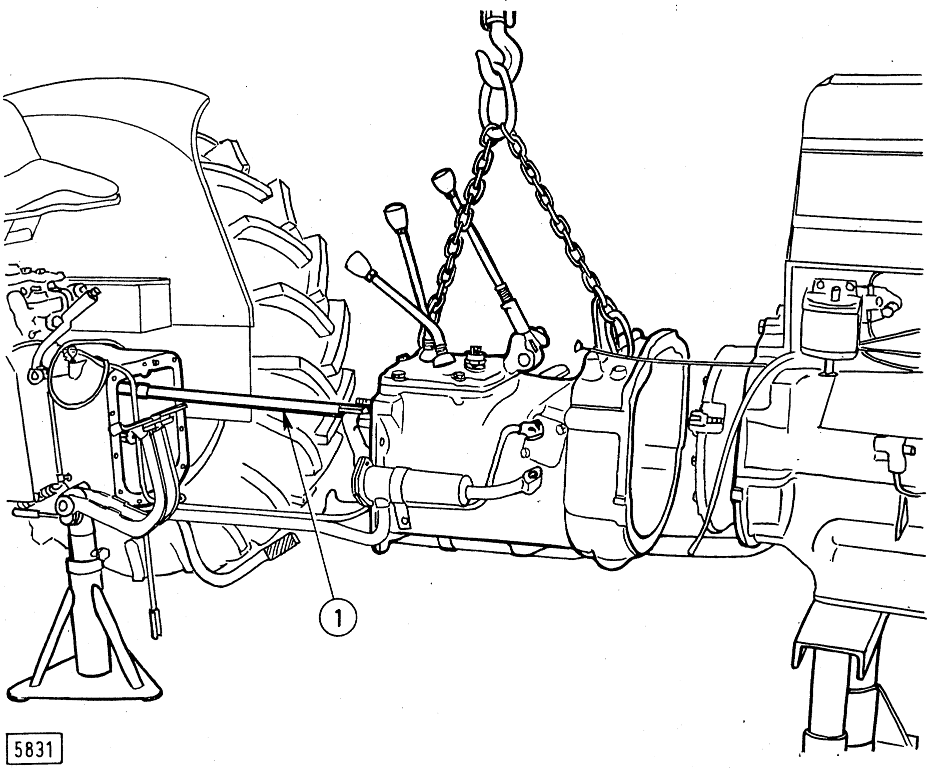


Fig. II/18 - Removing (refitting) the transmission unit.

1. P.T.O. clutch shaft.

— remove the transmission housing cover and gasket to allow the removal of the upper stud nut;

— detach the link from the transmission clutch control arm;

— apply a hoisting chain to the transmission housing and take the weight off;

— place the shop stand under the transmission housing, remove attaching nuts and bolts then detach the complete unit by withdrawing it slowly forward (Fig. II/18) and paying attention not to damage the P.T.O. clutch shaft (**1**).

DISMANTLING THE 8-SPEED TRANSMISSION

In order to facilitate disassembly we recommend installing the transmission unit on the turnover stand **ARR 2220** (Figs. II/19 and II/20).

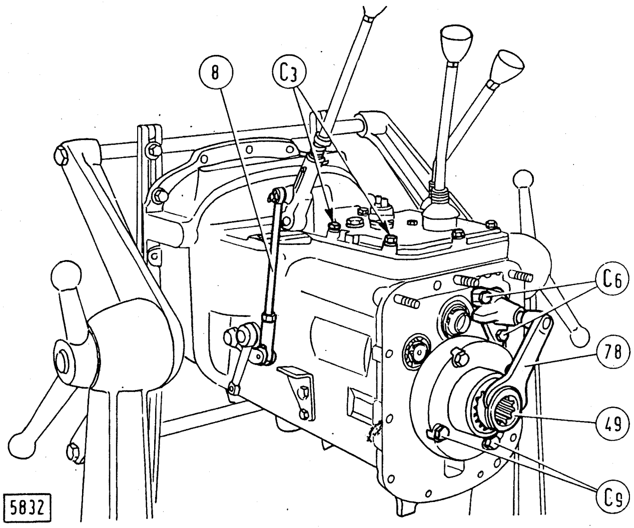


Fig. II/19 - Transmission unit installed on the shop turnover stand ARR 2220.

C_3. Top cover attaching cap screws. - C_6. Attaching cap screws, auxiliary speed reduction shifter bar support. - C_9. Reduction unit fixed gear cap screws. - 8. P.T.O. clutch control adjustable link. - 49. Reduction unit engagement sleeve. - 78. Reduction unit shifter fork.

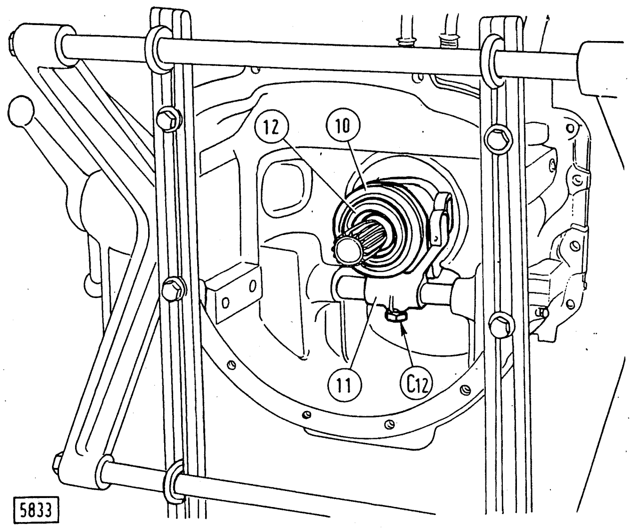


Fig. II/20 - Front view of transmission.

C_{12}. Lever (11) sets screw. - 10 and 11. P.T.O. clutch release collar and fork. - 12. Transmission clutch release collar.

Proceed then as follows.

1. Transmission and P.T.O. clutch release collars and fork levers:

— disconnect the link (**8**, Fig. II/19) from the P.T.O. clutch hand control lever;

— remove the setscrews (C_{12}, Fig. II/20);

— withdraw the outside levers and shafts (**14** and **15**, Fig. II/21), in the order, and withdraw, frontally, the release collars and their fork levers.

2. The transmission housing cover (Fig. II/22): dismantle it on the workbench; we recommend, while withdrawing the inside reverse control lever (**2**), to retain the release lever (**4**) with a screwdriver as shown in Fig. II/39.

3. Transmission and auxiliary reduction unit shifter bars, selector and inside leverage:

— withdraw the retaining pins towards the inside of the housing;

— withdraw the shifter bars towards the outside starting from the 3rd-4th gear control bar (**19**, Fig. II/23).

4. Auxiliary speed reduction unit carrier, shifter bar, fork and collar:

— remove the attaching capscrews (C_6) and remove them together towards the outside;

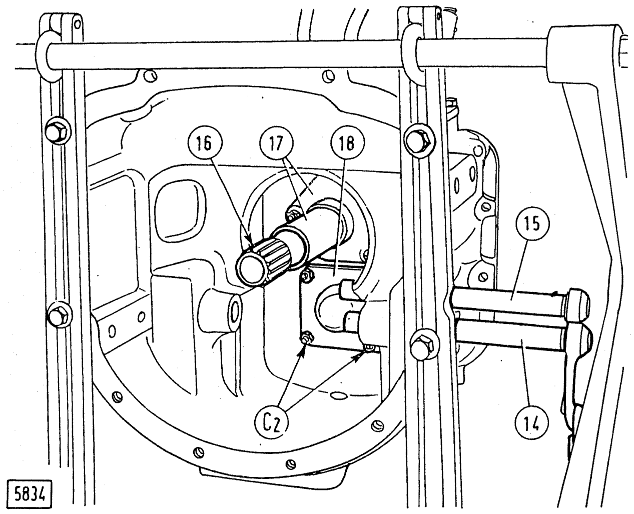


Fig. II/21 *- Removing (refitting) the transmission shaft front bearing caps.*

C_2. Caps (17 and 18) stud nuts. - 14. P.T.O. clutch control lever and shaft. - 15. Transmission clutch control lever and shaft. - 16. Driving gears shaft. - 17. Driving gear shaft bearing cap. - 18. Driven gear shaft bearing cap.

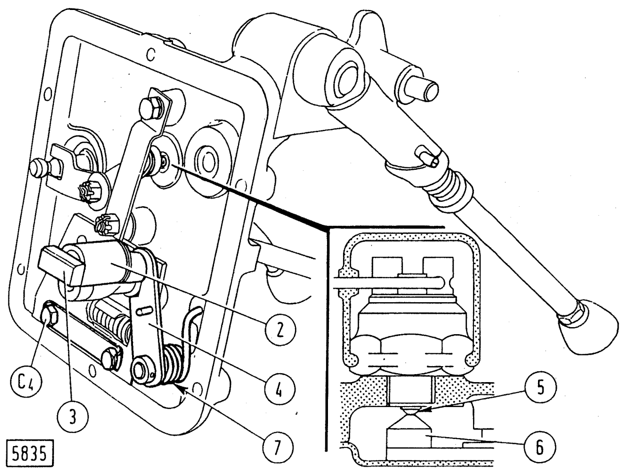


Fig. II/22 *- Transmission case cover with gear selector mechanism.*

C_4. Selector plate automatic return spring bracket screws. - 2. Reverse gear control inner lever. - 3. Lever (2) pad. - 4. Release lever. - 5. Engine starting push-button. - 6. Button (5) control - 7. Lever (4) return spring.

— withdraw then the bar and recover the poppet ball (**80**, Fig. II/37) and spring (**81**).

5. The epicyclic gear reduction:

— remove the fixed gear capscrews (C_9, Fig. II/23);

— disassemble the driven gear carrier (Fig. II/24) by removing the retainer disc (**55**) flat head screws; or ring (88) for post-modif. tractors.

6. Driving shaft and gears:

— remove the shaft front bearing caps (**17** and **18**, Fig. II/21) and recover the gasket (**29** and **30**, Fig. II/31);

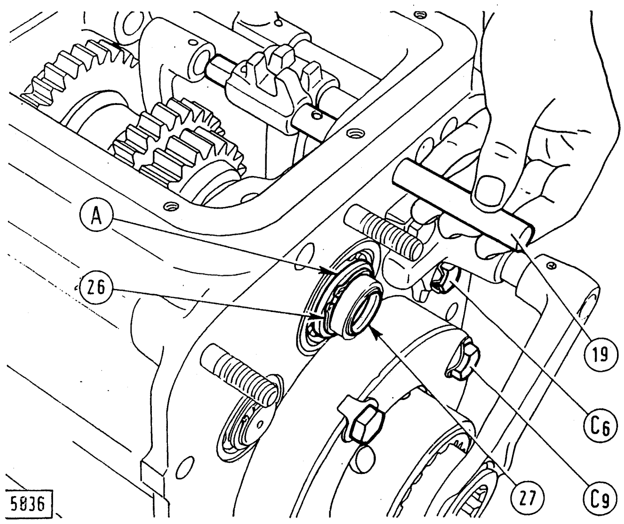


Fig. II/23 *- Removing (refitting) the transmission shifter bars.*

A. End float adjustment shim. - C_6. Reduction unit shifter bar support screws. - C_9. Epicyclic unit fixed gear screws. - 19. 3rd and 4th speed gear shifter bar. - 26. Retaining ring. - 27. Lip-type seal.

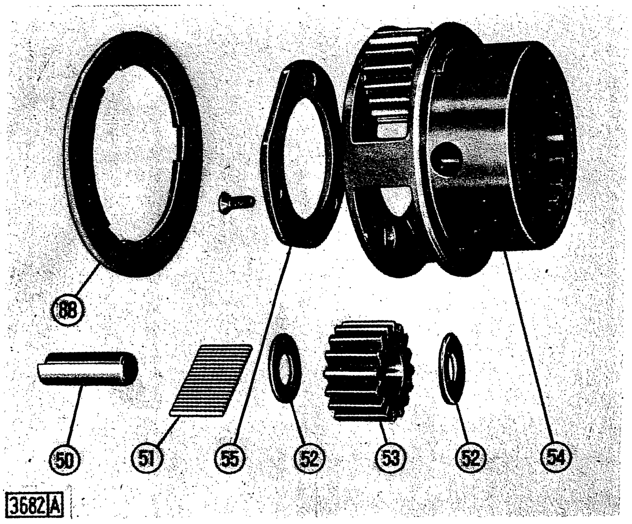


Fig. II/24 *- Exploded view of the epicyclic unit driven gears support.*
50. Pinion shaft. - 51. Bearing needles. - 52. Gear washers. - 53. Driven gear. - 54. Support. - 55. Shaft (50) retainer disc (pre-modification) - 88. Post-modification ring retaining pins (50).

— through the sliding collars, engage two speed gears simultaneously,

unscrew the driven shaft gear and bearing nut (C_{13}, Fig. II/31);

— remove the retaining ring (**26**, Fig. II/23) and the end play (**A**) adjusting shim, then withdraw the shaft seal (**27**);

— remove, if necessary, the bushing (**28**, Fig. II/25) using the sliding-hammer type puller **A 323126**;

— withdraw the driving shaft (**16**) with its front ball bearing by means of the drive bar **A 92532** as shown in Fig. II/26, then recover the gears from the housing;

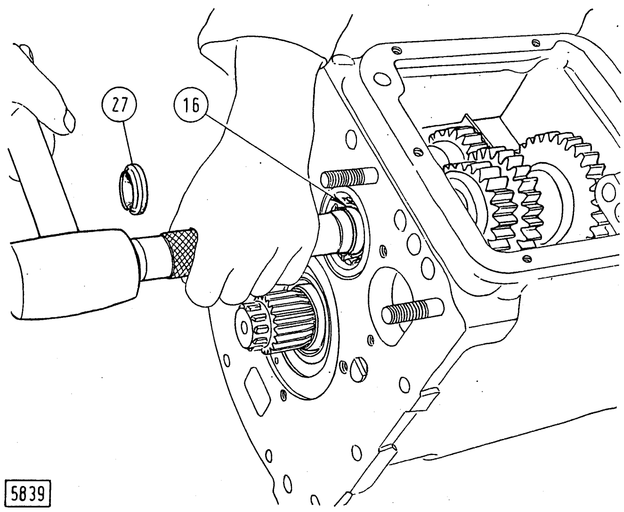


Fig. II/26 *- Removing the drive shaft (16) using the punch A 92532.*
27. Lip-type seal.

— if necessary, press the front ball bearing (**31**, Fig. II/31) off the shaft and remove the outer ring of the rear roller bearing (**32**) with the aid of driving bar **A 97058**.

7. Reverse gear shaft and transfer gear:

— remove the retaining ring (**33**, Fig. II/27) and end washer (**34**) only if the ball bearing is to be removed;

— withdraw the shaft (**35**) and rear ball bearings (**36**) as an assembly, using a crowbar, then withdraw the gear (**37**) from the housing;

— remove the needle bearing bushing (**42**) proceeding as illustrated in Fig. II/30.

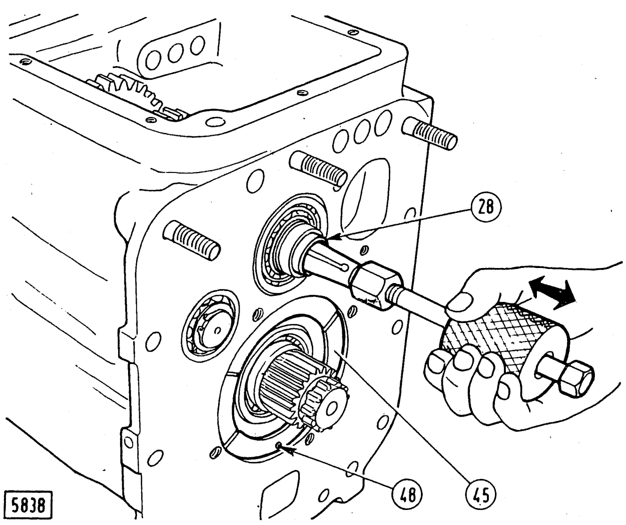


Fig. II/25 *- Removing the bushing (28) by the sliding-weight type puller A 323126.*
45. Epicyclic gear reduction inner thrust ring. - 48. Ring locating dowel.

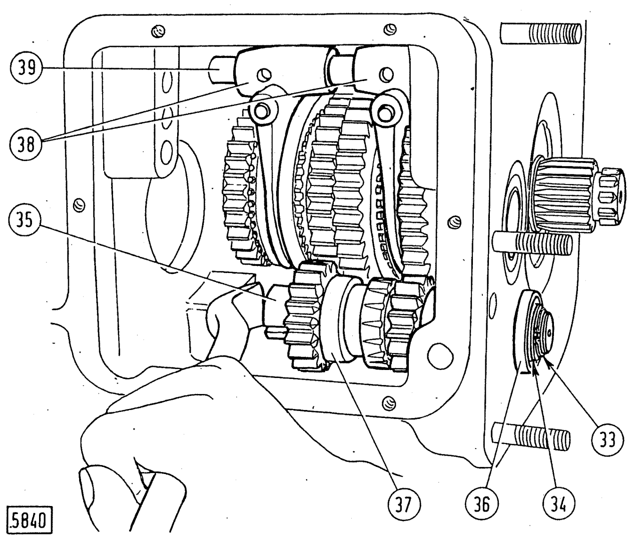


Fig. II/27 *- Removing the reverse gear axle (35).*
33. Retaining ring. - 34. Thrust washer. - 36. Rear ball bearing. - 37. Reverse transfer gear. - 38. Shifter fork. - 39. Shifter fork (38) bar.

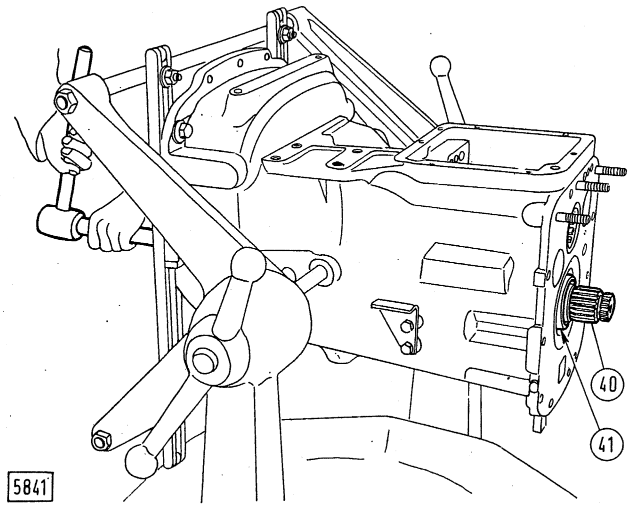


Fig. II/28 - Removing the driven shaft (40).
41. Rear roller bearing.

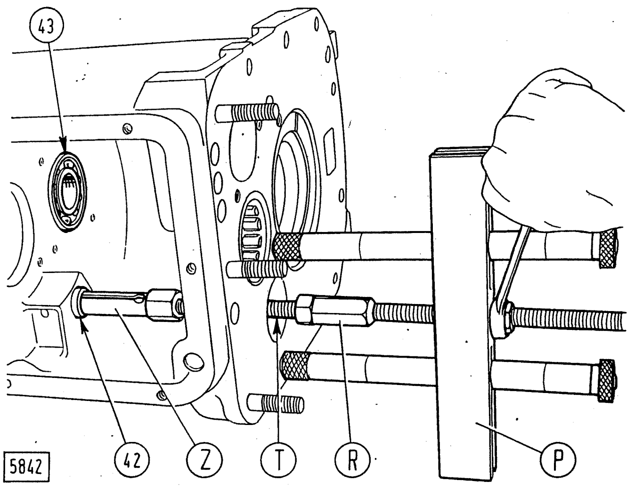


Fig. II/30 - Removing the reverse gear axle needle ring (42)
P. Bridge A 537105/12. - R. Extension A 537105/13. - T. Threaded rod A 323126/V. - Z. Collet A 323126/G. - 43. Driven gear shaft front ball bearing.

8. The transmission shifter forks withdrawing the bar (**39**, Fig. II/27) outwards, then recover the poppet balls (**70**, Fig. II/35) and springs (**71**).

9. Driven shaft and gears and synchromesh unit:

— withdraw the driven shaft (**40**, Fig. II/28) and ball bearing (**41**) rearwards as an assembly acting on the front end as illustrated;

— recover the gears and the synchromesh device from the housing;

— remove, at the press if necessary, the rear roller bearing (**41**) from the shaft and the front ball bearing (**43**, Fig. II/30) from the housing, the latter with the aid of the drive bar **A 97058**.

INSPECTION

Examine the chamfers on the reverse and 3rd speed driving gear hubs, reverse driven and transfer gear hubs, and on the engagement splines of the 1st-2nd speed gear, synchromesh and epicyclic gear units; eliminate seizure marks or nicks, if any.

Thoroughly examine the conditions of the following mating surfaces:

— of the synchromesh rings (**58**, Fig. II/29) and their mating surface on driven gears of the 3rd speed (**66**) and 4th one (**65**);

— of inside rings (**64**) and of their locations on the driven gears of all four speeds.

Check the functional efficiency of the synchromesh flat springs (**60**, Fig. II/29): a force of 1.40 ÷ ÷ 1.55 kg (3 ÷ 3.4 lb) applied at spring center should produce an arc of 1.5 mm (0.060 in).

Check the spring holders (**61**, Fig. II/33) for deep scoring or nicks, particularly on the central relief (**R**).

Make sure that the teeth (**d**, Fig. II/33) on the three splined sections of the synchromesh fixed collar and on the outside spline of the 1st-2nd speed gear fixed engagement collar (**44**, Fig. II/31) have sharp edges; if not, re-sharpen them with a fine grain carborundum stone. On new parts, these teeth should project 0.19 ÷ 0.25 mm (0.008 ÷

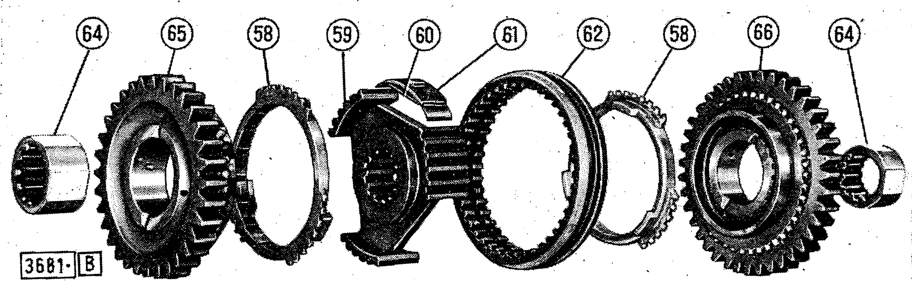


Fig. II/29- Exploded view of synchromesh unit.
58. Synchromesh tapered rings - 59. Fixed collar - 60. Flat spring 61. Spring (60) holder - 62. Sliding ring - 64. Driven gear inner rings - 65. 4th speed driven gear - 66. 3rd speed driven gear.

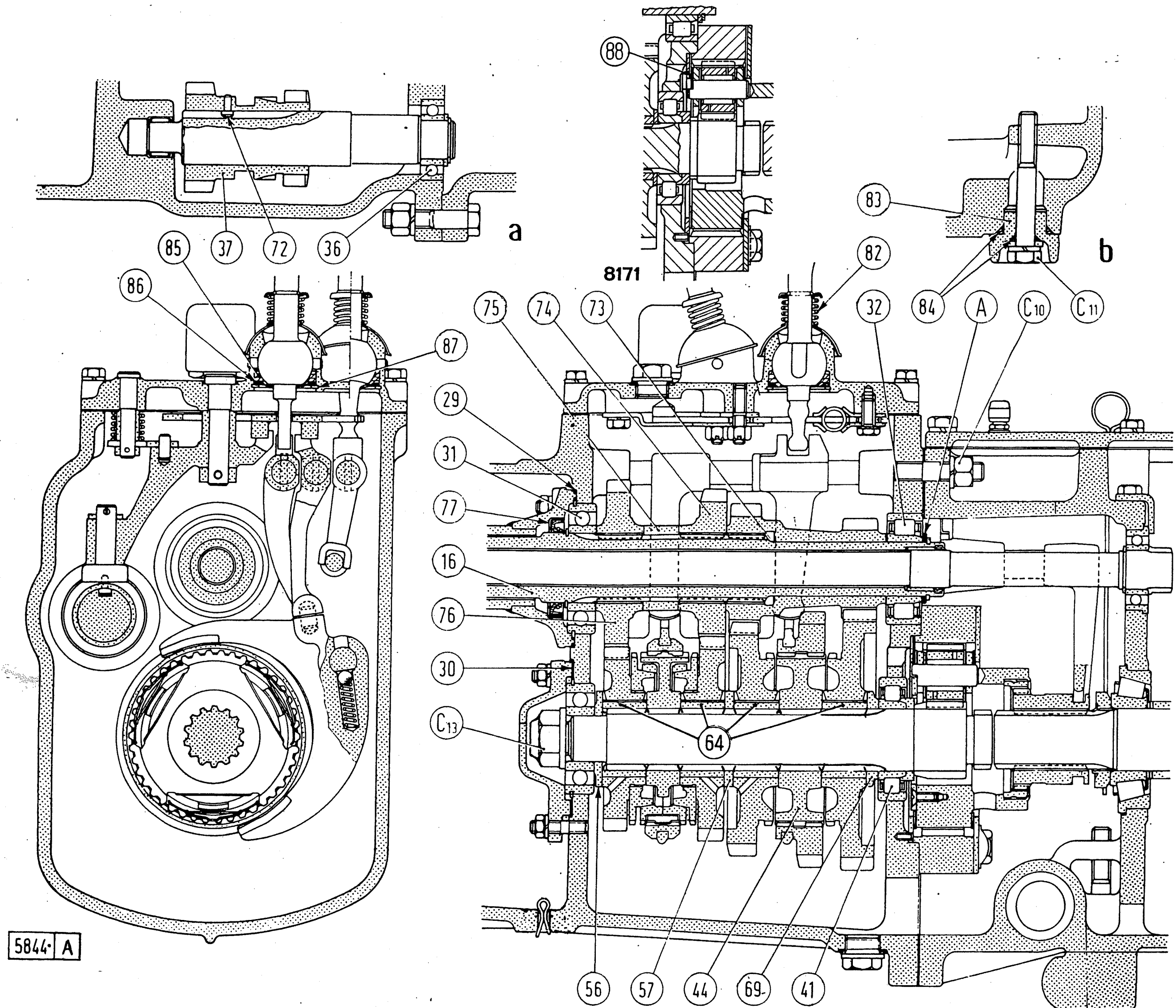


Fig. II/31 - *8-speed transmission cross-sections.*
a. Section through reverse gear axle.
b. Detail of the hydraulic lift pump suction pipe connection.
A. Driving gear float adjusting ring. - C_{10}. Transmission housings bolt and stud nuts. - C_{11}. Hydraulic lift pump suction pipe attaching cap screw. - C_{13}. Drive gear shaft locknut. - 16. Driven shaft. - 29 and 30. Gaskets. - 31. Ball bearing. - 32. Roller bearing. - 36. Roller bearing. - 37. Reverse transfer gear. - 41. Roller bearing. - 44. 1st and 2nd speed fixed sleeve. - 56, 57 and 69. Rear, intermediate and front washers. - 72. Gear (37) lock pin. - 73. 1st and 2nd speed driving gear. - 74. 3rd speed driving gear. - 75. Driving gears spacer. - 76. 4th speed driving gear. - 77. Oil seal. - 82. Hand levers retaining spring. - 83. Hydraulic lift pump suction pipe adaptor. - 84. O-rings. - 85, 86 and 87. Lever ball joints gasket, thrust washer and retaining ring.- 64. Driven gear inside ring.
88. Post-modification ring retaining planetary gear axles.

÷ 0.010 in); replace the collars only when no appreciable result is obtained.

In any case, faulty teeth are normally detected because of the sliding collar tendency to disengage spontaneously.

Check washers (52, Fig. II/24) and thrust rings (47, Fig. II/36), and replace those below specification requirements.

Check the functional efficiency of the selector mechanism springs (**7** and **13**, Fig. II/39), of poppet ball springs (**71**, Fig. II/35) and (**81**, Fig. II/37) and of hand control lever springs (**82**, Fig. II/31).

8-SPEED TRANSMISSION ASSEMBLY

In order to facilitate re-assembly, install the transmission housing on the turnover stand **ARR 2220**, then proceed as follows.

1. The synchromesh device:

— place on the 3rd speed driven gear (**66**, Fig. II/32) complete with inner ring, a synchromesh ring (**58**) and the fixed collar (**59**) with the three toothed sectors fitting in the ring previously installed and the spline chamfer on the gear side;

— insert the sliding collar (**62**, Fig. II/32) so that the projecting teeth (**D**) delimit the three splined sections of the fixed collar (**59**);

Note. - *The assembly conditions previously indicated is the only one which sets the three vanes* (**V**) *of the sliding ring* (**62**) *symmetrically with respect to the toothed sectors of the fixed ring* (**59**), *thus allowing the projections* (**R**) *of the spring holders* (**61**) *to fit in their respective locations* (*Fig. II/33*).

— place the flat springs (**60**) on their respective holders (**61**) as shown in Fig. II/33, then fit them in place;

— introduce the second synchromesh element (**58**, Fig. II/29) with the three front wings aligned with those of the aforementioned ring and finally install the 4th speed driven gear (**65**) and inside ring (**64**) as an assembly;

— try to engage the sliding collar by hand and in both directions.

2. Driven shaft, gears and synchromesh unit:

— place the front ball bearing (**43**, Fig. II/30) and retaining ring on the housing and attach the end cap with only two nuts;

— set the transmission housing upright with its back and uppermost;

— arrange in the housing the front end washer (**56**, Fig. II/31), the synchromesh unit (**B**, Fig. II/34), the central thrust washer (**57**, Fig. II/31), the 2nd speed gear (**63**, Fig. II/34) with inside ring, the fixed collar (**44**), the reverse driven gear (**67**), the 1st speed driven gear (**68**) with inside ring and the rear end washer (**69**) set as shown in Fig. II/31;

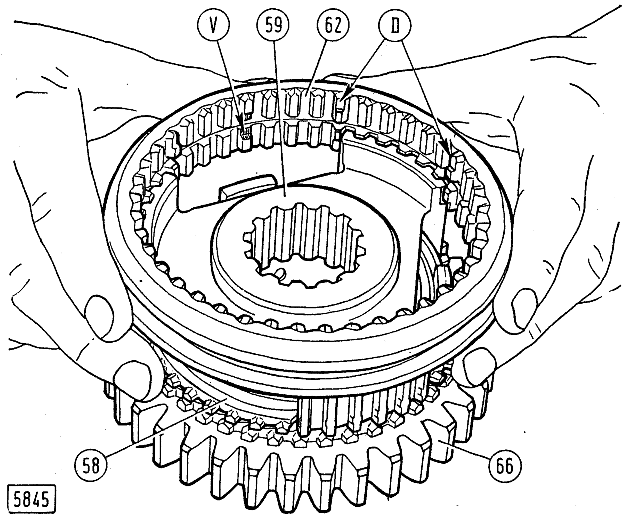


Fig. II/32 - *Installing the synchromesh unit engagement ring (62).*

D. Teeth in relief. - V. Flat spring holder seat. - 58. Synchromesh cone. - 59. Fixed sleeve. - 62. Engagement ring. - 66. 3rd speed driven gear.

— install the rear roller bearing (**41**) on the shaft, heating it in oil at 80 ÷ 90° C and arranging it as shown in Fig. II/31;

— introduce the driven shaft (**40**, Fig. II/34) as an assembly;

— turn the housing back horizontal, remove the front end cap and tighten the nut (C_{13}, Fig. II/31).

3. Shifter bar and forks:

— install the forks (**38**, Fig. II/35) considering that they are interchangeable;

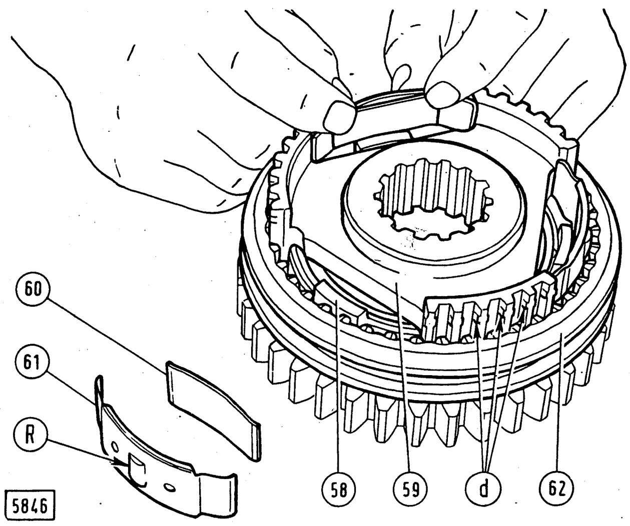


Fig. II/33 - *Fitting the synchromesh unit flat springs (60) and holders (61).*

d. Safety gear disengagement teeth. - R. Holder central projection. - 58. Synchromesh cone. - 59. Fixed ring. - 62. Engagement ring.

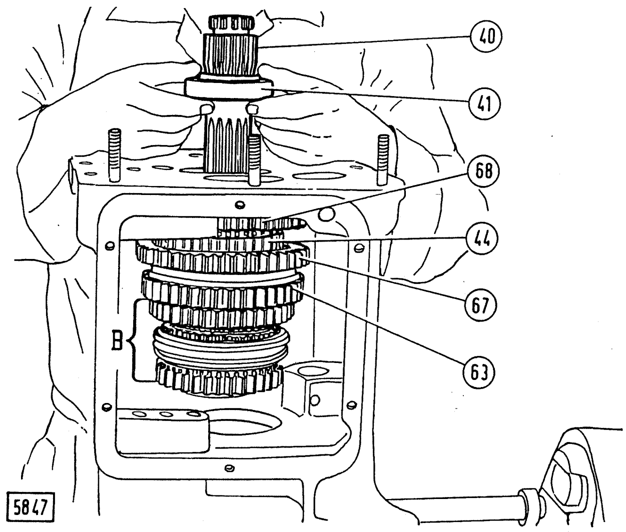


Fig. II/34 - *Installing the 8-speed transmission driven gears shaft (40).*
B. Synchromesh unit with 3rd and 4th speed engagement. - 41. Rear roller bearing. - 44. 1st and 2nd speed fixed engagement ring. - 63. 2nd speed driven gear. - 67. Reverse driven gear. - 68. 1st speed driven gear.

— fit the springs (**71**) in place making sure they are marked with red paint, place the poppet balls (**70**) suitably smeared with FIAT G 9 (multi-purpose, NLGI no. 2) grease and then insert the bar (**39**) with the stop flat uppermost;

— set the bar by holding down the ball springs as shown in Fig. II/35.

4. Reverse shaft and transfer gear:

— fit the needle bearing bushing (**42**, Fig. II/30) in the housing using the punch **A 92027**;

— install on the shaft the ball bearing (**36**, Fig. II/27) and secure it in place with end washers (**34**) and retaining ring (**33**);

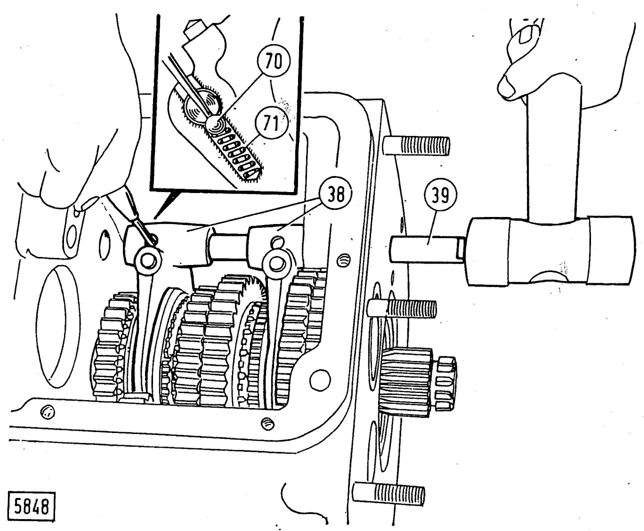


Fig. II/35 - *Fitting the shifter forks (38) bar (39).*
70 and 71. Poppet ball and spring.

— support the gear (**37**, Fig. II/31) from the inside of the housing and introduce the shaft as an assembly from the outside making sure that the pin (**72**) fits in the groove;

— make sure, using the drive bar **A 95058**, that the ball bearing (**36**) is correctly bedded in place.

5. Driving shaft and gears.

— heat the front end ball bearing (**31**, Fig. II/31) in oil at 80° ÷ 90° C, install it on the shaft complete with bushing (**28**, Fig. II/25) and seal (**27**, Fig. II/23) and stop it by installing the retaining ring;

— fit the outer ring of the rear end roller bearing (**32**, Fig. II/31) in the housing using the drive bar **A 97058**;

— introduce frontally the driving shaft assembly (**16**, Fig. II/31) and, from the inside, install on this shaft the 4th speed drive gear (**76**), the spacer (**75**) the 3rd speed drive gears (**74**) and the 1st-2nd speed ones (**73**), and finally the inner ring of the rear roller bearing (**32**) set as shown in the figure;

— fix the front cover (**17**, Fig. II/21) complete with inside seal (**77**, Fig. II/31) and outer sealing ring (**29**);

— make sure, using the drive bar **A 95058**, that the inner ring of the rear roller bearing (**32**, Fig. II/31) is well bedded in place, install the adjusting shim (**A**), selecting the thickness which will reduce to the least permissible value the end play of gears and bearings, and finally fit the retaining ring;

— through the sliding collars shift into two gears simultaneously, tighten the nut (**C_{13}**, Fig. II/31) to the specified torque value and lock it by punching;

— fix the end cap (**18**, Fig. II/21) and gasket (**30**, Fig. II/31).

6. Auxiliary epicyclic gear speed reduction unit:

— pre-assemble on the work bench the driven gears (**53**, Fig. II/24) on their carrier (**54**), lubricating with FIAT G 9 (multi-purpose, NLGI no. 2) grease the 18 rolling needles (**51**) to place them inside the hub of each gear;

— lock punch the flat-head screws attaching the driven gear shaft retaining disc (**55**) at two diametrically opposed points along the screw head slot (see Fig. II/36);

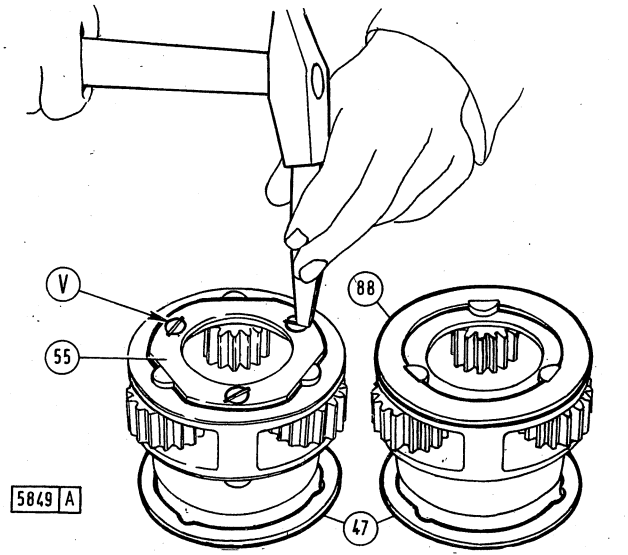


Fig. II/36 - *Punch locking the flat head screws (V) securing the epicyclic unit drive gears shaft retainer disc (55).*
47. Thrust ring - 88. Post-modification ring retaining pins.

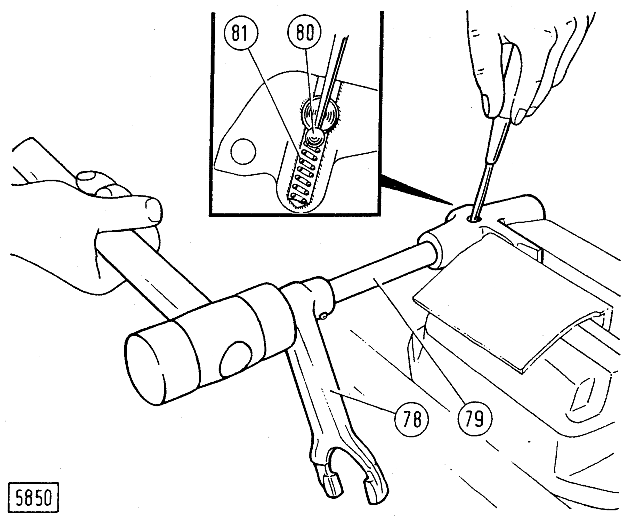


Fig. II/37 - *Fitting the epicyclic unit shifter fork (78) and bar (79).*
80 and 81. Poppet ball and spring.

— if previously disessambled, re-install the inside thrust washer (**45**) with the oil scrolls arranged as shown in Fig. II/25 and fit the retaining hollow pin (**48**);

— insert thrust rings (**47**, Fig. II/36) with the milled grooves of the outside thrust washer facing the end cap, then tighten the fixed gear attaching capscrews (C_9, Fig. II/19).

7. The auxiliary speed reduction unit support and shifter bar, fork and collar:

— fit the spring (**81**, Fig. II/37) in the support and place the poppet ball (**80**), with the aid of FIAT G 9 (multi-purpose, NLGI no. 2) grease, then install the shifter bar and fork as an assembly;

— make the shifter bar (**79**) function using a punch to compress the spring as illustrated in Fig. II/37;

— install the supporting unit mating the sliding collar (**49**, Fig. II/19) to the shifter fork (**78**), then tighten the attaching cap screws (C_6).

8. Shifter bars, selector and the transmission-auxiliary speed reduction internal control linkage:

— firstly, lock punch at three points the bottom end of the selector and lever holes to prevent the retaining pins from falling out;

— see the Fig. II/38 for the correct installation of shifter bars, selector and internal levers and secure them by fitting the locating hollow pins with the side cut arranged as shown in the figure.

9. Transmission housing cover (Fig. II/22):

— in case of previous removal, ensure the sealing tightness by applying a suitable jointing compound on the stud and on the gearshift lever attaching cap screw;

— pre-assemble it on the workbench considering that in order to install the reverse inside con-

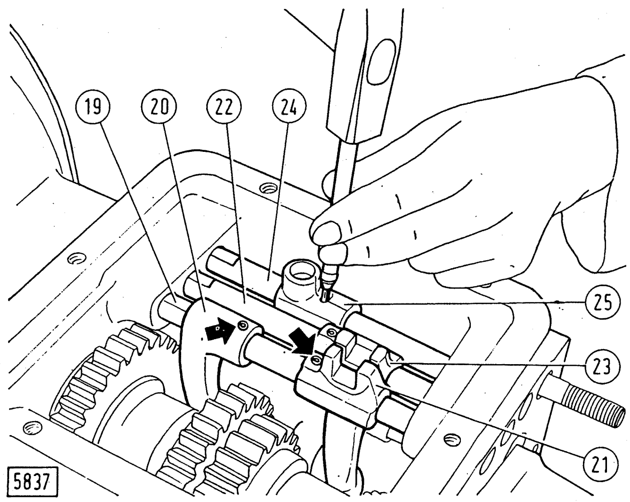


Fig. II/38 - *Fitting the transmission speed selector and shifter forks split dowel pins.*
(Arrows indicate the correct pin slot assembly position).
19, 20 and 21. 3rd and 4th speed shifter bar, fork and selector. - 22 and 23. 1st and 2nd speed shitfer bar and fork. - 24 and 25. Epicyclic unit shifter bar and fork.

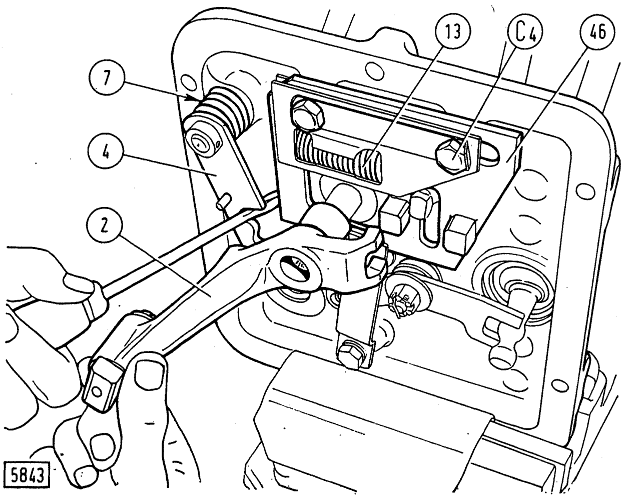


Fig. II/39 - *Fitting (removing) the reverse gear shifter fork (2).*

C_4. Spring (13) bracket cap screws. - 4. Detent lever. - 7. Lever (4) return spring. - 13. Selector plate automatic return spring. - 46. Speed selector plate.

trol lever (**2**), the release lever (**4**) return spring (**7**) must be compressed using a screwdriver, as shown in Fig. II/39;

— place, with the aid of grease, the gasket on the housing, then install the cover assembly, making sure that the ends of the hand control levers and the pad (**3**, Fig. II/22) of the inside reverse control lever fit the selectors (**23** and **25**, Fig. II/38) and the transfer gear (**37**, Fig. II/27), respectively.

10. Transmission and P.T.O. clutch release collars and shifter forks:

— tighten the cap screws (C_{12}) to the specified torque value and wire lock them;

— re-connect the link (**8**, Fig. II/19) to the P.T.O. clutch hand control lever.

TRANSMISSION INSTALLATION

Reverse the removal sequence and:

— re-attach the transmission housing inserting the gasket;

— make sure the o-rings (**84**, Fig. II/31) have been fitted before attaching the end (**83**) of the hydraulic lift pump suction line;

— be sure to meet torque requirements given in the data table

III - BEVEL GEAR AND DIFFERENTIAL

DESCRIPTION

The speed reduction unit housed inside the rear compartment of the transmission housing consists of a helical-tooth bevel gear and pinion.

Both the bevel gear, which is attached to the differential case, and the pinion revolve inside tapered roller bearings.
The differential, with two gears and two pinions, is equipped with a pedal controlled differential lock.

REMOVING THE REAR TRANSMISSION HOUSING

Remove the transmission housing as follows:

— drain the oil from both gearbox and rear transmission housings;

— remove the final drives according to the instructions of Section V and place a stop under the gearbox case;

— remove the operator's seat, hydraulic lift and its oil piping;

— set the P.T.O. clutch control lever in "ENGINE" then remove the cover with lever;

— apply a rope to the transmission housing and take the weight off with a hoist;

— remove the attaching bolts and nuts;

— carefully separate the gearbox and transmission housings paying attention not to bend or buckle the P.T.O. clutch shaft (**1**, Fig. III/1).

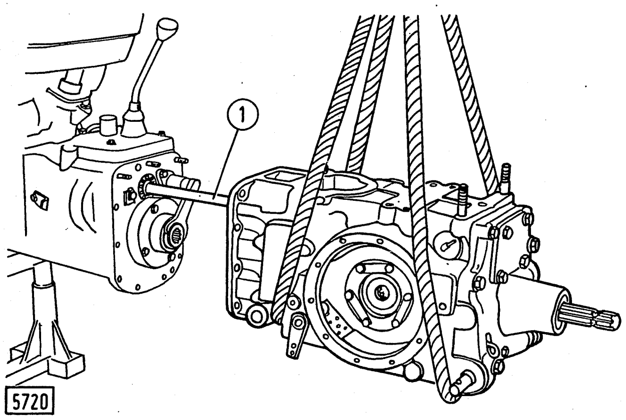


***Fig. III/1** - Hoisting off the rear transmission unit.*
1. P.T.O. clutch shaft.

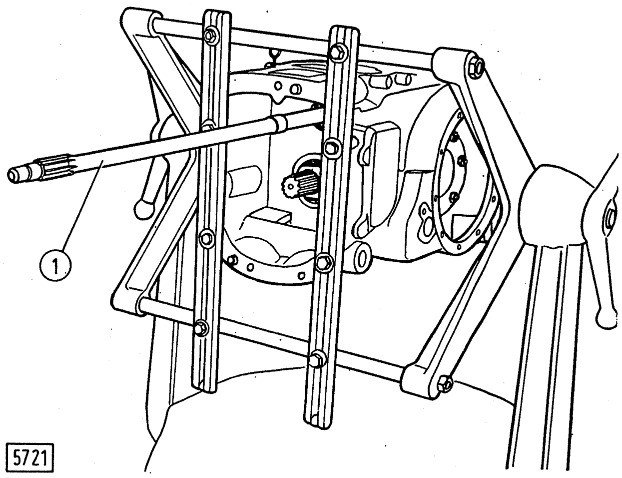


***Fig. III/2** - Rear transmission housing installed on turnover stand ARR 2220.*
1. P.T.O. clutch shaft.

DISMANTLING THE BEVEL GEAR AND DIFFERENTIAL

Disassemble the rear transmission housing installed on turnover stand **ARR 2220** (Fig. III/2), as follows:

— remove the back cover complete with shafts and P.T.O. driving and driven gear train;

— withdraw the sliding gear (**2**, Fig. III/3) of the P.T.O. clutch shaft (**1**) from above;

— remove the P.T.O. shaft bearing (**4**) holder (**3**);

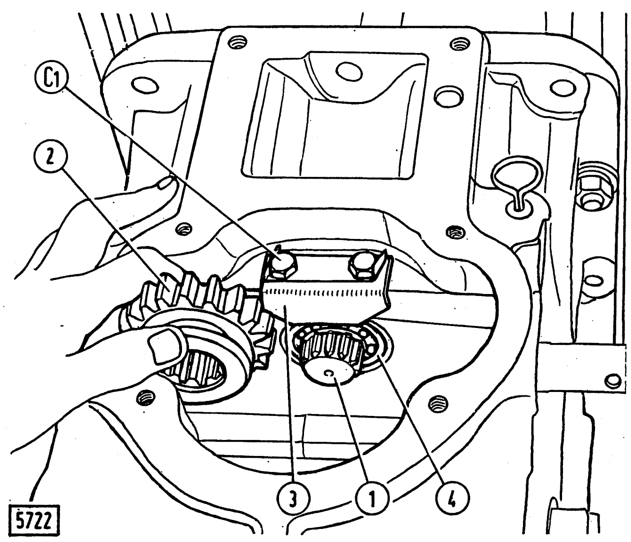


***Fig. III/3** - Removing (installing) the P.T.O. sliding gear (2).*
C_1. Bracket (3) attaching capscrews. - 1. P.T.O. clutch shaft. - 3. Bearing (4) retainer. - Ball bearing.

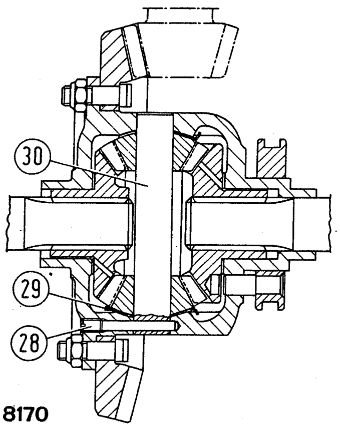


Fig.III/4– Cross section of main drive bevel gear (post-modification differential).
28. Screw securing axle (30) - 29. Thrust washer - 30. Pinion axle.

— tap the front end of the P.T.O. clutch shaft (**1**, Fig. III/3) with a lead hammer and withdraw it with the bearing (**4**) installed from the back of the housing;

— remove the screws, sheet metal oil shields (5 and 14,Fig.III/5), then depress the differential lock pedal and withdraw the bearing housing brackets (**6** and **13**) and their adjusting shim stacks (**Sd** and **Ss**);

— remove the bevel gear and differential units, manually;

— remove the differential lock pedal and supporting unit as an assembly;

— withdraw the spring rod (**27**, Fig. III/8) by removing the plug (**T**, Fig. III/6) first and then tapping its left hand side with bar and hammer only if necessary; recover then the spring (**25**, Fig. III/8) and the lock fork from the housing;

— unscrew the pinion shaft nut (C_3, Fig. III/6) using the wrench **A 711109** inserted on the wrench **A 511709** and then withdraw the tapered roller bearing cone (**24**, Fig. III/5);

— remove the bevel pinion complete (**20**) from the back of the housing and the P.T.O. driving gear (**22**) and its spacer (**23**) from the top;

— extract from the housing the front (**24**) and rear (**21**) end bearing cups with the puller **A 537105**.

Dismantle the bevel gear and differential as follows:

— split the bevel gear from the differential by removing the attaching bolts (C_2, Fig. III/5);

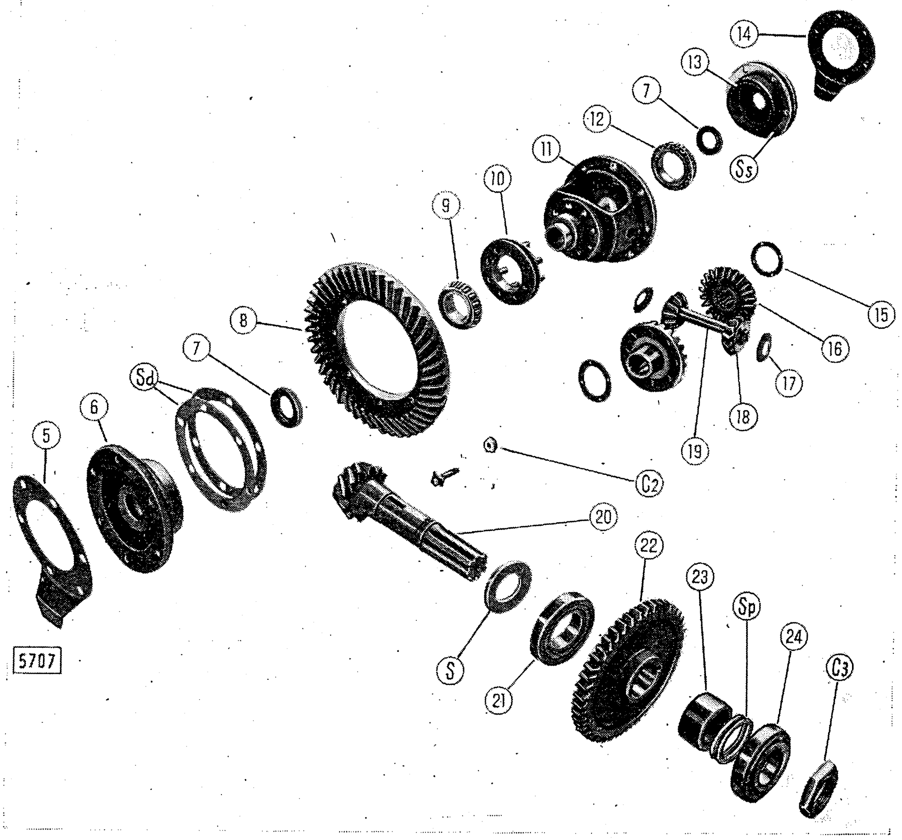


Fig III/5 - *Exploded view of the differential and bevel gear.*

C_2. Bevel gear bolt nut. - C_3. Bevel pinion shaft nut. - S. Pinion setting adjustment shim. - Sd and Ss. Bevel gear bearing and tooth backlash adjustment shims. - Sp. Bevel pinion bearing adjustment shims. - 5. Right side oil shield. - 6. Right bearing housing bracket, - 7. Oil seal. - 8. Bevel gear. - 9. Right-hand side cone. - 10. Differential lock collar. - 11. Differential case. - 12. Left-hand side bearing cone. - 13. Left side bearing housing bracket. - 14. Left oil shield. - 15. Differential gear thrust washer. - 16. Differential gear. - 17. Differential pinion thrust washer. - 18. Differential pinion. - 19. Differential pinion axle. - 20. Bevel gear pinion shaft. - 21. Rear tapered roller bearing. - 22. P.T.O. driving gear (for P.T.O.synchronized to the transmission) 23. Spacers - 24. Front tapered roller bearing.

— remove the bearing cones (**9** and **12**) using the split-type bearing puller attachment **A 511100/ /115** and universal puller **A 517010/160** and the cups from the housings with the universal puller **A 537105** (**b**);

— withdraw the differential lock collar (**10**, Fig. III/5);

— remove from the carrier (**11**) the differential pinions (**18**) and gears (**16**).

INSPECTION

Always compare the measured values vs. the tabulated data, and proceed as follows:

— check the bevel gear and pinion and differential gears and pinions for excessive tooth wear;

— measure the thickness of the thrust washers (**15** and **17**, Fig. III/5) for differential gears and pinions and the service wear of the pinion bushes; notice that if the bushes are renewed they require reaming after fitting to ensure the correct assembly clearance;

— check the functional efficiency of the tapered roller bearings and of the oil seals (**7**) of differential axle shafts;

— check the running surface of the differential lock collar and the functional efficiency of the locating hollow pins;

— check the differential lock return spring (**25**, Fig. III/7) characteristics vs/ the specifications given on the table of data.

BEVEL GEAR AND DIFFERENTIAL ASSEMBLY

Reverse the sequence of disassembly, see the Figs. III/5 and III/6 and take good note of the following points:

— smear grease over the differential pinion washers (**17**, Fig. III/5);

— install the two special-head bolts (C_2) securing the bevel gear to the differential carrier in the holes at both ends of the differential pinion axle (**19**). On post-modification tractors the securing of the pin (30, fig.III/4) is obtained by means of a screw (28) that after fitting must be peened in position;

— using the tool A 287033 fit the differential lock return spring (25) as shown in Figs.III/7 and III/8.

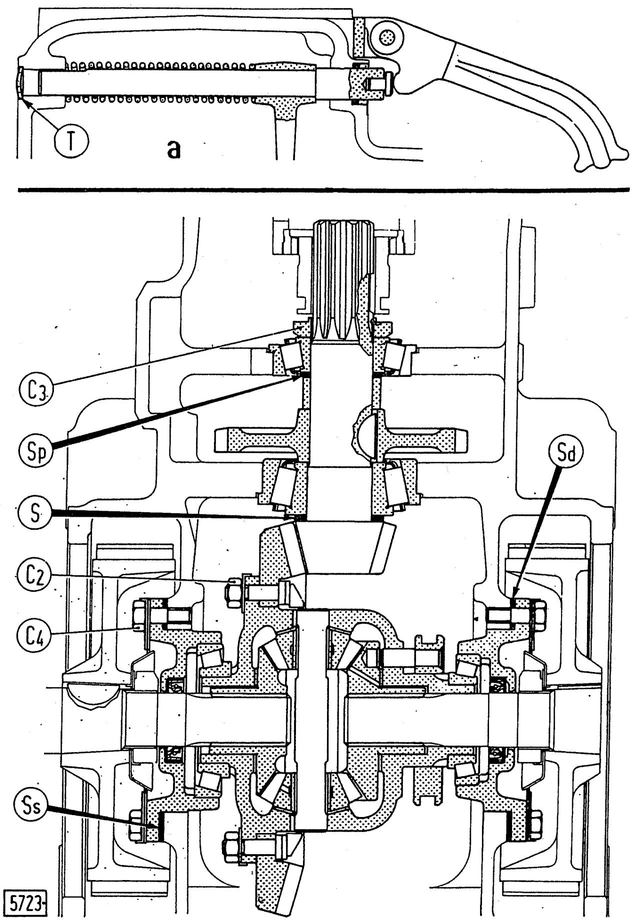


Fig.III/6 - Bevel gear and differential cross-sectional view (pre-modification differential).
a.Differential lock cross-section - C_2.Bevel gear bolt nut - C_3.Bevel gear pinion shaft nut - C_4.Differential bearing housing stud screws - S. Pinion setting adjustment shim - Sd and Ss. Bevel gear and tooth backlash adjustment shims - Sp. Bevel gear pinion bearing adjustment shims - T. Plug.

— install the differential bearing housing brackets (**6** and **13**, Fig. III/5) arranging them with the oil drain holes facing downwards as shown in Fig. III/9;

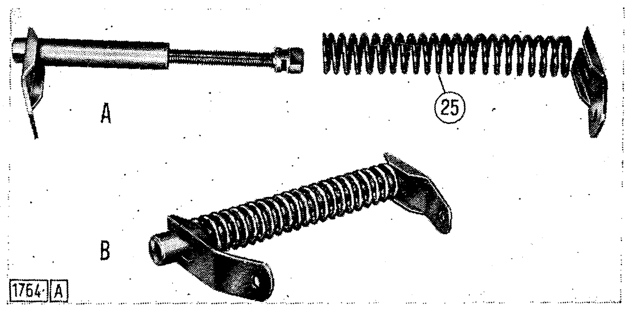


Fig. III/7 - *Arranging the differential lock return spring (25) on the tool A 287033.*
A. Spring prior to assembly. - B. Spring installed.

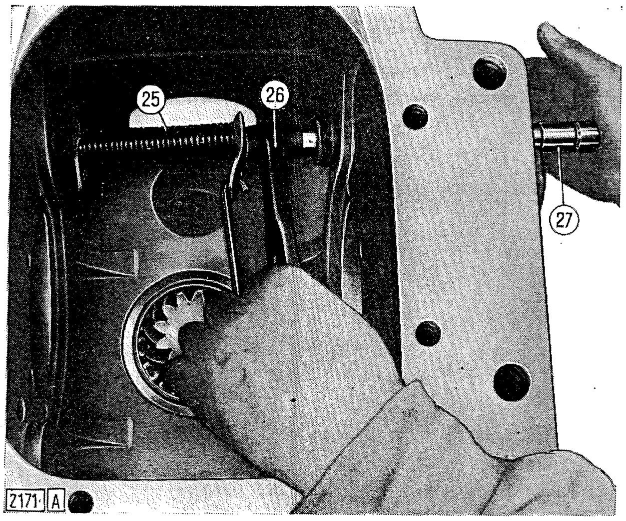


Fig. III/8 - *Installing the return spring (25) on the rod (27) of the differential lock fork (26) using the tool A 287033.*

— set the bevel gear and pinion (see following topic);

— arrange the oil shield discs (**5** and **14**, Fig. III/5) with their ears facing down.

BEVEL GEAR SETTING

Adjustment operations are grouped under the following sub-titles:

1. Adjusting the bevel gear pinion shaft tapered roller bearings and finding shim thickness (Sp, Fig. III/6). (*)

— Install in the housing the pinion shaft with a stack of shims (S_1, Fig. III/10) of any thickness, the tapered roller bearings (**21** and **24**) previously lubricated, the P.T.O. driving gear (**22**) and its spacer (**23**), then make sure that the gear, the rear bearing cone, the shim and the pinion back end are all in contact with each other.

— Lubricate the locknut (C_3) thread with crankcase oil and gradually tighten it with the torque **A 711041/2** (Fig. III/11) with torque increments of 0.2 kgm (1.5 ft. lb) up to the value of 1 kgm (7.2 ft. lb); simultaneously, turn the shaft a few turns after each torquing step to make sure the tapered rollers are properly bedded.

Note. - *After turning the shaft following the final torquing step, re-check the torque and re-set it if necessary.*

— Measure with a feeler gauge the clearance (**L_1**, Fig. III/10) between P.T.O. driving gear and spacer and select two adjustment shims (**Sp**, Fig. III/6) the sum of which is equal to the value of the clearance previously measured plus 0.05 mm.

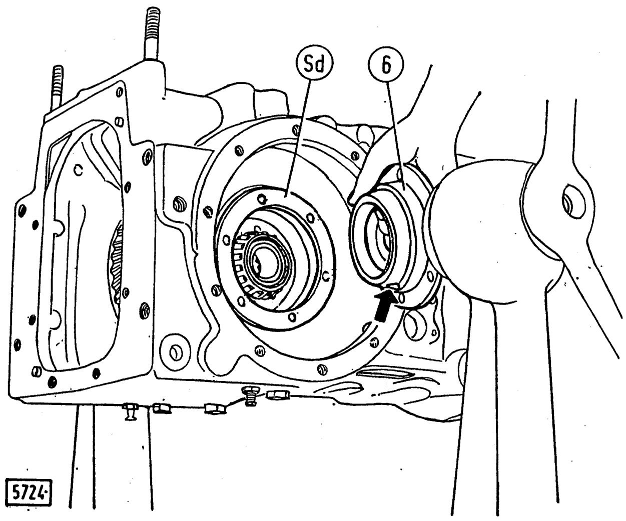


Fig. III/9 - *Fitting (removing) the differential bearing housings.*

(Arrow indicates correct assembly position of the oil drain hole).
Sd. Right-hand side bearing shims. - 6. Right bearing housing bracket.

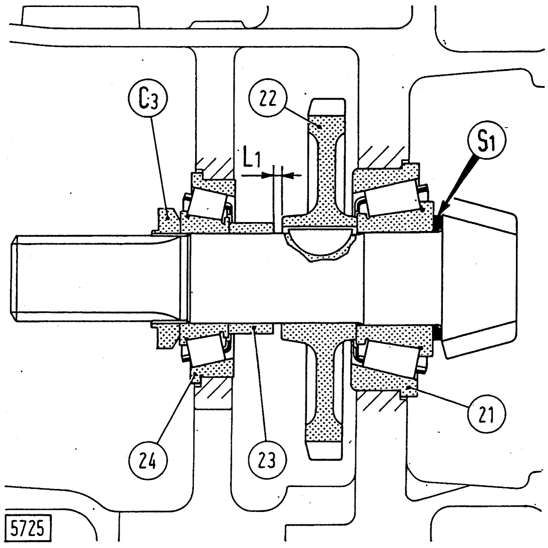


Fig. III/10 - *Adjusting the bevel gear pinion shaft tapered roller bearings.*

C_3. Bevel gear pinion shaft nut. - L_1. Clearance between gear (22) and spacer (23). - S_1 Pinion setting adjustment shim. - 21. Rear bearing. - 22. P.T.O. driving gear. - 23. Spacer. - 24. Front-end bearing.

(*) This adjustment can be carried out in a more precise manner using tool 293101 illustrated in Fig. III/18. Such tool is indispensable for the tractors not equipped with ground speed P.T.O. and for front wheel drive models, in which the driving gear (22, Fig. III/10) and the spacer (23) are respectively replaced by one spacer (3, Fig. III/18) or one gear.

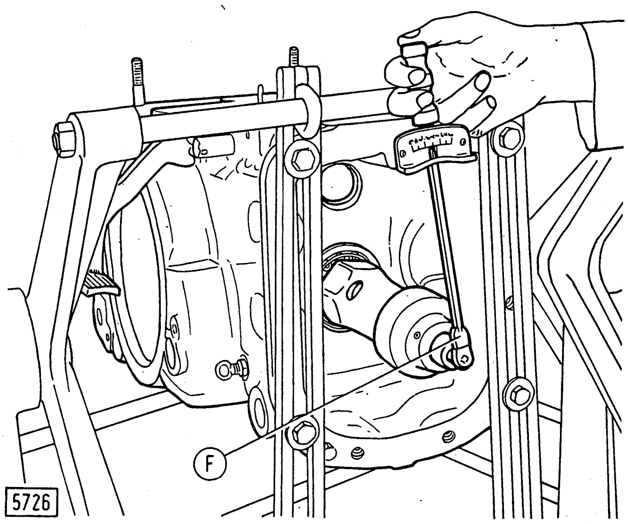


***Fig. III/11** - Tightening the nut (C_3, Fig. III/10) with the torque wrench A 711041/2 (F) to check the bevel pinion bearing setting.*

Note. - *When selecting the shims* (**Sp**), *measure each shim with a micrometer then add the readings. Do not rely on a single measurement of the stack or on the nominal thickness given for the individual shims.*

2. Checking the pinion cone centre distance and finding the correct thickness of the shim pack (S, Fig. III/6).

— Withdraw the bevel gear pinion shaft previously installed, install the dummy shaft **A 137010/B** (**E**, Fig. III/12) of the pinion cone centre caliper, insert the adjustment shims (**Sp**) found in para. **1** and then block the stack by means of the knurled knob.

— Install in the housing the caliper **A 137010/A** (**F**, Fig. III/13), block the right-side bearing housing complete with about 1 mm (0.040) of adjustment shims (**Sa**) with only three screws (C_4) tightened to the torque of 5.7 ÷ 6.3 kgm (41.2 ÷ 45.5 ft. lb) and then arrange the left-side bearing housing without adjustment shims still with only three screws (**D**), previously lubricated and arranged at 120° from each other. Cross-tighten the screws (**D**) with torque increments of 0.1 kgm (0.7 ft. lb) up to 0.6 kgm (4.3 ft. lb) per screw and, at the same time, turn the caliper by hand to bed in the tapered roller bearings.

— Arrange the caliper horizontally, screw up the knurled knob (**F**, Fig. III/13) bringing the end of the pin in abutment with the surface (**E**) of the shaft and take the reading of the dimension (**Qr**) and its sign given by the pointer as the knob stops turning.

— Write down the correction factor (**Qc**, Fig. III/14) etched on the pinion face, expressed in mm and preceded by the sign + or —, if different from zero.

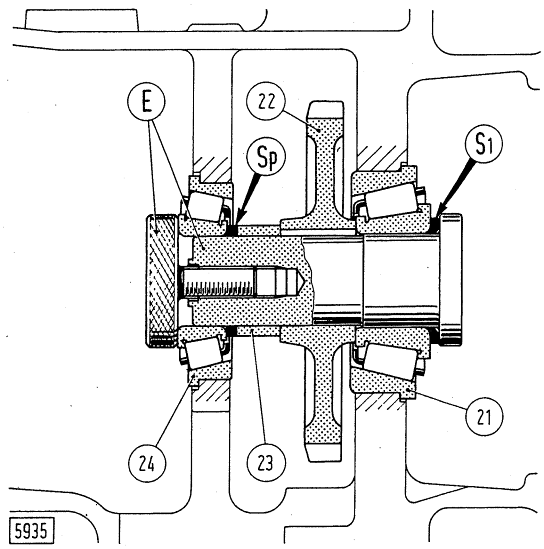


***Fig. III/12** - Arrangement of cone centre distance caliper shaft A 137010/B (E).*
S_1. Pinion cone centre check shim. - Sp. Pinion bearing shims. - 21. Rear bearing. - 22. P.T.O. driving gear. - 23. Spacer. - 24. Front bearing.

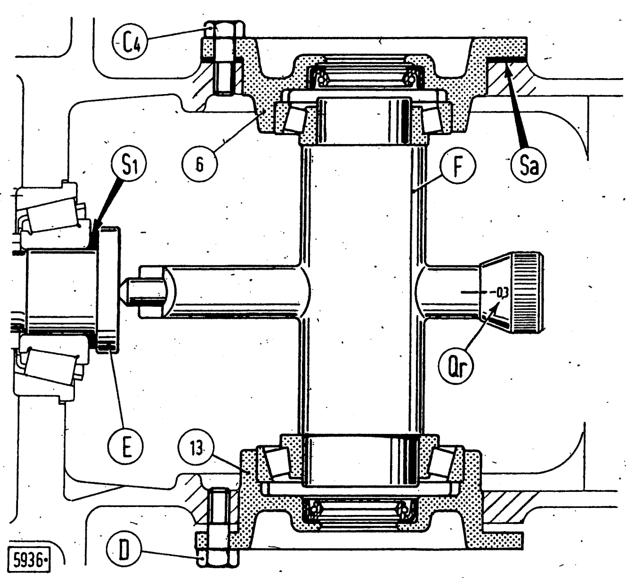


***Fig. III/13** - Arrangement of cone centre distance caliper A 137010/A (F).*
C_4. Bearing housing (6) screws - D. Bearing housing (13) screws - E. Caliper shaft A 137010 (B). - Qr. Caliper reading. - Sa = 1 mm (0.040) in. Shim stock for bearing housing (6). - S_1. Cone center distance check shims. - 6. Right bearing housing. - 13. Left bearing housing.

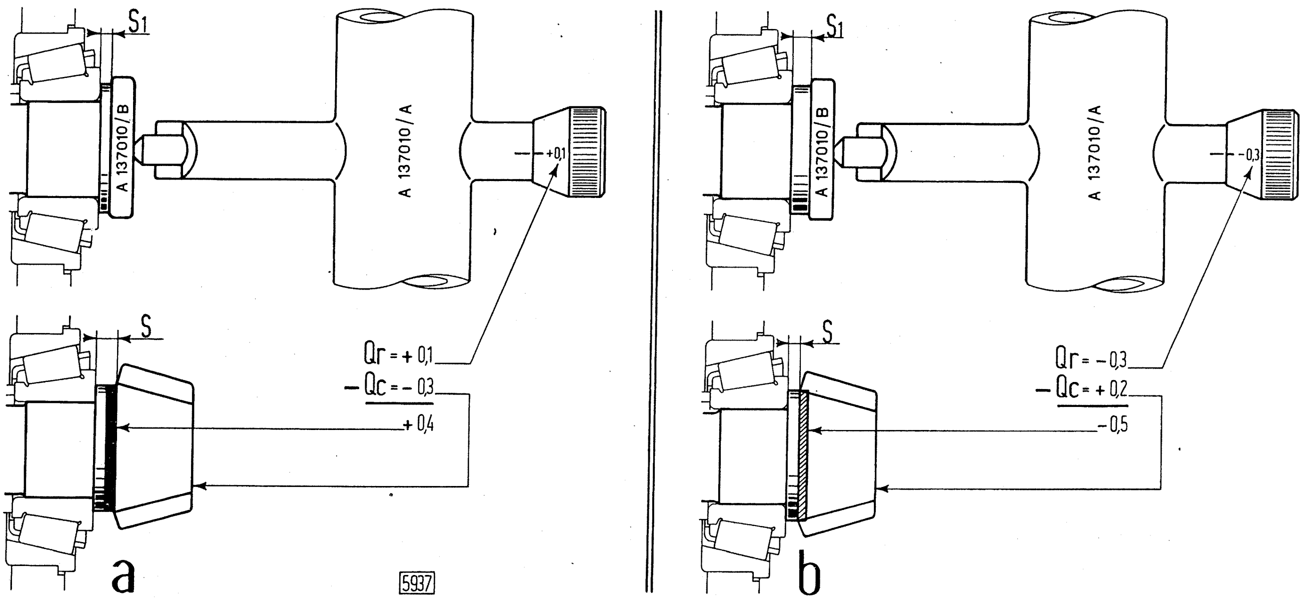


***Fig. III/14** - Exemplifying layouts of two pinion cone center distance settings.*
Qc. Correction dimension etched on the pinion face. - Qr. Caliper reading. - S. Correct pinion cone center distance setting shim. - S_1. Shim inserted to check the pinion cone center distance.

— Find the algebraic difference between the measured distance (**Qr**) and correction factor (**Qc**): the result will be the quantity of increment of reduction of the thickness and the adjustment shim stack (S_1) to obtain the final shim thickness (S, Fig. III/6).

Example 1 (**a**, Fig. III/14).

Caliper reading (**Qr**) . . . . . . + 0.1 mm

Correction factor (**Qc**) read on the pinion . . . . — 0,3 mm

Shim correction = **Qr** — **Qc** = + 0.1 — (— 0.3) = + 0.1 + 0.3 = + 0.4 mm

To position the pinion correctly, install a shim (S) 0.4 mm thicker than the caliper shim (S_1).

Example 2 (**b**, Fig. III/14).

Caliper reading (**Qr**) . . . . . . — 0.3 mm

Correction factor (**Qc**) read on the pinion . . . . + 0.2 mm

Shim correction = **Qr** — **Qc** = — 0.3 — (+ 0.2) = — 0.3 — 0.2 = — 0.5 mm

To position the pinion correctly, install an adjustment shim (S) 0.5 mm (0.020 in) thinner than the shim (S_1) arranged on the caliper.

— Install the bevel pinion and the adjustment shim just found (S, Fig. III/6) then torque tighten the nut (C_3) to the specified value.

3. Setting the bevel gear tapered roller bearings and finding the total shim stack (Sc) thickness.

— Install the differential and bevel gear as an assembly with the bearings properly lubricated, install a stack of shims (**Sa**, Fig. III/15) about 1 mm thick and the bearing housing bracket securing the latter with only three screws (C_4) tightened to a torque value of 5.7 ÷ 6.3 kgm (41.5 ÷ 45.5 ft. lb), and, finally, install the left side bearing housing bracket with no shims and also with three screws (D), well lubricated with thin crankcase oil and arranged at 120° from each other (Fig. III/16).

— Gradually cross-tighten the three screws (D) with the torque wrench **A 711041/2** and with torque increments of 0.1 kgm (0.7 ft. lb) up to the final value of 0.6 kgm (4.3 ft. lb) per screw simultaneously, turn the bevel gear a few turns by hand to ensure correct roller bedding.

— Measure the clearance (**L**, Fig. III/15) between transmission housing side and left side bearing housing bracket with a feeler gauge at three points 120° from each other and symmetrical

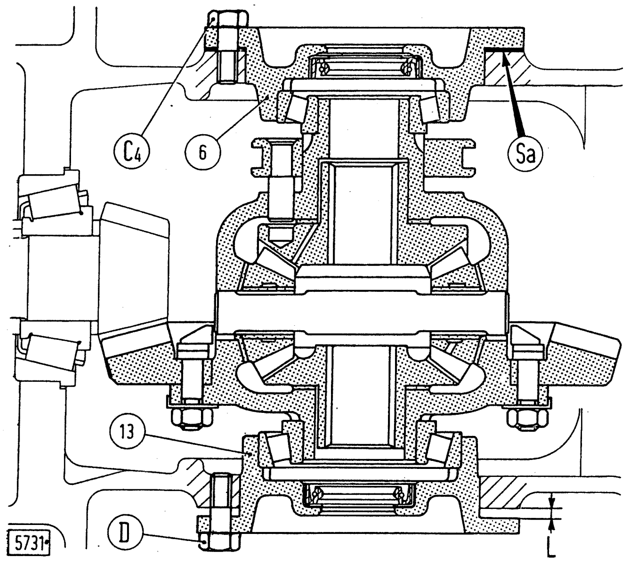


Fig. III/15 - Adjusting the differential-bevel gear tapered roller bearing.

C_4. Bearing housing bracket (6) stud screws. D. Setting check screw - L. Assembly clearance between transmission housing and left-hand bearing housing (13). - Sa. 1 mm (0.040 in). Shim stack thickness to be inserted on the right bearing housing. - 6. Right side bearing housing bracket. - 13. Left side bearing housing bracket.

with respect to the adjusting screws (D, Fig. III/17).

Find the average of the readings then add 0.05 mm.

Therefore, the total thickness (Sc) of shims to be installed is:

$$Sc = Sa + L + 0.05$$

where:

Sa = shim thickness inserted at the right-side bearing housing bracket;

L = clearance measured previously;

0.05 = play required to take up the end float caused by tightening the screws (D).

Example

Thickness of shim stack inserted at the right-side housing bracket . . . . . 0.95 mm

Clearance (L) measures . 2.70-2.70-2.65 mm

L = average clearance

$$= \frac{2.70 + 2.70 + 2.65}{3} = 2.683 \text{ mm}$$

$$Sc = Sa + L + 0.05 = 0.95 + 2.683 + 0.05$$
$$= 3.683, \text{ rounded in excess to } 3.70 \text{ mm.}$$

Note. - *Always round the result in excess to the second decimal figure, with 0.05 mm intervals.*

4. Checking the bevel gear and pinion tooth backlash and subdividing the total shim thickness (Sc), found in para. 3, into the shim stacks (Sd and Ss, Fig. III/6).

— Find the tooth clearance with the aid of a dial gauge placed perpendicularly to a tooth face.

Note. - *We recommend taking two more readings at two different points to make sure the bevel gear is not warped.*

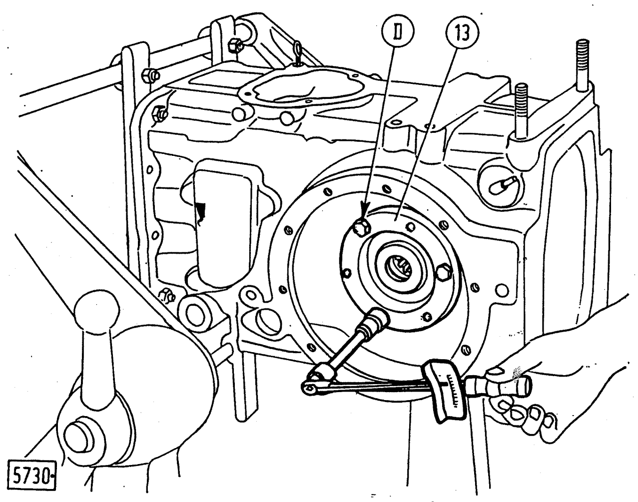


Fig. III/16 - Tightening the screws (D) with the torque *wrench A 711041/2 to check the bearing setting.*

13. Left bearing bracket.

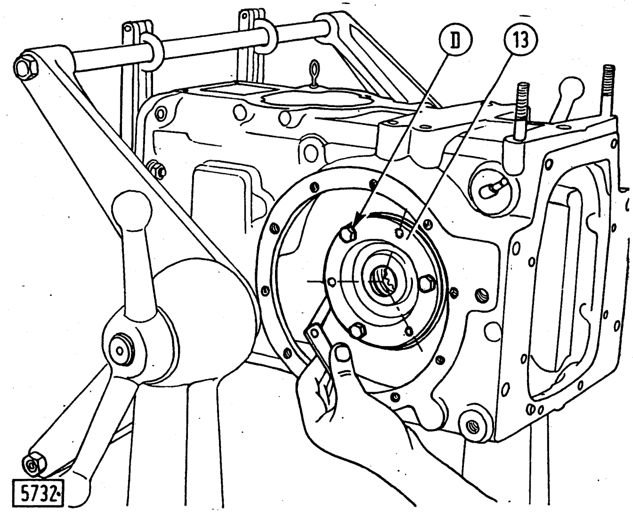


Fig. III/17 - Measuring the clearance (L, fig. III/15) with a feeler gauge.

D. Adjustment check screws - 13. Left side bearing housing bracket.

— Find the axial displacement (Z) of the bevel gear by multiplying the coefficient 1.5 (fixed ratio between bevel gear normal play and axial displacement) by the difference between the measured play (G) and the specified tooth backlash (0.20 mm):

$$Z = (G - 0.20) \times 1.5$$

where:

G = measured backlash;

0.20 = correct service backlash;

1.5 = fixed ratio between correct service backlash and bevel gear axial displacement.

— The shim stacks (Sd and Ss, Fig. III/6) to be inserted under the housing brackets will thus be given by:

$$Sd = Sa + Z$$

$$Ss = Sc - Sd$$

where:

Sa = shim stack inserted under the left side bearing housing bracket in para. 3;

Z = axial displacement of bevel gear found previously;

Sc = total value of shims found in para. 3.

Example: G = 0.92 mm

Z = (G — 0.20) × 1.5 = (0.92 — — 0.20) × 1.5 = 1.095 mm (rounded off to 1.1 mm)

Sd = Sa + Z = 0.95 + 1.1 = 2.05 mm

Ss = Sc — Sd = 3.70 — 2.05 = 1.65 mm.

— Insert the shims (Sd and Ss) under the brackets and then tighten the screws to the torque specified in Section IX.

Adjusting the bevel gear pinion shaft tapered roller bearings and finding shim thickness (Sp, Fig. III/6) using tool no. 293101 (tool indispensable for tractors not equipped with ground speed P.T.O. and for front wheel drive models).

Install on tool 293101 (E, Fig. III/18) the inner races (1) and (2) of the pinion shaft bearings and the relevant spacer (3).

Tighten nut (M) of tool completely.

Measure dimension (H_1, a) between top surface and tool spindle end (a).

Dismantle the pack, lubricate the bearings cones with engine oil and reinstall all the parts in the transmission housing (b).

Tighten the nut (M) completely and simultaneously keep turning the tool about ten revolution to secure proper bedding-in of the bearings.

Measure dimension (H_2, b) on the fixture under this condition.

The stack thickness of adjustment shims (Sp) to be fitted is given by:

$$Sp = H_2 - H_1 + 0.05$$

If necessary, round off in excess within 0,05 mm, the value of (Sp).

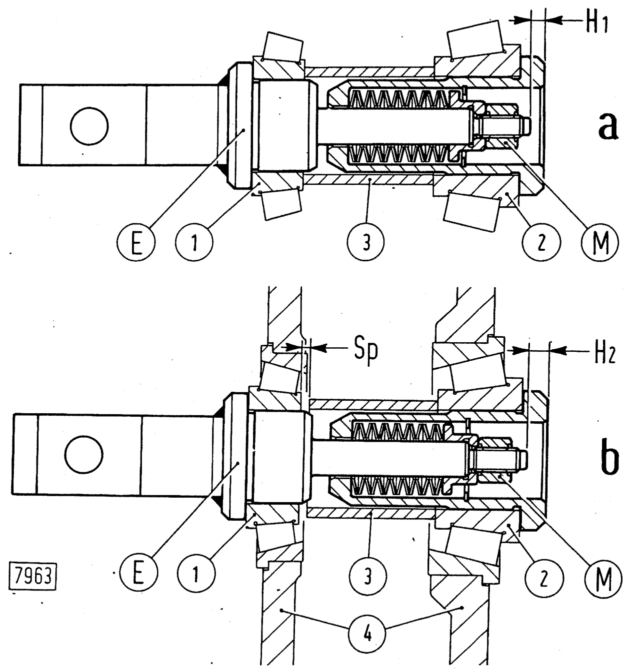


Fig. III/18 – Finding the thickness of the shim pack (Sp. Fig. III/6) for the adjustment of the pinion shaft tapered roller bearings.

E. Adjustment tool 293101 – H_1 and H_2. Dimensions to be found by means of a dial gauge in order to determine the value (Sp) – M. Tool locknut – Sp. Pinion bearing shims – 1 and 2. Inner races of the bearings – 3. Spacer – 4. Transmission housing.

IV - BRAKES

DESCRIPTION

The dry, contracting band brakes operate on two drums which are keyed to the differential axle shafts and are mechanically controlled by two indipendent service pedals (**P**, Fig. IV/1) placed at the tractor right-hand side.
The lock plate (**T**) blocks the pedal together for simultaneous highway control.
A further control is the parking brake hand control lever (**1**) placed on top of the transmission housing which blocks the driving wheels when the tractor is stationary.
The brakes are housed in the compartment between differential and each final drive (Fig. IV/1).
The band (**8**) of each brake is lined with three asbestos base friction elements for a total winding angle around the drum of 274°.

DISASSEMBLY

To dismantle each brake, first remove the final drive following the instructions given in the related chapter, then proceed as follows:

— remove the brake pedal return springs (**2**, Fig. IV/1) and free the outside lever (**6**) from the clevis (**3**), after removing the connecting pin and cotter;

— remove the bottom service and inspection cover (**7**) then, through the transmission housing compartment, remove the outside control lever (**6**) sets screw (**C$_3$**, Fig. IV/2);

— withdraw the pivot pins (**10**) and remove the complete brake band (**8**) and the inside lever (**9**).

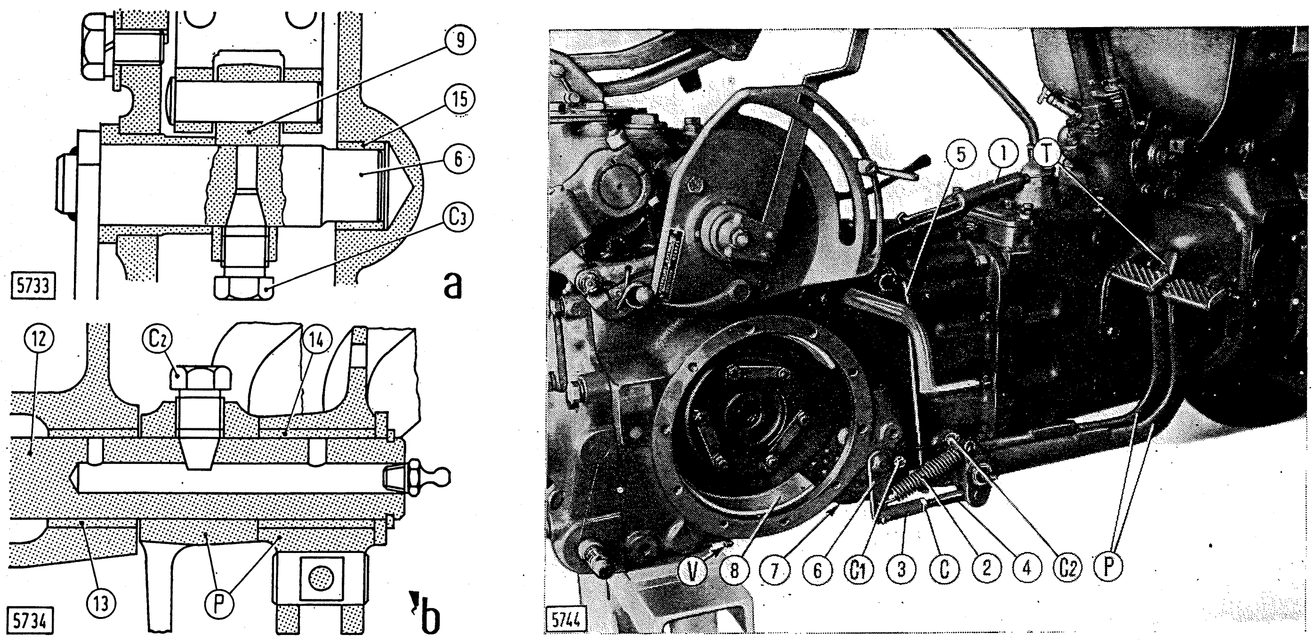


Fig. IV/1 - Service and parking brakes and their controls.

a. Inside lever (9) pivoting arrangement.
b. Pivoting arrangement of pedal (P) shaft (12).
C. Clevis (3) jam nut. - C$_1$. Outside lever bracket screw. - C$_2$. Left service brake pedal setscrew. - C$_3$. Inside lever (9) setscrew. - P. Service brake pedals. - T. Lockplate. - V. Brake band centering screw. - 1. Parking brake lever. - 2. Return spring. - 3 and 4. Brake pedal free run adjusting clevis and link. - 5. Parking brake lever (1) rod. - 6. Outside brake control lever. - 7. Cover. - 8. Band brake. - 9. Inside band control lever. - 12. Left side service brake shaft. - 13, 14 and 15. Bushings.

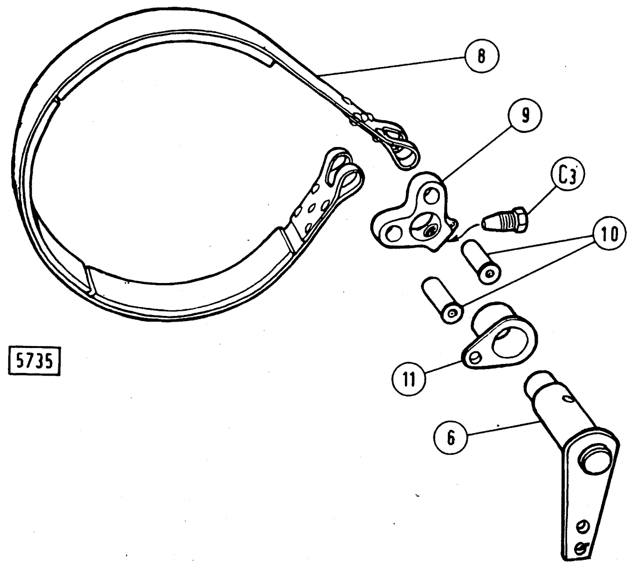


Fig. IV/2 - Exploded view of a service brake.
C_3. Lever (9) set screw. - 6. Outside brake control lever. - 8. Brake band. - 9. Inside lever. - 10. Brake band hinge pins. - 11. Lever (6) bracket.

INSPECTION

Check the brake band lining wear vs. service limits, considering that, the band is supplied as spare part already fitted up with the relevant linings.

If the bands are to be removed because of contamination by seeping transmission oil check the functional efficiency of the seals on the differential axle shafts.

Inspect the brake drum surfaces. If necessary, reface the drum diameter, which can be cut down to 224 mm (8.819 in), and replace the complete bands using original FIAT spares.

Check the bushings (**13, 14** and **15**, Fig. IV/1) for wear considering the permissible limits of the table of data.

ASSEMBLY

Make sure of the following:

— the setscrews (**C_3**, Fig. IV/2) are fitted with their heads towards the tractor back end. A different installation means that the levers (**6**) are fitted the wrong way;

— wire lock the screws on the levers (**9**).

ADJUSTMENT

As the brake linings wear out, the free travel of the pedals increases.
This free travel should not exceed 60 ÷ 70 mm (2.36 ÷ 2.76 in) and is equal for both pedals so to achieve simultaneous and equal braking force action when they are interlocked by the plate (**T**, Fig. IV/1).
Adjust, if necessary, as follows:

— make sure the parking brake lever (**1**, Fig. IV/1) is disengaged;

— screw up tight the brake band centering screws (**V**), screw them back of **one and a half turn,** then lock them by tightening the jam nuts;

— slacken the jam nuts (**C**) and unscrew the push rod (**4**) until the free travel of the pedals is annulled;

— then, screw up the rods (**4**) **two turns** so to obtain a free travel of 50 mm (1.97 in) for both pedals;

— tighten the jam nuts (**C**).

V - FINAL DRIVES AND REAR WHEELS

DESCRIPTION

The final drives are attached to the sides of the rear transmission and contain a single-reduction spur gear train.

The driving pinions are machined directly from the axle shaft ends, and the driven bull gears are splined into the driving wheel shafts.

The driving wheels with stamped steel rims and discs, can be supplied with tyres: 12.4/11-32; 14.9/13-30; 16.9/14-28; 16.9/14-30.

Eight different tread adjustments are obtained by suitable arrangement of wheel rims and discs, ranging from 1320 mm to 2020 mm (52" to 80") by steps of 100 mm (3.937 in).

Keep in mind that the 1320 mm (52") track setting cannot be obtained with tyres 14.9/13-30; 16.9/14-28; 16.9/14-30.

REMOVAL

Remove each final drive unit as follows:

— drain the final drive lubrication oil through the plug hole (T_1, Fig. V/2);

— remove screws and fenders from the brackets; disconnect the rear lighting cables before removing the right-hand side fender;

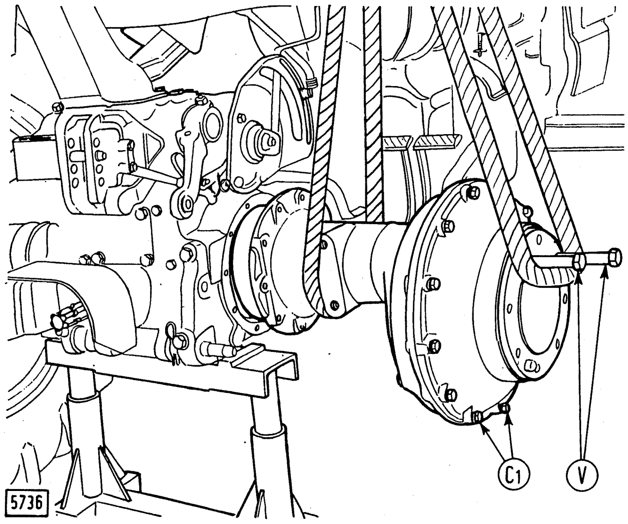


Fig. V/1 - Removing (refitting) the right-hand side final drive.
C_1. Cover cap screws. - V. M 16 × 1.5 bolts for hoisting rope application.

— apply a rope on the final drive and shop hoist;

— raise the unit until the weight is taken off the drive wheel;

— remove the wheel and tyre unit and place a shop stand under the rear transmission housing;

— fit two M 16 × 1.5 (V, Fig. V/1) bolts to the drive wheel shaft flange, arrange a hoisting rope around the housing and take the weight off;

— remove the final drive housing attaching cap screws and then the unit itself from the tractor (Fig. V/1).

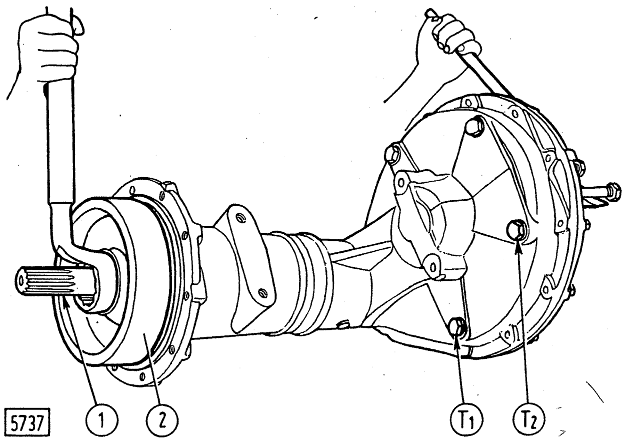


Fig. V/2 - Removing the brake drum locknut.
T_1. Oil drain plug. - T_2. Oil filler plug. - 1. Differential axle shaft. - 2. Brake drum.

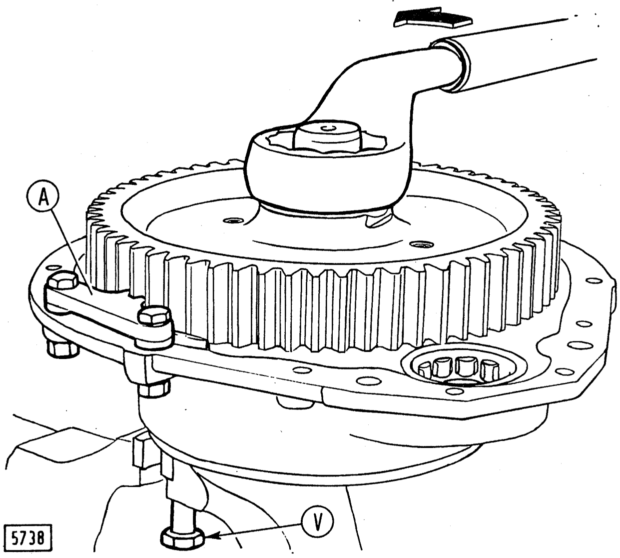


Fig.V/3 - Removing the bull gear locknut.
A. Gear stop A 587023 - V. M16x1,5 bolt for cover attachment to the bench vise.

DISASSEMBLY

Dismantle each final drive unit as follows:

— unscrew the brake drum nut stopping the rotation of the axle shaft by means of a crowbar as shown in Fig. V/2;

— remove the brake drum (**2**) with the puller **A 517010/C**;

— remove the final drive cover and bull gear as an assembly, after unscrewing the attaching cap screw (C_1, Fig. V/1), then clamp the assembly in a bench vice suitably arranging the M 16 × 1.5 bolts (**V**, Fig. V/3) already used for removal;

— apply on the cover the gear stop A 587023, then unscrew the bull gear nut (Fig.V/3) considering that the roller bearing inner ring (14,Fig.V/7) must be removed first;

— remove the bull gear from its shaft using the pullers 292904 (Fig. V/4) and withdraw the spacer (4, Fig. V/8);

— tap with a lead hammer in the direction shown by the arrow in Fig. V/8 to expel the shaft (**3**);

— straighten the lock plates then unscrew the attaching cap screws (C_2) to remove the bearing retaining plate (5) ;

— withdraw the retaining ring (**11**, Fig. V/5) then remove the axle shaft (**1**) and bearing (**9**) in the direction shown by the arrow in Fig. V/5 by acting at the opposite end with a lead hammer;

— remove the retaining ring and press the ball bearing (**9**) off the shaft, then remove the roller bearing inner ring (**7**, Fig. V/6) using the split-type bearing puller **A 511100/A 115** (**D**);

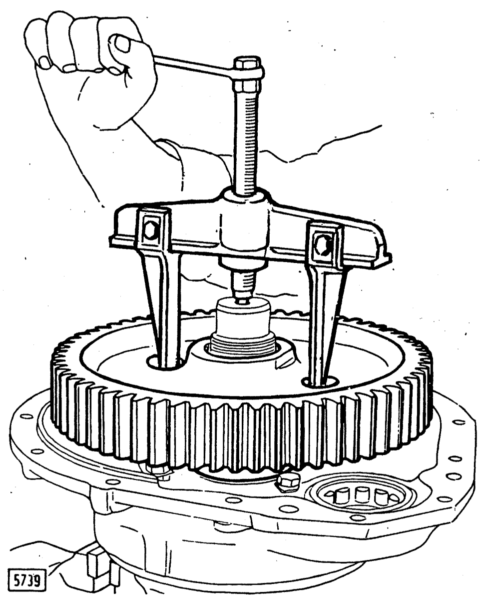


Fig. V/4 - Removing the bull gear by means of the puller

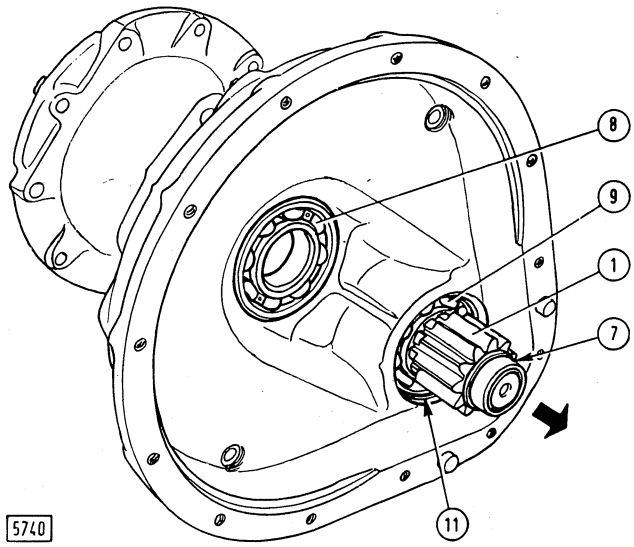


Fig. V/5 - Final drive housing.
(The arrow indicates the direction of withdrawal of axle shaft 1).
1. Differential axle shaft. - 7. Roller bearing inner ring. - 8 and 9. Ball bearings. - 11. Bearing (9) retaining ring.

— remove the ball bearing (**6**, Fig. V/8), the roller bearing outer ring (**7**) and the ball bearing (**8**, Fig. V/5) using the universal puller **A 537105**.

INSPECTION

After thorough washing of the disassembled parts, proceed as follows:

— make sure that the seals (**12** and **13**, Fig. V/7) are efficient and reliable;

— examine the gear working surfaces and check the tooth backlash;

— check the mating splines of bull gear and shaft;

— examine the bearings very carefully.

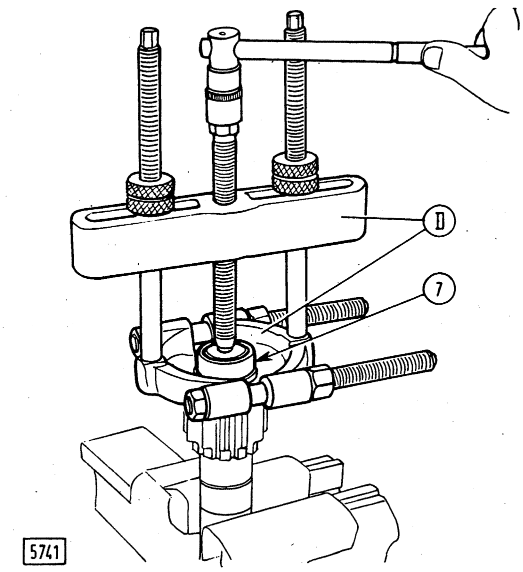


***Fig. V/6** - Pulling out the axle shaft outer roller bearing inner race (7).*

D. Split-type bearing puller A 511100/A115.

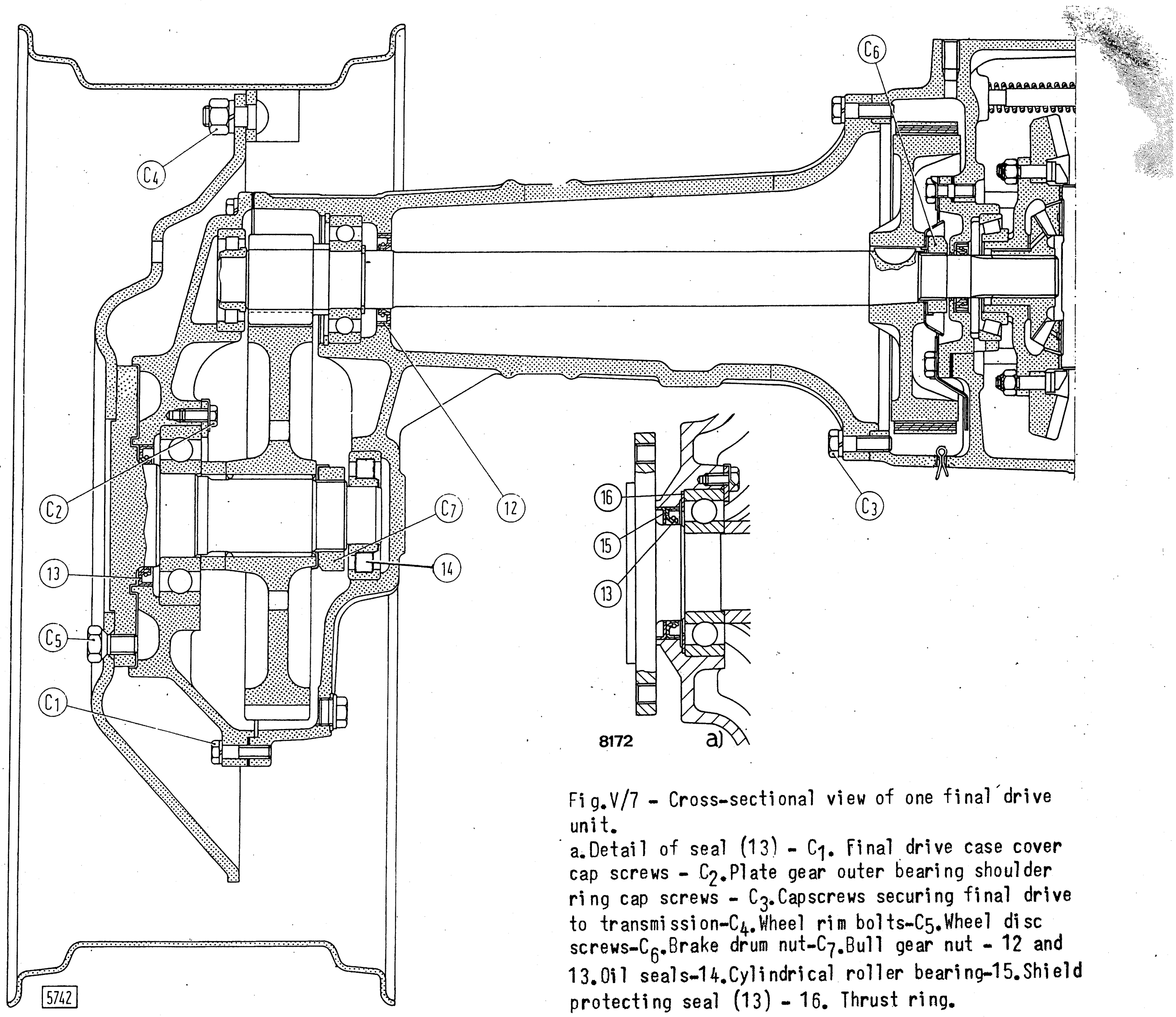


Fig.V/7 - Cross-sectional view of one final drive unit.

a. Detail of seal (13) - C_1. Final drive case cover cap screws - C_2. Plate gear outer bearing shoulder ring cap screws - C_3. Capscrews securing final drive to transmission - C_4. Wheel rim bolts - C_5. Wheel disc screws - C_6. Brake drum nut - C_7. Bull gear nut - 12 and 13. Oil seals - 14. Cylindrical roller bearing - 15. Shield protecting seal (13) - 16. Thrust ring.

ASSEMBLY

At assembly, take good notice of the following items:

— when installing the axle shaft and the driving wheel shaft be careful not to damage the seal (**12** and **13**, Fig. V/7);

— fit the outer roller bearing inner ring (**7**, Fig. V/5) to the axle shaft after pre-heating it in oil to 80° ÷ 90° C (176° ÷ 194° F);

— fit the outer ring of the roller bearing (**7**, Fig. V/8) into the final drive cover housing with the factory mark facing outside;

— install the retaining bearings using drive bars of appropriate dimensions;

— in case of replacement, arrange the seals (**12** and **13**) as shown in Fig. V/7;

— tighten the ball gear nut (**C**$_7$, Fig. V/7) after applying the gear stop (**A**, Fig. V/3) previously used at disassembly;

— be sure to meet the torque requirements specified in Section IX.

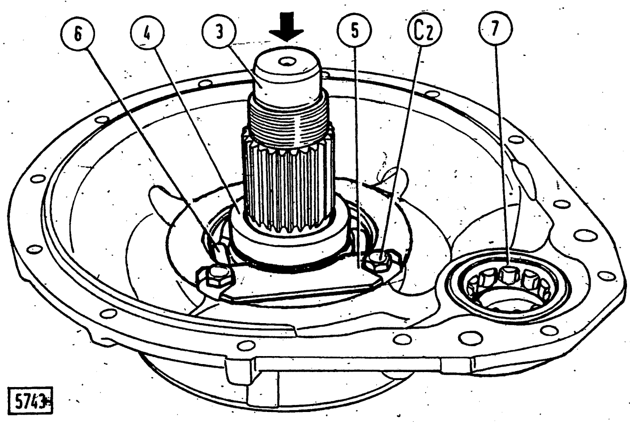


***Fig. V/8** - Removing (refitting) the bull gear shaft (3).* (The arrow indicates the direction of shaft removal). C$_2$. Washer (5) capscrews. - 4. Spacer. - 5. Bearing (6) retaining plate - 6. Ball bearing. - 7. Roller bearing outer ring.

VI - FRONT AXLE AND STEERING

STEERING BOX (GEMMER) (*)

Worm-and-nut steering box with **1 : 22.4** ratio.

Removal.

Remove the steering box as follows:

— remove the cowling separating it from the instrument panel and disconnecting from the latter the lighting-starting switch, the horn push-button, and the radiator curtain-control, if any;

— disconnect the throttle links from its leverage;

— detach the drag link (**1**, Fig. VI/1) or remove the steering arm (**8**) by means of the tool **A 44318** (**A**); after unscrewing the nut;

— remove then the steering box assembly complete with steering-wheel after unscrewing the attaching cap screws.

Disassembly.

Before starting to disassemble, drain the oil by removing one of the side cover lower screws and the threaded plug, then proceed as follows:

— remove the steering wheel after unscrewing the nut which secures it onto the steering shaft;

— remove the steering shaft key, remove the screws (**C_2**, Fig. VI/1) and then withdraw the cover (**5**) with steering column and hand throttle;

— remove the cap screws (**C_3**, Fig. VI/4), then withdraw the steering box nut shaft (**2**) and adjuster (**V**), nut (**V_1**) and side cover (**9**) as an assembly, using a lead hammer;

— withdraw the steering shaft upwards with worm (**4**) and upper taper roller bearing (**6**);

— withdraw the lower taper roller bearing (**7**) by hand;

— remove the cup of the lower bearing (**7**) using the universal puller **A 537105** (Fig. VI/2) and recover the shims.

Note. - *The inner races of both upper and lower taper roller bearings are machined directly on the body of the worm screw which, for service, is furnished together with the steering shaft, as an assembly.*

In case of replacement, remove the bushings (**10** and **11**, Fig. VI/3) from the steering box and from the side cover by means of the puller **A 323126** (**D**, Fig. VI/3); notice that the bushing (**11**) is to be removed after the oil seal (**12**).

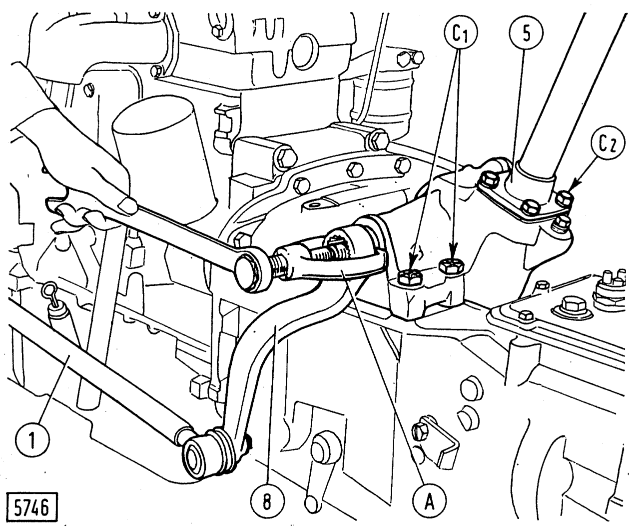


Fig. VI/1 - Removing the steering arm (8) from the steering box nut shaft by the puller A 443018 (A).
C_1. Steering box self-locking screws. - C_2. Cover (5) screws. - 1. Drag link. - 5. Top cover with steering column.

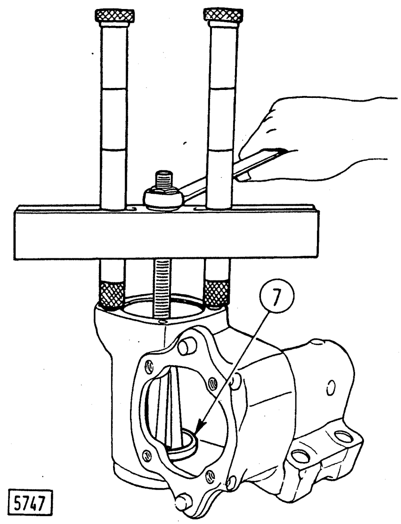


Fig. VI/2 - Removing the cup of the lower tapered roller bearing (7) with the universal puller A 537105

(*) For the BURMAN steering box overhaul refer to the instructions reported at page 220 of mod.640 appendix.

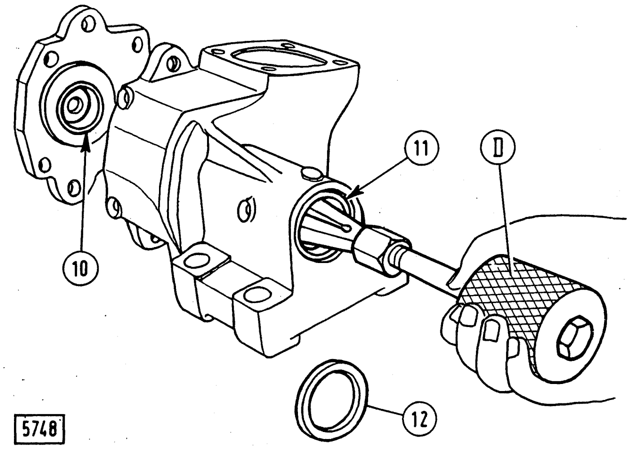


Fig. VI/3 - *Removing the steering box nut shaft bushing (11) by means of the puller A 323126 (D).*
10. Cover bushing. - 12. Oil seal.

Inspection.

Check the worm and nut surfaces for nicks or seizure marks.

Make sure that the clearance between bushings and nut shaft is within the permissible limits of Section IX.

Also, make sure that the nut has no end play because of worm nut thrust washers (**R**, Fig. VI/4); if so, replace the whole nut shaft as an assembly.

Try the worm screw roller bearings for free running and check the oil seal (**12**, Fig. VI/3) for efficiency and reliability.

Check the steering levers and tie-rods for bends or bucklings, and straighten them if necessary and then make sure, prior to assembly, that this operation has not weakened the parts.

Assembly.

Assembly the steering box as follows:

— insert the shim stack (S_1, Fig. VI/4) and fit the cup of the lower taper roller bearing (**7**) using the drive bar **A 96553**;

— fit the bushings to the steering box and to the side cover using the drive bar **A 93240**, then ream them to bring the diameter to the specifications of Section IX;

— fit the oil seal (**12**, Fig. VI/3) using the drive bar **A 95543** and arranging it as shown in Fig. VI/4;

— adjust the steering shaft taper roller bearings as indicated in the para. **1** of the following chapter;

— set the worm-and-nut as indicated in the para. **2**;

— be sure to meet the tightening torque requirements specified in Section IX.
Prior to assembly, the side cover screws (**C_3**, Fig. VI/6) and the adjusting lever (**V**) are smeared with a thin film of jointing compound (" RHODORSIL " CAF. 1).

Steering box adjustments.

The adjustment operations can be subdivided into two distinct phases and are grouped under the two following sub-titles:

1. *Adjusting the worm screw taper roller bearings.*

— Install the steering shaft in the steering box and lubricate the taper roller bearings to suit;

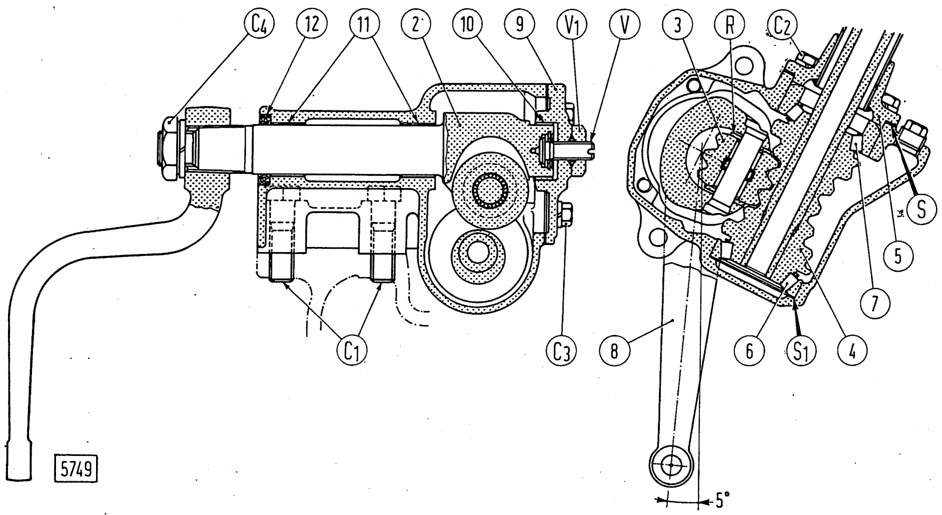


Fig. VI/4 - *Steering box cross-sections.*
C_1. Steering box self-locking screws. - C_2. Upper cover cap screws. - C_3. Side cover cap screws. - C_4. Steering arm (8) nut. - R. Nut thrust washers. - S. Worm bearings shims. - S_1. Worm-and-nut setting shims. - V. Nut adjusting screw. - V_1. Nut screw (V) locknut. - 2. Nut shaft. - 3. Nut. - 4. Worm. - 5. Upper cover. - 6 and 7. Tapered roller bearings. - 8. Steering arm. - 9. Side cover. - 10 and 11. Bushings. - 12. Oil seals.

— Fit the top cover and steering column to the steering box using only two of the four screws, properly lubricated with oil and with no lock washer.

— Gradually cross-tighten the screws (**T**, Fig. VI/5) by applying a torque of 0.3 kgm (2.2 ft. lb) by means of the torque wrench **A 711041/2**, and simultaneously turn the steering shaft **a**) by hand in order to favour the proper bedding of the rollers on their bearing races.

— Measure the clearance between top cover and steering box by taking two readings with a feeler gauge at diametrically opposed points on the axis X-X (**b**, Fig. VI/5) and then finding the average of the readings.

— Remove the cover (**5**), insert a shim stack (S, Fig. VI/4), adding 0.10 mm (0.004″) to the value found previously, then refit the cover and torque tighten the screws to specifications.

— Measure the torque which is required to make the steering shaft turn and if it is different from 0.05 ÷ 0.1 kgm (0.4 ÷ 0.7 ft. lb), repeat the adjustment.

2. *Adjusting the worm-and-nut setting.*

— Smear a thin film of lead oxide on the nut working surface.

— Install in the steering box the steering shaft nut with side cover and with the adjusting screw (**V**, Fig. VI/6) completely backed out, so that the nut is at the end of its run towards the side cover.

— Secure the side cover with two screws (**C_3**).

— Check the number of turns that the steering wheel makes between stops.

— Find the mid-position of the steering wheel between stops, corresponding to the position of the steering arm (**8**) for straightforward motion, as shown in Fig. VI/4.

— Screw up the adjusting screw (**V**, Fig. VI/6) so to take up the play between worm and nut, then block it with the jam nut (**V_1**).

— Check that the torque which is required to make steering shaft turn is 0.15 ÷ 0.26 kgm (1 ÷ 1.9 ft. lb) through the initial 30° in both directions, and 0.06 ÷ 0.12 kgm (0.43 ÷ 0.87 ft. lb) in proximity of the stop.

— Remove then the nut shaft complete and inspect the nut examining the uniformity of the contact areas on the working surfaces.

To correct, if necessary, suitably vary the shim stack (S_1, Fig. VI/4) considering that if the stack is increased then the shims (S), found in para. **1** should be **correspondently increased, and vice-versa.**

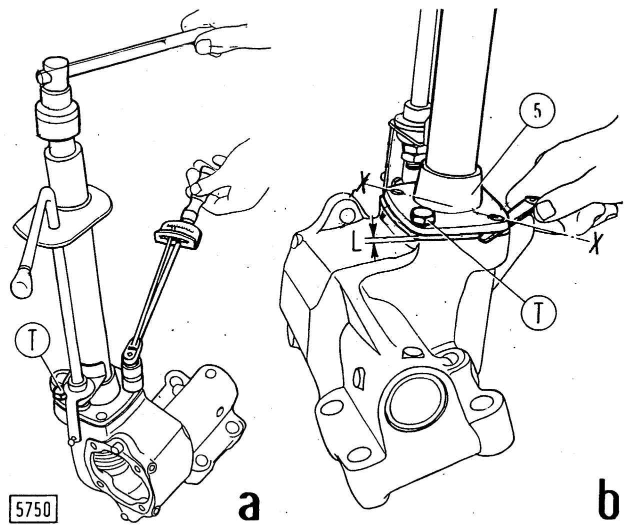


Fig. VI/5 - *Adjusting the steering shaft tapered roller bearings.*

a. Tightening the screws (T) with the torque wrench A 711041/2.

b. Measuring the clearance (L) between cover (5) and steering box with feeler gauge.

X-X. Clearance measuring axis. - 5. Top cover with steering column.

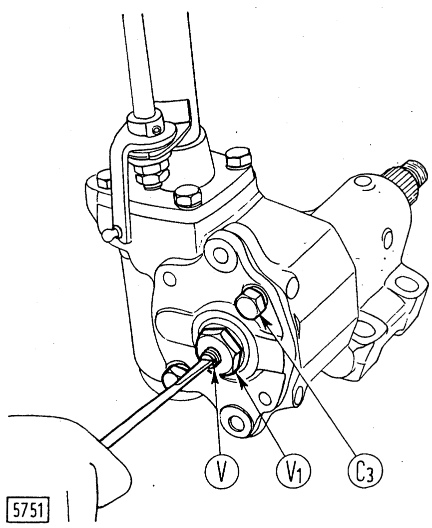


Fig. VI/6 - *Adjusting the worm-and-nut setting.*

C_3. Side cover cap screws. - V. Adjusting screw. - V_1. Adjusting screw (V) nut.

Note – The aforementioned adjustment may be used at steering box overhauls as a further check of the worm-and-nut setting, if the parts are reusable. In this case we suggest maintaining the original factory shim stack (S_1, Fig. VI/4). Alter the shim stack only when one or more parts are replaced.

FRONT AXLE AND STEERING WHEELS

Description.

The front axle with reversed U shaped section, is centrally pivoted and has telescopic beam extensions which allow a range of tread width adjustments. The front steering wheels with stamped steel rims and discs, can be supplied with tyres : 6.00-16;6.50-16; 6.00-19; 7.50-16.

By suitably arranging the front axle beam extension it is possible to obtain eight different thread widths,ranging from 1320 mm to 2020 mm (52" to 80") by steps of 100 mm (3.937 in).

Keep in mind that with tyres 7.50-16 only seven thread widths, ranging from **1350 mm to 1950 mm (53.149 to 76.771 in)** can be obtained by steps of 100 mm (3.937 in).

The min. steering radius is 3700 mm (145.668 in) without braking.

Overhaul.

If the front axle trunnion assembly requires servicing, proceed as follows :

- apply the hand brake and insert wooden wedges to block the drive wheels ;

- at one axle end, remove the bolt (C_9, Fig. VI/7), the steering lever (17) from the wheel spindle,

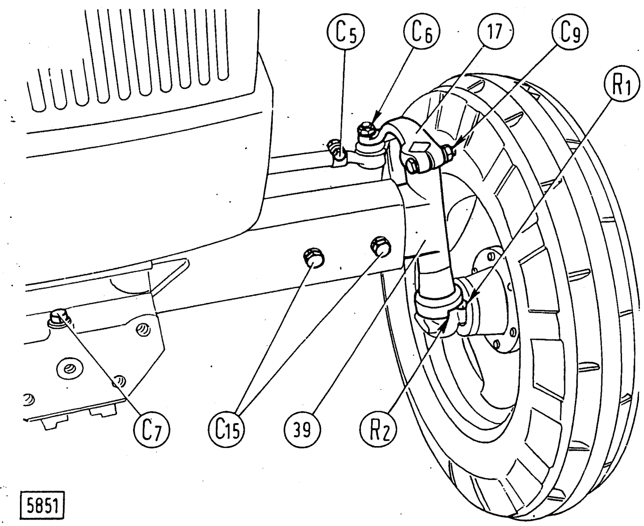


Fig. VI/7 – Front axle left end.
C_5.Tie-rod setscrew nut – C_6. Steering lever (17) ball socket blocking nut – C_7.Trunnion pin setscrew – C_9. Steering lever (17) bolt nut – C_{15}. Beam extension (39) setscrew – R_1 and R_2. Steering angle adjustable and fixed stops – 17. Steering lever – 39. Beam extension.

and remove the screws (C_{15});

— place a hydraulic jack under the crankcase oil sump and raise the front end of the tractor to take the weight off the axle;

— remove the front wheel, spindle-beam extension assembly **39**, Fig. VI/7);

— remove the setscrew (C_7, Fig. VI/8) and then the trunnion pin (**20**) using the sliding-weight type puller **A 147022** ter.

— remove the front axle and remaining wheel as an assembly and recover the end thrust washers (**25**, Fig. VI/9);

— remove the bushings (**33**) using the collet **A 323126/C**, the rod **A 323126/V** and the bridge

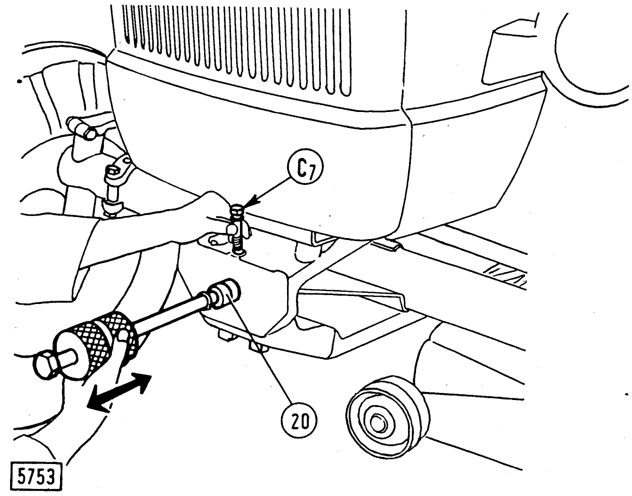


Fig. VI/8 - *Removing the trunnion pin (20) by means of the puller A 147022 ter.*
C_7. Trunnion pin setscrew.

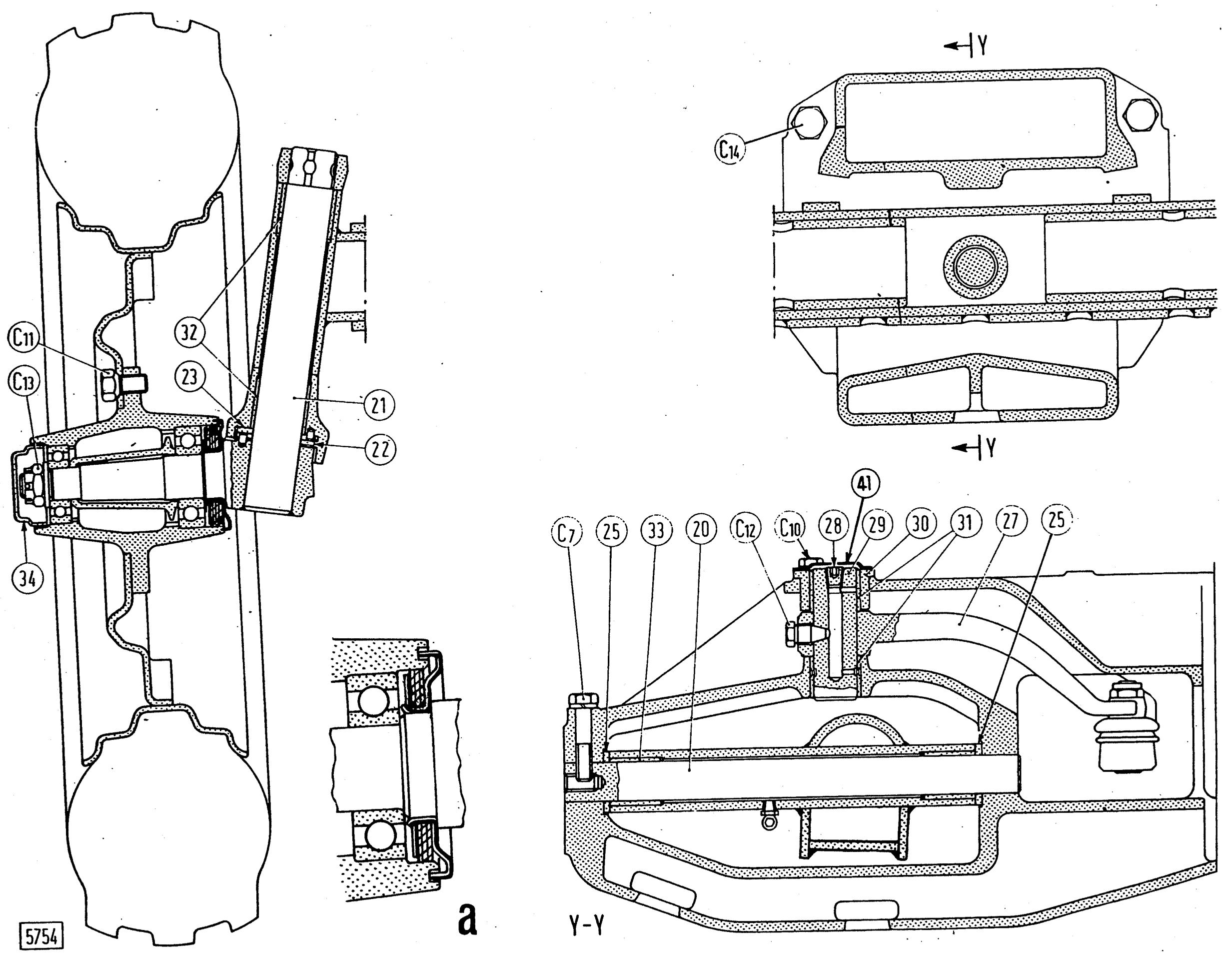


Fig. VI/9 - *Front axle cross-sections*
a) Detail of the new hub gasket.
C_7. Trunnion pin (20) setscrew. - C_{10}. Flange (30) cap screws. - C_{11}. Front wheel disc screws. - C_{12}. Steering lever setscrew. - C_{13}. Front wheel hub nut. - C_{14}. Bracket cap screws. - 20. Trunnion pin. - 21. Spindle. - 22. Bronze thrust washer. - 23. Steel thrust washer. - 25. Trunnion pin end washers. - 27. Steering lever. - 28. Recessed-head screw. - 29. Steering lever (27) pivot. - 30. Upper bushing flange. - 31, 32 and 33. Bushings. - 34. Wheel hub cap. - 41. Guard cover for pin.

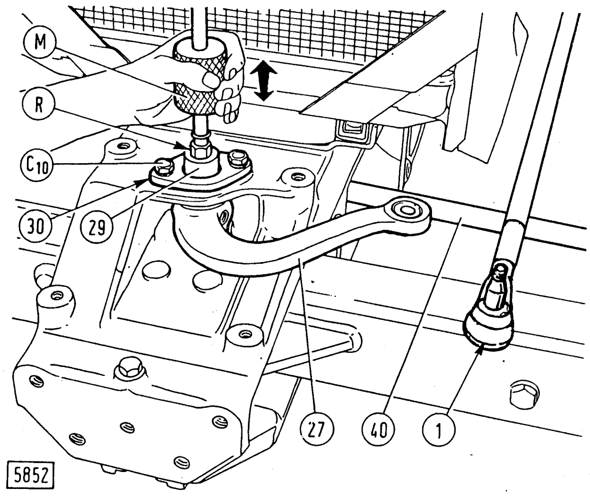


Fig. VI/10 - Removing the steering lever (27) pivot (29). C_{10}. Flange (30) capscrews. - M. Sliding-weight type puller A 147022 ter/A. - R. Reduction A 147022 ter/D. - 1. Drag link. - 30. Upper bushing flange. - 40. Tie-rod.

A 537105/12 belonging to the respective universal pullers.

Disassemble the steering lever pivot assembly as follows:

— remove the cowling and the storage battery;

— disconnect the cables and remove the headlamps;

— remove the grill and the battery tray with air cleaner;

— disconnect the steering lever (**27**, Fig. VI/10) from the drag link (**1**) and from the tie-rods (**40**) using the puller **A 147018**;

— remove the setscrew (C_{12}, Fig. VI/9) and the recessed head screw (**28**);

— withdraw the pivot (**29**) using a M 12 × 1.5 puller screw and the slidingweight puller **A 147022** ter as shown in Fig. VI/10;

— remove the flange (**30**) with bushing and, finally, the lever (**27**);

— remove the bushings (**31**, Fig. VI/9) respectively from the flange (**30**) using a suitable drive bar and from the axle bracket using the collet **A 323126/C**, the puller **A 323126/V** and the bridge **A 537105/12**, all of their respective universal pullers (Fig. VI/11).

The removal of the front wheel spindles and hubs can be effected for each wheel without removing the front axle, as follows:

— remove the hub cap (**34**, Fig. VI/9) and loosen the nut (C_{13}) following the removal of its cotter pin;

— loosen the front wheel screws (C_{11});

— apply the hand brake, suitable wedge the drive wheels, raise the tractor front end and lay the axle down on two shop stands, as shown in Fig. VI/12;

— remove the front wheel;

— remove the retaining bolt and nut (C_9, Fig. VI/12) and withdraw the wheel spindle (**21**) and hub together, to be disassembled later on the workbench;

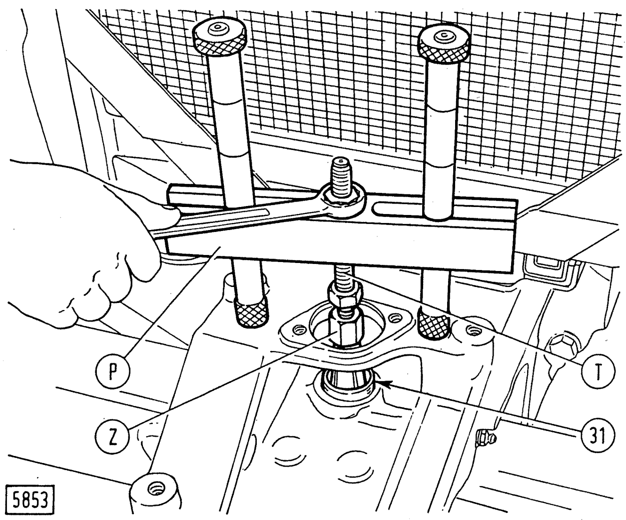


Fig. VI/11 - Removing the bushing (31) from the front axle bracket.

P. Bridge A 537105/12. - T. Puller rod A 323126/V. - Z. Collet A 323126/C.

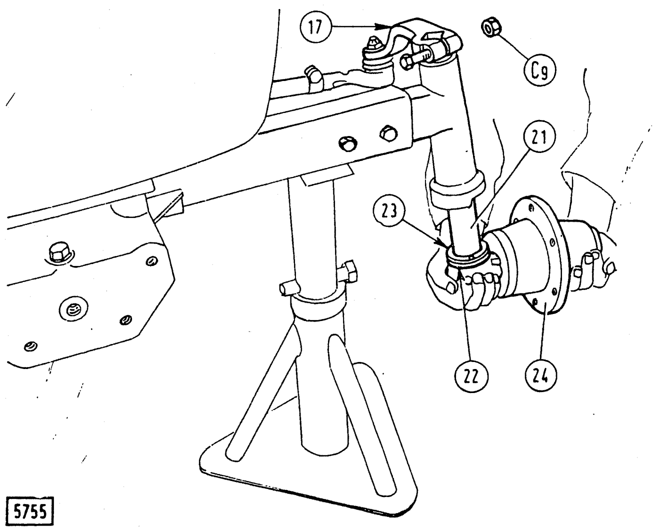


Fig. VI/12 - Fitting (removing) the steering spindle (21) complete with wheel hub (24).

C_9. Steering lever (17) set screw. - 17. Steering lever. - 22. Bronze thrust washer. - 23. Steel thrust washer.

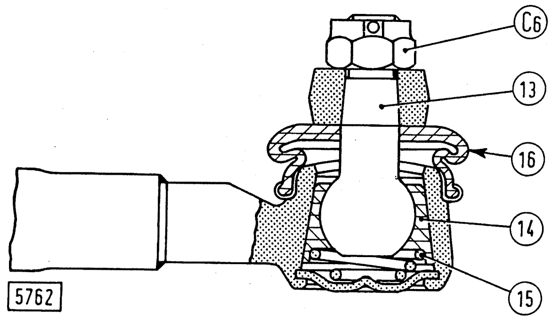


Fig. VI/13 - Self-lubricating ball joint.
C_6. Nut securing steering lever to ball pivot. - 13. Ball pivot. - 14. Tapered nylon bushing. - 15. Seat (14) retaining spring. - 16. Dust cap.

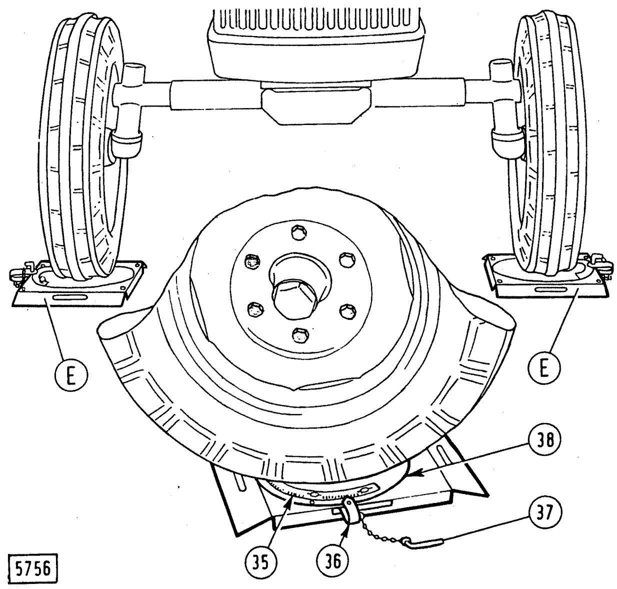


Fig. VI/15 - Checking the steering radius by means of the apparatus Ap 5106/P (E).
35. Graduated sector. - 36. Fixed pointer. - 37. Lock pin. - 38. Turning table.

— remove the bushings (**32**, Fig. VI/9) from the beam extension using the universal pullers already quoted.

Section IX contains the fits and tolerances for all mating parts previously considered.

At assembly, take good notice of the following cautions:

— the washers (**22**, Figs. VI/9 and VI/12) shall be installed with the oil scrolls facing the washers (**23**);

— be sure to meet the tabulated torque requirements;

— wire lock the screw (**C_{12}**, Fig. VI/9);

— complete the assembly by lubricating the axle trunnion, steering lever, wheel spindles and by filling the wheel hubs with grease.

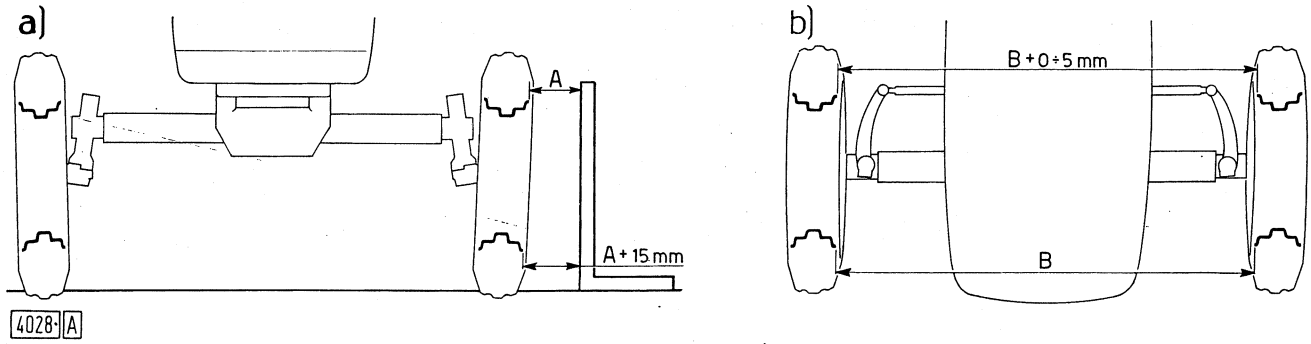
Front axle checks.

Check the front wheel setting and steering as follows:

Checking the front wheel alignment.

We recommend this check following every alteration of the thread adjustment or if front tyres show abnormal wear.

The front wheels, set for straightforward motion should be inclined 2° with respect to the ground, corresponding to a difference of about 15 mm (19/32″) between the wheel disc rim (**a**, Fig. VI/14) and parallel to the tractor longitudinal axis. However, a max. toe-in of 5 mm (13/64″), measured between the rims of the discs is permissible (**b**). To correct, adjust the end of right-side tie-rod.



a. Caster check.

b. Toe-in check.

Fig. VI/14 - Checking front wheel alignment.
(5 mm = 13/64″; 15 mm = 19/32″)

Checking the steering radius.

The correct inside steering angle of the front wheels is **53°** ÷ **55°**.

Check it as follows:

— raise the front end of the tractor by means of a hydraulic jack, so to take off most of the front tyre weight;

— set the front wheels for straightforward motion;

— block the turning tables of the two set-ups **Ap 5106/P** (**E**, Fig. VI/15) by inserting the lockpins (**37**), zero the scales of the graduated sectors (**35**) and place the fixture under the wheels;

— free the turning tables, steer all to the right and read the value of the steering angle indicated by the fixed pointer (**36**);

— make a full leftward steering and read the steering angle on the left-side fixture.

If necessary, correct the steering angles by removing or adding material on the beam extension (**39**, Fig. VI/7) at the fixed stops (**R_2**).

VII - HYDRAULIC LIFT UNIT

GENERAL

The hydraulic lift unit consists of the following major units:

— an oil pump (**P**, Fig. VII/35) incorporating the pressure-loaded principle by which service wear between gear and faces is taken up automatically; this pump is driven by the engine timing gears;

— a hydraulic lift unit (Fig. VII/3) feeding on transmission oil, with position and draft control operations, consisting of a cast iron block containing the power piston (single-acting). This piston acts through a ball-head push-rod upon a lever keyed to the rockshaft. The hydraulic control valve and control levers are attached to the same body;

— an optional external ram oil tapping (Fig. VII/32);

— a three-point linkage (Fig. VII/20) with lift rods, top link and adjustable check chains.

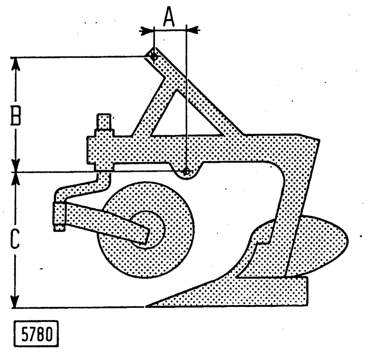


Fig.VII/2 - Implement mounting points. A. 0÷60 mm (0÷2.36 in) - B. About 460 mm (18.11 in) - C. Not less than 500 mm (19.68 in).

Attach the implement with the mounting points arranged as illustrated in Fig. VII/2.

Mounted implements should be of the shortest possible type and with weights not exceeding 550 kg (1,212 lb).

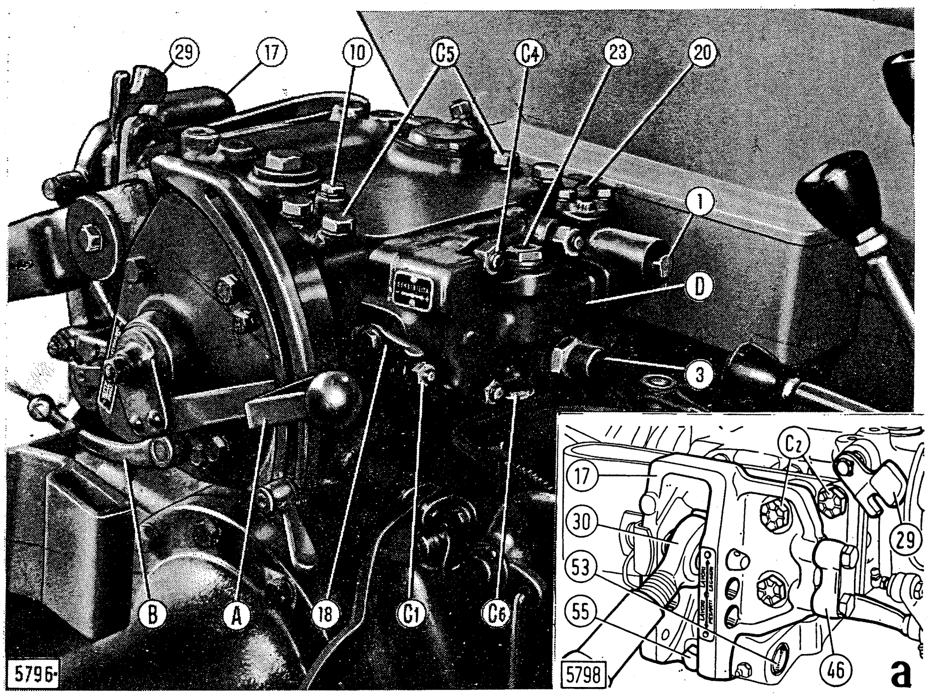


Fig. VII/3 - Hydraulic lift installed on tractor
a) Rear view of the link bracket and its three mounting holes.
A. Lift control lever. - B. Operation selection lever. - C_1, C_4. Stud nuts securing hydraulic control valve to lift carcase. - C_2. Capscrews securing control spring to top link bracket and to rear cover. - C_5. Capscrews securing hydraulic lift to transmission housing. - C_6. Dump valve plug. - D. Hydraulic control valve. - 1. Pressure relief valve. - 3. Cylinder safety valve. - 10. Arms max. lift adjusting screws. - 17. Top link bracket. - 18. Sensitivity regulation lever (turn it towards « + » to increase sensitivity or to « — » to reduce it). - 20. Oil line from pump. - 23. Pilot valve retaining plug. - 29. Top link bracket blocking wedge. - 30. Top link. - 46. Draft control lever. - 53. Top link bracket trunnion. - 55. Trunnion setscrew.

Specifications

Fluid type	FIAT Ambra 20 W/40
- fluid capacity of transmission case with level reaching the upper dipstick dent	17,5 kg (16 imp.qts)
- available fluid for external ram control	10 kg (9-3/4 imp.qts)
FIAT (Plessey licence) gear type hydraulic pump anti-clockwise rotation, seen from drive end	mod. A 22 X
- engine/pump speed ratio	1 : 0.91
- pump speed (with engine running at 2400 r.p.m.)	2180 r.p.m.
- corresponding output with an oil temperature of 50°÷60°C (122°÷140°F) and 150 kg/cm² (2133 p.s.i.) pressure	21.8 liters/1'(4.8 GPM)
Output on test bench at 1445 r.p.m. and at pressure 130÷140 kg/sq.cm (1849 to 1991 p.s.i.):	
- new or overhauled pump, not below	13,6 lts/min (3 GPM)
- used pump, not below	10,1 lts/min (2,2 GPM)
Pressure relief valve setting: A.M.	145÷155 kg/cm² (2062÷2205 p.s.i.)
Pressure relief valve setting: P.M.	190÷195 kg/cm² (2702÷2773 p.s.i.)
Single-acting ram:	
- bore and stroke	95x101 mm (3.74x3.98 in)
- capacity	715 c.c. (43.6 cu.in)
- cylinder safety valve pressure setting: A.M.	200÷210 kg/cm² (2845÷2987 p.s.i.)
- cylinder safety valve pressure setting: P.M.	230÷240 kg/cm² (3271÷3413 p.s.i.)
- nominal lifting capacity: A.M.	1070 kgm (7739 ft.lb)
- nominal lifting capacity: P.M.	1395 kgm (10090 ft.lb)
Three-point linkage category:	1 and 2
- maximum liftable weight at implement mounting points with lift rods:	
• shortened	1400 kg (3086 lb)
• extended	1110 kg (2447 lb)
- maximum lift stroke at implement mounting points with lift rods:	
• shortened	625 mm (24.60 in)
• extended	755 mm (29.72 in)
- lifting time with engine running at 2400 r.p.m.	1,8 sec.
Total weight of the hydraulic lift and linkage	137 kg (302 lb)

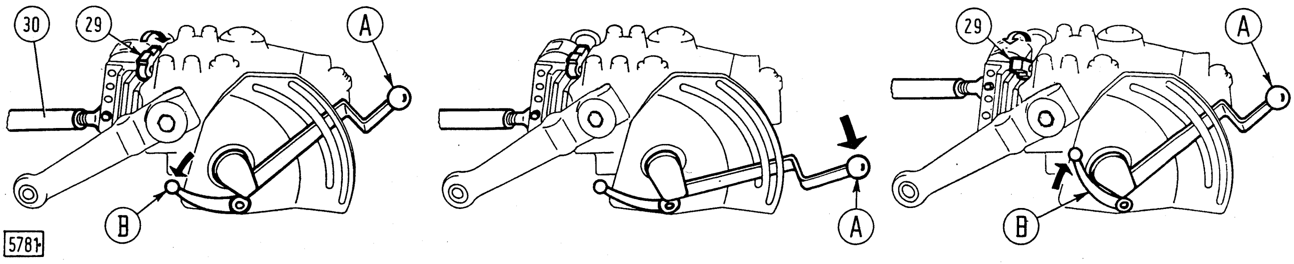


***Fig. VII/4** - Hydraulic lift setting for position control operation (a), in floating (b) and in draft control operation (c).*
A. Lift control lever. - B. Operation selector lever. - 29. Top link blocking wedge. - 30. Top link.

HYDRAULIC LIFT

The hydraulic lift installed on tractors **mod**. 640 offers three types of operation: position control, floating and draft control. Each operation is selected to suit the job application, the type of implement and the physical characteristics of the soil.

Position control. - The position control allows setting and keeping the implement at the desired height or depth, corresponding to the setting of the control lever (**A**, Fig. VII/3).
The vertical displacement of the implement is proportional to the length of the lever motion on the control quadrant.

The position control operation is particularly desirable for mounted implements which, in the course of operation, normally do not affect the tractor or affect it moderately from the point of view of the pulling force (and consequently adherence) but, on the other hand, must work at a predetermined depth (example: grader blade, post hole diggers, etc) or height above the ground (example: trailer, hoist, back-loader).
Position control is inserted by moving the operation selection lever downwards (**B**, Fig. VII/4, a). At work, the control valve wedge stop (**29**) must be inserted between top link bracket and hydraulic lift rear cover to avoid harmful and useless stressing of the control spring and, besides, the top

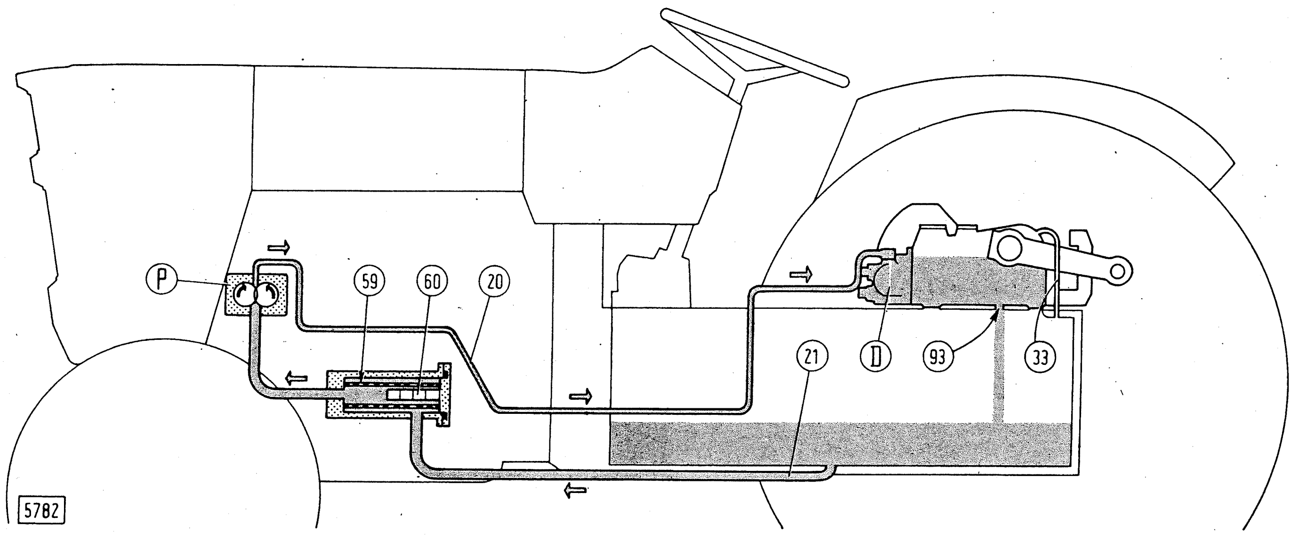


Fig. VII/5 - Hydraulic working diagram of lift unit feeding on transmission oil.
D. Hydraulic control valve. - P. Pump. - 20. Delivery line to control valve. - 21 Feeding line from transmission. - 33. Pressure equalizing line. - 59. Full flow screen filter on pump suction end. - 60. Internal magnetic plug. - 93. Oil drain line from hydraulic lift to transmission.

link (**30**) must be fitted in the lowest hole of the bracket.

Floating position. - When the hydraulic lift works in position of floating the lift arms are free so that the mounted implement can follow the ground profile by its own weight. This position is suitable therefore for implements which are to rest on the ground and follow its profile (example: soil compaction rollers, spreaders, etc. or for semi-mounted implements fitted with suitable supporting means (wheel, pad, etc.).

To set the lift in floating, arrange it as for position control and move the control lever (**A**, Fig. VII/4, b) downwards to stop.

Draft control. - The draft control operation allows to maintain the tractor pulling effort by automatically varying, within very close limits, the working depth of the implement in the presence of more or less compact soil and when the ground surface is irregular (bumps, ditches, etc.) so that the implement would tend to dig in more or to lift off the ground.

When the soil or ground are sufficiently homogeneous and level the vertical motion of the implement is controlled by moving the quadrant lever up or down (within the range U of the sector, Fig. VII/27).

When, in spite of the fact that the lever is set at the lowest position within the sector (**U**) of the quadrant, the implement does not reach a sufficient depth, then the top link must be fitted to a hole lower in the bracket (**a**, **Fig. VII/3**).

To lift the implement all the way up, move the lever up to the upper stop (range **V** of the quadrant, Fig. VII/27).

The draft control is particularly suitable for job applications requiring sustained pulling, such as plowing, harrowing, etc., carried on by means of mounted implements, as it transfers the vertical components of the loads on to the rear wheels of the tractor, thus improving adherence. To set the hydraulic lift for draft control just move the selection lever (**B**, Fig. VII/4, c) up and remove the wedge (**29**) blocking the top link bracket.

At work, regulate the " sensitivity " of the hydraulic lift considering that it should be the highest possible without subjecting to repeated and harmful jolting. To increase sensing turn the lever (**18**, Fig VII/3) clockwise; to reduce it, turn the lever counter-clockwise.

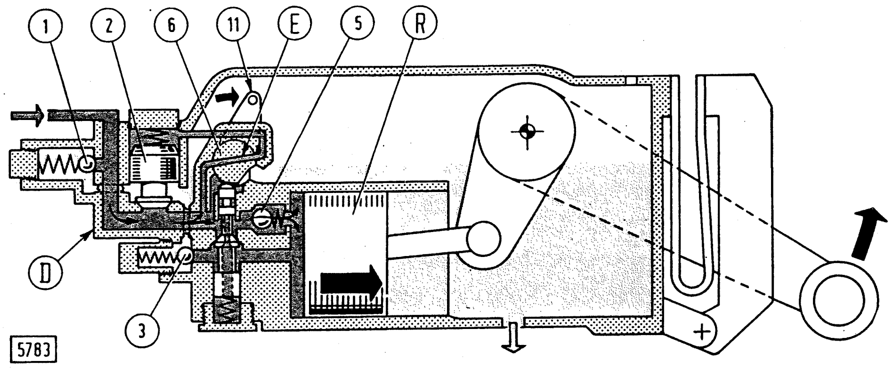
Caution. - *To manoeuver the selection lever* (**B**, *Fig VII/3) to shift from one type of operation to another, first move the lift arms up to avoid putting the control levers and linkage under strain.*

Lift hydraulics.

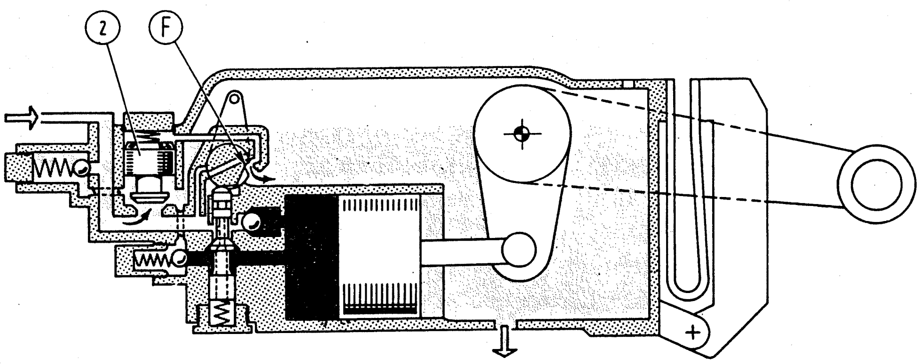
The Fig. VII/5 illustrates the hydraulic working diagram of the lift unit.

The oil pump (**P**) feeds directly on transmission oil through a screen type filter (**59**), internally

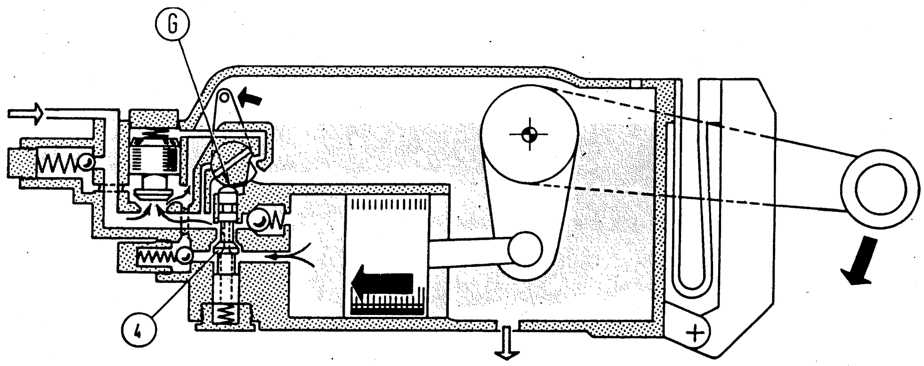
Pressure oil
Suction or drain oil
Static oil



S. Arms lifting.
The rotation of the spool (6) allows the oil flowing in from the pump to reach, through the cross port (E), the upper end of the pilot valve (2); as the cross-sectional area of the upper end of this valve is large than the lower one, the pressure applied at the top prevails and the valve is held closed, the pressure oil can thus flow into the cylinder through the valve (5) and actuates the lift arms control piston.



N. Neutral (lift arms stopped).
The spool uncovers the spill groove (F) thus draining the pressure oil which holds the pilot valve (2) closed. The pressure by the oil coming from the pump prevails at the botton of the pilot valve, consequently this valve opens and the oil is conveyed back to the reservoir rather than to the power cylinder.



A. Arms lowering.
The spool, through its cam (G), opens the valve (4) so that the oil, pushed by the piston, drains out to discharge.

***Fig. VII/6** - Oil flow pattern inside the hydraulic control valve and power cylinder during the three operating phases.*
D. Hydraulic control valve. - E. Spool cross hole. - F. Spool groove. - G. Spool cam. - R. Arms lifting power cylinder. 1. Pressure relief valve. - 2. Pilot valve. - 3. Cylinder safety valve. - 4. Drain valve. - 5. Cylinder inlet valve. - 6. Control valve spool. - 11. Spool control lever.

provided with a magnetic element which catches and retains circulating metallic particles (if any) and delivers it to the hydraulic lift control valve (**D**). The oil quantity which is not utilized by the lift cylinder drains into the hydraulic lift body from which it flows back into the transmission housing through a suitable duct (**93**).

Besides a tubelet (**33**) connects the upper compartement of the transmissions housing with the hydraulic lift and serves to equilize the pressure. The transmission housing, which also serves as reservoir for the hydraulic lift, contains 17,5 kg (16 imp. qts.) of oil, 10 kg (9½ qts.) of which can be utilized, with tractor standing on level grounds, for hydraulic lift operation and for that of auxiliary external ram applications, if any (see page 146). Fig. VII/6 illustrates the three working phases of the hydraulic lift and the operation is described in the legend. The valves contained in the hydraulic lift block and their major features are as follows:

— the double-section pilot valve (**2**) functions as a hydraulic cock. If bottomed on its seat it prevents the oil from draining out (lifting phase), and if lifted off allows oil draining (neutral and lowering phases);

— the one-way cylinder inlet valve (**5**). During the lifting phase the valve opens to let the delivery oil out. In the other phases the valve is held closed by the pressure of the oil trapped inside the cylinder;

— the drain valve (**4**) which, when bottomed on its seat, keeps the oil inside the cylinder (neutral or lifting phase) and dumps it when lifted off its seat (lowering phase);

— the pressure relief valve (**1**), set at 145 ÷ ÷ 155 kg/cm² (2062 ÷ 2204 p.s.i.), protects the hydraulic pump and oil lines;

— the cylinder safety valve (**3**), set at 200 ÷ ÷ 210 kg/cm² (2845 ÷ 2987 p.s.i.) limits the dynamic stresses acting upon the mechanical components (stresses which may occur when hauling implements on bumpy roads or ground).

The most important function of the hydraulic circuit is, however, that performed by the directional control valve spool (**6**) or rotating valve, which indirectly controls the closing of the pilot valve (Schematic **S**) and, directly, the opening of the drain valve (schematic **A**). The distribution of the oil to the cylinder is the same for both position and draft control operations; that which changes is the leverage quantity controlling the valve spool rotation, the operation of which is illustrated in Fig. VII/7 and described in the two following paragraphs.

Mechanics of the hydraulic lift position control operation.

The diagram (**X**) of Fig. VII/7 illustrates the internal and external leverage sub-assemblies which is involved in position control operation.

The downward shifting of the selection lever (**B**) for position control operation determines the release of roller (**64**) from the external levers (**62** and **63**) and the upward rotation of the cam (**65**) which comes in contact with the lever (**63**). The external levers, active in draft control (see diagram **Y**) are therefore excluded.

When the lever (**A**) is moved up in the control sector, the movements of the leverage are those indicated by the black arrows in scheme **X** and make the spool (**6**) turn to the position of delivery. As soon as the piston moves, the lever (**39**), connected to the inside arm, acts upon the rocker arm (**66**) in the direction indicated by the arrows drawn in light lines and tends to bring the spool back to neutral. This condition, however, occurs only when the lift arms reach the position set by the lever (**A**) within the sector range.

During the lowering phase the leverage moves in the opposite direction. In floating, the spool is permanently kept in spill position and the travel of the lever (**39**), in this case, is not sufficient to bring it back to neutral.

Mechanics of the draft control operation.

In draft control, the forces applied to the implement and transmitted through the top link (**30**, Fig. VII/7, **Y**) deform the control spring (**94**). As these deformations are strictly dependent upon the position of the lever (**A**) in the control sector, the control valve will go neutral (thus preventing downward motions of the implement) only when, for a given lever setting, the force (**F**) transmitted from the top link to the spring is such to impart to the latter a corresponding deformation.

Any further spring deformation caused by load variation transmitted through the top link, moves the valve spool off neutral. The valve is thus automatically controlled by the load imparted by

X. Position control operation. (The selector lever B is shifted downwards. The leverage drawn in light lines do not take part in this operation and concern the draft control operation only).

Y. Draft control operation. (The selector lever B is shifted upwards).

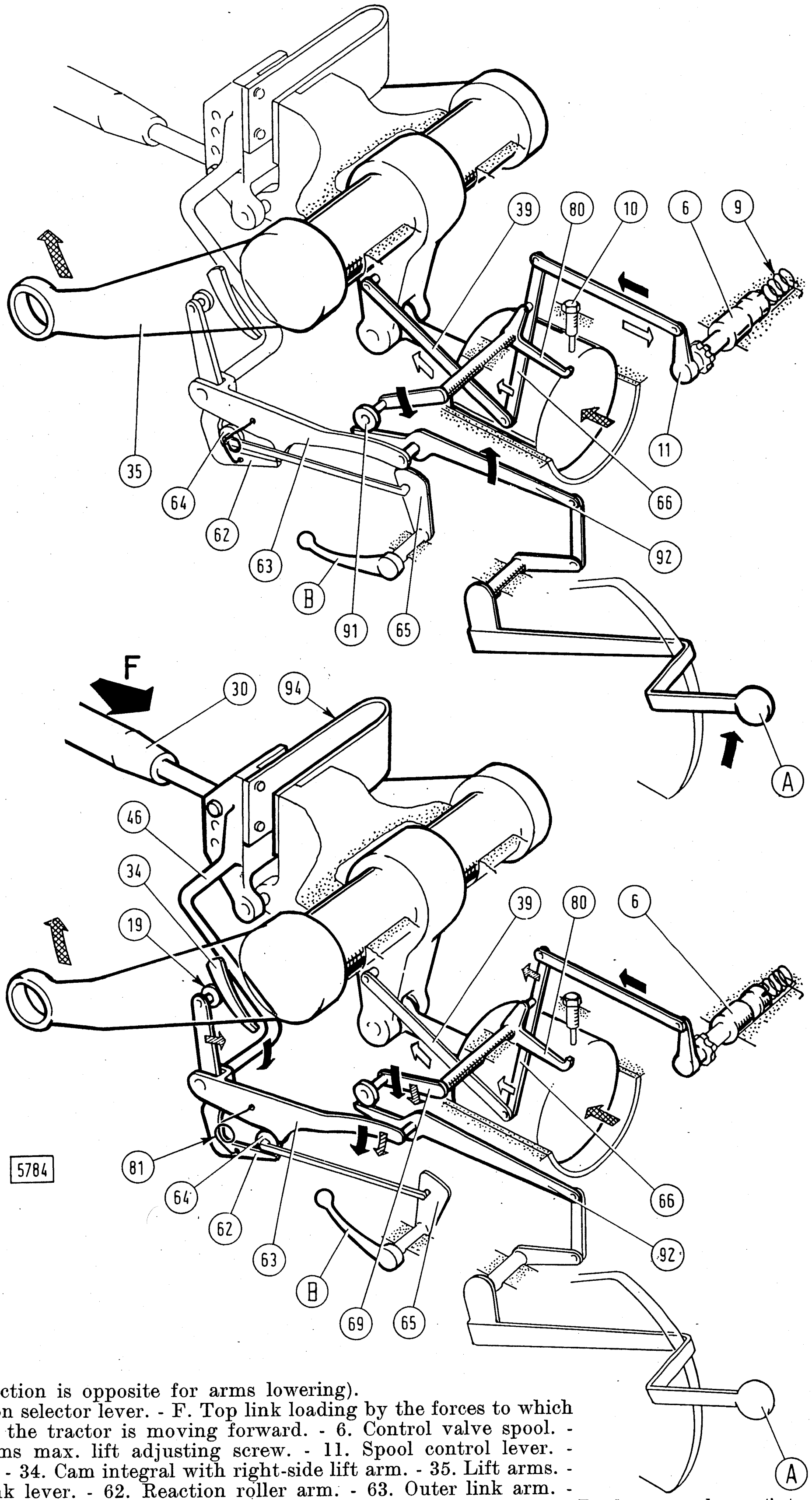


Fig. VII/7 - *Schematic diagram showing the operation of the valve spool control leverage for position and draft control, respectively.* (Black, light arrows and those with ligth cross-hatching refer to the motions which the leverage components make in the arms lifting phase. The arrows with heavy cross-hatching show the motion of the piston and arms lifting. The direction is opposite for arms lowering).
A. Lift control lever. - B. Operation selector lever. - F. Top link loading by the forces to which the implement is subjected when the tractor is moving forward. - 6. Control valve spool. - 9. Spool return spring. - 10. Arms max. lift adjusting screw. - 11. Spool control lever. - 19. Reaction roller. - 30. Top link. - 34. Cam integral with right-side lift arm. - 35. Lift arms. - 39. Inside arm link. - 46. Top link lever. - 62. Reaction roller arm. - 63. Outer link arm. - 64. Selection roller. - 65. Cam, integral with the selection roller. - 66. Rocker arm. - 69. Rocker arm lever (integral with the lever 80). - 80. Rocker arm lever (stops the arms lift when it reaches the screw 10). - 81. Levers (62 and 63) connecting spring. - 91. Rocker arm control roller (kept constantly in contact with the lever 92 by the torsional force of the spool return lever 9). - 92. Roller supporting lever. - 94. Control spring.

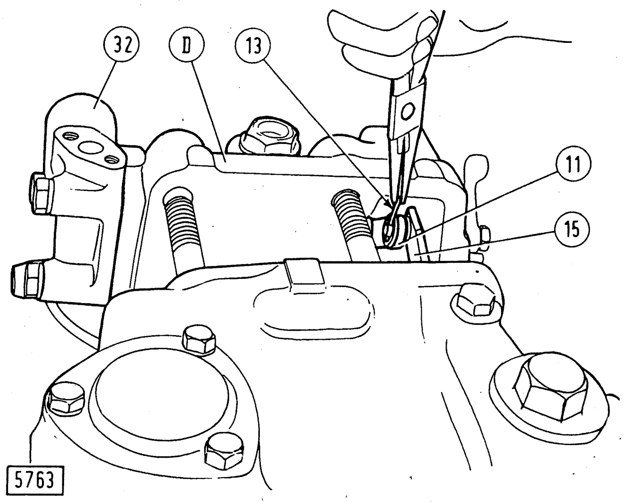


Fig. VII/8 - Control valve removal.
D. Control valve. - 11. Internal spool control lever. - 13. Cotter pin securing link (15) to spool control lever (11). - 15. Link. - 32. Pressure relief valve holder.

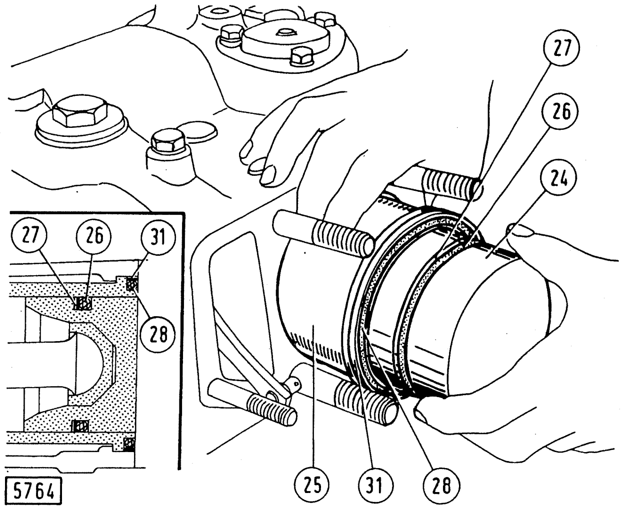


Fig. VII/10 - Removing the hydraulic lift piston and cylinder barrel.
24. Piston. - 25. Cylinder barrel. - 26. Piston ring. - 27. Piston seal rest (plastic material). - 28. Barrel sealing ring. - 31. Outer ring for barrel seal (brass).

the implement to the spring through the top link, so that:

— if spring compression increases, then the valve spool will turn towards delivery (implement lifting);

— if spring compression is reduced, then the valve spool will turn towards dumping (implement lowering).

The diagram (**Y**) illustrates the internal and external linkage which are involved in draft control. When the selection lever (**G**) is turned upwards, the external draft control leverage is inserted in the valve spool kinematics control chain.

In fact, the cam (**65**) integral with the selection lever (**B**) loses the contact with the lever (**63**) (see diagram **X**) so that the follower (**64**) is inserted between the levers (**62**) and (**63**), interlocking them, whilst the roller (**19**) contacts the cam (**34**).

The valve spool (**6**) is thus controlled by both the hand control lever (**A**) and control spring (**94**), the latter subject to the load variations transmitted through the top link (**30**).

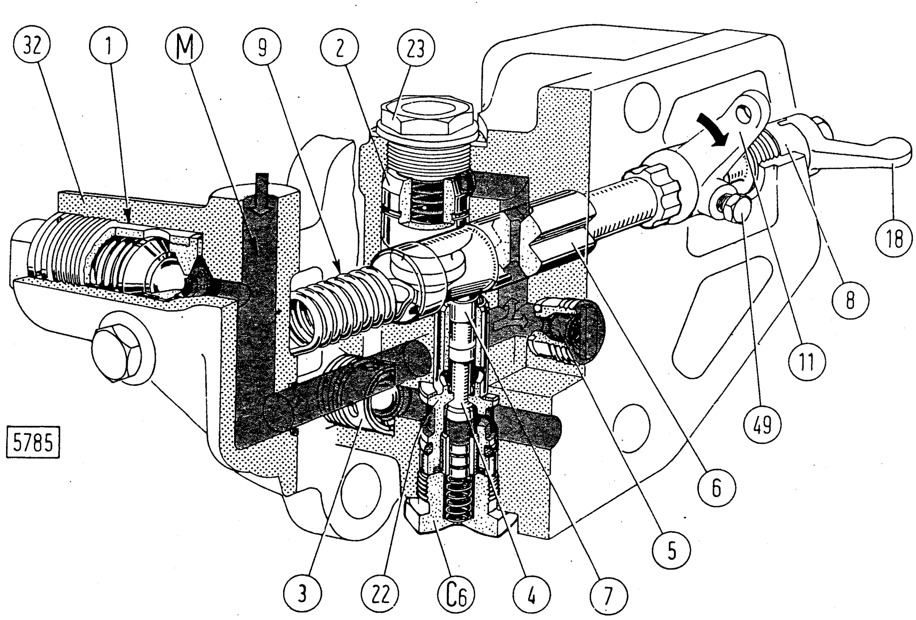


Fig. VII/9 - Hydraulic control valve cut-out.

(The black arrow indicates the torsional action by the spring 9 upon the spool control lever 11. The oil flow is referred to the arms lifting phase as shown in fig. VII/6).
C_6. Drain valve plug. - M. Pressure oil inlet. - 1. Pressure relief valve assembly. - 2. Pilot valve. - 3. Cylinder safety valve assembly. - 4. Drain valve. - 5. Cylinder oil inlet valve. - 6. Control valve spool. - 7. Drain valve actuating pin in contact with the spool cam. - 8. Sensing adjustment plug. - 9. Valve spool return spring. - 11. Spool control lever. - 18. Sensing adjusting lever. - 22. Drain valve holder. - 23. Pilot valve plug. - 32. Valve holder. - 49. Setscrew securing lever (11) to spool.

In particular, the layout (**Y**) illustrates, by means of the heavy black arrows, the leverage motions occurring when for a given setting of the control lever (**A**) in the quadrant, the top link (**30**) thrust increase determines the rotation of the valve spool (**6**) towards the outlet side.

If, on the other hand, the top link thrust is reduced instead of increasing, the leverage motion takes place in the opposite direction and the valve spool turns towards the drain side.

During work, the lifting or lowering phase continues until the load upon the top link is back to its original value and the valve spool is in neutral.

As in draft control operation the valve spool is subject to the straining of the control spring (**94**) only, the motion (indicated by the lighter arrows) transmitted on to the rocker arm (**66**) by the lever (**39**), which is connected to the inside arm, is annulled by the motion in the opposite direction (indicated by the light cross-hatching arrows) which is transmitted to the rocker arm through the levers and links (**62**, **63**, **92**, **69** and **80**) because of the motion of the follower-roller (**19**) over the cam (**34**), the latter integral with the right-hand side lift arm.

Hydraulic lift removal.

The hydraulic lift can be fully overhauled only if removed from the tractor. Should overhauling be required for the control valve only, or should the unit require replacement of piston or cylinder seals, or leverage checking, then these sub-assemblies can be easily removed from the lift without removing the whole unit from the tractor.

These component are removed as indicated in the following topics.

Remove the hydraulic lift from the tractor as follows:

— remove operator's seat with its support;

— disconnect the lift arms from three point linkage, the oil delivery line and the lift-transmission connecting line from the hydraulic lift unit;

— remove the stud nuts and the cap screws which secure the hydraulic lift to the transmission case, then remove the former using a hoist.

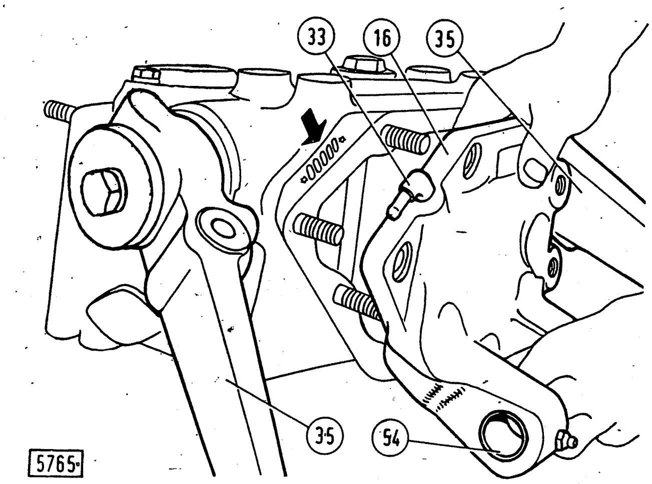


Fig. VII/11 - Removing the rear cover.
(The arrow shows the position of the hydraulic lift unit factory serial number).
16. Rear cover. - 33. Connection for hydraulic lift-transmission housing line. - 35. Lift arms. - 54. Top link bracket solid bushings.

Disassembly.

Disassemble the hydraulic lift as follows:

— Remove the control valve unit (**D**, Fig. VII/8) by unscrewing all attaching nuts and, prior to withdrawing it from the studs, be sure to remove the cotter pin (**13**) securing the link (**15**) to the spool control lever (**11**).

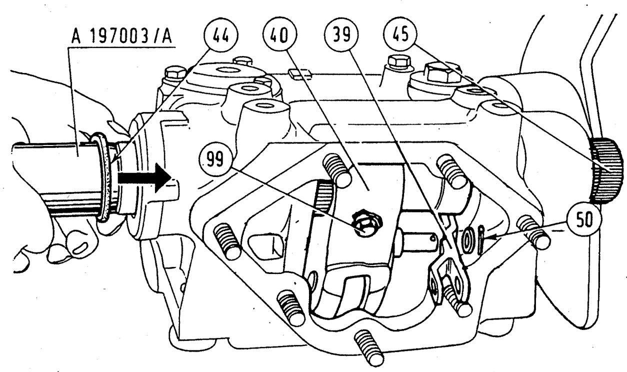


Fig. VII/12 - Removing the rocker shaft from the hydraulic lift unit.

(The arrow shows the direction of shaft removal).

A. 197003/A. Sealing ring protection. - 39. Lever connected to the inside arm. - 40. Inside arm. - 44. Shaft sealing ring. - 45. Rockshaft. - 50. Cotter pin securing the lever (39) to the mounting pin integral to the inside arm. - 99. Screw securing inside arm to rockshaft.

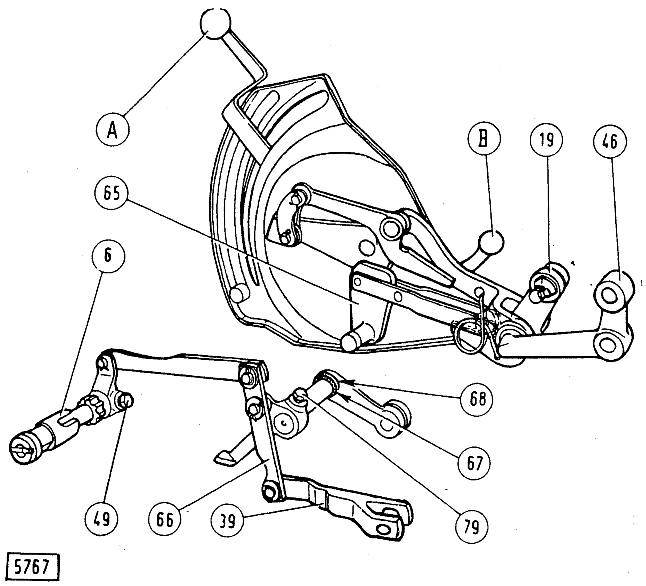


***Fig. VII/13** - External and internal spool control leverage and linkage.*

(The figure shows: top drawing, the external leverage assembly as removed from the hydraulic lift, bottom drawing, the internal leverages as they are in operation). A. Hydraulic lift control lever. - B. Operation selector lever. - 6. Control valve spool. - 19. Reaction roller. - 39. Inside arm link. - 46. Top link lever. - 49. Setscrew securing control lever to valve spool. - 65. Cam integral with the selector lever. - 66. Rocker arm. - 67. Sealing ring. - 68. Spacer. - 79. Screw securing the arms max. lift stop lever to the rocker arm control roller arm.

Unscrew the pressure relief valve (**1**, Fig. VII/9) and the cylinder safety valve (**3**), remove the drain and pilot valve plugs ($\mathbf{C_6}$ and **23**), then withdraw these valves and their springs from

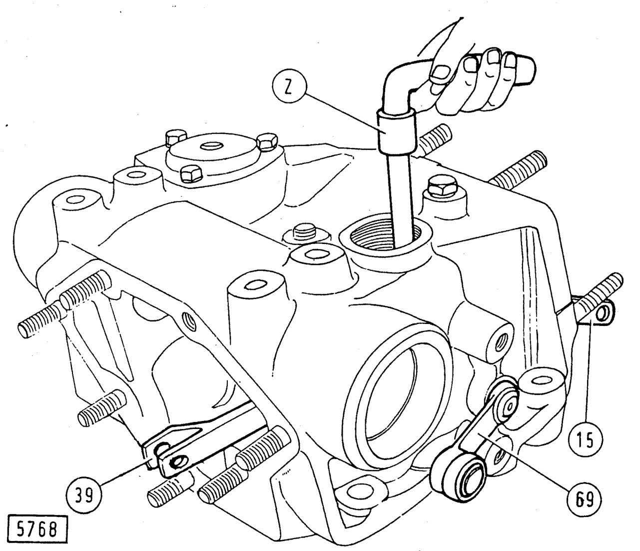


***Fig. VII/14** - Removing the internal control leverage.* Z. Box wrench for removing the screw (79, fig. VII/13). - 15. Valve spool control link. - 39. Lever connected to the internal arm. - 69. Rocker arm drive roller supporting lever.

the control valve lock. If necessary, remove the cylinder inlet valve (**5**) by unscrewing the retaining plug with the aid of the special wrench **A 695112**.

To remove the control valve spool (**6**) it is necessary to remove the lever (**18**) with the sensing adjustment plug (**8**), the valve holder (**32**) or the auxiliary external ram top (**P**, Fig. VII/32) and the lever (**11**, Fig. VII/9) after unscrewing the setscrew.

Following the removal of the control valve, it is possible to withdraw the piston (**24**, Fig. VII/10) and cylinder barrel (**25**) and their sealing rings.

— Detach the draft control operation outside lever (**46**, Fig. VII/3) from the top link bracket, then remove the latter and the control spring as an assembly.

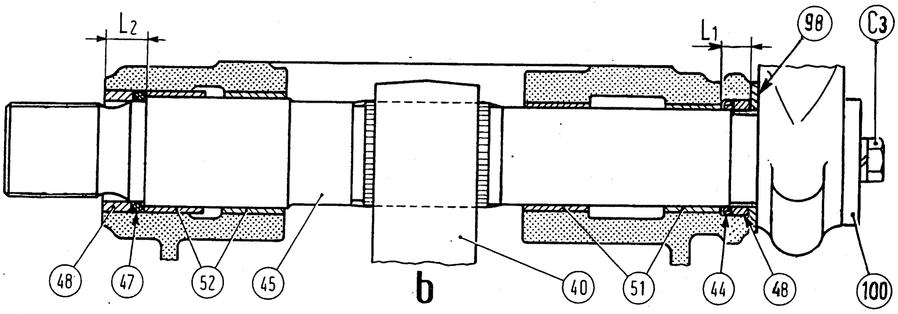
This must be preceded by the removal of the screw (**55**) to withdraw the pivot pin, and of the screws ($\mathbf{C_2}$) to detach the spring from the hydraulic lift rear cover. Remove the stud nuts (**16**) and then the rear cover, as shown in Fig. VII/1.

— Remove the lift arms (35, fig.VII/11), the cotter pin (50,fig.VII/12) and the screw (99) before withdrawing the rockshaft (45) in the direction shown by the arrow on the figure.

To avoid damaging the sealing ring (**44**) located on the left-hand side of the rockshaft, first turn the latter in the sense opposite to that of withdrawal until the sealing ring comes off its seat, then withdraw it using the protection **A 197003/A**. Inside the hydraulic lift, the arm (**40**) and piston push rod will remain free.

— Remove the outside linkage assembly (Fig. VII/13) and control lever as an assembly, after removing the cap screws which secure it to the hydraulic lift.

Remove then the inside levers by unscrewing first the screw (**79**) introducing the box wrench (**Z**, Fig. VII/14) through the hydraulic lift top opening; then, withdraw towards the outside the roller supporting lever (**69**) with sealing ring (**67**, Fig. VII/13) and spacer (**68**). As for removal (installation) of the single levers see Figs. VII/13 and VII/15 c.



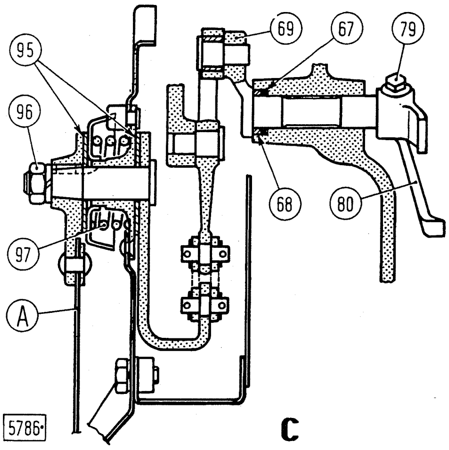


Fig. VII/15 – *Rocker shaft cross-sectional view.*
b. Sectional view of rockshaft.
c. External control leverage section.
A. Lift control lever – L_1 = 13.5 ÷ 13.8 mm (0.531" ÷ 0.543"). Recessing of the left side outer bushing – L_2 = 20.5 ÷ 20.7 mm (0.807" ÷ 0.815"). Recessing of the right-side bushing – 40. Inside arm – 44. Left-hand side seal – 45. Rockshaft – 47. Right-hand side seal – 48. Spacer, 13.5 ÷ 13.8 mm (0.532" ÷ 0.543"). 51. Left-side bushings – 52. Right-side bushings – 67. Oil seal – 68. Spacer – 69. Rocker arm roller supporting arm 79. Screws securing lever (80) to roller supporting arm (69) – 80. Arms max. lift stop lever - 95. Friction discs – 96. Control lever nut – 97. Spring - 98. Left-side spacing ring. - 100. Left arm retaining plate – C_3. Left arm retaining plate screw.

Inspection.

Wash components in kerosene then proceed to inspect and check them referring to the data reported on the table of page 176.

— Check the functional efficiency of the sealing rings (Fig .VII/10) installed between cylinder barrel and control valve and between cylinder liner and piston.

Check the plastic seal back-up for wear and conditions of the soldered joint on the barrel seal brass ring.

If necessary, remove burrs with emery paper and re-solder.

Replace, if functionally poor, the sealing rings installed on the control valve block valves and rockshaft, the sealing ring (**67**, Fig. VII/13) on the roller lever and that between hydraulic lift and transmission case, at the outlet duct (**93**, Fig. VII/5).

— Check the clearance between rockshaft and bushings and between top link hinge pin and bushings.

If the bushings (**51** and **52**, Fig. VII/15 and **54**, Fig. VII/11) are to be replaced, then remove them using the punches **A 94048**, **A 95058** and **A 92027** respectively.

When installing the new bushings be sure to meet the specification requirements reported on the Fig. VII/15 and ream the inside diameters, if necessary, to specifications.

— Check the control valve spool for wear, the correct spool and bore clearance being 0.025 ÷ ÷ 0.035 mm (0.001 ÷ 0.0014). If a new spool is to be installed, consider that it is not available alone as spare as they are fitted to their respective bores at the factory.

— Check sealing tightness of the drain valve as indicated in the topic on page 162. Make sure that the sealing surfaces of the pilot valve are free from scoring or faults and grind, if necessary, the cast iron walls of the bore on the hydraulic lift body.

Verify flexibility of the valve springs vs. the data reported in the table on page 177.

— Check the pressure setting of the relief valve and of the cylinder safety valve according to the instructions given on page 162.

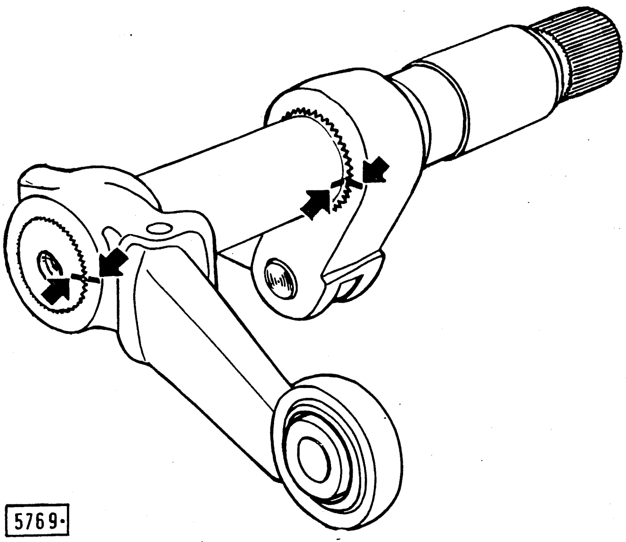


Fig. VII/16 - Assembly marks for correct installation of internal arm and lift arms on the rockshaft.

Assembly and refitting.

The hydraulic lift is re-assembled and re-fitted to the tractor by reversing the sequence of operations described in the preceding chapters, then tighten the screws and nuts to torque specifications. Also, consider the following indications:

— arrange the inside arm and lift arms on the rockshaft with the assembly marks aligned (Fig. VII/16);

— install the seals on the rockshaft using the protection **197003/A**, to avoid damages when going over the splined ends, then fit them definitely in their respective seats using the punch **A 197003/B** (Fig. VII/17);

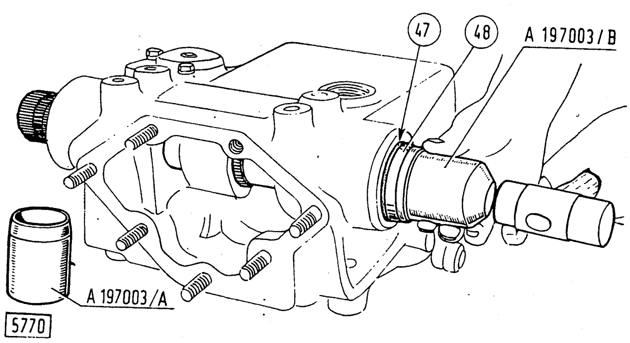


Fig. VII/17 - Fitting the sealing rings to the rockshaft with the aid of the protection A 197003/A and installation tool A 197003/B.

47. Sealing ring. - 48. Spacer.

— the spool control lever (**11**, Fig. VII/9) is arranged, after press-fitting, with the setscrew (**49**) on the piston side;

— the spool return spring (**9**) is installed so that it tends to rotate the spool towards lifting position, that is, so that the lever is pushed towards the piston.

After assembly, make sure the rockshaft end play is 0.1 to 0.3 mm (0.0039 to 0.0118 in).

When refitting the hydraulic lift to the tractor make sure the oil drain duct (**93**, Fig. VII/5) from hydraulic lift to transmission is provided with its sealing ring.

Oil filter.

The filter for the hydraulic lift fluid is installed on the pump suction line (Fig. VII/5). It consists of a metallic mesh cartridge containing a magnetic element which traps the metallic particles, if any, circulated by the oil.

After every 200 hours of operation, disassemble the filter and clean it.

Remove the cover screws then withdraw the magnetic plug (**60**, Fig. VII/18) integral with the cover and then the cartridge (**59**); at the same time, recover the oil flowing out of the upper suction line. Wash the components in kerosene and clean the inside of the container.

Check the functional efficiency of the sealing ring (**61**) on the cover and then re-install the parts after drying them.

Three-point linkage

The three point linkage consists of (Fig.VII/20):

— two lower links (**74**) hinged on the tractor body;

— two adjustable lift rods (**72** and **76**) connecting the lower links to the hydraulic lift.
The left hand tie-rod is adjusted by rotating its lower part, the right hand tie-rod is instead adjusted by means of crank (77).
The length of the right side rod is adjusted by turning the crank (**77**).
This latter adjustment can be made during work also to adjust the tilt angle of the implement;

— an adjustable top link (**30**) which allows mounting the implement at centre (third point).
By retracting or extending the top link, the implement pitch angle is increased or reduced so to allow the best setting for the job conditions at hand;

— two adjustable side chains (**73**) limiting or preventing implement side sway.

When both lift rods are extended or retracted of the same amount, the max. travel of the implement off the ground is increased or reduced, and, conversely, the available working depth is reduced or increased. When making this adjustment, make sure that the implement is not lifted more than necessary with the lift arms all the way up (travel position) and that, at work, the implement can make a supplement of downward travel, that is, it will not be prevented from doing so by the hydraulic ram travel stop.

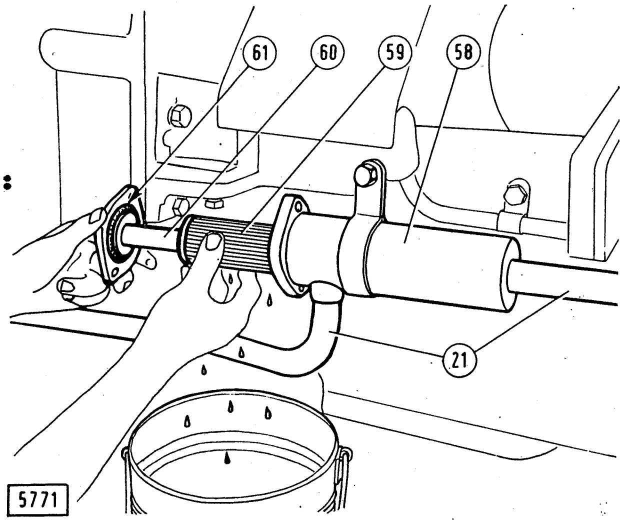


***Fig. VII/18** - Checking and servicing the hydraulic lift oil filter.*

21. Pump suction line. - 58. Filter container. - 59. Filtering cartridge. - 60. Magnetic plug. - 61. Filter cover sealing ring.

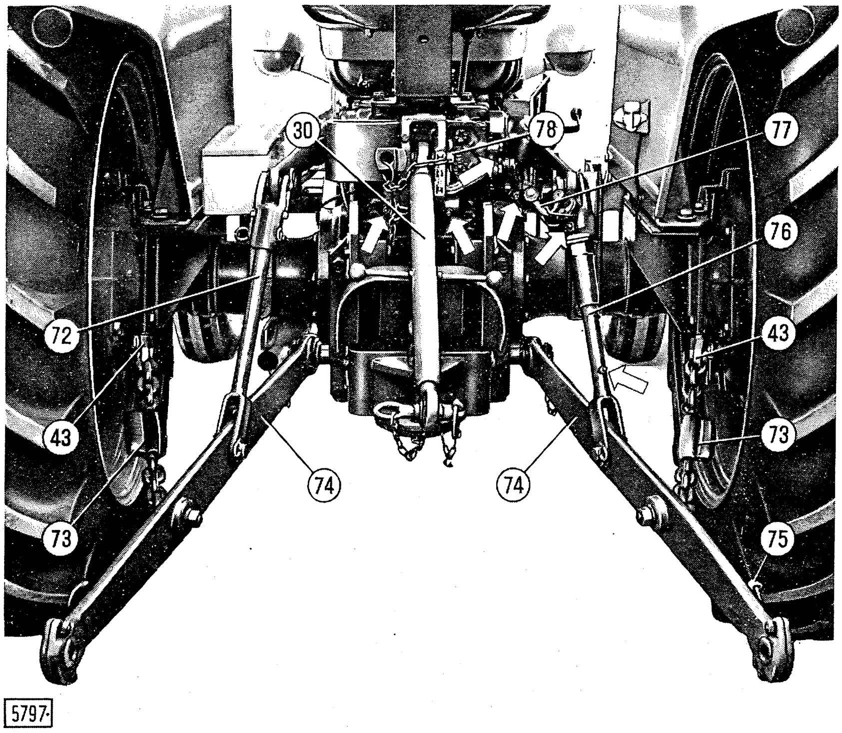


Fig. VII/20 - *Rear view of the hydraulic lift and three-point linkage.*
(The arrows locate the grease nipples).

30.Top link, with turnbuckle sleeve for length adjustment - 43. Check chains (73) mounting brackets - 72. Left-side adjustable lift rod - 73. Side check chains - 74. Lower links - 75. Stop pins, with snap locks, for implement linkage - 76. Right-side lift rod - 77. Right-side lift rod adjustment crank, with spring lock- 78. Top link linch pin (three mounting positions, see fig. VII/3).

Right-side lift rod.

A cross-section of the right lift rod is shown in Fig. VII/21. To remove this rod, if necessary, just straighten the safety washer (**88**), unscrew the sleeve (**89**) to withdraw the driven gear and then the screw (**83**) to withdraw the driving gear. These parts are then freed easily by removing the wire lock, removing the hollow pin (**82**) and then by unscrewing completely the lower rod (**90**) from the driven gear stem.

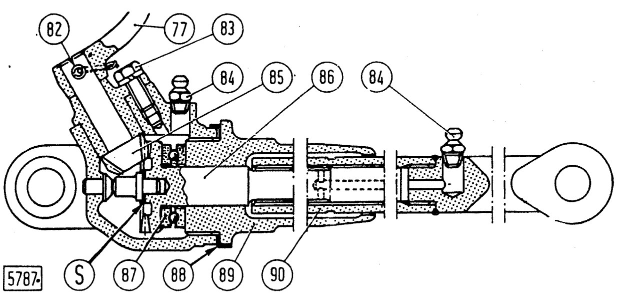


Fig. VII/21 - *Right-side lift rod section.*
S. End play adjusting shims. - 77. Adjustment crank. - 82. Spring pin with safety wire lock. - 83. Driving gear holder cap screw. - 84. Grease nipples. - 85. Driving gear. - 86. Driven gear. - 87. Bearing balls (no. 12). - 88. - Safety washer. - 89. Sleeve. - 90. Lower rod.

Prior to re-assembly, lubricate all lift rod components with FIAT G 9 (multi-purpose NLGI no. 2) grease and insert a shim stack (**S**) between rod and driven gear so to obtain an end play of 0.1 ÷ ÷ 0.3 mm (0.004 ÷ 0.012 in).

Periodically, apply this same type of grease to the two pressure fittings (**84**) to lubricate the gears, bearing and the lower rod inside thread.

Adjustments.

Once the hydraulic lift is correctly installed on the tractor, make the four adjustments which follow. Bear in mind that correct adjustment is a must for proper lift performance.

A. *Setting the control spring movement.*

The correct setting of the double-acting control spring (**94**, Fig.VII/23) ensures that the valve spool will not exceed the preset limits and that the complete displacement, subdivided into compression and tension, is the desired one;

all this is necessary to avoid mechanical troubles such as spring permanent yields or rupture or leverage straining, etc.

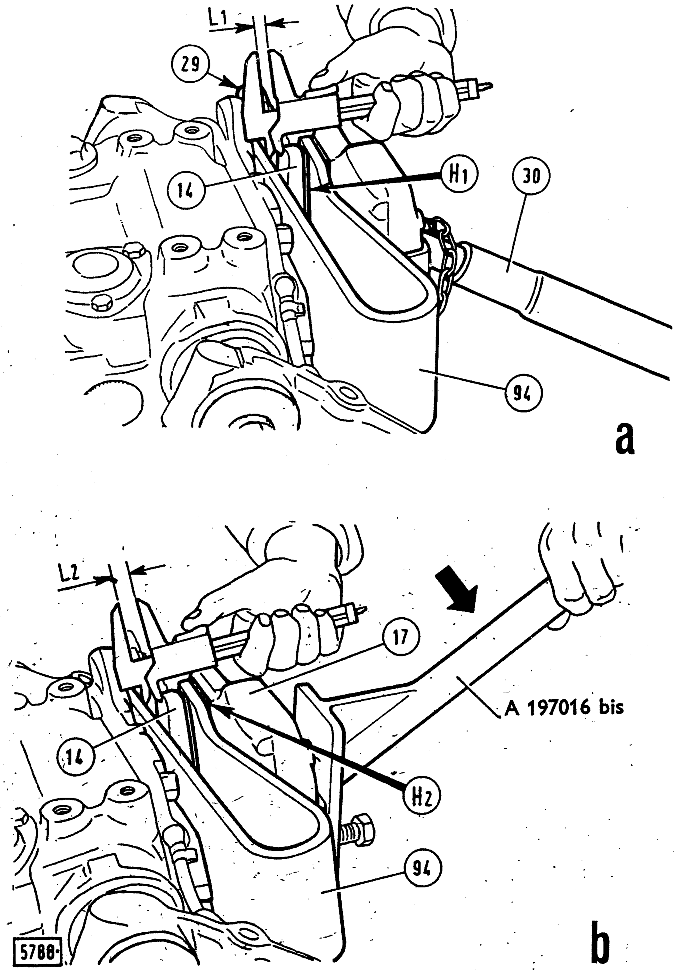


Fig. VII/23 - Adjusting the control spring setting.

a. Checking the gap L_1 with free spring. - b. Checking the gap L_2 with spring held under full tension by means of the lever A 197016 bis. - A 197016 bis. Lever connected to the top link bracket holes to stretch the control spring (push the lever downwards).
H_1. Gap (L_1) adjusting shims. - H_2. Gap (L_2) adjusting shims. - L_1 = 12.7 ÷ 13 mm (0.500″ ÷ 0.512″). Nominal gap between plate (14) and the free spring. - L_2 = = 19.2 ÷ 19.7 mm (0.756″ ÷ 0.775″). Nominal gap betweel plate (14) and fully stretched spring. - 14. Spring mounting plate. - 17. Top link bracket. - 29. Spring movement wedge stop. - 30. Top link. - 94. Control spring.

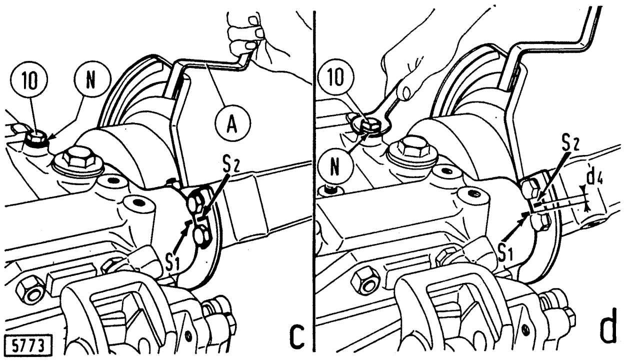


Fig. VII/24 - *Adjusting the maximum lift arm travel.*
c) Max. lift.
d) Lift arms following pressure relief valve blow-out (residual travel).
A. Lift control lever at upper stop inside the quadrant. - $d_4 = 4 \div 5$ mm (0.156″ ÷ 0.197″). Distance between marks (S_1 and S_2) following the blow out of the pressure relief valve. - N. Screw (10) adjustment shims. - S_1. Setting mark on hydraulic lift body. - S_2. Setting mark on the cam integral with the right side arm. - 10. Arms max. lift adjusting screw.

Adjust the hydraulic lift as follows:

— remove the wedge (**29**, Fig. VII/23) used as stop for the spring (**94**) and check (with spring free) that the distance (**L_1**) between the mounting plate (**14**) and the spring measures 12.7 ÷ ÷ 13 mm (0.500 ÷ 0.512 in). If the distance is less, reduce the shims (**H_1**) inserted between spring and plate; increase them if the distance exceeds the limits.

— Connect a lever, such as the **A 197016 bis**, to the top link bracket holes and push downwards until the spring under tension has effected its full stroke.
Make sure now that the distance (**L_2**) between mounting plate (**14**) and spring measures 19.2 ÷ 19.7 mm (0.756 ÷ 0.776 in). If less, reduce the shims (**H_2**) inserted between control spring and top link bracket; if more, increase the shim thickness.

Caution. - *Install the smallest possible number of spring setting shims, as the presence of more than three shims may jeopardize the spring installation and alter the conditions of assembly.*

B. *Setting the maximum lift arms travel.*

The condition of upper lift arms stopping at max. height should occur automatically following the rotation of the spool to neutral setting, which allows the inlet oil to drain out freely.

If not, the piston would end its stroke when the inside rockshaft control lever is stopped by the hydraulic lift body and, under these conditions, the oil under pressure delivered by the pump would drain out through the pressure relief valve.

Adjust as follows:

— apply a load of at least 50 kg (110 lb) to the three-point lower links;

— start the engine and run it up to medium speed;

— lift the arms up and set the hydraulic lift control lever (**A**, Fig. VII/24) at the highest point in the control quadrant;

— in this position, scribe two assembly marks **S_1** and **S_2** (c), in register, on the hydraulic lift body and on the cam integral with the right-side arm;

— slowly unscrew a few turns the arms max. lift stop screw (**10**) until the pressure relief valve (**1**, Fig. VII/3) blows open;

— make sure that the residual upward travel by the lift arms following the opening of the pressure relief valve is comprised between 4 ÷ 5 mm or 0.158 ÷ 0.197 in (**d_4**, Fig. VII/24) as measured at the quoted assembly marks. If the residual travel is less, then reduce the shims (**N**) under the head of the screw (**10**), and if more, then add shims to suit.
In the course of adjustment, hold the hydraulic lift contro lever at the lower stop.

Caution. - *No variation of the lift arms travel length following a reduction or an increase of the number of shims inserted under the head of the screw is probably caused by wrong assemblage or inside leverage deformation: in this case inspect and check the hydraulic lift inside components.*

C. *Sensitivity adjustment.*

To be functionally efficient, the pulling action requires the maximum sensitivity of the reaction by the control valve spool (**6**, Fig. VII/25).

This sensitivity depends upon the position taken, in neutral setting, by the spool cam (**G**) with respect to the drain valve push rod (**7**). The posi-

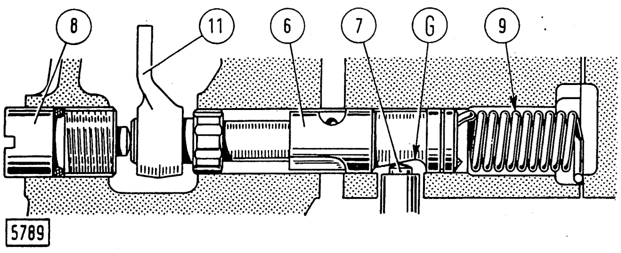


***Fig. VII/25** - Control valve spool section.*
G. Spool cam. - 6. Control valve spool. - 7. Drain valve actuating pin. - 8. Sensitivity adjustment plug (without outside lever). - 9. Spool return spring (works in both compression and torsion). - 11. Inside spool control lever.

tion of the spool cam is adjusted, if necessary, through the plug (**8**) and the outside lever (**18**, Fig. VII/26).

Adjust as follows:

— apply a load of at least 50 kg (110 lb) to the three-point linkage lower links;

— remove the lever (**18**, Fig. VII/26) by removing the attaching screw;

— start the engine and run it up to medium speed;

— set the hydraulic lift control screw at the upper stop and then shift the selection control lever (**B**) down in " position control ";

— starting from the upper end, shift the hydraulic lift control lever down to about the centre of the sector, then scribe on the periphery of it the mark indicating the position (**A_1**) of the lever. Wait then until the lift arms stop;

— gradually, move the lever up until the arms start raising. Mark on the sector new position (**A_2**) of the lever;

— check that the distance **A_1** and **A_2** measured on the periphery of the sector is within 7 ÷ 10 mm (0.275 ÷ 0.394 in) (**d_1**).
If the distance is greater, screw up the spool adjustment plug (**8**), and if smaller, then unscrew the plug to suit.

Following adjustment, refit the lever (**18**) to the adjustment plug (**8**), arranging it as horizontally as possible as illustrated in the Fig VII/3.

Caution. - *Before making each new check, be sure to operate the lift a few times, thus allowing the valve spool* (**6**, *Fig. VII/25*) *and its spring* (**9**) *to return to their normal operating conditions.*

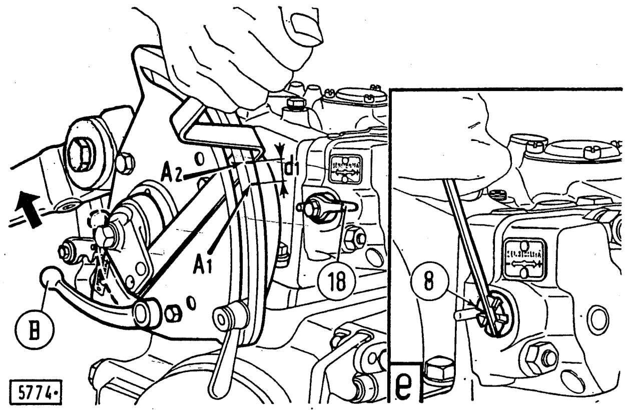


***Fig. VII/26** - Checking control valve spool sensitivity.*
e) Detail of sensitivity adjustment.
A_1. Control lever starting position mark.
A_2. Mark corresponding to the commencement of arms lift. - B. Selector lever in " draft control " (down). - d_1. 7 ÷ 10 mm (0.275″ ÷ 0.394″). Spread between marks measured on the top of the quadrant. - 18. Lever on the sensing adjustment plug. - 8. Lift sensing adjustment plug.

D. *Adjusting the draft control operating range.*

The gap between reaction roller (**19**, Fig. VII/29) and cam (**34**), the latter integral with the right-side arm, locates the " draft control " zone (**U**, Fig. VII/27) on the control lever sector.

If the quoted zone is arranged wrongly, the following troubles may occur:

— too high: at the lower end of the sector there is a too ample neutral zone which will make it impossible to react to the forces set up on the top link bracket (third point);

— too low: it will be impossible to control the highest loads (as the entire control spring compression stroke cannot be taken advantage

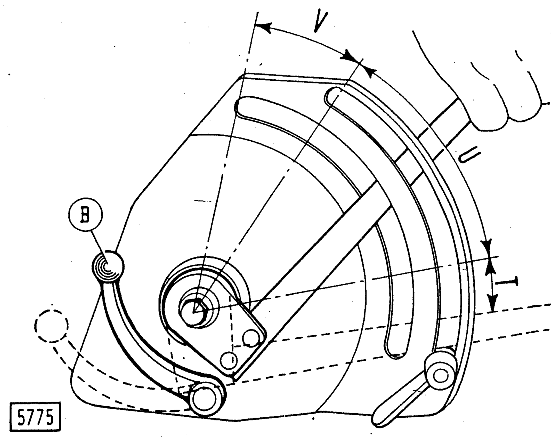


***Fig. VII/27** - Control lever quadrant draft control range.*
B. Selection lever in " draft control " (up). - T. Neutral range, the corresponding arc measured on the sector circumference must not exceed 5 mm (0.197″). - U. Draft control operation range. - V. Lifting range.

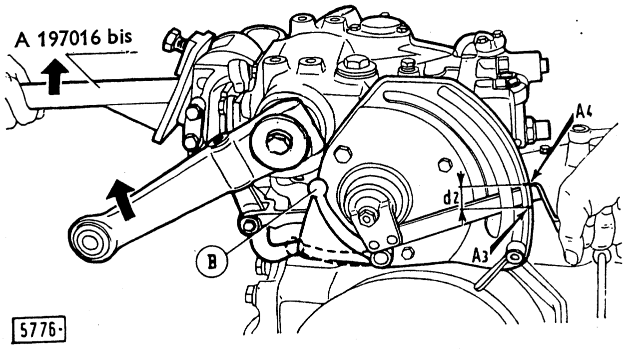


Fig. VII/28 - Checking the draft control operating range. A_3. Check mark indicating the position of the hydraulic lift control lever at end of travel (down). - A_4. Check mark indicating the position of the lever for commencement of lift arms raising. - B. Selection lever in " draft control " (shifted up). - A 197016 bis. Tool bar connected to the top link bracket mounting hole for control spring compressione (shift the lever up). - d_2. ($\leqslant$ 5 mm = = 0.197″). Distance between check marks A_3 and A_4 measured on the quadrant outer rim.

of) and, consequently, to work with certain implements under given job conditions.

Adjust as follows:

— apply a load of at least 50 kg (110 lb) to the three-point linkage lower links, making sure that the entire lowering stroke can be effected before the load will touch the ground.
If necessary, raise the back of the tractor or arrange the loads over a depression of the ground;

— start the engine and run it up to medium speed;

— move the hydraulic lift control lever to the highest point in the quadrant and then set the selection lever (**B**, Fig. VII/28) up in " draft control ";

— move the control lever down to lowest position in the quadrant and scribe a mark on the periphery of the sector and corresponding to the position (A_3) of the lever;

— apply a bar, such as the **A 197016 bis**, to the top link bracket holes and push upwards so to compress the control spring completely.
Under these conditions the lower links of the three-point hitch must not raise.
If, on the contrary, the lower links with their load move up, then the gap (**d_3**, Fig. VII/29) between the reaction roller (**19**) and cam (**34**) should be reduced. This is done by raising the lift arms until the cam lifts off the roller and then act upon the roller cam so that the arms remain unaffected when the aforementioned operation is repeated;

— gradually tap the control lever upwards, keeping the spring fully compressed, and stop as soon as the arms start moving up. Scribe on the sector a mark corresponding to the new position (**A_4**, Fig. VII/28) of the lever;

— make sure that the distance between the marks **A_3** and **A_4** (**d_2**) is less than 5 mm (0.197 in). If not, increase the gap (**d_3**, Fig. VII/29) between the roller (**19**) and cam (**34**) through the excentric pin on the roller;

— put the spring under full tension by pushing downwards on the bar **A 197016 bis** connected to the top link bracket holes and then make sure that, under this condition, the lift arms are raised all the way up when the control lever is shifted to its highest position in the quadrant (zone **V**, Fig. VII/27). If not, reduce the distance **A_3-A_4** (**d_2**, Fig. VII/28) further, according to the same procedure indicated above.

Following adjustments, lock the reaction roller excentric pin by tightening its nut to torque specification.

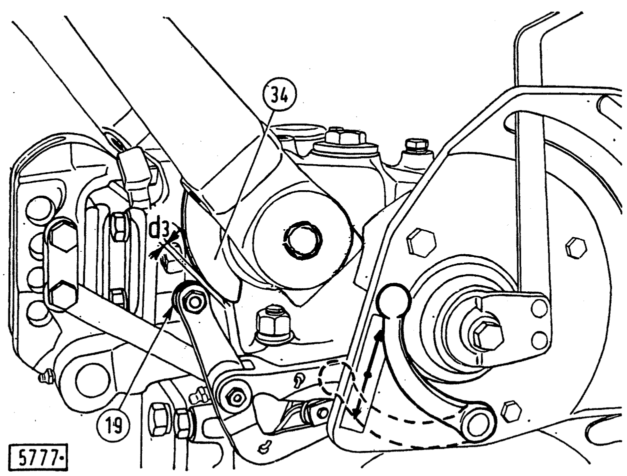


Fig. VII/29 - Adjusting the draft control range.
d3.Cam-to-follower gap with arms lifted 1.5 mm (.059")-
19.Cam roller with eccentric pin for adjusting the distance between the roller itself (34) and the cam.-
34.Cam integral to the right-side lift arm.

Checking the pressure relief and safety valves calibration and the drain valve tightness.

The pressure relief valve (**1**, Fig. VII/3) and cylinder safety valve (**3**) are tested by means of the hand pump **A 12131** (Fig. VII/31) and valve holders **A 197032/B** and **A 197032/D**.

The relief valve is to open at a pressure of 145 ÷ 155 kg/sq.cm (2062 ÷ ÷ 2204 p.s.i.) A.M. or 190 ÷ 195 kg/sq. cm (2702 ÷ 2773 p.s.i.) and the safety valve at 200 ÷ 210 kg/sq.cm (2845 ÷ ÷ 2987 p.s.i.) A.M. or 230 ÷ 240 kg/sq. cm (3271 ÷ 3413 p.s.i.) P.M.

If these specification requirements cannot be met, then replace the complete valves as separate components are not available as spares.

The pressure relief valve can also be tested with the hydraulic lift installed on the tractor, as follows:

— insert between the outlet connection (**20**, Fig. VII/30) and valve mounting cover (**32**) the adaptor **28575**, then connect it to the pressure gauge (0 ÷ 250 kg/sq. cm scale) which is part of the test kit **A 711500**;

— run the engine to warm the hydraulic fluid up to a temperature of 50 ÷ 60°C (122° ÷ 140° F);

— move the control lever (**A**) to its highest point in the quadrant and then unscrew the max. arms lift adjuster (**10**) slowly until the pressure relief valve opens (**1**).

With the engine running at 2400 r.p.m. the pressure gauge reading should be comprised between 150 ÷ 175 kg/sq. cm (2133 ÷ 2489 p.s.i.); if not, replace the valve (**1**) as an assembly.

Check drain valve tightness as follows:

— fit the valve and sealing rings, seat and spring inside the adaptor **A 197036** and then connect the latter to the hand pump **A 12131** (Fig. VII/31);

— actuate the pump until the pressure gauge gives a reading of 250 ÷ 300 kg/sq. cm (3556 ÷ ÷4267 p.s.i.);

— subsequently, using a time counter (seconds), find the time the pressure takes to drop from 200 down to 100 kg/sq. cm (2845-1422 p.s.i.). This time should not be less than six seconds. If less, first replace the sealing rings (**57**), then re-check the valve tightness.

If the trouble persists, replace the complete valve as an assembly.

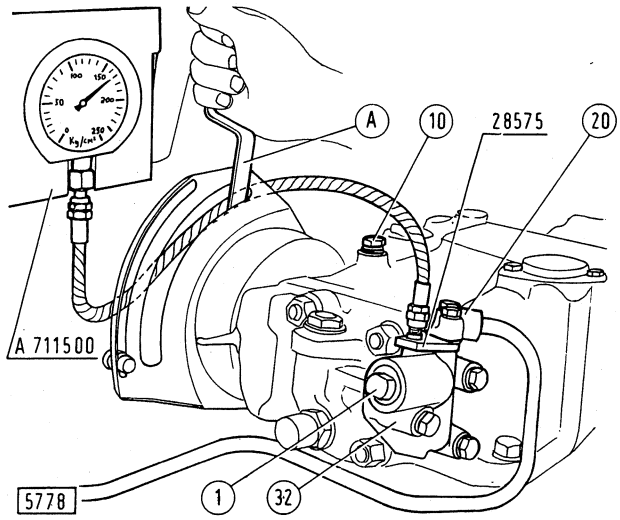


Fig. VII/30 - *Checking the maximum working pressure of the hydraulic circuit (pressure relief valve setting).*

A. Lift control lever at upper stop. - A 711500. Hydraulics universal test set-up - 28575. Test adaptors. - 1. Pressure relief valve. - 10. Arms maximum lift adjusting screw. - 20. Oil delivery line pump to control valve. - 32. Valve holder.

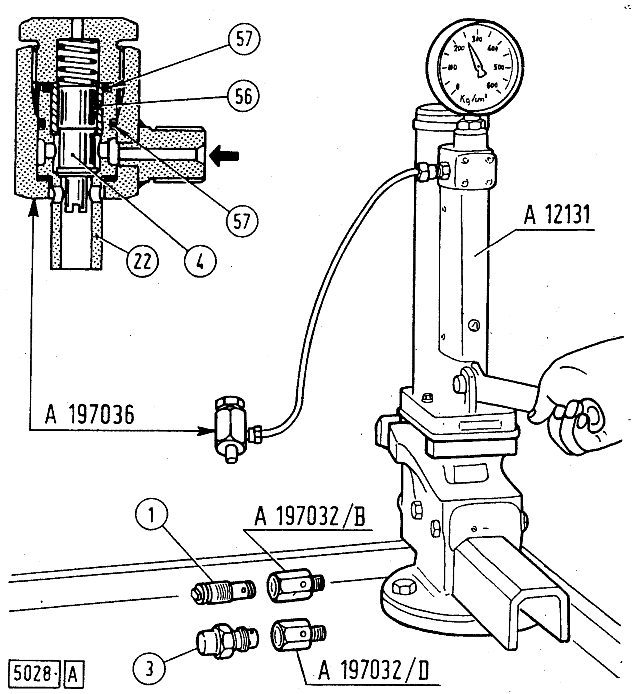


Fig. VII/31 - *Test set-up for checking the calibration of the pressure relief valve (1), safety cylinder valve (3) and drain valve (4) sealing efficiency.*

A 12131. Hand pump. - A 197032/B. Pressure relief valve. - A 197032/D. Safety valve adaptor. - A 197036. Drain valve adaptor. - 22. Drain valve location. - 56. Valve liner. - 57. Sealing rings.

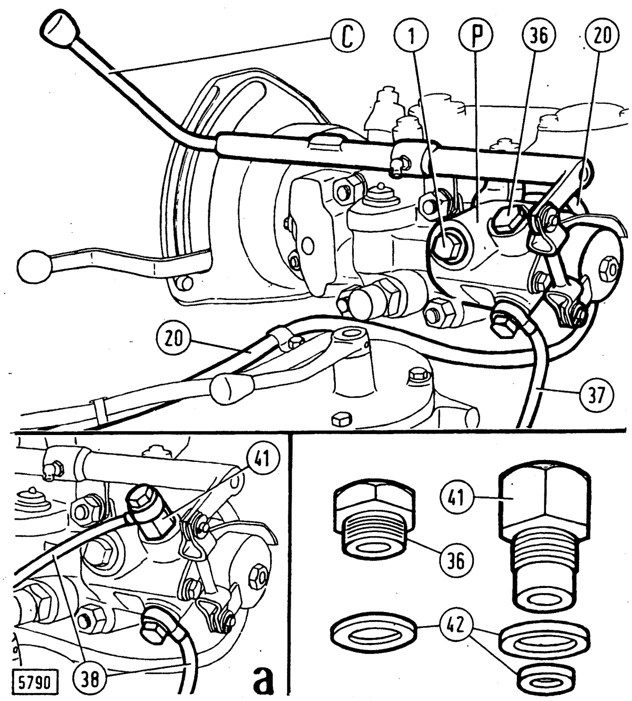


Fig. VII/32 - *Optional pressure connection fitted to the control valve of the hydraulic lift version actuating both single and double-acting rams.*

C. Spool control valve (at the right-hand side of the operator). - P. External ram feed connection. - 1. Pressure relief valve. - 20. Oil line from pump. - 36. Double-acting rams feeding port plug. - 37. Single-acting rams power oil line. - 38. Double-acting rams power oil lines. - 41. Double-acting rams power oil adaptor. - 42. Adaptor sealing rings.

EXTERNAL HYDRAULIC TAPPING

The external hydraulic tapping (**P**, Fig. VII/32) is employed for the remote control of auxiliary attachments actuated by single and double-acting hydraulic cylinders.

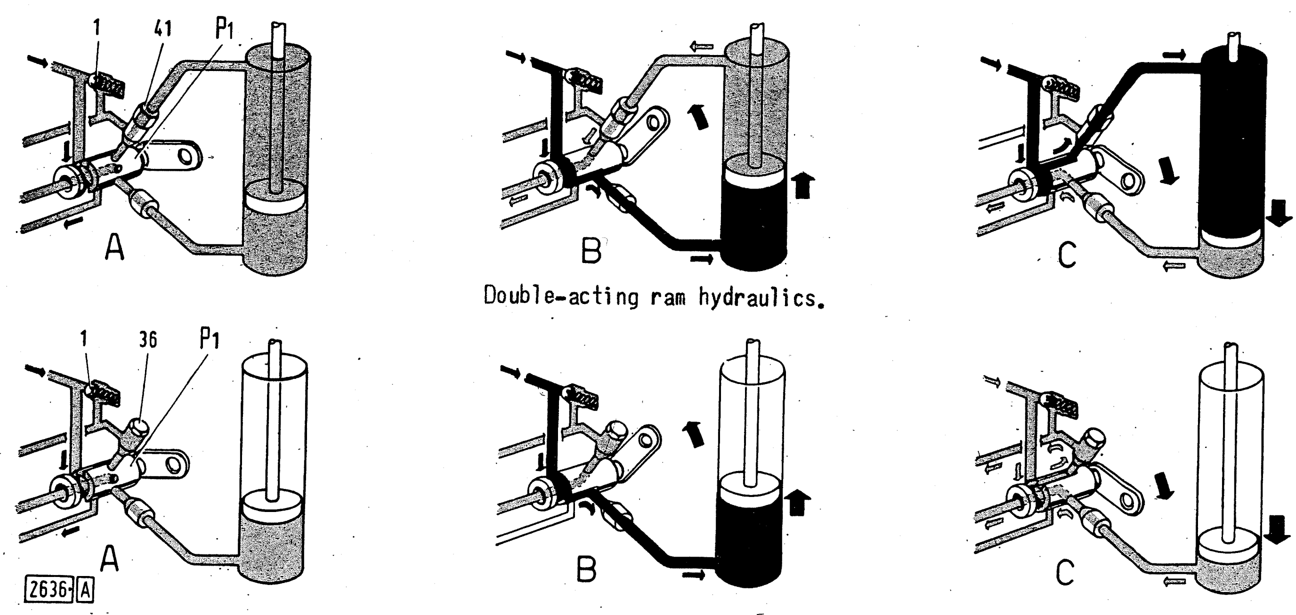
It is attached in place of the cover (**32**, Fig. VII/30) fitted to the left side of the hydraulic lift body, and remove the pressure relief valve (**1**) from the cover to apply it to the tapping (**1**, Fig. VII/32). If the device is used to actuate single-acting cylinders, connect a line (**37**) to the lower hole; if it is used to actuate double-acting cylinders, connect two oil lines (**38**) to the existing holes, being sure to apply the adaptor (**41**) in place of the plug (**36**). The holes are tapped for a M 16 × × 1.5 thread.

The external hydraulic tapping feeds on hydraulic lift oil, though separately controlled through the hand lever (**C**, Fig. VII/32).

However, the simultaneous operation of hydraulic lift and external tapping is not possible.

With the tractor stationary on level ground, the maximum fluid quantity for filling the hydraulic cylinders and their lines is 10 Kg (9-3/4 qts), approx.

The Fig. VII/33 illustrates the hydraulic working diagram for a single and double-acting cylinder, respectively.



Single-acting ram hydraulics.

Fig. VII/33 - *Hydraulics working diagram in remote single-and double-acting rams feeding phase.*

A. Stop. - B. Lift. - C. Lowering. - P_1. Remote rams feeding valve spool. - 1. Pressure relief valve. - 36. Double-acting rams feeding port plug. - 41. Double-acting rams adaptor.

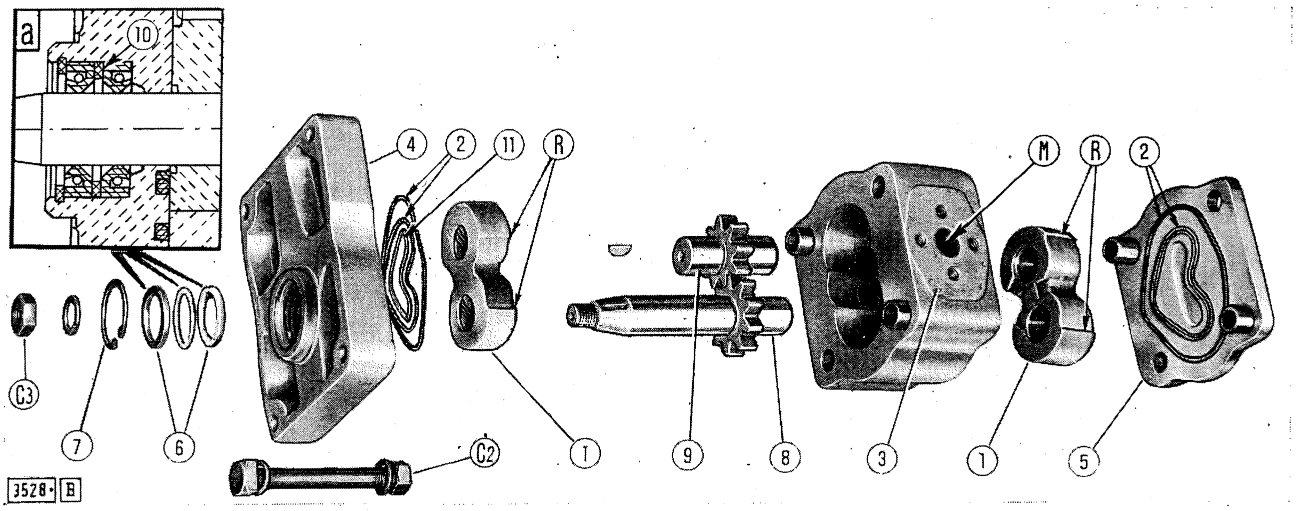


***Fig. VII/34** - Exploded view of hydraulic pump.*
a) Detail of shaft oil assembly.
C_2. Cover and flange bolt nuts. - C_3. Pump driving shaft coupling nut. - M. Pump delivery port (of smaller diameter than the inlet port). - R. Bearing fillets, delivery end. - 1. Bearings. - 2. Cover and flange sealing rings. - 3. Body. - 4. Flange. - 5. Cover. - 6. Shaft oil seal. - 7. Circlip. - 8. Drive gear shaft. - 9. Driven gear shaft. - 10. Spacer. - 11. Seal back-up ring (to be installed also on pumps found without one).

To disassemble the external tapping, first remove the control lever locknut and then withdraw components out. Then, check tightness of the sealing ring on the valve spool and check the sliding clearance of the spool which should be within the limits of 0.015 ÷ 0.020 mm (0.0006 ÷ 0.0008 in).

HYDRAULIC PUMP

The pump (**P**, Fig. VII/5) which feeds the hydraulic lift circuit is a gear type "sandwich construction" unit that does nor require any maintenance, checking or periodical adjustments because both gear shaft lubrication and the taking-up of service wear between gears and bearings is done automatically by the pressure of the oil circulating through the pump (pressure-loaded bearing principle).

Bearing bores housing the shafts are lubricated by the same oil circulated by the pump through the recesses on inlet side of bearings. Service wear is taken up by the pressure of the oil acting upon the plane face of the bearings adjacent to the flange and cover within the area delimited by the two sealing rings.

The pump is driven from the engine timing gear (**17**, Fig. VII/35) through an oldham coupling.

To reach the driving gear, bushings and bearings, remove the timing gear case cover as described in the section "Engine".

The related data are tabulated on page 177.

The pump is quickly damaged when running dry, therefore, never run the engine when the transmission housing is dry.

Overhauling.

Overhaul the pump when output drops of about 25 percent with respect to that given in the specifications of page 146.

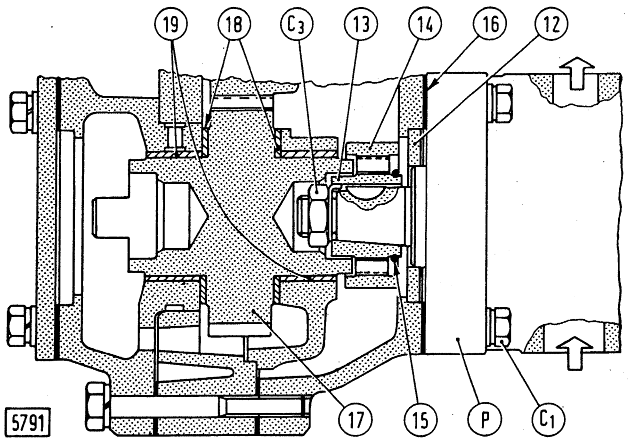


***Fig. VII/35** - Pump driving unit.*
C_1. Capscrews securing pump to engine timing gearcase cover. - C_3. Coupling nut. - P. Oil pump - 12. Pump alignment ring. - 13. Pump drive coupling. - 14. Coupling driving ring. - 15. Driving ring (14) circlip. - 16. Gasket. - 17. Pump driving gear. - 18. Thrust washers. - 19. Bearing bushes.

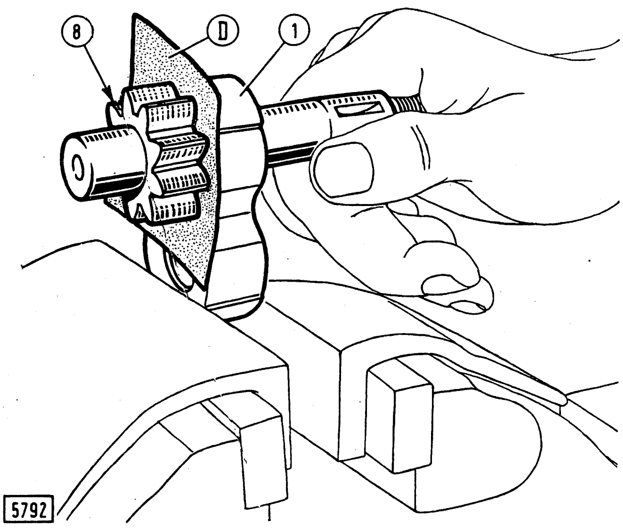


***Fig. VII/36** - Polishing drive gear faces.*
D. Emery paper. - 1. Bearing. - 8. Gear.

Removal.

Remove the pump from the tractor by removing the capscrews which secure it to the engine timing gear case cover and the capscrews securing the suction and delivery oil lines (**21** and **20**, Fig. VII/5).

Withdraw it then at front and recover the alignment ring (**12**, Fig. VII/35), the driving ring (**14**) and the gasket inserted between pump and timing gear case cover.

Disassembly.

Clamp the pump is a bench vise provided with soft lead jaws, then disassemble it as follows:

— unscrew the nut (C_3, Fig. VII/34) from the drive shaft, then withdraw the drive sleeve and retaining ring;

— remove flange and cover and their sealing rings after removing the attaching bolts;

— withdraw gears and bearings, tapping the shaft ends with a plastic mallet. We recommend scribing assembly marks before disassembly to ensure correct assembly of the parts, if still usable;

— withdraw from the cover the drive shaft seals and the spacer, after removing the retaining ring;

— remove the inner and outer seals from flange and cover, the latter provided with a plastic back-up ring.

Inspection.

Following a thorough cleaning of the parts, but avoiding solvents which may damage the oil seals, proceed as follows.

— Check flange and cover seals and the two drive shaft seals for scored working surfaces or permanent damage, and refit them if found functionally efficient. However, it is best to replace all of them at overhauls.

— Check tha making gear and bearing faces with lampblack. These surfaces must be perfectly smooth and normal to their axes. If wear is very small these faces are polished as shown in Fig. VII/36, by inserting a sheet of emery paper lubricated with paraffin and turning the shaft and gear slowly.

— Check on a surface gauge the flats on the bearing mating faces, and if wear is still small, polish them by passing them over a sheet of emery paper lubricated with paraffin and laid on a flat surface.

Then, remove burrs and polish the side surfaces so that bearings slide in under slight hand pressure.

— Measure shaft and bore wear vs. data tabulated on page **177**.

— Measure the bearing clearance which should be comprised within the limits of 0.1 ÷ 0.2 mm (0.004 ÷ 0.008 in) (Fig. VII/37).

Assembly.

Prior to assembly, lubricate all pump components using the hydraulic fluid, to avoid seizure or binding during the initial period of service. Assemble the pump referring to Fig. VII/34 and taking notice of the scribed assembly marks and of the following points:

— after fitting the sealing rings insert on the inside of the ring anti-extrusion plastic ring (Fig. VII/38), also on those pumps which were not provided with it;

— arrange the gear bearings inside the pump body with the relieved radii (**R**, Fig. VII/34) on the outer circumference facing the delivery end port (**M**) and with the front faces with the lubrication scrolls adjacent to the gears;

— thoroughly dry the shaft seal lands in the cover, then introduce them complete with spacer arranged as shown in detail (**a**) of Fig. VII/34,

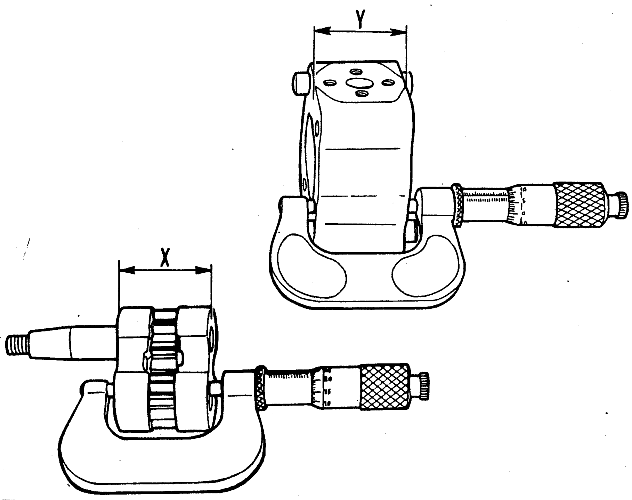


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Fig. VII/37 - Bearing and gear end clearance measurement.
Length X less than Y by 0.1 ÷ 0.2 mm (0.004″÷0.008″).

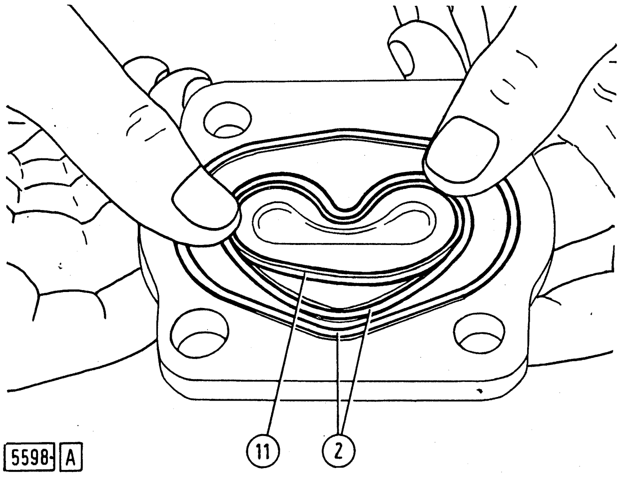

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Fig. VII/38 - Fitting the seal back up ring (11) to the pump cover on the inside of the inner O-ring.
2. Sealing rings.

and, finally, fill the cavity between the seal lips with FIAT MR 3 grease (wheel bearing grease, NLGI no. 3).

When fitting the complete cover be sure to cover with a suitable sheet band the end thread and the key seat of the drive shaft to avoid damaging the rubber rings against sharp corners;

— tighten the pump cover bolt nuts gradually and to the specified torque value.

If, following overhauling, the pump performance is poor, entrust it to a specialized shop properly equipped for bench testing.

Installation.

Assemble the drive coupling and refit the pump to the tractor inserting the alignment ring (**12**, Fig. VII/35) and gasket (**16**) between the timing gear case cover and the pump.

Fix the suction line flange (**21**, Fig. VII/5) and, before securing the delivery pipe (**20**), pour in some oil through the upper duct, in order to favour the priming of the pump avoiding the risk of seizure during the initial service period.

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Hydraulic lift inoperative.	1. Lack of oil.	Fill up to level.
	2. Control valve stuck.	Remove and clean it.
	3. Pump inoperative.	Disassemble and inspect it.
Hydraulic lift jerky.	1. Lack of oil.	Fill up to level.
	2. Oil strainer clogged.	Clean it.
	3. Air entering the suction line.	Check connections and seals.
Hydraulic lift does not hold the load up (with engine running the load keeps oscillating up and down; with engine stopped, the load drops).	1. Faulty adjustment of the control valve spool.	Readjust the valve spool.
	2. Drain valve leaking or stuck. Defective oil seals.	Disassemble, check tightness and replace defective parts.
	3. Poor sealing of the oil cylinder inlet valve.	Remove, check and clean the components.
	4. Oil leaks by the piston seal or the cylinder seal.	Replace the seals.
	5. Poor sealing or low calibration of the cylinder safety valve.	Replace it.
Pressure relief valve cuts in when lift arms are at maximum height.	1. Wrong adjustment of lift arms travel.	Reduce to suit the number of shims inserted under the head of the travel adjusting screw.
Poor lifting capacity, less than estimated.	1. Wrong pressure relief valve setting.	Replace it.
	3. Low pump efficiency (normally accompanied by a considerable increase of the lifting time).	Test pump performance and overhaul it, if necessary.
Presence of engine sump oil in the hydraulic lift fluid.	1. Poor performance of hydraulic pump shaft seals.	Check the parts and replace defective ones.

VIII - POWER TAKE OFF - BELT PULLEY

POWER TAKE-OFF

The power take-off (**a**, Fig. VIII/1) is arranged internally in the transmission housing back cover and can be operated in two ways: one directly from the engine crankshaft through the clutch (see Section I) and therefore indipendent from the tractor motion, and the other synchronized to the transmission.

The lever (**L**, Fig. VIII/1) selects the type of operation. This lever, which acts on the sliding gear (**1**, Fig. VIII/3) working as a grooved collar, connects the drive shaft (**2**) directly to the engine, or, by shifting the gear (**1**) into engagement with gear (**3**) integral with the bevel pinion shaft, synchronizes the P.T.O. with the transmission speeds.

To shift the lever (**L**, Fig. VIII/1) from the setting of neutral (**F**) with the P.T.O. disengaged to the position of " Motore " (Engine) (**M**), just disengage the P.T.O. clutch plate first; to shift the lever to the setting of " CAMBIO " (**C**), the engine must be stopped.

The standard end of the output shaft has the following characteristics:

— shaft diameter . . . . **1-3/8"**

— rotation (looking from the back end) . . . . **clockwise**

— shaft speed with the lever set in " Motore " (engine)
- engine running at 1970 r.p.m. . . . . **540 r.p.m.**
- engine running at max. power speed, 2400 r.p.m. . . . . **659 r.p.m.**

- speed with the lever set in "Cambio"(Transmission) with rear tyres 12.4/11.36... 3.8 revs. per meter

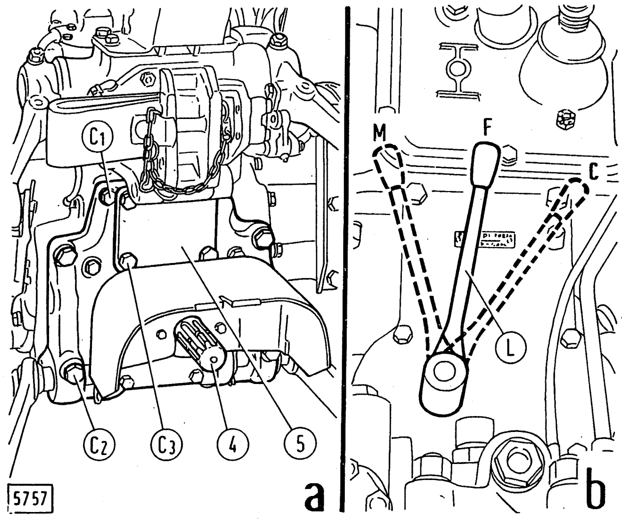


Fig. VIII/1 - P.T.O. installation.
a. Unit incorporated inside the transmission housing rear cover.
b. P.T.O. controls.
C. Proportional ground-speed P.T.O. - C_1. and C_2 Rear transmission cover capscrews. - C_3. Cover (5) capscrews. - F. Neutral position with P.T.O. disengaged. - L. Engagement control lever. - M. Indipendent P.T.O. - 4. Driven shaft with standard spline. - 5. P.T.O. drive and belt pulley application cover.

Overhauling.

Proceed as follows:

— drain the gearbox and transmission cases of lubricating oil;

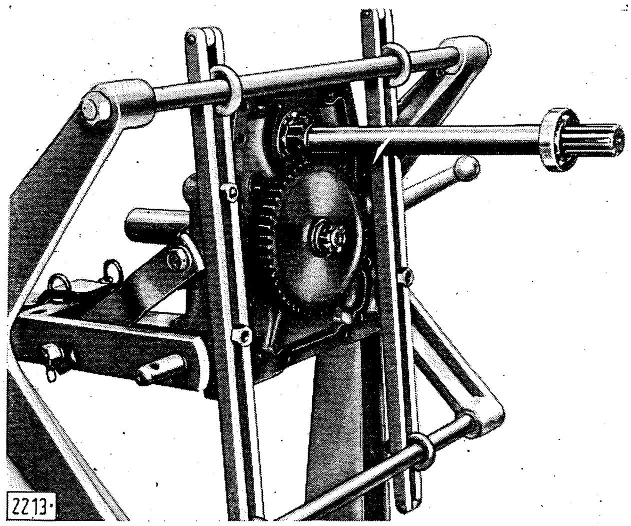


Fig. VIII/2 - P.T.O. unit installed on turnover stand ARR 2220.
(The unit is shown complete with tractor drawbar).

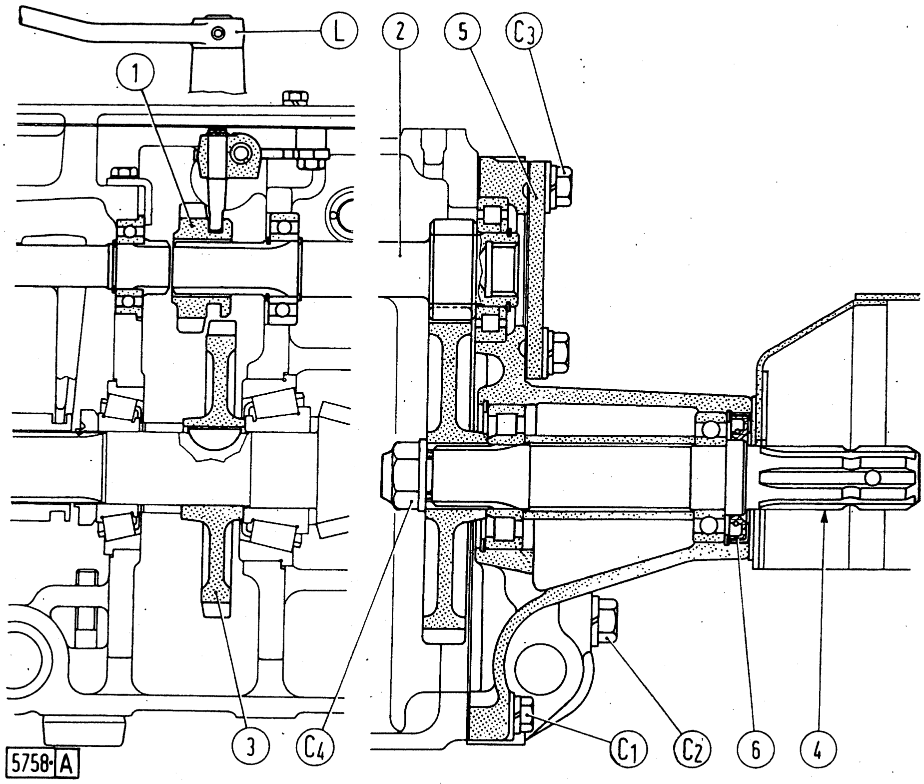


Fig. VIII/3 - Power take-off cross sectional view.

C_1 and C_2. Rear transmission cover capscrews. - C_3. Cover (5) capscrews. - C_4. Driven shaft gear locknut. - L. Engagement control lever. - 1. Engagement sliding gear. - 2. Driving shaft. - 3. Driving shaft with engageen synchronized with the transmission. - 4. Driven shaft. - 5. P.T.O. drive and belt pulley application cover. - 6. Oil seal.

Note - For tractors without ground speed P.T.O. the gear (3) and relevant spacer are replaced by a single spacer.

— set the lever (**L**, Fig. VIII/1) in " Motore " (Engine);

— remove the belt pulley assembly, if installed, to facilitate the removal;

— remove the attaching capscrews and then the transmission housing and power take-off as an assembly.

For disassembly, we recommend installing the unit on the turnover stand **ARR 2220** (Fig. VIII/2). Remove the transmission housing rear cover to gain access to the sliding gear (**1**, Fig. VIII/3) and the P.T.O. engagement unit for removal. Examine the oil seal (**6**) carefully and replace it unless absolutely reliable.

Reassemble the unit considering the Figs. VIII/2 and VIII/3.

When installing the unit, act on the splined end of the driven shaft to facilitate meshing of the drive shaft (**2**, Fig. VIII/3) with the sliding gear splines (**1**).

BELT PULLEY

The belt pulley is optional and is applied in place of the cover (**5**, Fig. VIII/3). The unit can be installed with the pulley arranged either on the right or on the left, according to the sense of rotation which is desired. In both cases, the breather (**7**, Fig. VIII/4) must be arranged uppermost and the drain plug (**T**) down; if necessary, exchange the two parts.

The housing contains a pair of bevel gears offering a speed reduction ratio of 1 : 1.923, the drive shaft (**8**, Fig. VIII/5) of which is driven from the splined end of the P.T.O. drive shaft (**2**, Fig. VIII/3).

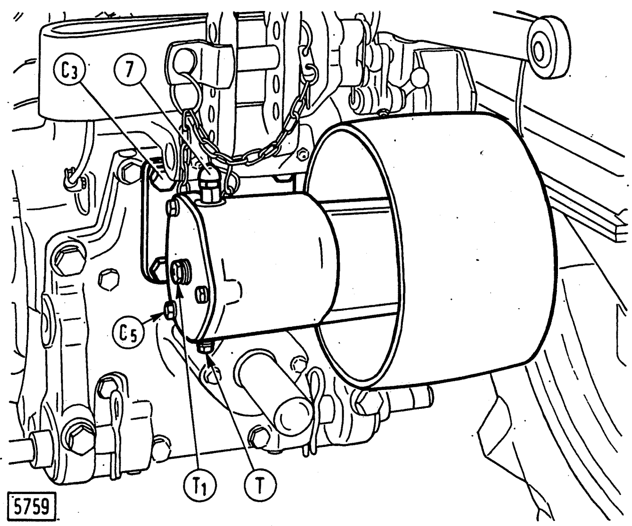


Fig. VIII/4 - Belt pulley installation.

C_3. Belt pulley attaching capsvrews. - C_5. Housing cover capscrews. - T. Oil drain plug. - T_1. Oil filler and level check plug. - 7. Breather.

The pulley is engaged by lowering the control lever of the P.T.O. clutch and by setting the P.T.O. lever (L,Fig.VIII/1) in "Motore" (Engine) (M).
Belt pulley specification are :

— angular speed (with engine running at the max. power speed of 2400 r.p.m.)	**1248 r.p.m.**
— linear speed	**16.3 m/sec. (53-1/2 ft/sec.)**
— pulley diameter	**250 mm (9.84 in)**
— face width	**150 mm (5.9 in)**

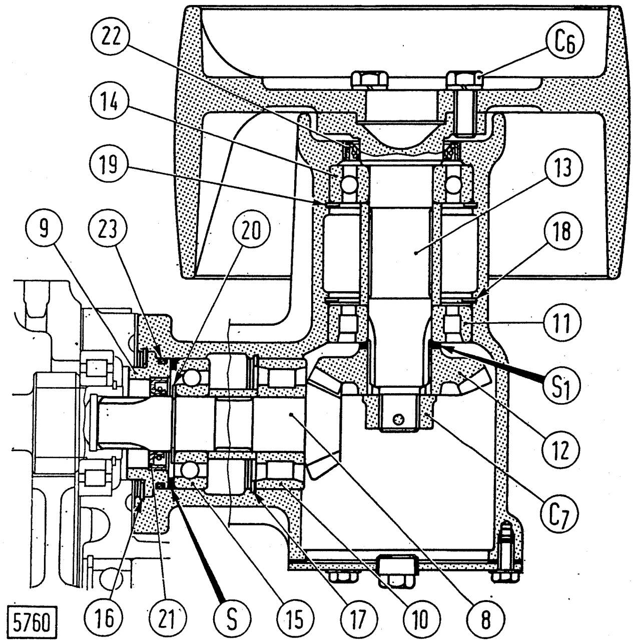


Fig. VIII/5 - Belt pulley cross-sectional view.
C_6. Belt pulley capscrews. - C_7. Driven gear locknut. - S. Driving gear shim. - S_1. Driven gear shim. - 8. Drive gear shaft. - 9. Flange. - 10 and 11. Cylindrical roller bearings. - 12. Driven gear. - 13. Driven shaft. - 14 and 15. Ball bearings. - 16, 17, 18, 19 and 20. Snap rings. - 21 and 22. Oil seals. - 23. O-ring.

Overhauling.

Remove and disassemble the unit as follows:

— drain the oil;

— remove the pulley from the driven shaft and the cover from the opposite end;

— remove the retaining ring (**16**, Figs. VIII/5 and VIII/6), then, using a punch, drive out the drive gear shaft (**8**) and bearings, spacer and cap (**9**);

— remove the cotter pin and unscrew the nut (C_7);

— remove the driven gear (**12**), recover the shim and withdraw the driven shaft (**13**);

— remove the roller bearing outer rings (**10** and **11**) and the ball bearing (**14**) after withdrawing the retaining rings (**17**, **18** and **19**).

Examine the functional efficiency of the seals (**21**, **22** and **23**) and replace unreliable ones.
Re-install the parts referring to Figs. VIII/5 and VIII/6.

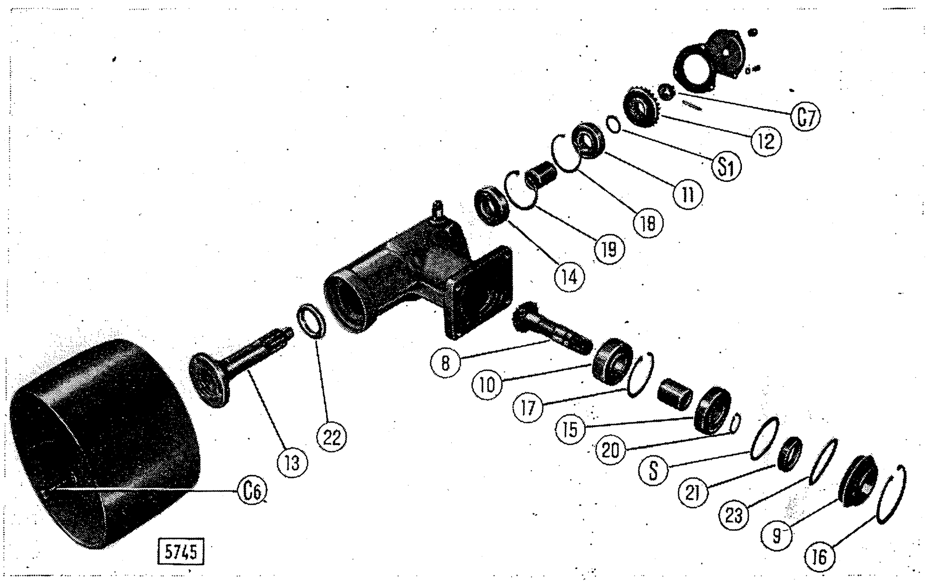


Fig. VIII/6 - Exploded view of bet pulley.
(See legend of fig. VIII/5 for annotated parts).

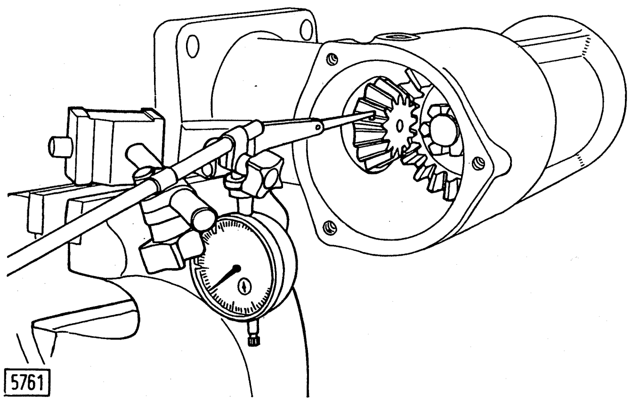

5761

Fig. VIII/7 - Tooth backlash of belt pulley bevel gear train.

Bevel gear setting.

Proceed by trial-and-error, considering the following points:

— check tooth mesh by the lead oxide (red lead) method;

— measure the tooth backlash (Fig. VIII/7) which should be 0.15 mm (0.006 in);

— set the two gears to suit (**8** and **12**, Figs. VIII/5 and VIII/6) by varying the shim thickness (S and S_1).

IX - FITS AND TOLERANCES - TORQUE SPECIFICATIONS SERVICE TOOLS

FITS AND TOLERANCES

DESCRIPTION	Size of new parts and wear limits	
	mm	in
I - Clutch		
Backlash, clutch shaft and disc splines	0.010 ÷ 0.106	0.0004 ÷ 0.0042
Thickness of P.T.O. and transmission clutch friction discs (FERODO) (***1*** *and* ***6***, Fig. I/7)	8.500 ÷ 8.900	0.335 ÷ 0.350
Wear limit	6.5	0.256
Thickness of friction disc (***1***, Fig. I/19) of the P.T.O. clutch (LUK)	8.200 ÷ 8.800	0.323 ÷ 0.346
Thickness of friction disc (***6***) of the transmission clutch (LUK)	8.400 ÷ 9.000	0.331 ÷ 0.354
Wear limit	6.5	0.256
Thickness of friction disc (***1***, Fig. I/19) of the P.T.O. clutch (O.M.G.)	8.700 ÷ 9.000	0.342 ÷ 0.354
Thickness of friction disc (***6***) of the transmission clutch (O.M.G.)	8.500 ÷ 9.100	0.334 ÷ 0.358
Wear limit	6.5	0.256
Diameter of driving gear shaft bearing cap hub (***17***, Fig. II/21)	48.961 ÷ 49.000	1.9276 ÷ 1.9291
Inside diameter of transmission clutch release collar (***12***, Fig. I/11)	49.050 ÷ 49.112	1.9311 ÷ 1.9335
Assembly clearance between release collar and supporting hub	0.050 ÷ 0.151	0.0020 ÷ 0.0059
Outside diameter of transmission clutch release collar (***12***)	57.954 ÷ 58.000	2.2816 ÷ 2.2835
Inside diameter of P.T.O. clutch release collar (***10***)	58.060 ÷ 58.134	2.2858 ÷ 2.2887
Clearance between P.T.O. and transmission clutch collars	0.060 ÷ 0.180	0.0024 ÷ 0.0071
Diameter of transmission clutch shaft	27.948 ÷ 28.000	1.1003 ÷ 1.1024
Inside diameter of the clutch pedal bushing (fitted)	28.020 ÷ 28.072	1.1031 ÷ 1.1052
Assembly clearance of transmission clutch pedal shaft in bushing	0.020 ÷ 0.124	0.0008 ÷ 0.0049
Interference fit of pedal shaft bushing	0.043 ÷ 0.103	0.0017 ÷ 0.0041
Specifications of transmission clutch pressure plate return springs (***20***, Fig. I/6):		
— free nominal lenght	25.2	0.99
— compressed length under a load of 11 ÷ 12 kg (24.5 ÷ 26 lb)	11.2	0.44
Specifications of modified P.T.O. clutch release lever return springs (***22***, Fig. I/12):		
— free nominal length	40.8	1.61
— length under a load of 25 ÷ 27 kg (55 ÷ 59.5 lb)	29.85	1.17
II - Transmission.		
Spline backlash:		
— transmission driven and driving gears	0.010 ÷ 0.106	0.0004 ÷ 0.0042
— transmission 1st-2nd speed gear engagement collar	0.100	0.0039
— synchromesh engagement collar	0.100	0.0039
— epicyclic gear train straight drive engagement	0.070 ÷ 0.170	0.0027 ÷ 0.0067
— epicyclic gear train engament	0.340 ÷ 0.440	0.063 ÷ 0.017
Tooth backlash:		
— transmission gears	0.100 ÷ 0.200	0.0039 ÷ 0.0079
— epicyclic gear train	0.070 ÷ 0.130	0.0027 ÷ 0.0051
Outside diameter of gear hub sleeves (***64***, Fig. II/29)	49.955 ÷ 49.970	1.9666 ÷ 1.9672
Diameter of gear housing bores transmission driven gears	50.050 ÷ 50.075	1.9704 ÷ 1.9714
Assembly clearance of sleeves in driven gear hubs	0.080 ÷ 0.120	0.0031 ÷ 0.0047
Wear limit	0.30	0.012
Diameter of transmission driven shaft (***40***, Fig. II/34)	39.945 ÷ 39.970	1.5726 ÷ 1.5736
Diameter of P.T.O. clutch shaft (***1***, Fig. II/18)	24.964 ÷ 24.985	0.9828 ÷ 0.9836
Inside diameter of fitted bushing (***28***, Fig. II/25)	25.040 ÷ 25.092	0.9858 ÷ 0.9879
Running clearance of P.T.O. clutch shaft in bushing	0.55 ÷ 0.128	0.0021 ÷ 0.0050
Wear limit	0.30	0.012
Interference fit of bushings (***28***) on drive shaft	0.037 ÷ 0.091	0.0014 ÷ 0.0036

Continued: " Fits and tolerances "

DESCRIPTION	Size of new parts and wear limits mm	in
Diameter of epicyclic gear train driven pinion shafts (*50*, Fig. II/24)	14.389 ÷ 14.400	0.5665 ÷ 0.5670
Diameter of bearing needles (*51*)	2.990 ÷ 3.000	0.1178 ÷ 0.1181
Diameter of bearing needle location on driven gears (*53*)	20.410 ÷ 20.430	0.8035 ÷ 0.8043
Assembly clearance of shafts, bearing needles and their locations on driven gears	0.010 ÷ 0.061	0.0004 ÷ 0.0024
Wear limit	0.15	0.006
Thickness of 8-speed transmission drive gear adjustment shim (*A*, Figs. II/23 and II/31)	3.70-4-4.30 (tolerance ± 0.05)	0.146-0.157-0.169 (tolerance ± 0.002)
Thickness of thrust washers (*52*, Fig. II/24) and rings (*47*, Fig. II/36) for epicyclic gear train driven gears and carrier	1.470 ÷ 1.530	0.0579 ÷ 0.0602
Wear limit	1.30	0.051
Specifications of speed selector plate automatic return springs (*13*, Fig. II/39):		
— free nominal length	61.5	2.42
— length under a load of 5.1 ÷ 5.7 kg (11.5 ÷ 12.5 lb)	48	1.89
Specifications of gearshift and auxiliary reduction unit hand levers retaining springs (*82*, Fig. II/31):		
— free nominal length	33.7	1.33
— length under a load of 3.9 ÷ 4.3 kg (8.5 ÷ 9.5 lb)	20	0.79
Specifications of shifter bar poppet balls springs (*71*, Fig. II/35):		
— free nominal length	35.5	1.40
— length under a load of 8.2 ÷ 10 kg (18 ÷ 22 lb)	28.5	1.12
Specifications of transmission epicyclic gear unit shifter bar poppet ball (*81*, Fig. II/37):		
— free nominal length	35.5	1.40
— length under a load of 11.7 ÷ 12.9 kg (25.8 ÷ 28.5 lb)	31.5	1.24
III - Bevel gear and differential.		
Bevel gear and pinion tooth backlash	0.15 ÷ 0.20	0.006 ÷ 0.008
Differential gear and pinion tooth backlash	0.15 ÷ 0.20	0.006 ÷ 0.008
Differential gear and axle shaft splines backlash	0.010 ÷ 0.106	0.0004 ÷ 0.0042
Diameter of differential pinion axle (*19*, Fig. III/5)	23.980 ÷ 23.959	0.9440 ÷ 0.9432
Inside of diameter of differential pinion bushings (*18*) (fitted) (1)	24.020 ÷ 24.072	0.9457 ÷ 0.9577
Assembly clearance between axle and bushings	0.041 ÷ 0.092	0.0016 ÷ 0.0036
Wear limit	0.25	0.0098
Interference fit of differential pinion bushings (*18*)	0.050 ÷ 0.250	0.0020 ÷ 0.0098
Diameter of differential gear hubs (*16*, Fig. III/5)	43.961 ÷ 44.000	1.7307 ÷ 1.7323
Diameter of gear hub locations in differential case (*11*)	44.080 ÷ 44.119	1.7354 ÷ 1.7370
Assembly clearance between gear hubs and differential case locations	0.080 ÷ 0.158	0.0031 ÷ 0.0062
Wear limit	0.35	0.014
Diameter of differential case hub (*11*)	59.954 ÷ 60.000	2.3604 ÷ 2.3622
Diameter of differential lock roller (*10*)	60.120 ÷ 60.200	2.3669 ÷ 2.3701
Assembly clearance between differential collar and case hub	0.120 ÷ 0.246	0.005 ÷ 0.010
Thickness of differential gear thrust washers (*15*, Fig. III/5)	1.5 ÷ 1.6 (tolerance ± 0.03)	0.059 ÷ 0.063 (tolerance ± 0.001)
Wear limit	1	0.040

(1) Ream after fitting.

Continued: " Fits and tolerances "

DESCRIPTION	Size of new parts and wear limits mm	in
Thickness of differential pinion thrust washers (*17*, Fig. III/5)	1.470 ÷ 1.530	0.058 ÷ 0.060
Wear limit	1	0.040
Thickness of bevel gear bearings and tooth backlash adjustment shims (*Sd* and *Ss*, Figs. III/5 and III/6)	0.15-0.2-0.5 (tolerance ± 0.02)	0.006-0.008-0.020 (tolerance ± 0.0008)
Thickness of pinion setting adjustment shims (*S*)	3.8-3.9-4-4.1-4.2-4.3-4.4-4.5-4.6-4.7-4.8 (tolerance ± 0.02	0.150-0.153-0.157-0.161-0.165-0.169-0.173-0.177-0.181-0.185-0.186 tolerance ± 0.0008)
Thickness of pinion bearing adjustment shim (*Sp*)	1.7-1.75-1.8-1.9-2-2.1-2.2-2.25-2.3 (tolerance ± 0.01)	0.067-0.069-0.071-0.075-0.079-0.083-0.087-0.088-0.091 (tolerance ± 0.004)
Specifications of the differential lock return spring (*25*, Fig. III/7):		
— free nominal length	188	7.40
— length under a load of 28.5 ÷ 31.5 kg (62.8 ÷ 69.5 lb) . .	126.5	4.98
IV - Brakes.		
Thickness of the brake band lining	6	0.236
Lining width	56	2.204
Outside diameter of brake drums	225	8.858
Wear limit	224	8.8189
Diameter of the pins of the outside band control levers (*6*, Fig. IV/1)	23.948 ÷ 24.000 26.948 ÷ 27.000	0.9428 ÷ 0.9449 1.0609 ÷ 1.0630
Inside diameter of bushings (*15*) (fitted)	24.040 ÷ 24.092	0.9464 ÷ 0.9485
Diameter of pin locations	27.040 ÷ 27.092	1.0645 ÷ 1.0666
Assembly clearance of band control lever pins, locations and end bushings	0.040 ÷ 0.144	0.0016 ÷ 0.0057
Interference fit of bushings (*15*) in transmission housing locations	0.037 ÷ 0.091	0.0014 ÷ 0.0036
Diameter of the left brake control shaft (*12*, Fig. IV/1)	27.948 ÷ 28.000	1.1003 ÷ 1.1024
Inside diameter of bushings (*13* and *14*), fitted	28.020 ÷ 28.072	1.1031 ÷ 1.1052
Assembly clearance between left side drive shaft and bushings	0.020 ÷ 0.124	0.008 ÷ 0.0049
Interference fit of bushings (*13* and *14*) in transmission case and on right side pedal	0.043 ÷ 0.103	0.0017 ÷ 0.0041
V - Final drives and sprocket wheels.		
Final drive gear tooth backlash	0.150 ÷ 0.250	0.006 ÷ 0.010
Differential gear and axle shaft splines backlash	0.010 ÷ 0.106	0.0004 ÷ 0.0042
Final drive bull gear and drive wheel shaft splines backlash .	0.050 ÷ - 0.048	0.0020 ÷ 0.0019
VI - Steering and front wheels.		
Diameter of steering case nut shaft (*2*, Fig. VI/4)	34.875 ÷ 34.900	1.3730 ÷ 1.3740
Inside diameter of bushing (*10*) (fitted) (1)	34.912 ÷ 34.937	1.3745 ÷ 1.3755
Inside diameter of bushings (*11*) (fitted) (1)	34.925 ÷ 34.950	1.3750 ÷ 1.3760
Assembly clearance between nut shaft and bushings:		
— steering box cover bushing	0.012 ÷ 0.062	0.0005 ÷ 0.0024
— steering box bushings	0.025 ÷ 0.075	0.0010 ÷ 0.0029

(1) Ream after fitting.

Continued: " Fits and tolerances "

DESCRIPTION	Size of new parts and wear limits mm	Size of new parts and wear limits in
Interference fit of bushings:		
— steering box cover bushing (*10*)	0.013 ÷ 0.063	0.0005 ÷ 0.0025
— steering box bushings (*11*)	0.014 ÷ 0.089	0.0006 ÷ 0.0035
Thickness of worm and nut setting adjustment shims (*S*, Fig. VI/4)	0.10 (tolerance ± 0.01)	0.004 (tolerance ± 0.004)
Thickness of worm gear taper roller bearing shims (S_1)	0.10-0.15-0.50 (tolerance ± 0.01)	0.004-0.006-0.020 (tolerance ± 0.0004)
Diameter of spindles (*21*, Fig. VI/9)	37.975 ÷ 38.000	1.4951 ÷ 1.4961
Inside diameter of bushings (*32*)	38.020 ÷ 38.100	1.4968 ÷ 1.5000
Assembly clearance of spindles in bushings	0.020 ÷ 0.125	0.0008 ÷ 0.0049
Wear limit	0.35	0.014
Interference fit of bushings (*32*)	0.050 ÷ 0.230	0.0020 ÷ 0.0090
Diameter of front axle trunnion pin (*20*, Fig. VI/9)	31.975 ÷ 32.000	1.2588 ÷ 1.2598
Inside diameter of bushings (*33*) (fitted)	32.020 ÷ 32.100	1.2605 ÷ 1.2637
Assembly clearance between trunnion pin and bushings	0.025 ÷ 0.125	0.0009 ÷ 0.0049
Wear limit	0.35	0.014
Interference fit of bushings (*33*) in the front axle bracket	0.050 ÷ 0.230	0.0020 ÷ 0.0090
Diameter of the steering lever pivot (*29*, Fig. VI/9)	34.975 ÷ 35.000	1.3770 ÷ 1.3780
Inside diameter of bushings (*31*) (fitted)	35.050 ÷ 35.112	1.3799 ÷ 1.3824
Assembly clearance between steering lever pivot and bushings	0.050 ÷ 0.137	0.0020 ÷ 0.0054
Wear limit	0.35	0.014
Interference fit of bushings (*31*)	0.050 ÷ 0.120	0.0020 ÷ 0.0047
Thickness of the spindle bronze thrust washers (*22*, Figs. VI/9 and VI/12) and steel ones (*23*)	3.925 ÷ 4.000	0.1545 ÷ 0.1575
Wear limit of thrust washer (*22*)	3	0.118
Thickness of trunnion pin washers (*25*, Fig. VI/9)	5.100 ÷ 5.250	0.2008 ÷ 0.2067
Wear limit	4	0.157
VII - Hydraulic lift unit.		
Hydraulic lift.		
Diameter of piston (*24*, Fig. VII/10)	94.980 ÷ 95.000	3.7394 ÷ 3.7401
Inside diameter of cylinder barrel (*25*)	95.036 ÷ 95.071	3.7416 ÷ 3.7429
Running clearance of piston	0.036 ÷ 0.091	0.0014 ÷ 0.0036
Diameter of rockshaft (*45*, Fig. VII/15) bushing locations:		
— right-hand side	54.970 ÷ 55.000	2.1642 ÷ 2.1653
— left-hand side	46.975 ÷ 47.000	1.8494 ÷ 1.8504
Inside diameter of the assembled rockshaft bushings:		
— right-hand side (*52*)	55.100 ÷ 55.170	2.1693 ÷ 2.1720
— left-hand side (*51*)	47.100 ÷ 47.170	1.8543 ÷ 1.8571
~~Assembly~~ clearance of rockshaft in bushings	0.100 ÷ 0.200	0.0040 ÷ 0.0079
Interference fit of bushings (*51* and *52*) in hydraulic lift body locations	0.020 ÷ 0.102	0.0008 ÷ 0.0040
Diameter of top link bracket trunnion (*53*, Fig. VII/3)	24.948 ÷ 25.000	0.9822 ÷ 0.9842
Inside diameter of bushings (*54*, Fig. VII/11) fitted (1)	25.020 ÷ 25.072	0.9850 ÷ 0.9871
Assembly clearance between top link bracket trunnion and bushings	0.020 ÷ 0.124	0.0008 ÷ 0.0049
Interference fit of bushings (*54*) in top link bracket	0.050 ÷ 0.230	0.0020 ÷ 0.0090
Assembly play between rock shaft and left hand bushing	0.100 ÷ 0.195	0.0039 ÷ 0.0077

(1) Ream after fitting

Continued: " Fits and tolerances "

DESCRIPTION	Size of new parts and wear limits mm	in
Thickness of rockshaft washers	3.275 ÷ 3.300	0.129 ÷ 0.130
Thickness of washers (*N*, Fig. VII/24) for the lift arms stop adjustment screw	0.45 ÷ 0.55	0.018 ÷ 0.021
Thickness of adjustment shims (H_1-H_2, Fig. VII/23) for top link bracket control spring	0.25 ÷ 0.35	0.0098 ÷ 0.0137
Assembly clearance between valve spool (*6*, Fig. VII/9) and its location (4)	0.025 ÷ 0.035	0.0010 ÷ 0.014
Assembly clearance between external ram spool (P_1, Fig. VII/33) and valve bore (4)	0.015 ÷ 0.020	0.0006 ÷ 0.0008
Specifications of drain valve spring:		
— free nominal length	22	0.87
— length under load (2.3 ÷ 2.6 kg = 5 ÷ 5.7 lb)	10	0.39
Specifications of pilot valve spring:		
— free nominal length	46	1.81
— length under load (1.8 ÷ 2.2 kg = 4 ÷ 4.8 lb)	20	0.79
Hydraulic pump (A 22 X).		
Diameter of driving and drien vshafts	17.400 ÷ 17.424	0.6850 ÷ 0.6860
Diameter of bearing bores	17.450 ÷ 17.470	0.6870 ÷ 0.6878
Running clearance of shafts in bearing bores	0.026 ÷ 0.070	0.0010 ÷ 0.0027
Wear limit	0.220	0.009
Diameter of bearing locations in pump body	37.270 ÷ 37.294	1.4673 ÷ 1.4683
Permissible wear	0.094	0.004
Drive and driven gear widths	16.323 ÷ 16.348	0.6423 ÷ 0.6436
End clearance of gears and bearings in pump body	0.100 ÷ 0.200	0.004 ÷ 0.008
Thickness of pump driving gear thrust washers (*18*, Fig. VII/35)	1.45 ÷ 1.50	0.057 ÷ 0.059
Diameter of drive gear shaft (*17*) bushing locations	36.975 ÷ 37.000	1.4557 ÷ 1.4567
Inside diameter of assembled bushings (*19*) (1)	37.050 ÷ 37.075	1.4587 ÷ 1.4596
Assembly clearance of gear shafts and bushings	0.050 ÷ 0.100	0.0020 ÷ 0.0039
Interference fit of gear bearing bushings (*19*)	0.063 ÷ 0.140	0.0025 ÷ 0.0055
VIII - Power take-off - Belt pulley.		
Gear tooth backlash:		
— P.T.O. driving and driven gears	0.100 ÷ 0.200	0.004 ÷ 0.008
— belt pulley bevel gears	0.15	0.006
Splines backlash:		
— P.T.O. engagement sliding gear and belt pulley driven gear	0.010 ÷ 0.106	0.0004 ÷ 0.0042
— P.T.O. driven gear	0.024 ÷ 0.072	0.0009 ÷ 0.0028
— belt pulley drive gear shaft with P.T.O. drive shaft	0.070 ÷ 0.166	0.0027 ÷ 0.0065
Thickness of belt pulley drive and driven gear adjustment shims (*S* and S_1), Fig. VIII/5	1.6-1.8-2-2.2-2.4 (tolerance ± 0.05)	0.063 - 0.071 0.079 - 0.087 0.094 (tol.± 0.002)

(1) Ream after fitting.

(4) At assembly, control valve spools are suitably selected and fitted by grinding and polishing to the correct clearance.

TORQUE SPECIFICATIONS

DESCRIPTION	Size and thread (metric)	Ultimate strength of material kg/mm² (1)	TORQUE kgm	TORQUE Lb.ft
0 - Frame, mudguards, floorplates and drawbar.				
Capscrew, floorplate front	10 × 1.25	80-Zinc plate	6	43.4
Capscrews, radiator supporting bracket	12 × 1.25	80-Zinc plate	10.5	75.9
Capscrews, mudguards to supporting brackets	12 × 1.25	80-Zinc plate	10.5	75.9
Capscrews, floorplate rear	12 × 1.5	80-Zinc plate	9.5	68.7
Capscrews, mudguards supporting brackets	14 × 1.5	80-Zinc plate	16	115.7
Nuts, mudguard brackets	14 × 1.5	50-Zinc plate (brackets: 50)	8.5	61.5
Capscrews, trailer brake mounting	16 × 1.5	80-Zinc plate	23	166.4
Capscrews, front hitch clevis (optional)	16 × 1.5	80-Zinc plate	23	166.4
Nuts, trailer hitch bridge (optional)	18 × 1.5	50-Zinc plate (rod: 80)	31.5	227.8
Bolt nuts, drawbar (optional)	18 × 1.5	80-Zinc plate (bolts: 100-Zinc plate)	46	332.7
Bolt nuts, drawbar (optional) plate lower attachment	20 × 1.5	50-Zinc plate (bolts: 80-Zinc plate)	46	332.7
Bolt nuts, drawbar (optional) plate upper attachment	20 × 1.5	80-Zinc plate	46	332.7
I - Clutch.				
Capscrews securing 11" LUK or O.M.G. clutch to engine flywheel (C_4, Fig. I/26)	8 × 1.25	80-Zinc plate	2.4	17.3
Capscrews securing FERODO clutche to engine flywheel (C_4, Figs. I/11 and I/14)	10 × 1.25	80-Zinc plate	6	43.4
Capscrews, 11" FERODO clutch cover (C_6, Figs. I/5, I/14)	10 × 1.25	100	6.3	45.6
Capscrews, clutch transmission housing to engine crankcase:				
— housing to crankcase upper capscrews (C_3, Figs. I/11 and I/19)	12 × 1.25	80-Zinc plate	10.5	75.9
— crankase to housing side and lower capscrews (C_5, Figs. Figs. I/11 and I/19)	12 × 1.25	80-Zinc plate	10.5	75.9
Capscrews, fuel tank support:				
— capscrews, front, support to crankcase (C_7, Fig. I/3)	12 × 1.25	80-Zinc plate	10.5	75.9
— capscrews, rear, support to clutch-transmission housing (C_8)	12 × 1.25	80-Zinc plate	10.5	75.9
Setscrews, clutch release forks (C_{12}, Figs. I/11, I/19, and II/12)	16 × 1.5	80-Zinc plate	21	151.9
II - Transmission.				
Capscrews, transmission housing cover	8 × 1.25	80-Zinc plate	2.6	18.8
Stud nuts, shafts front bearing caps (C_2, Fig. II/21)	8 × 1.25	50-Zinc plate (Studs: 50)	1.75	12.6

(1) Strength of material are in Kg/mm².

Continued: " Torque specifications "

DESCRIPTION	Size and thread (metric)	Ultimate strength of material kg/mm²	TORQUE kgm	TORQUE Lb.ft
Capscrews, gearbox cover (C_3, Fig. II/19)	8 × 1.25	80-Zinc plate	2.6	18.8
Capscrews, selector plate return spring bracket (C_4, Figs. II/22 and II/39)	8 × 1.25	80-Zinc plate	2.6	18.8
Capscrews, auxiliary speed reduction unit shifter fork bar support (C_6, Figs. II/19 and II/23)	10 × 1.25	80-Zinc plate	6	43.4
Capscrews, epicyclic unit fixed gear (C_9, Figs. II/19 and II/23)	12 ÷ 1.5	80-Zinc plate	9.5	68.7
Bolt and stud nuts, gearbox and transmission housing (C_{10}, Fig. II/31)	12 × 1.5	50-Zinc plate (studs: 80, bolts: 80-Zinc plate)	10	72.3
Capscrew, oil pump suction pipe (C_{11})	12 × 1.5	80-Zinc plate	9.5	68.7
Locknut, driven gears shaft (C_{13})	24 × 1.5	60 (shaft: 80)	31.5	227.8
III - Bevel gear and differential.				
Capscrews, P.T.O. shaft bearing retaining plate (C_1, Fig. III/3)	8 × 1.25	80-Zinc plate	2.6	18.8
Bolt nuts, bevel gear to differential (C_2, Figs. III/5 and III/6)	12 × 1.25	100-Zinc plate (bolts: 80)	12	87
Capscrews, differential bearing housings (C_4, Figs. III/6 and III/15)	10 × 1.25	nuts 50-Zinc plate screws 80 Zinc plate	6	43.4
Capscrews, differential lock pedal bracket	10 × 1.25	80-Zinc plate	6	43.4
Locknut, bevel gear pinion shaft (C_3, Figs. III/5, III/6 and III/10)	40 × 1	60 (Shaft: 80)	36	260.4
IV - Brakes.				
Screw, outside lever bracket (C_1, Fig. IV/1)	8 × 1.25	80-Zinc plate	2.6	18.8
Setscrew, left brake pedal (C_2)	16 × 1.5	80-Zinc plate	21	151.9
Setscrew, inside levers (C_3, Figs. IV/1 and IV/2)	16 × 1.5	80-Zinc plate	21	151.9
V - Final drives and sprocket wheel.				
Capscrews, final drive housing covers (C_1, Figs. V/1 and V/7)	10 × 1.25	80-Zinc plate	6	43.4
Capscrews, driven gear outer bearing washers (C_2, Figs. V/7 and V/8)	10 × 1.25	80-Zinc plate	6	43.4
Capscrews, final drives to transmission housing (C_3, Fig. V/7)	12 × 1.5	80-Zinc plate	9.5	68.7

Continued: " Torque specifications ".

DESCRIPTION	Size and thread (metric)	Ultimate strength of material kg/mm²	TORQUE (¹) kgm	TORQUE (¹) Lb.ft
Bolt nuts, wheel rims (C_4, Fig. V/7)	16 × 1.5	80-Zinc plate (bolts 100) cadium plate)	24	173.6
Capscrews, drive wheel discs (C_5)	16 × 1.5	100 - Cadium plate	34.5	249.53
Nut, brake drums (C_6)	38 × 1.5	50 (Shaft: 80)	18	130.2
Nut, final drive bull gear (C_7)	55 × 1.5	60 (Shaft: 100)	95	687.1
VI - Steering and front wheels.				
Capscrews, steering box cover (C_2, Figs. VI/1 and VI/4)	10 × 1.25	80-Zinc plate	4.5	32.5
Capscrews, steering box side cover (C_3, Figs. VI/4 and VI/6)	10 × 1.25	80-Zinc plate	4.5	32.5
Bolt nut, steering tie rods (C_5, Fig. VI/7)	10 × 1.25	50-Zinc plate (bolts: 80-Zinc plate)	6	43.4
Setscrews, steering lever pivot flange (C_{10}, Figs. VI/9 and VI/10)	10 × 1.25	80-Zinc plate	6	43.4
Setscrew, front axle trunnion pin (C_7, Figs. VI/7 and VI/9)	12 × 1.25	80-Zinc plate	9.5	68.7
Bolt nut, steering levers (C_9, Fig. VI/7)	12 × 1.25	50-Zinc plate (bolts: 80-Zinc plate)	9.5	68.7
Blocking screw nut, steering lever to socket ball (C_6)	14 × 1.5	50-Zinc plate (rod: 90)	5.5	39.8
Capscrews, front wheel discs (C_{11}, Fig. VI/9)	14 x 1.5	80 - Zinc plate	13	94
Self-locking screws, steering box to gearbox (C_1, Figs. VI/1 and VI/4)	16 × 1.5	80-Zinc plate	20	144.6
Setscrew, steering lever (C_{12}, Fig. VI/9)	16 × 1.5	80-Zinc plate	21	152
Capscrews, front axle bracket (C_{14})	16 × 1.5	80-Zinc plate	23	166.4
Setscrew nuts, beam extension (C_{15}, Fig. VI/7)	16 × 1.5	50-Zinc plate (screws: 80-Zinc plate)	23	166.4
Nut, steering wheel	20 × 1.5	50-Zinc plate	9	65.1
Nut, front wheel hubs (C_{13}, Fig. VI/9)	20 × 1.5	80-Zinc plate (rod: 80)	25	180.8
Nut, steering arm (C_4, Fig. VI/4)	7/8″-14 UNF	80 (Shaft: 80)	19	137.4
VII - Hydraulic lift and linkage.				
Hydraulic lift.				
Nut, cam roller excentric pin (*19*, Fig. VII/29)	8 × 1.25	80-Zinc plate (Pin: 110)	3.1	22.4
Stud nut, control valve to lift body (C_1, Fig. VII/3)	10 × 1.25	50-Zinc plate (Stud: 80)	6	43.4
Stud nuts, hydraulic lift rear cover (*16*, Fig. VII/11)	12 × 1.5	80-Zinc plate (Stud: 100)	14	101.26

(¹) All torque values in this table are calculated for threads lubricated with motor oil.

Continued: " Torque specifications ".

DESCRIPTION	Size and thread (metric)	Ultimate strength of material kg/mm²	TORQUE (1)	
			kgm	Lb.ft
Capscrews, control spring to top link bracket and rear cover (C_2, Fig. VII/3)	14 x 1.5	100	16	115.7
Screw, lift arm retaining plate (C_3)	14 × 1.5	80 -Zinc plate	10	72.3
Stud nuts, control valve to hydraulic lift (C_4) . .	14 × 1.5	50-Zinc plate (Stud: 80)	16	115.7
Stud nuts, hydraulic lift to tractor (C_5) . . .	14 × 1.5	50-Zinc plate (Stud: 80)	16	115.7
Capscrews, hydraulic lift to tractor	14 × 1.5	80-Zinc plate	16	115.7
Cylinder pressure safety valve (3)	24 × 1.5	80	3.5	25.3
Plug, pump valve (C_6)	24 × 1.5	80	6.5	47
Hydraulic pump.				
Capscrews, pump to timing gear case cover (C_1, Fig. VII/35)	6 × 1	80-Zinc plate	1.1	8
Bolt nuts, pump covers (C_2, Fig. VII/34) . . .	3/8″-24 UNF	80 (bolts: 80)	4.2	30.4
Nut, drive coupling to shaft (C_3)	7/16″-20 UNF	80 (Shaft: 110)	2.8	20.2
VIII - Power take-off - Belt pulley.				
Capscrews, belt pulley housing cover (C_5, Fig. VIII/4)	8 × 1.25	80-Zinc plate	2.6	18.8
Capscrews, transmission housing rear cover (C_1, Figs. VIII/1 and VIII/3)	12 × 1.5	80-Zinc plate	10	72.3
Capscrews, belt pulley to driven shaft (C_6, Figs. VIII/5 and VIII/6)	12 × 1.5	80-Zinc plate	9.5	68.7
Capscrews, belt pulley drive unit (C_3, Figs. VIII/1, VIII/3 and VIII/4)	14 × 1.5	80-Zinc plate	16	115.7
Capscrews, transmission housing rear cover (C_2, Figs. VIII/1 and VIII/3)	16 × 1.5	80-Zinc plate	23	166.4
Nut, P.T.O. driven shaft gear (C_4, Fig. VIII/3)	22 × 1.5	60 (Shaft: 80)	26	188
Nut, belt pulley driven gear (C_7, Figs. VIII/5 and VIII/6)	22 × 1.5	60 (Shaft: 60)	26	188

(1) All torque values in this table are calculated for threads lubricated with motor oil.

SERVICE TOOLS

Tool Number	DESCRIPTION
I - Clutch.	
291184 **A 517063 L**	- Alignment and fitting spigot for 11" clutch (FERODO, LUK or O.M.G.) on engine flywheel (Figs. I/4, I/13 and I/26).
291187 **A 517106**	- Adjusting wrench for 11" P.T.O. clutch lever links.
291291/2	- Clutch adjuster (Figs. I/8 and I/22).
293650	- Universal clutch adjuster. (Figs. I/9 and I/21).
II - Transmission.	
292909 **A 323126**	- Sliding weight type puller (Figs. II/25 and II/30).
292911 **A 537105**	- Universal puller (Fig. II/30).
290090 **2216/F**	- Turnover overhauling stand (Fig. II/19)
III - Bevel gear and differential.	
290786 **A 137010**	- Gauge, bevel pinion cone center distance (Figs. III/12, III/13 and III/14).
290870 **A 287033**	- Installation tool, differential lock shifter fork (Figs. III/7 and III/8).
291052 **A 511100/115**	- Split-type bearing puller (Fig. III/4).
292904 **A 517010/160**	- Universal puller (Fig. III/4).
292911 **A 537105**	- Universal puller (Fig. III/4).
291269 **A 711041/2**	- Torque wrench (0÷2 kgm) for bevel gear adjustment check (Figs. III/11 and III/16).
290090 **2216/F**	- Turnover overhauling stand

Tool Number	DESCRIPTION
293101	- Tool, bevel gear pinion bearings setting.
293342	- Wrench for bevel pinion securing locknut.
V - Final drives and sprocket wheels.	
291052 **A 511100/A 115**	- Split-type bearing puller (Fig. V/6)
291230 **A 587023**	- Gear stop, final drive driven gear (Fig V/3)
VI - Steering and front wheels.	
290792 **A 147018**	- Puller, steering linkage ball joints.
292927 **A 147022 ter**	- Puller, front axle trunnion (Fig. VI/8).
292909 **A 323126**	- Sliding-weight puller (Figs. VI/3, VI/10)
A 443018	- Puller, steering arm (Fig. VI/1)
292911 **A 537105**	- Universal puller (Figs. VI/2 and VI/11).
291269 **A 711041 2**	- Torque wrench (0÷2 kgm) for bevel gear adjustment check (Fig. VI/5).
290238 **Ap 5106 P**	- Checking apparatus, tractor steering radius (Fig. VI/15).
VII - Hydraulic lift and linkage - Hydraulic lift	
290284 **A 12131**	- Hand pump, valve testing and calibration (Fig. VII/31).
290692 **A 92027**	- Drive bar, top link bracket bushing (**54**, Fig. VII/11)
290702 **A 94048**	- Drive bar, rockshaft left-side bushings (**51**, Fig. VII/15b).

Tool Number	DESCRIPTION
A 95058 290706	- Drive bar, rockshaft right-side bushings (52).
A 197003/A 290817	- Protection for rockshaft seal disassembly (assembly) (Fig. VII/12).
A 197003/B 290818	- Drive bar, rockshaft seal installation (Fig. VII/17).
A 197016 bis 290819	- Test bar, hydraulic lift setting check (Fig. VII/23).
A 197032/B 290824	- Adaptor, pressure relief valve (Fig. VII/31).
A 197032/D 290826	- Adaptor, safety valve.
A 197036 290834	- Adaptor, drain valve.

Tool Number	DESCRIPTION
A 695112 291259	- Wrench, cylinder oil inlet valve plug removal (installation).
A 711500 291314	- Universal pressure gauge and fittings set for hydraulic circuitry working pressure tests (Fig. VII/30).

VIII - Power take-off - Belt pulley.

290090 - 2216/F	- Turnover overhauling stand (Fig. VIII/2).

VII - HYDRAULIC LIFT - A 22X PUMP

291233	Diesel engine drive unit.
291235	Electric motor drive unit.
290385	Drive coupling for pump.

Test bench 291231	Test bench 292574	
		Adaptor for pumps:
290419	290331	- suction side
290418	290330	- pressure side
		Reductions:
290448	-	- suction side
		Flexible hoses:
290445	290424	- suction side
290447	290424	- pressure side
		Attachment screws for adaptors:
290436	290359	- suction side
290434	290358	- pressure side

ELECTRICAL SYSTEM

ELECTRICAL SYSTEM

DESCRIPTION

The electric current generating, starting and lighting plant functions at 12 V (Fig.23).

The current generator is a self-rectifying, 3 phase alternator.The charging plant inclu= des a voltage regulator of the vibrating-con tacts type and a magnetic switch which controls a dashboard-mounted,redlight warning lamp. The 12 V. battery is provided with self-level ling, splash-proof plugs.

The starting motor is of the solenoid control type with armature axial drive.

The headlamps are provided with spring mounts.

Rear floodlight with built-in switch is optional.

All lights and equipment are protected by proper fuses.

I - BATTERY CHARGING PLANT

The battery charging plant (Fig.1)includes the following units: alternator, voltage re gulator and magnetic switch.

A red warning light (18,Fig. 20),which is installed on the instrument panel, signals trouble that eventually develops in the system.

SPECIFICATIONS AND DATA

Alternator	
Type (3-phase, self-rectifying) and model	FIAT A 12 M-124/12/42 M
Nominal voltage	12 V
Rotation (pulley end)	clockwise
Cut-in speed at 12 V (20 °C = 68° F) (*)	950 to 1050 r.p.m.
Current output delivered to battery at 14 V, 5000 r.p.m. and at operating temperature (*)	Not less than 42 amp
Max. current (*)	53 amp (approx.)
Field winding resistance at 20 °C (68° F):	
— across collector rings	41 to 45 ohms
— across connection 67 and ground at 500 r.p.m.	4.5 to 4.8 ohms
Resistance of each armature statoric phase	0.11 ± 0.005 ohms
Brush spring pressure (unworn brushes)	0.43 Kg (0.95 lb)

(*) These data apply to alternators with properly bedded brushes.

Voltage regulator	
Model	FIAT - RC 2/12 B
Alternator speed for checking and setting purpose	5000 r.p.m.
Battery capacity	40 to 50 amp. hr
Thermic stabilization current	7 amp
2nd stage test current	2 to 12 amp
2nd stage setting voltage	13.9 to 14.5 Volts
1st stage test current	25 to 35 amp
1st stage setting voltage	less than 2nd stage voltage by 0.2 to 0.7 V
Resistance between terminal "15" and ground	26 to 30 ohms
Resistance between terminals "15" and "67" with open contacts	5.35 to 5.95 ohms
Armature air gap	1.45 to 1.55 mm (0.057 to 0.061 in)
Gap between contacts of the 2nd stage	0.35 to 0.55 mm (0.014 to 0.022 in)
Magnetic switch	
Excitation winding resistance	27 to 31 ohms
Contact opening voltage	4.9 to 5.7 volts

ALTERNATOR

The FIAT alternator is a self-rectifying three-phase generator (Fig.2) and is belt-driven by the fan pulley.

The rotor revolves on sealed ball bearings.

The diode rectifiers are installed on the support opposite the drive end.

The internal cooling of the alternator is assured by a centrifugal fan, coupled to the drive pulley.

OVERHAUL

Remove the alternator from the tractor and disassemble on the workbench after removing the nut (C_2, Fig. 2) securing the drive pulley, the pulley and the bracket through rod nuts (C_1).

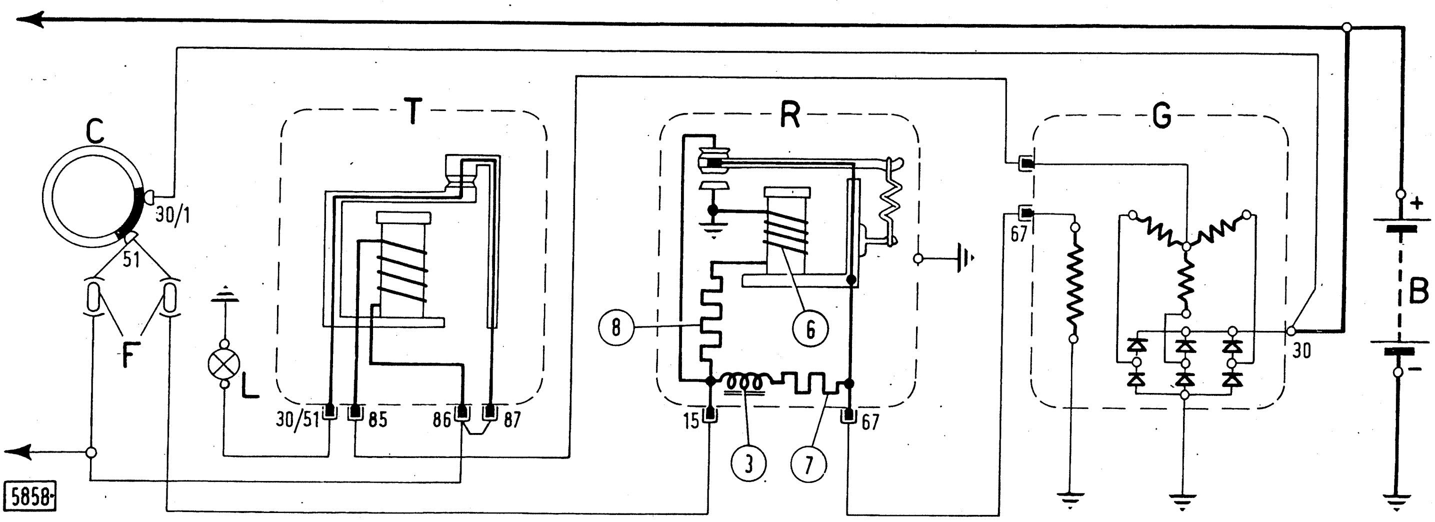


Fig. 1 - Battery charging plant and components wiring diagrams.
B. Battery. - C. Switch set in tractor travel position. - F. Fuses. - G. Alternator. - L. Warning light. - R. Voltage regulator. - T. Magnetic switch. - 3. Auxiliary inductance coil. - 6. Magnetic ring coil. - 7. Regulation resistance. - 8. Magnetic ring coil additional resistance.

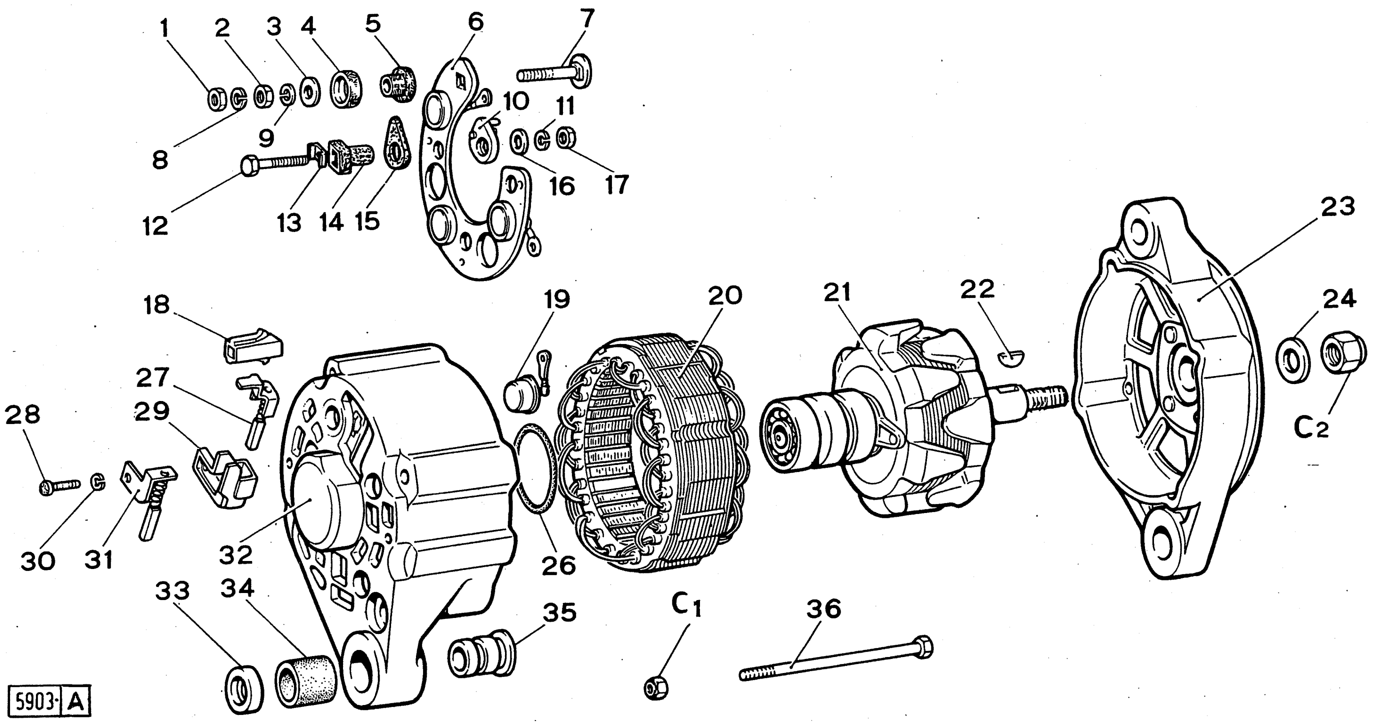


Fig. 2 - Exploded view of the alternator.

C_1. Through bolt nut. - C_2. Pulley nut. - 1 and 2. Nuts. - 3. Plain washer. - 4 and 5. Positive terminal insulators. - 6. Positive diode plate. - 7. Positive terminal screw. - 8 and 9. Lockwashers. - 10. Diode lead terminal insulators. - 11. Lockwasher. - 12. Diode and stator winding lead plate (6) screw. - 13. Insert. - 14 and 15. Insulators. - 16. Plain washer. - 17. Nut. - 18. Alternator charge signal blade terminal insulated connector. - 19. Negative rectifier diode. - 20. Stator. - 21. Rotor. - 22. Tongue. - 23. Drive end plate with bearing. - 24. Lockwasher. - 26. Bearing outer race sealing ring. - 27. Positive brush. - 28. Screw. - 29. Brush holder. - 30. Lockwasher. - 31. Negative brush. - 32. Rectifier diode end plate. - 33, 34, 35. Details of alternator swing mount sleeve. - 36. Through bolt.

Withdraw the stator from the diodes-end bracket, after disconnecting from their respective terminals the stator winding leads and withdrawing the battery charging warning light blade-type plug.

Check diode efficiency bearing in mind that in case of one or more defective positive diodes the plate (6) with diodes must be replaced as an assembly, whilst the negative diodes, when damaged, can be replaced on the alternator end plate by others of the same polarity. Replace the negative diodes as follows:

a) the diode replaced must be of the type available as a spare just for the purpose. These diodes, besides the

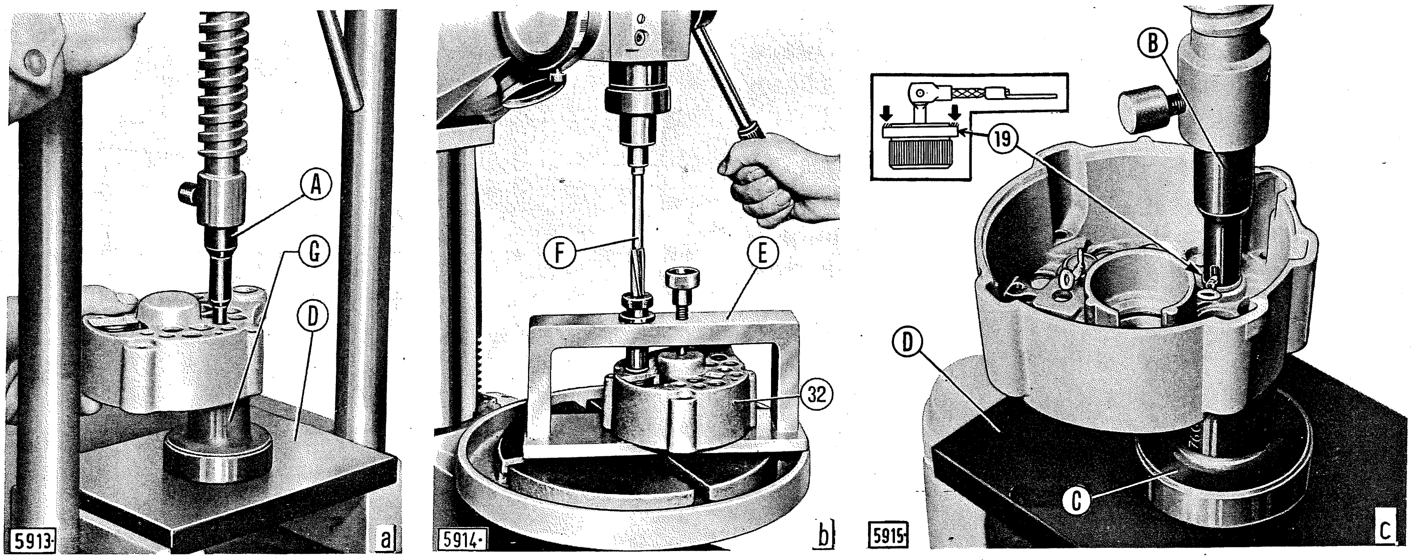


Fig. 3 - Removing the negative diode rectifiers (a), reaming their housing bores (b) and fitting them (c) by means of the handpress M 166 and brench drill (drill speed 1000 r.p.m.).

(Arrows in detail (c) show the correct application of the tool for diode fitting) - A. Diode removal tool - B. Diode fitting tool - C. Diode installation anvil - D. Supporting plate - E. Diode end plate holding fixture - F. Diode housing bore reamer - G. Diode removal anvil - 19. Diode rectifier - 32. Diode end plate.

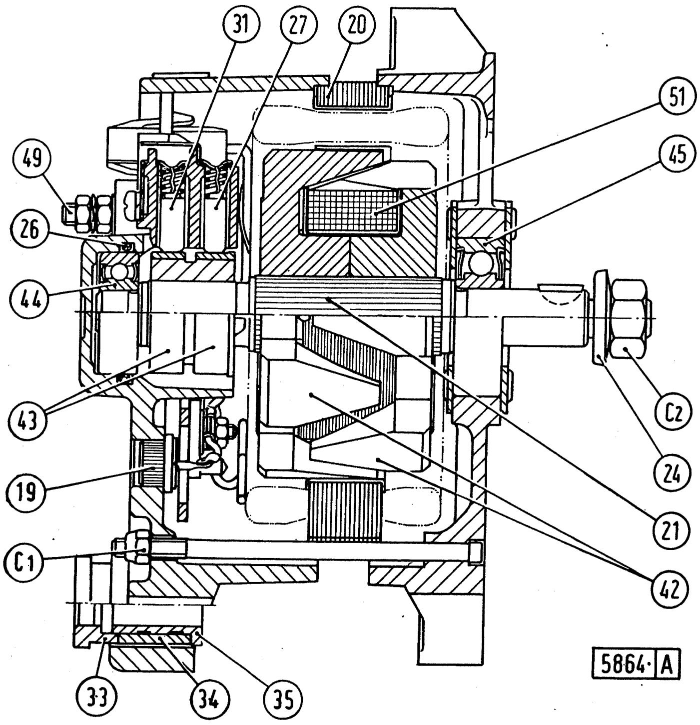


Fig. 4 - Alternator cross section.
C_1. Through bolt nut. - C_2. Pulley nut. - 19. Negative rectifier diode. - 20. Stator laminations stack. - 21. Rotor. - 24. Lockwasher. - 26. Bearing outer race sealing ring. - 27. Positive brush (connected to terminal " 67 "). - 31. Negative brush. - 33, 34, 35. Details of alternator swing-mount sleeve. - 42. Rotor poles. - 43. Slip rings. - 44. Diode end ball bearing. - 45. Drive end ball bearing. - 49. Positive terminal " 30 ". - 51. Rotor winding.

designations, are marked with the letter " R " stamped on the container case, and, furthermore, the diameter of the knurled section is about 0.5 mm (0.020 in) larger (13.24 to 13.31 mm instead of 12.73 to 12.80 mm, or 0.521 to 0.634 in instead of 0.475 to 0.503 in);

b) rebore the discarded diode locating hole before fitting the new diode , to 13.12 to 13.16 mm dia. (0.517 to 0.518 in).

The special tooling illustrated in Fig. 3 has been designed to avoid the possibility of damaging the parts at disassembly, reaming and press-fitting. Check brushes for wear and, eventually, replace them together with their holder.

At reassembly refer to Figure 4 and besides:

— pay attention to the concentricity of the two holes for the alternator mounting trunnion;

— pay a particular attention to the installation of the brush-holder to make sure that each brush bears with its whole surface flat over the slip ring;

— be sure to fit the safety cone-washer of the alternator driving pulley with the dished-in side facing the pulley.

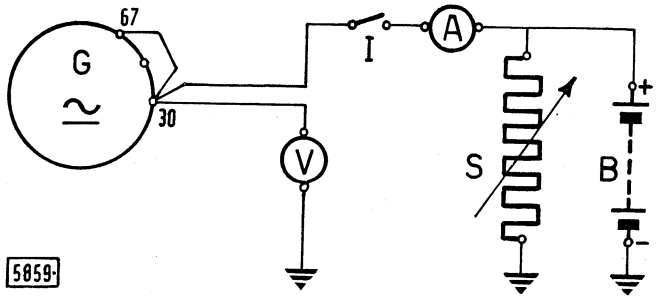


Fig. 5 - Wiring diagram for output tests.
A. Ammeter. - B. Battery. - G. Alternator under test. - I. Switch. - S. Reostat. - V. Voltmeter.

At installation, adjust the alternator belt tension by suitably moving it on its mounting bracket, until a belt slack of 1 to 1.5 cm (0.39 to 0.59 in) is obtained by applying a pressure of 5 to 7 Kg (11 to 15.5 1b) between crankshaft and alternator pulleys.

ALTERNATOR BENCH TEST

To verify the alternator efficiency (see table of data), measure:

— output current at 14 V and operating temperature (diagram of Fig. 6) on the test bench and with connections made as shown in Figure 5 ;

— total resistance of the rotor magnetizing coil, measured between terminal " 67 " and ground at 500 r.p.m.;

— resistance of each phase of the armature winding, disconnecting the phase leads from the diode ones and measuring it between each phase and star center lead.

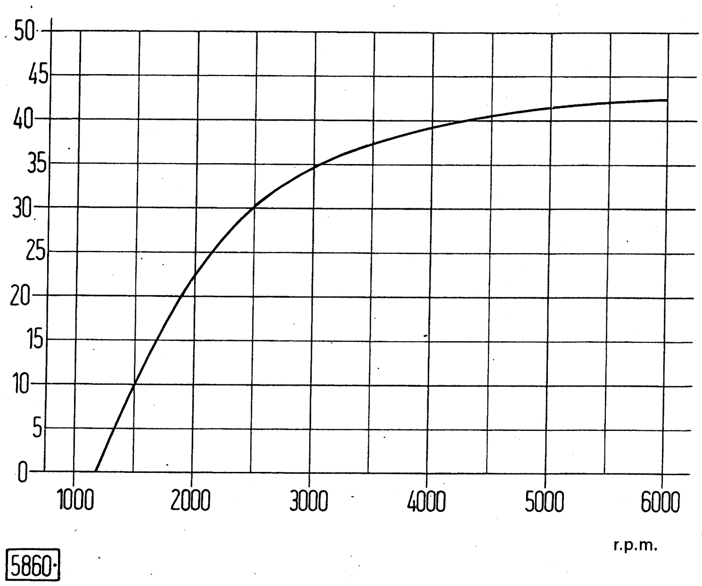


Fig. 6 - Minimum output curve at operating constant voltage of 14 V and bedded brushes.

Note - For the new alternators equipped with diode end bearing (44, Fig.4) without sealing, and only one slip ring side gasket, at reassembly, refill the bearing with FIAT grease type MR3.

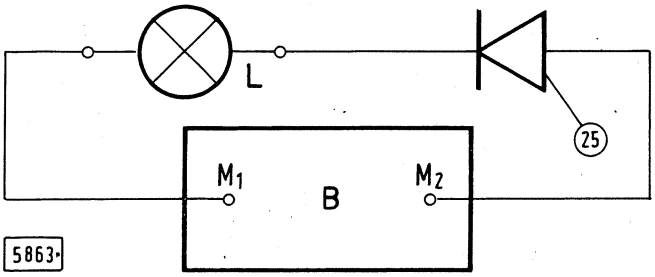


Fig. 7 - Wiring diagram of spy circuit for rectifier diode testing.

B. Battery. - L. Spy light. - M_1 and M_2. Battery terminals. - 25. Diode under test.

Diode rectifiers

The diode rectifiers adopted for the alternator are silicon units of the injection type and made by I.R.C.I. and SIEMENS.

The diode designations are as follows:

— positive diodes: I.R.C.I. "4 AF 2"; SIEMENS "E 11" (red designation).

— Negative diodes: I.R.C.I. "4 AF 2"; SIEMENS "E 12" (black designation).

To check the efficiency of the rectifier unit make sure that the single diodes are exempt from the following defects:

— interrupted (in which case they will not allow the flow of current in both directions);

— short-circuited (under this condition the diode allows the current to flow in both directions).

Wire up as shown in Fig. 7 and reverse the terminal connections (M_1 and M_2) to the battery.

The diode can be considered efficient when the light goes on with only one battery connection and remains out with the other.

A similar check can be carried on by means of a "tester" which is a device with low voltage feeding from a cell or storage battery.

This device allows two resistance readings: one across the diode case and insulated terminal, and the other across insulated terminal and container.

The diode can be considered efficient if it shows no resistance (or very low) in one direction and extremely high (> 100.000 Ohms) in the opposite direction.

Important - To avoid damaging the diodes never check them on a test rig by means of A. C. circuits with 110 V or more.

VOLTAGE REGULATOR

The voltage regulator is a vibrating-contact unit with double regulation stage. (Fig. 8).

The regulator identification data are stamped on the base plate insulation.

No component of the voltage regulator or part thereof is supplied for spare parts service, therefore, the complete unit must be replaced when functioning irregularly and the calibrating data found in the course of the bench tests do not meet specification requirements (calibration is suggested only in exceptional cases).

See Fig. 1 for wiring diagram of regulator and its connections.

Bench test data are reported in the table on page 188

For this purpose, wire up the voltage regulator as shown in Figure 9 warm it up to operating temperature, then check the 2nd and successively the 1st regulation stage under the specified current conditions.

Important - Do not let the voltage regulator function with the switch (I, Fig. 9) open, i.e., with the battery disconnected, as this might damage the regulator contacts.

If setting is required, this can be done by loading or slightly unloading the spring (13, Fig. 8) depending on whether the voltage reading is respectively lower or higher than specified. If this adjustment does not give satisfactory results, it will also be possible to adjust by either increasing or reducing the air gap between armature and core (by raising or lowering the fixed contact of the 1st stage after slackening the nut 19). Make sure to keep the contacts centered and re-establish the original gap (0.35 to 0.55 mm = 0.014 to 0.022 in) between contacts of the 2nd stage.

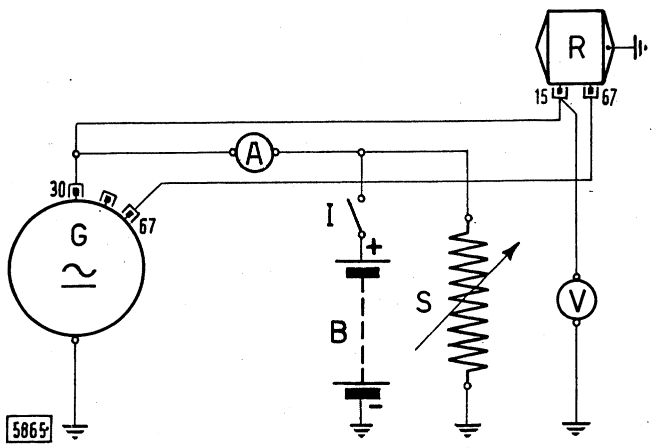
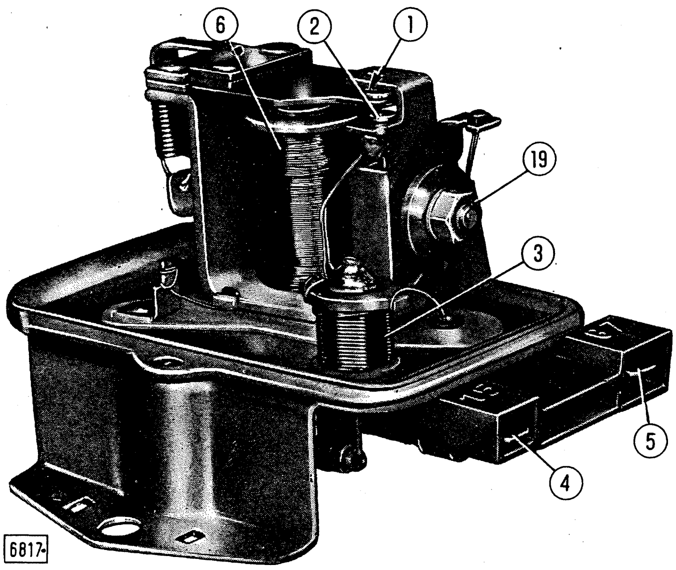


Fig. 9 - Voltage regulator test wiring diagram.

A. Ammeter. - B. Battery. - G. Alternator (A 12 M - 124/12/42 M). - I. Cut-out. - R. Voltage regulator under test. - S. Rheostat. - V. Voltmeter.



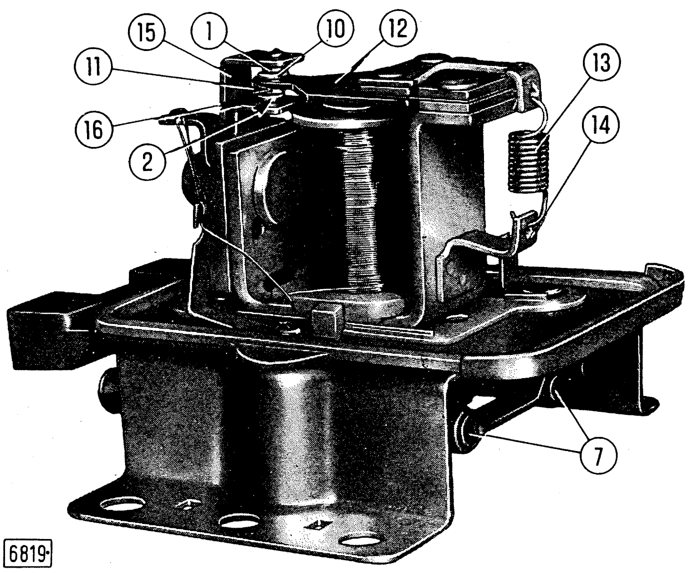


Fig. 8 - Side views of voltage regulator without cover.

1. Fixed contact of first regulation stage. - 2. Fixed contact of second regulation stage. - 3. Auxiliary inductance coil. - 4. Blade plug " 15 ". - 5. Blade plug " 67 ". - 6. Magnetizing coil. - 7. Regulation resistors. - 10. Movable contact of first regulation. - 11. Movable contact of second regulation stage. - 12. Armature. - 13. Calibration spring. - 14. Calibration spring mounting bracket (this bracket must be deformed to adjust the spring loading). - 15 and 16. First and second stage fixed contact holders. - 19. First and second stage fixed contact holders locknut.

MAGNETIC SWITCH

The magnetic switch (Fig. 10) serves to signal any trouble which has developed in the alternator charging system through the lighting of a red warning lamp.

Its wiring diagram and connections are shown in Fig. 1.

Identification data are stamped on the cover. Specifications are reported in the table of data. If actual performance does not meet specification requirements, then replace the complete unit.

IMPORTANT NOTES AND CAUTIONS

The battery is connected to the alternator charging circuit always with the correct polarity (" + " terminal connected to terminal " 30 " of the alternator). Should the battery be connected to the charging circuit under conditions of inverse current the diode rectifiers will be damaged.

The same caution is to be kept in mind if an external battery is used to start the tractor engine.

When the tractor-installed battery is to be re-charged by external equipment be sure to disconnect the battery from the tractor charging plant. If not, the alternator diode rectifiers may be damaged.

The alternator should never be operated with battery disconnected from the terminal " 30 " of the alternator, which may result into damage of the diode rectifiers.

To check if the alternator is functioning correctly, always use the voltmeter and ammeter. Never short-circuit the terminal " 30 " of the alternator, neither to ground nor toward the terminal " 67 ".

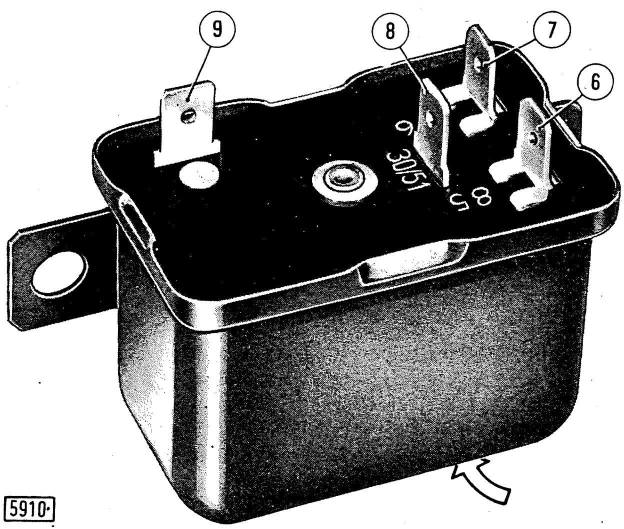


Fig.10 - Magnetic switch bottom view.

(Arrow shows the position where the switch identification data are marked).

6. Blade terminal " 85 ". - 7. Blade terminal " 86 ". - 8. Blade terminal " 30/51 ". - 9. Blade terminal " 87 ".

The stator of the alternator can be subjected to insulation tests at a high voltage rate (greater than 50 V) on the test rig only. However, before attempting these tests, be sure to disconnect the diode rectifiers from the stator phases. If not, the diode rectifiers will be irremediably damaged.

To check if the voltage regulator or the alternator are functionally efficient, never short the terminals "15" and "67" of the voltage regulator. When this is done, there will be a short which burns the fuse and may damage the contacts of the voltage regulator.

The ground connection across engine and frame must always function efficiently.

The check of ground efficiency may be done by inserting a voltmeter across engine and the negative post of the battery, with the engine running at medium speed and headlights on: the voltmeter should show no voltage drop.

The cable which is to be connected to the blade terminal "67" of the alternator must not be exchanged with the cable which is to be connected to the star centre of the alternator (unmarked blade terminal). Should there occur an inversion of contacts, the regulator fuse is interrupted and the contacts of the regulator may be damaged. In the latter case the voltage regulator shall be replaced.

Should any cable of the charging plant be replaced, make sure that the new cables are of the same section and length of the original ones.

The wrong connection of the cable connected to the terminal "15" of the voltage regulator with the cable connected to the blade terminal "67" and viceversa causes the contacts to deteriorate quickly.

When the quoted cables are exchanged of place, the voltage regulator unit must be replaced.

No addition should be made of extra units or equipment drawing current from the electric circuit between the alternator and voltage regulator (that is, from the cable between the terminal "30" of the alternator and the switch, from the terminal "51" of the switch and from the cable between the switch and voltage regulator).

In fact, under these conditions, the alternator voltage rises impairing the life of the electrical equipment and battery. The addition of electrical units or equipment is made by drawing current from other circuits.

TROUBLE-SHOOTING CHART

When the charging plant is working correctly, the warning light behaves as follows:

— with the starting and lighting switch in position I (travel position), for the insertion of the lighting and warning light circuits, the warning lamp lights up;

— when the engine is started, the warning light goes out and will not go on if the engine is accelerated.

If trouble exists, then it will show up as quoted in the trouble-shooting guide below.

TROUBLE	POSSIBLE CAUSE	LOCATION AND REMEDIES
A. With the lighting and starting (main) switch in position I (travel position) the warning light goes on. As the engine is started, the warning lamp stays lighted even if the engine is accelerated, or goes out and, successively, goes on at certain alternator speeds and at certain current absorbtion levels by the electrical equipment.	**1. Voltage regulator fuse (8 amp) broken off.**	**Locate and eliminate the shortcircuit which has burnt the fuse and check the instruments and components of the charging plant protected by this fuse, that is: voltage regulator, alternator rotor induction winding and connections. Then, replace the burnt fuse.**
	2. Broken off circuit between blade terminal "15" of voltage regulator and junction "51" of the switch, or broken off connection between alternator terminals "67" of alternator and voltage regulator.	**Check continuity of circuits, replace any broken-off cables and correct junction defects, if any.**
	If trouble persists, it is possible to locate it by checking as specified at the foot of this table.	

TROUBLE	POSSIBLE CAUSE	LOCATION AND REMEDIES
	3. Misadjusted voltage regulator. First stage contacts oxidized or dirty. Stuck contacts (welded) of the second stage.	Check the voltage regulator.
	4. Defective or misadjusted magnetic switch.	Check the magnetic switch.
	5. Break-off, or short circuit to ground, of the alternator rotor induction winding, or of slip ring connections. One or more positive rectifiers is short-circuited. Stuck or worn-out brush, or brushes.	Check the alternator. Replace the rectifier diode end plate as an assembly. Check brushes and, if necessary, fit new factory spares.
	6. Broken-off connection between star center and alternator star center blade terminal, or broken-off connection between this terminal and terminal " 85 " of the magnetic switch.	Check continuity of circuits, correct any insulation defects and, if necessary, replace the cable between alternator star center and magnetic switch blade terminal " 85 ".
B. When the lighting and starting switch (master switch) is set on I (travel position) the warning light does not go on. The warning light stays off even when the engine is started.	1. Broken-off filament of warning light bulb.	Replace the lamp.
	2. Broken-off connection between battery and terminal " 30 ". Broken-off connection between the alternator terminal " 30 " and switch junction " 30/1 ". Broken-off warning light connections.	Check continuity of all circuits, replace broken-off cables and reestablish correct junctions.
	3. Wear or oxidization of switch contacts of circuits " 30/1 " and " 51 ".	Check the starting and lighting switch contacts leading to blade terminals " 30/1 " and " 51 ". If contacts are worn, replace the switch. If oxidized, just remove oxidation.
	4. Defective magnetic switch.	Check the magnetic switch.
	5. One or more short-circuited alternator negative diode rectifiers. Grounded stator winding phase. Inside connection of the alternator between star center and blade terminal short-circuited to ground, or same condition on lead between the quoted blade terminal and terminal " 85 " of magnetic switch.	Check the alternator. Replace the short-circuited negative diodes. Check the cable between the alternator center star blade terminal " 85 " of magnetic switch and eliminate insulation defects or replace the cable,
C. When the lighting and starting switch (master switch) is set in I (travel position) the warning light does not go on. When engine is started, the warning lamp gives off a weak light which remains so even if the engine is accelerated.	1. Broken-off cable between the switch junction " 51 " and magnetic switch blade terminal " 86 ".	Check the cable and terminal any functional defective of replace it.
	2. Burnt 8 amp fuse protecting the magnetic switch.	Locate and eliminate the short circuit which has caused the fuse trouble by checking all instruments and connections protected by the same fuse. Then, replace the burnt fuse.

Trouble-shooting guide in case of irregular warning light operation.

If the trouble covered in the point A in the table persists even after all checks and repairs at points 1 and 2 have been carried out, it is possible to locate the trouble proceeding as follows. This proceeding requires a fully efficient and charged battery and an alternator belt tension within specifications.
This voltage, checked at battery terminals with engine running at mean rotation speed should give one of the following readings:

a) greater than 15 V (high reading). The trouble is to be found in the voltage regulator;

b) within 13.5 to 15 V (normal reading). In this case, two voltage readings are necessary to locate the trouble:

— across the blade terminal «85» of magnetic switch and ground;

— across the terminal «85» of the magnetic switch and the positive terminal of the battery or the terminal «30» of the alternator.

The voltage readings may give three results:

— if the two readings give about the same value (half the voltage reading at the battery terminals), the trouble is caused by the magnetic switch;

— if the two readings differ by 1 V, or more, then the trouble is due to the alternator;

— if the two readings are null, the trouble is the one specified at point A 6 of the trouble-shooting chart.

c) less than 13.5 V (low reading). In this case also, take the two voltage readings already quoted at the point b) to locate the trouble. As for the point b), the voltage readings may give three results:

— if the two readings are about the same (half the reading at the battery terminals) the trouble is to be found in the voltage regulator;

— if the two readings differ by 1 V or more, then the trouble is due to the alternator;

— if the two readings give no results, the trouble is the one specified at point A 6 of the trouble-shooting chart.

SUMMARY OF THE EFFECTS ON CHARGING SYSTEM OPERATION BY DIODE RECTIFIER TROUBLE AND OF THE MAGNETIC SWITCH BEHAVIOUR IN PRESENCE OF SAID TROUBLE.

This summary covers both troubles which may occur throughout the operating system and troubles due to mishandling or to continued operation of a defective alternator overlooking the warning light behaviour (see preceding table). The following chart offers information which is complementary to that given previously and should enable the serviceman to gain a more thorough knowledge necessary to re-establish the normal operating condition of a defective charging plant.

DIODE RECTIFIER TROUBLE AND WARNING LIGHT BEHAVIOUR	EFFECTS UPON THE CHARGING PLANT
One or more negative diodes are short-circuited.	**a) With engine stopped and main switch in 0 setting (all off).** **No battery discharge.**

DIODE RECTIFIER TROUBLE AND WARNING LIGHT BEHAVIOUR	EFFECTS UPON THE CHARGING PLANT
— The warning lamp signals the trouble in conditions b) by giving no light.	b) With engine stopped and main switch in I setting (travel position). The battery discharges a current which is due to the magnetic switch excitation winding summed to that absorbed by the alternator excitation windings and by the warning light (normal current under these conditions). c) With engine running. Both current output and regulated voltage tend to drop. The voltage across star center and alternator positive terminal tends to rise up to values approaching 9 V. There is little evidence of these troubles when only one diode is short-circuited.
One or more positive diodes are short-circuited. — The warning lamp signals the trouble under the conditions c) by remaining lighted or by lighting up again.	a) With engine stopped and main switch in 0 setting (all off). Slight battery discharge across the short-circuited diode or diodes, alternator armature winding, magnetic switch excitation wiring and warning light. b) With engine stopped and main switch in I setting (travel position). No further current is discharged from the battery besides that (normal under these conditions) due to the absorption by the alternator excitation winding and warning light. c) With engine running. The voltage across the alternator star centre and positive terminal tends to drop to values lower than 4 V.
Short-circuit across one positive and one negative diodes not belonging to the same phase. The warning light does not signal the trouble.	a) With engine stopped, also with main switch in 0 setting (all off). An inverse current of about 40 amp is produced. This current causes a quick discharge of the battery. b) With engine running. An inverse current is produced of lower magnitude than that occurring at a) but sufficient to cause a quick discharge of the battery.
Short-circuit across a pair of diodes belonging to the same plate.	The effect is equivalent to that caused by a short-circuit across the battery positive and negative terminals.

BATTERY

SPECIFICATIONS AND DATA

Type	MARELLI 6 ATP 27 in alternative: TITANO 6 DE 12 F SAEM 6 CS 13
Nominal voltage	12 V
Nominal capacity (at 20 hr. discharge) MARELLI	143 Amp.hr
Nominal capacity (at 20 hr. discharge) TITANO	136 Amp.hr
Overall dimensions (length × width × height)	510 x 216 x 244 mm (20.1 x 8.5 x 9.6 in)
Weight, with electrolyte	54 Kg (119 lb)
Electrolyte density at 15 to 25 °C:	
— full charge	1.27 to 1.28 gr/cm³
— medium charge	1.20 to 1.22 gr/cm³
— discharged	1.11 gr/cm³

DESCRIPTION

The 12 V battery, which is installed on the axle support, in front of the radiator (Fig. 11), has the following features: the cell connecting bridges are immersed in the rubber cement to improve outside insulation and to reduce post and terminal oxidation, and also, the cells are provided with splash-proof and self-levelling plugs.

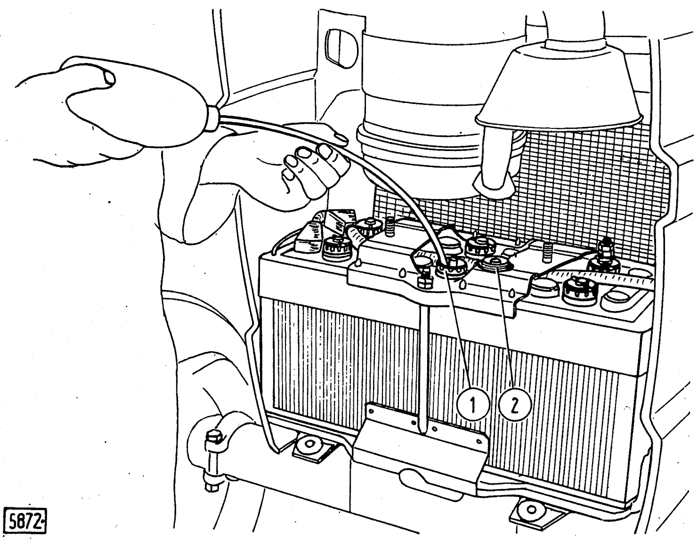


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Fig. 11 - Checking the battery electrolyte level.
1. Filler plugs. - 2. Plug caps.

The battery is easily removed from the tractor: just disconnect the ground cable first to avoid violent discharges.

CHECKS AND MAINTENANCE

The electrolyte level should be checked after every 200 hours of work with battery rested and cool. Make sure that plugs (1, Fig. 11) are tight and then remove the cover (2) and pour some distilled water down the funnel of each plug until the water starts rising up in the funnel.

Fit then the cover to each cap, after making sure that it is perfectly clean.

Check terminals and posts for cleanliness and tightness and smear them with petroleum jelly (vaseline) to prevent oxidation.

If the tractor is to remain idle for a long time, it is recommended that the battery be kept under shed in a dry room and be re-charged once a month.

Check the state of charge by unscrewing the plug and introducing the densimeter C 852 into each element; according to the values found, the state of the battery can be verified referring to the data reported in the table.

STARTING MOTOR

SPECIFICATIONS AND DATA

Starter model	MARELLI MT 38 QA-QB (*)
Voltage	12 V
Nominal power output	4 HP
Rotation, looking from drive end	clockwise
Pinion and gear ratio	9/110
Poles	4
Excitation (windings)	in series - in parallel
Engagement	armature axial drive
Control	solenoid
Data for bench test	
Performance test (at 20 °C = 68 °F):	
— current not above	875 amp.
— torque output	2.3 kgm (16.6 ft.lb)
— speed	1200 to 1800 r.p.m.
— voltage	8.5 V
Stall test (at 20 °C = 68 °F):	
— current, not above	2000 amp.
— voltage	5.5 V
— torque output, not below	4.5 kgm (32.5 ft.lb)
— total internal resistance	0.0035 to 0.0042 ohms
No-load test (at 20 °C = 68 °F) (1):	
— current, not above	140 amp.
— voltage	12 V
— speed	900 to 1400 r.p.m.
Resistances (at 20 °C):	
— main field winding	0.0001 to 0.0007 ohms
— auxiliary parallel winding	0.17 to 0.19 ohms
— auxiliary series winding	0.13 to 0.15 ohms
Mechanical specification test	
Spring pressure on brushes (not worn)	0.8 to 1.1 kg (1.8 to 2.4 lb)
Mica undercutting	0.8 mm (0.032 in)
Clutch coupling efficiency: slip torque	12 to 16 kgm (87 to 115.5 ft.lb)
Dia. of commutator	47.840 to 48.000 mm (1.8835 to 1.8898 in)
— wear limit	47.2 mm (1.858 in)
— max throw	0.03 mm (0.0012 in)
Solenoid (14 to 16 amp.)	
Resistance of the winding at 20 °C (68 °F)	0.75 to 0.85 ohms
Stall voltage (min.)	8 V
Armature stroke	5.4 to 5.8 mm (0.213 to 0.228 in)
Carrying force at 12 V and with armature at end of run	4.2 to 4.8 Kg (9.2 to 10.5 lb)

(1) Data obtained by feeding the series and parallel auxiliary winding only.

(*) Post-modification tractors are equipped with Marelli starters MT 68A and MT 68AA. For specifications and cross sections of the above starters refer to pages 305 onward.

Cont.: « Specifications and data »

	mm	in
Assembly data		
I. D. between poles	83.15 to 83.35 83.45 to 83.85	3.274 to 3.282 3.285 to 3.301
O. D. of armature	82.346 to 82.400 82.946 to 83.000	3.242 to 3.244 3.266 to 3.268
I. D. of drive end bearing bushing	35.050 to 35.089	1.3800 to 1.3815
O. D. of pinion shaft section in bearing bushing	34.950 to 34.975	1.3760 to 1.3769
Running clearance of pinion shaft in bearing bushing	0.075 to 0.139	0.003 to 0.005
I. D. of armature pilot bushing	16.645 to 16.670	0.6553 to 0.6562
O. D. of armature stub axle in pilot bushing	16.482 to 16.500	0.6489 to 0.6496
Running clearance of armature stub axle in pilot bushing	0.145 to 0.188	0.006 to 0.007
I. D. of bushings fitted into pinion hub	22.000 to 22.033	0.8661 to 0.8674
Dia. of armature shaft journals	21.927 to 21.960	0.8633 to 0.8646
Running clearance of armature shaft in bushings	0.040 to 0.106	0.002 to 0.004
Lubrication		
Coupling helix (to be lubricated at overhaulings)	FIAT MR 3 (NLGI 3)	
Drive end bearing bushing (lubricate after every 200 hours of work with same engine crankcase oil)	FIAT Ambra 20 W - 40 oil (SAE oil 20 - 40 multi-grade motor oil)	

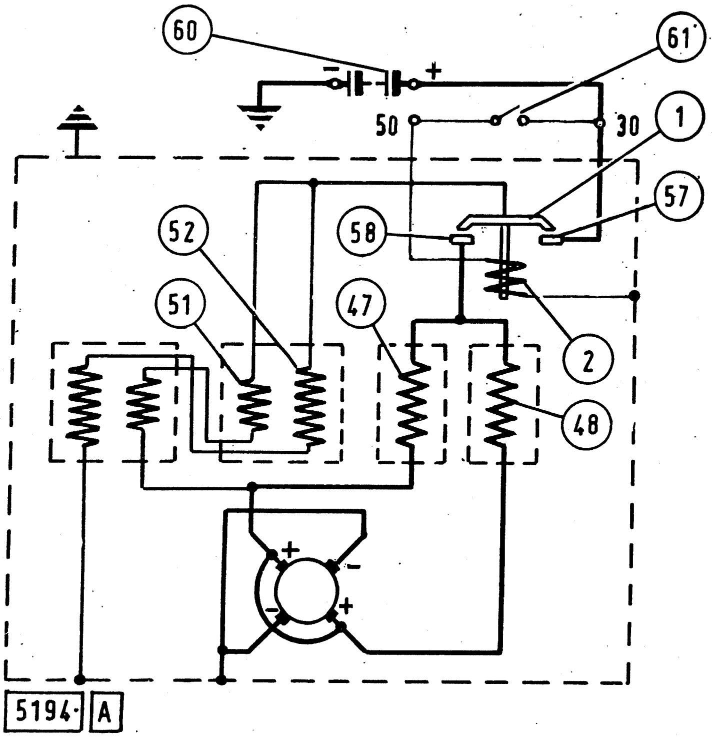


Fig. 12 - Wiring diagram of MARELLI starting motors.
1. Solenoid-operated contact bridge. - 2. Starter relay. - 47, 48. Main field winding. - 51. Auxiliary series winding. - 52. Auxiliary parallel winding. - 57. Auxiliary windings contact. - 58. Main field winding contact. - 60. Battery (12 V). - 61. Starting push-button.

DESCRIPTION

The MARELLI-made starting motors, consist of the following major components:

— a solenoid starter switch (2, Fig. 13) with a double set of moving contacts, the upper of which closes first hence energising the auxiliary windings whilst the lower one, on the excitation of the main winding, closes afterwards being retarded by the stop (4);

— four windings, two of which consist of the auxiliary winding coils, two coils each, (51 in series and 52 in parallel, Fig. 12) and the remaining two by a coil each of the main field winding (47 and 48);

— an armature revolving on self-oiling bushings which, in the first stage, turns slowly as the auxiliary windings are energized and at the same time moves axially to engage the pinion with the flywheel gear, to disengage the stop (4, Fig. 13), and to exert pressure on the return spring.

In the second stage, as the main field is energized, the armature transmits the maximum torque to the pinion;

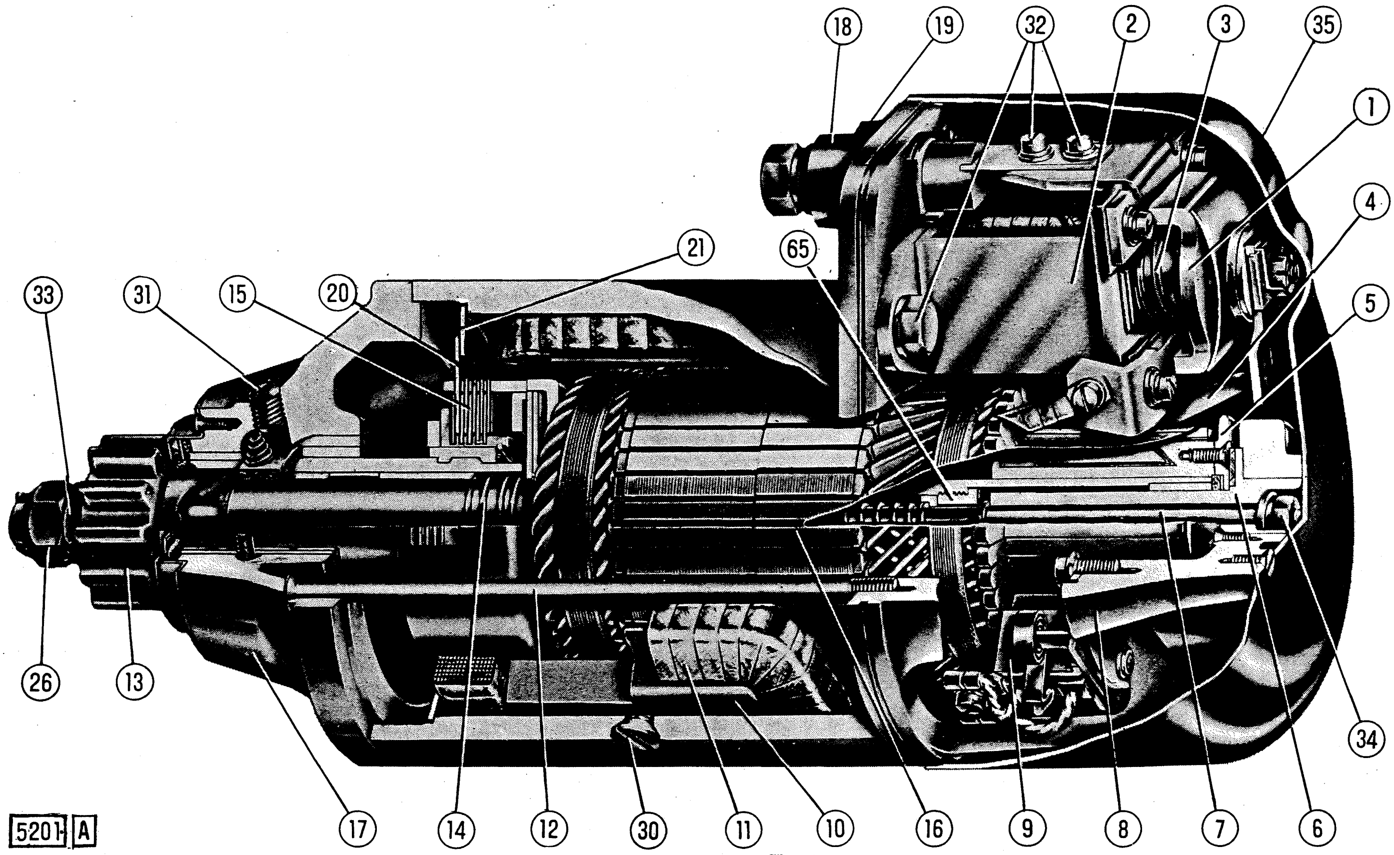


Fig.13 - Cut-away of Marelli axial drive starter series.

1. Solenoid-operated contact bridge. - 2. Starter relay. - 3. Relay spring. - 4. Stop lever. - 5. Disconnecting plate. - 6. Armature pilot bushing. - 7. Armature retracting coil spring and pin. - 8. Brush holder plate. - 9. Brush. - 10. Pole shoe. - 11. Field winding. - 12. Through-bolt. - 13. Pinion. - 14. Compliancer spring. - 15. Clutch coupling. - 16. Armature. - 17. Drive end cover. - 18. Positive terminal. - 19. Solenoid feeding terminal. - 20. Clutch release ring. - 21. Stop ring. - 26. Jam nut (with cotter pin). - 30. Pole shoe screw. - 31. Lube hole plug. - 32. Starter relay screws. - 33. Pinion locknut (with thrust end wear washer). - 34. Armature holding nut. - 35. End cover plate. - 65. Pin (7) retaining ring nut.

— a clutch coupling (15) which consists of a sleeve screwed on the pinion hub and which tends to unscrew when the pinion encounters resistance to rotation (stalling and starting) hence contributing to compressing the laminations and thus locking the armature and pinion together. On the contrary, if the pinion is dragged along by the flywheel (following the firing of the engine), the sleeve tends to screw up hence annulling friction between laminations, thus allowing the pinion to idle to prevent the armature attaining excessive speed.

Once the push-button control is abandoned and the pinion and armature return to rest position by effect of the opposing spring force the clutch ring (20) of larger diameter abuts against the outer ring (21) solid with the carcase releasing the clutch stack;

— a pinion (13) which is free on the armature shaft extension and turns at the outside of the bracket (17), the latter provided with a bushing that is lubricated after every 200 hours of operation by removing the plug (31) and pouring a few drops of crankcase oil down the hole.

Identification data are stamped on the carcase, next to the feed terminals.

SERVICE INSTRUCTIONS

Remove starter from tractor and disassemble it on workbench as follows: separate brackets from carcase by removing the protection shield (35, Fig. 13), brushes and field winding terminals, nut (34) and the four through-roods.

Then, unscrew the nuts (26 and 33) to withdraw the parts illustrated in Fig. 14.

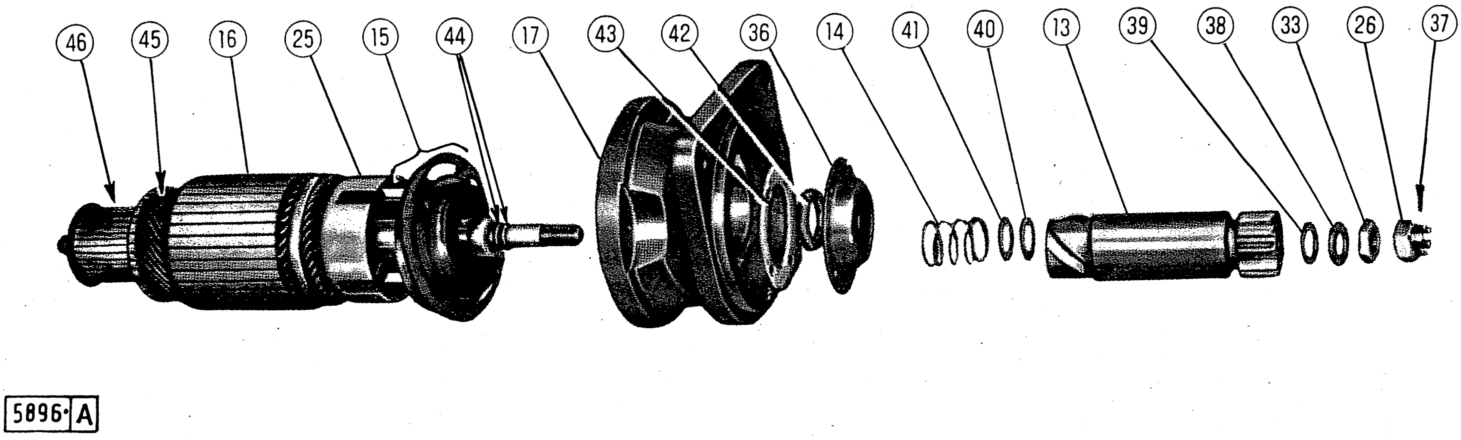


Fig. 14 - Exploded view of drive pinion and armature.
13. Pinion. - 14. Thrust spring. - 15. Clutch assembly. - 16. Armature. - 17. Drive end plate. - 25. Clutch housing (integral with armature). - 26. Locknut. - 33. Pinion locknut. - 36. Seal retainer. - 37. Cotter pin. - 38. Thrust washer. - 39. Wear washer. - 40. Insulating washer. - 41. Plain washer. - 42. Pinion outer seal. - 43. Casting seal. - 44. Pinion inner sealing rings. - 45. Armature windings. - 46. Commutator.

Clean the disassembled parts carefully and check:

— wear of self-lubricating parts, bearing in mind that excessively worn bushings might cause the armature to interfere with the pole shoes;

— spring pressure on brushes and brush wear. Always replace all brushes even if only one is found defective or worn;

— out-of-round of armature commutator, turning it if out-of-round exceeds 0.03 mm (0.001 in), and afterward undercut the mica between blades from 0.5 to 0.8 mm (0.020 to 0.031 in) deep, using the tool **A. 3963**;

— check that the armature coils and armature are insulated from the armature carcase (a, Fig. 15), that no winding coil or blade of the commutator is short circuited (b) and, finally, that no interruption exists in the electrical continuity of the circuit (c);

— verify the field winding insulation with respect to the carcase and pole shoes (Fig. 16) and check the windings for interruptions. In the event that a new winding is to be fitted, we recommend heating it up first to approximately 50 °C (122 °F) by feeding it with a 12 V current for about 1 minute in order to increase its flexibility and favour proper bedding under the poles.

The poles must then be blocked in place by tightening the screws in the hand press **M. 166**, using simultaneously the stretcher **A. 721050.**

After assembly, check that the inside diameter across the pole shoes is within the specified limits; if not, assembly was not correct. In any event, re-check the assembly sequence, but in no case should the pole shoes be rebored;

— clutch slip torque with the tool **A. 427052** and torque wrench. If the torque value is lower than 12 Kgm (86.8 ft. lb), add one or more shims (S, Fig.17).

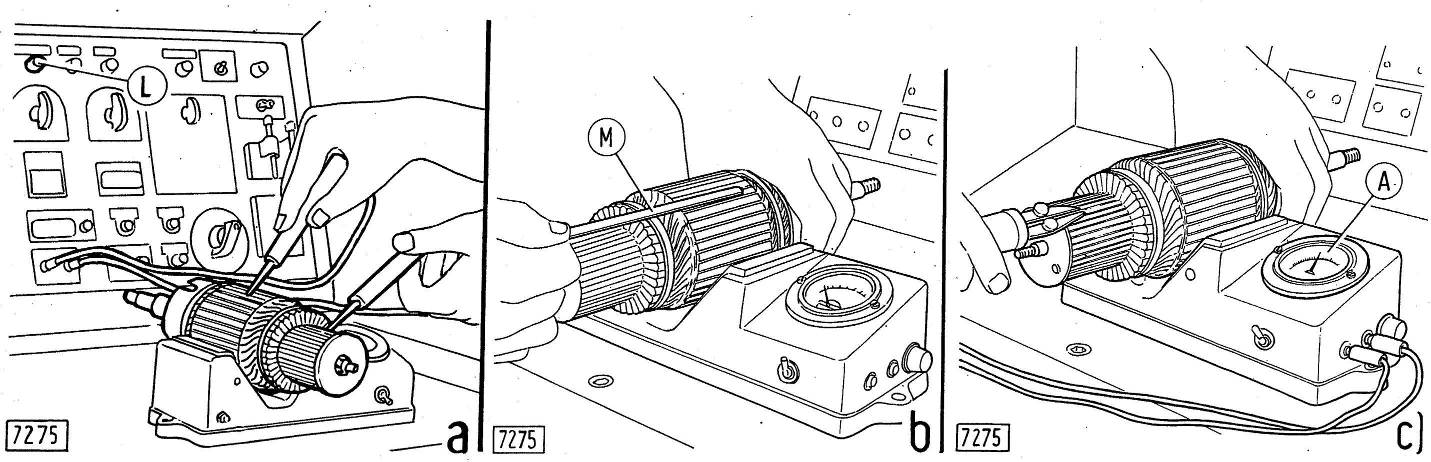


Fig. 15 - Checking ground insulation (a), wiring short-circuit (b) and continuity (c) of an armature winding.
A. Ammeter (zero reading at broken off coils). - L. 220 V spy lamp (lights up when grounding occurs). - M. Steel blade (vibrates in the presence of short-circuited coils).

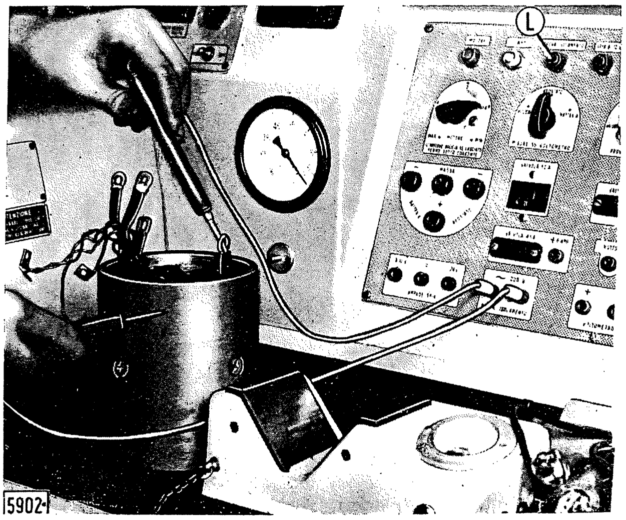


Fig.16 - Checking the ground insulations of a field winding, 220V test rig circuit . (If grounding occurs the spy lamp L lights).

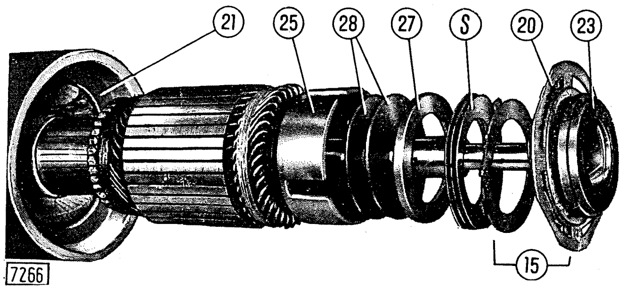


Fig.17 - Friction joint parts and drive end view of carcase.

S.Clutch adjustment shims - 15.Clutch (5 tombac and 5 steel laminations) - 20.Clutch disengagement ring (tombac) - 21.Retaining ring (solid with the carcase) 23. Helical sleeve - 25 .Housing fixed to the arma ture - 27.Push ring - 28. Take-up rings.

Reassemble the motor by referring to Figs. 14 and 17 and considering the following notes:

- fit (dry)the armature sealing rings (44, Fig.14)and then spread a covering layer of grease.Afterwards, while fitting the pinion, rotate it a few times back and forth to pre= vent the rings to come off their locations ;

- fit the compression ring (27, Fig. 17)of the clutch coupling arranging it with the flat surface abutting against the shims (S);

- lubricate with grease FIAT MR3 (NLGI 3) the sleeve-pinion mesh, and the front bra= cket bushing with the crankcase oil ;

- fit the anti-wear washer (39, Fig. 14) always abutting against the pinion ;

- connect the field winding terminals as fol= lows (Fig.18) :

terminals (47 and 48) to the lower fixed contact point of the solenoid ;

terminals(49 and 50) to the positive bush holders;

terminals(51 and 52)to the upper mobile contact of the solenoid ;

terminal (53)(grounded)to the negative brush holder ;

terminal (54) to the positive brush holder.

Besides, the positive brush holders are elec= trically interconnected through the copper blade (55).

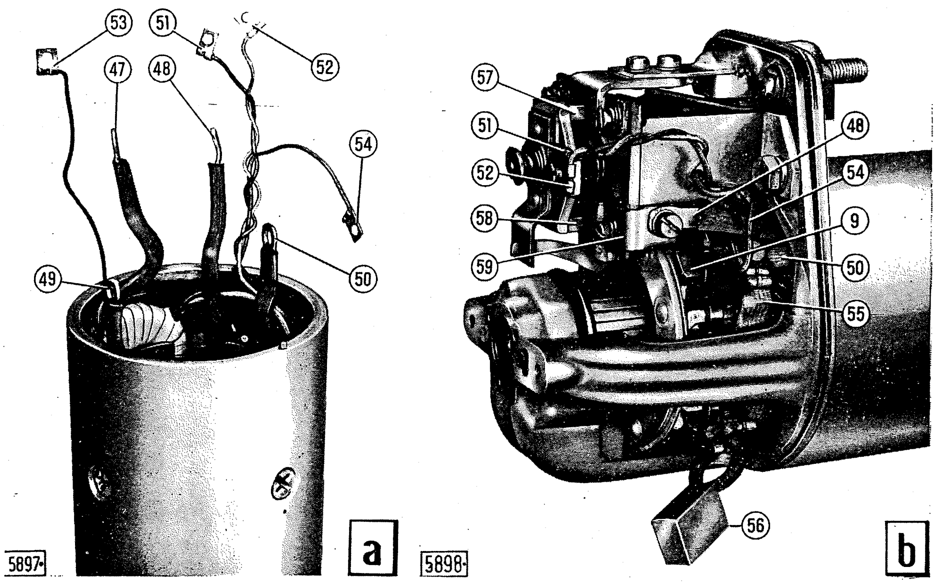


Fig. 18 - Terminals of field windings (a) and their respective connections (b).

9. Positive brush. - 47. 48, 49. 50. Terminals of main field winding coils. - 51, 52. Terminals of auxiliary winding coils. - 53. Terminal of auxiliary shunt winding coil. - 54. Terminal of auxiliary series winding coil. - 55. Positive brush holder connection. - 56. Negative brush. - 57. Upper moving contact. - 58. Lower moving contact. - 59. Lower fixed contact.

After assembly, make sure that the terminal and winding attachment screws do not drag or interfere with the commutator.

BENCH TESTING INSTRUCTIONS

Starter efficiency is checked by means of the load and no-load and stall tests. For this purpose, install the starter on the test bench and wire up as illustrated in Figure 19.

Feed specified current to the starter and, for each test, compare measured values to the data reported in the chart at the beginning of this chapter.

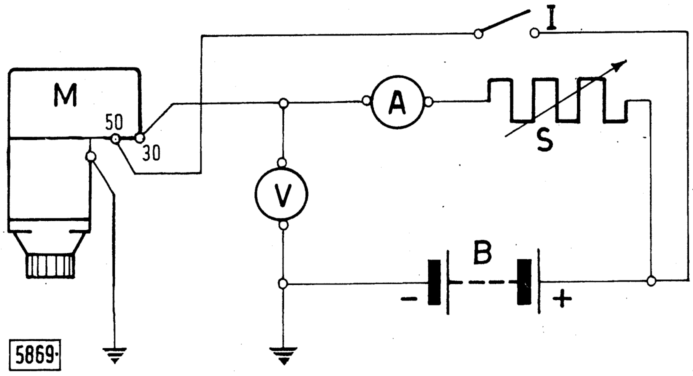


Fig. 19 - Test rig wiring diagram for starting motor. A. Ammeter. - B. Battery. - M. Starter under test. - I. Starter push button. - S. Rheostat. - V. Voltmeter.

TROUBLE - SHOOTING CHART

TROUBLE	POSSIBLE CAUSE	LOCATION AND REMEDIES
Starter inoperative or turning too slowly.	**Battery posts and terminals loose or oxidized.**	**Clean ports and terminals.**
	Battery discharged or deteriorated	**Check battery.**
	No contact of brushes with commutator due to brushes sticking, or guides worn out, springs out of shape, or ingress of dirt.	**Check brushes and clean guides and commutator. Check spring load on brushes. If necessary, replace brushes and springs.**
	Solenoid contacts oxidized, worn or insulated because of the presence of dirt.	**Check and clean the contact points. Oxidation may be due to shorted coils because of excessive current absorption. If so, replace solenoid as an assembly.**
	Armature or field windings partially shorted or grounded. Blacking of insulators, damaged commutator bars.	**Replace defective parts.**
	Thrown armature or commutator.	**Replace armature as an assembly.**
	Excessive voltage drop in cables.	**Check cables and their connections.**
Noisy operation.	**Worn armature bearing bushings.**	**Replace bushings.**
	Pinion disengagement from flywheel is delayed because of inefficient return spring or guide collar seizure.	**Disassemble motor and replace defective parts.**
Starter turns but fails to start the engine.	**Worn pinion or flywheel crown teeth.**	**Replace pinion or flywheel crown.**
	Ineffective clutch.	**Replace it as an assembly.**
Starter output fails short of full power rating.	**Low battery charge.**	**Re-charge the battery.**
	Brushes sticky in holder.	**Clean brush holders.**
	Clutch slips.	**Recondition or replace it.**
	Brushes not bedded properly.	**Set the brushes properly by running the starter idle for a while at 30 to 40 seconds intervals.**
Brushes wear out quickly.	**Thrown commutator.**	**Turn it.**
	Projecting mica.	**Undercut it.**
	Loose brush holder screws.	**Tighten the screws.**
	Wrong type of brushes.	**Replace brushes with original spares.**

ACCESSORY EQUIPMENT

LIGHTING AND STARTER CONTROL SWITCH

6-position, 60 amp. unit

Position 0-30 30/1

All circuits off.

Position I-30-51 30/1

Starter and starting aid switch. - Oil pressure warning light switch. - Battery charging warning light. - Voltage regulator (alternator). - Electric horn. - Fuel level indicator control. - Engine water temperature gauge transmitter.

Position II - 30-51 30/1-58

Same equipment as in position I plus:
and number plate
— Front and rear parking lights. - Parking spy and dashboard lighting lamp. - Auxiliary rear floodlight. - Connector

Position III-30-51 30/1-58-56b.

Same equipment as in position II plus dimmed headlights.

Position IV-30-51 30/1-58-56a

Same equipment as in position II plus driving headlights.

Position V-30 30/1-58

Front and rear parking lights. - Parking and dashboard lights indicator. - Auxiliary rear floodlight .- Connector.

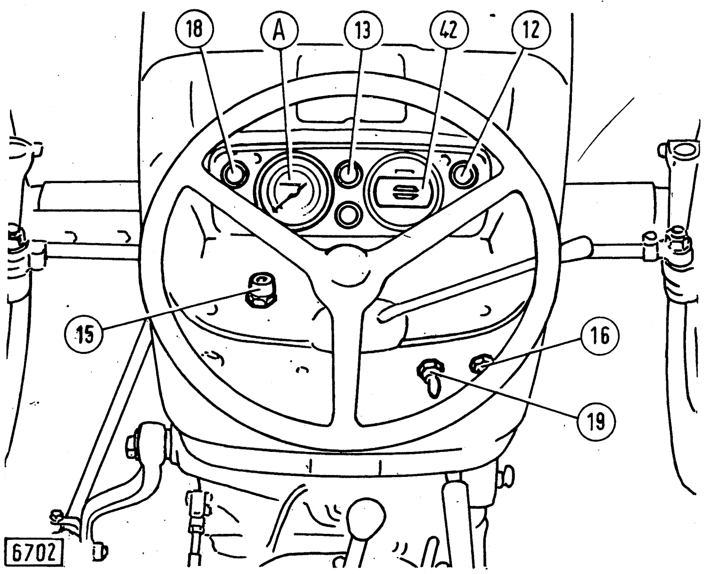


Fig. 20 - Dashboard accessories.
A. Tractormeter (engine R.P.M. and P.T.O. tachometer and hour-meter). - 12. Engine lubrication oil pressure warning light (red). - 13. Park lights spy lamp (green). - 16. Electric horn push-button. - 18. Battery charging plant warning light (red). - 19. Lights and starter control switch. -
42. Fuel level indicator and cooling water temperature electric thermometer - 15. Starter and starting aid switch.

STARTER AND STARTING AID SWITCH

This switch is conditioned by the position of the lighting and starter switch i.e., it functions only if the latter is set in position I, II, III and IV.

Position 0-30 15/54

Rest.

Position I-30 15/54-T

Starting aid inserted.

Position II-30-50 15/54-T

Starting aid inserted and engine starting.

Position III-30-50 15/54

Engine starting.

FUSES

Six fuses are contained in a box and one in a cylindrical holder (Fig.21).The capacity of fuse(1) is 16 amp;for all the others is 8 amp.

They protect (Fig.21) :

- fuse (1) = electric horn and starting aid ;

— fuse (2) = fuel level indicator gauge, cooling water temperature warning light, lubrication oil pressure warning light, alternator warning light magnetic switch;

— fuse (3) = right front parking light, left tail light and number plate light, parking lights spy lamp and connector ;

— fuse (4) = left front parking, right tail light and rear floodlight (if any);

— fuse (5) = dimmed headlights;

— fuse (6) = driving headlights;

— fuse (11) = voltage regulator.

The starting circuit and the alternator circuit have no fuse protection.

Before replacing any burnt fuse, be sure to find the cause of trouble.

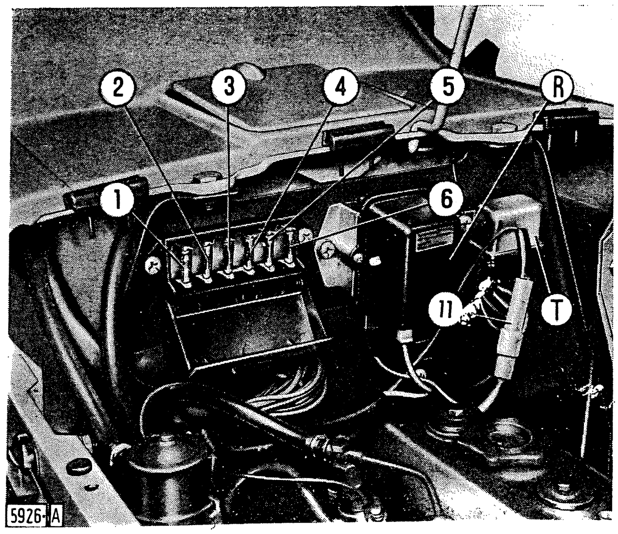


Fig. 21 - Arrangement of the voltage regulator (R) and magnetic switch (T) fuses.
2, 3, 4, 5, 6. 8-amp fuses. 11. Voltage regulator fuse (8 amp). — 1. 16 Amp.fuse.

12 V BULBS

Headlamps:

— double filament bulbs (dimmed and driving lights)	45/40 W
— parking lights	5 W
Rear lights	5 W

Warning lights:

— parking lights on; insufficient engine lubrition pressure; defective battery charging plant	5 W
— Rear flodlight	35 W

AIMING THE HEADLAMP BEAMS

In order to set the headlamp beams to meet traffic law regulations, proceed as follows (Fig. 22) :

— arrange the tractor on level grounds in front of a light-colored, shaded wall. Make two cross marks on the wall, corresponding to the centers of the two headlamps;

— drive the tractor back about 5 m (L) maintaining it perpendicular to the wall;

— check divergency with the headlights; the center of the vertical line passing through each cross mark (diverging to the outside should not exceed 13 cm);

— check inclination by means of the low beams: the demarcation line between dark and lightened areas must be below the two cross marks, at least 1/20 th (H_2) of the height from the ground (H_1) of the same marks.

To adjust, if necessary, loosen the nuts securing the shank of each lamp to its support.

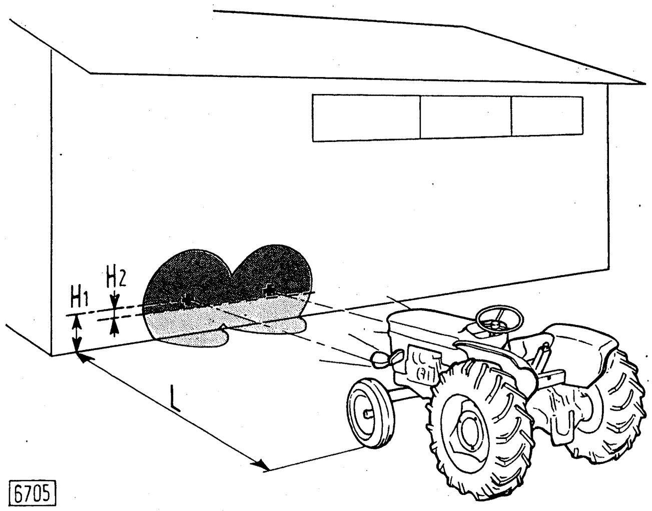


Fig. 22 - Headlamp aiming test.
L = 5 m (16′ 5″). Distance of tractor from the wall. - H_1. Height of cross marks from ground. - $H_2 = H_1 : 20$. Distance between the cross marks and the demarcation dashed line between the dark area and the area lighted by the low beams.

ELECTRIC HORN

The electric horn circuit comprises the following units:

— an electric horn (3, Fig. 23) located behind the engine cooling fan;

— a control push-button (16, Fig. 20) on the instrument panel;

— one 16-amp fuse (1, Fig. 21) contained in the fuse box.

Electric horn may not function because of:

— push-button inefficient or stuck;

— faulty horn.

Check electrical connections and wiring for interruptions or traces of oxidation.

Should the trouble be due to the push-button mechanism, replace it.

Components are not available as spares and, consequently, if the electric horn is defective it must be replaced as an assembly.

Through a suitable adjusting screw, located on the back of the unit, on connections side, it is possible to regulate the sound tone of the electric horn. The tone is raised by turning this screws clockwise; it becomes lower if the screw is turned counterclockwise.

TORQUE DATA

Item	Thread (metric)	Material (°)	Torque	
			Kgm	ft.lb
ALTERNATOR Self-locking nuts, alternator mounting bolts (C_1, Fig. 2)...	M 6x1	R 50 (bolts R50)	0.5	3.6
Locknut, alternator drive pulley (C_2)	M14x1.5	R 50 (shaft R 80)	6	43.4

(°) Ultimate strength (Kg/mm^2).

TOOL LIST

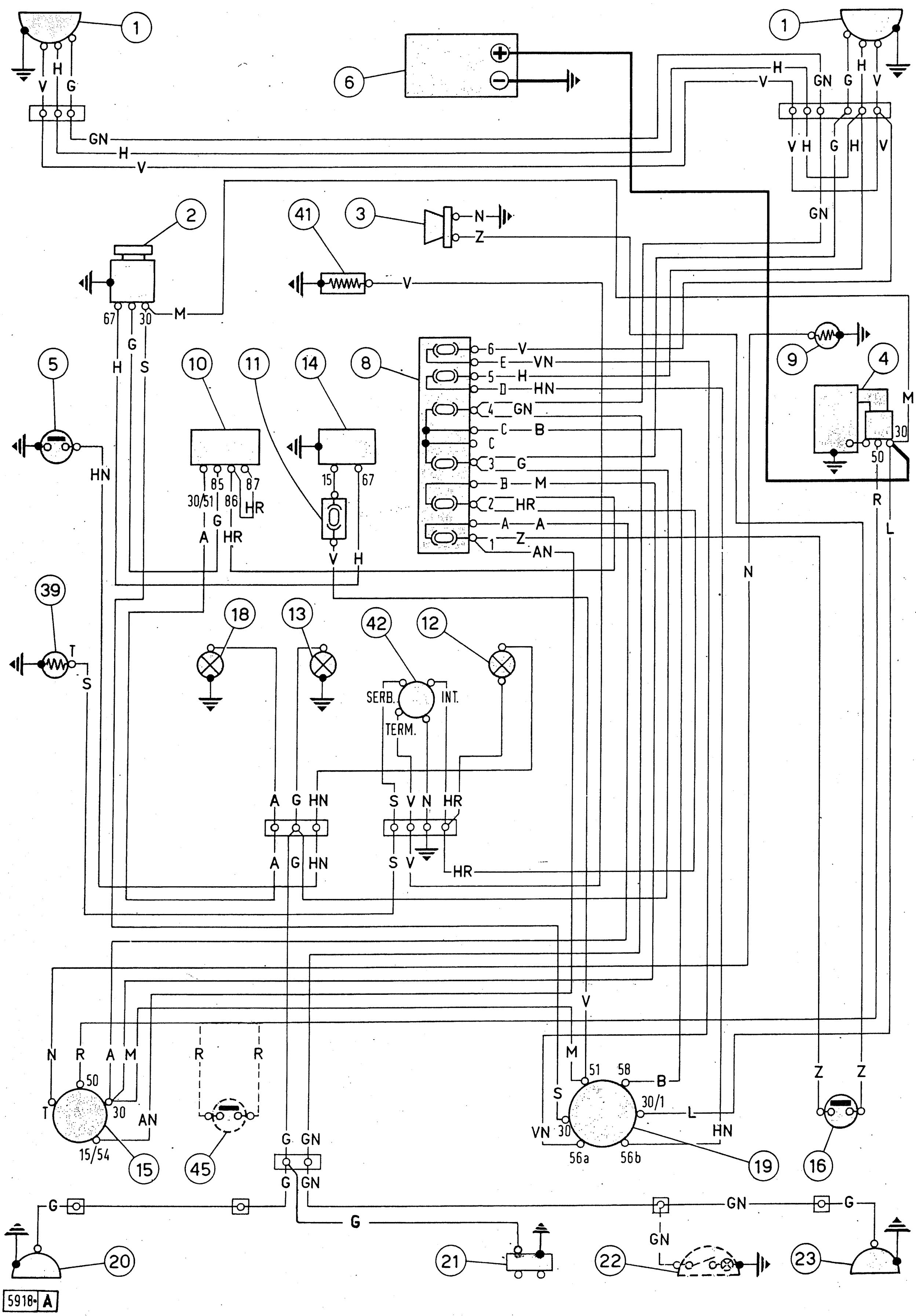
Catalog No.	Description
	ALTERNATOR
290679-A 76027	Removal tool, diode rectifiers (Fig. 3)
290680-A 76028	Installation tool, diode rectifiers
290681-A 76029	Diode removal anvil
292195-A 76032	Ditto, support
290683-A 76035	Attaching tool, diode installation plate
290686-A 90340	Reamer, diode locations
291352-A 723027	Electric tester
290682-A 76031	Diode installation anvil
	VOLTAGE REGULATOR
292819- A 5014	Test oven, voltage regulator checks and calibration
	BATTERY
290050- C 852	Densimeter
	STARTING MOTOR
290190- A 3963	Mica undercutter
290242- A 7125	Dynamometer, brush spring check
290973- A423048	Armature shaft alignment tool for turning down commutators
292307- A427052	Adaptor, drive clutch slippage test (to be used with torque wrench A. 711041/12)
291347- A721050	Installation tool, for fitting the pole windings to the carcase
291353- A723046	Pin wrench, armature return spring and pin retaining ring nut

Fig.23 - Wiring diagram.

1. Dimmed and driving headlights and parking light.
2. Alternator.
3. Electric horn.
4. Starting motor.
5. Switch for engine low lubrication oil pressure warning light (12).
6. Battery (12 V).
8. Fuse box.
9. Starting aid.
10. Magnetic switch for battery charging plant warning light (18).
11. Voltage regulator (14) fuse.
12. Lubrication oil pressure warning light (red).
13. Parking lights spy lamp (green light).
14. Voltage regulator.
15. Starting aid (9) and starter control switch.
16. Electric horn (3) push-button control.
18. Battery charging plant warning light (red).
19. Lights and starter control switch.
20. Left tail and number plate light.
21. 2-pole connector.
22. Rear floodlight with built-in switch (optional).
23. Tail light.
39. Fuel level indicator (42) control.
41. Electric thermometer (42) transmitter.
42. Fuel level indicator and cooling water temperature electric thermometer.
45. Engine starting safety switch (optional)

Cable colour code

A = Light blue
B = White
G = Yellow
H = Grey
L = Blue
AN = Light blue striped black.
AB = Light blue striped white
M = Brown
N = Black
R = Red
S = Pink
V = Green
Z = Violet
GN = Yellow striped black
HN = Grey striped black
HR = Grey striped red
VN = Green striped black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APPENDIX

MODELS
640 – 640 DT – 640 DT 3

ENGINE
TRANSMISSION

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ENGINE

BOSCH INJECTION PUMP

SINGLE-PLUNGER INJECTION PUMP TYPE BOSCH: EP/VA 4/110 H 1200 CL 136-4

TRACTOR MODEL 640

ENGINE TYPE FIAT 8045 02 200

INJECTORS: EPPZ 10F1- 770577

Nozzle holder: KB70S1F10-767107 ; nozzle: DLL 140S 64F- 770578 ; holes diameter: 0.3 mm

holes number: 3 Pressure setting: 225÷235 Kg/sq. cm (3200÷3340 p.s.i.)

Spring: WSF 2044/6X-656829 ; spring free length: 27÷27.5 mm.

Fuel delivery lines: PRR 25F 17Z-768068

fuel delivery lines dimensions: 6x1.5x480 mm

ASSEMBLY DATA

Pump rotation: anticlockwise . Injection order: 1-3-4-2 Plunger pre-lift from B.D.C. 0.5±0.02 mm. Fixed injection advance before T.D.C. in cylinder 1 in compression: 11°±1°

Length of preloaded control plunger spring: 24.6 mm

TEST SPECIFICATIONS

Test A: BOSCH test machine with injectors fitted with pressure springs WSF 2044/4 X and nozzles EFEP 182.

RABOTTI test machine equipped with graduated ring injectors with springs FIAT 656829 and nozzles EFEP 182.

Injector pressure setting: 150 Kg/sq. cm (2135 p.s.i.).

Fuel lines: 2x6x840 mm.

Test B: Test machine equipped with nozzle holders and nozzles same as those mounted on the engine.

Fuel lines: 1.5x6x700 mm.

Injectors pressure setting: 225÷235 Kg/sq. cm (3200÷3340 p.s.i.).

Test fluid: FIAT CFB at 40±5 °C (104±9 °F) (for temperatures below specifications, add 0.25 cu. cm to deliveries for 1000 strokes per each °C less).

Feed pressure of test machine at pump inlet: 0.2 Kg/sq. cm (2.8 p.s.i.).

CALIBRATION DATA

Type of test	Throttle lever setting	Pump R.P.M.	Transfer pump inside pressure kg/sq.cm	Timing device plunger stroke (°) mm.	TEST A: Single element output per 1000 strokes c.c.	TEST A: Backleakage per 100 strokes c.c.	TEST B: Single element output per 1000 strokes c.c.	TEST B: Backleakage per 100 strokes c.c.
Control lever arrangement	max ■	700±5	–	–	0	–	0	–
	max ●	700±5	–	–	62.5÷65.5	–	53÷56	–
	max ●	1250	–	–	37÷45	–	29÷37	–
Transfer pump pressure check	—	100	0.6÷1.1	–	–	–	–	–
	—	700±5	4.5÷5	–	–	–	–	–
	—	1200	6.5÷7	–	–	–	–	–
Start excess fuel check	max ●	300	–	–	⩽ 66	–	⩽ 59	–
	max ●	100	–	–	⩾ 130	–	⩾ 130	–
Advance setting	—	250÷400	–	0 beginning	–	–	–	–
	—	700±5	–	3 ÷4	–	–	–	–
	—	1150÷1200	–	6.5(end)	–	–	–	–
Fuel cut-off (1)	max ●	1300÷1350	–	–	0	–	0	–
	max ●	1250	–	–	37÷45	–	29÷37	–
Delivery and backleakage check (2)	max ●	1200^{+0}_{-20}	–	–	* 59÷62	–	* 50÷53	–
	max ●	1000	–	–	–	45÷70	–	45÷70
	max ●	700±5	–	–	62.5÷65.5	–	53÷56	–
	max ●	500±5	–	–	61.5÷64.5	80÷110	54.5÷57.5	80÷110
Low idling adjustm. (3)	min ●	400÷500	–	–	0	–	0	–
	min ●	350	–	–	12÷22	–	10÷18	–

Notes.

(°) Measured with gauge 292817

* Max. difference between individual deliveries: 2.5 cc. per 1000 strokes.

● Output lever in full load position. ■ Output lever in stop position.

(1) Adjust max. speed stop screw.

(2) Adjust max. output stop screw.

(3) Adjust idling speed stop screw.

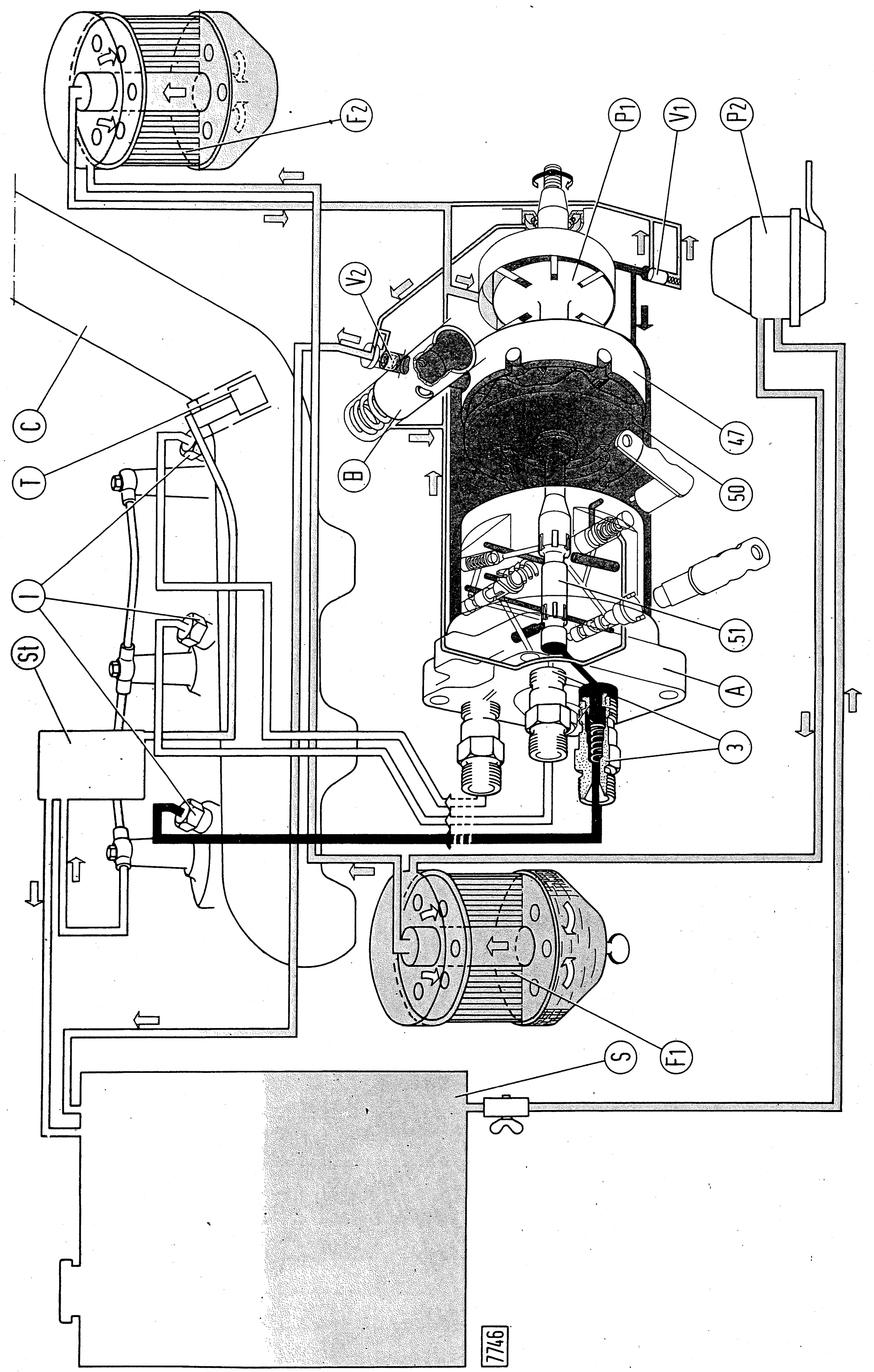
ENGINE BRAKE TEST DATA

Test specifications:

— engine installed on test bench without fan, air cleaner and exhaust muffler;
— atmospheric pressure 740 ± 5 mm of mercury;
— ambient temperature 20 ± 3 °C (68 ± 5 °F);
— relative humidity 70 % ± 5;
— fuel specific weight 830 ± 10 gr/lt;
— temperature of fuel backleakage at pump outlet 54 ± 2 °C (129 ± 4 °F).

Throttle lever setting	Engine - speed R.P.M.	Power output of engine runned-in for a total of 2 hours HP	Power output of engine runned-in for a total of 50 hours HP	Fuel consuption time (250 c.c.) sec.
Max (under load)	2400	⩾ 60	⩾ 62	⩾ 64.1
Max torque	1400	⩾ 38,5	⩾ 40.5	⩾ 97.7
High idle	⩽ 2600	–	–	–
Low idle	650÷700	–	–	–

Notes.



- Diaphragm type pump suction and pressure fuel and fuel returning to the main tank (injection pump and injectors leak-off).
- Thermostart fuel.
- Transfer pump delivery circuit.
- High pressure fuel with injector in pressure charge.

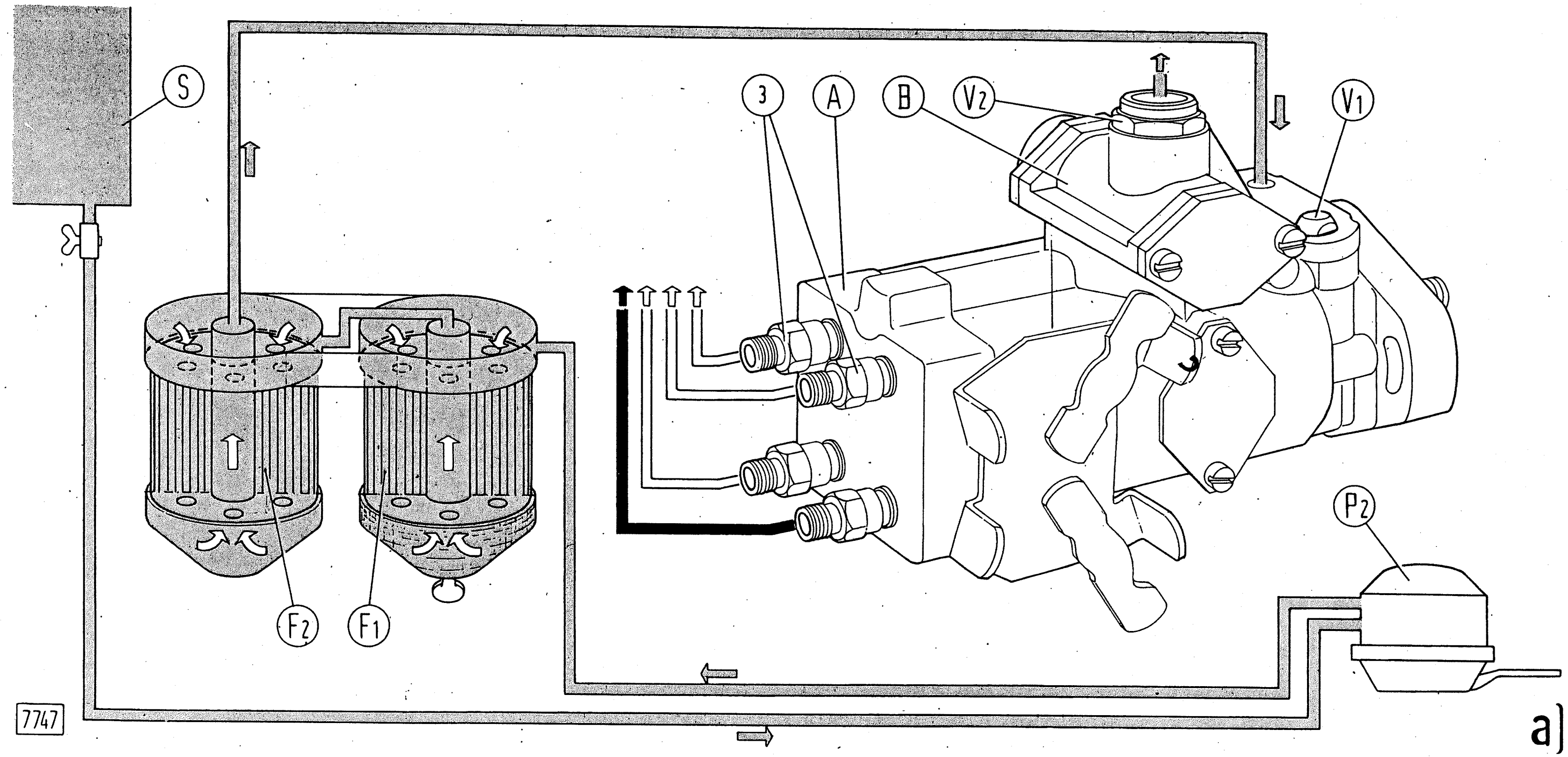


Fig.1 - Wiew of the fuel general circuit (for 3-cylinder engine) with injection pump BOSCH type EPVA-CL

a. Detail of 4-cylinder engine general circuit.
A. Complete hydraulic head - B. Automatic timing device - C. Air intake manifold into the cylinders - F_1 and F_2. First and second fuel filter connected in series - I. Injector - P_1. Vane fuel transfer pump - P_2. Diaphragm fuel priming pump - S. Fuel tank - St. Starting aid fuel tank - T. Starting aid - V_1. Transfer pressure control valve - V_2. Bleeding and backleakage valve from pump body - 3. Outlet pipe fitting - 47. Roller ring - 50. Face cam plate - 51. Main plunger.

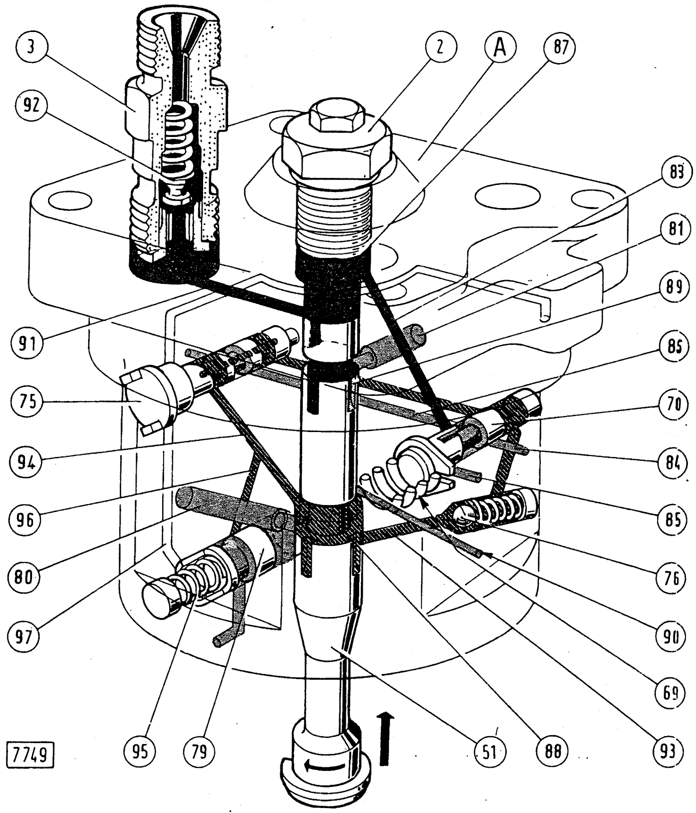


Fig.2 - Perspective view of the hydraulic head

A. Hydraulic head - 2. Central plug - 3. Outlet pipe fitting - 51. Main plunger - 69. Control spring - 70. Control plunger - 75. Throttle - 76. Check valve - 79. Starting excess fuel plunger - 80. Auxiliary governing pump inlet duct - 81. High pressure pump inlet duct - 83. Duct connecting hi-pressure chamber and control plunger - 84. Control plunger stop duct - 85. End of delivery spill duct - 86. Compensating duct - 87. Distributing slot - 88. Auxiliary governing circuit filling groove - 89. High pressure circuit filling slot- 90.Auxiliary governing circuit supply-spill port - 91. High-pressure outlet to injectors - 92. Delivery valve - 93. Auxiliary governing circuit filling duct - 94. Governing circuit filling and spill duct through the throttle- 95. Starting excess fuel control spring - 96. Auxiliary governing pressure by-pass duct - 97. Leakage spill port.

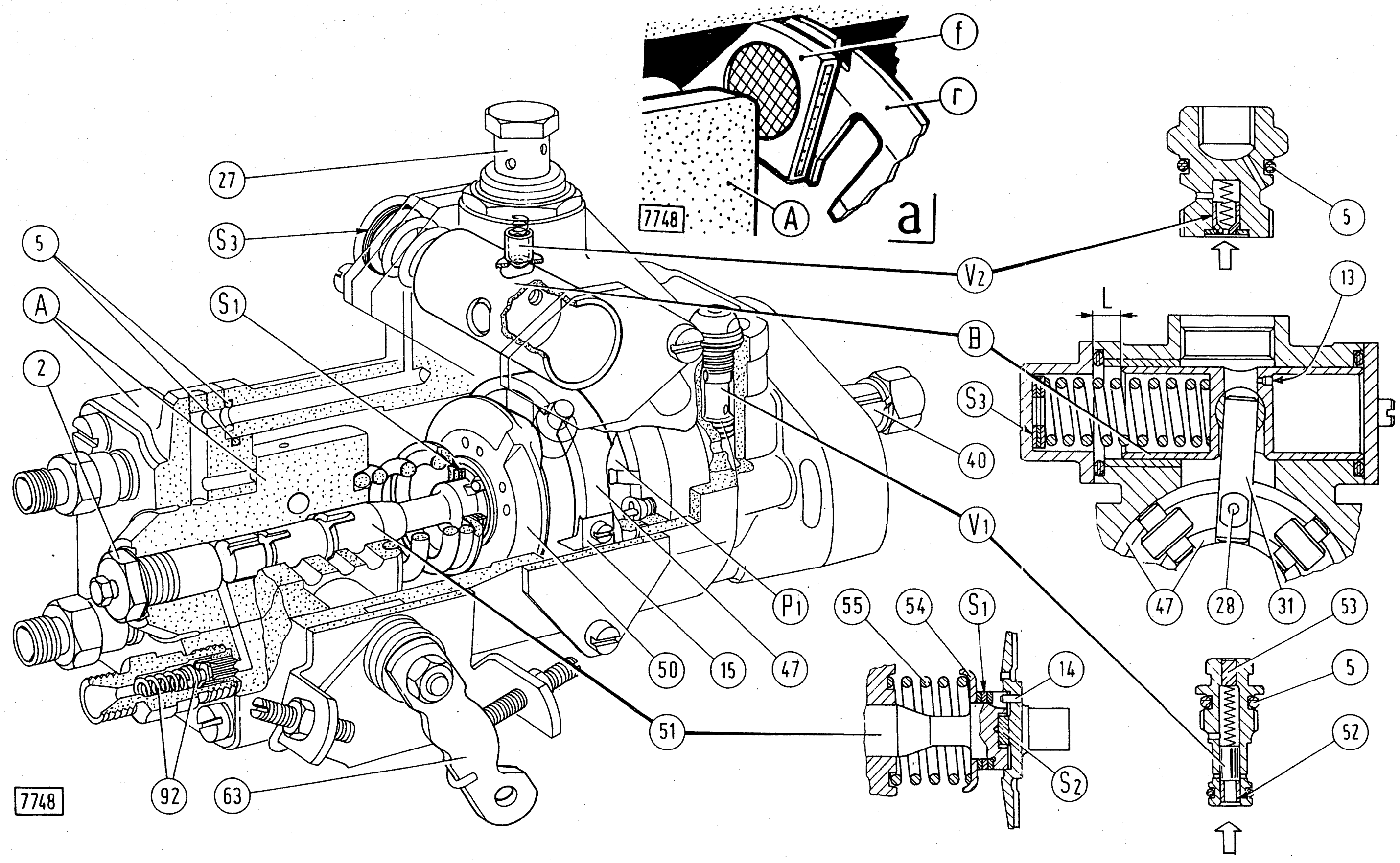


Fig.3 – Perspective view of BOSCH injection pump

a. Installation of the filtering ring (f) with relevant spring washer (r) between pump body and hydraulic head (A) (post-modification).

A. Hydraulic head – B. Automatic advance timing device plunger – L. Max stroke of the timing device plunger – P_1. Vane-type fuel transfer pump – S_1. Main plunger returning spring preloading shims – S_2. Main plunger prelift adjusting shim – S_3. Timing device spring preloading shims – V_1. Transfer pump pressure control valve – V_2. Bleeding and back-leakage valve from pump body – 2. Central plug – 5. O-ring gasket – 13. Through-port for the pressure fuel going to the timing device control plunger, coming from the pump body – 14. Plunger drive dowel – 15. Timing index – 27. Back-leakage outlet to the tank – 28. Axle (31) check rod pin – 31. Timing control axle – 40. Pump drive shaft – 47. Roller ring – 50. Face cam plate – 51. Main plunger – 52. Valve (V_1) plunger check rod circlip – 53. Valve (V_1) setting plug – 54 and 55. Plunger returning spring and cup – 63. Speed control lever – 92. Delivery valve to injector.

TORQUE DATA

ITEM	Thread	Torque	
		Kgm	lb.ft
Bleeding and backleakage valve (V_2,fig.3)	M20x1	5	36.17
Backleakage outlet	M12x1.5	2.30	16.7
Screws, timing device covers	M6x1	0.55	3.9
Screws,control levers plate	M6x1	0.70	5
Screws,hydraulic head (A)	M6x1	1.20	8.7
High pressure connections (3,fig.2)	M14x1.5	4.30	31.2
Central plug (2)	M14.5x2	6.50	88.8
Bleeding screw on central plug	M6x1	0.45	3.2
Nuts,securing control levers	M6x1	0.60	4.3
Screws,cover on pump body	M6x1	0.55	3.9
Screw,securing timing index (15,fig.3)	M4x0.7	0.25	1.8
Screw,securing vane pump ring	M5x0.8	0.50	3.5
Nut securing driving gear	M12x1.75	6.50	88.8
Connection, pump inlet	M12x1.5	4.30	31.2
Pressure control valve (V_1)	M14x1	0.85	6.1

SERVICE TOOLS

Tool No.	Description	Tool No.	Description
290752	Pump mounting plate to swivel stand 290239.	292591	Extension with thread M 14.5x2 (to be used with tool 290774).
290761	Test instruments and gauges (1 pressure gauge 0 to 10 kg/cm^2, 1 vacuum gauge 0-76 cm.Hg and one graduated burette).	292553	Tool, to remove pressure regulating valve spring pin.
290763	Pump mounting on test machine.	292554	Protection, ring and rollers.
290779	O-ring installation tool.	292555/1	Tool, to remove-install pump shaft.
290784	Pressure pipe to injectors for test A.	292556	Spanner, for metering valve and control plunger shafts.
290766	Cup, supply pump rotor removal-installation.	292557/1	Lifter, pressure regulating valve adjustment.
290774	Adjuster main plunger stroke.	292558	Guide hydraulic head positioning.
290778	Spacer, to rate plunger spring preload.	292817	Tool, for checking automatic advance and pressure take of at fuel inlet.
290780	Tool, o-ring removal.	293378	Plate for removal and installation of pump shaft (to be used with tools nos.292555/1 and 293392).
292548	Protection, rubber ring installation.		
293387	Spacer for automatic advance check (to be used with tool 292817).		
293392	Screw for removal - installation of pump shaft (to be used with tools 292555/1 and 293378).		

TRANSMISSION

MANUAL STEERING

Steering Box	
Type	Ball recirculation
Make	BURMAN
Reduction ratio	28 to 1
Steering column bearings	Two, ball
Steering shaft bushes	Two, white metal lined steel shells
Worm gear bearing adjustment	See page 220
Rocker shaft end play adjustment	See page 221
Worm bearing shim thickness (S, Fig. 1)	.05-.25 mm (.0020-.0100 in)
Top cover gasket thickness (12)	.15 mm (.0060 in)
Rocker shaft shim thickness (S_1)	.15-.25 mm (.0060-.0100 in)
Side cover gasket thickness (10)	.25 mm (.0100 in)
Rocker shaft journal diameter (8, Fig. 1)	38.010 to 38.060 mm (1.4964 to 1.4197 in)
Rocker shaft bush fitted I.D. (15)	38.087 to 38.105 mm (1.4995 to 1.5002 in)
Rocker shaft clearance in bushes	.027 to .065 mm (.0011 to .0025 in)
Bush interference fit in housing	.050 to .118 mm (.0020 to .0046 in)
Upper worm cam journal diameter (2, Fig. 1)	25.360 to 25.400 mm (.9984 to 1.0000 in)
Centred bush fitted I.D. (14) (Not reamed)	25.425 to 25.464 mm (1.0010 to 1.0025 in)
Worm cam journal clearance in bush	.025 to .104 mm (.0010 to .0041 in)

STEERING BOX (BURMAN)

To dismantle proceed as follows:

— Take off rocker shaft (8) after withdrawing side cover (10) and shims (S_1).

— Remove top cover assembly (12), shims (S), spacer (11) and worm cam (2), gradually turning the latter anti-clockwise.

Remove nut (7) from the casing together with 14 balls. Renew any damaged bushes and seals using suitable extractors and drivers.

Ensure that worm cam (2) and nut (7) are free from wear or signs of pick-up in the grooves; if faulty, these items should be renewed together with the balls. When reassembling the steering box refer to the illustration below and carry out the two adjustments described on page 221. After adjusting, fit the swing lever (17) to the rocker shaft (8) adhering to the instructions given in the detail (a) of fig.1.

To Install Worm Cam and Adjust Ball Bearings

Pack bottom bearing race (6, Fig. 1) with **grassofiat G 9** or other approved grease, insert the balls in position and place the race assembly in the steering box.

Position collar (7) over the worm cam, together with the balls embedded in grease to prevent them from falling, and introduce the cam in the casing through the side cover aperture pushing upwards as far as possible.

Pack the top bearing race (1) integral with the worm cam, embed the balls on the race packed with grease, insert the outer race from the top cover aperture and push the assembly downwards, ensuring that the top and bottom bearing balls do not come off their seats.

Fit spacer (11).

Install top cover (12), without shims (S) and bolt to the casing using two of the four screws (C_5) positioned diagonally and lubricate with engine oil.

Progressively tighten the two screws (C_5) in alternating fashion until a .9 kgm (6.5 lbft) torque is reached, simultaneously turning the worm cam (a) to settle the bearings.

Measure the gap between top cover (12) and steering box face, using a suitable feeler gauge at two diametrically opposed points along plane X-X (b) and arithmetically average the readings.

Remove top cover (12), interpose a pack a shims (S, Fig. 1) of thickness equal to the average reading, refit the top cover and tighten the screws to the torque given on page 255.

Check the steering shaft rotating torque; the correct torque should be .12 to .29 kgm (.9 to 2.1 lb ft). To adjust, alter the thickness of shims (S) as necessary.

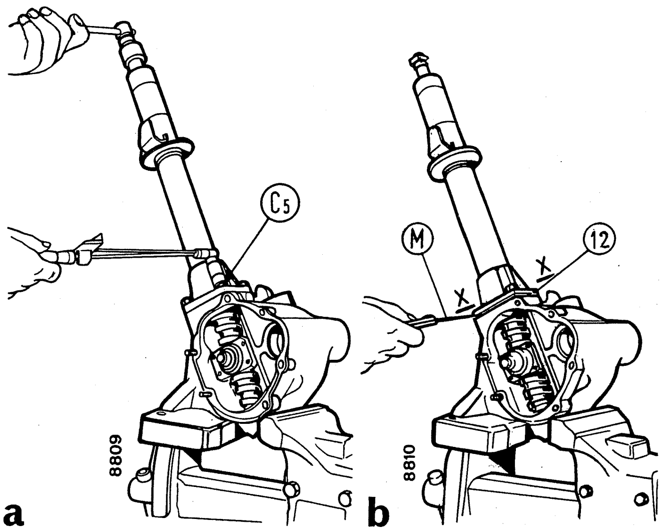


Fig. 2 - **Adjusting Worm Cam Bearings**

a. Tighten two screws (C_5) to .9 kgm (6.5 lb.ft) - **b.** Measuring top cover gap using feeler gauge M - X-X. Plane of gap measurement

To Adjust Rocker Shaft End Float

Insert rocker shaft (8) in the steering case, paying particular attention to prevent damaging seal (16).

Interpose a pack of shims (S_1) between side cover and steering case face so as to obtain a rocker shaft end play of .1 mm (.004 in), with steering wheel in straight-ahead driving position and with a tightened cover.

Finally, tighten the cover screws and nuts to the torque given in the table on page 255.

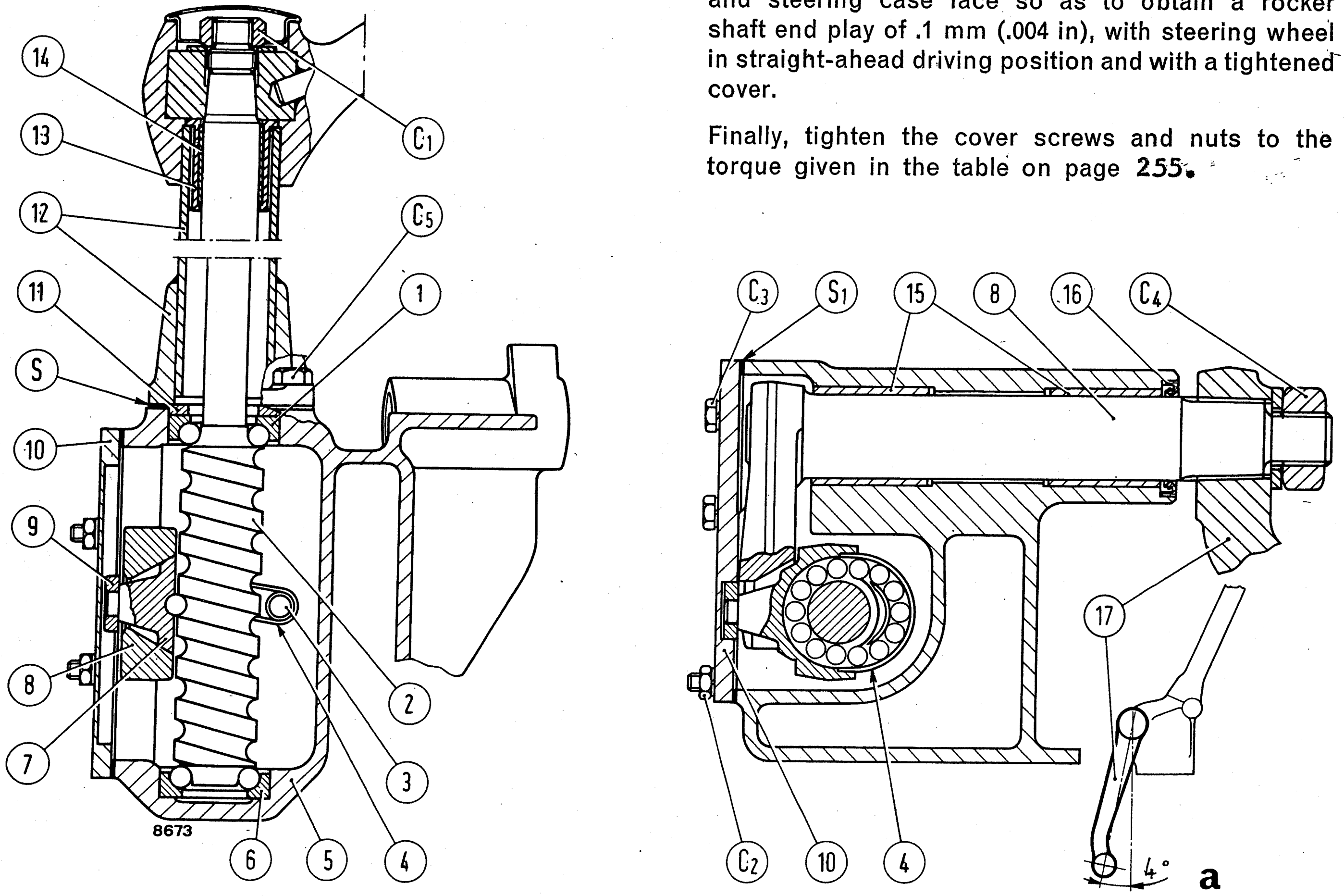


Fig. 1 - **Sections through Steering Unit**

a. Fit swing lever (17) to rocker shaft (8) so that, with the wheels in the straight ahead driving position, the swing lever is 11° forward of the vertical - C_1. Steering wheel nut - C_2/C_3. Side cover nut and screw - C_4. Swing lever nut - C_5. Top cover screw - S/S_1. Shims - 1/6. Ball bearings - 2. Worm cam - 3. Balls - 4. Ball transfer tube - 5. Casing - 7. Nut - 8. Rocker shaft - 9. Roller - 10. Side cover - 11. Spacer - 12. Top cover - 13. Outer rubber bush - 14. Lubricated-for-life inner bush - 15. Rocker shaft bushes - 16. Seal - 17. Swing lever

SUBSIDIARY SPEED REDUCTION UNIT

The subsidiary speed reduction unit, of the epicyclic gear type, is secured to the normal gear transmission and reduction unit (in this case equipped with the proper attachments and driving splines) allowing four forward creeper speeds and one in reverse. The lever (L) with three positions engages at the same time, through an inner lever and two shifter bars, the forks (3 and 4) controlling the engagement collars (1 and 2).

According to the position of the lever (L), the straight drive or standard reduction unit can be engaged through collar (1) or the subsidiary reduction unit can be engaged through collar (2).

Before the engagement or disengagement of the reduction unit it is advisable to disengage the gearbox clutch and stop the tractor. For overhaul refer to the standard gear reduction unit procedures.

Note – For the transmission ratios and speeds of the tractor equipped with auxiliary reduction unit, see the relevant table on page 99.

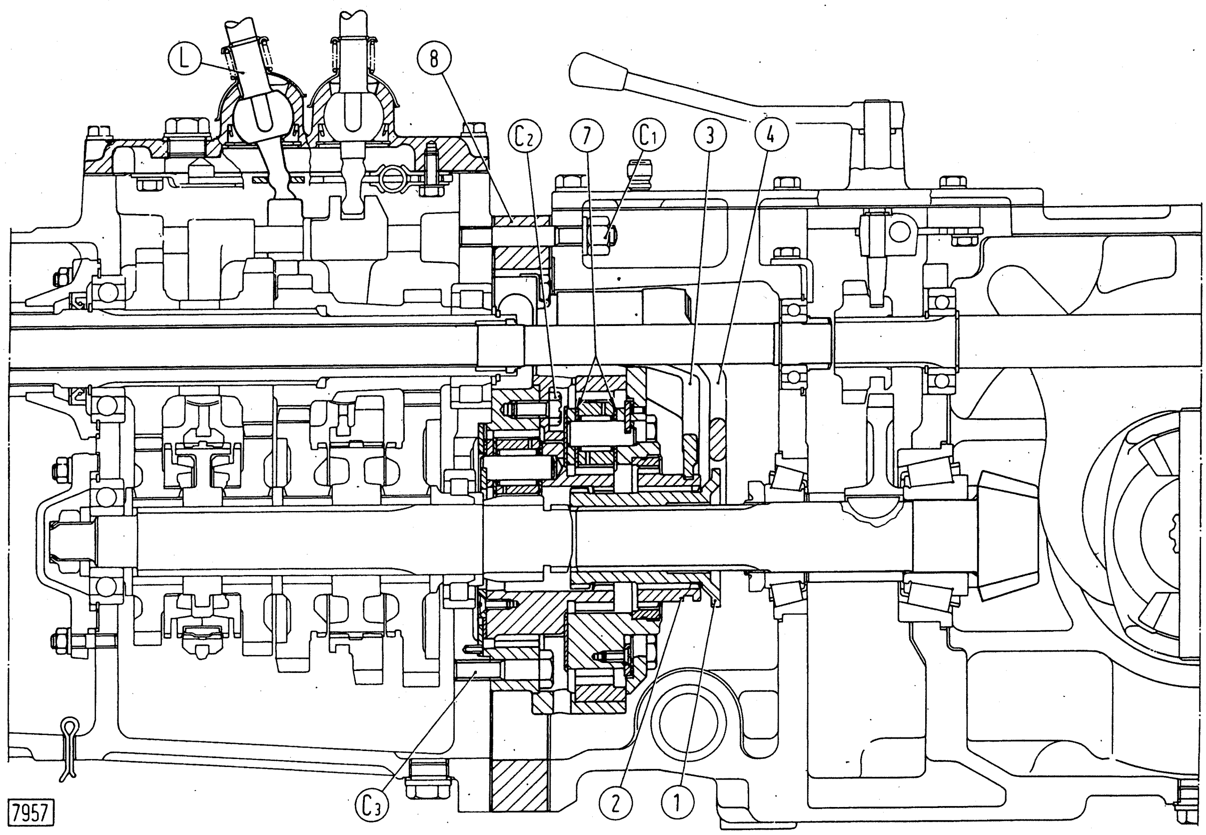


Fig. 1 - Sectional views of transmission and epicyclic speed reduction unit.

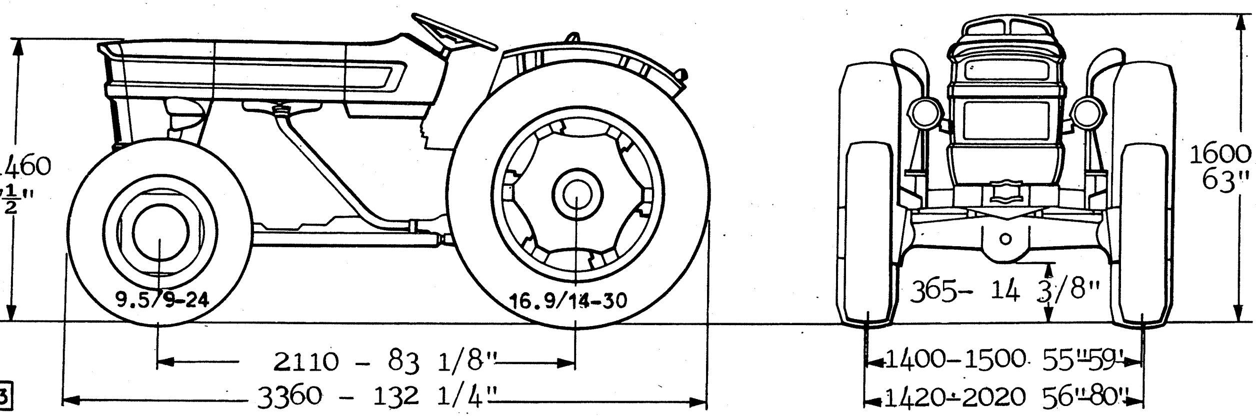
L. Speed reduction gears reduction lever - C_1. Capscrews and stud nuts securing clutch-transmission and transmission housing - C_2. Self-locking screws securing subsidiary reduction unit carrier - C_3. Self-locking screw securing the standard reduction unit ring gear - 1. Standard reduction unit and straight drive engagement collar - 2. Subsidiary reduction unit engagement collar - 3 and 4. Standard reduction unit and subsidiary reduction unit shift forks - 7. Thrust rings of reduction unit driven gear - 8. Spacer between transmission housings.

FRONT DRIVE AXLE AND POWER STEERING FILL UP DATA

Fill point	Level check intervals hours	Change intervals hours	LUBRICANT FIAT	LUBRICANT International	Q.ty Kg	Q.ty Imp/units
Gearbox, rear transmission housing, front drive transfer gearbox and hydraulic lift (*)	400	1600	Ambra 20W-40	MIL-L-2104B	20	5 Gals
Bevel gear-differential and front drive axle housing	400	1600	Ambra 20W-40	MIL-L-2104B	3,3 (4,6)	3 qts (1 Gal.)
Front drive epicyclic reduction (each)	400	1600	Ambra 20W-40	MIL-L-2104B	1,5 (1,85)	2 4/5 pts (1.7 qts)
Power steering(*)	400	1600	Ambra 20W-40	MIL-L-2104B	2,2	4 pts
Grease nipples, front axle pivot and steering	50	-	FIAT G9 grease	NLGI2	—	—
Spherical bearings and universal joints of front drive axle shafts (at assembly)	-	-	FIAT MR3 grease	NLGI3	—	—

Note - The enclosed values refer to mod.640 DT3. For other lube data see table on page 100 reporting the fill-up data relevant to model 640.

(*) For temperatures below 0°C (32°F) use oliofiat AMBRA 10W/30.



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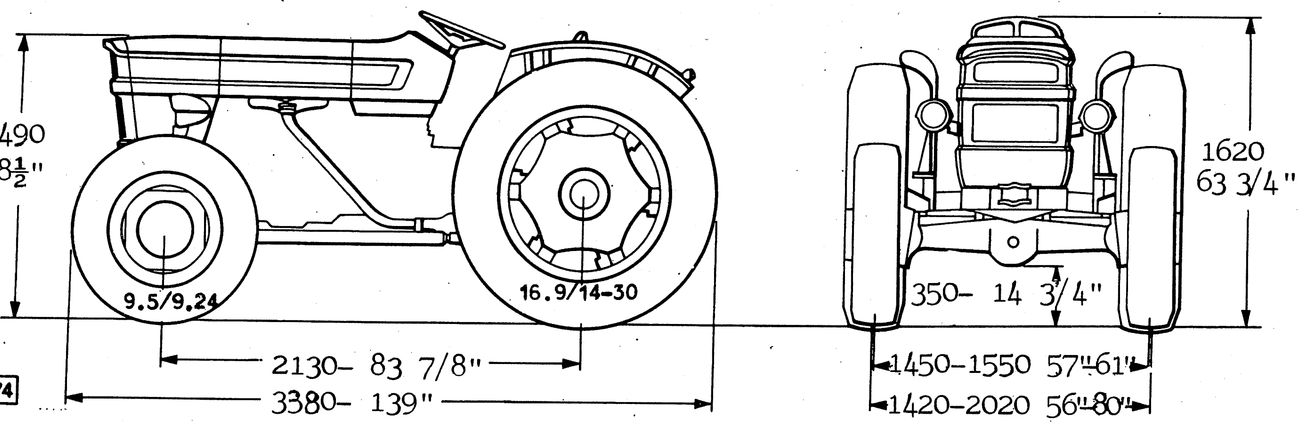
Overall dimensions of the tractor model 640 DT



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Overall dimensions of the tractor model 640 DT3.

Tractor weight: model 640 DT, kg 2380 (5245 lb)–640 DT3, kg 2500 (5510 lb)

FRONT WHEEL DRIVE

FRONT AXLE

DESCRIPTION

The front wheel drive installed on the 4-wheel drive version is of the oscillating, supporting structure type.

The front wheel drive is engaged by pulling back the control lever (A,Fig. 8). Motion is tapped from the tractor gearbox through the front drive tran= smission box installed under the gear box to the front axle bevel gear through a universal joint propeller shaft. A 2-gear differential transmits power to the front wheels through axle shafts interconnected by means of uni= versal joints and final drives of the epicyclic gear type (3-planetary gear sets), incorporated inside the wheel hubs.

The model 640 can be supplied with a heavy-duty type front axle (640 DT3), equipped with components diffe rently proportioned with respect to the standard front wheel drive type (640 DT) as indicated in the specifi cation and data table.

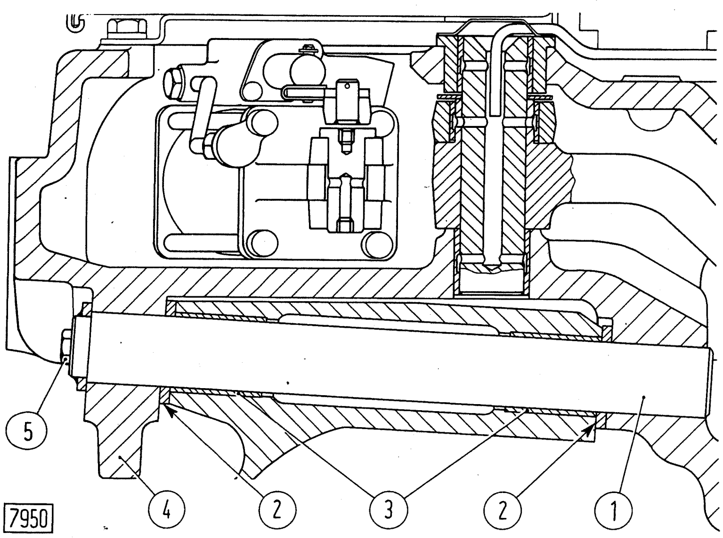


Fig.1 - Cross-section of front axle pivot assembly

1. Axle trunnion - 2. End washers - 3. Bushings - 4. Axle mounting - 5. Screw securing trunnion

REMOVAL

Remove the front wheel drive unit from the tractor as follows :

- put on the hand brake, place a stand under the front axle support, lifting the front end of tractor ;
- remove the propeller shaft and both steering tie-rods ;
- drive out the front axle trunnion by means of the sliding-hammer type puller 292927 with adaptor 290793 (M12x1.25);
- remove the axle and recover from the inside the end washers (2, Fig.1).

OVERHAULING THE EPICYCLIC-GEAR FINAL DRIVES, WHEEL HUBS AND STEERING JOINTS

The final drives can be overhauled on the tractor also: in this case, put on the hand brake and insert suitable wooden wedges under both front wheels.

Disassembly and inspection

If the front drive has been removed from the tractor we recommend installing it on the universal stand (Fig.2).

Proceed then on each sub-assembly ac= cording to the following notes and direc tions.

1. Epicyclic gear final drive cover and housing complete with gears :

- drain lubricating oil ;
- make assembly marks on cover and wheel hub (13, Fig.3).

Remove the o-rings and replace them if damaged.

If necessary, remove the planetary gears from the housing after driving out their axles (1, fig.5) and recovering end washers (2). Separate the cylindrical

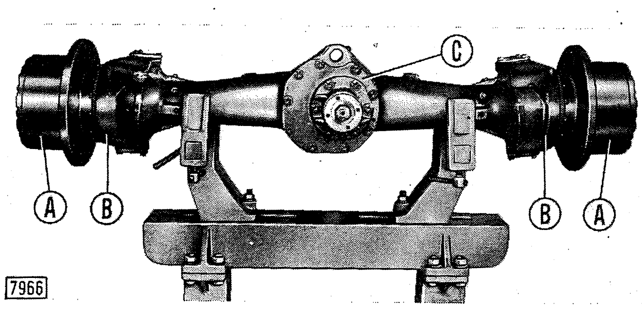


Fig.2 - Front drive unit installed on turnover stand Ar. 2215.

A. Wheel hubs complete with planetary gear final drives - B.Steering joints - C.Bevel gear and differential housing.

roller bearings from gears only in case they are to be replaced.

Note - All the above operations can be carried out on the tractor,without removing the front wheels.

2. Fixed final drive ring gear and cluster gear (10 and 11, Fig. 3) :

- remove the sun gear (3, Fig.5);
- unscrew the locknut (C_{10}) with the wrench 292517 (Fig.3,a);
- withdraw the complete group from the splindle shaft (Fig.3,b) using, if necessary, two puller screws M8x1,25 fitted to the holes indicated by the arrow in (a).

Recover the bearing spacer (12,b) and shims (S_1).

In case of replacement, remove the bearings using two puller screws (Fig. 4,a) or suitable pullers of the set 292904 (b).

3. Wheel hub (13, Fig.3).

4. Spindle shaft complete with wheel hub support.

Replace the bushings (9, Fig. 5) , if worn after removing it by means of a suitable puller belonging to the set 292911.

5. The halfshaft (5) :

- drain the lubricating oil in the bevel gear -differential case.

- remove screw (4) securing the bearing support.

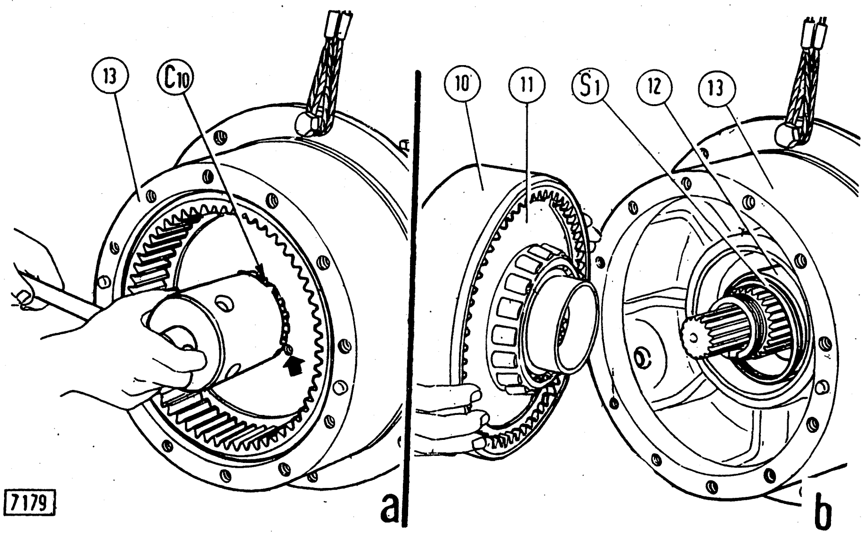
6. The knuckle pin caps, recovering the relevant shims (S_2, Fig.5).

If necessary, remove using suitable pullers the spherical bearings (10) with anti-friction plastic cages.

Fig.3 - Removing (installing) the ring nut (C_{10}) securing the wheel hub,with wrench A.292517(a),the crown and gear group (10 and 11) and the wheel hub unit (13,b).

(Arrow indicates one of the two threaded holes spaced 180°suitable for puller screw use).

S_1.Wheel hub gear bearing shims-
12. Bearing spacer.



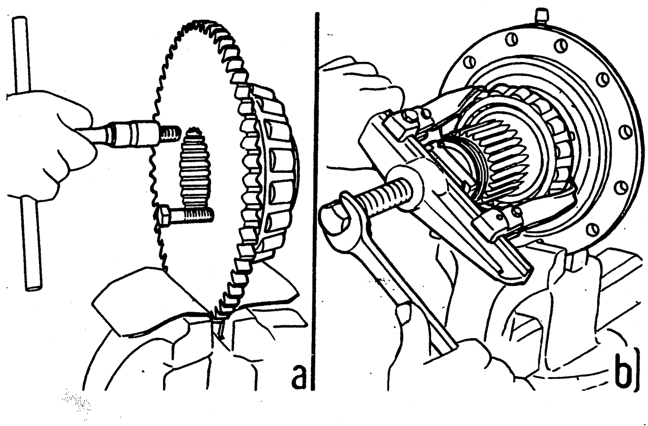


Fig.4 - Removing the bearings from gear (a)using two puller screws (M8x1.25) and the spindle shaft (b) with universal puller.

ASSEMBLY

Refer to Fig.5, paying attention to the assembly marks made previously,and tighten bolts and nuts to the torque values specified in the table of data. Also consider the following notes :

- fit the oil seals after having cleaned and dried their seats. The oil seals for the axle shafts (11,Fig.5) must be oriented with their lip on the oil tight side and be a light press fit in their respective seats.
We recommend a light application of clean grease on the lip.
Successively when fitting the axle shafts be careful not to cut or damage the seal lip with any sharp edge :

- adjust the steering bearing and wheel bearings pre-load as specified in the chapter describing the adjustments (pag.230);

- fill up the units (wheel hub,bevel gear and differential case) with specified quantities of oil of the proper type and grade.

OVERHAULING THE BEVEL GEAR-DIFFERENTIAL UNIT

After draining the lube oil from the bevel gear-differential case and removing the group consisting of epicyclic-gear final drives, wheel hubs and steering points from both ends of the front drive, remove the complete bevel gear differential unit (c, Fig. 2) by withdrawing the case from the axle housing.

Disassembly, inspection, assembly

Separate the bevel pinion bearing housing from the bevel gear-differential case, recover the seal (7, Fig.5), the shims (S_4) and disassemble on the work bench as follows :

- install the complete support on the rig 291707, remove the self-locking nut (C_2, Fig.5) and withdraw the drive sleeve being careful not to damage the oil seal (6);

- drive out the bevel pinion complete tapping carefully on the threaded end, then disassemble it. Check o-ring (7) and seal (6) and replace them if damaged.

To disassemble the bevel gear-differential unit :

- separate the unit from the bearing housing by removing the adjustment ring nuts (8) and caps (18, Fig. 6);

- remove the self-locking screws (C_5, Fig.5) to detach the bevel gear ;

- if necessary, remove the differential gears by withdrawing the pinions shafts.

Measure wear on component parts versus the relevant specifications reported in the table of data.

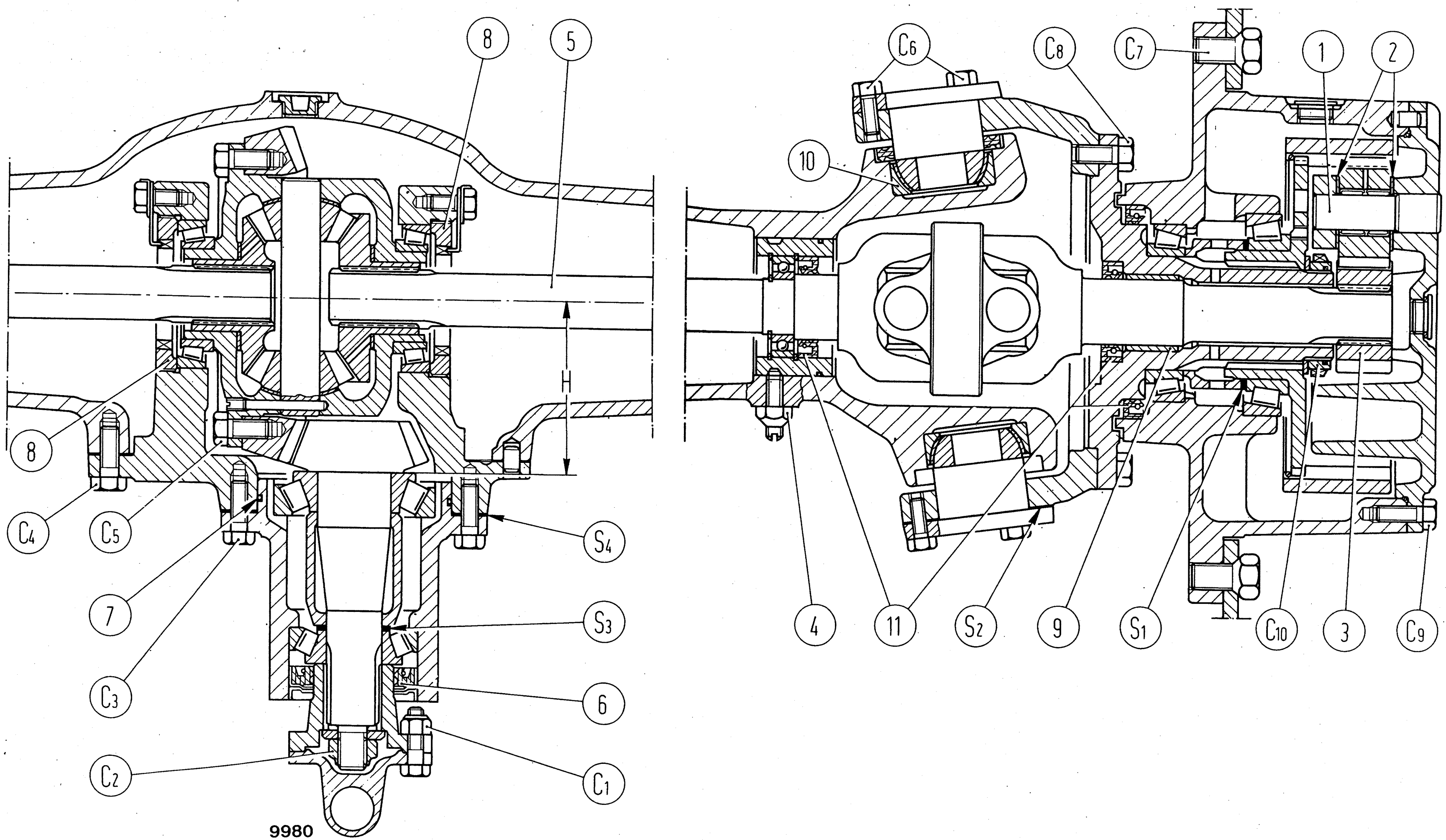


Fig. 5 - Front drive cross section.

C_1. Nuts, prop-shaft screws - C_2. Nut, bevel gear pinion shaft - C_3. Screws, pinion housing - C_4. Differential case screws - C_5. Bevel gear crown screws - C_6. Bearing housing screws - C_7. Front wheel screws - C_8. Spindle shaft screws - C_9. Planet gear housing screws - C_{10}. Ring nut, wheel shaft bearing - S_1. Wheel hub bearing adjustment shims - S_2. Steering spindle adjustment shims - S_3. Bevel gear pinion shaft bearing adjustment shims - S_4. Bevel gear pinion cone center distance adjustment shim pack - 1. Planet gear pins - 2. End washers - 3. Sun gear - 4. Screw, securing axial position of axle shafts - 5. Axle shafts - 6. Oil seal - 7. O-ring - 8. Ring nuts for bevel gear bearing adjustment - 9. Bushings - 10. Spherical bearings 11. Axle shaft oil seals - H = 107 mm (4,212 in). Nominal dimension from crown wheel centre line to back of pinion.

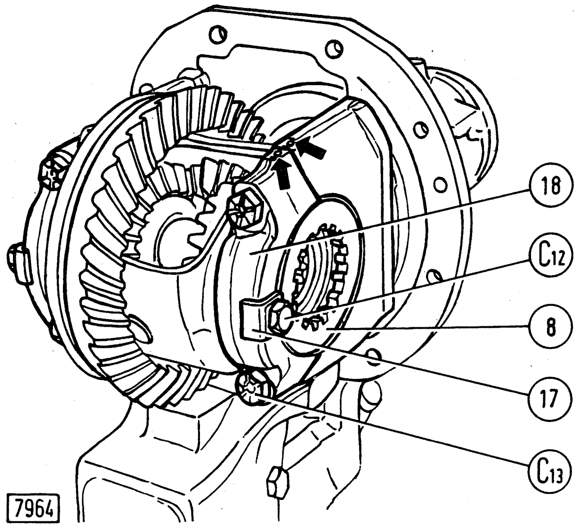


Fig.6 - View of bevel gears and differential.

(Arrows indicate marks punched during manufacture on differential housing and supports).

C_{12}. Ring nut safety tab screws - C_{13}. Cap holding screws - 8. Adjustment ring nuts - 17.Ring nut safety tab - 18. Bearing caps.

At assembly, arrange the differential supporting caps, making sure that the factory assembly marks are in register (Fig. 6).

Adjust the bevel gear and pinion setting using the necessary special tools and following the directions given in the chapter dealing with the adjustments.

Make sure to tighten threaded fastenings to torque specification.

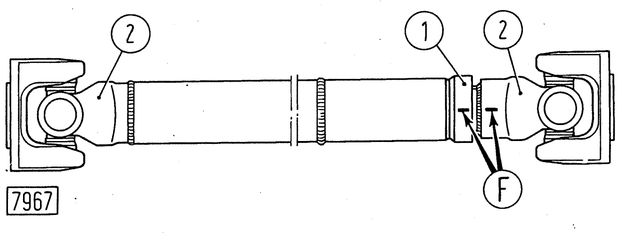


Fig. 7 - Propeller shaft.

F. Arrow marks on shaft for correct joint assembly - 1. Joint coupling sleeve - 2. Clevises.

PROPELLER SHAFT

The propeller shaft (Fig. 7) transmitting motion to the front axle has universal joints at both ends with link block provided with needle bearings lifetime lubricated.

To remove the shaft as a unit from the tractor first remove the nuts (C_1, Fig.5) which secure it to the pinion sleeve and the bolts (C_{13}, Fig.8) which secure it to the transfer unit flange.

To disassemble the shaft, unscrew the sleeve (1, Fig.7) to separate the universal joints.

At re-assembly make sure to apply multipurpose grease FIAT G9 (NLGI 2) to the clevises inside and over splined sections. Besides, arrange the clevises(2) so that the reference arrows (F), are in register and the center lines through the link block pins lie over the same plane.

FRONT DRIVE TRANSFER GEAR UNIT

Description

The transfer gear unit transmitting the engine torque to the front drive is enclosed in a case (B, Fig.8)attached below the rear transmission casing and consists of a spur gear train. The front drive is engaged by means of a sliding collar (8, Fig.9,b) on tractor 640 DT3 and by means of a gear (6, Fig.9,a) sliding on the output shaft on tractor 640 DT. The front drive engagement is actuated on both models by the hand control lever (A, Fig.8).

Overhaul

Remove the transfer gear unit from tractor as follows :

- drain the oil from transmission case ;

- disconnect the propeller shaft, place a trolley below the case and remove the complete unit after removing the screws which secure it to the tractor.

For the transfer gear case belonging to tractor 640 DT3 (Fig.9,b) disassemble the unit by removing :

- the snap ring (1), the cover (2) by manouvering a screw (M8x1.25) inserted in the threaded hole present on the cover ;

- the snap rings (4) on driven shaft;

- the driven shaft (3) supporting the gears using suitable drifts.

Check the seal (10) on the driven shaft, the ring seal (5) on cover (2) and the ring seals on the shifter rod.

Re-fit the parts referring to Fig. 9,b considering that at assembly is necessary to adjust the position and the end play of the driven gear (6) by means of shims (7) in such a way that, after the engagement, the collar (8) is completely in mesh with the splines of the driven gear and with an axial play of 0.2 to 0.5 mm (.008 to .02 in).

For the transfer gear case belonging to tractor 640 DT (Fig.9,a) disassemble the unit by removing :

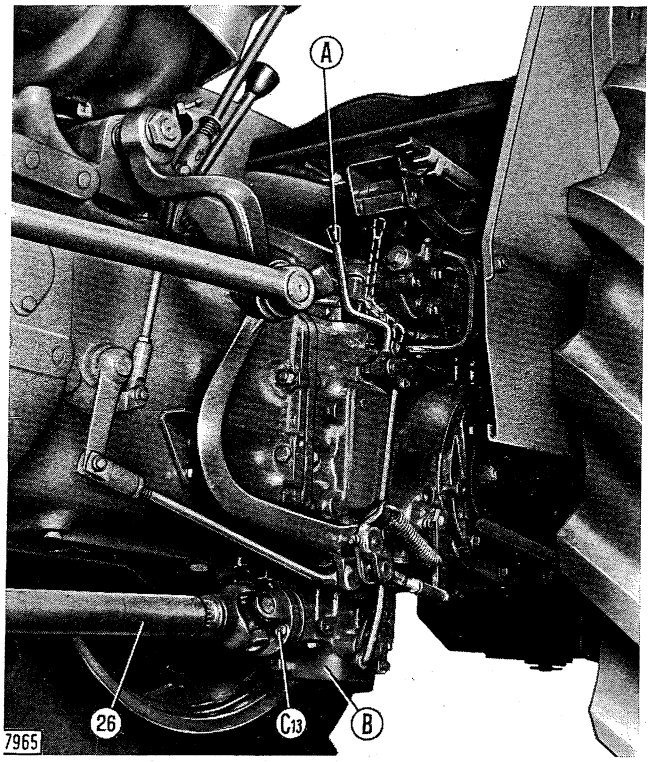


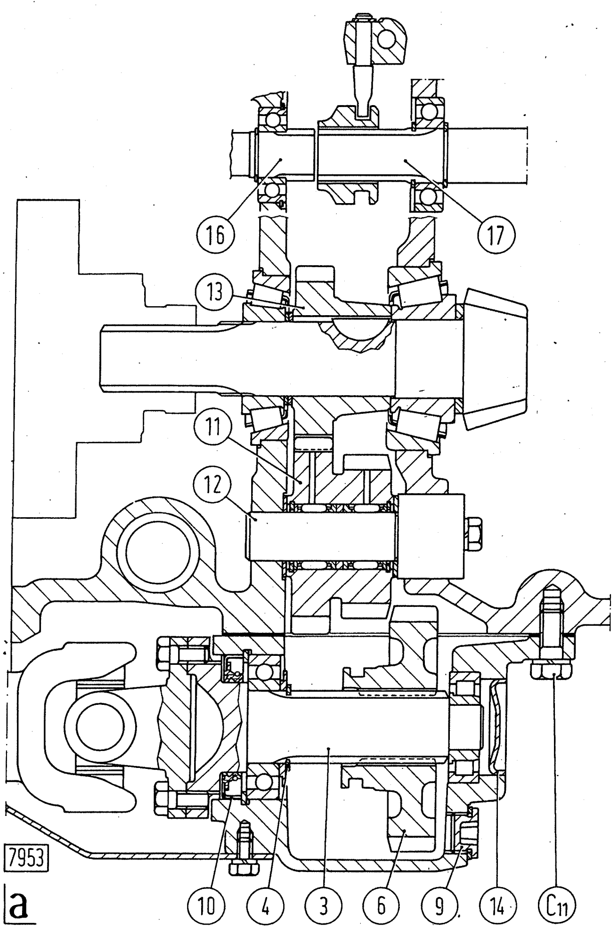
Fig. 8 - Front drive transfer gearbox installed.
A. Control lever (the broken lines indicate that the F W D control lever is shifted in) - B. Transfer gearbox - C_{13}. Prop-shaft securing screws - 26. Propeller shaft.

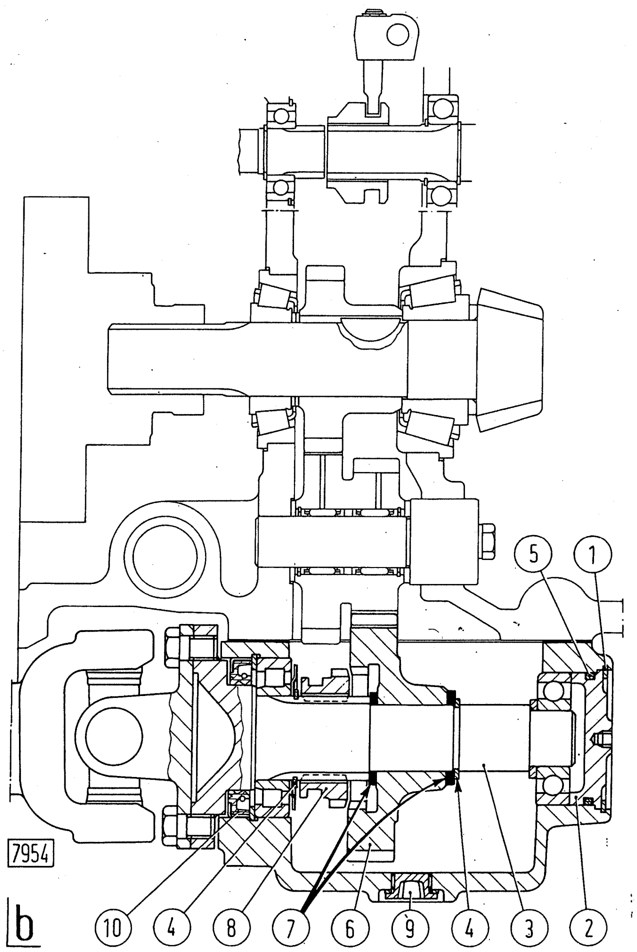
- the plug (14) and the snap ring (4) from driven shaft ;

- the driven shaft (3) supporting the gears using a suitable drift. Check the driven shaft seal (10) and the ring seals on the shifter rod.

Re-assemble the parts referring to Fig.9,a.

Re-fit the transfer gear unit to the tractor inserting the gasket.





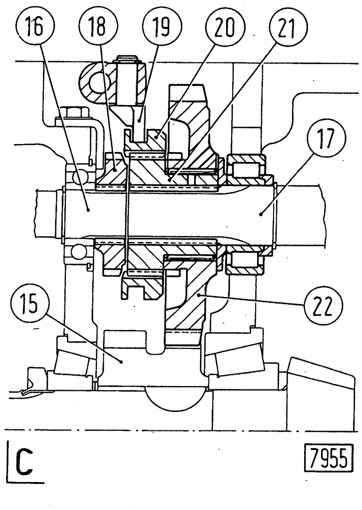


Fig. 9 - Sectional view of front drive transfer units for tractor 640 DT (a) and for tractor 640 DT3 (b).

C. Sectional view of the ground speed P.T.O. control. In this case the gear 13 (a) is replaced by double gear (15) - C_{11}. Screws securing transfer unit casing - 1. Snap ring - 2. Cover - 3. Drive shaft - 4. Snap ring - 5. O-ring - 6. Driven gear - 7. Adjustment shims - 8. Engagement collar - 9. Oil drain plug - 10. Oil seal - 11. Driving gear - 12. Driving gear shaft - 13. Driving gear keyed to pinion shaft - 14. Plug - 15. Double gear keyed to pinion shaft - 16. P.T.O. clutch shaft - 17. P.T.O. driving shaft - 18. P.T.O. driving gear in engine speed position - 19. Fork - 20. P.T.O. engagement collar - 21. Fixed gear supporting collar (20) - 22. Ground speed P.T.O. driving gear.

ADJUSTMENTS OF FRONT AXLE

Note - In the following description the torque values and the specific tool numbers in brackets refer to tractor model 640 DT3.

Adjusting the steering spindles (Fig .10).

Install upper cover (40) together with tool A 292220 (292220), tightening the securing screws at a torque of 6.5 (12) Kgm or 46.5 (87) ft.lb.

Install lower cover (41), without shims, and lubricate the tightening screws with engine oil.

Tighten progressively the three screws of the lower cover until, with a torque wrench and tool (A), the torque necessary to rock the housing is 2.8 to 3.2 kgm or 20.2 to 23.2 ft.lb (2.3 to 2.7 Kgm or 16.6 to 19.5 lb.ft) (disregarding the torque necessary to overcome the inertia at the start).

Measure clearance (H) between the lower cover and housing, at the screws. The average value of the three readings, will give the thickness of the stack of shims (S_2, Fig. 5) to be fitted.

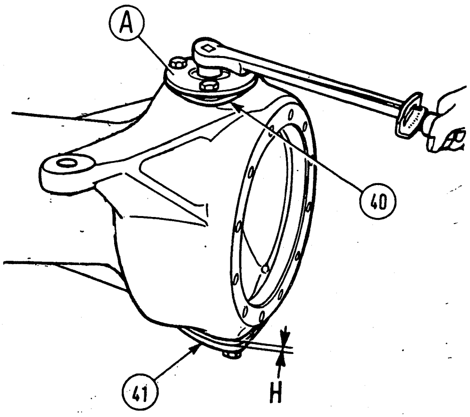


Fig.10 - Finding the spherical bearings shim stack (S_2, Fig.5) by means of tool A 292220 (292220) H. Clearance between case and cover - 40. Upper cover - 41. Lower cover.

The stack thickness of adjustment shims (S_1, Fig. 5) to be fitted is given by:

$$S_1 = H_1 - H_2$$

If necessary, round off in excess the value (S_1) within 0,05 mm or 0,019 in.

Adjusting the wheel hub bearings (fig. 11, b, c).

Install on fixture (D) 292500 (292505) the inner races (24 and 25) of the wheel hub bearings with spacer (12).

Tighten completely nut (E) of the tool.

Measure dimension (H_2) between the fixture spindle end below the top surface of the same fixture.

Dismantle the shim stack, lubricate the bearing inner races with engine oil and re-install them on the fixture inserting wheel hub (13) complete with the bearing cups.

Tighten nut (E) completely and simultaneously keep on turning the wheel hub about 10 revolutions to ensure a proper bedding-in of the bearings.

Measure as before dimension (H_1) on the fixture under these conditions.

Adjusting the bevel gear pinion shaft bearings (Fig. 12, d, e).

Install inner races (3 e 7) of the bevel gear pinion and spacer (4) on fixture (E) 292501 (292503).

Tighten nut (M) of tool completely (a torque of 4 Kgm or 29 lb.ft is sufficient).

Measure dimension (H_4) of the fixture spindle end below the top surface of the same fixture.

Dismantle the previous shim stack ,

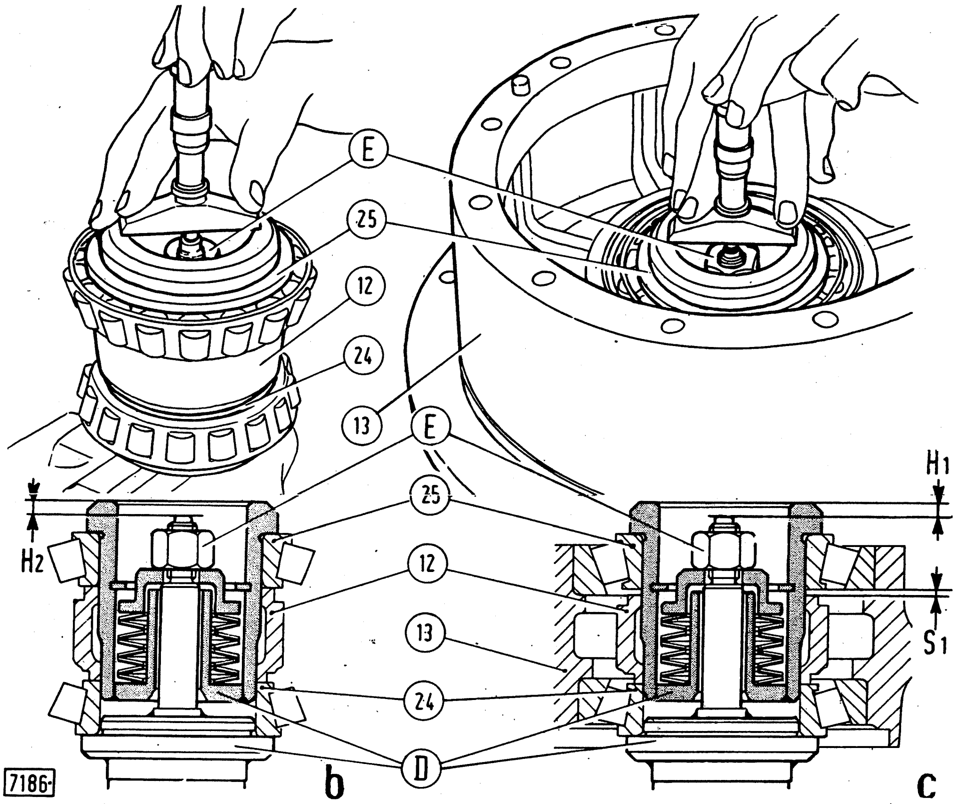


Fig.11 - Finding correct shimming value (S_1, Fig.5) for wheel hub bearings using the special adaptor D 292500 (292505).
b. How to measure dimension(H_2)-
c.How to measure dimension (H_1)-
E.Special tool nut - H_1.and H_2. Recessing of the tool central locating pin below the top face-
S_1.Thickness of shim stack -
12. Spacer - 13. Wheel hub -
24. Inside bearing cone - 25. Outer bearing cone.

lubricate the bearing inner races and re-install them on fixture (E)inserting pinion support (6) complete with the bearing outer races.

Tighten completely nut (M) and simultaneously keep on turning the pinion support about 10 revolutions to ensure a proper bedding-in of the bearings .

Measure dimension (H_3) on the fixture under these conditions.

The stack thickness of adjustment shims (S_3,Fig.5) to be fitted is given by :

$$S_3 = H_3 - H_4$$

If necessary, round off in excess, within 0,05 mm (.0019 in), the value of stack (S_3).

Setting the pinion cone center distance (Fig.13).

Install measuring elements (A,B)of fixture 292502 (292506) in the pinion support complete with inner bearing (3).

Secure the assembly to the differential support housing placing a first stack of shims (S) about 3 mm (.1181 in) thick, tightening two securing screws at a torque of 11.5(18) Kgm or 82.6 (130.2) ft.lb.

Arrange the locating element (D) of the gauge on the bevel gear-differential bearing housings and secure the caps by tightening the screws to a torque of 11.5 (18) Kgm or 82.6 (130.2) ft.lb.

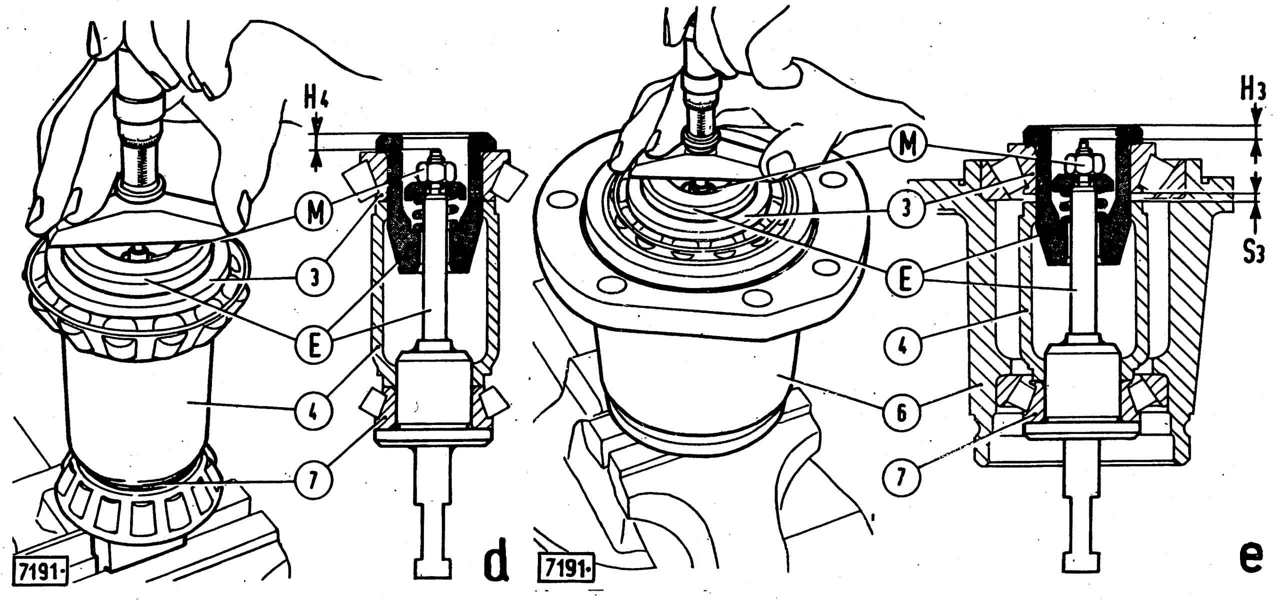


Fig.12 - Finding the correct shimminh value (S_3, Fig.5) for pinion shaft bearing adjustment using the special adaptor E 292501 (292503).

d. How to measure dimension (H_4) - e. How to measure dimension (H_3) - H_3, H_4. Recessing of the adaptor central locating pin below top face - M. Nut - S_3. Thickness of adjustment shim stack - 3. Inner bearing - 4. Spacer - 6. Bevel pinion support - 7. Outer bearing.

Tighten shaft (B) until the inner end touches element (D); keep it in position and, acting on sleeve (A), rotate bearing (3) about 10 revolutions to ensure proper bedding-in.

Measure, clearance(X).

The final value of the shims (S_4, Fig.5) to be fitted is given by :

$$S_4 = S - X \pm (Q)$$

where (Q) is the correction figure etched on the pinion, in mm, preceded by the sign + or –.

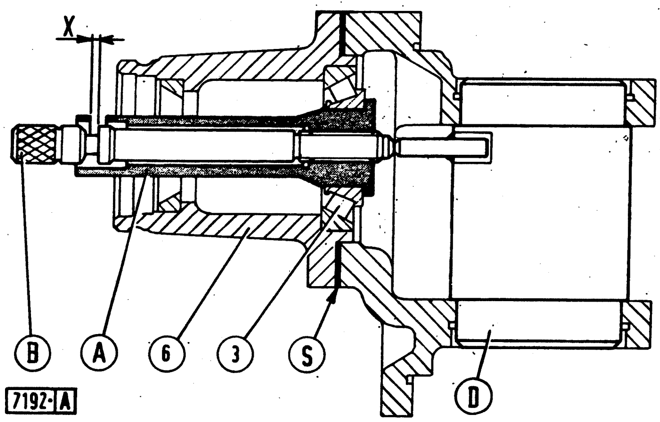


Fig.13 - Finding the correct shimming value (S_4, Fig.5) for bevel gear pinion location using special tool 292502 (292506).

A, B, C. Part of the tool - S. Shims for obtaining dimension (X) - X. Dimension to be measured - 3. Inner bearing - 6. Bevel pinion housing.

Adjusting the bevel gear bearings and checking the bevel gear and pinion tooth backlash.

Install the bevel gear-differential unit on its support without pinion and tighten the cap self-locking screws to a torque of 6 (10) Kgm or 43.5 (72.3) ft.lb.

Lubricate the bearings with engine oil, act on ring nuts with wrench 292416 (292219) turning, simultaneously, the bevel gear until the bearings end-play is eliminated.

Screw-up each ring-nut one more detent and tighten completely the cap screws at a torque of 11.5 (18) kgm or 82.6 (130.2) ft.lb. Under these conditions, the twisting torque necessary to make the bearing turn is from 0.15 to 0.28 Kgm or 1.08 to 2.02 ft.lb disregarding the torque necessary to overcome the inertia at the start), corresponding to a dynamometer reading of 2 to 3 Kg (4.4 to 6.6 lb). This bearing rolling torque is measured by means of a dynamometer connected to a rope wound around the differntial housing.

Secure the pinion unit to the differential housing and set the bevel gear tooth backlash at the value of 0,15 to 0,20 mm or 0.0059 to 0.0078 by screwing-up one of the ring nuts and unscrewing the other one of the same amount of detents.

DRIVING WHEELS

The driving wheels, both front and rear, can be supplied with the tyres indicated in the following table.

It is indispensable to match the tyres as indicated to avoid tyre slippages and wear.

Front		Rear
9.5/9-24	with	12.4/11-36
9.5/9-24	"	16.9/14-30
8.3/8-24	"	14.9/13-30

At the rear, eight track settings can be obtained from 1320 to 2020 mm (52" to 80") in steps of 100 mm (3.94 in) each (the 1320 mm or 52" track setting cannot be obtained with tyres 16.9/14-30).

Keep in mind that it is advisable to adopt the track setting value nearest to that of the front steering and driving wheels.

At the front by turning the wheels two track settings are available : 1400 mm (55") and 1500 mm (59") for mod. 640 DT , 1450 mm (57 ") and 1550 mm (61 ") for mod 640 DT3.

POWER STEERING

The power steering is supplied as an optional and can be of the external cylinder type, or with the cylinder placed inside the front axle bracket (on the DT models only the second type is installed).

POWER STEERING WITH CYLINDER INSTALLED IN FRONT AXLE BRACKET COMPARTMENT

The steering power-assist plant consists of the following major parts (Fig.2) :

- the oil reservoir (S) containing the filter (6) with replaceable element made of tin-plated steel mesh, located on the pump suction end.The reservoir is bracketed on the front end of engine ;

- the gear-type pump (P_1) driven by the engine timing gears ;

- a valve block (B), inserted on the suction and pressure lines,provided with two valves,incorporated; pressure relief valve (1) set at 95 to 100 Kg/cm^2 (1351 to 1422 p.s.i.) and anti-cavitation (check) valve (2) which allows steering the tractor with engine stopped or pump inoperative. In these cases, the anti-cavitation valve opens allowing the oil discharging from either chamber of the cylinder to flow to the other , thus avoiding the occurrence of vacuum in the latter ;

- a double-acting hydraulic cylinder (C) and spool-type control valve (D) installed in the front axle bracket (Fig.1) ;

- piping and hoses, connecting the various circuit components.

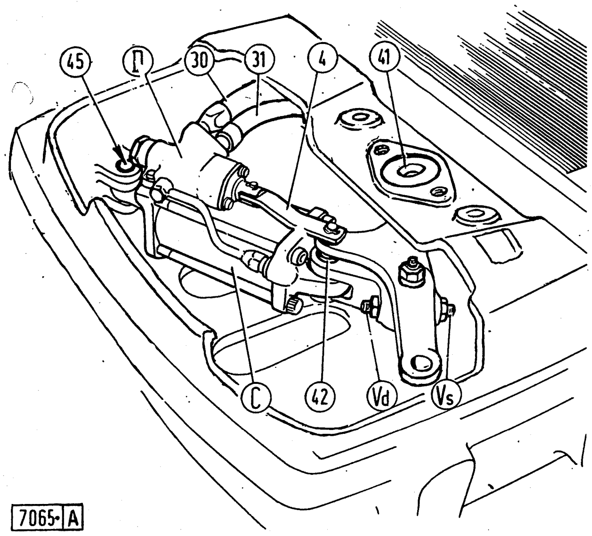


Fig.1 - Power-assist cylinder and control valve installation in front axle mounting.

C. Power-assist cylinder - D. Control valve - Vd. Right-hand side adjustment screw - Vs. Left-hand side adjustment screw - 4. Valve spool control rod- 30 and 31. Power and drain line - 41. Steering arm center pivot - 42. Cylinder attachment pin to steering arm - 45. Piston rod attachment pin to front axle bracket.

Power-assist operation (Figs.2 and 4).

The lever (35), controlled through the drag link (36) is pivoted on the fixed central pin (41) and is free to turn with respect to the steering arm (37) through an angle which is given by the distance (X_1 and X_2) separating the ends of the adjustment screws (Vd and Vs), positively attached to the arm (37), from the pin (38) which is in turn attached to the lever (35). In the course of this rotation the lever (35) actuates the control valve rod through the link (4). With the engine stopped or if the hydraulic plant is inoperative it is still possible, by applying a sufficient force to the steering wheel, to turn the lever (35) beyond this angle, dragging the arm (37) also (mechanical steering).

The steering arm (37) which controls the tie-rods is pivoted on the central fixed pin (41) and can be actuated : normally by the power-assist cylinder, through the connecting pin (42); in case of mechanical steering by the lever (35) through the intermediate pin (38) and one of the adjustment screws.

The hydraulic control valve can take one of the following positions :

a. Neutral : no power cylinder motion. In this position, in fact, the rod (12) remains centered with respect to the grooves on the control valve body and the ports (E, H, L, N) are uncovered. This allows the free flow of the oil from the pump to the reservoir.

The cylinder chambers (A_2 and B_2) are open to each other and to drain. The pin (38) solid with the control lever (35) is set at an intermediate position between the two adjustment screws (Vd and Vs).

b. Right-hand steering. The clockwise rotation of the steering wheel causes a forward longitudinal displacement of the link (36) and the clockwise rotation of the lever (35) which tends to take up the play (X_1).

This displacement is transmitted, through the link (4), to the control valve spool (12) which moves inward, overcoming the opposing spring force.

Following the axial displacement of the spool the ports (H and N,a), through which flows the oil coming from the pump and directed to the cylinder chamber (A_2) and to the drain are partially covered, or, when the lever rotates to the fullest extent (play X_1, completely taken up), completely covered.

The pressure oil is thus allowed to flow into the cylinder chamber (B_2) through the port (L) and passage (B_1) and cause the displacement of the same and, consequently, the clockwise rotation of the arm (37).

The oil contained in the opposite chamber of the cylinder (A_2) can drain out through the passage (A_1) and port (E) which has remained open.

Simultaneously with the cylinder moves the control valve body also, positively connected to it, and consequently the spool (12) tends to return to neutral as shown in (a).

However, steering continues if the operator "precedes" the control valve displacement by turning the steering wheel, holding the spring compressed.

Steering is completed when operator lets the steering wheel loose thus allowing the spool (12) to return to neutral by effect of the movement of the cylinder and control valve.

c. Left-hand steering. The steering wheel and the levers and linkage move in the direction opposite to that indicated in para(b). In this case, it is the clearance (X_2) between levers (35 and 37) which is taken up and the control valve ports (E and L) are covered.

The oil will thus drain out of the chamber (B_2,c) through the port (N) and the axial passage in the spool (12), and pressurize the chamber (A_2) through (H).

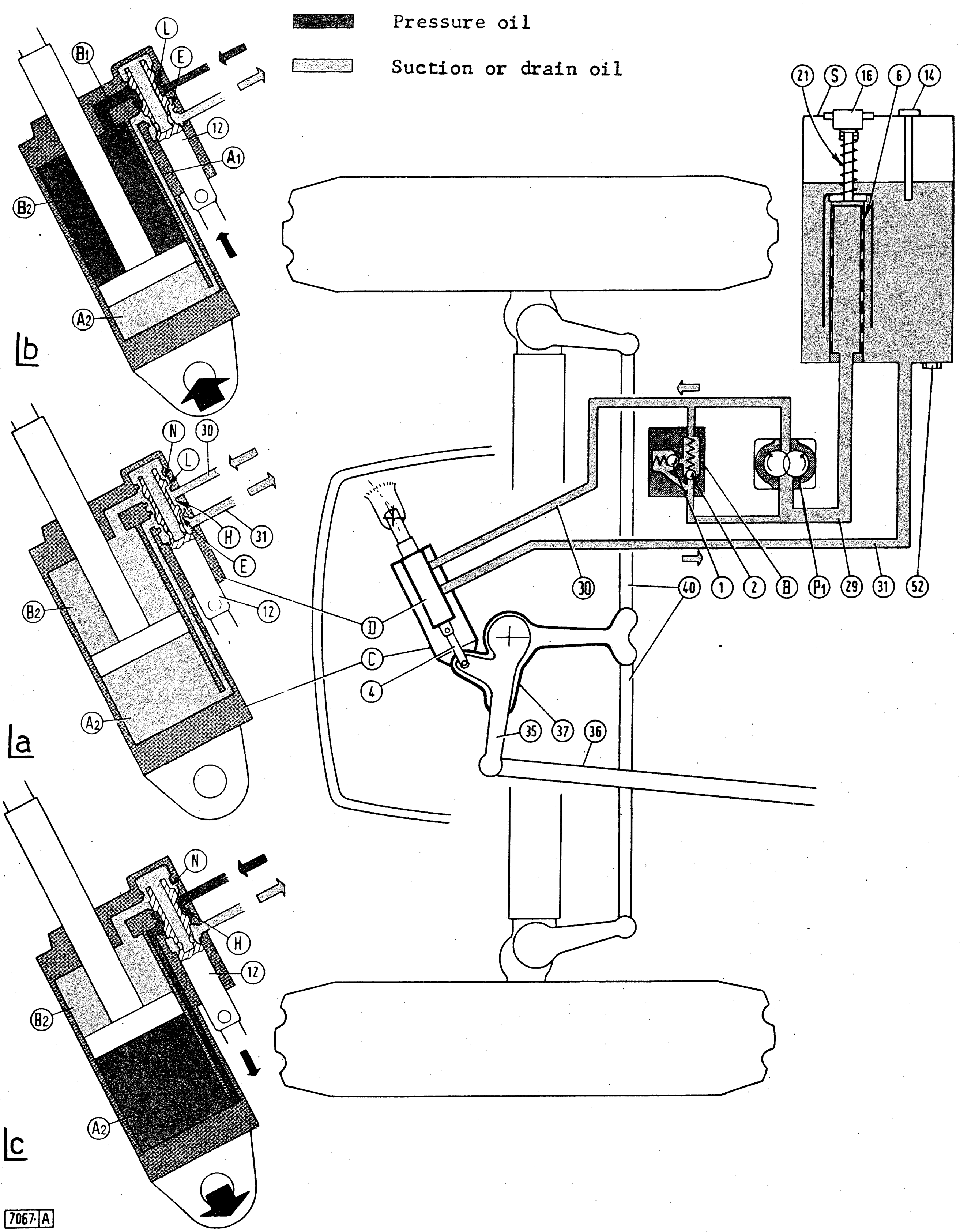


Fig. 2 - Power steering hydraulic diagram.

a. Neutral - b. Right-hand steering - c. Left-hand steering.

A_1 and A_2. Connection line and cylinder chamber on hinging side - B. Valve block - B_1 and B_2. Connection line and cylinder chamber on piston rod side - C. Power steering cylinder - D. Control valve - E, H, L, N. Control valve ports - P_1.Hydraulic pump - S. Oil reservoir - 1. Pressure relief valve - 2. Check valve - 4. Link connecting control lever to valve spool - 6. Filter cartridge - 12. Valve spool - 14. Oil filler plug with dipstick - 16. Breather and access plug to filter - 21. Cartridge retaining spring - 29. Suction line - 30. Pressure line - 31. Drain line - 35. Control lever - 36. Drag link - 37. Steering arm - 40. Tie-rods - 52. Oil drain plug.

The cylinder is subjected to a displacement which will cause the steering arm (37) to turn counterclockwise and will stop with the return to neutral by the control valve, once the rotation of the steering wheel is stopped.

Overhauling the power-assist cylinder and control valve.

Withdraw the pins (42 and 45,Fig.4) attaching the cylinder to the steering arm and front axle bracket by unscrewing the retaining screws and nut and then separating the valve spool from the control link (4).

Disconnect the oil lines (30 and 31) and then remove the cylinder (C) and control valve (D) as an assembly.

Separate the control valve from cylinder by removing the two screws (44, Fig.4) and disconnecting the connecting pipe (32).

Disassemble the control valve by removing the cover screws (7 and 8, Fig.3) and withdrawing, carefully, the spool (12) and clevis (5).

Disassemble the cylinder by removing the four tie-rods (19) securing the heads to the barrel.

Wash components in kerosene,avoiding solvents which might damage the rubber rings, and check :

- oil seals, replacing them if hardened or out-of-shape, or with the lips cut or torn-off ;

- assembly clearance between pivots and bushings or between pivots and

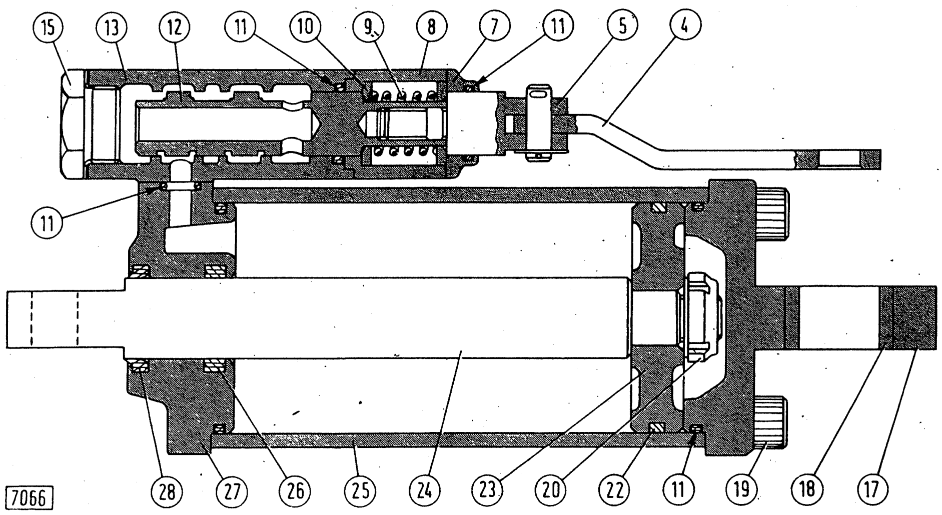
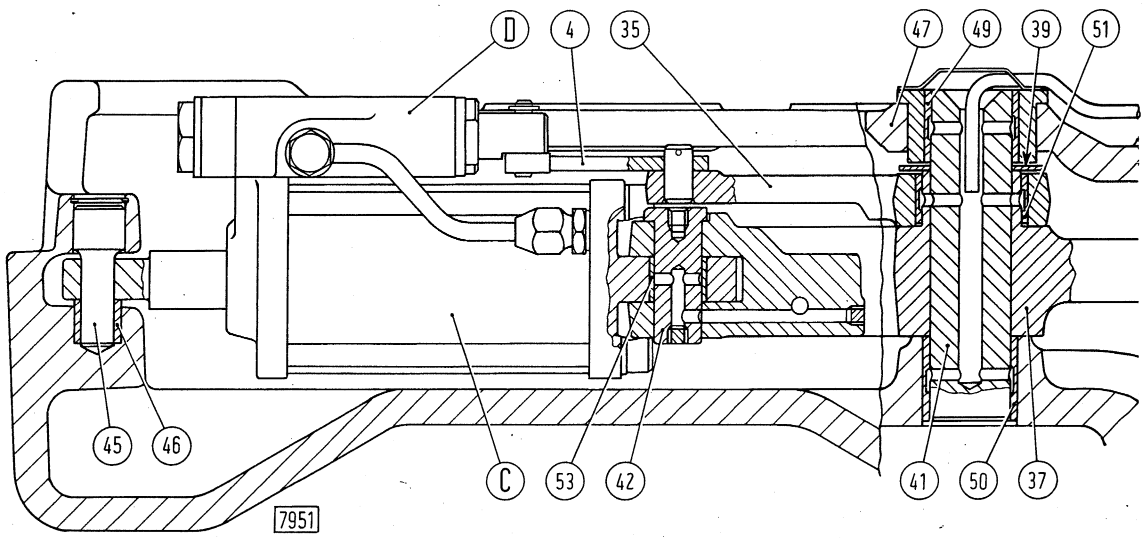


Fig.3 - Power-assist cylinder section.

4. Link connecting control lever to valve spool - 5. Clevis - 7. Cover - 8. End cover - 9. Return spring - 10. Washers - 11. O-rings - 12.Valve spool - 13. Control valve body - 15. Plug - 17. Hinge-side cylinder head - 18. Bushing - 19. Cylinder heads connecting rods - 20. Piston self-locking locknut - 22. Piston ring - 23. Piston - 24.Rod - 25. Barrel - 26. Oil seal - 27. Rod-end cylinder head - 28. Mud scraper.



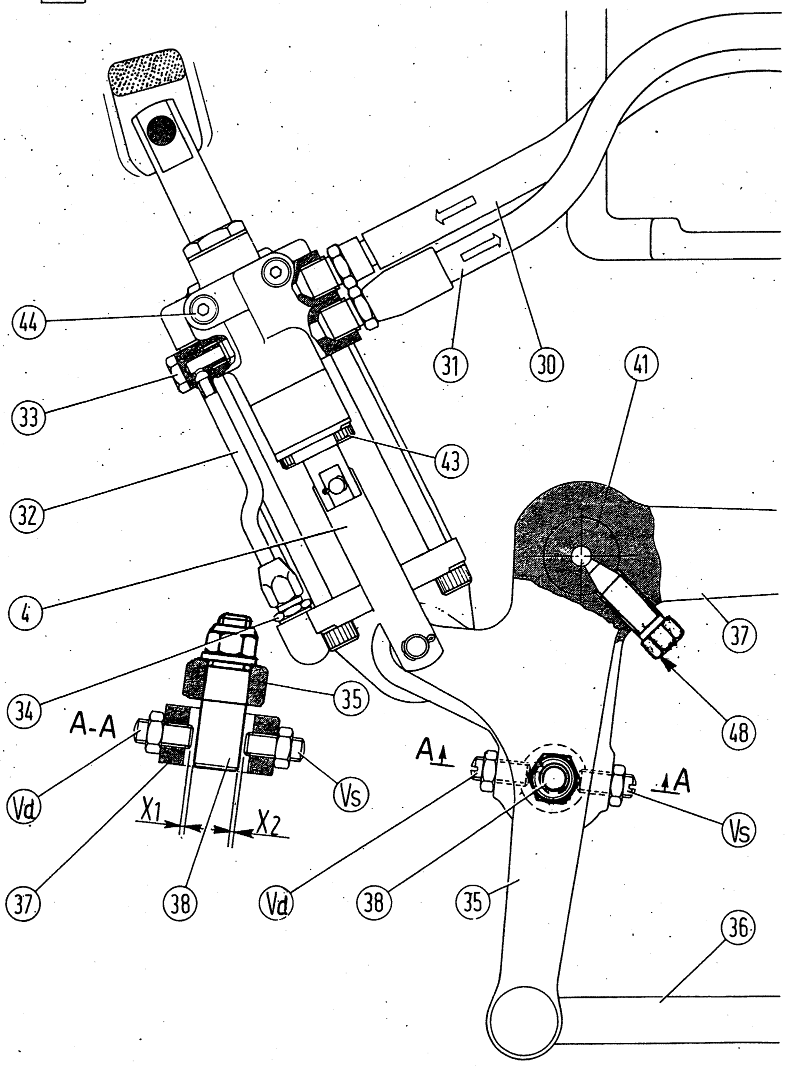


Fig.4 - Power-assist cylinder installation in front axle mounting and sectional view of the control levers.

C. Power-assist cylinder - D. Control valve - Vd and Vs. Adjustment screws for the control valve spool travel - X_1 and X_2.(= 1.5 mm or 0.059 in). Clearance between screws and pin (38) - 4. Valve spool control rod - 30. Power line - 31. Drain line - 32. Tube connecting control valve to the cylinder chamber opposite the piston rod - 33 and 34. Connections - 35. Control lever - 36. Drag link - 37. Steering arm - 38. Central pin solid with lever (35) - 39. Thrust washer - 41. Steering arm pivot pin - 42. Pin connecting hydraulic cylinder and steering arm - 43 and 44. Screws securing cylinder control valve cover to body - 45. Piston rod attachment pin - 46. Bushing - 47. Front axle mounting - 48. Pin (41) retaining screw - 49 and 50. Pin (41) pivot bushes - 51 and 53. Bushings.

their locations in the various le= vers comparing the measures to the data or the specification table ;

- surface conditions of valve and cylinder rod to make sure they are free from scoring or faults.

At assembly, lubricate components and refit them referring to Figs. 3 and 4, and make sure to insert the o-rings, considering that :

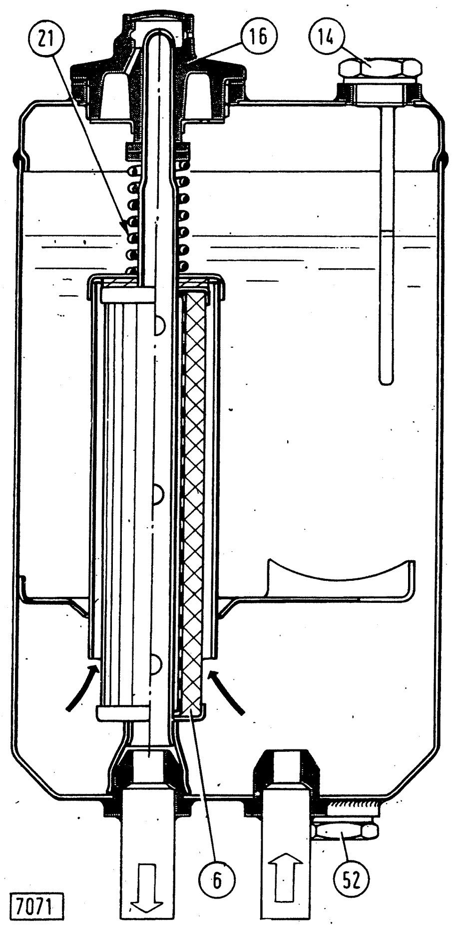


Fig.5 - Hydraulic oil reservoir.
(Arrows indicate the oil flow pattern).
6. Metal filter cartridge - 14. Oil filler plug with dipstick - 16. Breather and access plug to oil filter - 21. Cartridge retaining spring - 52. Oil drain plug.

- the valve spool (12) is screwed on the clevis (5) with loctite type "Nut Lock" ;

- the cylinder rod packings (26 and 28) and spring end washers (10)must be oriented as indicated in the figure.

Overhauling the oil pump and reser = voir.

Overhaul the pump as indicated in the topic onpage 165and following for the hydraulic lift pump.

Pump assmbly and performance data are given in the table on page 252 .

As for the oil reservoir, after di sassembling, clean it thoroughly and then check :

- fluid tightness, eliminating any leak by welding ;

- breather hole in the oil filter ac cess plug (16, Fig.5): it must be unobstructed ;

- metallic filtering element (16) af- ter washing it in kerosene and dry= ing with compressed air.

Adjusting the control valve spool travel.

The maximum displacement of the valve spool (12,Fig.3) with respect to the valve body depends upon the gap (X_1 and X_2,Fig. 4) existing between the screws (Vd and Vs)and pin (38). In other words, it is a function of the angular displace= ment of the lever (35) with respect to the arm (37).

To adjust first remove the parts which prevent access to the front axle bracket inside compartment and then proceed as follows :

- disconnect the drag link (36,Fig. 6)from steering lever (35) using,if necessary, the puller 291002 ;

- make sure, by manoeuvering the steering lever (35) back and forth that the same stops in the central position corrisponding to the neu= tral setting of the control valve spool. Under these conditions, check with a feeler gauge that the gap (X_1, Fig.7,a) between the adjustment screw (Vd) and pin (38) measures 1.5 mm (0.059 in).

If necessary, adjust the gap through the screw (Vd) after slackening the jam nut :

- act manually upon the control lever in the direction indicated by the ar= row in (b),until the pin (38) is brought to abut against the screw (Vd) previou sly adjusted and check,with a feeler gauge, that the gap (X_3) between the left-side adjustment screw (Vs) and pin (38) is from 2.9 to 3 mm (0.114 to 0.118 in).If necessary,adjust the gap through the same screw;

- finally, lock the adjustment screws (Vd and Vs) with the jam nuts.

The adjustment specification indi cated above are minimum values in = tended to limit as much as possible the play at the steering wheel; ho= wever, we recommend that the corre= sponding travel of the spool be suf ficient to assure the complete cove ring of the control valve ports du= ring operation (ports H and N during phase b of Fig.2 and E,L in phase c).

To this end,following the adjust= ment,remove plug(3, Fig.8) insert a pressure gauge and check that with the steering wheel completely tur= ned in one direction and then in the other and with the engine running

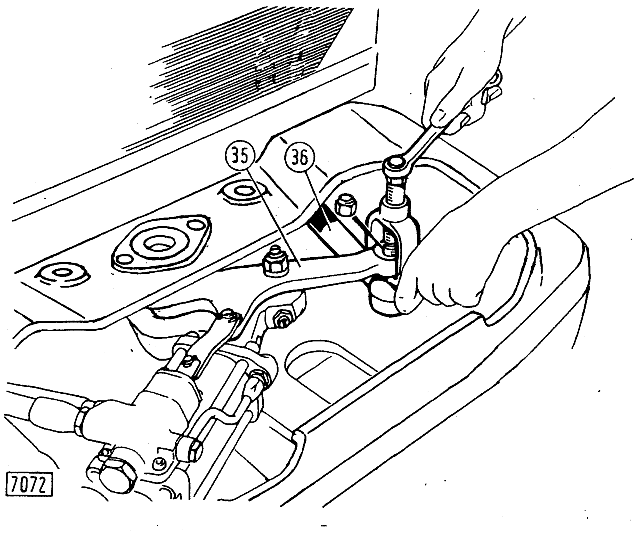


Fig.6 - Removing the drag link (36) from control lever (35) with puller 291002.

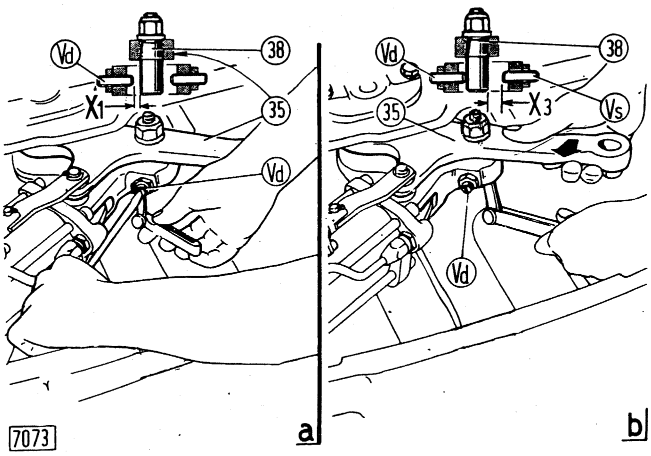


Fig.7 - Checking and adjusting the control valve spool travel.

a.Checking the play (X_1)and adjusting the right-hand side screw (Vd) - b.Checking the play (X_3) and adju- sting the left-hand side screw (Vs) - Vd e Vs.Adjust ment screw - X_1 - 1.5 mm (0.059 in). Clearance bet- ween right-side screw (Vs) and pin (38) with control lever in neutral - X_3 - 2.9 to 3 mm (0.114 to 0.118 in). Clearance between left-side screw (Vs) and pin (38), with control lever set fully forward in the direction shown by the arrow - 35. Power- assist valve spool control lever - 38. Pin, solid to lever (35).

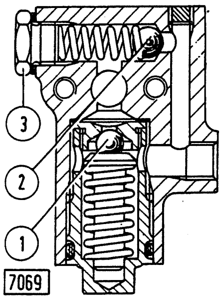


Fig.8 - Valve block section.

1. Oil pressure relief valve - 2. Check valve - 3. Check valve plug (test gauge connection).

at medium speed the pressure reading on the gauge reaches the pressure relief valve setting (95 to 100 Kg/cm^2 = 1351 to 1422 p.s.i.). If the gauge reading is appreciably lower, increase the gap (X_1 or X_2, or both, Fig.4) until the specified value is obtained.

Checking the working pressure setting

To check the maximum working pressure (pressure relief valve setting) on the steering power-assist system installed on tractor, proceed as follows :

- start engine and steer the tractor enough to bring up the temperature of the hydraulic fluid from 50 to 60°C (122 to 140°F);

- stop engine, remove the plug (3, Fig.8) from the valve block (B), replace with adaptor 291325 (threaded M 14x1.5) and connect the latter to a pressure gauge (ex.pressure gauge with scale 0-250 Kg/cm^2 of the universal kit 291314) ;

- start engine, run it at medium speed or turn the steering wheel to left or right to stop ; under these conditions the pressure relief valve (1) opens and the pressure gauge reading should correspond to valve setting (95 to 100 Kg/cm^2 = 1359 to 1422 p.s.i.); if the pressure reading differs appreciably from the value above, replace the pressure relief valve as an assembly, as separate components are not given as spares.

POWER STEERING WITH CYLINDER INSTALLED OUTSIDE THE FRONT AXLE BRACKET

The power steering system comprises the following main parts (Fig.9) :

- the oil reservoir (S) containing the filter (6) with replaceable element made of tin-plated steel mesh.
  The reservoir is bracketed on the front end of the engine ;

- the gear type pump (P_1), driven by the engine timing gear ;

- a valve block (B), inserted on the suction and pressure lines, provided with two valves, incorporated : pressure relief valve (1) set at 95 to 100 Kg/cm^2 (1351 to 1422 p.s.i.) and anti-cavitation (check) valve (2) which allows steering the tractor with engine stopped or pump inoperative ;

- one operating cylinder with double-acting ram (C) and built-in control valve, installed in parallel with the draglink (D) connected at one end to the support (3) secured to the gear box casing and at the other to the steering arm (4) ;

- oil tubes and hoses connecting the pump to the operating cylinder cir= cuit.

Operation of power cylinder

The front ball-head pin (17,Fig.10) of the operating cylinder rod, actua= ted by the draglink, sets the cylinder control valve (37) in the following positions :

a) Neutral position : power cylinder inoperative. In this position the con trol valve rod (37) remains in a ba= lanced position between shoulders of valve spool (41) because of the force excercised by the springs (30 and 36) leaving the ports (I and L). This al lows the oil delivered by the pump to flow back, through ports (E and F)and line (40) into discharge.

b) Retracted position : turning to the left. If the front ball stud (17), is subjected to a side force acting upon

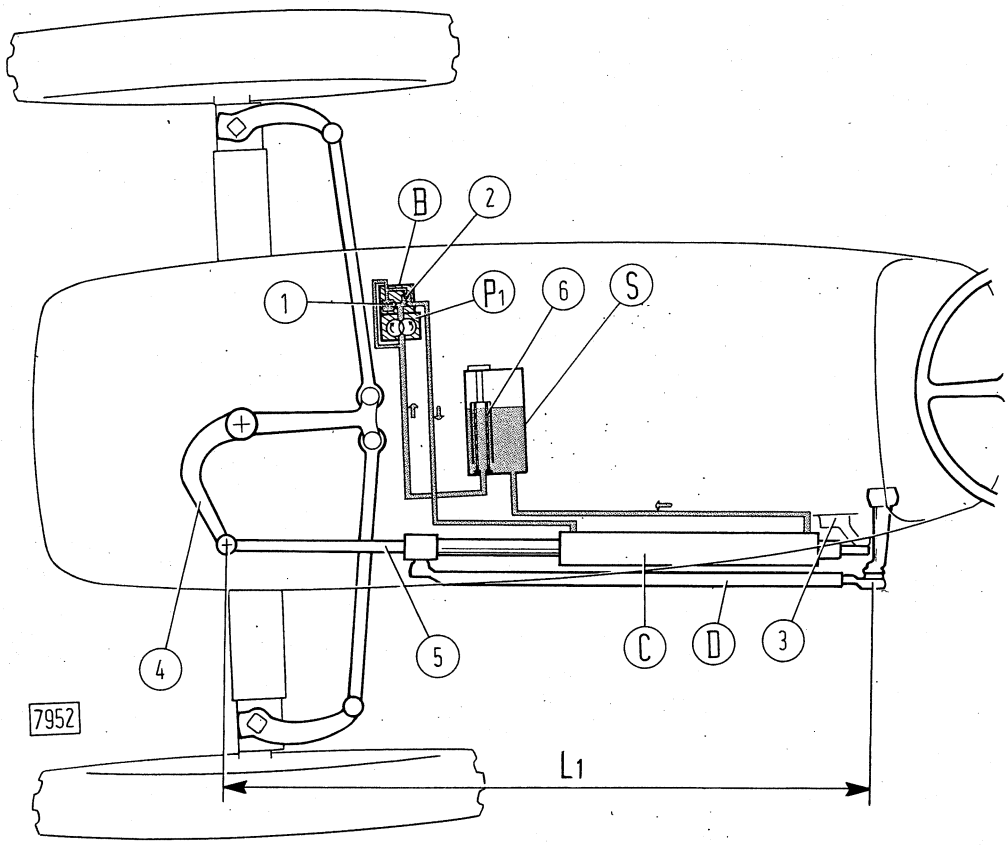


Fig.9 - Power steering hydraulic diagram.
B. Valve block - C. Cylinder - D. Draglink - L_1. (= 1165 mm or 45.866 in). Total length of draglink (D) and front end (5) - P_1. Pump - S.Reservoir - 1. Pressure relief valve - 2. Anticavitation (check valve) - 3. Power cylinder support plate - 4. Control lever - 5. Cylinder front end, adju= stable - 6. Filter.

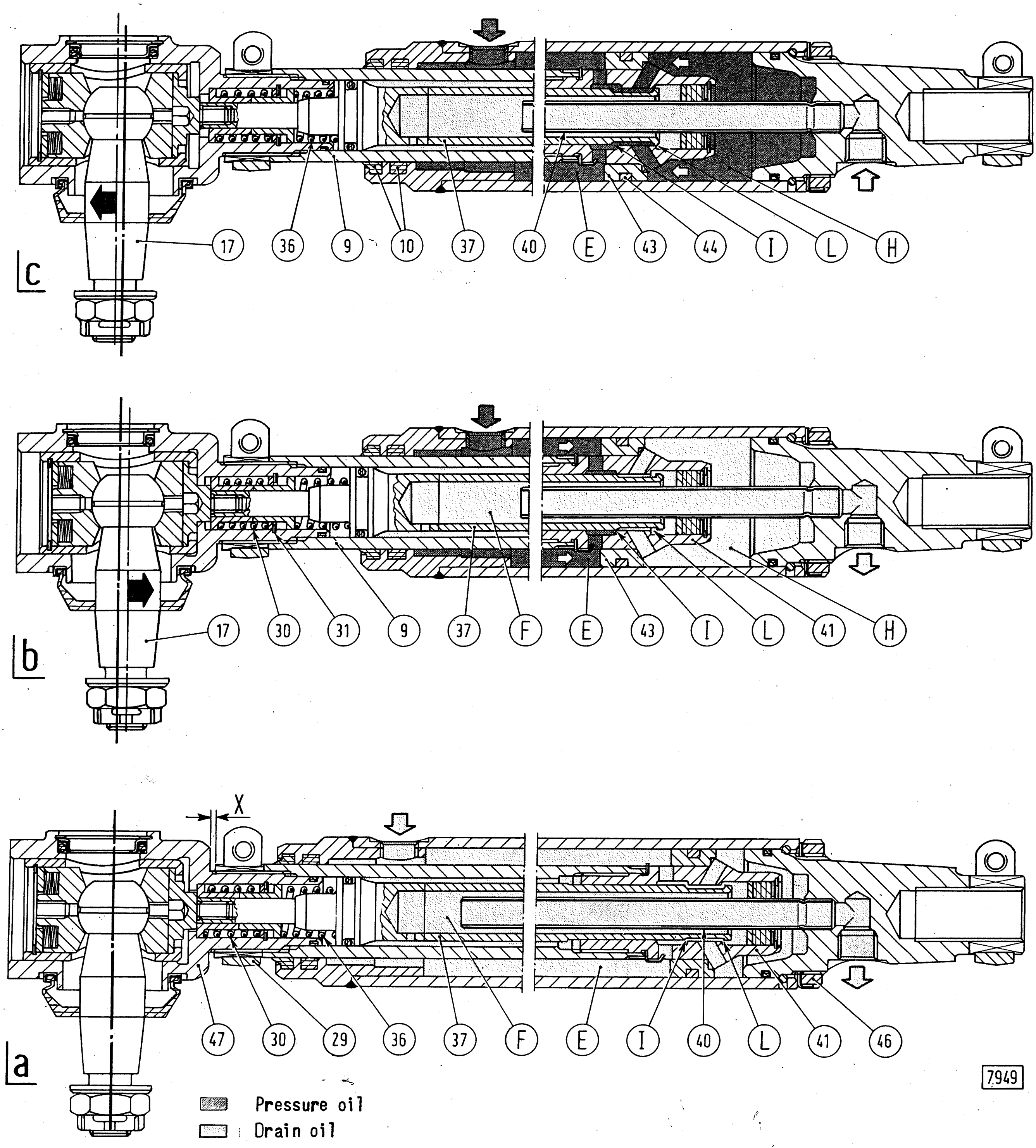


Fig.10 - Working diagrams of power steering cylinder.

a) Neutral position - b) Retracted position (turning to the left) - c) Extended position (turning to the right) - E. Chamber with minor pressure area - F. Oil discharge chamber - H. Chamber with major pressure area - I and L. Oil ports - X. (= 0 to 4 mm or 0 to 0.1575 in). Adjustment gap for the correct positionning of valve body (41) with respect to control valve rod (37) - 9. Cylinder rod - 10. Oil seals - 17. Cylinder control ball stud - 29. Control head clamp - 30 and 36. Reaction springs - 31. Retaining ring - 37. Control valve rod - 40. Discharge line - 41. Valve body - 43. Piston - 44. Seal ring - 46. Cylinder head locknut - 47. Control head body.

the piston (43) and exceeding the pre-load of the reaction spring (30), the valve spool moves in the same direction with respect to the cylinder rod (9). This will restrict and, if the load is at its maximum intensity, it will shut off the oil flow through port (I); consequently the pressure exercised by the oil in the active chamber (E) increases and forces the piston (43) to pull the cylinder rod (9) back.

The oil present in the opposite chamber (H) flow freely into discharge through slots in piston (43), ports in valve body (41), chamber (F) and line (40).

The retraction movement of cylinder rod (9) will stop as soon as the load upon the ball stud (17) decreases, allowing the reaction spring (30) to bring the valve back into neutral position.

c) Extended position : turning to the right. If the force acting upon front ball stud (17) occurs in the direction opposite to the previous one and its magnitude is such as to overcome pre-load of reaction spring (36), the control valve rod (37) will move with respect to the cylinder rod (9) in the same direction.

This will restrict or completely shut off the oil flow through the port (L), and pressure will rise both in the major and minor chambers (H and E). The pressure obviously will prevail in the major chamber where the piston head is larger in diameter, forcing the piston to push the cylinder rod (9) outward.

The forward motion of piston (43) and cylinder rod (9) will stop as soon as lessening of the load exercised on the front ball-head pin (17) allows reaction spring (36) to bring the valve back into neutral.

Overhauling the oil pump and reservoir.

See operations indicated on page 240.

Power-assist cylinder installation on tractor.

Install the power cylinder (C, Fig.9) complete with end (5) and draglink (D) and adjust the total length (L_1) at 1165 mm (45.866 in) acting on threaded end (5).

Adjusting the neutral position of the power cylinder control valve.

This adjustment must be carried out only if the tractor, with the engine running, tends to steer to the right or to the left.

The trouble occours when, in neutral position (a, Fig.10) the control valve rod (37) is not in a centered position between shoulders of valve body (41). If port (L) is restricted, the tractor tends to steer to the right ; if port (I) is restricted the tractor tends instead to turn to the left.

To perform this adjustment proceed as follows:

- remove the bolt of the control head clamp (29), securing cylinder rod (9);
- screw slightly the cylinder rod (9) inside control head body (47) if the tractor tends to steer to the right, or unscrew the rod if the tractor tends instead to turn to the left ;
- the adjustment done, secure the control head clamp (29) with the relevant bolt.

Checking the working pressure setting.

Proceed as described on page 242.

ASSEMBLY DATA

Description	mm (in)
SUBSIDIARY REDUCTION UNIT	
Spline backlash of collars :	
- straight drive engagement	0.070 to 0.170 (0.0028 to 0.0067)
- standard and subsidiary reduction units engagement..	0.170 to 0.270 (0.0067 to 0.0106)
Backlash of epicyclic reduction gear teeth	0.070 to 0.130 (0.0028 to 0.0051)
Thickness of subsidiary reduction unit planet gears end washers	1.470 to 1.530 (0.0578 to 0.0603)
Wear limit	1.3 (0.051)
Reduction unit poppet balls spring specifications :	
- free length	35.5 (1.40)
- length under a load of 11.7-12.9 Kg(25.8-28.4 lb) ..	31.5 (1.24)
FRONT WHEEL DRIVE	
FRONT AXLE	
Type	steering, supporting structure, centrally pivoted.
Bevel gear (main reduction)	taper helical teeth.
Reduction ratio (16/40)	1 : 2.5
Backlash of bevel gear teeth	0.15-0.20 (0.006-0.008)
Taper roller bearing supporting the pinion	2
Pinion bearing adjustment shims (S_3, Fig. 5)	1.25-1.3-1.4-1.5-1.6-1.65-1.7-1.8. (0.049-0.051-0.055-0.059-0.063-0.065-0.067-0.071) (°) 1-1.5-1.7-1.75-1.8-1.9-2-2.1-2.2-2.25-2.3. (0.039-0.059-0.067-0.069-0.071-0.075-0.079-0.083-0.086-0.088-0.090) (*)

(°) For Model 640 DT (*) For Model 640 DT3

Description	mm (in)
Pinion cone center distance adjustment shims (S_4, Fig. 5)	0.1-0.2-0.5 (0.004-0.010-0.019)
Tapered roller bearings supporting the differential-bevel gear unit ....no.	2
Rolling torque corresponding to assembly preload of bearings	0.15 to 0.28 Kgm (1.1 to 2.2 ft.lb)
Differential	
Differential pinions .... no.	2
Thickness of differential gear thrust washers..	1.5 to 1.6 (0.059 to 0.063)
Thickness of differential pinion thrust washers	1.47 to 1.53 (0.057 to 0.059)
Diameter of pinion axles	23.959 to 23.980 (0.9432 to 24.000) (°) 23.979 to 24.000 (0.9440 to 0.9449) (*)
Bore of differential pinion bushings (fitted and reamed)	24.020 to 24.072 (0.9527 to 0.9477) (°) 24.020 to 24.053 (0.9527 to 0.9470) (*)
Assembly clearance between differential pinion bushings and axles	0.040 to 0.113 (0.0016 to 0.0044) (°) 0.020 to 0.074 (0.0008 to 0.0029) (*)
Interference fit of bushing on differential pinions	0.050 to 0.250 (0.0020 to 0.0098) (°) 0.050 to 0.130 (0.0020 to 0.0051) (*)
Backlash between differential gear and pinion teeth	0.15 (0.0059) (°) 0.20 (0.008) (*)
Final drives	epicyclic, incorporated in wheel hubs.
Planet gear in each final drive .... no.	3
Type of gears	spur

(°) For Model 640 DT (*) For Model 640 DT3

Description	mm (in)
Thickness of driven gear end washers (2, Fig.5)...	1.47 to 1.53 (0.0578 to 0.0602)
Backlash of sun gear, planet gear and internal gear teeth	0.10 to 0.20 (0.004 to 0.008)
Axle shafts	with double universal joints.
Backlash between differential pinion, planet gear and axle shaft splines	0.010 to 0.106 (0.004 to 0.0042)
Outside diameter of wheel shaft bushings (9,Fig.5)	47.000 to 47.020 (1.8504 to 1.8512) (°) 52.000 to 52.020 (2.0472 to 2.0479) (⁎)
Bore of seat for bushings in wheel hub	46.900 to 46.950 (1.8464 to 1.8484) (°) 51.900 to 51.950 (2.0432 to 2.0451) (⁎)
Interference fit of bushings in their seats	0.050 to 0.120 (0.0019 to 0.0047)
Bore of wheel shaft bushings (after fitting without reaming)	40.030 to 40.070 (1.5759 to 1.5775) (°) 45.030 to 45.070 (1.7728 to 1.7744) (⁎)
Diameter of axle shafts in correspondence of bushings	39.975 to 40.000 (1.5737 to 1.5748) (°) 44.975 to 45.000 (1.7706 to 1.7717) (⁎)
Assembly clearance of axle shaft in its bushing ...	0.030 to 0.095 (0.00118 to 0.00374)
Steering joints	
Type	spherical with plastic cages.
Thickness of adjustment shims (S_2,Fig. 5)	0.10-0.15-0.20-0.25-0.30 (0.004-0.006-0.008-0.010-0.012)
Wheel hubs	
Tapered roller bearings supporting the wheel hubs..no.	2

(°) For Model 640 DT (⁎) For Model 640 DT3

Description	mm (in)
Thickness of wheel hub bearings adjustment shims (S_1, Fig.5)	1.8 - 1.9 - 2 - 2.1 2.2-2.3-2.4-2.5-2.6 2.7-2.8-2.9-3-3.1-3.2 (0.086-0.090-0.094-0.098-0.102-0.106-0.110-0.114-0.118-0.122-0.126) (°) 1.8 - 1.9 - 2 - 2.1 2.5-2.6-2.7-2.8-2.9-3-3.1-3.2-3.3-3.4-3.5 (0.098-0.102-0.106-0.110-0.114-0.118-0.122-0.126-0.130-0.134-0.138) (*)
<u>Gearbox-front axle propeller shaft</u>	
Type	tubular with universal joints running on needle bearings.
<u>Front wheel drive pivot</u>	
Diameter of trunnion pin	37.975 to 38.000 (1.4951 to 1.4961)
Bore of trunnion bushings	38.020 to 38.100 (1.4969 to 1.5000)
Assembly clearance between trunnion pin and bushings	0.020 to 0.125 (0.0008 to 0.0049)
Interference fit of bushings	0.050 to 0.120 (0.0024 to 0.0047)
Thickness of trunnion thrust washer	5.100 to 5.250 (0.2008 to 0.2067)
Max. oscillation of axle in both direction	11°
<u>TRANSFER GEAR UNIT</u>	
Type of gear	spur
Reduction ratio between bevel pinion shaft and transfer unit output shaft	$\frac{24}{27} \times \frac{23}{36} = \frac{1}{1.760}$
Unit gear backlash	0.10 to 0.20 (0.004 to 0.008)

(°) For Model 640 DT (*) For Model 640 DT3

Description	mm (in)
Side play on splines of power take off engagement and fixed engagement gear on shaft	0.010 to 0.106 (0.0004 to 0.0042)
Driven gear (6) adjustment shims (7, Fig.9,b)	3-3.5-4-4.5-5 (0.1181-0.1378-0.1575-0.1772-0.1969).
Specifications of sliding sleeve control hand lever spring :	
- free length	24.3 (0.9567)
- Length under test load of 14 to 15 kg (30.8 to 33.1 lb)	17.8 (0.7008)
POWER STEERING (WITH POWER CYLINDER INSIDE AXLE BRACKET)	
Diameter of control lever pin (41, Fig.4)	34.975 to 35.000 (1.3769 to 1.3780)
Bore of control lever bushings (49 and 50) fitted ...	35.050 to 35.112 (1.3799 to 1.3824)
Assembly clearance between bushings and pin	0.050 to 0.137 (0.0019 to 0.0054)
Interference fit of bushings in their seats	0.050 to 0.120 (0.0019 to 0.0047)
Linkage	
Outside diameter of control valve lever bushing (51, Fig.4)	47.000 to 47.020 (1.8504 to 1.8511)
Bore of bushing seat in control lever (35)	46.900 to 46.950 (1.8465 to 1.8484)
Interference fit of bushing in its seat	0.050 to 0.120 (1.6554 to 1.6579)
Diameter of hub on control lever (37)	41.975 to 42.000 (1.6525 to 1.6535)
Assembly clearance between bushing and lever hub	0.050 to 0.137 (0.0020 to 0.0054)
Diameter of pivot pin connecting end of cylinder (42)	19.967 to 20.000 (0.7861 to 0.7874)
Inside diameter of bushing (53)	20.020 to 20.033 (0.7882 to 0.7887)
Assembly clearance between pin and bushing	0.020 to 0.100 (0.0008 to 0.0039)

Description	mm (in)
Diameter of cyl.rod attachment pin (45)	14.200 to 14.230 (0.5591 to 0.5603)
Inside diameter of attachment pin location	14.300 to 14.400 (0.5630 to 0.5669)
Assembly clearance between pin and location	0.070 to 0.200 (0.0027 to 0.0079)
Thickness of washers (39) for pin of control lever..	2.20 to 2.35 (0.0866 to 0.0917)
Distributor	CALZONI
Type	spool, secured to cylinder.
Setting of pressure relief valve	95 to 100 Kg/cm^2 (1351 to 1422 p.s.i.) (obtained by inser ting shims under the spring).
Shims for setting of pressure relief valve	0.5 ± 0.05 (0.0197 ± 0.0020)
Assembly clearance between spool and body	0.006 to 0.035 (0.0002 to 0.0014)
Cylinder	CALZONI FB 2/10
Cylinder bore	70 (2.75)
Maximum stroke	94 (3.70)
Piston rod diameter	25 (0.98)

Spring specifications	Length free mm (in)	Length under load mm (in)	Test load kg	Test load lb
Pressure relief valve spring ...	39.4 (1.55)	30.2 (1.19)	13.6÷15	29.9 to 33.1
Anticavitation (check) valve spring	33 (1.30)	15 (0.59)	0.20÷0.25	0.48 to 0.55
Control valve spool return spring	27.1 (1.07)	20 (0.79)	23.6÷28.8	51.9 to 63.4

Pump model	C14X (°) C18X (°°) C10X (*)
Type	gear
Make	FIAT, PLESSEY licence
Drive	by engine timing gears
Rotation (looking from drive end)	clockwise
Engine/pump speed ratio	1 : 0,91

(°) Pre-modification pump-(°°) Pre-modification pump (with cylinder outside the axle support),or post-modification (with cylinder inside the axle support)-(*) Post-modification pump (with cylinder outside the axle support).

Description	mm (in)
Max. speed (with engine at 2400 r.p.m.)	2184 r.p.m.
Nominal output at max. speed	14 lt/min (3.1 GPM) (°) 17.8 " (3.9 GPM) (°°) 9.9 " (2.2 GPM) (*)
Delivery on test bench at a speed of 1445 r.p.m. and pressure 95 to 100 Kg/cm^2 (1351 to 1422 p.s.i.) :	
- new or overhauled pump, not below	8.60 lt/min (1.9 GPM) (°) 11.2 " (2.5 GPM) (°°) 6.2 " (1.4 GPM) (*)
- used pump, not below	6.40 lt/min (1.4 GPM) (°) 8.5 " (1.9 GPM) (°°) 4.6 " (1 GPM) (*)
Temperature of testing oil	55° to 65°C (131° to 149°F)
Testing oil viscosity	SAE 20W
Diameter of gear shafts	17.400 to 17.424 (0.6850 to 0.6860 in)
Diameter of shafts bores on supports	17.450 to 17.470 (0.6869 to 0.6877 in)
Running clearance of shafts in bearing bores	0.026 to 0.070 (0.0010 to 0.0027 in)
Wear limit	0.220 (0.009 in)
Driven and driven gear widths	10.256 to 10.281 (0.4038 to 0.4047 in) (°) 13.190 to 13.215 (0.5192 to 0.5202 in) (°°) 7.322 to 7.348 (0.2882 to 0.2892 in) (*)
End clearance of gears and bearing in pump body	0.1 to 0.2 (0.0039 to 0.0078 in)
Max. wear on pump body on suction side in correspondence with the gears	0.1 (0.0039 in)
<u>POWER STEERING</u> (WITH CYLINDER EXTERNAL TO FRONT AXLE BRACKET). <u>Linkage</u> See data reported on page 175 relevant to linkage of tractor 640 without power steering.	
Cylinder	CALZONI T 35/27 with control valve incorporated.
Bore	48 (1.89)
Max. stroke	270 (10.63)
Active area in both directions	8.5 cm^2 (1.31 sq.in)

(°) Pre-modification pump - (°°) Pre-modification pump (with cylinder outside the axle support), or post-modification (with cylinder inside the axle support) - (*) Post-modification pump (with cylinder outside the axle support).

Description	mm (in)
Setting of the pressure relief valve	95 to 100 Kg/cm^2 (1351 to 1422 p.s.i.) (obtained by means of shims installed under the spring).
Shims for setting the pressure relief valve	0.5 ± 0.05 (0.0197 ± 0.0020)
Pump (C14X - C18X - C10X) See data on page 251.	

TORQUE SPECIFICATIONS

ITEM	Thread	Material	Torque Kgm	Torque ft.lb
SUBSIDIARY REDUCTION UNIT				
Capscrew and stud nuts securing gearbox housing to rear transmission housing (C_1, Fig.1)	M12x1.5	R50 Znt	9.5	69
Self-locking screw securing subsidiary reduction unit carrier (C_2).	M10x1.25	R80 Znt	5	36
Self-locking screw securing the standard reduction unit ring gear (C_3).......................	M12x1.5	R80 Znt	8	58
FRONT WHEEL DRIVE				
Screw, bevel gear pinion support housing (C_3, Fig. 5)	M12x1.5 M14x1.5	R 100	11.5 18	83 (°) 130 (x)
Screw, bevel-gear-differential housing to axle body (C_4)	M12x1.25 M14x1.5	R 100	11.5 18	83 (°) 130 (x)
Screw, planetary gear carrier (C_9)	M10x1.25 M12x1.25	R 100	6.5 11.5	46 (°) 83 (x)
Screw, differential caps (C_{13}, Fig. 6)	M12x1.25 M14x1.5	R 100	11.5 18	83 (°) 130 (x)
Nut, bevel gear pinion shaft sleeve (C_2, Fig.5)	M18x1.5 M20x1.5	R 60	25 30	181 (°) 217 (x)
Screw, front wheel (C_7)	M16x1.5	R 100	26.5	191.5
Screw, wheel hub support (C_8)..	M12x1.5 M14x1.5	R 100	11.5 18	83 (°) 130 (x)
Screw, spindle shaft caps (C_6)..	M10x1.25 M12x1.25	R 100	6.5 12	46 (°) 87 (x)
Self-locking screw, bevel gear crown (C_5)	M12x1.25	R 120	13	94
Ring nut, wheel hub bearings (C_{10})	M55x2 M60x2	GUK/70	52.5 55	379.5 (°) 398 (x)
Nut, prop-shaft front flange screw (C_1)	M10x1.25 M12x1.25)	R80 Znt (screw R120)	7.5 15	54 (°) 108 (x)

(°) For mod. 640 DT
(x) For mod. 640 DT3

Cont. : "Torque specifications"

I T E M	Thread	Material	Torque	
			Kgm	ft.lb
Self-locking screw, prop shaft rear flange (C_{13}, Fig. 8)	M10x1.25 M12x1.25	R 100	7.5 15	54 (°) 108 (x)
Screw securing front axle support..	M16x1.5	R 100	33.5	242
POWER STEERING (with power cylinder inside axle bracket).				
Nut, securing driving sleeve of pump	7/16"20 UNF	R90 Bon	2.8	20
Self-locking nut, drag link	M14x1.5	R50 Znt	5.5	39.5
Self locking nut, for fixed and adjustable tierods secured to steering arm and wheel hubs	M16x1.5	–	13.5	97.5
POWER STEERING (with cylinder external to front axle bracket).				
Nut, securing driving sleeve of pump	7/16"20 UNF	R90 Bon	2.8	20
Self-locking nut, steering levers to spindle	M12x1.5	R50 Znt	9.5	69
Self-locking nut, securing fixed and adjustable tie rods to steering lever	M14x1.5	R50 Znt	5.5	39.5
Self-locking nut securing end of cylinder	M14x1.5	R50 Znt	5.5	39.5
STEERING BOX (BURMAN) Steering box to tractor	M 16 x 1.5	–	22.5	163
Nut, steering wheel to post (C_1, page 221)	M 18 x 1.5	–	24	173
Screw, top cover to steering box (C_5)	M 10 x 1.5	–	5	36
Screw, side cover to steering box (C_3)	M 8 x 1.25	–	2.8	20
Nut, side cover to steering box (C_2)	M 8 x 1.25	–	2.8	20
Nut, swing lever (C_4)	M 24 x 2	–	25	181

(°) For model 640 DT.
(x) For model 640 DT3.

SERVICE TOOLS

FRONT WHEEL DRIVE	
291707/1	Support for bevel pinion assembly.
292502 (°) 292506 (x)	Bevel pinion cone center distance adjuster.
292501 (°) 292503 (x)	Bevel pinion bearings adjuster.
292416 (°) 292219 (x)	Wrench, crown wheel ring nuts adjustment.
292927	Puller, front axle trunnion.
290793	Adaptor, for puller 292927.
292500 (°) 292505 (x)	Wheel hub bearings adjuster.
292517	Wrench, wheel hub bearing ring nut.
292220	Rolling torque gauge, for spindle spherical bearings.
POWER STEERING	
291325	Adaptor, for checking the pressure relief valve setting to be used with the pressure gauge of test kit 291314.

Pump (C 14X - C 18X - C10X)

Refer to the service tool listed for pump A22X on page 183except for the following items :

290367 (°°)	Supporting brackets for pump testing (with Diesel engine 291233).

Test bench 291231	Test bench 292574	Denomination
290417(replacing 290419)	290330 (replacing 290331)	Pump suction adaptor.
290434(replacing 290436)	290358(replacing 290359)	Attachment screws for pump suction adaptors.

(°) For Model 640 DT (x) For Model 640 DT3
(°°) C14X and C18X pumps only.

MODEL 480

See Appendix page 313 for:

- engine with Bosch injection pump;
- subsidiary reduction unit;
- model 480 DT;
- power steering.

The following section deals with those parts differing from the ones of model 640.
The model 640 parts that are also valid for model 480 are indicated in the table of contents and in the text.

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(°) See 640, pages 89 and 93, disregarding data and torque values for the engine vibration damper.

(x) See 640, page 95 with the addition of tool A127031 securing the auto advance device.

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ENGINE

0 - SPECIFICATIONS - REMOVAL - INSTALLATION

DESCRIPTION : See 640 considering that the engine installed on model 480 is a three cylinder in line.

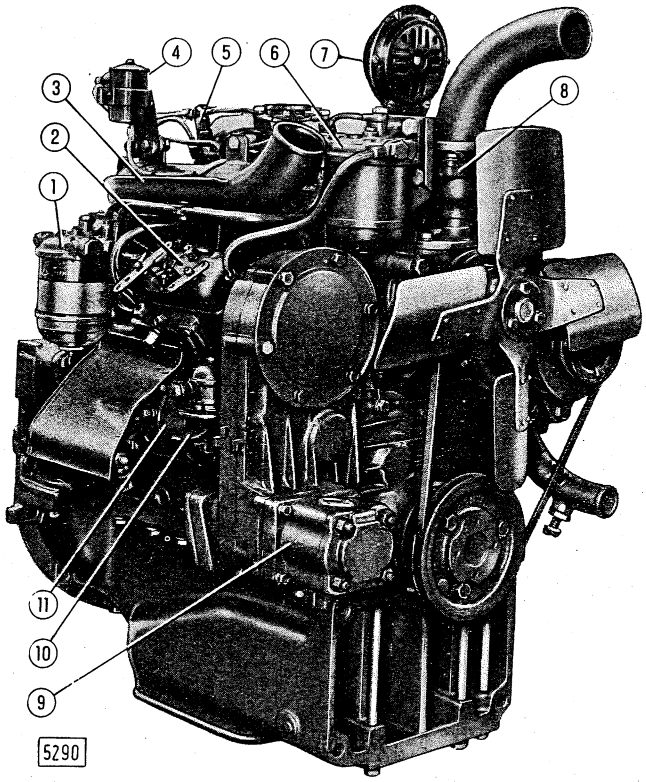


Fig. 1 - *Three-quarter right front view of engine.*

1. First fuel filter. - 2. Fuel injection pump. - 3. Air intake manifold. - 4. Starting aid reservoir. - 5. Injector. - 6. Second fuel filter. - 7. Electric horn. - 8. Pipe with thermostat location. - 9. Hydraulic oil pump. - 10. Fuel transfer pump. - 11. Electric starting motor.

SPECIFICATIONS

Engine type	FIAT 8035.02.300
Cycle	Diesel
Strokes	4
Number of cylinders . . .	3
Bore and stroke 100 × 110 mm	(3.93 × 4.33 in)
Capacity 2592	cm³ (159 in³)
Number of main bearings . .	4
Injection sequence	1-2-3
Compression ratio	17 : 1
Sense of rotation (looking at front)	Clockwise
Rated speed	2400 r.p.m.
High idling	2600 r.p.m.
Low idling	650 r.p.m.
Starter pinion to flywheel crown gear ratio	9/110
Engine/alternator speed ratio	1 : 1.827
Lubrication pressure	3 ÷ 4 kg/cm² (42.7 ÷ 56.9 p.s.i.)
Engine/oil pump speed ratio	1 : 0.500
Engine/water pump speed ratio	1 : 1.464
Hourmeter calibration (1 hour)	96,000 engine revs.
Engine weight (without air cleaner and lubricating oil)	299 kg (660 lb)

TEST RIG DATA (with CAV injection pump) (*)

Brake test

See 640 except for the following points :

– fixed injection advance before T.D.C. in cylinder no.1 compression : 17°±1°.

Throttle lever setting	Engine speed r.p.m.	Power output of engine runned-in for a total of 2 hours HP	Power output of engine runned-in for a total of 50 hours HP	Fuel consumption time (100 cu.cm) sec.
Max. (under load)	2400	⩾ 44	⩾ 46	⩾ 34.5
Max. (max torque)	1600	⩾ 30.5	⩾ 32	⩾ 51
Max. idle	⩽ 2600	—	—	—
Min. idle	650	—	—	—

Belt pulley test.

The test is carried on under the same ambient conditions specified for the engine installed on test machine. Besides, the belt must be adequately stretched and slip must not exceed 3 percent.

Throttle lever setting	Speed: engine r.p.m.	Speed: belt pulley r.p.m.	Power output of engine runned-in for a total of 2 hours HP	Power output of engine runned-in for a total of 50 hours HP	Fuel consumption time (100 cu.cm) sec.
Max. (under load)	2400	1408	⩾ 39.8	⩾ 42.7	⩾ 34.5
Max. (max torque)	1600	939	⩾ 28.3	⩾ 29.7	⩾ 51
Max. idle	⩽ 2600	⩽ 1530	—	—	—
Min. idle	650	382	—	—	—

(*) For the test rig data of engine fitted with Bosch fuel injection pump see the relevant table in appendix section.

I - CRANKCASE - CYLINDER HEAD - OIL SUMP

CYLINDER HEAD

See 640, except for the following variations:

- the cylinder head tightening sequence as illustrated in Fig.2.

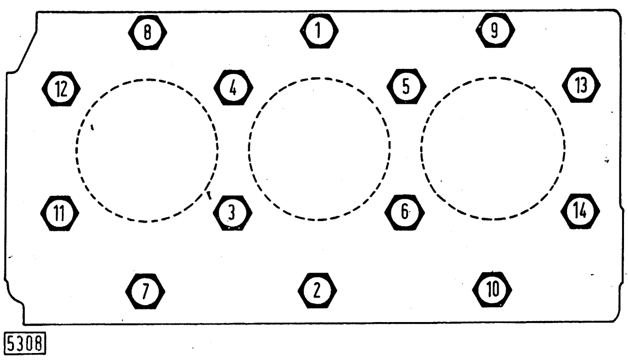


Fig.2 - *Cylinder head tightening sequence.*

II - VALVES AND TIMING MECHANISM

TIMING DATA

See 640 except for the differences illustrated in Fig.3.

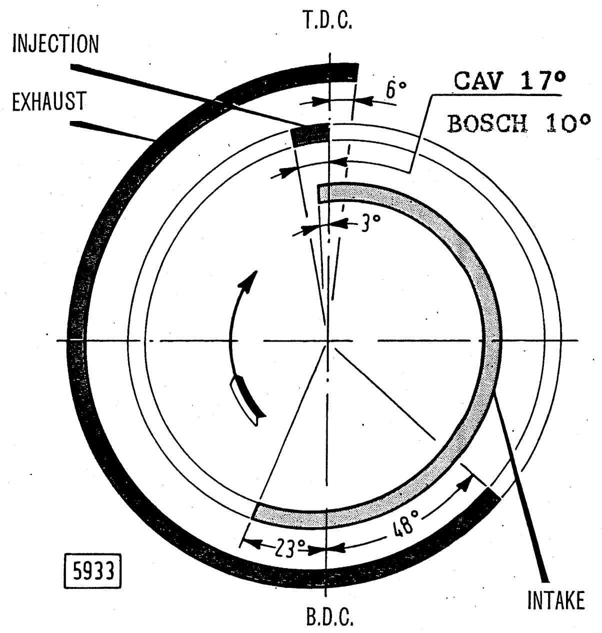


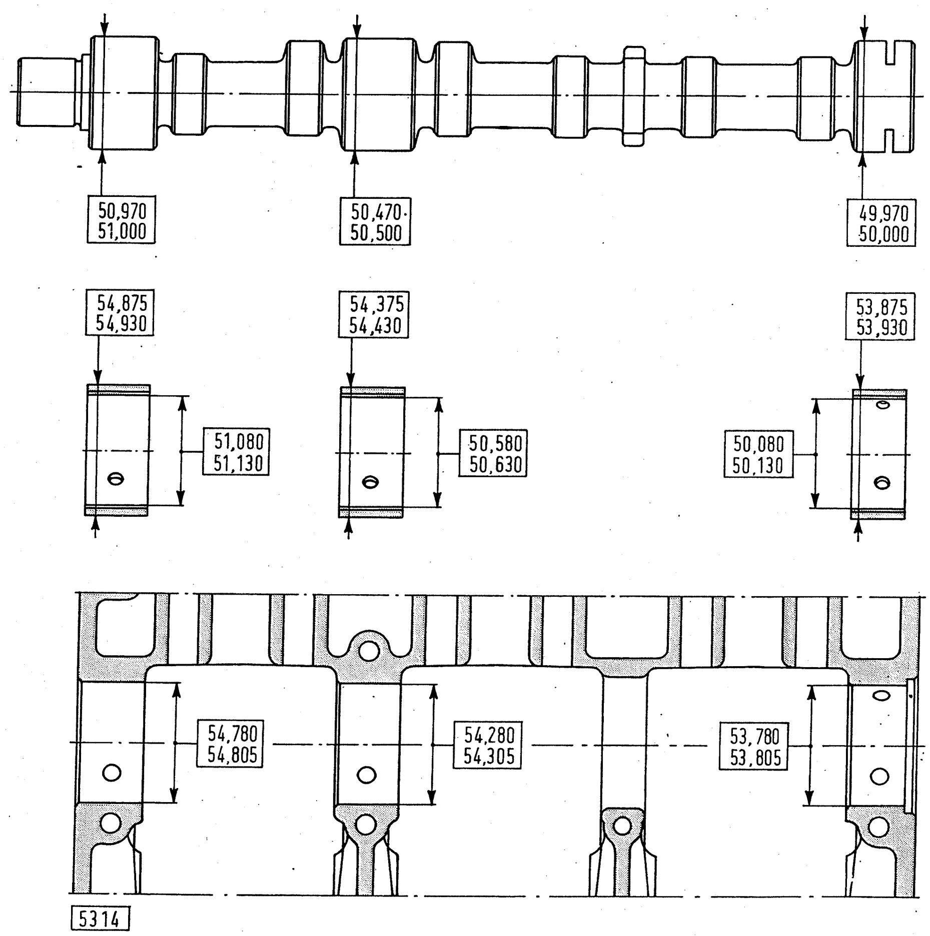
Fig. 3 - Timing diagram.

CAMSHAFT

See 640 except the differences illustrated in Fig. 4

Fig. 4 - Dimensions of camshaft journals and sleeve bearings.

Note - I. D. refers to fitted bearings.



VALVE GAP ADJUSTMENT

Adjustment of the gap between valves and rocker arms can be effected indifferently on engines installed or removed from tractor, as follows:

— turn the crankshaft until the first piston is at T.D.C. at beginning of intake stroke and valves are in balanced position; this position of piston 1 is set when the mark « P.M.S. 1 » stamped on the flywheel rim is in register with the pointer (Fig. II/14-640);

— make the crankshaft turn one full revolution, bringing the mark P.M.S. 1 back to the previous position;

— set the intake and exhaust valve gap on cylinder 1 at 0.25 mm (0.010 in) using the special wrench A 313046 and a feeler gauge ;

— repeat for all remaining pairs of valves, holding in mind that the stamped mark P.M.S. 1 does not apply to pistons 2 and 3; consequently mark the position corresponding to T.D.C. at intake on the flywheel with chalk.

TIMING GEAR ASSEMBLY

To gain access to the timing gears remove the case cover as outlined (camshaft removal).

Remove the timing gears from the case as follows:

— camshaft driving gear (10): see instructions on relevant chapter, pag. 30-640 ;

- idler gear (29, Fig. II/15-640), remove snap ring first, then with draw it together with the two thrust washer ;

— fuel supply pump driving gear (31); first remove the pump with its the cam drive gear bearing then remove the shaft retaining ring and withdraw the shaft with gear (31);

— injection pump driving gear (32): back out the attaching nut (C_6) functioning as puller.

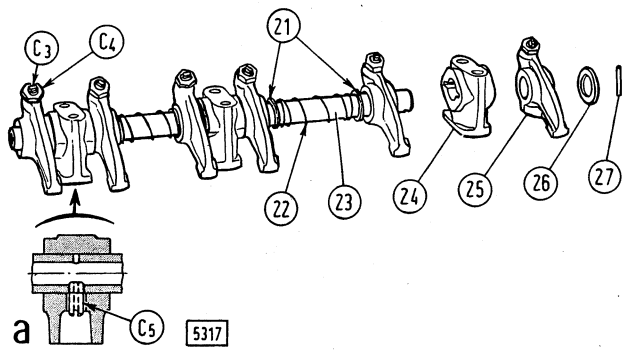


Fig. II/11 - Rocker arms and their supports, springs and shafts.

C_3. Valve-to-rocker arm gap adjusting screw - C_4. Screw (C_3) locknut. - C_5. Screw with lubricating oil hole securing rocker arm supports to shafts. - 21. End washer. - 22. Spring. - 23. Rocker arm shaft. - 24. Rocker arm shaft support. - 25. Rocker arm. - 26. End cup. - 27. Split dowel.

a. Third cylinder rocker arm support.

Fig. II/15-640 illustrates correct position of assembly of the camshaft driving gear (28) and of the other fuel injection pump (32) and transfer pump (31) gears. The injection pump gear is marked with the engine model designation and the angular position of the number 4 indicating the mesh with respect to the shaft key, 188°54' ±15'.

Install the timing gears as follows:

— bring piston 1 to T.D.C. and turn the crankshaft until the pointer is in register with the « P.M.S. 1 » mark stamped on the flywheel rim;

— arrange feed and injection pump driving gears on respective shafts so to line up the assembly marks 4-4;

— install then the idler and timing gears and line up the pairs 1-1, 2-2, 3-3;

— torque tighten the gear capscrews to tabulated values.

The timing gears, installed on their respective shafts, are housed inside the timing gear case and are lubricated through an oil duct in the case; make sure this duct is free and descale it by poking through with a metal wire of suitable diameter

III - CRANK GEAR ASSEMBLY

CRANKSHAFT

See 640 except for the thrust washers that are fitted to the third main bearing as illustrated in Fig. 6.

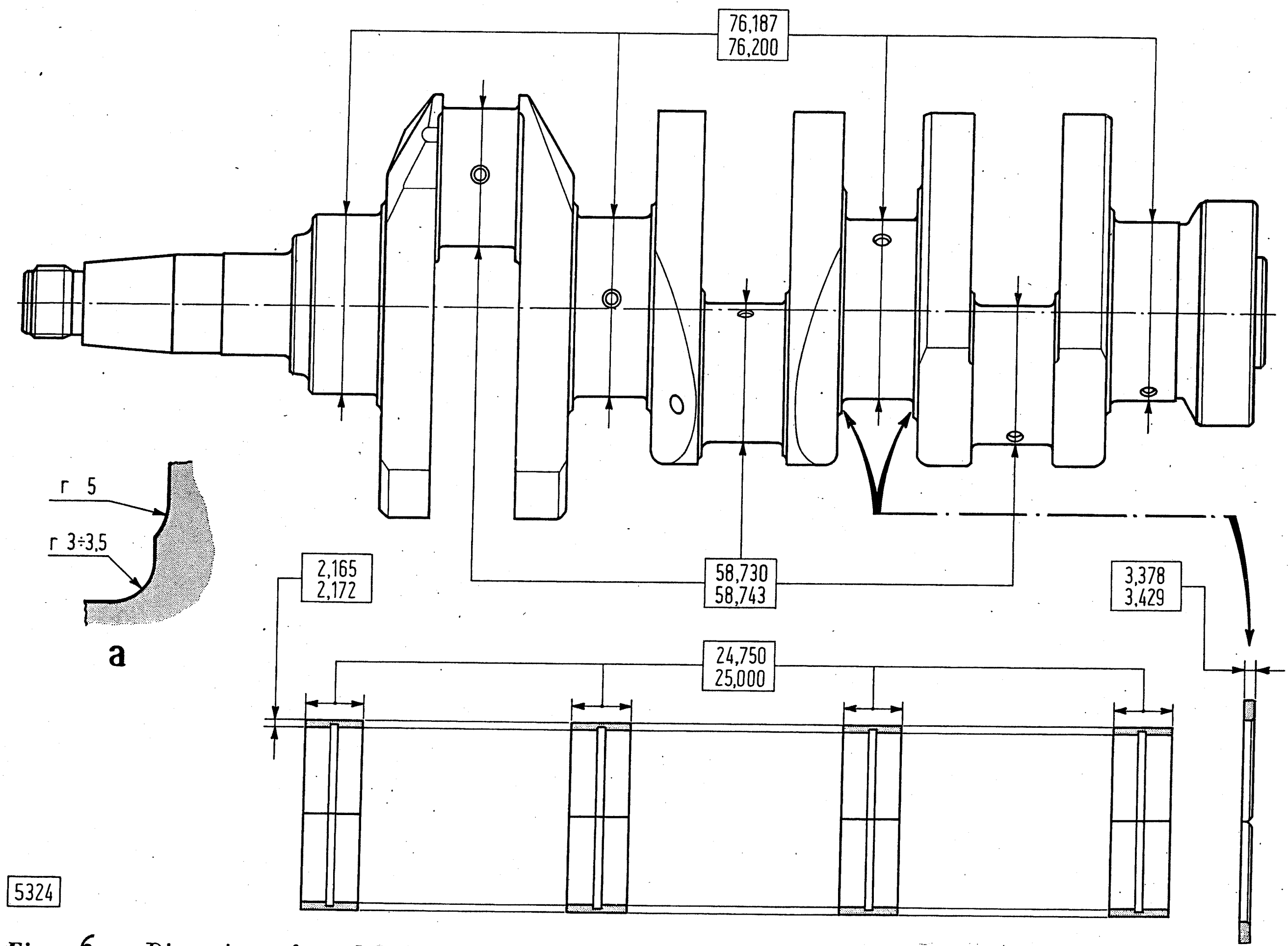


Fig. 6 - Dimensions of crankshaft journals and of standard thrust washers (mm - See conversions in Section VII).
a. Jornal radii and fillets.

IV - FUEL SYSTEM

SPECIFICATIONS :

See 640 except for the following :

Injection pump type .... CAV DPA 3233 F410-770534(°)

Pump setting on engine : when cylinder no.1 is away from T.D.C. of .... 16° ÷ 18°

Pump pressure outlet corresponding to cylinder no.1 . W mark

Pressure pipes from injection pump to injectors ..... 2 x 6 x 427

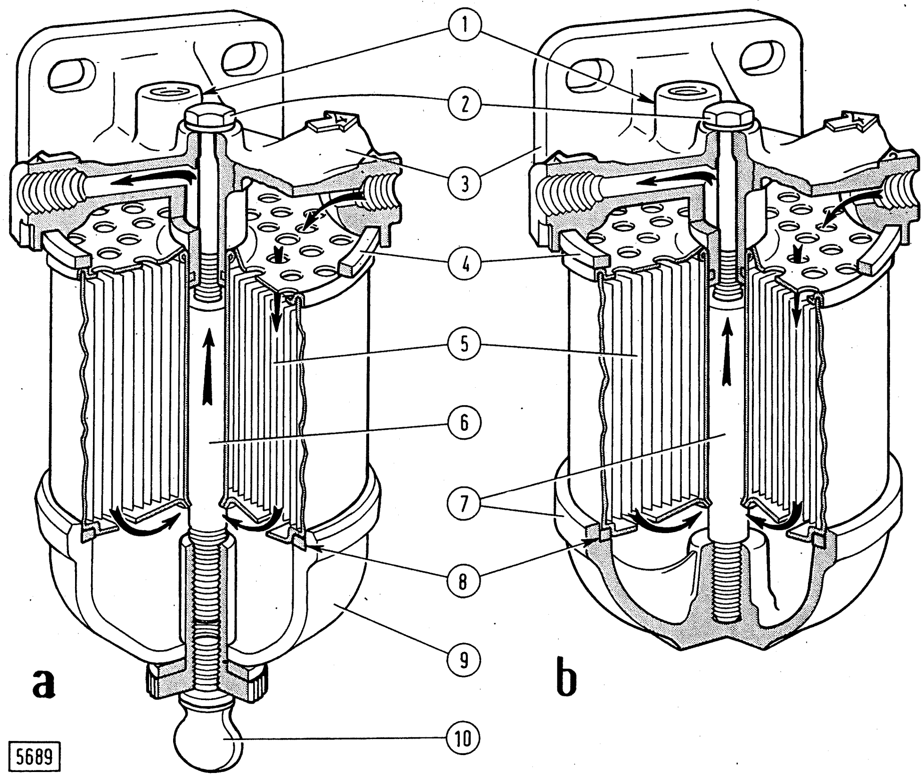
(°) For Bosch injection pump see the relevant table in appendix section.

FUEL FILTERS

See 640 except for the changes illustrated in Fig. 7.

Fig. 7 - Fuel filters.

a. First fuel filter. - b. Second fuel filter. - 1. Vent. - 2. Control screw. - 3. Cover with fuel inlet and outlet valves. - 4. Rubber seal. - 5. Filtering element. - 6. Rod. - 7. Sediment bowl and rod. - 8. Seal. - 9. Transparent bowl. - 10. Bowl (9) attaching screw.



FUEL SYSTEM BLEEDING

See 640 except for the differences illustrated in Fig.8.

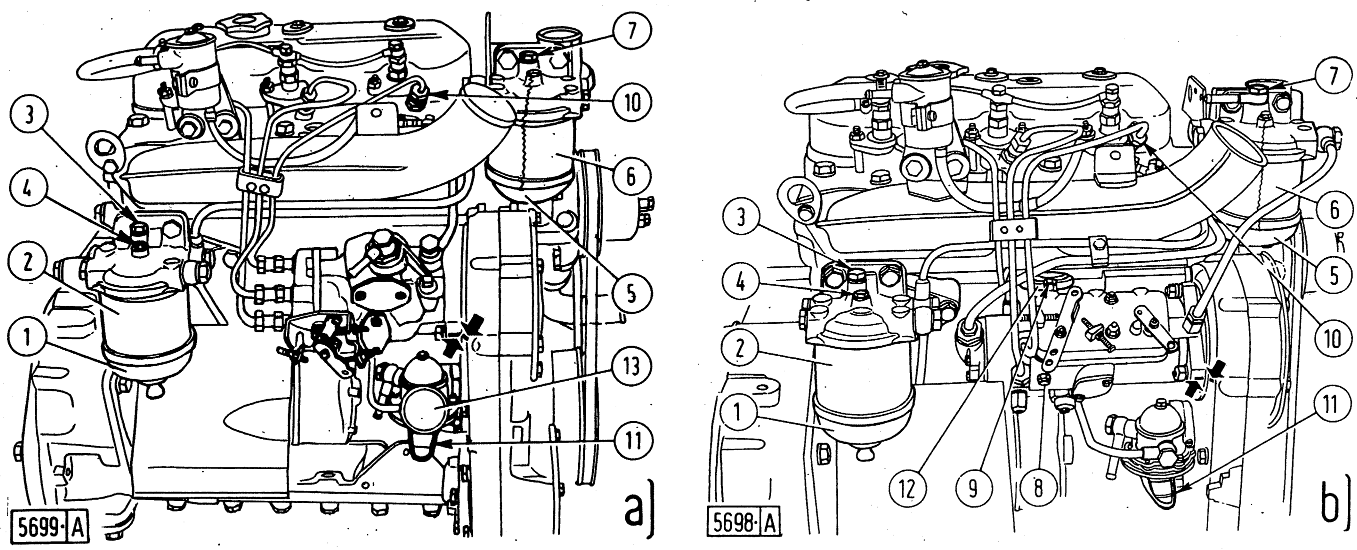


Fig. 8 - Bleeding the fuel system of engines fitted with Bosch (a) and CAV (b) inection pumps. (arrows show pump and crankcase marks to be lined up at assembly).

1. Transparent bowl complete with lower screw for discharging condensed water from 1st fuel filter - 2. First filter element - 3. First filter air bleed plug - 4. Filter element and bowl securing screw - 5. Second filter bowl (non-stransparent and without lower screw) - 6. Second filter element - 7. Second filter air bleed plug - 8. Hydraulic head (CAV injection pump) air bleed screw - 9. Governor housing air bleed screw (CAV injection pump) 10. Injector connections - 11. Fuel pump actuating lever - 12. Pressure equalizer installed on CAV injection pump (3 cylinders engine) - 13. Pressure equalizer installed on fuel pump (Bosch injection pump only).

C.A.V. INJECTION PUMP

GENERAL DESCRIPTION

See 640 except for the views of the pump reported in the figure below :

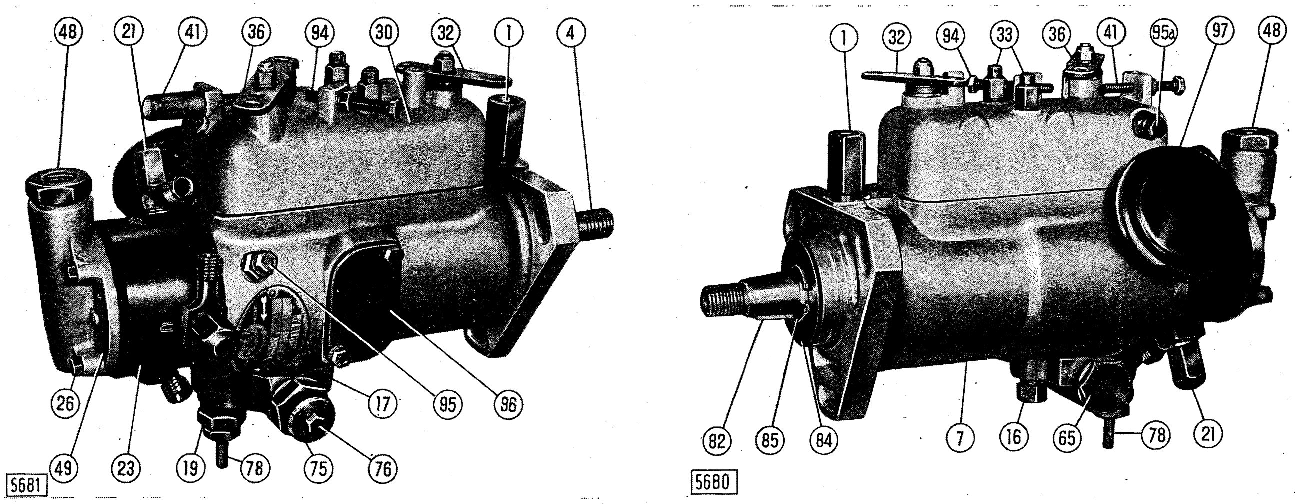


Fig. 9 - *C.A.V. fuel injection pump.*

1. Leak-off connection. - 4. Drive shaft. - 7. Pump housing. - 16. Auto advance device stud. - 17. Advance device housing. - 19. Hydraulic head locating fitting. - 21. High-pressure connection. - 23. Hydraulic head. - 26. End plate cap screw. - 30. Control cover. - 32. Shut-off lever. - 33. Cover stud nuts. - 36. Throttle arm. - 41. Maximum speed adjustment screw. - 48. Fuel inlet connection. - 49. End plate with transfer pressure regulating valve. - 65. End plug. - 75. Piston cap. - 76. Piston cap screw (test machine advance check gauge application). - 78. Manual retard device pin. - 82. Key. - 84. Thrust washer. - 85. Circlip. - 94. Idling speed adjustment screw. - 95. Hydraulic bleed screw. - 95a. Governor bleed screw. - 96. Control cover. - 97. Pressure equalizer.

OPERATION

See 640 except for the following variation that substitutes the last sentence in paragraph d pag. 53 :

- the cam ring lobes are six; however there are only three inlet ducts.

— the high pressure outlets in the cylinder head are equal in number to the lobes of the cam ring; which, however, have three blind ducts (93, Fig. 10) in alternate position with respect to the three high pressure open outlets. This is because during the ineffective delivery stroke the fuel present in the rotor (though in very reduced quantity as there is no charging phase) is directed into the blind ducts.

These are interconnected through the ducts (90) and the annular groove (91) so that the accumulated fuel returns into the rotor as soon as the corresponding return stroke of the plungers commences (fuel supply).

Assembly - See 640 except for the fitting of the circlip (15, Fig. IV/50, 640) that must be arranged with the sharp edge side, used as pump timing index, facing down (Fig. 12, a).

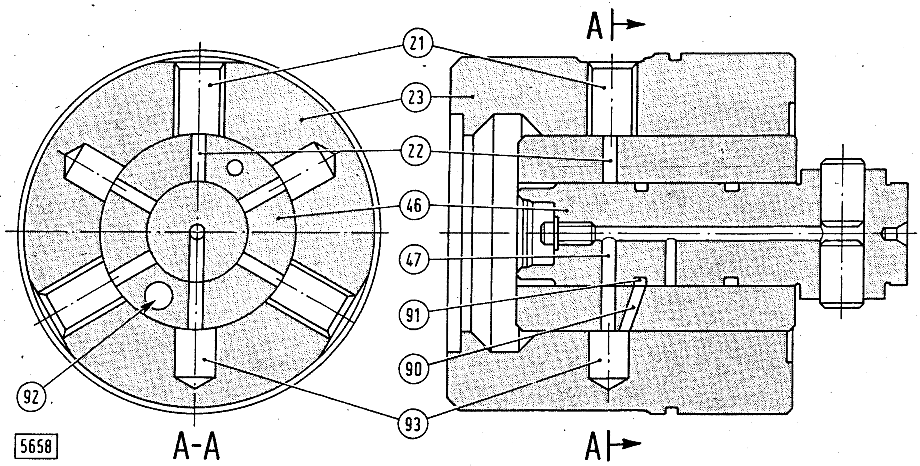
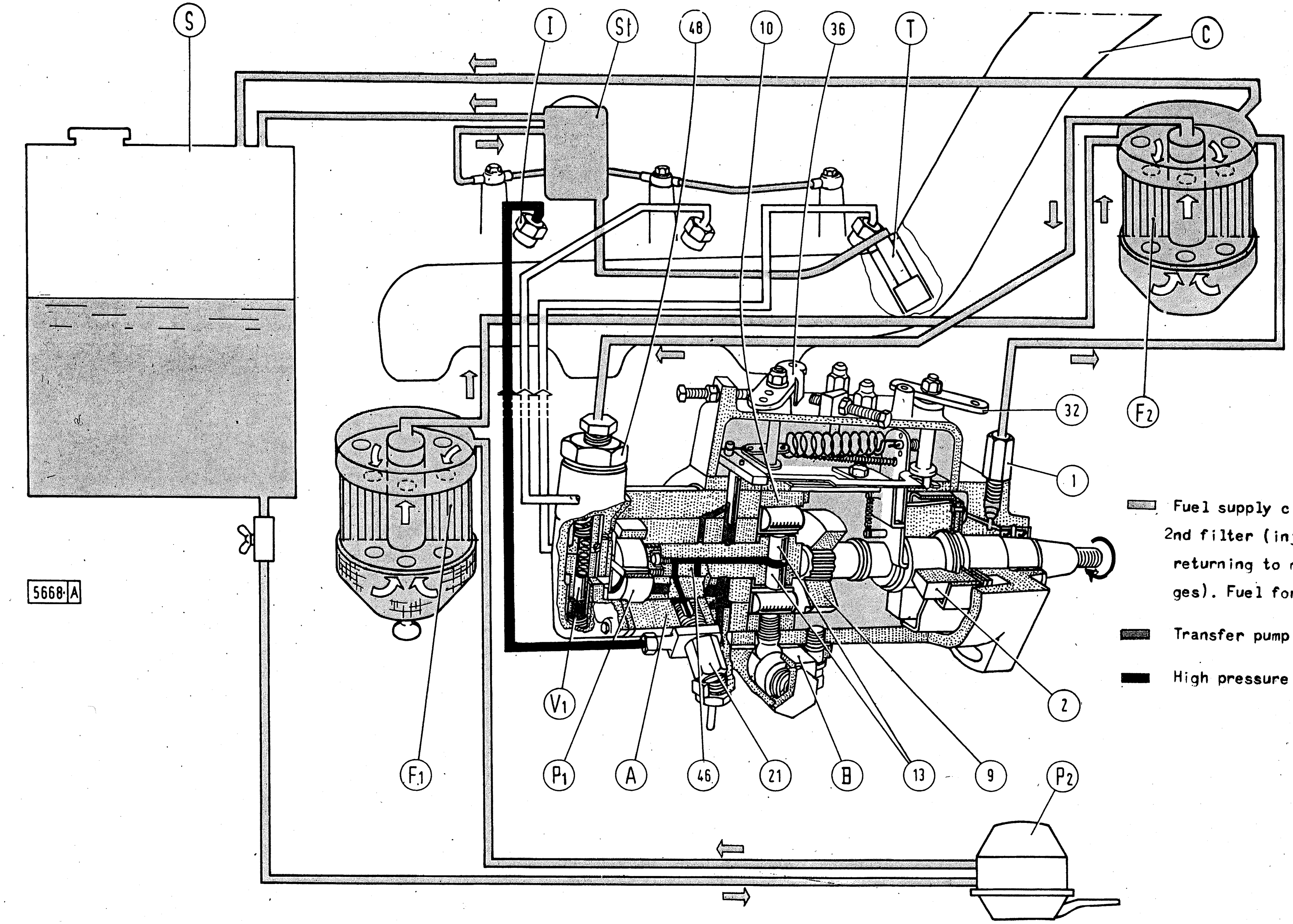


Fig. 10 - *Cross-sectional views of hydraulic head (23) and rotor (46).*

21. Outlet connection bore. - 22. Outlet port. - 47. Distributor port. - 90. Fuel passage. - 91. Annular groove. - 92. Fuel port to metering valve from transfer pump. - 93. Blind connection.



Fuel supply circuit, fuel returning to 2nd filter (injection pump leakages), fuel returning to main tank (injectors leakages). Fuel for starting aid.

Transfer pump delivery circuit.

High pressure fuel to operating injector.

Fig. 11 - C.A.V. injection pump fuel circuit diagram.

A. Hydraulic head - B. Auto advance device - C. Inlet manifold - F_1 and F_2. 1st and 2nd fuel filter in series - I. Injectors - P_1. Blade-type transfer pump - P_2. Diaphragm fuel priming pump - S. Fuel tank - St and T. Reservoir with starting aid - V_1. Transfer pressure regulating valve - 1. Leak-off connection - 2. Governor weights - 9. Splined drive plate - 10. Cam ring - 13. Plungers - 21. High-pressure connection - 32. Shut-off lever - 36. Throttle arm - 46. Rotor - 48. Fuel inlet connection.

PUMP TESTS

Service tools for testing sequence.

See 640 adding tool A 127031 for tests from 1 to 5 (see pag. 273) installed in place of automatic advance manual cut off device from which it differs externally only for a small hole.

Checking the automatic advance timing.

The test consists in checking the functional efficiency of the device at the various speeds by reading the corresponding values on the graduated scale of the gauge A 127003, which is controlled by the advance control plunger.
A test is also required for the manual retard device. Remove it and fit instead the test device A 127031, which is similar to it and differs only for a small diameter hole and for the absence of the pin.

Whilst the installation of the latter test device, which is required only for tests from order n. 1 through 5, is simple enough being nothing but at exchange of parts, the installation of the test gauge A 127003 needs some explanations; proceed as follows:

— remove the screw (76, Fig. IV/69-640) from the plug (75) on the spring side of the automatic timing device and fit the pick-up end, integral with the threaded sleeve, in the hole inside the graduated scale support;

— introduce the pick-up end in the hole inside the disassembled screw up to the cup bore (70), then screw the sleeve up the threaded hole inside the plug (75). The scale of the tool is thus fixed between plug and threaded sleeve;

— with the pump stopped, zero the dial scale and set the indicator contact in line with the pick-up shaft by adjusting the screw located at the back of the quadrant.

To carry on these tests, make the pump run at the speeds specified in the « Master Test Schedule » and make sure the instrument readings are within specified limits; if not, remove the plug (75) and vary the shims (74) or replace the springs (72 and 73). The shim, 0.5 mm (0.020″) thick, installed at the factory, must not be removed and the overall thickness cannot exceed 3 mm (0.118″). Should precise reading be difficult because of the pointer oscillations, stabilize it by putting a finger on it. Remove the device A 127031 after the test number 5.

Pump timing check (internal)

The injector testing pump must be connected with the outlet pressure connection marked W. Set the sharp edge of circlip in register with letter A as indicated in Fig. 12,a .

The assembly mark on the outer flange must be scribed with the indexing tool no. A127027 set at 268°.

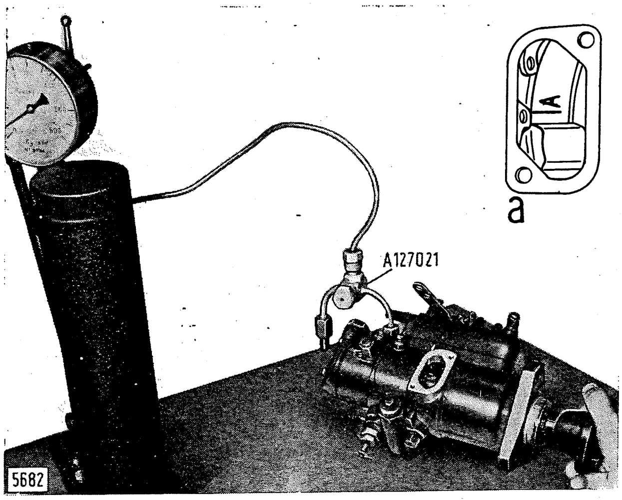


Fig.12 - Internal phasing of pump under 30 atm (427 p.s.i.) from pressure fitting W.

CALIBRATION DATA FOR FUEL INJECTION SYSTEM C.A.V.

General test conditions.

Test oil : type FIAT PROT.CFB

Oil temperature: 30°÷35°C (86°÷95°F)

Test machine supply pressure : 0.2 Kg/cm² (2.8 p.s.i.)

Diameter of pumping plungers: 9.0 mm (0.354 in).

Assembly arrangement of pump on the engine: mark **A** of drive plate in register with the flat end of the ring;

outlet port of distributing rotor in register with the outlet pressure fitting marked with the letter **W**;

beginning of delivery to cylinder no. 1 in compression: **16°** ÷ **18°** before T.D.C.

Specific test conditions.

Arrange the test rig for the tests **A** and **B** as follows:

Test **A** - Bosch test rig equipped with injectors with pressure spring **WSF 2044/4X** and nozzles - **EFEP 182.**

- Rabotti test rig type Atmo **700F** equipped with standard rig graduated ring, pressure spring **FIAT 656829** and nozzles **EFEP 182.**

Injector pressure setting: 175 kg/cm² (2489 p.s.i.).

Pressure pipes: 2 × 6 × 865 mm.

Test **B** - Test rig equipped with nozzle holders type **KB 70 S1 F10** and nozzles type **DLL 140S 64F.**

Injector pressure setting: 225 ÷ 235 kg/cm² (3200 ÷ 3342 p.s.i.).

Pressure pipes: **2** × 6 × 700 mm.

Pump rotation looking from drive end: counterclockwise.

Assembly data.

Distance measured between governor cover stud and metering valve pin **53÷54 mm (2.086 ÷ 2.126 in).**

Control spring (38, Fig. **13**) mounting holes: hole no. **1** in control arm and hole no. 3 in throttle arm.

Roller to roller dimension (Fig.IV/68-640): 49,98 mm (1.9676 in).

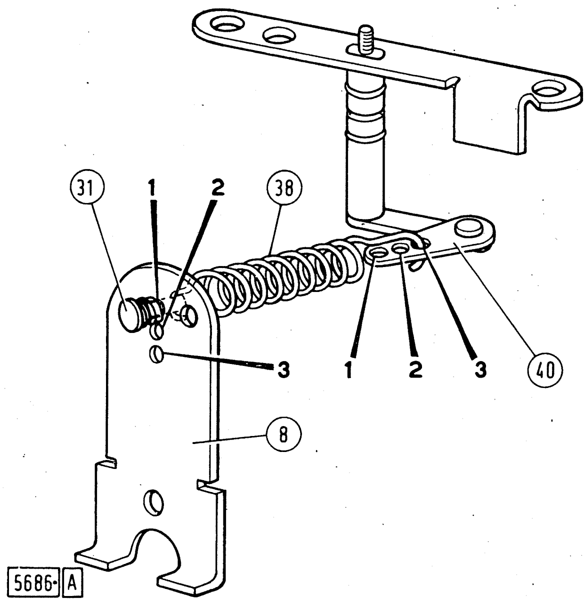


Fig. 13 - *Attaching holes of control spring (38) in throttle arm (40) and control arm (8) through the spring guide (31).*

Order of operations.

See the directions covering specialized tool use given in the topic dealing with the testing procedure. Starting from a primed and bled pump, go on as follows:

MASTER TEST SCHEDULE FOR FUEL INJECTION SYSTEM C.A.V. DPA 3233 F410

Order No.	TEST	Pump r.p.m.	Requirements and remarks
1	Vacuum at transfer pump suction (1) . .	100	406 mm of mercury within 60 seconds or less.
2	Transfer pump internal pressure (1) (2) . .	100	1.2 ÷ 1.8 kg/cm² (17 ÷ 25.6 p.s.i.)
3	Auto advance at max. torque speed (1) (3)	800	4 ÷ 5 deg. of advance; if necessary, vary the shims (74) - never reduce them to less than 0.5 mm (0.020″) and to more than 3 mm (0.118″) in thickness.
4	Auto advance at max. power speed (1) . .	1200	5.8 ÷ 6.3 deg. of advance.
5	Auto advance at starting (1)	180	1.2 ÷ 1.5 deg. of advance.
6	Disengagement of the auto advance at cold starts (4)	300	0 deg. advance. Actuate the manual retard device.
7	Final check of max. auto advance (4) . .	900	5.8 ÷ 6.3 deg. of advance.
8	Max. fuel transfer pressure (2)	1180 ÷ 1200	5 ÷ 6 kg/cm² (71.1÷85.3 p.s.i.) with throttle lever max. setting and stop control excluded.
9	Backleakage fuel (× 100 strokes) . . .	1180 ÷ 1200	4 c.c. or more. Control lever setting of test 8.
10	Maximum power speed delivery at one injector (× 1000 strokes)	1180 ÷ 1200	Throttle lever stop (41) completely unscrewed. Test A: 50÷53 c.c. Test B: 48÷51 c.c. Max. spread between any two deliveries (Tests A and B) not to exceed 4 c.c.
11-12	Maximum delivery of a single injector (× 1000 strokes)	800 ÷ 805	Throttle lever max. setting. Fuel transfer pressure: 3.8 ÷ 4.6 kg/cm² (54 ÷ 65.5 p.s.i.). Test A: 45÷ 48 c.c. Test B: 50÷ 53 c.c. Max. spread between any two deliveries (Tests A and B) not to exceed 4 c.c.
13	Delivery of one injector (× 1000 strokes) at low speed	100	Max throttle lever setting, actuate the manual retard device. Test A: 40 c.c. or more.
14	Stop control check (delivery per injector at 1000 strokes)	200	Test A: 4 c.c. or less. Shut off lever in stop and speed control lever in max. setting.
15	Delivery per injector at low idling speed (× 1000 strokes)	200	Test A: ⩽ 5 c.c. Throttle lever all closed with screw backed out.
16	Governed fuel delivery and max. fuel stop setting (per single injector and 1000 strokes)	1270	Test A: 9 c.c. or less. Max. throttle lever setting.
17	Final injector delivery check (× 1000 strokes)	1180 ÷ 1200	Test A: 50 ÷ 53 c.c. Max. speed con-control lever setting.

(Continued)

(1) The normal retard device (auto advance cut-off) is replaced by the tool **A 127031**.
(2) Fit adaptor **A 127009** in place of the screw securing the hydraulic head to the pump body for connecting to the test pressure gauge line.
(3) Read on dial of test gauge **A 127031** fitted on the auto advance device plug in place of the small screw.
(4) Proceed to final installation of the auto advance device in place of tool **A 127031** and bleed the pump.

Continued: « Master test schedule ».

Order No.	TEST	Pump r.p.m.	Requirements and remarks
18	Pump timing	—	Prime with hand pump (at 30 atm = 427 p.s.i.) through outlet connection W, arrange circlip with flat end in register with letter mark **A** on distributing rotor drive plate. Scribe outside mark on flange mounting to engine crankcase using the tool **A 127027** at 268°.

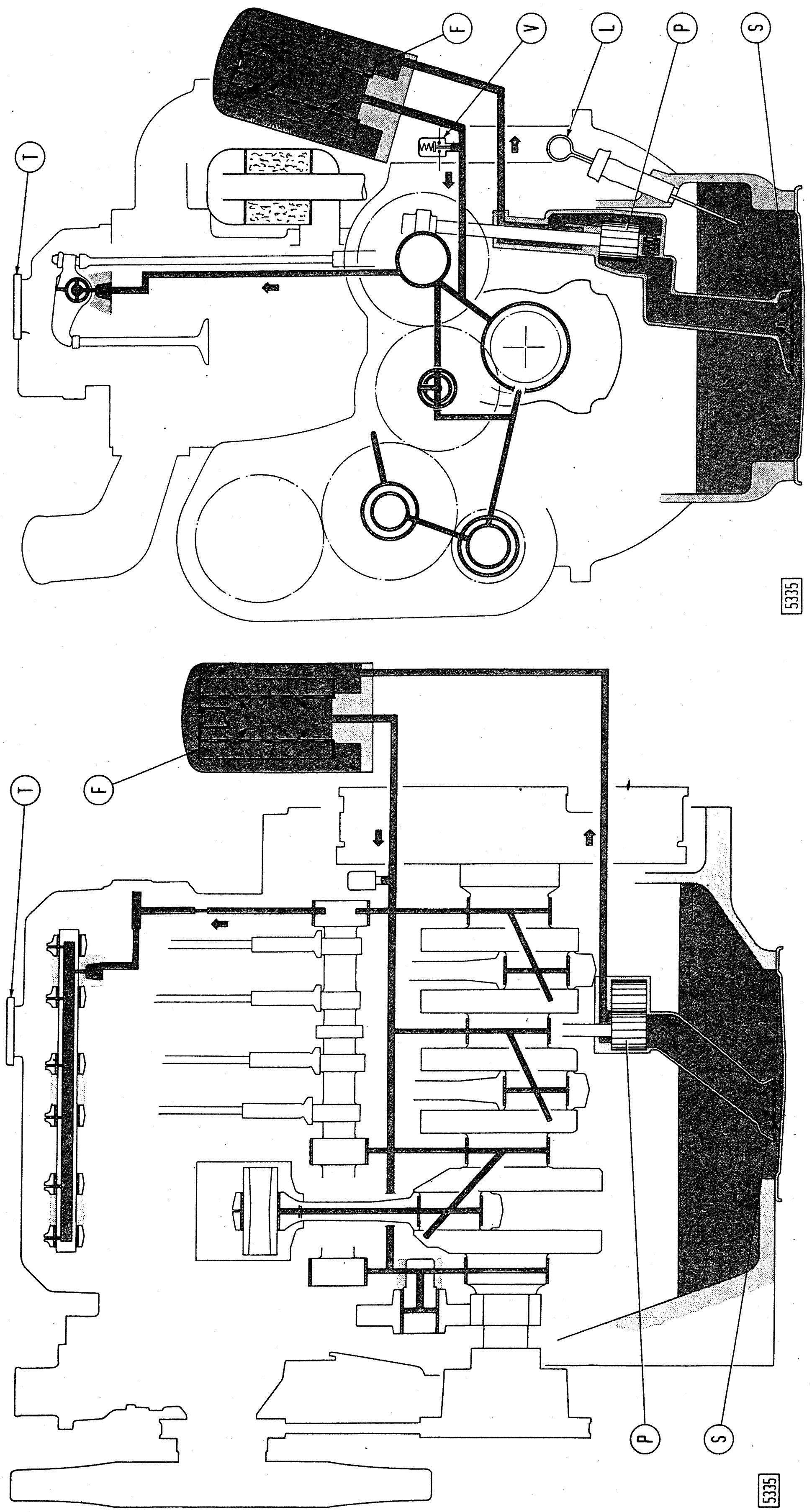


Fig. 14 – Engine lubrication diagram.
F. Filter – L. Dipstik gauge – P. Gear-type pump – S. Oil sump bell – T. Oil filter plug – V. Pressure switch for insufficient oil pressure indicator (on panel).

ENGINE LUBE SCHEDULE AND CAPACITIES

Fill point	Level check intervals hours	Change intervals hours	LUBRICANT FIAT	LUBRICANT International	LUBRICANT Q.ty kg
Engine: Complete lube circuit	10	200	Ambra 20 W-40 (1)	Multigrade motor oil (Mil-L-2104 B) for all engine applications	6.8 kg (6.6 qts)
Engine: Oil sump only					6 kg (5.9 qts)
Air cleaner cup	50	(2)			1 kg (1-1/4 qt.)

Capacities:
- — cooling system . . . . . . 13 liters (2.8 imp. gal)
- — fuel tank . . . . . . 54 liters (~ 12 imp. gal)

(1) Use 20 W-40 grade for ambient temperatures above 0° C (32° F) and 10 W-30 below 0° C.
(2) Change the oil if contaminated or if deposits are about 1 cm (~ 3/8″) thick.

POWER TRAIN AND ATTACHMENTS

O - DESCRIPTION - SPECIFICATIONS - LUBRICATION

GENERAL DESCRIPTION

The power train consists of the following major units:

- 10" FIAT make dual-plate dry clutch with single foot control ;
- transmission with epicyclic gear reduction: six forward (four with synchro=mesh) and two reverse speeds ;
- main drive bevel gear and two-gear differential with lock and pedal;
- dry contracting band service brakes with mechanical control and indipendent pedals;
- single-reduction final drives;
- telescoping front axle centrally pivoted: with reversed U-shape channel ;
- steering with wheel and worm gear and unit box.

The Controlmatic hydraulic lift is of the position and draft control type. The P.T.O. and drive are incorporated in the transmission housing rear cover and the belt pulley is optional.

TRANSMISSION RATIOS, PERFORMANCE, WEIGHT AND CONSUMPTION DATA

Speed gears	Transmission and epicyclic gear train speed reduction ratios 1 :	Overall speed reduction ratios frome engine to drive wheels (1 wheel turn per engine revs) 1 :	Maximum speed (with engine running at 2400 r.p.m. and rear tyres 12.4/11-28) Km/h	MPH
1st Low	10.575	233.4	2.3	(1.43)
2nd "	5.85	129.1	4.2	(2.61)
3rd "	3.716	82.0	6.5	(4.04)
1st High	2.938	64.8	8.2	(5.10)
2nd "	1.625	35.8	14.9	(9.26)
3rd "	1.032	22.7	23.4	(14.54)
1st Creeper(°)	32.658	720.9	0.74	(0.46)
2nd " "	18.066	398.8	1.34	(0.83)
3rd " "	11.476	253.3	2.11	(1.31)
Low reverse	7.2	158.9	3.4	(2.11)
High reverse	2.0	44.1	12.1	(7.52)
Creeper Rev.(°)	22.235	490.861	1.09	(0.68)

Bevel gear speed reduction ratio 12/47	1 : 3.917
Final drive speed reduction ratio 11/62	1 : 5.636
Total speed reduction ratio (final drives+bevel gear).....	1 : 22.076
Tractor weight (with standard fittings,oil,coolant and fuel,operator excluded)	1830 kg (4034 lb)

(°) With subsidiary reduction unit (optional).

POWER TRAIN AND ATTACHMENT LUBRICANTS

Fill point	Inspection schedule hours	Change schedule hours	Lubricant FIAT	Lubricant International	Capacity kg	Capacity Imp. qts.
Transmission housing rear train housing and hydraulic lift unit (*)	400	1600	AMBRA 20 W - 40	MIL-L-2104B(1)	16	15
Final drives (each)	400	1600	AMBRA 20 W - 40	MIL-L-2104B(1)	1.5	1.4
Steering box	400	—	AMBRA 20 W - 40	MIL-L-2104B(1)	0.35	0.35
Drive pulley	50	1600	AMBRA 20 W - 40	MIL-L-2104B(1)	0.4	0.4
Front wheel hub (each) ...	400	—	MR3 Grease	NLGI 3 (2)	0.25	0.25
Grease nipples	50	—	G9 Grease	NLGI 2 (3)	—	—

Fuel tank capacity (clean fuel oil) .... 54 liters (12 Imp. gal)

(1) Multigrade motor oil, SAE viscosity no. 20 W-40, detergent to spec. MIL-L-2104 B and suitable for general lubrication purposes.
(2) Mineral grease, litium-calcium soap base, consistency NLGI no. 3.
(3) Mineral grease, litium-calcium soap base, consistency NLGI no.2.
(*) For temperature below 0°C (32°F) use oliofiat AMBRA 10W/30.

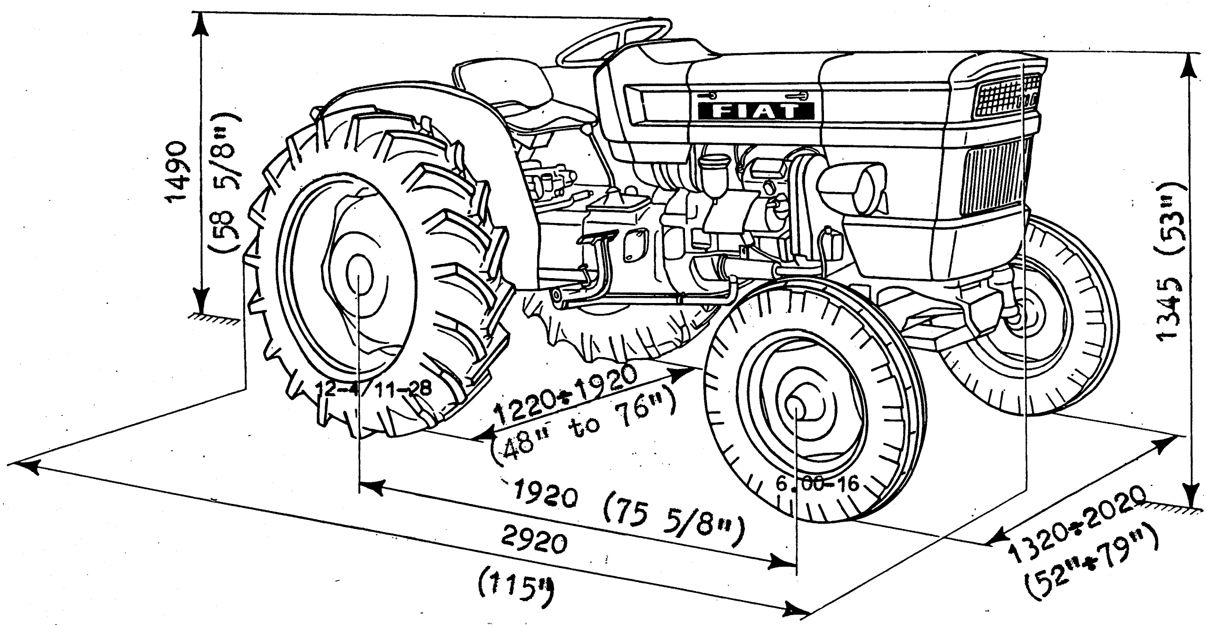


Fig.0/1 - Overall dimensions of the tractor model 480.

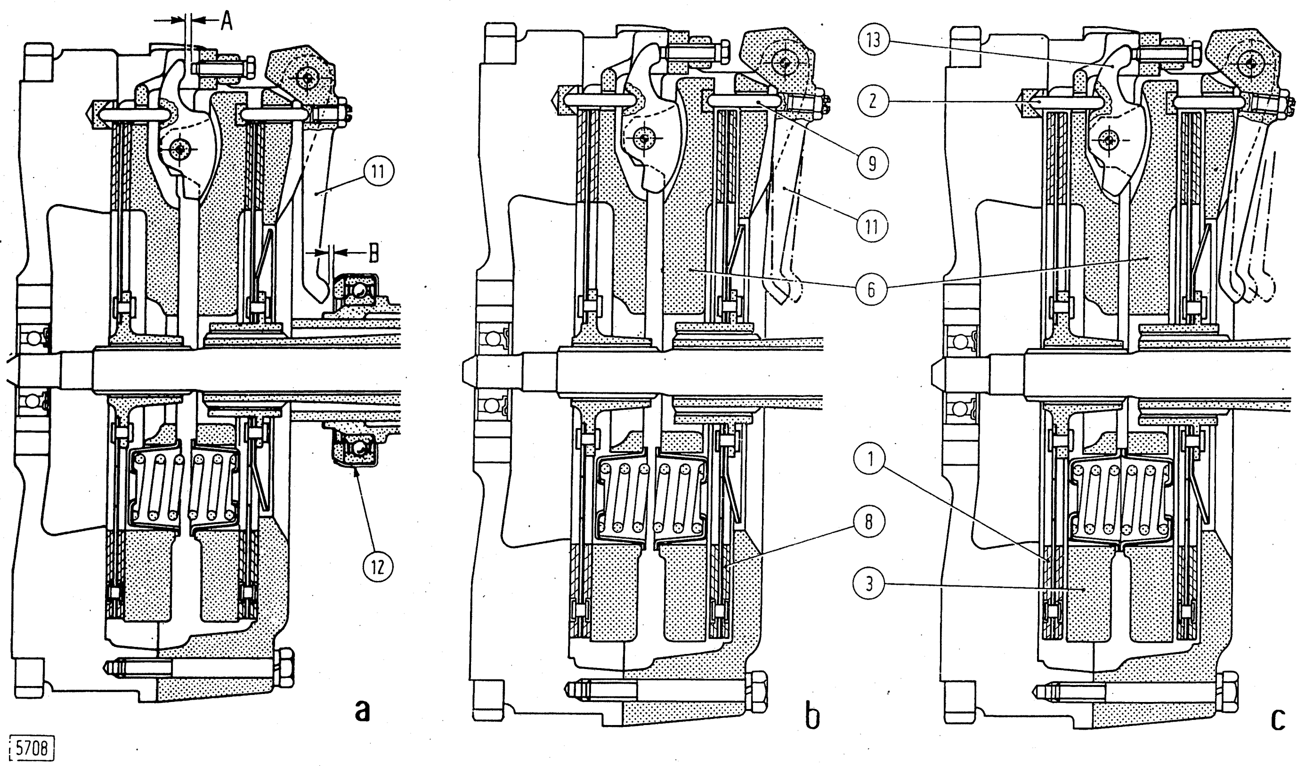
I - CLUTCH

10″ CLUTCH DESCRIPTION AND OPERATION

The **FIAT** spring loaded clutch installed on tractor **mod.**480 groups into a single unit two 10″, dry, single-plate clutches one of which acts upon the transmission and the other controls the power take-off (Fig. I/1).

A single control pedal disengages the two plates in succession during its travel.
The first length of travel serves to disengage the clutch connecting the engine to the transmission (b);
the second length up to the travel stop serves to disengage the P.T.O. clutch (c).

The correct free travel of the pedal is 35 mm (1-3/8″); it is necessary to take up the play (**B**, Fig. I/1) between the transmission clutch release levers (**11**) and bearing (**12**), while the remaining length of travel involves the compression of the levers by the bearing.
The levers (**11**) act then upon the rods (**9**) which in turn transmit the load to the pressure plate (**6**), the separation of which allows the disengagement of the transmission clutch driven plate (**8**).
Continuing on its travel
the pedal allows the disengagement of the P.T.O. clutch plate: the levers (**13**), pivoted on pressure plate (**6**), during the transmission clutch (**b**) disengagement take up the play (**A**) with the adjusting screws. These levers, with their fulcrum on rods (**2**), act upon the screws thus moving the pressure plate (**3**) away causing the disengagement of the P.T.O. clutch plate (**1**).



a. Engaged clutch. b. Transmission clutch plate disengaged. c. Completely disengaged clutch.

Fig. I/1 - 10″ clutch working drawings.

(The annotated parts are described in the text).

10" CLUTCH REMOVAL

Split the engine with front axle as an assembly from the tractor transmission housing (Fig. I/4) and then remove the clutch unit from the engine flywheel as follows:

1. Disconnect the battery ground cable and protect the terminal.
2. Remove, in the order:

— the hood back plate, and from this remove the lighting-starting switch, the electric horn push-button and the radiator curtain control on those tractors which are equipped with one;

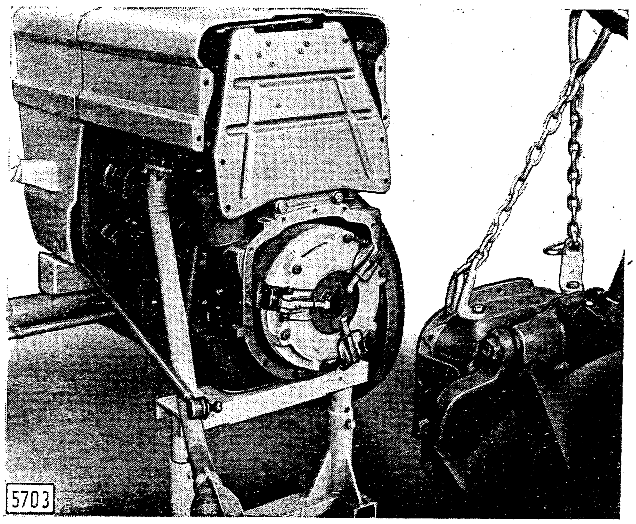


Fig. I/4 - Removing the front axle-engine unit with clutch from the transmission of the tractor

— the rear hood after separating it from the side panels and dashboard;

— the dashboard, disconnecting the tractormeter cable, electrical connections and starting switch unit;

— the fuel tank after closing the cocks, disconnecting the fuel level indicator wires and fuel lines and removing the mounting brackets.

3. Disconnect the electric cables from the engine starting safety push-button and from the rear lighting connections and place the cable strap assembly on the engine (**Fc**, Fig. I/3 – 640).
4. Remove the fuel tank supports by separating them from the central panel, disconnecting the throttle controls from the linkage and unscrewing the engine stop control knob.
5. Drain the transmission and rear train housings of lubricating oil and detach;

— hydraulic lift oil lines from the pump installed on the engine;

— the exhaust muffler from the left-hand side final drive, loosening then the stud nuts which secure it to the exhaust manifold;

— the drag link from the steering box arm.

6. Put on the hand brake, insert two wooden wedge blocks between the front axle and its support, attach a lifting chain to the transmission housing and to a shop hoist, then take

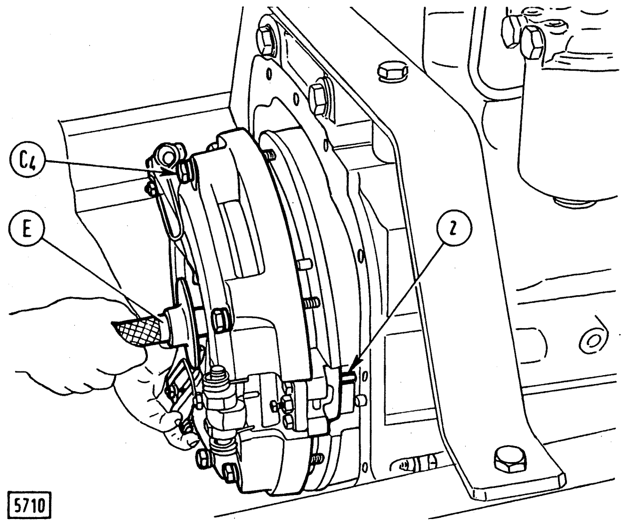


Fig. I/5 - Removing (refitting) the 10" clutch from the engine flywheel using the alignment spigot A 117163 (E).

C_4. Clutch to flywheel attaching cap screws. - 2. P.T.O. clutch release lever rod.

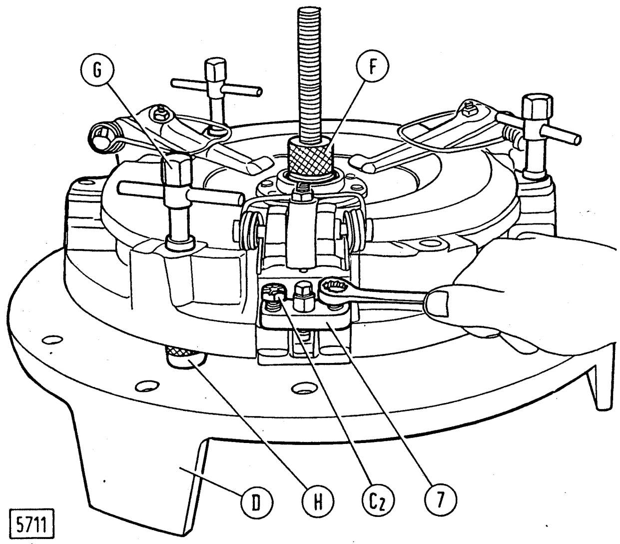


Fig. I/7 - Dismantling (assembling) the 10" clutch on the universal fixture A 711063/68B (D).

C_2. Supporting plate (7) screws. - F. Central spacer. - G. Clutch mounting threaded rods. - H. Outer spacing bushings. - 7. P.T.O. clutch release lever adjusting screw plate.

the weight off and place a hydraulic jack under the engine oil sump.

7. Remove all attaching capscrews (C_3 and C_5, Fig. I/8) and move the engine-front axle unit forward, separating it from the transmission housing and then placing it on a shop stand (Fig. I/4) after suitably wedging the front wheels.

8. Remove the clutch unit from the engine fly-wheel, as follows:

— remove, in alternate order, four of the six attaching cap screws (C_4, Fig. I/5) and loosen the remaining two screws;

— introduce the alignment spigot **A 117163** (**E**, Fig. I/5) inside the clutch shaft locations;

— withdraw the remaining two screws and remove the complete unit and the three rods (**2**) from their flywheel locations.

10" CLUTCH DISASSEMBLY

Prior to disassembly, mark the following items: pressure plates (**3** and **6**, Fig. I/6), P.T.O. clutch release lever screw plates (**7**) and clutch cover (**10**) in order to ensure the correct positioning of the parts in their original locations at reassembly thus maintaining the dynamic balance as set at the factory.

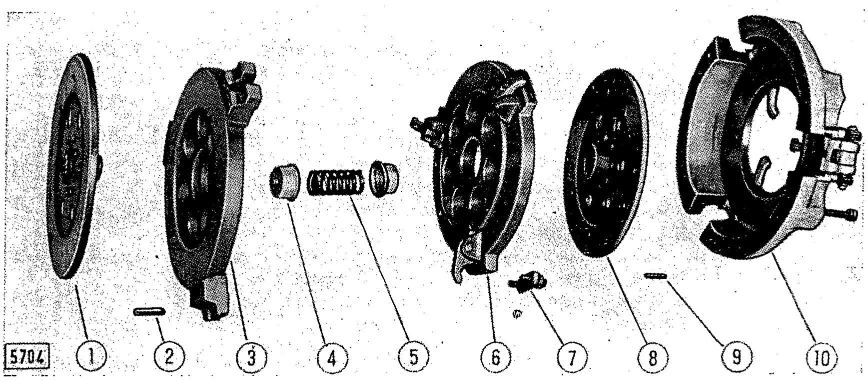
Clutches can be disassembled without using specialized tooling, as follows:

— place on any suitable surface the clutch unit without P.T.O. plate (**1**, Fig. I/6) and push rods (**2**);

— gradually and in succession, unscrew the cap screws (C_2, Fig. I/7) of the pressure plates (**3** and **6**, Fig. I/6) to unload the springs (**5**) which are compressed between these two plates;

Fig. I/6 . Exploded view of the 10" clutch.

1. P.T.O. clutch driven plate. - 2. P.T.O. clutch release lever rod. - 3. P.T.O. clutch pressure plate. - 4. Spring (5) cups. - 5. Engagement spring. - 6. Transmission clutch pressure plate. - 7. P.T.O. clutch release lever adjustment screw plate. - 8. Transmission clutch driven disc. - 9. Transmission clutch release lever-push rod. - 10. Clutch cover.



— dismantle then the clutch into its parts (Fig. I/6).

The aforementioned operations are done more easily by installing the clutch unit on the base plate of the universal fixture **A 711063/68 B** as illustrated in Fig. I/7.

INSPECTION

Checks required for the 10″ clutch are as follows:

— functional efficiency of the disc friction linings (**1** and **8**, Fig. I/6) and conditions of mating

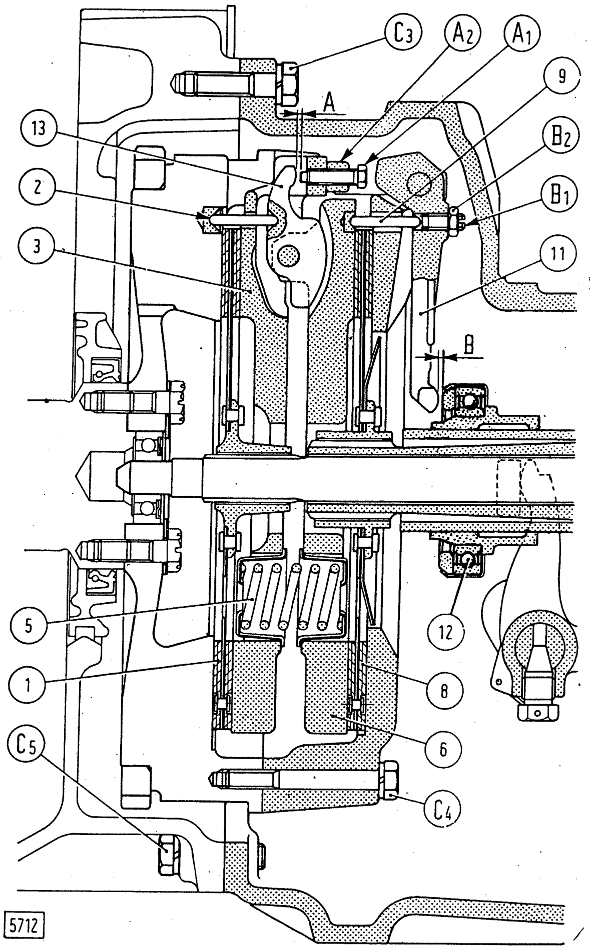


Fig. I/8 - 10″ clutch cross-section.
A = 1.5 mm (0.060″) P.T.O. clutch release lever adjusted play. - A_1. P.T.O. clutch release lever adjusting screw. - A_2. Screw (A_1) locknut. - B = 3 mm (0.118″). Adjusted clearance between transmission clutch release levers and thrust bearing (12). - B_1. Transmission clutch release lever complanarity adjusting screw. - B_2. Screw (B_1) locknut. - C_3 and C_5. Attaching cap screws of the clutch-transmission case to the engine block. - C_4. Capscrews securing the clutch unit to the engine flywheel. - 1. P.T.O. clutch disc. - 2. Lever (13) rod. - 3. P.T.O. clutch pressure plate. - 5. Engagement spring. - 6. Transmission clutch pressure plate. - 8. Transmission clutch disc. - 9. Lever (11) rod. - 11. Transmission clutch release lever. - 12. Thrust bearing. - 13. P.T.O. clutch release lever.

metallic surfaces; the latter are polished, if necessary. If the discs are impregnated with oil it is best to replace them, as washing in gasoline and brushing are not enough;

— the friction surfaces of the pressure plates should be free from scoring or signs of abnormal wear, and if so it is possible to reface them by turning them down on a lathe (see limits on page 297;

— the hubs of the driven plates shoulds have no play on the rivets;

— the side clearance of the disc hub splines with the splined shafts;

— the functional efficiency of the throw-out collar thrust bearing and of the clutch shaft pilot bearing in the flywheel;

— loading spring strain values vs. specifications on page 297;

— sliding surface conditions of throw-out collar and support. If wear is still within limits, the support can be rotated 180°, and if not, replace the parts if excessive play causes grease leakage.

10″ CLUTCH ASSEMBLY

Prior to assembly, lubricate the following items with a film of FIAT G 9 (multi-purpose) grease: transmission clutch release lever pivots, the ball heads of the clutch release rods (mainly to hold them in place at assembly), the outer surfaces of the forks of the pressure plates (**3** and **6**, Fig. I/6) and the inside surface of the fork locations on the clutch cover (**10**).

Assemble the clutch referring to the following notes:

— place the pressure plate (**3**, Fig. I/6), adjusting screw (**7**) supporting plate, pressure plate (**6**) and the clutch cover (**10**) in their original positions arranging them with their assembly marks (scribed at disassembly) in register;

— arrange the transmission clutch disc (**8**) with the protruding part of the hub facing towards the mounting plane;

— tighten the attaching cam screws (C_2, Fig. I/7) to the torque value specified on page 299.
The aforementioned operations are facilitated if carried on the universal fixture **A 711063/68** as illustrated in Fig. I/7.

10″ CLUTCH ADJUSTMENTS

The data necessary for the correct adjustment of the clutch are annotated by the letters **A** and **B** in the legend of Fig. I/8.

The dimension **A** is set with the clutch installed on flywheel (fig.1/9), whilst the distance **B** between release bearing (**12**) and the tips of the release levers (**11**) is set when adjusting the free travel of the control pedal (see linkage adjustments on page 286.

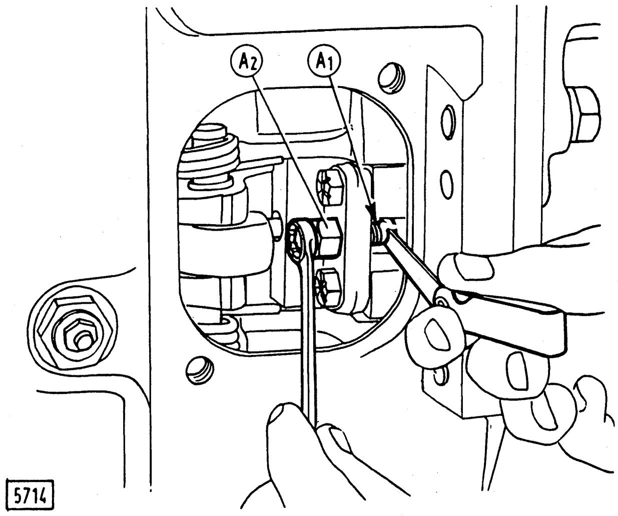


Fig. I/9 - *Adjusting the P.T.O. release lever play through the transmission case right-hand side window.*
A_1. Adjusting screw. - A_2. Locknut.

Adjustments to be carried on with the clutch installed on the universal fixture are the following two:

1. *Setting the clearance* (**A**, *Fig. I/8*) *of the P.T.O. clutch release levers* (**13**).

   This adjustment must be carried out or checked on the tractor through the inspection cover window on the right-hand side of the transmission housing (Fig. I/9). To bring the screws (**A_1**) in line with the window, shift the transmission in neutral and make the crankshaft rotate to suit.

Lever complanarity is also checked with the clutch installed on the tractor using the alignment spigot **A 117163** previously indicated for the removal of the clutch from the engine flywheel.

10″ Clutch control linkage adjustment.

The free, or idle, travel with which the footrest of the pedal makes to start disengaging the engine-transmission clutch, i.e. before the thrust bearing acts upon the levers (**11**, Fig. I/8), is 35 mm (1-3/8″).

2. *Adjusting the release lever complanarity* (*Fig. I/10*):

— install the gauge block (**L**), bring the mark " **4/A** " as illustrated and secure it by the nut (**I**);

— check, using a feeler gauge, that a max. clearance of 0.1 mm (0.040″) exists between the lever tips and the gauge block, the latter resting on the central spacer (**F**). If otherwise, adjust the levers by slackening the nut (**B_2**) and screwing up the adjusting screw (**B_1**); once the specified clearance is achieved, tighten the locknut (**B_2**).

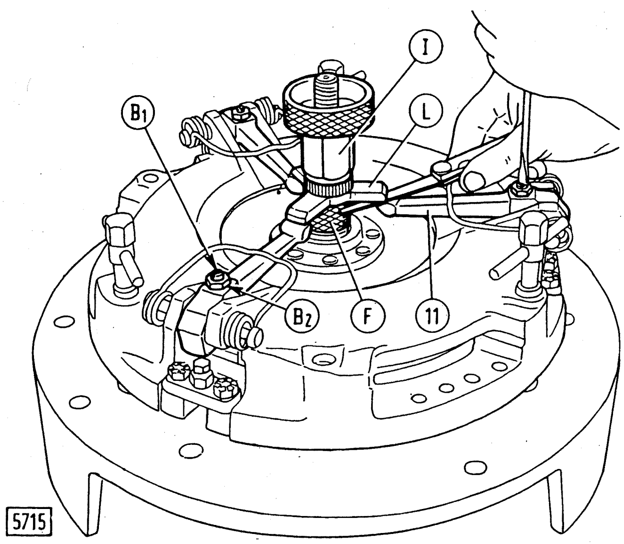


Fig. I/10 - *Adjusting the complanarity of the 10″ clutch release lever complanarity on the universal fixture A 711063/68 B.*
B_1. Levers (11) adjusting screw. - B_2. Screw (B_1) locknut. - F. Central spacer. - I. Nut. - L. Gauge block.

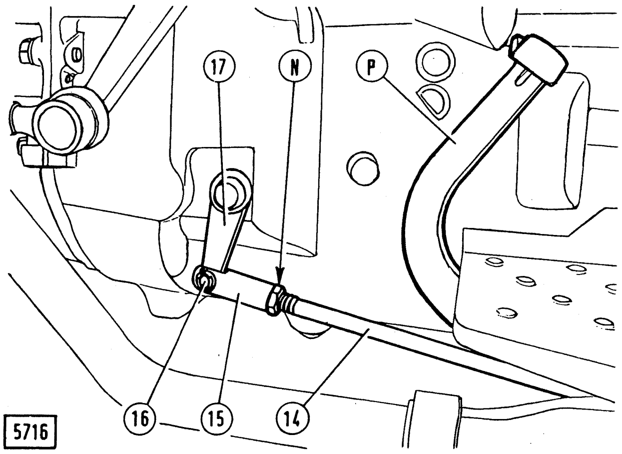


Fig. I/11 - Adjusting the free pedal travel of the 10" clutch.

N. Clevis (15) locknut. - P. Clutch pedal. - 14. Adjusting rod. - 15. Pedal free travel adjusting clevis. - 16. Clevis (15) pivot pin. - 17. Release collar arm.

When because of disc lining wear, the free travel left is down to about 25 mm (1"), adjust it as follows:

— disconnect clevis (**15**, Fig. I/11) from the arm (**17**) by withdrawing the pivot pin (**16**);

— loosen the clevis nut (**N**) to suit, and increase the length of the rod (**14**) to suit by screwing back the clevis. The pedal travel varies of 10 mm (25/64") per each full turn of the clevis;

— re-connect the free travel setting clevis to the thrust bearing (**12**, Fig. I/8) arm by fitting the pivot pin and retighten the clevis locknut;

— make sure the pedal free travel, measured on the footplate, is 35 mm (1-3/8"), approx.

10" CLUTCH INSTALLATION

Prior to installation, fill the pilot bearing location in the flywheel with FIAT G 9 (multipurpose NLGI 2 grease).

Center the clutch unit on the pilot bearing using the alignment spigot **A 117163** (Fig. I/5), then tighten the attaching cap screws (**C_4**).

Reattach the engine-front axle unit to the transmission tightening the screws to the torque values specified on page 299 .

CLUTCH-TRANSMISSION SHAFT FLEXIBLE COUPLING

If the transmission in noisy the sleeve coupling is disassembled to check the conditions of the rubber blocks which should be replaced if badly worn.

At reassembly, make sure the alignment of the inner and outer sleeve splines is arranged as illustrated in Fig. I/12 and tighten the through bolt nuts (C_1) to the specified torque value.

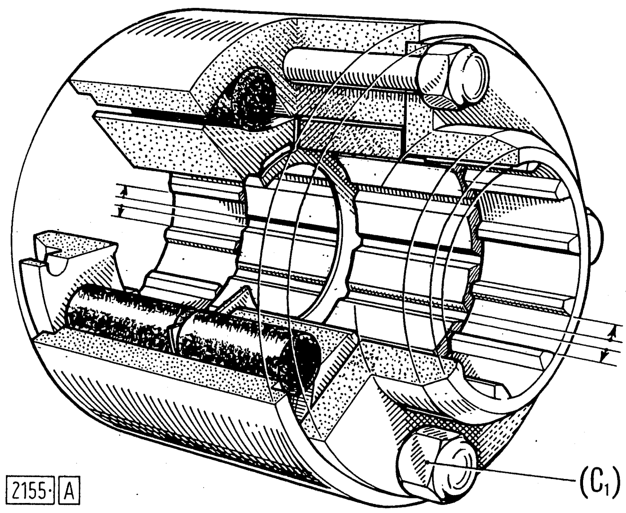


Fig. I/12 - Phantom view of the clutch-transmission shaft coupling

(Arrange the splines so that the grooves of the inner sleeves are symmetrical to the full teeth of the outer flanges).

C_1. Through-bolt self-locking nuts.

II - TRANSMISSION

6 - SPEED TRANSMISSION

The transmission (Fig. II/1) installed on the tractor **model 480** offers three forward and one reverse speeds.
The auxiliary epicyclic gear speed reduction unit, arranged at the rear end of the transmission driven gear shaft, doubles the range of available speeds so that the tractor offers six forward and two reverse speeds.
All transmission and planetary gear unit gears have straight teeth.
The driving gears (**31**, Fig. II/7) and the driven ones (**63** and **57**, Fig. II/8) of the 5th and 6th speeds (2nd and 3rd low) are in constant mesh and speed engagement is aided by a synchromesh device (**A**, Fig. II/7).
This device, though being of the conventional free-cone type, has three flat outer springs (**60**, Figs. II/8 and II/12) arranged in suitable holders (**61**) and applying a radial force upon the synchromesh tapered rings (**58**). Consequently, the axial mating of the cones (**58**) over their respective tapered surfaces in the driven gears (**57** and **63**), brakes down the speed of the latter thus synchronizing it with that of the fixed sleeve (**59**) thus facilitating the quick engagement of the sliding collar (**62**) with the tractor in motion at different engine speeds.
The engagement of the 4th forward speed and of the 2nd reverse one (1st forward and 1st reverse low speeds) is achieved by shifting the driving gear (**30**, Fig. II/7) sideways.

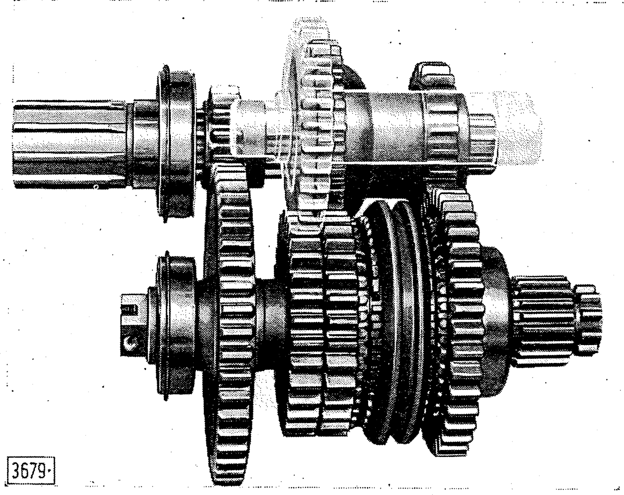


Fig. II/1 *- 6-speed transmission gears and shafts.*

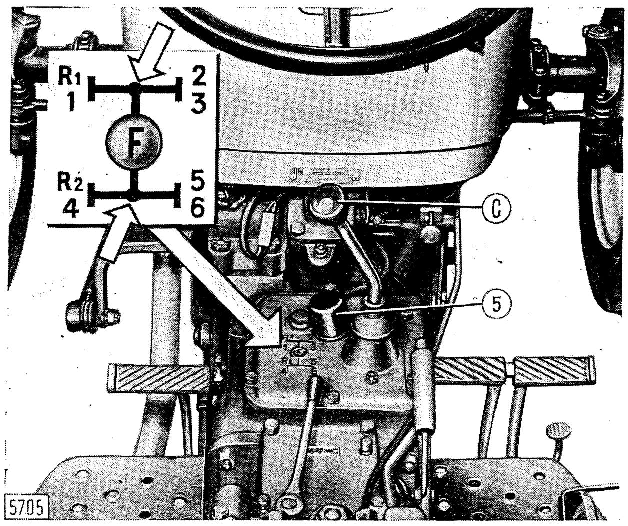


Fig. II/2 *- Top view and controls of the tractor*
(Arrows show neutral position for the hi-and low-speed ranges).
C. Gearshift lever. - F. Neutral setting of lever (C). - 5. Engine starting push button control (optional).

Both the engagement of the auxiliary unit and the selection of the desired transmission speed are achieved through a single control lever (**C**, Fig. II/2) which is equipped with a return spring that automatically brings it back to the neutral settings indicated by the arrows in the figure.
The safety push-button (**5**, Fig. II/2) allows the engine to be started only when the control lever (**C**) is neutral (**F**).
In fact, if the lever is in neutral for both low and high speed ranges, as shown by the arrows, or if the transmission is shifted in gears, the push rod (**6**, Fig. II/4) does not close the contacts of the push-button (**5**) thus holding the electric starting motor circuit open.

REMOVING THE 6-SPEED TRANSMISSION

Split the engine-front axle assembly off the transmission housing by performing the operations of page 282 for the removal of the 10″ clutch, then proceed as follows:

— remove the floorplates from the transmission housing;

— remove the complete steering box, the transmission housing front cover and gasket so to allow removing the upper stud nut;

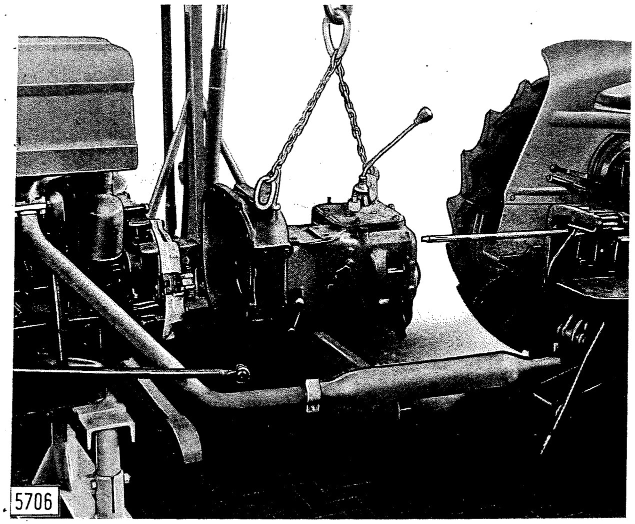


Fig. II/3 - Removing (installing) the transmission case unit

— disconnect the link from the clutch control outside arm;

— apply a hoisting chain to the transmission housing and take the weight off;

— place a hydraulic jack under the transmission housing, remove attaching nuts and bolts and then the transmission unit withdrawing it forward (Fig. II/3) and paying attention not to damage the P.T.O. clutch shaft.

DISMANTLING THE TRANSMISSION

In order to facilitate disassembly we recommend installing the transmission unit on the turnover stand **ARR 2220** (Figs. II/5 and II/6).

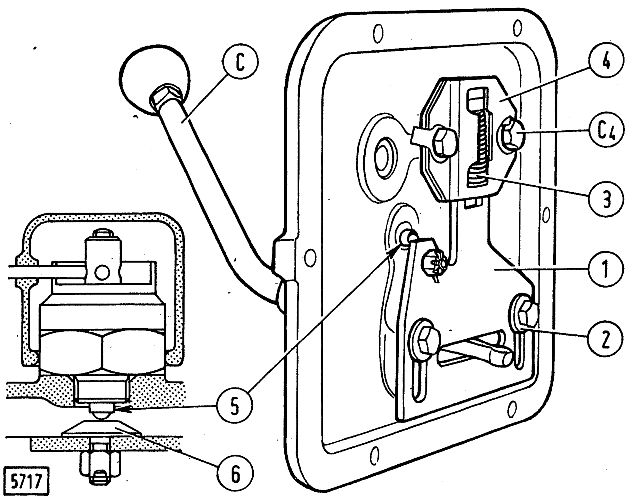


Fig. II/4 - Gearshift lever and gear selector mechanism.
C. Gearshift lever. - C_4. Bracket attaching cap screws. - 1. Selector plate. - 2. Spacers. - 3 and 4. Selector plate automatic return spring and brackets. - 5. Engine starting safety button. - 6. Button (5) control.

Proceed then as follows.

— Remove:

the transmission top cover (Fig. II/4), complete;
the clutch release collar (**7**, Fig. II/5)

the shifter fork (**21**) and shaft (**36**) after removing the capscrew (C_{12}).

— Remove the attaching capscrews (C_5, Fig. II/5) and withdraw the clutch shaft (**24**, Fig. II/7) and support together with the clutch-transmission shaft joint (**G**).

Note. - *Due to the bedding of the nylon housing* (**25**, *Fig. II/7*) *on the rear end of the clutch shaft, the latter may come off together with the shaft.*

— Remove the two front bearing washers for driving and driven shafts using the protection **A 137003** to withdraw the cover (**26**, Fig. II/7) in order to avoid damaging the oil seal.

— Through the selectors, shift in two speeds simultaneously, withdraw the cotter pin and unscrew the bearing and drive gears locknut (C_{13}, Fig. II/10).

— Remove selectors (**9** and **12**, Fig. II/6) and the shifter fork (**14**) as follows: withdraw the locating hollow pins shifting the auxiliary speed reduction selector (**12**) into either of the extreme neutral settings to avoid interference of the pin with the shifter fork (**14**);

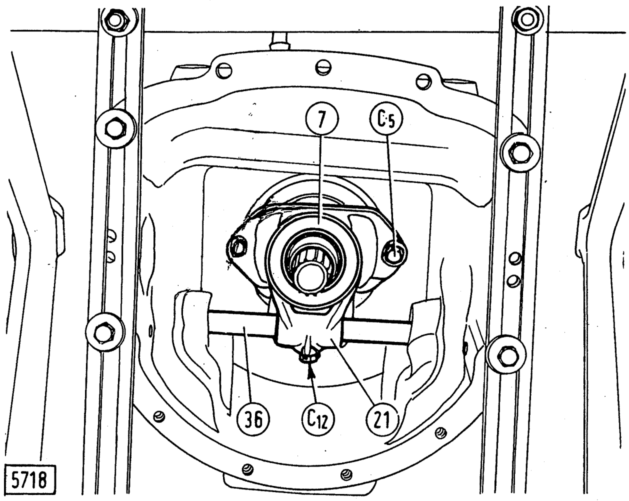


Fig. II/5 - Front view of transmission case installed on turnover shop stand ARR 2220.
C_5. Clutch shaft bracket attaching capscrews. - C_{12}. Lever (21) setscrew. - 7. Clutch release collar. - 21. Fork lever. - 36. Lever (21) shaft.

remove the shifter bars starting from the bar (**8**);
recover the spacers (**10** and **15**) from the side bars, the five poppet balls (**16**, Fig. II/10) and their three springs (**17**).

— Withdraw the shifter bar (**19**, Fig. II/6) with fork (**20**) and the auxiliary reduction sleeve (**49**) outwards.

— Remove the epicyclic reduction unit after removing the attaching cap screws (C_9, Fig. II/6).

— Remove and disassemble the driving shaft (**27**, Fig. II/7) as follows:
withdraw it frontwards complete with ball bearing (**28**), its oil shield (**29**) and driving gear (**30**), acting with a drive bar in the direction shown by the arrow in Fig. II/6 and following the removal of the oil seal (**75**);
recover the driving gear (**31**, Fig. II/7) and side washer (**34**);
if necessary, remove the front ball bearing (**28**) using the universal puller **A 537105**, and the rear one (**35**) with the drive bar **A 97058**.

— Remove the retaining plate (**22**, Fig. II/6), use a puller screw M 10 × 1.25 to withdraw the reverse gear axle (**41**, Fig. II/10) and then recover the gear (**40**) from the housing.

— Remove the support (**23**, Fig. II/6) and withdraw the bar (**64**, Fig. II/10) and the 2nd-5th and 3rd-6th speed gear shifter fork (**65**).

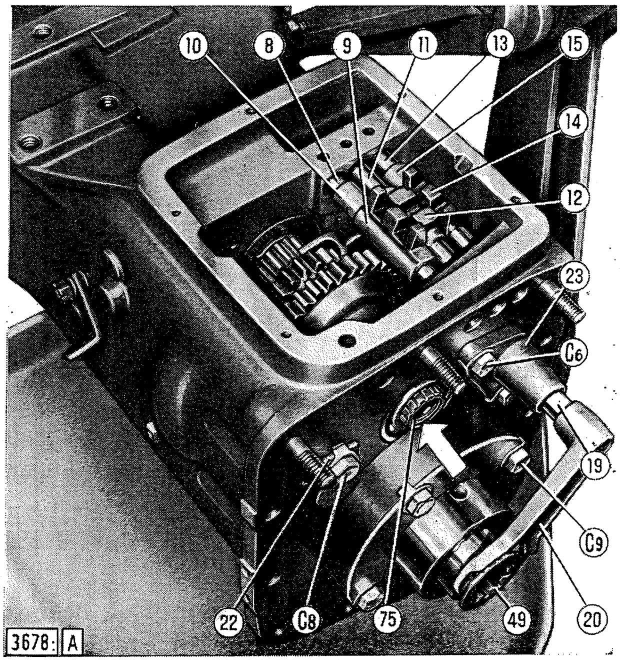


***Fig. II/6** - Transmission housing installed on turnover stand ARR 2220.*

(Arrow shows direction for removal of transmission drive shaft).
C_6. Bracket (23) attaching capscrews. - C_8. Retaineng plate (22) attaching cap screws. - C_9. Epicyclic gear attaching cap screws. - 8. Shifter bar for gear selector (9). - 9. 2nd - 5th and 3rd - 6th speed gear selector. - 10. Spacer, long, for shifter bar (8). - 11. Shifter bar for gear selector (12). - 12. Selector for shifter bar (19). - 13. Shifter fork (14) bar. - 14. Shifter fork for 1st - 4th forward and 1st - 2nd reverse gears. - 15. Spacer, short, for shifter bar (13). - 19. Shifter fork (20) bar. - 20. Auxiliary speed reduction shifter fork. - 22. Reverse axle retainer .- 23. Shifter bar (19) bracket. - 49. Reduction unit engagement sleeve. - 75. Lip seal.

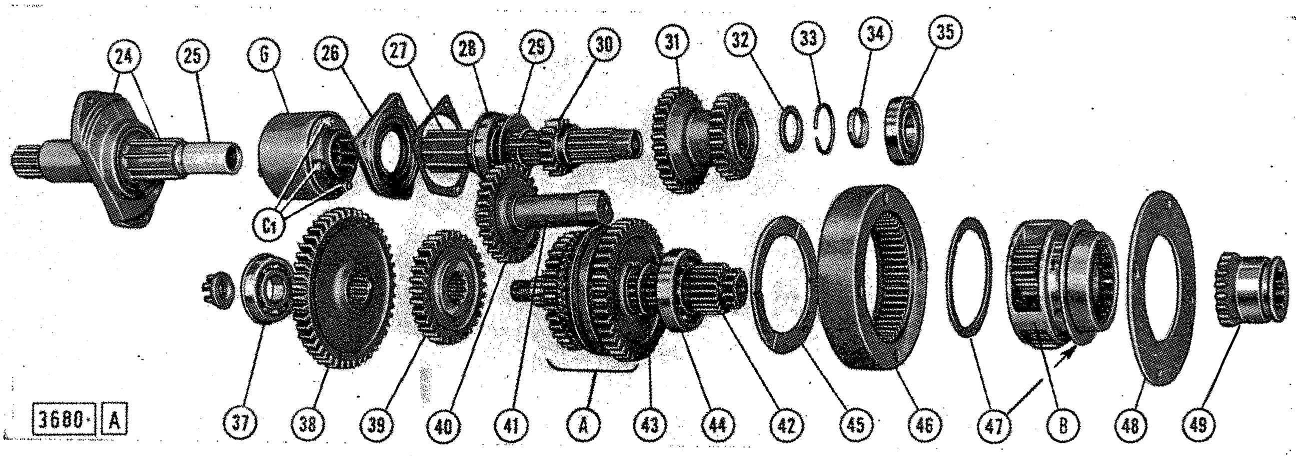


***Fig. II/7** - Exploded view of the 6 - gear transmission.*

A. Synchromesh. - B. Reduction driven gears support. - C_1. Self-locking nuts, for flexible coupling through bolts. - G. Clutch-transmission shafts flexible coupling. - 24. Clutch shaft, complete. - 25. Shaft (24) nylon bushing. - 26. Bearing (28) cap with seal. - 27. Driving shaft. - 28. Front ball bearing. - 29. Oil shield. - 30. Drive gear, lst-4th forward and 1st - 2nd reverse. - 31. Drive gears, 2nd - 5th and 3rd - 6th speed gears. - 32. Gear (31) washer. - 33. Retainer ring. - 34. Bearing washer. - 35. Rear ball bearing. - 37. Front ball bearing. - 38. 1st - 4th forward driven gear. - 39. 1st - 2nd reverse driven gear. - 40. Reverse transfer gear. - 41. Reverse gear axle. - 42. Driven shaft. - 43. Bearing washer. - 44. Rear ball bearing. - 45. End ring. - 46. Reduction unit ring gear. - 47. Thrust rings. - 48. Outer disc. - 49. Reduction unit engagement shifter sleeve.

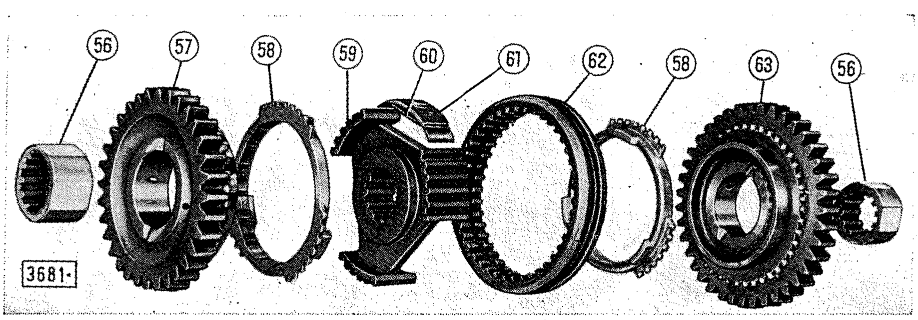


Fig. II/ 8 - Exploded view of synchromesh unit.

56. Inner sleeves for gears (57 and 63). - 57. 3rd and 6th forward driven gear. - 58. Synchromesh cones. - 59. Fixed collar. - 60. Flat spring. - 61. Spring (60) holder. - 62. Sliding ring. - 63. 2th and 5th forward driven gear.

— Remove and disassemble the driven shaft (**42**, Fig. II/7), as follows:
withdraw it rearwards complete of the ball bearing (**44**) acting with a drive bar applied to its front end;
recover the synchromesh unit (**A**) out of the housing;
if necessary, remove the front ball bearing (**37**) from the housing the drive bar **A 97058** and the rear one (**44**) from the shaft by means of the universal puller **A 537105**.

INSPECTION

Examine the gear hub chamfers (**30, 38** and **40**, Fig. II/7) and those of the synchromesh and epicyclic gear reduction splines, and eliminate seizure marks or nicks, if any.
Make sure that the teeth (**d**, Fig. II//12) on the three splined sections of the synchromesh fixed collar have sharp edges; if not, re-sharpen them with

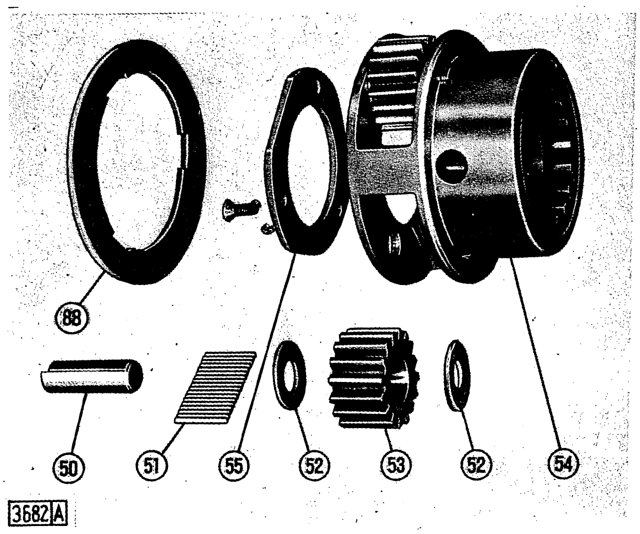


Fig. II/9 - Exploded view of epicyclic unit driven gears support.

50. Pinion shaft. - 51. Bearing needles. - 52. Gear washers. - 53. Driven gear. - 54. Support. - 55. Shaft (50) retainer disc (pre-modification) - 88. Post-modification ring retaining pins (50).

a fine grain carborundum stone. On new parts, these teeth should project 0.19 ÷ 0.26 mm (0.008 ÷ ÷ 0.010 in) and replace the fixed collar only when no appreciable result is obtained. In any case, faulty teeth are normally detected because of the sliding collar tendency to disengage spontaneously.
Thoroughly examine the conditions of the following mating surfaces:

— of synchromesh rings (**58**, Fig. II/8) and their mating surface on driven gears of the 2nd-5th and 3rd-6th speeds (**63** and **57**, respectively);

— of inside rings (**56**) and of their locations on the aforementioned gears.

Check the functional efficiency of the synchromesh flat springs (**60**, Fig. II/12): a force of 1.40 ÷ ÷ 1.55 kg (3 ÷ 3.4 lb) applied at spring center should produce a bend of 1.5 mm (0.060 in).
Check the spring holders (**61**, Fig. II/12) for deep scoring or nicks, particularly on the central relief (**R**).
Measure the thickness of the auxiliary speed reduction driven gear washers (**52**, Fig. II/9) and of the rings (**47**, Fig. II/7), replacing those below the wear limit, if any.
Check the functional efficiency of the springs (**3**, Fig. II/4) and (**17**, Fig. II/10) of the shifter bar poppet balls and selector mechanism and of the gearshift lever retaining spring (**69**).

TRANSMISSION ASSEMBLY

In order to facilitate re-assembly install the transmission housing on the turnover stand **ARR 2220**, then proceed as follows.

— Assemble the synchromesh unit (**A**, Fig. II/7) separately on the work bench, as follows:

arrange on the shaft the 2nd and 5th speed driven gear (**63**, Fig. II/11) with inner ring, one synchromesh ring (**58**) and the fixed ring (**59**) with the three toothed sectors fitting the vanes of the previously fitted rings;

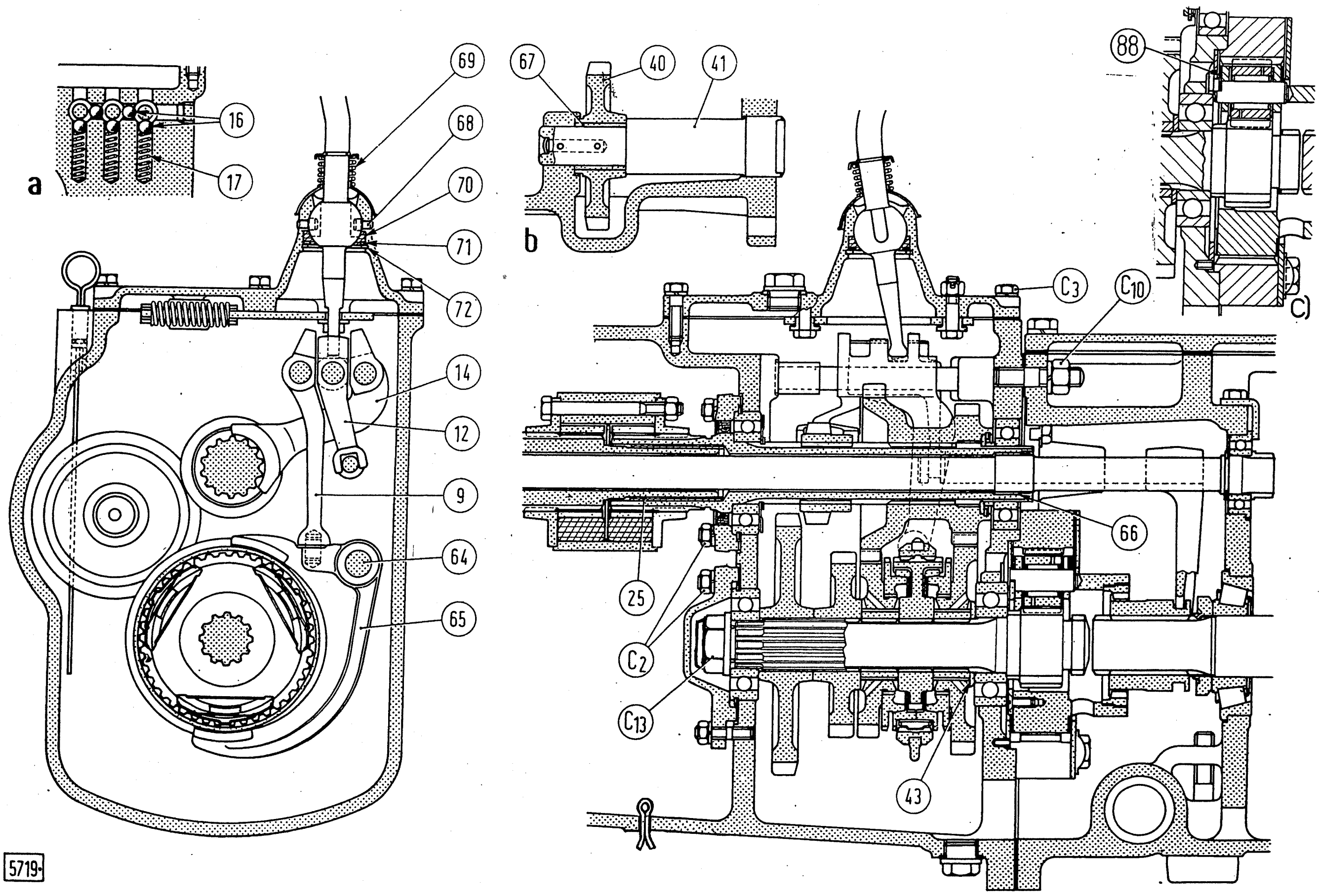


Fig. II/10 *- 6-speed transmission cross-sections.*
a. Detail of poppet balls and springs.
b. Section through reverse gear axle.
c. Section view of the post-modification planetary reduction.
C_2. Stud nuts securing the front caps of shafts. - C_3. Cap screws securing the top transmission housing cover. - C_{10}. Transmission housings bolt and stud nuts. - C_{11}. Hydraulic lift pump suction pipe attaching cap screw. - C_{13}. Driven gear shaft lock nut. - 9. Shifter fork (65) selector. - 12. Reduction unit engagement bar selector. - 14. Shifter fork for 1st - 4th forward and 1st - 2nd reverse gears. - 16 and 17. Shifter bars balls and springs. - 25. Clutch shaft nylon bushing. - 40. Reverse transfer gear. - 41. Reverse gear axle. - 43. Bearing washer. - 64. Shifter fork (65) bar. - 65. 2nd - 5th and 3rd - 6th gear shifter fork. - 66. P.T.O. shaft bushing. - 67. Reverse gear axle bushing. - 68. Gearshift lever dowels. - 69. Gearshift lever retaining spring. - 70, 71 and 72. Gaskets, gearshift ball joint retaining and thrust rings. - 73. Hydraulic lift pump suction pipe adaptor. - 74. O-ring. - 88. Post-modification ring retaining planetary gear axles.

Caution. - *Arrange the two inner rings* (**56**, *Fig. II/8*) *and the fixed ring* (**59**) *on the shaft, with the spline chamfered ends positioned as illustrated in Fig. II/10.*

install the sliding ring (**62**, Fig. II/11) so that the relieved teeth (**D**) delimit the splined sectors of the fixed ring (**59**);

Note. - *The assembly condition previously indicated is the only which sets the three vanes* (**V**) *of the sliding ring* (**62**) *symmetrically with respect to the toothed sectors of the fixed ring* (**59**), *thus allowing the projections* (**R**) *of spring holders* (**61**) *to fit in their respective locations* (*Fig. II/12*).

place the flat springs (**60**) on their holders (**61**) as shown in Fig. II/12, then fit them in place, introduce the second synchromesh element (**58**, Fig. II/8) with the three front wings aligned with those of the aforementioned ring, and finally install the 3rd-6th driven gear (**57**) complete with inside ring (**56**);

try to engage the sliding collar by hand in both directions, then withdraw the synchromesh unit from the shaft.

— Refit the driven shaft (**42**, Fig. II/7) as follows: arrange in the housing the front ball bearing (**37**) with its retaining ring, then fit the end cap securing it with two nuts only;

set the transmission housing upright with the back end uppermost;

arrange, inside the housing, the 1st-4th speed driven gears (**38**, Fig. II/7) and 1st-2nd reverse ones (**39**) as illustrated in Fig. II/10, the synchromesh unit (**A**) and the thrust washer (**43**)

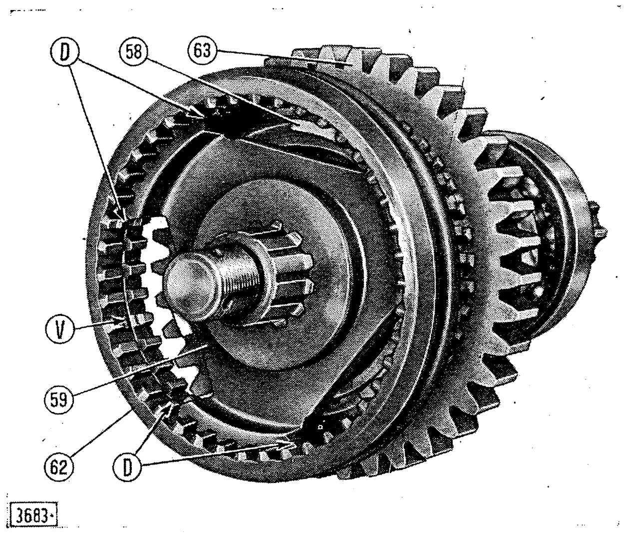


Fig. II/11 - *Installing the synchromesh unit engagement ring (62).*
D. Teeth in relief. - V. Flat spring holder seat. - 58 Synchromesh cone - 59. Fixed sleeve. - 63. 2nd and 5th forward driven gear.

with the outer chamfer oriented as shown in Fig. II/10;
install the rear ball bearing (**44**, Fig. II/7) on the shaft, heating it in oil at 80° ÷ 90° C;
introduce the driven shaft, complete;
turn the housing back horizontal, remove the front cap and tighten the nut (C_{13}, Fig. II/10).

— Place the transfer gear (**40**) as shown in the detail (**a**), then fit the reverse gear axle (**41**).

— Place the 2nd-5th and 3rd-6th speed shifter fork (**65**) complete with dowel and fit the

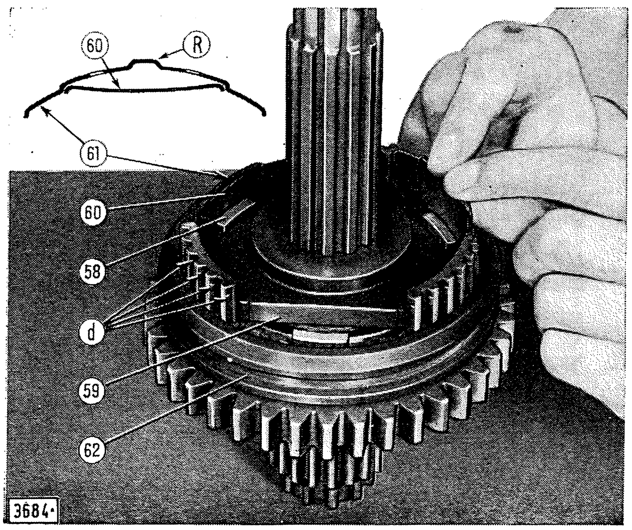


Fig. II/12 - *Installing the synchromesh unit flat springs (60).*
d. Speed gear disengagement safety teeth. - R. Central relief on spring holder (61). - 58. Synchromesh cone. - 59. Fixed collar. - 61. Flat spring (60) holder. - 62. Sliding ring.

shifter bar (**64**) with the end threaded hole facing back (Fig. II/13).

— Install the driving shaft (**27**, Fig. II/7), as follows:
fit the rear ball bearing (**35**) in the housing using the punch **A 97058**;
install on the shaft the front ball bearing (**28**) with thrust ring after heating it in oil at 80° ÷ ÷ 90° C (176° ÷ 194° F) and the oil shield (**29**) as shown in Fig. II/10 and lock them in place with their retaining ring;
place the 1st-4th forward and 1st-2nd reverse driving gear (**30**, Fig. II/7) over the shaft;
install the complete shaft from the front end, insert from the inside of the housing the 2nd-5th and 3rd-6th speed driving gear (**31**) complete with thrust washer (**32**) and its retaining (**33**), and, finally, the end ring (**34**);
use the protection **A 137003** to refit the front cap (**26**) complete with outer and inner seals;
bed in the rear ball bearing (**35**) with the aid of the drive bar **A 97058** (Fig. II/13) and check the 2nd-5th and 3rd-6th driving gear (**31**, Fig. II/7) for free rotation by hand without end play.

— Assemble the auxiliary epicyclic gear reduction unit on the work bench, as follows:
place the driven gears (**53**, Fig. II/9) on the carrier (**54**) lubricating with FIAT G 9 (multipurpose, NLGI no. 2) grease the 18 rolling needles (**51**) to place them inside the hub of each gear;
lock punch the flat-head screws attaching the driven gear shaft retaining disc (**55**) at two diametrically opposed points along the screw head slot (see Fig. II/36 - 640);

— Install the epicyclic gear unit after refitting the inside thrust washer (**45**) with the oil scrolls arranged as shown in Fig. II/13 and its retaining pin.

— Install the support (**23**, Fig. II/6), bar (**19**) with shifter fork (**20**) and the speed reduction unit engagement collar (**49**).

— Install the transmission speed selectors and shifter bars and forks, as follows:
firstly, lock punch at three points the lower part of the holes through selectors and fork to prevent the retaining hollow pins from falling out, then arrange them in succession as shown in the Fig. II/6, II/10 and II/14;
install the three springs (**17**, Fig. II/10) in the housing, place the poppet balls (**16**) and make the shifter bars function, starting from either

side and using a punch to compress the springs as illustrated in Fig. II/15;
fix the selectors and shifter fork to their respective bars, by fitting the hollow pins with the split side turned as shown in Fig. II/14.

— Shift into two speed gears simultaneously, tighten the driven shaft lock nut (C_{13}, Fig. II/10), then fit the cover with gasket.

— Place the gasket on the housing with the aid of grease then fit the cover, making sure that the lower end of the gearshift lever (**C**, Fig. II/4) fits in the seat on the epicyclic gear unit central selector (**12**, Fig. II/14).
In case the speed gear selector mechanism has been disassembled, re-assemble it and ensure tightness by applying jointing compound to the attaching screws.

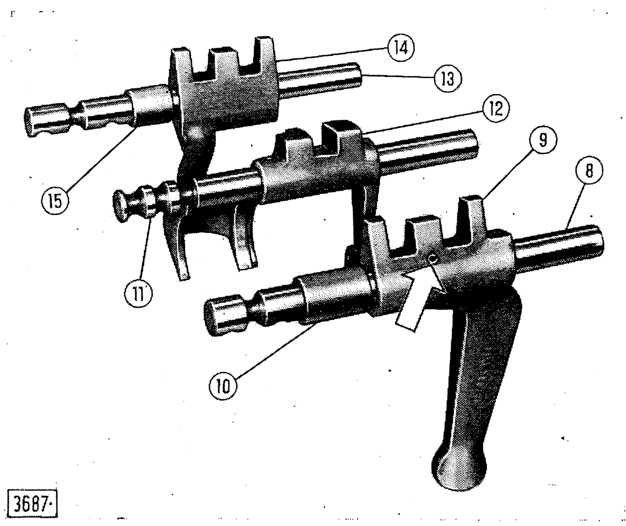


Fig. II/14 - 6-speed transmission shifter bar, selectors and fork.
(Arrow indicates the correct installation of split dowel pins).
8. Selector (9) bar. - 9. 2nd - 5th and 3rd - 6th speed gear shifter fork selector. - 10. Spacer, long, for shifter bar (8). - 11. Selector (12) bar. - 12. Reduction unit shifter bar selector. - 13. Shifter fork bar (14). - 14. 1st - 4th forward and 1st - 2nd reverse gears shifter fork. - 15. Spacer, short, for shifter bar (13).

SPEED TRANSMISSION INSTALLATION

Reverse the removal sequence and:

— re-attach the transmission housing inserting the gasket;

— make sure that the o-rings (**74**, Fig. II/10) have been fitted before attaching the end (**73**) of the hydraulic lift pump suction line;

— be sure to meet the torque requirements given in the data table of page 299.

NOTE: On post-modification tractors the spacers (10 and 15, fig.III/14) of shifter bars have been suppressed.

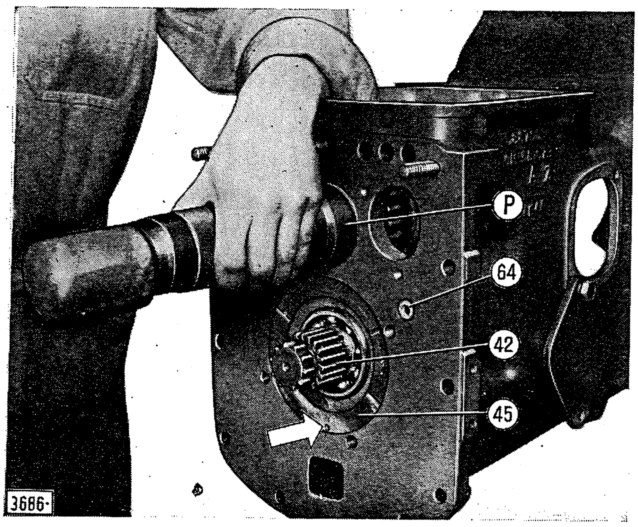


Fig. II/13 - Taking up the end float of 2nd - 5th and 3rd - 6th speed drive gear.
(Arrow shows the retainer dowel of epicyclic gear reduction end plate).
P. Punch A 97058. - - 42. Driven shaft. - 45. Reduction unit thrust ring. - 64. 2nd - 5th and 3rd - 6th speed gear shifter bar.

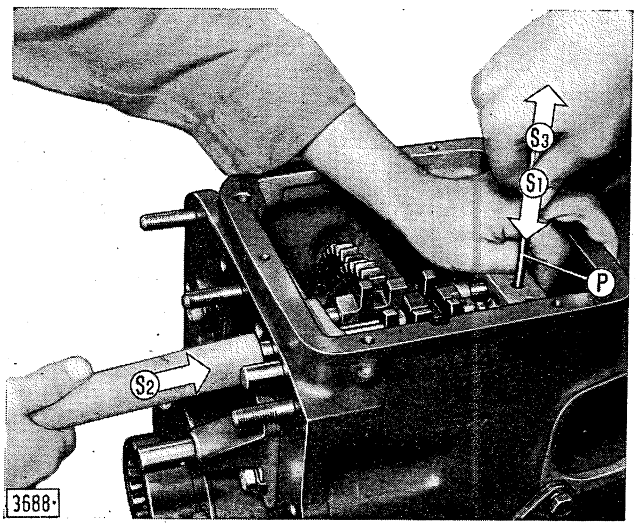


Fig. II/15 - Installation of shifter bars, poppet balls and springs.
(Arrows show correct sequence of operations).
P. Punch U 511731. - S_1, S_2, S_3. Sequence.

V - FINAL DRIVES AND REAR WHEELS

DESCRIPTION

See 640 except for the following changes :

The driving wheels with stamped steel rims and discs, can be supplied with tyres : 12.4/11-28; 13.6/12-28; 14.9/13-28 ; 12.4/11-32.

Eight different tread adjustments are obtained by suitable arrangement of wheel rims and discs, ranging from 1220 mm to 1920 mm (48" to 76") by steps of 100 mm (3.937 in).

Keep in mind that the 1220mm(48") track setting cannot be obtained with tyres 14.9/13-28.

FINAL DRIVES

DISASSEMBLY

See 640 except for the bull gear stop that is now no. 290812.

VI - FRONT AXLE AND STEERING

FRONT AXLE AND STEERING WHEELS

DESCRIPTION

See 640 except for the following changes :

The front steering wheels with stamped steel rims and discs, can be supplied with tyres : 6.00-16; 6.00-19; 7.50-16.

By suitably arranging the front axle beam extension it is possible to obtain eight different thread widths, ranging from 1320 mm to 2020 mm (52" to 80") by steps of 100 mm (3.937 in).

Keep in mind that with tyres 7.50-16 only seven thread widths, ranging from 1450 mm to 2050 mm (57"to 80") can be obtained by steps of 100 mm (3.937 in).

The min. steering radius is 3400 mm (133.858 in) without braking.

VII - HYDRAULIC LIFT UNIT

Specifications - See 640 except for the following variations :

Fluid capacity of transmission case with level reaching the upper dipstick dent	16 kg	(15 imp.qts)
FIAT (Plessey licence) gear type hydraulic pump : clockwise rotation, seen from drive end	mod.	C 22 X
Single-acting ram :		
– bore and stroke	90x96 mm	(3.54x3.78 in)
– capacity	610 c.c.	(3.72 cu.in)
– nominal lifting capacity	915 Kgm	(6608 lb.ft)
Three-point linkage category		1^
– maximum liftable weight at implement mounting point with lift rods :		
• shortened	1420 Kg	(3131 lb)
• extended	1100 Kg	(2425 lb)
– maximum lift stroke at implement mounting point with lift rods :		
• shortened	575 mm	(22.63 in)
• extended	700 mm	(27.55 in)
– lifting time with engine running at 2400 r.p.m.	1.75	sec.
– total weight of the hydraulic lift and linkage..	104 Kg	(230 lb)

Disassembly

See 640 keeping in mind that control lever (39) is connected to the inside arm (40) as illustrated in Fig. VII/12.

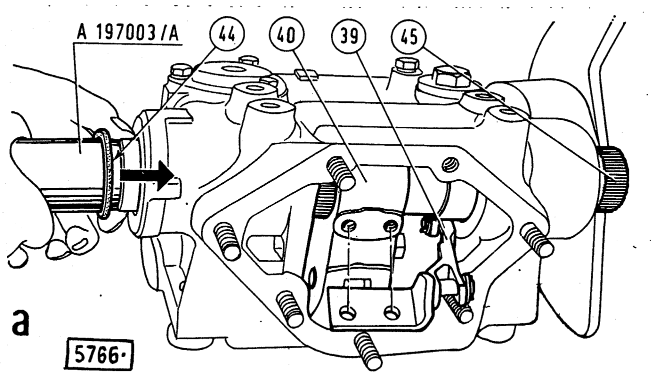


Fig.VII/12 - Removing the rocker shaft from the hydraulic lift unit.

A. 197003/A. Sealing ring protection - 39. Lever connected to the inside arm - 40. Inside arm - 44. Shaft sealing ring - 45.Rockshaft.

ADJUSTMENTS

A. *Setting the control spring movement.*

The correct setting of the double-acting control spring (**94**, Figs. VII/22) ensures that the valve spool will not exceed the preset limits and that the complete displacement, subdivided into compression and tension, is the desired one; all this is necessary to avoid mechanical troubles such as spring permanent yields or rupture or leverage straining, etc.

Adjust the hydraulic lift installed on the tractor **mod.480** as follows:

— remove the wedge (**29**, Fig. VII/22) inserted between top link bracket and hydraulic lift rear cover.

— Check (with control lever free) that the distance (L_1) between top link upper stop and the rear cover of the hydraulic lift is 14.8 ÷ 15.1 mm (0.0583 ÷ 0.594 in). If the distance is less, add shims (**H**) between control spring (**94**) and top link bracket (**17**); reduce them if more.

— Connect a lever, such as the **A 197016 bis**, to the top link bracket holes and push downwards until the spring has effected its full tension stroke. Make sure now that the distance (L_2) between the upper top link bracket stop and rear cover of the hydraulic lift is comprised between 19 ÷ 20 mm (0.748 ÷ 0.787 in); if it is more, correct it by building up the lower stop surface through electric welding.

For the other adjustments, see 640 points B, C and D.

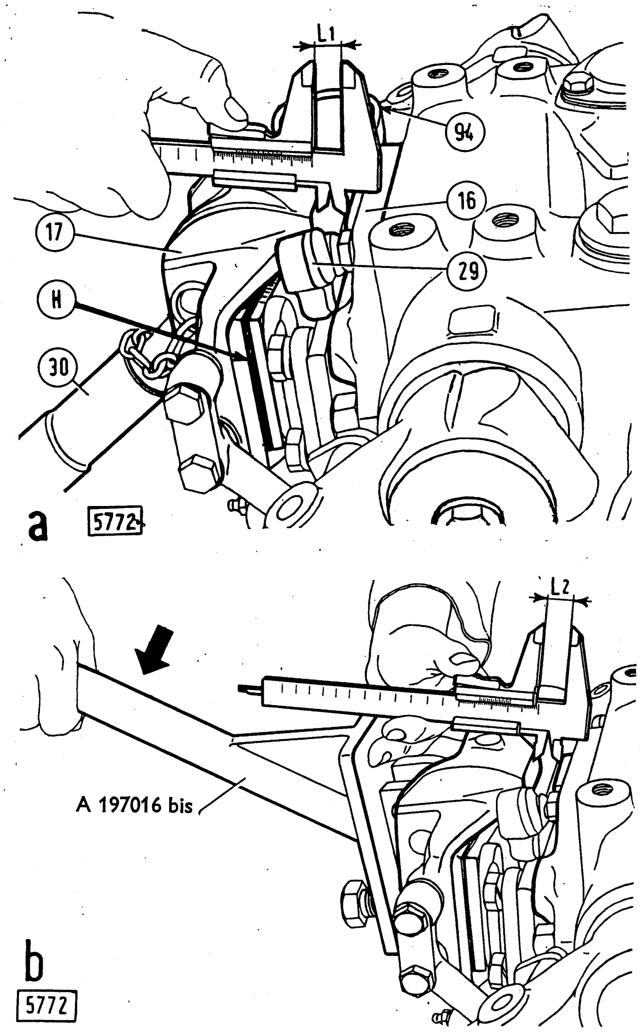


Fig. VII/22 *- Adjusting the control spring setting*

a) Position of top link bracket with spring free.
b) Position of top link bracket with spring held under full tension by means of the lever A 197016 bis.
A 197016 bis. Lever connected to the top link bracket holes to stretch the control spring (push the lever downwards). - H. (L_1) adjusting shims. - L_1 = 14.8 ÷ 15.1 mm (0.583″ ÷ 0.595″). Nominal gap between bracket and lift cover with free spring. - L_2. = 19 ÷ 20 mm (0.748″ ÷ ÷ 0.787″). Nominal gap between bracket and lift cover with spring fully stretched. - 16. Lift rear cover. - 17. Top link bracket. - 29. Top link bracket wedge stop. - 30. Top link. - 94. Control spring.

VIII - POWER TAKE OFF - BELT PULLEY

POWER TAKE OFF

See 640 except for the following variations :

- speed with the lever set in "Cambio" (Transmission with rear type 12.4/11-28) .... 4.1 revs per meter

IX - FITS AND TOLERANCES - TORQUE SPECIFICATIONS SERVICE TOOLS

FITS AND TOLERANCES

DESCRIPTION	Size of new parts and wear limits	
	mm	in
I - Clutch.		
Backlash, clutch shaft and disc splines	0.010 ÷ 0.106	0.0004 ÷ 0.0042
Thickness of P.T.O. and transmission clutch friction discs (*1* and *8*, Fig. I/6)	8.580 ÷ 9.400	0.3378 ÷ 0.3701
Wear limit	7	0.275
Thickness of P.T.O. clutch pressure plate (*3*)	24.800 ÷ 24.900	0.9764 ÷ 0.9803
Wear limit	24.5	0.964
Thickness of transmission clutch pressure plate (*6*)	23.000 ÷ 23.100	0.9055 ÷ 0.909
Wear limit	22.7	0.894
Diameter of clutch release collar support	51.954 ÷ 52.000	2.0454 ÷ 2.0472
Inside diameter of the clutch release collar (*7*, Fig. II/5) . . .	52.030 ÷ 52.104	2.0484 ÷ 2.0513
Assembly clearance between release collar and support	0.030 ÷ 0.150	0.0012 ÷ 0.0059
Diameter of clutch control pedal shaft	27.948 ÷ 28.000	1.1003 ÷ 1.1024
Inside diameter of clutch pedal shaft bushing (fitted)	28.020 ÷ 28.072	1.1031 ÷ 1.1052
Assembly clearance of shaft in bushing	0.020 ÷ 0.124	0.0008 ÷ 0.0049
Interference fit of pedal shaft bushing	0.043 ÷ 0.103	0.0017 ÷ 0.0041
Specifications of clutch springs (*5*, Fig. I/6):		
— free nominal length	68	2.68
— engagement length under a load of 88 ÷ 97 kg (194 ÷ 214 lb)	51.7	2.04
— disengaged length under a load of 123 ÷ 136 kg (271 ÷ 300 lb)	45.2	1.78
II - TRANSMISSION		
Spline backlash :		
- transmission driven gears	0.010 ÷ 0.106	0.0004 ÷ 0.0042
- transmission drive gears	0.015 ÷ 0.093	0.0006 ÷ 0.0037
- synchromesh engagement collar	0.100	0.0039
- epicyclic gear train straight drive engagement	0.070 ÷ 0.170	0.0027 ÷ 0.0067
- epicyclic gear train engagement	0.340 ÷ 0.440	0.063 ÷ 0.017
Tooth backlash :		
- transmission gears	0.100 ÷ 0.200	0.0039 ÷ 0.0079
- epicyclic gear train	0.070 ÷ 0.130	0.0027 ÷ 0.0051
Outside diameter of gear hub sleeves (56, Fig.II/8)	44.955 ÷ 44.970	1.7698 ÷ 1.7704
Diameter of gear housing bores :		
- 2nd - 5th and 3rd-6th (63 and 57, Fig.II/8) speed driven gears	45.050 ÷ 45.075	1.7736 ÷ 1.7746
Assembly clearance of sleeves in driven gear hubs	0.080 ÷ 0.120	0.0031 ÷ 0.0047
Wear limit	0.30	0.012

Continued: " *Fits and tolerances* "

DESCRIPTION	Size of new parts and wear limits	
	mm	in
Diameter of clutch shaft (*24*, Fig. II/7)	31.880 ÷ 31.910	1.2551 ÷ 1.2563
Diameter of transmission drive shaft (*27*) bushing housing bore	36.030 ÷ 36.080	1.4185 ÷ 1.4205
Dimensions of clutch shaft bushing (*25*) (°)		
— outside diameter	36.100 ÷ 36.300	1.4212 ÷ 1.4291
— thickness	1.960 ÷ 2.000	0.077 ÷ 0.079
Diameter of transmission reverse gear axle (*41*, Fig. II/10)	24.967 ÷ 25.000	0.9829 ÷ 0.9842
Inside diameter of bushing (*67*) (fitted) (°°)	25.040 ÷ 25.092	0.9858 ÷ 0.9881
Running clearance of reverse gear axle and bushing	0.040 ÷ 0.125	0.0015 ÷ 0.0049
Wear limit	0.30	0.012
Interference fit of reverse gear bushing (*67*)	0.037 ÷ 0.091	0.0014 ÷ 0.0035
Diameter of epicyclic gear train driven pinion shafts (*50*, Figs. II/9)	14.389 ÷ 14.400	0.5665 ÷ 0.5670
Diameter of bearing needles (*51*)	2.990 ÷ 3.000	0.1178 ÷ 0.1181
Diameter of bearing needle location on driven gears (*53*)	20.410 ÷ 20.430	0.8035 ÷ 0.8043
Assembly clearance of shafts, bearing needles and their locations on driven gears	0.010 ÷ 0.061	0.0004 ÷ 0.0024
Wear limit	0.15	0.006
Thickness of thrust washers (*52*, Figs. II/9) and rings (*47*, Figs. II/7) for epicyclic gear train driven gears and carrier	1.470 ÷ 1.530	0.0579 ÷ 0.0602
Wear limit	1.30	0.051
Specifications of speed selector plate automatic return springs (*3*, Fig. II/4) and (*13*, Fig. II/39):		
— free nominal length	61.5	2.42
— length under a load of 5.1 ÷ 5.7 kg (11.5 ÷ 12.5 lb)	48	1.89
Specifications of gearshift and auxiliary reduction unit hand levers retaining springs (*69*, Fig. II/10)		
— free nominal length	33.7	1.33
— length under a load of 3.9 ÷ 4.3 kg (8.5 ÷ 9.5 lb)	20	0.79
Specifications of shifter bar poppet balls springs (*17*, Fig. II/10)		
— free nominal length	35.5	1.40
— length under a load of 8.2 ÷ 10 kg (18 ÷ 22 lb)	28.5	1.12
III - Bevel gear and differential : See 640		
IV - Brakes : See 640 except for this dimension :		
Linings width	50	1.9685
V - Final drives and rear wheels : See 640		
VI - Steering and front wheels : See 640		
VII - Hydraulic lift unit : see 640 except for :		
Diameter of piston	89.980 ÷ 90.000	3.5424 ÷ 3.5433
Inside diameter of cylinder	90.036 ÷ 90.071	3.5447 ÷ 3.5460
Running clearance of piston	0.036 ÷ 0.091	0.0014 ÷ 0.0036
VIII - Power take off - Belt pulley : see 640		

(°) Ream after fitting.
(°°) The amount of play, which can be detected by trial only, is a function of the bushing ductility.

TORQUE SPECIFICATIONS

DESCRIPTION	Size and thread (metric)	Ultimate strength of material kg/mm²	TORQUE	
			kgm	Lb.ft
I - CLUTCH				
Self locking nut, clutch-transmission shaft, elastic coupling bolts	8x1.25	50 Zinc plate (Bolt : 80 Zinc plate)	2.6	18.8
Capscrews securing clutch to engine flywheel	12x1.25	80 Zinc plate	10.5	75.9
Capscrews clutch-transmission housing to engine crankcase	12x1.25	80 Zinc plate	10.5	75.9
Setscrew clutch release fork	16x1.5	80 Zinc plate	21	152
II - TRANSMISSION				
Stud nut, shaft bearing caps	8x1.25	80 Zinc plate	1.7	12
Locknut, driven gear shaft	22x1.5	60 (shaft 80)	26	188
Bolt and stud nuts, gearbox and transmission housing	12x1.5	50 Zinc plate (studs: 80 bolt : 80 Zinc plate)	9.5	69
Capscrew, selector plate return spring bracket	8x1.25	80 Zinc plate	2.6	18.8
Capscrew, auxiliary speed reduction unit shifter fork bar support	10x1.25	80 Zinc plate	6	43.4
Capscrew epicyclic unit fixed gear	12x1.5	80 Zinc plate	9.5	69
III - BEVEL GEAR AND DIFFERENTIAL See 640				
IV - BRAKES - See 640				
V - FINAL DRIVES AND REAR WHEELS - See 640 except for this torque :				
Capscrew, drive wheel discs	16x1.5	100 Cadmium plate	26.5	191.5
VI - STEERING AND FRONT WHEELS : See 640				
VII - HYDRAULIC LIFT : See 640				
VIII - POWER TAKE OFF - BELT PULLEY: See 640				

SERVICE TOOLS

Tool Number	DESCRIPTION

I - Clutch.

Tool Number	Description
A 117163 290736	Alignment and fitting spigot for 10″ clutch on engine flywheel (Fig. I/5).
A 711063/68 B 291291	Universal clutch fixture (Figs. I/7, I/10)

II - Transmission.

Tool Number	Description
A 137003 290785	Protection for 6-speed transmission drive shaft front seal.
A 323126 292909	Sliding weight type puller (Figs. II/25 and II/30 –640)
292911– A 537105	Universal puller
290090–2216/F	Turnover overhauling stand (Figs. II/5, II/6).
293335	Shield for drive shaft front seal (mods. 500-540)

III - Bevel gear and differential.

Tool Number	Description
A 137010 290786	Gauge, bevel pinion cone center distance
A 287033 290870	Installation tool, differential lock shifter fork
A 511100/115 291051	Split-type bearing puller (Fig. III/4 – 640)
292904– A 517010/160	Universal puller
292911– A 537105	Universal puller
291269– A 711041/2	Torque wrench (0 ÷ 2 kgm) for bevel gear adjustment check (Figs. III/11 and III/16 – 640)
290090–2216/F	Turnover overhauling stand

Tool Number	DESCRIPTION

V - Final drives and sprocket wheels.

Tool Number	Description
A 187014 290812	Gear stop, final driven gear.
A 511100/A115 291052	Split-type bearing puller (Figs. V/4 and V/6 – 640)

VI - Steering and front wheels.

Tool Number	Description
A 147018 290792	Puller, steering linkage ball joints.
A 147022 ter 292927	Puller, front axle trunnion
A 323126 292909	Sliding-weight puller (Figs. VI/3, VI/10 and VI/11 – 640)
A 443018	Puller, steering arm
A 537105 292911	Universal puller (Figs. VI/2 and VI/11 – 640)
A 711041/2 291269	Torque wrench (0 ÷ 2 kgm) for steering gear adjustment check
Ap 5106/P 290238	Checking apparatus, tractor steering radius

VII - Hydraulic lift and linkage.

Tool Number	Description
A 12131 290284	Hand pump, valve testing and calibration
A 92027 290692	Drive bar, top link bracket bushing
A 94048 290702	Drive bar, rockshaft left-side bushings

Tool Number	DESCRIPTION
A 95058 290706	- Drive bar, rockshaft right-side bushings
A 197003/A 290817	- Protection for rockshaft seal disassembly (assembly).
A 197003/B 290818	- Drive bar, rockshaft seal installation.
A 197016 bis 290819	- Test bar, hydraulic lift setting check.
A 197032/B 290824	- Adaptor, pressure relief valve.
A 197032/D 290826	- Adaptor, safety valve.
A 197036 290834	- Adaptor, drain valve.

Tool Number	DESCRIPTION
A 695112 291259	- Wrench, cylinder oil inlet valve plug removal (installation).
A 711500 291314	- Universal pressure gauge and fittings set for hydraulic circuitry working pressure tests.

VIII - Power take-off - Belt pulley.

290090-2216/~~P~~ Turnover overhauling stand.

VII – HYDRAULIC LIFT-PUMP MOD. C22X

See tool list for pump mod. A22X on page 183 adding pump supporting bracket 290367.

ELECTRICAL SYSTEM

ELECTRICAL SYSTEM

II - BATTERY

SPECIFICATIONS AND DATA

Type	MARELLI 6 ATP 21 in alternative TITANO 6DE 10F
Nominal voltage	12 V
Nominal capacity (at 20 hr.discharge)	110 Ah
Overall dimensions (length x width x height)	510 x 190 x 244 mm (20.1 x 7.5 x 9.6 in)
Weight,with electrolyte	46 kg (101 lb)
Electrolyte density at 15° to 25°C:	
- full charge	1.27 to 1.28 gr/cm^3
- medium charge	1.20 to 1.22 gr/cm^3
- discharged	1.11 gr/cm^3

III - STARTER MOTOR

SPECIFICATIONS AND DATA

Type	FIAT - M 125-3/12	MARELLI MT68AA-MT68A
Tension	12 V	12 V
Nominal power output	3 Kw	3.5 Kw
Rotation seen from drive end	clockwise	clockwise
Pinion and gear ratio	9/110	9/110
Poles	4	4
Excitation (windings)	in series - in parallel	in series
Engagement type	axial drive,with free wheel	axial drive, with free wheel
Control	solenoid	solenoid
Test rig data		
Performance test (at 20°C - 68°F) :		
- current, not above	500 amp	700 amp
- torque output	1.52 kgm (11 ft.lb)	2 kgm (14.5 ft.lb)
- speed	1850 to 1900 r.p.m.	1400 to 1800 r.p.m.

STARTER SPECIFICATIONS

(continued)

- voltage	9.6 V	9 V
Stall test (at 20°C - 68°F)		
- current, not above	1300 amp	1400 amp
- voltage, not below	5.1 V	5 V
- torque output	≥ 4.9 kgm (35.5 ft.lb)	≥ 5 kgm (36 ft.lb)
- total internal resistence	0.0041 ± 0.0002 ohm	0.004 ± 0.0004 ohm
Idling test (at 20°C - 68°F)		
- current, not above	60 amp	85 amp
- voltage	12 V	12 V
- speed	4800 r.p.m.	7000 to 10000 r.p.m.
Resistence (at 20°C - 68°F)		
- primary field winding (in series)	0.00156 ± 0.0001 ohm	0.002 ± 0.0002 ohm
- secondary field winding (in parallel) ..	4 ± 0.1 ohm	-
Mechanical specifications checks		
Spring pressure on brushes (not worn)	1.35 to 1.65 kg(2.98 to 3.64 lb)	1.50 to 1.80 kg(3.3 to 4.0 lb)
End float of armature shaft	0.6 to 1.8 mm (0.024 to 0.071 in)	0.3 to 0.6 0.0118 to 0.0236 in
Mica undercutting	0.8 to 1 mm (0.032 to 0.040 in)	1 mm 0.3937 in
Freewheel efficiency: static torque to drag pinion into slow speed	5 to 7 kg.cm (0.36 to 0.51 ft.lb)	6 to 8 kg.cm(0.43 to 0.5 ft.lb)
Commutator dia	53 mm (2.087 in)	44.840 to 45.000 (1.765 to 1.77 in)
- wear limit	51 mm (2.201 in)	43.5 mm (1.7125 in)
- max.throw..............................	0.02 mm (0.0008 in)	0.08 mm (0.0031 in)
Solenoid		
Coil resistence (at 20°C - 68°F)	0.35 ± 0.02 ohm	0.22 ± 0.02 ohm
Current input at 12V	33 ÷ 35 amp	54 amp
Stall voltage (min)	8 V	≤5.5 V
Switch-on voltage (min)	11.35 to 11.45 mm(0.447 to 0.53 in)	(See fig.6)
Armature stroke	13.65 to 15.15 mm(0.537 to 0.597 in)	
Carrying force at 12V and with armature at end of run	57 kg 125.5 lb	≤40 kg (88 lb)

STARTER SPECIFICATIONS (continued)

Assembly data		
I.D. between poles	83.55 to 83.72 mm (3.289 to 3.296 in)	75.830 to 76.000 mm (2.9854 to 2.9921 in)
O.D. of armature	82.60 to 82.65 mm (3.252 to 3.254 in)	74.900 to 75.000 mm (2.9488 to 2.9527 in)
I.D. of armature shaft oiling bearing bushings:		
- drive end bushings	16.159 to 16.232 mm (0.6362 to 0.6391 in)	12.475 to 12.502 mm (0.4911 to 0.4922 in)
- central bushing	24.111 to 24.163 mm (0.9492 to 0.9509 in)	20.200 to 20.264 mm (0.7952 to 0.7977 in)
- commutator end bushing	16.101 to 16.153 mm (0.6369 to 0.6380 in)	14.000 to 14.022 mm (0.5511 to 0.5520 in)
Dia.of armature shaft section corresponding to:		
- drive end bushing	15.973 to 16.000 mm (0.6289 to 0.6299 in)	12.425 to 12.440 mm (0.4891 to 0.4897 in)
- centre bushing	23.967 to 24.000 mm (0.9435 to 0.9449 in)	19.677 to 20.000 mm (0.7746 to 0.7874 in)
- commutator end bushing	15.973 to 16.000 mm (0.6289 to 0.6299 in)	13.957 to 13.984 mm (0.5494 to 0.5505 in)
Running clearance of armature shaft journals in bushing:		
- pinion end	0.159 to 0.259 mm (0.0062 to 0.0101 in)	0.035 to 0.077 mm (0.0013 to 0.0030 in)
- centre	0.111 to 0.196 mm (0.0043 to 0.0077 in)	0.200 to 0.587 mm (0.0078 to 0.0231 in)
- commutator end	0.101 to 0.180 mm (0.0039 to 0.0070 in)	0.016 to 0.065 mm (0.0006 to 0.0025 in)
Interference fit of drive end bearing bushing	0.050 to 0.100 mm (0.0020 to 0.0039 in)	—
Interference fit of centre and commutator end bearing bushing	0.030 to 0.080 mm (0.0012 to 0.0032 in)	—
I.D. of bushing fitted on pinion hub	16.950 to 17.000 mm (0.6674 to 0.6693 in)	—
Diameter of armature shaft	16.800 to 16.830 mm (0.6614 to 0.6626 in)	—
Running clearance of armature shaft in bushing	0.120 to 0.200 mm (0.005 to 0.008 in)	—
Lubrication (at overhauling)		
Screwed sleeve helix	grassofiat MR 3	grassofiat MR 3
Commutator end washer	—	grassofiat MR 3

DESCRIPTION

The starting motor consists of the following major components :

- an electromagnet (6,fig.4) provided internally with a core (29) that under the magnetic force induced by the solenoid coil moves forward to carry out the following operations : exerting pressure on the return spring, positive engagement of the pinion with the flywheel ring gear through control lever (23); connection in circuit of the field winding fixed contacts, hence allowing the passage of the energising current necessary to operate the starter ;

- four windings, two of which consist of the main (16, fig.1) and secondary (17) field winding coils (two coils each), and the remaining two by a coil each of the main field winding (16) ;

- an armature (11, fig.4) revolving on self-oiling bushings and provided, at the end opposite the commutator , with helical splines along which the pinion moves longitudinally,allowing engagement of the pinion and flywheel gears ;

- a pinion (10) moving longitudinally along the armature to which it is connected mechanically by means of a roller freewheel device. This device connects armature and pinion when the latter meets resistance to rotation (stalling and starting phase) whilst it allows the pinion to slip once the engine fires and so prevents pinion overdriving and the armature attaining excessive speeds.

DISMANTLING THE STARTER

Remove the starter from the tractor then dismantle the motor according to the sequence and instructions given below :

- Remove the back cover (1, fig. 4) complete with thrust disc (22), with draw the brushes from their respective holders, disconnect the starter winding lead from terminal (3) and withdraw from the armature the carcase complete with brush holder;

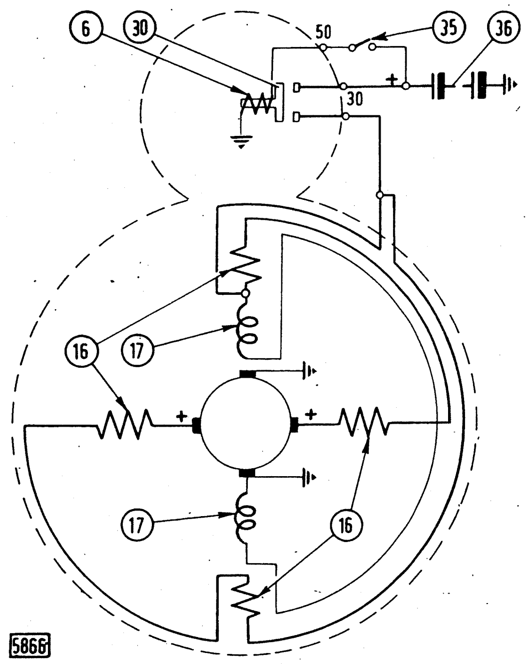


Fig.1 - Wiring diagram of starting motor - Var.1

6. Electromagnet - 16. Main field winding - 17.Secondary field winding - 30.Moving contact - 35. Starting push button - 36. Battery (12 V).

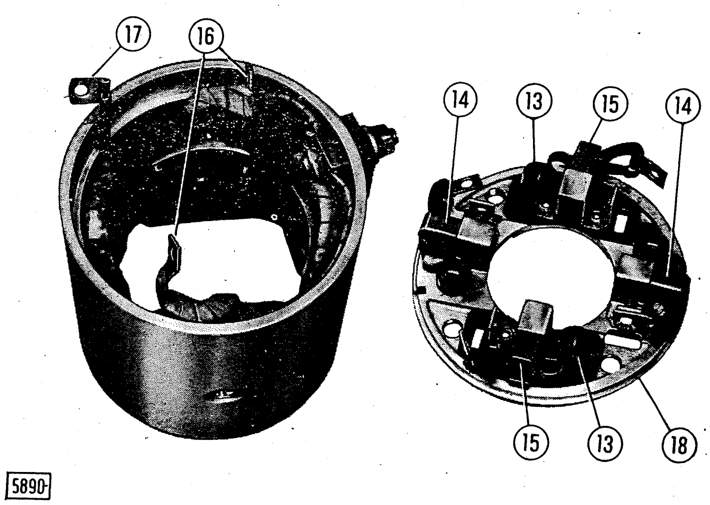


Fig. 2 - Yoke and commutator end shield (18) with brush holder.

13.Brush holder springs (pointing on brush side) - 14. Negative brushes (grounded) - 15. Positive brushes- 16. Primary field winding terminals - 17. Secondary field winding terminal (grounded).

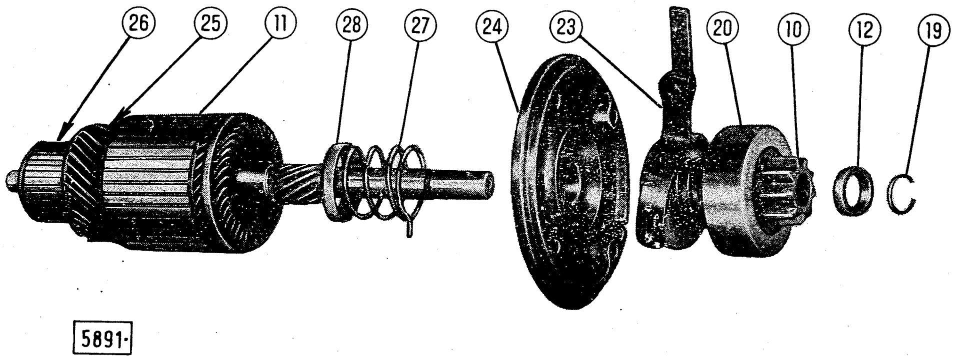


Fig.3 - Armature assembly (11) with central flange (24) and frewheel .

10.Drive pinion - 12. Pinion stop ring - 19.Snap ring - 20.Freewheel-23.Shifter fork - 25.Armature winding - 26. Commutator - 27.Armature return spring - 28. Spring cup.

- separate the complete brush holder (18,fig.2) from the starter carcase disconnecting the terminals (16 and 17) ;

- remove the solenoid assembly (6 , fig. 4) and withdraw the pin (9) after the removal of the retaining cotter pin ;

- separate the driving end head (8) from the armature (11);

- remove the snap ring (19) to split the components as illustrated in fig. 3.

Clean the disassembled parts carefully and check :

1. Wear of self-lubricating parts, bearing in mind that excessively worn bushings might cause the armature to interfere with the pole shoes.

2. Spring pressure on brushes and brush wear. Always replace all brushes even if only one is found defective or worn.

3. Out-of-round of armature commutator, turning it if out-of-round exceeds 0.02 mm (0.0008 in), and afterward undercut the mica between blades within

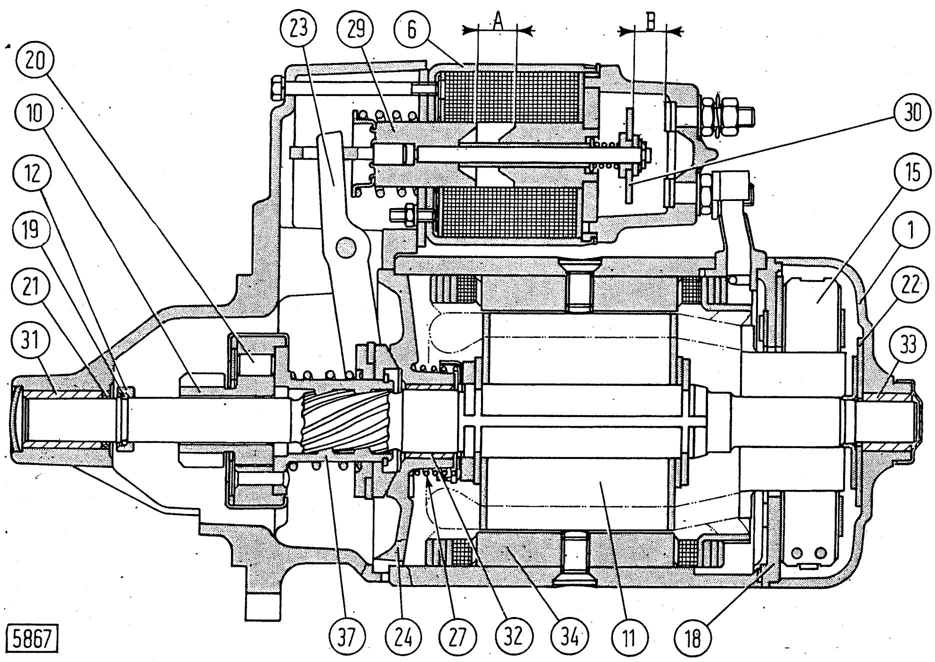


Fig.4 - Section of FIAT starting motor with electromagnetically operating pinion gear shift.

A. 13.65÷15.15 mm (0.537÷0.596 in).Solenoid core stroke - B.11.35÷13.45 mm(0.447÷0.530 in).Moving contact stroke- 1.Back cover - 2. Poles securing screws - 3. Starter winding terminal - 4. Terminal to "+" battery post - 5.Electromagnet feeding terminal - 6. Electromagnet - 8. Drive end casting - 9. Pinion gear shift lever pivot - 10. Pinion - 11. Armature - 12. Pinion stop ring - 15. Positive brushes - 18. Brush holder plate - 19. Snap ring - 20. Freewheel roller - 21. Pinion end seal - 22. Thrust disc - 23.Shifter fork - 24. Flange - 27. Armature return spring - 29. Core - 30. Moving contact - 32, 32 e 33. Armature bearing bushings - 34. Pole - 37. Shifter collar.

the specified limits, using the tool A. 3963.

4. Check that the armature coils and armature are insulated from the armature carcase (a, Fig. 15-640), that no winding coil or blade of the commutator is short circuited (b) and, finally, that no interruption exists in the electrical continuity of the circuit (c).

5. Verify the field winding insulation with respect to the carcase and pole shoes and check the windings for interruptions. In the event that a new winding is to be fitted, we recommend heating it up first to approximately 50°C (122°F) by feeding it with a 12V current for about 1 minute in order to increase its flexibility and favour proper bedding under the poles.

The poles must then be blocked in place by tightening the screws in the hand press M.166, using simultaneously the stretcher 721050.

After assembly, check that the inside diameter across the pole shoes is within the specified limits; if not, assembly was not correct. In any event, re-check the assembly sequence, but in no case should the pole shoes be rebored.

6. Functional efficiency of the freewheel: the torque necessary, under static conditions, to drag the pinion in to the slow rotation must be 5÷7 Kg.cm (0.36÷0.50 lb.ft).

Reassemble the motor by referring to fig. 4 and considering the following notes:

- no special caution is required to fit the starter end covers to the carcase because assembly is insured by suitable locating dowels;

- lubricate the pinion engagement helix with fluid grade (SAE 10W) motor oil.

BENCH TESTING INSTRUCTIONS

Starter efficiency is checked by means of the load and no-load and stall tests. For this purpose, install the starter on the test bench and wire up as illustrated in Fig. 5.

Feed specified current to the starter and, for each test, compare measured values to the data reported in the chart.

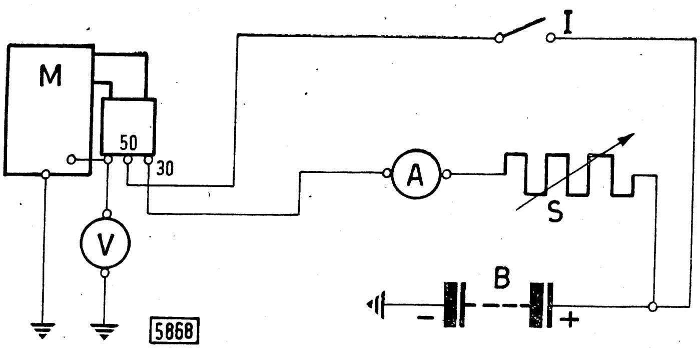


Fig.5 - Test rig wiring diagram for starting motor. A. Ammeter - B. Battery - M. Starting motor under test - 1. Starting push-button - S. Rhedstat - V. Voltmeter.

TOOL LIST

See 640 pag.207, taking away the tools listed below.

Part.No.	Description
A. 423048 / 290973	Armature shaft alignment tool for turning down commutators.
A. 427052 / 292307	Adaptor, drive clutch slippage test(to be used with torque wrench A.711041/12).
A. 723046 / 291353	Wrench, armature return spring and pin retaining ring nut.

TROUBLE-SHOOTING CHART

TROUBLE	POSSIBLE CAUSE	LOCATION AND REMEDIES
Starter inoperative or turning too slowly.	Battery posts and terminals loose or oxidized.	Clean posts and terminals.
	Battery discharged or deteriorated.	Check battery.
	No contact of brushes with commutator due to brushes sticking, or guides worn out, springs out of shape, or ingress of dirt.	Check brushes and clean guides and commutator. Check spring load on brushes. If necessary, replace brushes and springs.
	Solenoid contacts oxidized, worn or insulated because of the presence of dirt.	Check and clean the contact points. Oxidation may be due to shorted coils because of excessive current absorption. If so, replace solenoid as an assembly.
	Armature or field windings partially shorted or grounded. Blacking of insulators, damaged commutator bars.	Replace defective parts.
	Thrown armature or commutator.	Replace armature as an assembly.
	Excessive voltage drop in cables.	Check cables and their connections.
Noisy operation.	Worn armature bearing bushings.	Replace bushings.
	Pinion disengagement from flywheel is delayed because of inefficient return spring or guide collar seizure	Disassemble motor and replace defective parts.
Starter turns but fails to start the engine.	Worn pinion or flywheel crown teeth.	Replace pinion or flywheel crown.
	Funtionally inefficient freewheel.	Replace defective parts.
Starter output fails short of full power rating.	Low battery charge.	Re-charge the battery.
	Brushes sticky in holder.	Clean brush holders.
	Freewheel slips.	Recondition or replace it.
	Brushes not bedded properly.	Set the brushes properly by running the starter idle for a while at 30 to 40 seconds intervals.
Brushes wear out quickly.	Thrown commutator.	Turn it.
	Projecting mica.	Undercut it with tool.
	Loose brush holder screws.	Tighten the screws.
	Wrong type of brushes.	Replace brushes with original spares.

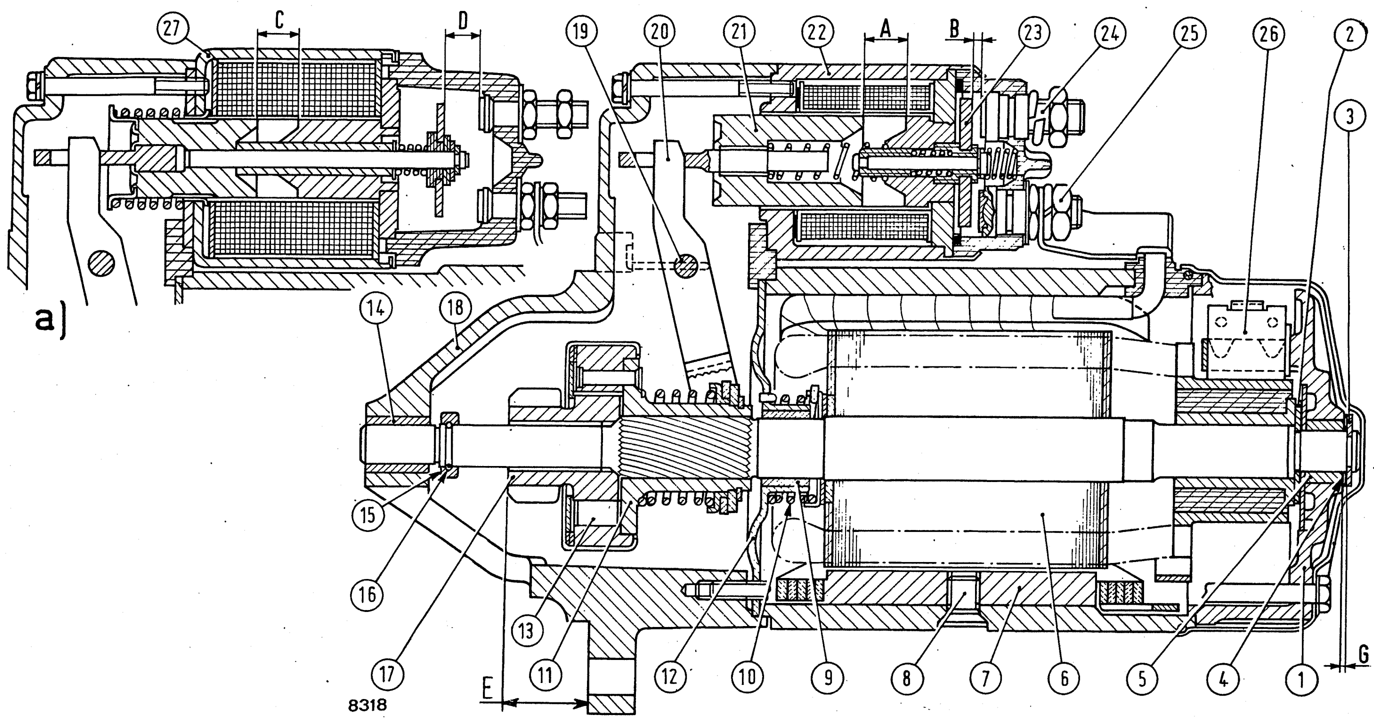


Fig.6 - Cross section of Marelli starter motor mod. MT 68AA.

a. Cross section of the single winding solenoid (27) as installed on Marelli starter model MT68A - A = 13.8 to 14.9 mm (0.543 to 0.586 in) solenoid core stroke - B = 3 mm (0.118 in) solenoid mobile contact stroke - C = 12.5 to 13.4 mm (0.492 to 0.527 in) solenoid core stroke - D = 11.5 mm (0.452 in) solenoid mobile contact stroke - E = 26 to 27.6 mm (1.023 to 1.086 in) distance between mounting flange and drive pinion end - G = 0.3 to 0.6 mm (0.011 to 0.023 in) armature shaft end play, adjustable by means of shims (4) - 1. Rear bracket - 2. Washer - 3. Trust washer - 4. End play (G) adjustment shims - 5. Bush - 6. Armature - 7. Pole shoe - 8. Pole shoe screw - 9. Bush - 10. Armature return spring - 11. Freewheel hub - 12. Intermediate bracket - 13. Freewheel - 14. Bush - 15. Pinion thrust ring - 16. Jump ring - 17. Pinion - 18. Drive end bracket - 19. Engaging lever pivot pin - 20. Engaging lever - 21. Solenoid core - 22. Double winding solenoid - 23. Mobile contact - 24. Positive battery terminal - 25. Field cable terminal - 26. Brush.

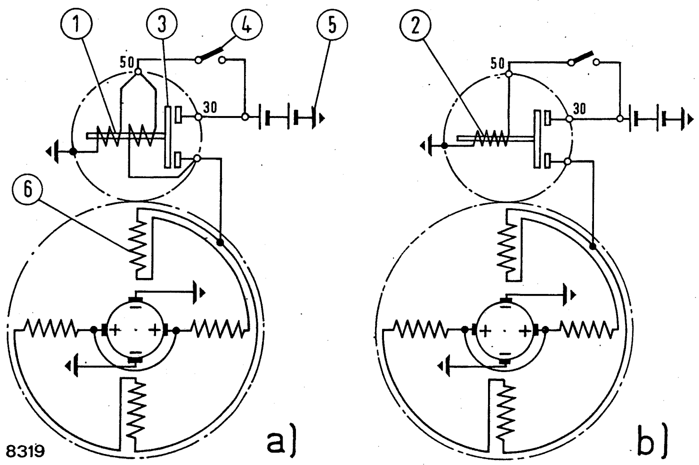


Fig.7 - Wiring diagrams for Marelli starter motors mods. MT 68AA (a) and MT68A (b).

1. Double winding solenoid - 2. Single winding solenoid - 3. Mobile contact - 4. Starting button - 5. Battery - 6. Primary winding.

DESCRIPTION

The Marelli starter motor model MT68AA operated by means of a double winding solenoid is installed on post-modification models 480 - 500 - 540 - 640. However a series of engines for the model 640 has been equipped with the Marelli starter MT68A that is interchangeable with the model MT68AA and differs only for the solenoid that is of the single winding type.

For the starter motors specifications and data see the table at page 305.

APPENDIX

MODELS 480-480 DT | ENGINE
TRANSMISSION

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ENGINE

BOSCH INJECTION PUMP

SINGLE PLUNGER INJECTION PUMP TYPE

EP/VA 3/110H 1200 CL 134-5

TRACTOR MODEL 480

ENGINE TYPE FIAT 8035.02.200

INJECTORS: EPPZ 10F1-770577

Nozzle holder: KB70 S1 F10-767107 ; nozzle: DLL 140S 64F-770578 ; holes diameter: 0.35mm

holes number: 3 . Pressure setting: 225÷235 Kg/sq. cm (3200÷3340 p.s.i.)

Spring: WSF 2044/6X-656829 ; spring free length: 27÷27.5 mm.

Fuel delivery lines: PRR 25F 15Z-767452

fuel delivery lines dimensions: 1.5x6x427 mm

ASSEMBLY DATA

Pump rotation: anticlockwise . Injection order: 1-2-3 . Plunger pre-lift from B.D.C. 0.7±0.02 mm. Fixed injection advance before T.D.C. in cylinder 1 in compression: 9°±1° **(pre-modification) and 10°+1° (post-modification).**

Length of preloaded control plunger spring: 24.6 mm.

TEST SPECIFICATIONS

Test A: BOSCH test machine with injectors fitted with pressure springs WSF 2044/4 X and nozzles EFEP 182.

RABOTTI test machine equipped with graduated ring injectors with springs FIAT 656829 and nozzles EFEP 182.

Injector pressure setting: 150 Kg/sq. cm (2135 p.s.i.).

Fuel lines: 2x6x840 mm.

Test B: Test machine equipped with nozzle holders and nozzles same as those mounted on the engine.

Fuel lines: 1.5x6x700 mm.

Injectors pressure setting: 225÷235 Kg/sq. cm (3200÷3340 p.s.i.).

Test fluid: FIAT CFB at 40÷5 °C (104÷9 °F) (for temperatures below specifications, add 0.25 cu. cm to deliveries for 1000 strokes per each °C less).

Feed pressure of test machine at pump inlet: 0.2 Kg/sq. cm (2.8 p.s.i.).

CALIBRATION DATA

Type of test	Throttle lever setting	Pump R.P.M.	Transfer pump inside pressure kg/sq.cm	Timing device plunger stroke (°) mm.	TEST A Single element output per 1000 strokes c.c.	TEST A Backleakage per 100 strokes c.c.	TEST B Single element output per 1000 strokes c.c.	TEST B Backleakage per 100 strokes c.c.
Control lever arrangement	max ■	700±5	–	–	0	–	0	–
	max ●	700±5	–	–	62÷64	–	51.5÷53.5	–
	max ●	1250	–	–	37÷45	–	29÷37	–
Transfer pump pressure check	—	100	0.6÷1.1	–	–	–	–	–
	—	700±5	5÷5.5	–	–	–	–	–
	—	1200	7÷7.5	–	–	–	–	–
Start excess fuel check	max ●	250	–	–	≤ 65	–	≤ 55	–
	max ●	100	–	–	≥130	–	≥130	–
Advance setting	—	250÷400	–	0 beginning	–	–	–	–
	—	700±5	–	4÷5	–	–	–	–
	—	1150÷1200	–	9.5(end)	–	–	–	–
Fuel cut-off (1)	max ●	1300÷1350	–	–	0	–	0	–
	max ●	1250	–	–	37÷45	–	29÷37	–
Delivery and backleakage check (2)	max ●	1200 −20 +0	–	–	* 58÷60	–	* 47÷49	–
	max ●	1000	–	–	–	45÷70		45÷70
	max ●	700±5	–	–	62÷64	–	51.5÷53.5	–
	max ●	500±5	–	–	62÷64	80÷110	53÷55	80÷110
Low idling adjustm. (3)	min ●	400÷500	–	–	0	–	0	–
	min ●	350	–	–	12÷22	–	10÷18	–

Notes.

(°) Measured with gauge 292817

* Max. difference between individual deliveries: 2.5 cc. per 1000 strokes.

● Output lever in full load position. ■ Output lever in stop position.

(1) Adjust max. speed stop screw.
(2) Adjust max. output stop screw.
(3) Adjust idling speed stop screw.

ENGINE BRAKE TEST DATA

Test specifications:

— engine installed on test bench without fan, air cleaner and exhaust muffler;
— atmospheric pressure 740 ± 5 mm of mercury;
— ambient temperature 20 ± 3 °C (68 ± 5 °F);
— relative humidity 70 % ± 5;
— fuel specific weight 830 ± 10 gr/lt;
— temperature of fuel backleakage at pump outlet 54 ± 2 °C (129 ± 4 °F).

Throttle lever setting	Engine - speed R.P.M.	Power output of engine runned-in for a total of 2 hours HP	Power output of engine runned-in for a total of 50 hours HP	Fuel consuption time (100 c.c.) sec.
Max (under load)	2400	≥ 44.5	≥ 46	≥ 36.6
Max (max torque zone)	1400	≥ 27.5	≥ 28.5	≥ 56.2
High idle	≤ 2650	–	–	–
Low idle	650÷700	–	–	–

Notes.

TRANSMISSION

SUBSIDIARY SPEED REDUCTION UNIT

The subsidiary speed reduction unit, of the epicyclic gear type, is secured to the normal gear transmission and reduction unit (in this case equipped with the proper attachments and driving splines) allowing three forward creeper speeds and one in reverse. The lever (L) with three positions engages at the same time, through an inner lever and two shifter bars, the forks (3 and 4) controlling the engagement collars (1 and 2).

According to the position of the lever (L), the straight drive or standard reduction unit can be engaged through collar (1) or the subsidiary reduction unit can be engaged through collar (2).

Before the engagement or disengagement of the reduction unit it is advisable to disengage the gearbox clutch and stop the tractor. For overhaul refer to the standard gear reduction unit procedures.

Note – For the transmission ratios and speeds of the tractor equipped with auxiliary reduction unit, see the relevant table on page 279.

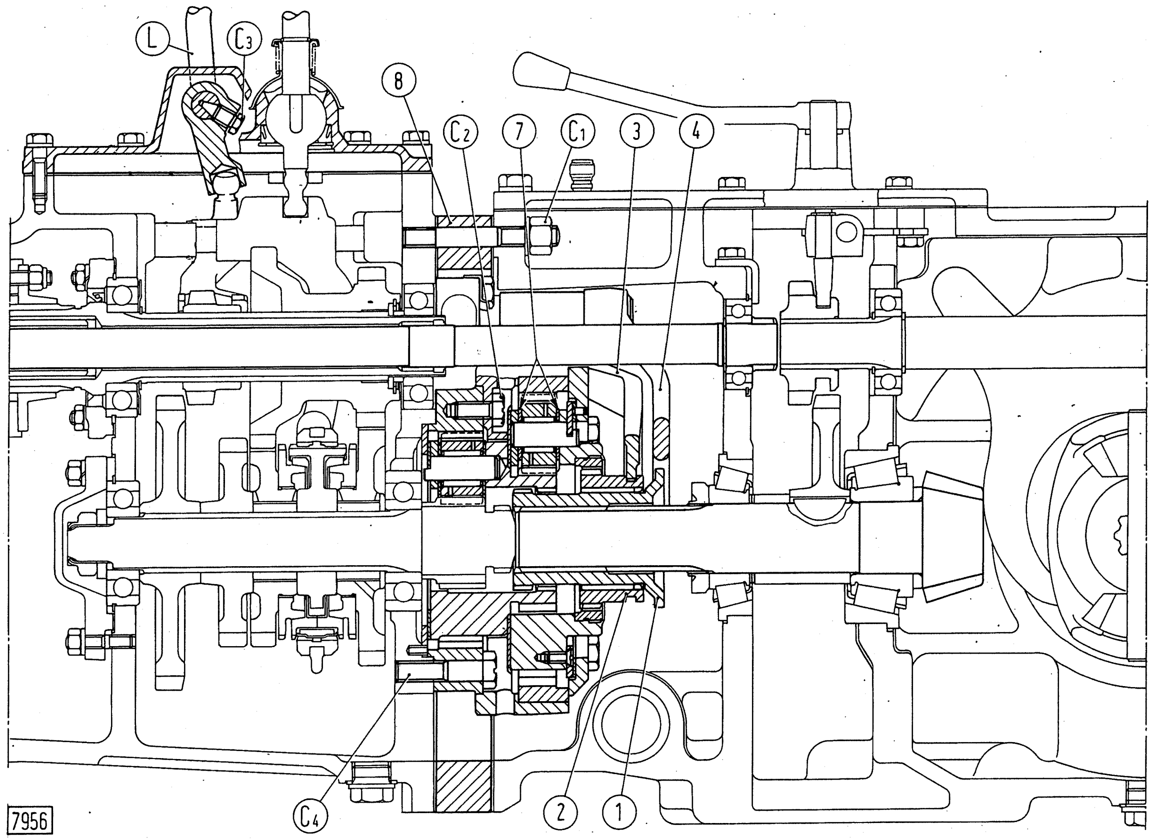


Fig. 1 – Sectional views of transmission and epicyclic speed reduction unit.

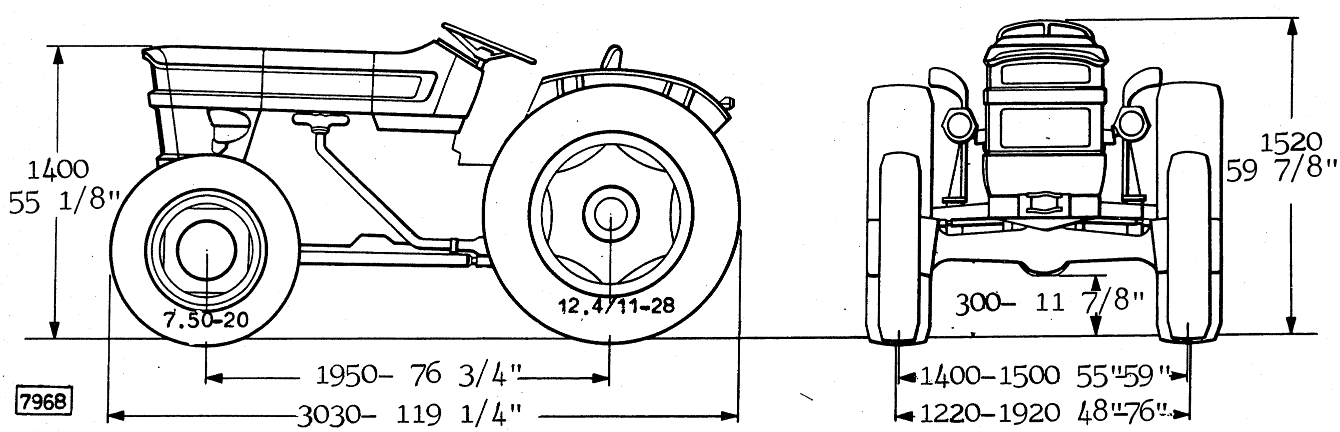
L. Speed reduction gears reduction lever – C_1. Capscrews and stud nuts securing clutch-transmission and transmission housing – C_2. Self-locking screws securing subsidiary reduction unit carrier – C_3. Screw securing inner lever controlling the reduction unit – C_4. Self-locking screw securing the standard reduction unit ring gear – 1. Standard reduction unit and straight drive engagement collar – 2. Subsidiary reduction unit engagement collar – 3 and 4. Standard reduction unit and subsidiary reduction unit shift forks – 7. Thrust rings of reduction unit driven gear – 8. Spacer between transmission housings.

FRONT DRIVE AXLE AND POWER STEERING FILL UP DATA

Fill point	Level check intervals hours	Change intervals hours	LUBRICANT		Q.ty	
			FIAT	International	Kg	Imp/units
Gearbox, rear transmission housing, front drive transfer gearbox and hydraulic lift (*)	400	1600	Ambra 20W-40	MIL-L-2104B	17,5	3,9 gals
Bevel gear-differential and front drive axle housing	400	1600	Ambra 20W-40	MIL-L-2104B	3,3	3 qts
Front drive epicyclic reduction (each)	400	1600	Ambra 20W-40	MIL-L-2104B	1,5	$2\frac{4}{5}$ pts
Power steering (*)	400	1600	Ambra 20W-40	MIL-L-2104B	2,2	4 pts
Grease nipples, front axle pivot and steering	50	-	FIAT G9 grease	NLGI2	-	-
Spherical bearings and universal joints of front drive axleshafts (at assembly)	-	-	FIAT MR3 grease	NLGI3	-	-

Note - For other lube data see table on page 280 reporting the fill-up data relevant to model 480.

(*) For temperatures below 0°C (32°F) use oliofiat AMBRA 10W/30.



Overall dimension of the tractor model 480 DT.

Tractor weight .... Kg 1980 (4365 lb)

FRONT WHEEL DRIVE - MODEL 480 DT

The overhaul and adjustment of the front wheel drive, of the propeller shaft and of the transfer gear box can be carried out as indicated for model 640 DT (from page 224 to page 234).

DRIVING WHEELS

The driving wheels, front and rear, can be equipped with the tyres indicated in the following table. It is indispensable to mate the tyres as indicated, to avoid slippages and wear.

Front		Rear
7.50-20	with	12.4/11-28
9.5/9-20	with	12.4/11-32
9.5/9-20	with	14.9/13-28

At the rear eight different threads adjustments (from 1220 to 1920 mm or 48" to 76" by steps of 100 mm or 3.937 in) can be obtained. The thread adjustment of 1220 mm or 48" cannot be obtained with tyres 14.9/13-28. Keep in mind that it is advisable to keep the tread values as near as possible to those of the front steering-driving wheels.

At the front, by turning the wheels, it is possible to obtain two thread adjustments: 1400 mm and 1500 mm (55" to 59").

POWER STEERING

The power steering is supplied as an optional and can be of the external cylinder type or with the cylinder installed in the front axle bracket (for the DT models only the second type is available).

POWER STEERING WITH CYLINDER INCORPORATED IN THE FRONT AXLE BRACKET.

See model 640 except for the following chapter.

Overhauling the pump and reservoir.

Proceed as indicated on page 240 considering that only part of the pump data are differing as can be seen from table on page 323.

POWER STEERING WITH EXTERNAL CYLINDER

See model 640 except for the following chapters.

Overhauling the pump and reservoir

Proceed as indicated on page 240 considering that only part of the pump data are differing as can be seen from table on page 323.

Instructions for installing the power-assist cylinder on tractor

Install the power assist cylinder (C, Fig.9, page 243) complete with end (5) and control rod (D) and adjust the total length (L_1) at 1050 mm (41.3386 in) acting on the threaded end (5).

ASSEMBLY DATA

SUBSIDIARY SPEED REDUCTION UNIT	
See 640, page 246.	
FRONT WHEEL DRIVE	
See 640 DT, pages 246,247,248,249,250 except for the reduction ratio between bevel pinion and transfer gear box output shaft	$\frac{24}{27} \times \frac{24}{35} = \frac{1}{1,640}$
POWER STEERING -See 640, pages 250, 251, 252 and 253 except the following values relevant to the hydraulic pump:	
- pump model	A 14XS(°) A 10X (*) A18X (°°)
- rotation (driving shaft side)	anticlockwise
- thickness of drive and driven gears	10.500 to 10.515 mm (0.4134 to 0.4139 in) (°) 13.190 to 13.215 mm (0.5193 to 0.5203 in) (°°) 7.322 to 7.348 mm (0.2882 to 0.2892 in) (*)

(°) Pre-modification pump - (°°) Pre-modification pump(with cylinder outside the axle support), or post-modification (with cylinder inside the axle support) - (*) Post-modification pump (with cylinder outside the axle support).

TORQUE SPECIFICATIONS

Description	Thread	Material	Torque Kgm	Torque ft.lbs
Capscrews and stud nuts securing clutch-transmission and transmission housing (C_1,Fig.1)	M12x1,5	R50 Znt	9,5	68.7
Self-locking screw securing subsidiary reduction-unit carrier (C_2)	M10x1,25	R80 Znt	5	36
Screw securing inner lever controlling the reduction unit (C_3)	M10x1,25	R100	5,2	37,6
Self-locking screw securing the standard reduction unit ring gear (C_4)	M12x1,5	R80 Znt	8	57,8
FRONT WHEEL DRIVE - FRONT AXLE - See 640 DT pages 254, 255.				
POWER STEERING - See 640 DT , pages 255				

SERVICE TOOLS

FRONT WHEEL DRIVE - See 640 DT, page 256.

POWER STEERING - See 640, page 256, removing the supporting bracket 290367 for testing pumps A14XS-A18X - A10X.

MODELS
500-500 «Special»

See Appendix page 341 for:

- engine with Bosch injection pump;
- subsidiary reduction unit;
- model 500 DT – 500 DT "Special";
- power steering.

The following section deals with those parts differing from the ones of models 640 – 480.
The model 640 and 480 parts that are also valid for models 500 and 500 "Special", are indicated in the table of contents and in the text.

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(°) See 640, pages 89 and 93, disregarding data and torque values for the engine vibration damper.

(*) See 640, page 95 with the addition of tool A127031 securing the auto advance device.

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ENGINE

O - SPECIFICATIONS - REMOVAL - INSTALLATION

DESCRIPTION

See 640 considering that the engine installed on model 500 is a three cylinder unit.

SPECIFICATIONS

See 480 page 263 except for the following variations :

Engine type .... { FIAT 8035.02.301 with 10" FIAT clutch
FIAT 8035.02.303 with 11" LUK clutch (x) }

Max. power speed	2500	r.p.m.
High idling	2700	r.p.m.

TEST RIG DATA

See table on page 332 for the engine equipped with CAV fuel injection pump and table on page 344 for the engine equipped with BOSCH fuel injection pump.

IV - FUEL SYSTEM

SPECIFICATIONS

See 640 except for the following data :

Injection pump type	CAV DPA 3233 F580-770644 (°)
Pump setting on engine : when cylinder no.1 is away from T.D.C. of	16° to 18°
Pump pressure outlet corresponding to cylinder no.1	W mark
Pressure pipes from injection pump to injectors	2x6x427 mm

(°) For BOSCH injection pump refer to page 344.

(x) For models "Special".

CAV INJECTION PUMP

SINGLE-PLUNGER INJECTION PUMP TYPE

CAV DPA 3233 F580 - 770644

TRACTOR MODEL 500

ENGINE TYPE FIAT { 8035.02.301 / 8035.02.303 }

INJECTORS: EPPZ 10F1-770577

Nozzle holder: KB70 S1 F10-767107 ; nozzle: DLL 140S 64F-770578 ; holes diameter: 0.35mm

holes number: 3 . Pressure setting: 225÷235 Kg/sq. cm (3200÷3340 p.s.i.)

Spring: WSF 2044/6X-656829 ; spring free lenght: 27÷27.5 mm

Fuel delivery lines: PRR 1F 15Z-768356

fuel delivery lines dimensions: 2x6x427 mm

ASSEMBLY DATA

Pump rotation: anticlockwise. Injection order: 1-2-3 . Distance between governor cover stud and metering valve pin: 54^{-1}_{+0} mm. Control spring mounting hole on control arm: upper

Control spring mounting hole on trottle lever link: metering valve pin side end.

Distance between cam ring rollers: 49.98 mm. Fixed injection advance before T.D.C. in cylinder 1 in compression 17°±1° . Timing mark on pump body at 268° (°) from key seat (by tool A. 127027).

TEST SPECIFICATIONS

Test A: BOSCH test machine with injectors fitted with pressure springs WSF 2044/4X and nozzles EFEP 182.

RABOTTI test machine equipped with graduated ring injectors with springs FIAT 656829 and nozzles EFEP 182.
Injector pressure setting: 175 Kg/sq. cm (2489 p.s.i.).
Fuel lines: 2x6x865 mm.

Test B: Test machine equipped with nozzle holders and nozzles, same as those mounted on the engine.
Fuel lines: 2x6x700 mm.
Injectors pressure setting: 225÷235 Kg/sq. cm (3200÷3340 p.s.i.).

Test fluid: FIAT CFB at 30+5 °C (86+9 °F).

Feed pressure of test machine at pump inlet: 0,2 Kg/sq. cm (2.8 p.s.i.).

CALIBRATION DATA

Test N°	Throttle lever setting	Pump R.P.M.	Time to reach 406 mmHg vacuum at pump suction sec.	Transfer pump inside pressure Kg/sq.cm	Advance degrees	TEST A Single element output per 1000 strokes c.c.	TEST A Backleakage per 100 strokes c.c.	TEST B Single element output per 1000 strokes c.c.
1-2	–	100	⩽ 60	1.2÷1.8	–	–	–	–
3	–	800	–	–	4÷5	–	–	–
4	–	1250	–	–	5.8÷6.3	–	–	–
5	–	180	–	–	1.2÷1.5	–	–	–
6	–	300	–	–	0	–	–	–
7 (°)	–	900	–	–	5.8÷6.3	–	–	–
8-9-10 (¹)	max ●	1250^{-20}_{+0}	–	5÷6	–	★ 50÷53	⩾ 14	★ 48÷51
11-12	max ●	800±5	–	3.8÷4.6	–	★ 45÷48	–	★ 50÷53
13	max ●	100	–	–	–	⩾ 40	–	–
14	max ■	200	–	–	–	⩽ 4	–	–
15 (¹)	min ●	200	–	–	–	⩽ 5	–	–
16 (²)	max ●	1320	–	–	–	⩽ 9	–	–
17 (³)	max ●	1250^{-20}_{+0}	–	–	–	50÷53	–	–

Notes - Tests are to be carried out strictly in the order specified.
For 3 cylinders only, tests 1 to 5 are to be carried out with the tool 290760 replacing the manual advance cut-off device.
Other tests must be carried out with cut-off device installed.
Test 6 and 13 are to be carried out with the cut-off device actuated.
● Shut-off lever excluded. ■ Shut-off lever in stop position.
★ Max. difference between individual deliveries: 4 c.c. per 1000 strokes.

(°) For 3 cylinders only.
(¹) Throttle lever with stop screw backed out (To adjust maximum delivery, turn the regulating plates).
(²) Fuel cut-off. Calibrate delivery as required by means of the throttle stop screw.
(³) Final delivery check.

ENGINE BRAKE TEST DATA

Test specifications:

— engine installed on test bench without fan, air cleaner and exhaust muffler;
— atmospheric pressure 740 ± 5 mm of mercury;
— ambient temperature 20 ± 3 °C (68 ± 5 °F);
— relative humidity 70% ± 5;
— fuel specific weight 830 ± 10 gr/lt;
— temperature of fuel backleakage at pump outlet 54 ± 2 °C (129 ± 4 °F).

Throttle lever setting	Engine-speed R.P.M.	Power output of engine runned-in for a total of 2 hours HP	Power output of engine runned-in for a total of 50 hours HP	Fuel consumption time (100 c.c.) sec.
Max (under load)	2500	⩾ 46	⩾ 48	⩾ 33
Max (max torque zone)....	1600	⩾ 30.5	⩾ 32	⩾ 51
High idle.	⩽ 2700	–	–	–
Low idle	650	–	–	–

Notes.

POWER TRAIN AND ATTACHMENTS

O – DESCRIPTION – SPECIFICATIONS – LUBRICATION

DESCRIPTION

The power train consists of the following major units :

- 10" FIAT make dual-plate dry clutch with single control ;
- 11" LUK make dual-plate dry clutch with separate controls (models "Special") ;
- transmission with epicyclic gear reduction : with eight forward (four with synchromesh) and two reverse speeds ;
- main drive bevel gear and two gears differential with pedal controlled lock ;
- dry contracting band service brakes with mechanical control and independent pedals ;
- single-reduction final drives ;
- telescoping front axle centrally pivoted with reversed U shaped section ;
- steering, wheel controlled, of the worm and nut type.

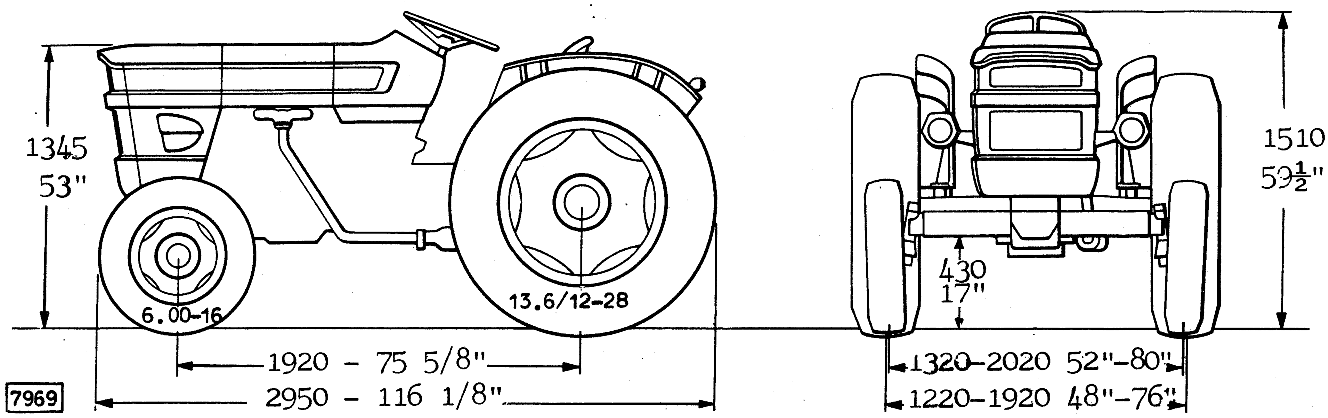
The Controlmatic hydraulic lift is of the position and draft control type. The P.T.O. and drive are incorporated in the transmission housing rear cover while the belt pulley is an optional.

TRANSMISSION RATIOS, PERFORMANCE AND WEIGHT

Speed gears	Transmission and epicyclic gear train speed reduction ratios 1 :	Overall speed reduction ratios from engine to drive wheels (1 wheel turn per engine revs) 1 :	Maximum speed (with engine running at 2500 r.p.m. and rear tyres 12.4/11-28)	
			Km/h	M P H
1st Low	10,575	256.3	2,1	1.30
2nd "	7.029	170.3	3,2	1.98
3rd "	4.799	116.3	4,7	2.91
4th "	3.716	90.0	6,1	3.78
1st High	2.938	71.2	7,8	4.85
2nd "	1.952	47.3	11,7	7.26
3rd "	1.333	32.3	17,1	10.62
4th "	1.032	25.0	22,1	13.73
1st Creeper (x)	32.658	791.513	0,70	0.43
2nd " "	21.706	526.072	1,06	0.66
3rd " "	14.824	359.268	1,55	0.96
4th " "	11.476	278.143	2,00	1.24
Low Reverse	7.359	178.3	3,1	1.92
High Reverse	2.044	49.5	11,1	6.89
Creeper Reverse (x)	22.729	550.878	1,01	0.63

Bevel gear speed reduction ratio 10/43 .... 1 : 4.3
Final drive speed reduction ratio 11/62 .... 1 : 5.636
Total speed reduction ratio (final drives+bevel gear) .... 1 : 24.236
Tractor weight (with standard fitting, oil coolant and fuel, operator excluded) .... 1740 Kg (3836 lb)

(x) With subsidiary reduction unit, optional (see appendix).



Overall dimensions of the tractor models 500-500 "Special"

VII - HYDRAULIC LIFT UNIT

Specifications

See 640 except for the following variations :

Fluid capacity of transmission case with level reaching the upper dipstick dent .... 16 Kg (15 imp.qts)

FIAT (Plessey licence) gear type hydraulic pump (clockwise rotation, seen from drive end) model C22X

- pump speed (with engine running at 2500 r.p.m.) ...... 2275 r.p.m.
- corresponding output with an oil temperature of 50° to 60°C (122° to 140°F) and 150 Kg/cm² (2133 p.s.i.) pressure .... 22,7 liters/min (4.99 GPM)

Single-acting cylinder :

- bore and stroke .... 90x96 mm (3.54x3.78 in)
- capacity .... 610 c.c. (37.2 cu.in)
- nominal lifting capacity.. 915 Kgm (6618 ft.lb)

Three-point linkage category.... 1

- maximum liftable weight at implement mounting points with lift rods connected to lower links :
  - all shortened .... 1420 Kg (3130 lb)
  - all extended .... 1100 Kg (2424 lb)
- implement mounting points range with lift rods connected to lower links :
  - all shortened .... 575 mm (22.64 in)
  - all extended .... 700 mm (27.56 in)
- lifting time with engine running at 2500 r.p.m. .... 1,8 sec.

Total weight of the hydraulic lift and linkage .... 104 Kg (229 lb)

VIII - POWER TAKE OFF - BELT PULLEY

POWER TAKE OFF

See 640 except for the following variations :

- shaft speed with the lever set in "engine"
  - engine running at 2160 r.p.m. .... 540 r.p.m.
  - engine running at max. power speed of 2500 r.p.m. .... 625 r.p.m.
- speed with the lever set in "Cambio" (Transmission) with rear tyres 12.4/11.28 .... 4.1 revs.per meter

BELT PULLEY

See 640 except for the following variations :

- speed (with engine running at the max. power speed of 2500 r.p.m.) .... 1300 r.p.m.
- linear speed .... 17 m/sec (55.8 ft/sec)

IX - FITS AND TOLERANCES - TORQUE SPECIFICATIONS - SERVICE TOOLS

FITS AND TOLERANCES

I - 10" FIAT clutch : see 480, page 297.

I - 11" LUK clutch : see 640, page 173.

II - Transmission : see 640, page 173.

III - Bevel gear and differential : see 640, page 174.

IV - Brakes : see 640, page 175 except for the following data :
Lining width .... 50 mm (1.968 in)

V - Final drives : see 640, page 175 .

VI - Steering and front wheels : see 640, page 175.

VII - Hydraulic lift unit : see 640, page 176 except for the following data :

Diameter of piston .... 89,980 to 90,000 mm (3.5422 to 3.5433 in)

I.D. of cylinder barrel .... 90.036 to 90.071 mm (3.5447 to 3.5461 in)

Running clearance of piston .... 0.036 to 0.091 mm (0.0014 to 0.0036 in)

VIII - Power take-off - Belt pulley : see 640, page 177.

TORQUE SPECIFICATIONS

I - 10" FIAT clutch : see 480, page 299.

I - 11" LUK clutch : see 640, page 178.

II - Transmission : see 640, page 178.

III - Bevel gear and differential : see 640, page 179 .

IV - Brakes : see 640 , page 179 .

V - Final drives and driving wheels : see 640, page 179 except for this torque value :

Capscrews, drive wheel discs .... M16x1.5; R100 Cdt; 26.5 Kgm (191.6 ft.lb)

VI - Steering and front wheels : see 640, page 180 .

VII - Hydraulic lift : see 640, page 180 .

VIII - Power take-off - Belt pulley : see 640, page 181 .

SERVICE TOOLS

I - 10" FIAT clutch : see 480, page 300 .

I - 11" LUK clutch : see 640, page 182 .

II - Transmission : see 640, page 182 .

III - Bevel gear and differential : see 640, page 182 .

V - Final drives and driving wheels : see 480, page 300 .

VI - Steering and front wheels : see 640, page 182 .

VII - Hydraulic lift : see 480, page 300 .

VIII - Power take-off - Belt pulley : see 640, page 183 .

APPENDIX

MODELS 500-500 "Special"	ENGINE
500 DT – 500 DT "Special"	TRANSMISSION

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ENGINE

BOSCH INJECTION PUMP

SINGLE-PLUNGER INJECTION PUMP TYPE:
EP/VA 3/110H 1250 CL 134-6

TRACTOR MODEL 500

ENGINE TYPE FIAT { **8035.02.201** / **8035.02.203** }

INJECTORS: EPPZ 10F1-770577

Nozzle holder: KB 70 S1 F10-767107; nozzle: DLL 140 S64F-770578 ; holes diameter: 0.35 mm

holes number: 3 . Pressure setting: 225÷235 Kg/sq. cm (3200÷3340 p.s.i.)

Spring: WSF 2044/6X-656829 ; spring free length: 27÷27.5 mm.

Fuel delivery lines: PRR 25F 15Z-767452

fuel delivery lines dimensions: 1.5x6x427 mm

ASSEMBLY DATA

Pump rotation: anticlockwise . Injection order: 1-2-3 . Plunger pre-lift from B.D.C. 0.7±0.02mm. Fixed injection advance before T.D.C. in cylinder 1 in compression: 9°±1° **(pre-modification) and 10°±1° (post-modification).**

Length of preloaded control plunger spring: 24.6 mm.

TEST SPECIFICATIONS

Test A: BOSCH test machine with injectors fitted with pressure springs WSF 2044/4 X and nozzles EFEP 182.

RABOTTI test machine equipped with graduated ring injectors with springs FIAT 656829 and nozzles EFEP 182.

Injector pressure setting: 150 Kg/sq. cm (2135 p.s.i.).

Fuel lines: 2x6x840 mm.

Test B: Test machine equipped with nozzle holders and nozzles same as those mounted on the engine.

Fuel lines: 1.5x6x700 mm.

Injectors pressure setting: 225÷235 Kg/sq. cm (3200÷3340 p.s.i.).

Test fluid: FIAT CFB at 40÷ 5 °C (104÷9 °F) (for temperatures below specifications, add 0.25 cu. cm to deliveries for 1000 strokes per each °C less).

Feed pressure of test machine at pump inlet: 0.2 Kg/sq. cm (2.8 p.s.i.).

CALIBRATION DATA

Type of test	Throttle lever setting	Pump R.P.M.	Transfer pump inside pressure kg/sq.cm	Timing device plunger stroke (°) mm.	TEST A Single element output per 1000 strokes c.c.	TEST A Backleakage per 100 strokes c.c.	TEST B Single element output per 1000 strokes c.c.	TEST B Backleakage per 100 strokes c.c.
Control lever arrangement	max ■	700±5	–	–	0	–	0	–
	max ●	700±5	–	–	62÷64	–	51.5÷53.5	–
	max ●	1320	–	–	37÷45	–	29÷37	–
Transfer pump pressure check	—	100	0.6÷1.1	–	–	–	–	–
	—	700±5	5÷5.5	–	–	–	–	–
	—	1250	7.2÷7.7	–	–	–	–	–
Start excess fuel check	max ●	250	–	–	⩽ 65	–	⩽ 55	–
	max ●	100	–	–	⩾ 130	–	⩾ 130	–
Advance setting	—	250÷400	–	0 beginning	–	–	–	–
	—	700±5	–	4÷5	–	–	–	–
	—	1150÷1200	–	9.5 (end)	–	–	–	–
Fuel cut-off (1)	max ●	1350÷1400	–	–	0	–	0	–
	max ●	1320	–	–	37÷45	–	29÷37	–
Delivery and backleakage check (2)	max ●	1250^{-20}_{+0}	–	–	* 58÷60	–	* 47÷49	–
	max ●	1000	–	–	–	45÷70	–	45÷70
	max ●	700±5	–	–	62÷64	–	51.5÷53.5	–
	max ●	500±5	–	–	62÷64	80÷110	53÷55	80÷110
Low idling adjustm. (3)	min ●	400÷500	–	–	0	–	0	–
	min ●	350	–	–	12÷22	–	10÷18	–

Notes.

(°) Measured with gauge 292817

* Max. difference between individual deliveries: 2.5 cc. per 1000 strokes.

● Output lever in full load position. ■ Output lever in stop position.

(1) Adjust max. speed stop screw.

(2) Adjust max. output stop screw.

(3) Adjust idling speed stop screw.

ENGINE BRAKE TEST DATA

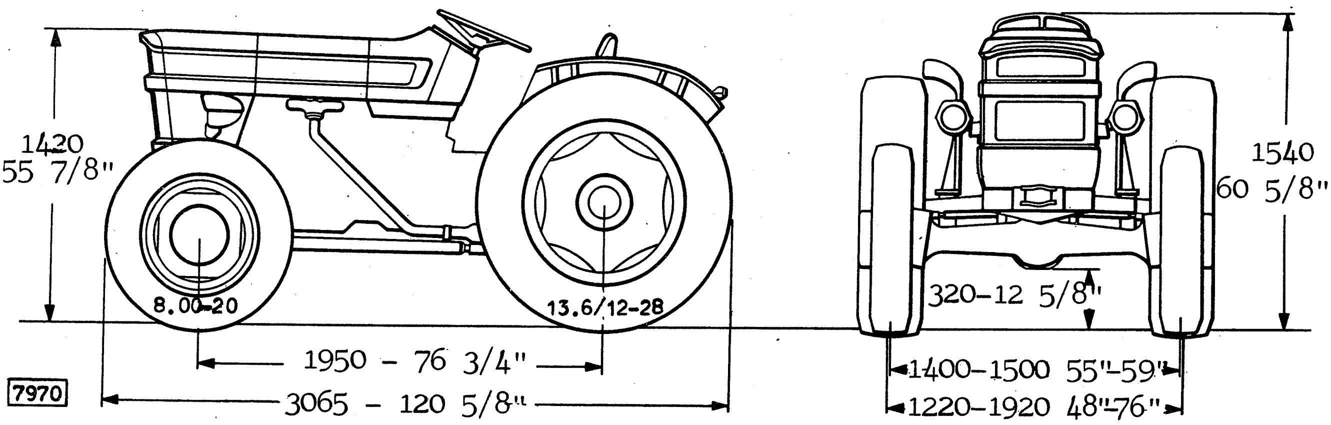
Test specifications:

— engine installed on test bench without fan, air cleaner and exhaust muffler;
— atmospheric pressure 740 ± 5 mm of mercury;
— ambient temperature 20 ± 3 °C (68 ± 5 °F);
— relative humidity 70 % ± 5;
— fuel specific weight 830 ± 10 gr/lt;
— temperature of fuel backleakage at pump outlet 54 ± 2 °C (129 ± 4 °F).

Throttle lever setting	Engine - speed R.P.M.	Power output of engine runned-in for a total of 2 hours HP	Power output of engine runned-in for a total of 50 hours HP	Fuel consuption time (100 c.c.) sec.
Max (under load)	2500	⩾ 46	⩾ 48	⩾ 34.6
Max (max torque zone)	1400	⩾ 27	⩾ 28.5	⩾ 56.2
High idle	⩽ 2750	–	–	–
Low idle	650÷700	–	–	–

Notes.

TRANSMISSION



Overall dimensions of the tractor models 500 DT - 500 DT "Special"

Tractor weight .... 2020 Kg (4415 lb)

FRONT WHEEL DRIVE - MODEL 500 DT- 500 DT "Special"

The overhaul and adjustments of the front wheel drive, of the propeller shaft and of the transfer gear box can be carried out as indicated for model 640 DT (from page 224 and 234).

DRIVING WHEELS

The driving wheels, front and rear can be equipped with the tyres indicated in the following table. It is indispensable to mate the tyres as indicated, to avoid slippages and wear.

Front		Rear
8.00-20	with	13.6/12-28
9.5/9-20	with	12.4/11-32
9.5/9-20	with	14.9/13-28

At the rear eight different threads adjustments (from 1220 to 1920 mm or 48" to 76" by steps of 100 mm or 3.937 in) can be obtained. The thread adjustment of 1220 mm or 48" cannot be obtained with tyres 14.9/13-28. Keep in mind that it is advisable to keep the tread values as near as possible to those of the front steering-driving wheels.

At the front, by turning the wheels, it is possible to obtain two thread adjustments: 1400 mm and 1500 mm (55" to 59").

POWER STEERING

The power steering is supplied as an optional and can be of the external cylinder type or with the cylinder installed in the front axle bracket (for the DT models only the second type is available).

POWER STEERING WITH CYLINDER INCORPORATED IN THE FRONT AXLE BRACKET.

See model 640 except for the following chapter.

Overhauling the pump and reservoir.

Proceed as indicated on page 240 considering that only part of the pump data are differing as can be seen from table on page 349 .

POWER STEERING WITH EXTERNAL CYLINDER

See model 640 except for the following chapters.

Overhauling the oil pump and reservoir

Proceed as indicated in the topic on page 240, taking into consideration that some pump data are different as can be seen from the following table.

Instructions for installing the power-assist cylinder on tractor.

Install the power-assist cylinder (C, Fig. 9 page 243) complete with end (5) and control rod (D) and adjust the total length (L_1) at 1050 mm (41.3386 in) acting on the threaded end (5).

ASSEMBLY DATA

SUBSIDIARY SPEED REDUCTION UNIT See 640, page 246.	
FRONT WHEEL DRIVE - See 640 DT, pages 246,247,248,249 and 250 except for the value of the ratio between the bevel pinion shaft and transfer gear output shaft	$\frac{23}{27} \times \frac{23}{35} = \frac{1}{1.786}$
POWER STEERING - See 640, pages 250,251,252 and 253 except for the following values concerning the hydraulic pump:	
- pump model	A 14XS(°) A18X(°°) A10X (*)
- pump rotation (seen from drive end)	anticlockwise
- max. pump speed (with engine running at 2500 r.p.m.)	2275 r.p.m.
- nominal output at max. speed	14.6 lit/min (3.2 G.P.M.) (°) 18.8 lit/min (4.1 G.P.M.) (°°) 10.4 lit/min (2.3 G.P.M.) (*)
- test bench output at 1445 r.p.m. and with 95 to 100 kg/cm² (1,351 to 1,442 p.s.i.) pressure: for new or overhauled pump, not below	8.7 lit/min (°) (1.9 G.P.M.) 11.2 lit/min (°°) (2.4 G.P.M.) 6.2 lit/min (*) (1.4 G.P.M.)
for used pump, not below	6.3 lit/min (°) (1.4 G.P.M.) 8.2 lit/min (°°) (1.8 G.P.M.) 4.6 lit/min (*) (1 G.P.M.)
drive and driven gear widths	10.500 to 10.515 mm (0.4134 to 0.4139 in) (°) 13.190 to 13.215 mm (0.5193 to 0.5203 in) (°°) 7.322 to 7.348 mm (0.2882 to 0.2892 in) (*)

(°) Pre-modification pump - (°°) Pre-modification pump (with cylinder outside the axle support), or post-modification (with cylinder inside the axle support) - (*) Post-modification pump (with cylinder outside the axle support).

SERVICE TOOLS

FRONT WHEEL DRIVE-FRONT AXLE : See 640DT, page 256.

POWER STEERING - See 640, page 256, removing supporting bracket 290367 for testing pumps A14XS - A18X - A10X.

MODELS

540-540 «Special»

See Appendix page 367 for:

- subsidiary reduction unit;
- models 540 DT – 540 DT "Special";
- power steering.

The following section deals with those parts differing from the ones of models 640 – 480.
The model 640 and 480 parts that are also valid for models 540 and 540 "Special" are indicated in the table of contents and in the text.

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(°) See 640, pages 89 and 93, disregarding data and torque values for the engine vibration damper.
(*) See 640, page 95 with the addition of tool A127031 securing the auto advance device.

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ENGINE

O – SPECIFICATIONS – REMOVAL – INSTALLATION

DESCRIPTION

See 640 considering that the engine installed on model 540 is a three cylinder unit.

SPECIFICATIONS

See 480 page 263 except for the following variations :

Engine type { FIAT 8035.02.302 with 10" FIAT clutch
FIAT 8035.02.304 with 11" LUK clutch (°)

Max. power speed .... 2600 r.p.m.

High idling .... 2800 r.p.m.

TEST RIG DATA

See table on page 358

IV – FUEL SYSTEM

SPECIFICATIONS

See 640 except for the following data :

Injection pump type .... CAV DPA 3233 F420-770535

Pump setting on engine : when cylinder no.1 is away from T.D.C. of .... 16° to 18°

Pump pressure outlet corresponding to cylinder no.1 . W mark

Pressure pipes from injection pump to injectors ..... 2x6x427 mm

(°) For models "Special"

CAV INJECTION PUMP

SINGLE PLUNGER INJECTION PUMP TYPE

CAV DPA 3233 F420 - 770535

TRACTOR MODEL 540

ENGINE TYPE FIAT { 8035.02.302
8035.02.304

INJECTORS: EPPZ 10F1-770577

Nozzle holder: KB70 S1F10-767107 ; nozzle: DLL 140S 64F-770578 ; holes diameter: 0.35 mm

holes number: 3 . Pressure setting: 225÷235 Kg/sq. cm (3200÷3340 p.s.i.)

Spring: WSF 2044/6X-656829 ; spring free lenght: 27÷27.5 mm

Fuel delivery lines: PRR 11F 15Z-768356

fuel delivery lines dimensions: 2x6x427 mm

ASSEMBLY DATA

Pump rotation: anticlockwise Injection order: 1-2-3 Distance between governor cover stud and metering valve pin: 54^{-1}_{+0} mm. Control spring mounting hole on control arm: upper

Control spring mounting hole on trottle lever link: metering valve pin side end.

Distance between cam ring rollers: 50.03(°)mm. Fixed injection advance before T.D.C. in cylinder 1 in compression 17° ± 1° . Timing mark on pump body at 268° from key seat (by tool A. 127027).

TEST SPECIFICATIONS

Test A: BOSCH test machine with injectors fitted with pressure springs WSF 2044/4X and nozzles EFEP 182.

RABOTTI test machine equipped with graduated ring injectors with springs FIAT 656829 and nozzles EFEP 182.
Injector pressure setting: 175 Kg/sq. cm (2489 p.s.i.).
Fuel lines: 2x6x865 mm.

Test B: Test machine equipped with nozzle holders and nozzles, same as those mounted on the engine.
Fuel lines: 2x6x700 mm.
Injectors pressure setting: 225÷235 Kg/sq. cm (3200÷3340 p.s.i.).

Test fluid: FIAT CFB at 30+5 °C (86+9 °F).

Feed pressure of test machine at pump inlet: 0,2 Kg/sq. cm (2.8 p.s.i.).

CALIBRATION DATA

Test N°	Throttle lever setting	Pump R.P.M.	Time to reach 406 mmHg vacuum at pump suction sec.	Transfer pump inside pressure Kg/sq.cm	Advance degrees	TEST A Single element output per 1000 strokes c.c.	TEST A Backleakage per 100 strokes c.c.	TEST B Single element output per 1000 strokes c.c.
1-2	–	100	⩽ 60	1.2÷1.8	–	–	–	–
3	–	800	–	–	3÷4	–	–	–
4	–	1300	–	–	5.8÷6.3	–	–	–
5	–	180	–	–	1.2÷1.5	–	–	–
6	–	300	–	–	0	–	–	–
7 (°)	–	900	–	–	5.8÷6.3	–	–	–
8-9-10 (1)	max ●	1300^{-20}_{+0}	–	5÷6	–	* 51÷54	⩾ 14	* 48.5÷51.5
11-12	max ●	800±5	–	3.8÷4.6	–	* 46.5÷49.5	–	* 52÷54
13	max ●	100	–	–	–	⩾ 44	–	–
14	max ■	200	–	–	–	⩽ 4	–	–
15 (1)	min ●	200	–	–	–	⩽ 5	–	–
16 (2)	max ●	1370	–	–	–	⩽ 9	–	–
17 (3)	max ●	1300^{-20}_{+0}	–	–	–	51÷54	–	–

Notes - Tests are to be carried out strictly in the order specified.
For 3 cylinders only, tests 1 to 5 are to be carried out with the tool 290760 replacing the manual advance cut-off device.
Other tests must be carried out with cut-off device installed.
Test 6 and 13 are to be carried out with the cut-off device actuated.
● Shut-off lever excluded. ■ Shut-off lever in stop position.
* Max. difference between individual deliveries: 4 c.c. per 1000 strokes.

(°) For 3 cylinders only.
(1) Throttle lever with stop screw backed out (To adjust maximum delivery, turn the regulating plates).
(2) Fuel cut-off. Calibrate delivery as required by means of the throttle stop screw.
(3) Final delivery check.

ENGINE BRAKE TEST DATA

Test specifications:

— engine installed on test bench without fan, air cleaner and exhaust muffler;
— atmospheric pressure 740 ± 5 mm of mercury;
— ambient temperature 20 ± 3 °C (68 ± 5 °F);
— relative humidity 70% ± 5;
— fuel specific weight 830 ± 10 gr/lt;
— temperature of fuel backleakage at pump outlet 54 ± 2 °C (129 ± 4 °F).

Throttle lever setting	Engine-speed R.P.M.	Power output of engine runned-in for a total of 2 hours HP	Power output of engine runned-in for a total of 50 hours HP	Fuel consumption time (100 c.c.) sec.
Max (under load)	2600	⩾ 48.5	⩾ 51	⩾ 31.5
Max (Max torque zone)	1600	⩾ 33	⩾ 35	⩾ 47.8
High idle.	⩽ 2800	–	–	–
Low idle	650	–	–	–

Notes.

POWER TRAIN AND ATTACHMENTS

O - DESCRIPTION - SPECIFICATIONS - LUBRICATION

DESCRIPTION

The power train consists of the following major units :

- 10" FIAT make dual-plate dry clutch with single control ;
- 11" LUK make dual-plate dry clutch with separate controls (models "Special");
- transmission with epicyclic gear reduction : with eight forward (four with synchromesh) and two reverse speeds ;
- main drive bevel gear and two gears differential with pedal controlled lock ;
- dry contracting band service brakes with mechanical control and independent pedals ;
- single-reduction final drives ;
- telescoping front axle centrally pivoted with reversed U shaped section ;
- steering, wheel controlled, of the worn and nut type.

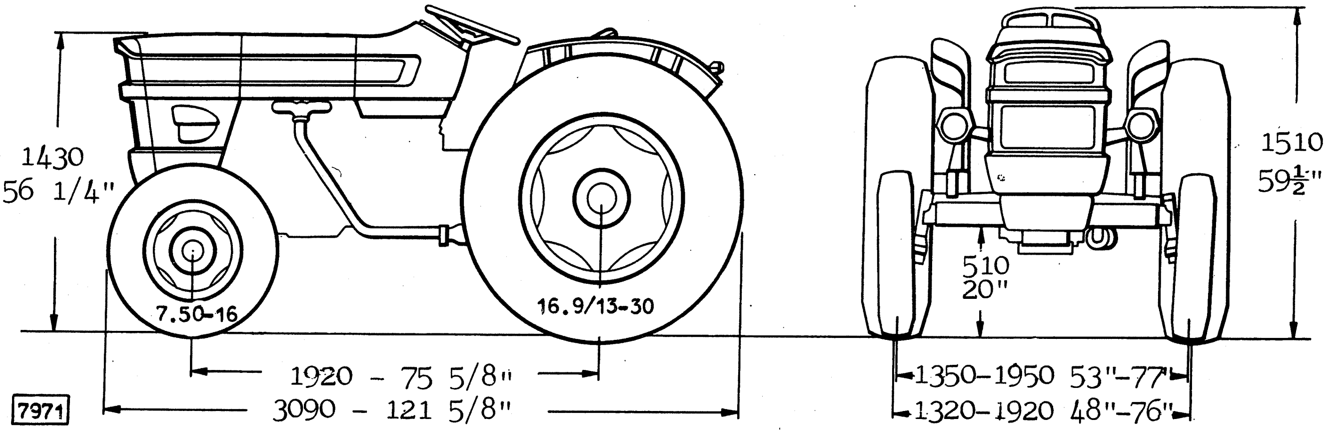
The Controlmatic hydraulic lift is of the position and draft control type. The P.T.O. and drive are incorporated in the transmission housing rear cover while the belt pulley is an optional.

TRANSMISSION RATIOS, PERFORMANCE AND WEIGHT

Speed gears	Transmission and epicyclic gear train speed reduction ratios 1 :	Overall speed reduction ratios from engine to drive wheels (1 wheel turn per engine revs) 1 :	Maximum speed (with engine running at 2600 r.p.m. and rear tyres 12.4/11-32) Km/h	MPH
1st Low	10.575	256.3	2.4	1.5
2nd "	7.029	170.3	3.7	2.3
3rd "	4.799	116.3	5.4	3.3
4th "	3.716	90.0	6.9	4.3
1st High	2.938	71.2	8.8	5.5
2nd "	1.952	47.3	13.2	8.3
3rd "	1.333	32.3	19.3	12.0
4th "	1.032	25.0	25.0	15.5
1st Creeper (x)	32.568	791.513	0.80	0.49
2nd " "	21.706	526.072	1.20	0.74
3rd " "	14.824	359.268	1.76	1.09
4th " "	11.476	278.143	2.27	1.40
Low Reverse	7.359	178.3	3.5	2.2
High Reverse	2.044	49.5	12.6	7.9
Creeper Reverse (x)	22.729	550.878	1.14	1.21

Bevel gear speed reduction ratio 10/43 .... 1 : 4.3
Final drive speed reduction ratio 11/62 .... 1 : 5.636
Total speed reduction ratio (final drives + bevel gear) .... 1 : 24.236
Tractor weight (with standard fitting, oil coolant and fuel, operator excluded) .... 1800 Kg (3968 lb)

(x) With subsidiary reduction unit, optional (see appendix).



Overall dimensions of the tractor models 540–540 "Special"

V – FINAL DRIVES AND REAR WHEELS

DESCRIPTION

The rear wheels, with rims and discs in stamped steel can be equipped with tyres 12.4/11-32; 12.4/11-36; 14.9/13-28; 14.9/13-30; 16.9/14-28.

By suitable arrangement of wheel rims and discs eight different tread adjustments (from 1220 to 1920 mm or 48" to 76") by step of 100 mm or 3.937 in can be obtained Keep in mind that the tread adjustment of 1220 mm or 48" cannot be obtained with tyres : 14.9/13-28; 14.9/13-30; 16.9/14-28.

FINAL DRIVES

DISASSEMBLY – See 640 except for the final drive bull gear stop listed with the tool no. 290812.

VII – HYDRAULIC LIFT UNIT

Specifications

See 640 except for the following variations :

- fluid capacity of transmission case with level reaching the upper dipstick dent .... 16 Kg (15 imp.gal)

FIAT (Plessey licence) gear type pump (clockwise rotation seen from drive end)...mod.C22X

- pump speed (with engine running at 2600 r.p.m.)...2365 r.p.m.
- corresponding output with an oil temperature of 50° to 60°C (122° to 140°F) and 150 Kg/cm² (2133 p.s.i.) 23.6 lit/min (5.18 G.P.M.)

Single-acting cylinder :

- bore and stroke .... 90x96 mm (3.54x3.78 in)
- capacity .... 610 c.c. (37.2 cu.in.)
- nominal lifting capacity..... 915 Kgm (6618 ft.lb)
- maximum liftable weight at implement mounting points with lift rods connected to lower links :
  - all shortened .... 1200 Kg (2645 lb)
  - all extended .... 930 Kg (2050 lb)

- implement mounting points range with lift rods connected to lower links :
  - all shortened .... 615 mm (24.21 in)
  - all extended .... 710 mm (27.95 in)

- lifting time with engine running at 2600 r.p.m. .... 1.85 sec.

Total weight of the hydraulic lift and linkage .... 104 Kg (229 lb)

VIII – POWER TAKE OFF – BELT PULLEY

BELT PULLEY

See 640 except for the following variations :

- shaft speed with the lever set in "engine"
  - engine running at 2160 r.p.m. .... 540 r.p.m.
  - engine running at max. power speed of 2600 r.p.m. .... 650 r.p.m.

Speed with the lever set in "Cambio" (transmission) with rear tyres 12.4/11-32 .... 3.78 revs per meter

BELT PULLEY

See 640 except for the following variations :

- speed (with engine running at the max.power speed of 2600 r.p.m.).... 1352 r.p.m.
- linear speed .... 17,7 m/sec (58.1 ft/sec)

IX – FITS AND TOLERANCES – TORQUE SPECIFICATIONS – SERVICE TOOLS

FITS AND TOLERANCES

I – 10" FIAT clutch : see 480, page 297.

I – 11" LUK clutch : see 640, page 173.

II – Transmission : see 640, page 173.

III – Bevel gear and differential : see 640, page 174.

IV – Brakes : see 640, page 175 except for the following data :
Lining width .... 50 mm (1.968 in)

V – Final drives : see 640, page 175.

VI – Steering and front wheels : see 640, page 175.

VII – Hydraulic lift unit: see 640, page 176 except for the following data :

Diameter of piston .... 89,980 to 90,000 mm (3.5422 to 3.5433 in)

I.D. of cylinder barrel	90.036 to 90.071 mm (3.5447 to 3.5461 in)
Running clearance of piston	0.036 to 0.091 mm (0.0014 to 0.0036 in)

VIII - Power take-off - Belt pulley : see 640, page 177.

TORQUE SPECIFICATIONS

I - 10" FIAT clutch : see 480, page 299.

I - 11" LUK clutch : see 640, page 178.

II - Transmission : see 640, page 178.

III - Bevel gear and differential : see 640, page 179

IV - Brakes : see 640, page 179.

V - Final drives and driving wheels : see 640, page 179 except for this torque value :

Capscrews, drive wheel discs .... M16x1.5; R100 Cdt ; 26.5 Kgm (191.6 ft.lb)

VI - Steering and front wheels : see 640, page 180.

VII - Hydraulic lift : see 640, page 180.

VIII - Power take-off - Belt pulley : see 640, page 181.

SERVICE TOOLS

I - 10" FIAT clutch : see 480, page 300.

I - 11" LUK clutch : see 640, page 182.

II - Transmission : see 640, page 182.

III - Bevel gear and differential : see 640, page 182.

V - Final drives and driving wheels : see 480, page 300.

VI - Steering and front wheels : see 640, page 182.

VII - Hydraulic lift : see 480, page 300.

VIII - Power take-off - Belt pulley : see 640, page 183.

APPENDIX

MODELS 540-540 "Special"
540 DT-540 DT "Special"

TRANSMISSION

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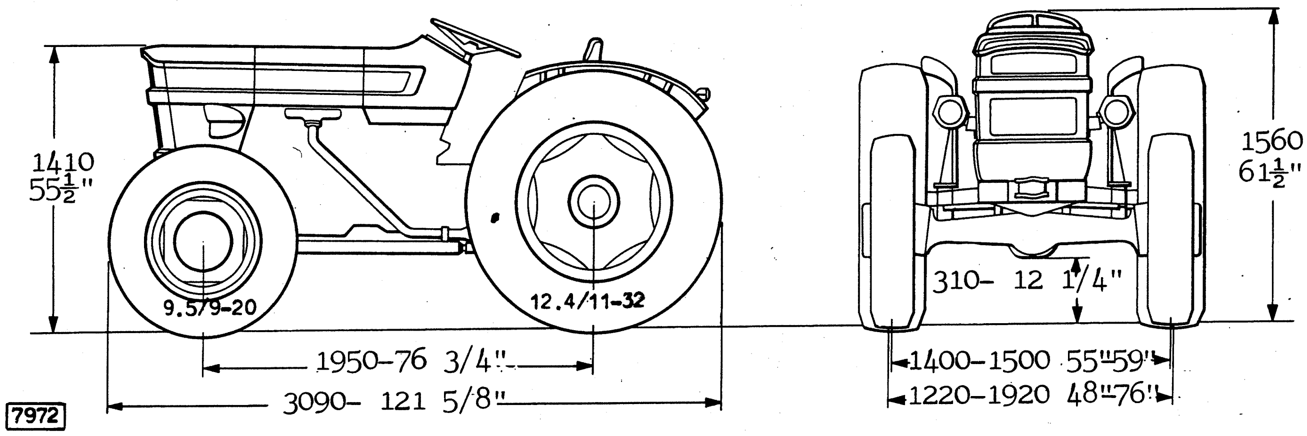
TRANSMISSION



Overall dimensions of the tractor models 540DT - 540DT "Special"

Tractor weight .... Kg 2050 (4520 lb)

FRONT WHEEL DRIVE - MODEL 540DT - 540DT "Special"

The overhaul and adjustments of the front wheel drive, of the propeller shaft and of the transfer gear box can be carried out as indicated for model 640 DT (from page 224 and 234).

DRIVING WHEELS

The driving wheels, front and rear can be equipped with the tyres indicated in the following table. It is indispensable to mate the tyres as indicated, to avoid slippages and wear.

Front		Rear
9.5/9-20	with	12.4/11-32
9.5/9-20	with	14.9/13-28
8.3/8-24	with	14.9/13-30

At the rear eight different threads adjustments (from 1220 to 1920 mm or 48" to 76" by steps of 100 mm or 3.937 in) can be obtained. The thread adjustmento of 1220 mm or 48" cannot be obtained with tyres 14.9/13-28 and 14.9/13-30. Keep in mind that it is advisable to keep the thread values as near as possible to those of the front steering-driving wheels.

At the front, by turning the wheels, it is possible to obtain two thread adjustments : 1400 mm and 1500 mm (55" to 59").

POWER STEERING

The power steering is supplied as an optional and can be of the external cylinder type or with the cylinder installed in the front axle bracket (for the DT models only the second type is available).

POWER STEERING WITH CYLINDER INCORPORATED IN THE FRONT AXLE BRACKET

See model 640 except for the following chapter.

Overhauling the pump and reservoir.

Proceed as indicated on page 240considering that only part of the pump data are differing as can be seen from table on page 370.

POWER STEERING WITH EXTERNAL CYLINDER

See model 640 except for the following chapters.

Overhauling the pump and reservoir

Proceed as indicated on page 240, considering that only part of the pump data are differing as can be seen from the following table.

Instructions for installing the power assist cylinder on tractor

Install the power assist cylinder (C, Fig.9, page 243) complete with end (5) and control rod (D) and adjust the total length (L_1) at 1050 mm (41.3386 in) acting on the threaded end (5).

ASSEMBLY DATA

SUBSIDIARY SPEED REDUCTION UNIT - See 640, page 246.	
FRONT WHEEL DRIVE - See 640DT, pages 246,247,248,249 and 250 except for the reduction ratio between bevel pinion shaft and transfer gear box output shaft	$\frac{25}{26} \times \frac{22}{37} = \frac{1}{1.749}$ (1) $\frac{25}{27} \times \frac{23}{36} = \frac{1}{1.690}$ (2)
POWER STEERING - See 640, pages 250,251,252 and 253 except for the following values relevant to the hydraulic pump:	
- pump model	A14XS (°) A18X (°°) A10X (*)
- rotation (driving shaft side)	anticlockwise
- max.pump speed (with engine running at 2600 r.p.m.).	2365 r.p.m.
- nominal output at max.speed	15 lit/min (°) (3.3 G.P.M.) 19.5 lit/min (°°) (4.3 G.P.M.) 10.8 lit/min (*) (2.4 G.P.M.)
- test bench output at 1445 r.p.m. and with 95 to 100 kg/cm^2 (1,351 to 1,422 p.s.i.) pressure:	
for new or overhauled, not below	8.5 lit/min (°) (1.8 G.P.M.) 11 lit/min (°°) (2.4 G.P.M.) 6.2 lit/min (*) (1.4 G.P.M.)
for used pump, not below	6.1 lit/min (°) (1.3 G.P.M.) 7.9 lit/min (°°) (1.7 G.P.M.) 4.5 lit/min (*) (1 G.P.M.)
- drive and driven gear widths	10.500 to 10.515 mm (0.4134 to 0.4139 in) (°) 13.190 to 13.215 mm (0.5193 to 0.5203 in) (°°) 7.322 to 7.348 mm (0.2882 to 0.2892 in) (*)

(°) Pre-modification pump - (°°) Pre-modification pump (with cylinder outside the axle support), or post-modification (with cylinder inside the axle support) - (*) Post-modification pump (with cylinder outside the axle support).

(1) Pre-modification (2) Post-modification

SERVICE TOOLS

FRONT WHEEL DRIVE-FRONT AXLE : See 640 DT, page 256.

POWER STEERING : See 640, page 256, removing supporting bracket 290367 for testing pumps A14XS -A18X - A10X.

TRACTORS PRODUCTION 1977

On tractors 480 - 500 Special - 540 Special of 1977 production, it is foreseen the installation of only one type of engine equipped with a CAV or BOSCH injection pump.
For the CAV injection pump calibration data and engine test data, refer to informations reported at pages 358 - 359.
The data concerning the engines equipped with BOSCH injection pump are reported in the tables below.

BOSCH FUEL INJECTION SYSTEM: EP/VA3/110H 1300 CL:134-8 - 770798

ENGINE : FIAT 8035.02.202

ENGINE PERFORMANCE TEST

Test specifications:

Engine on bench with fan, air cleaner and exhaust silencer removed.

Barometric pressure 740 ± 5 mm Hg at 239 metres (785 ft) above sea level.

Fuel density, 830 ± 10 g/litre.

Ambient temperature, 20° ± 3 °C.

Relative humidity, 70 % ± 5 %.

Throttle	Engine rpm	Metric HP		Time to burn 100 cm3 of fuel (seconds)
		2-hour run-in	50-hour run-in	
Maximum, full load	2,600	48 min (°)	51 min	32.4 min
Maximum, full torque	1,400	28 min (°)	31 min	53.8 min
Maximum, no-load	2,960 max	—	—	—
Minimum, no-load	650 to 700	—	—	—

(°) Anticipated

ASSEMBLY DATA

Direction of rotation (drive end)	Anti-clockwise
Firing order	1-3-4-2
Rotor stroke to spill cut-off	.7 ± .02 mm (.028 ± .0008 in)
Pump timing	10° ± 1° B.T.D.C.
Pre-loaded shuttle spring length	24.6 mm (.9685 in)
Delivery connection to cylinder No. 1	Marked with letter A

TEST PLAN

Procedure A

BOSCH test machine with WSF 2044/4X injector springs and EFEP 182 spray nozzles

RABOTTI test machine with FIAT 656829 injector springs and EFEP 182 spray nozzles

Release pressure	150 kg/cm² (2,133 psi)
Pipes	2 x 6 x 840 mm

Procedure B

Test machine with injector bodies and nozzles as fitted to engine

Release pressure	225 to 235 kg/cm² (3,200 to 3,343 psi)
Pipes	1.5 x 6 x 700 mm
Calibration fluid	FIAT CFB at 40° to 45 °C (for lower test temperatures add .25 cm³/1,000 shots to each degree)
Fuel pressure	.2 kg/cm² (2.8 psi)

CALIBRATION DATA

Test No.	Lever position L_1 = Shuttle L_2 = Throttle	Speed rpm	Transfer pressure kg/cm²	Advance piston stroke (*) mm	PROCEDURE A		PROCEDURE B	
					Injector delivery cm³/1,000 shots	Back leakage cm³/100 shots	Injector delivery cm³/1,000 shots	Back leakage cm³/100 shots
1	L_1 = Shut-off L_2 = Full	700 ± 5	—	—	0	—	0	—
2	L_1-L_2 = Full	700 ± 5	—	—	58 to 60	—	51 to 53	—
3	L_1-L_2 = Full	1,370	—	—	32 to 40	—	25 to 33	—
4		100	.6 to 1.1	—	—	—	—	—
5	+	700 ± 5	4.5 to 5	—	—	—	—	—
6		1,300	6.7 to 7.2	—	—	—	—	—
7	L_1-L_2 = Full	250	—	—	57 max	—	54 max	—
8	L_1-L_2 = Full	100	—	—	130 min	—	130 min	—
9		250 to 400	—	0 (start)	—	—	—	—
10	—	700 ± 5	—	3.5 to 4.5	—	—	—	—
11		1,050 to 1,100	—	6.8 (end)	—	—	—	—
12	L_1 = Full	1,450 to 1,500	—	—	0	—	0	—
13	L_2 = Full (1)	1,370	—	—	32 to 40	—	25 to 33	—
14		1,300 $^{+0}_{-20}$	—	—	53 to 55 (•)	—	49 to 51 (•)	—
15	L_1 = Full (2)	1,000	—	—	—	30 to 55	—	30 to 55
16	L_2 = Full	700 ± 5	—	—	58 to 60	—	51 to 53	—
17		500 ± 5	—	—	55 to 57	60 to 90	51 to 53	60 to 90
18	L_1 = Full	400 to 500	—	—	0	—	0	—
19	L_2 = Idle (3)	350	—	—	12 to 22	—	10 to 18	—

(*) Using tool **292817**
(•) Max. spread 2.5 cm³/1,000 shots
(1) Adjust max. speed screw
(2) Adjust max. fuel screw
(3) Adjust idling speed screw