

**CAV**

**Workshop Manual**

**DPA  
FUEL INJECTION PUMP**

2124

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# DPA MECHANICALLY GOVERNED PUMPS

## INTRODUCTION

The DPA distributor type fuel injection pump, incorporating a sensitive all-speed governor, is a compact, self-contained unit for high speed multi-cylinder diesel engines of up to 2 litres (122 in<sup>3</sup>) capacity per cylinder.

It is a relatively simple design, and incorporates no ball or roller bearings, gears or highly stressed springs. The number of working parts remains the same irrespective of the number of engine cylinders the pump is required to serve.

## DESCRIPTION AND OPERATION

### GENERAL

The pump is flange mounted to the engine. It is oiltight, and during operation all moving parts are lubricated by fuel oil under pressure, so that no additional lubrication system is required. Pressure maintained within the pump housing prevents the ingress of dust, water and other foreign matter.

Fuel injection is effected by a single element having twin opposed plungers located within a transverse bore in a central rotating member which acts as a distributor and revolves in a stationary member known as the hydraulic head. The pump plungers are actuated by lobes on an internal cam ring. Fuel is accurately metered to the pumping element, and the high pressure charges are distributed to the engine cylinders at the required timing intervals through ports in the rotor and the hydraulic head.

The integral governor is of the mechanical fly-weight type, and gives accurate control of engine speed under all load conditions. Most pumps have an automatic device which varies the point of commencement of injection.

The single pumping element ensures uniform delivery of fuel to each engine cylinder, and eliminates having to balance the deliveries from each of the high-pressure delivery pipes.

### WORKING PRINCIPLE

The internal cam ring, mounted in the pump housing, normally has as many lobes as there are engine cylinders and operates the opposed pump plungers through cam rollers carried in shoes sliding in the rotor body. The plungers are forced inwards simultaneously as the rollers contact the diametrically opposed cam lobes. This is the injection stroke. The plungers are returned by pressure of the inflowing fuel and this forms the charging stroke.

The pump rotor is driven by the engine through a splined shaft, keyed shaft or other drive to suit the engine manufacturer's requirements. Pumps may be mounted horizontally, vertically or at any convenient angle.

The accurate spacing of cam lobes and delivery ports ensures the exact equality of the timing interval between injections,

and components which affect timing are designed with one assembly position only to ensure precision.

Fuel entering the pump through the main inlet connection is pressurised by a sliding vane transfer pump carried on the rotor inside the hydraulic head. The pressure rise is controlled by a regulating valve assembly located in the pump end plate. The fuel then flows through the passages to the pumping elements.

The outward travel of the opposed pumping plungers is determined by the quantity of fuel metered, which varies in accordance with the setting of the metering valve. In consequence, the rollers which operate the plungers do not follow the contour of the internal cam ring but contact the cam lobes at points which vary according to the degree of plunger displacement.

The maximum amount of fuel delivered can be regulated either by limiting the outward travel of the plungers or by limiting the stroke of a shuttle valve according to pump type.

As the rotor turns, the inlet port is cut off and the single distributor port in the rotor registers with an outlet port in the hydraulic head. At the same time the plungers are forced inwards by the rollers contacting the cam lobes, and fuel under injection pressure passes up the central bore of the rotor through the aligned ports to one of the injectors. The rotor normally has as many inlet ports as the engine has cylinders, and a similar number of outlet ports in the hydraulic head.

The cam lobes are contoured to provide relief of pressure in the injector lines at the end of the injection cycle; this gives a sharp cut-off of fuel and prevents 'dribble' at the nozzles.

The governor flyweight assembly is mounted on the drive shaft and is contained entirely within the pump body. Linkage transmits the movement of the governor flyweights to the control lever on the metering valve. The governor control mechanism is enclosed in a housing mounted on the pump body.

## OVERHAUL

### SERVICE PROBLEMS

In all communications with a CAV Agent or Depot, quote the Despatch Number of the item of equipment. Every Agent and Depot has full information on current Service Modifications, and will advise on genuine CAV spare parts for pumps and equipment serviced by an operator.

If a DPA pump is damaged, faulty (even when the fault has been temporarily cured), or if routine attention does not remedy malfunctioning, contact the Agent or Depot without delay.

### MAINTENANCE RECORDS

Where DPA pumps are serviced in an operator's workshops, accurate documentation saves much time, and fuel system 'history' cards are most useful. Separate record cards can be kept for different types of pumps, and details of service

bulletins, issued to all CAV Agents, should be noted for reference. Maintenance schedules are invaluable when related to the specific service conditions under which the pump operates. Experience will dictate any variation of the recommended service intervals, and reference to the information available in the schedule assists in keeping pumps in a fully operational condition.

## GENERAL

The instructions in this manual cover the dismantling of typical DPA pumps. Except in the case of a complete overhaul, full dismantling is not always necessary. When a pump requires attention, the recommended practice is to set it up on a test machine and check to locate specific faults or maladjustments. Repairs or adjustments can then be undertaken on the basis of the test results.

Dismantling, assembly, testing and adjustment of the DPA pump must be carried out by trained personnel, using specialised tools and test apparatus. The service tools listed in this publication must be used to obtain the closest possible approach to factory standards.

Conditions of scrupulous cleanliness must be observed in workshops where pump overhaul is carried out. The following equipment must be available in the workshop when fuel injection equipment is to be serviced:—

- 1 A bench covered with sheet metal or linoleum, which should preferably be kept for injection equipment only.
- 2 A divided storage tray.
- 3 A vice with soft metal or fibre jaws.
- 4 A tank containing clean test oil for large components and a small bath with a lid, containing clean test oil which should be kept only for pump plungers and small components.
- 5 A complete kit of special tools, see Special Tools, Page 42
- 6 Non-fluffy cloths must be used for drying the hands. Under no circumstance use cotton waste.

## TYPEPLATE

The number stamped on the typeplate attached to the pump housing identifies the type and model of the pump. Pumps that are of identical build, but with modified settings for different applications are further identified by the setting code stamped beneath the ordering number.

Should the typeplate be obscured by paint, care must be taken to ensure that the type details are not defaced when removing the paint.

## OVERHAUL PROCEDURE

When fitting new component parts or assemblies, always ensure that the Part Number is correct for the pump type. Part Numbers can be checked in the Spares List, Publication No 3157.

If any part in a mated assembly is damaged or worn, the complete assembly must be rejected. Any component showing signs of fretting, wear, damage, corrosion, cracks or distortion must be discarded.

All 'O' seals, gaskets, tab washers, locking and sealing devices must be discarded and new ones fitted. Gasket kits, as designated in the Spares List, contain all necessary seals, gaskets and washers for most types of pump. In a few cases, additional separate items are also required.

Drive shaft seals are used in various combinations according to pump type and application. They may be used singly or in pairs. The lips of the seals may face inwards or outwards and in paired applications they may face together or away from each other. It is essential when the seal or seals are removed that note is taken of the quantity, and how they were fitted, so that replacement seals will be correctly positioned for that particular pump.

When investigating damage for which there is no obvious explanation, check that all related components are genuine approved parts of the correct Part Number.

## COMPONENT INSPECTION

It will be found convenient and time-saving to note location of and inspect individual parts during dismantling, so that replacements can be obtained with the minimum of delay.

The following information lists possible defects and indicates the main items that may require replacement. The inspection requirements listed are the minimum advisable:

- 1 Check for damage to internal and external threads, especially on the transfer and distributor rotor, hydraulic head, studs, inlet and outlet connections, and connections and screws liable to be removed or torque loaded while the pump is on the engine.
  - 2 Look for distorted or fractured springs. Check that all springs quoted in the Parts List for the particular pump are present. In case of fouling or malfunctioning, ensure the correct springs are fitted.
  - 3 Check any scoring, wear, corrosion or any other damage to machined surfaces, including the pump body, hydraulic head bore, cam ring, end plate, advance device location, and end plate locating face.
  - 4 When fitting new 'O' rings and oil seals care must be taken to use protection caps, etc to avoid damage. Inspection of seals after assembly is recommended. Internal seals should be dipped in clean test oil prior to being assembled; external seals should be lightly coated with grease.
  - 5 Inspect for wear and damage to drive shafts, splines and associated parts; this is especially important on drive plates and quill shafts. Check the drive shaft end float if the face of the thrust housing is worn.
- On up-rated pumps, the complete drive shaft assembly must be discarded if any part is defective. The assembly consists of drive shaft, governor weight carrier, cush drive and mated drive plate.
- Note:** On many types of pump the drive shaft and drive plate are lapped together during manufacture to give a free fit with a controlled backlash. These parts should be kept together and in the event of wear, the complete assembly must be renewed.
- 6 Inspect for wear and scoring of all mechanical governor linkages, shafts, pivot points, arms and weights. Ensure the

correct number and type of governor weights are fitted.

7 Inspect for nicked, scratched, worn, corroded or otherwise damaged pump plungers and their mated bores.

**Note:** *Great care must be taken with pump plungers and bores.* Plungers must only be removed from the bore if there is a need to inspect them and then only for the short time required for inspection. Ensure that each plunger is correctly replaced in the end of the bore from which it came. Plungers and the bores must be cleaned with clean test oil and assembled wet. The plungers should be retained in the bore of the rotor by corks.

The rotor must be assembled to the hydraulic head and the complete assembly immersed in a covered bath of clean test oil until required for assembly.

8 Examine the transfer pump for chipped, broken or worn transfer pump blades. Blades may be either carbon or resin-bonded material. They are identified by the fact that resin-bonded blades have a groove in the base of the central slot; carbon blades have no groove. The blades are not interchangeable, and replacement blades **MUST** be of the same type.

9 Inspect for damage to rollers and shoes. Examine roller

surfaces and check for free rotation in shoes. Roller and shoe assemblies must be kept together.

10 Check for valve wear or scoring. Pay special attention to the metering valve and its bore. Examine the metering valve for looseness of its pin resulting from severe service conditions. Check the regulating valve, the excess fuel valve, external maximum fuel adjuster, and proportional and non proportional pressurising valves, if fitted.

**Note:** A small number of DPA pumps are fitted with hydraulic heads having an oversize metering valve bore and an oversize metering valve to suit. Pumps fitted with an oversize metering valve have the number 6,375 etched on the hydraulic head between the outlet connections adjacent to the metering valve bore. Spare Parts List No 3145-8 gives the metering valve part number under each individual pump.

11 Check for defects in the outlet pressurising valve. Shake the assembly and listen for movement of ball or valve, this denotes a collapsed spring.

12 Inspect for wear in the throttle and shut-off shafts, throttle and shut-off arms, throttle and shut-off levers and advance device components.

## PUMP WITH QUILL SHAFT & HUB CUSH DRIVE

### DISMANTLING

Turn the pump on its side, inspection cover plate upwards. Remove cover plate securing screws and shakeproof washers. Detach cover plate and discard cover plate gasket. Drain pump oil into suitable receptacle.

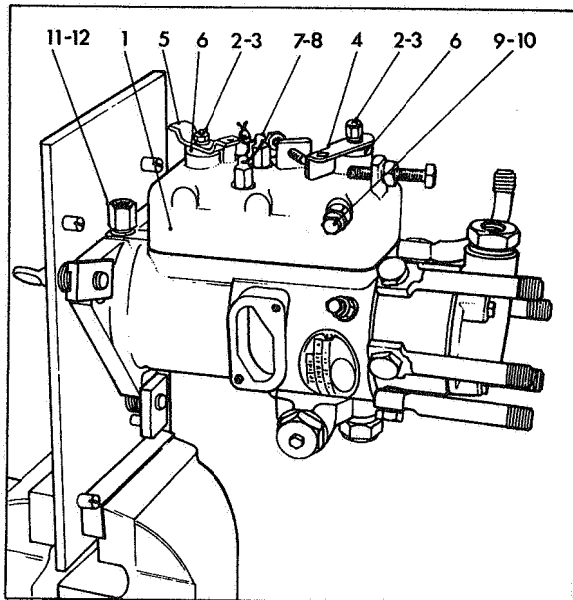


Fig 1 Pump & mounting fixture

Secure Fixture Part No 7044-888F in vice. Secure the pump to the fixture with governor control cover (1) uppermost as shown in Fig 1.

Unscrew and remove throttle arm and shut-off lever securing nuts and washers (2 & 3). Detach throttle arm (4), shut-off lever (5) and dust caps (6). Remove lead seals and locking wire and unscrew and remove cover stud nuts and washers (7 & 8).

Unscrew and remove cover vent screw assembly and washer (9 & 10). Unscrew and remove drain connection and washer (11 & 12).

Fit Protection Cap Part No 7144-459A to throttle shaft. Lift off the governor control cover and at the same time lightly press down on the top of the throttle shaft protection cap. The throttle shaft must be pressed through the cover and remain with the pump and connected to the governor spring. Transfer the Protection Cap Part No 7144-459A to shut-off shaft and press the shaft out of the governor control cover. Remove and discard all shaft seals and the governor control cover gasket.

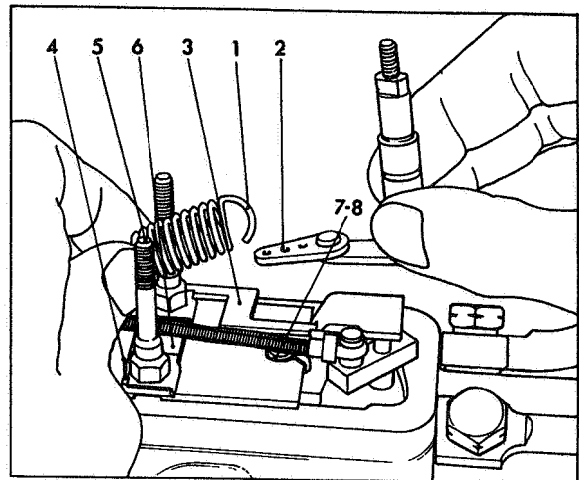


Fig 2 Dismantling throttle link

Unhook and remove governor spring (1) Fig 2 from idling spring guide and throttle shaft link (2). Remove idling spring and idling spring guide. Remove shut-off bar (3). Press down tabs on tab washers (4). Remove control cover studs (5), tab washers, keep plate (6), bracket screw and washer (7 & 8).

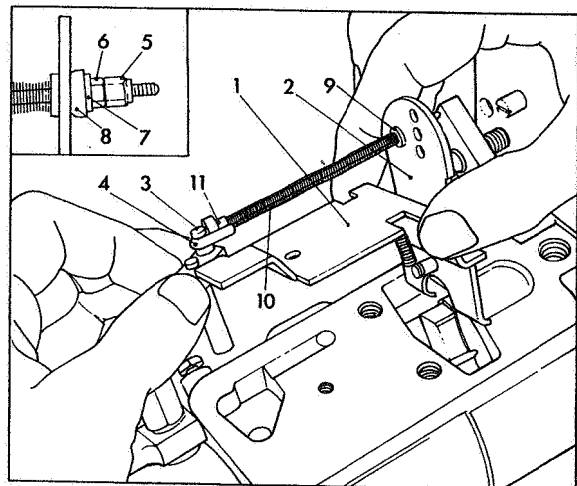


Fig 3 Removing governor linkage assembly

As shown in Fig 3 lift off as an assembly, control bracket (1) complete with governor arm (2), metering valve (3) and linkage hook assembly.

Detach metering valve from linkage hook (4) and immerse in clean test oil. Dismantle governor spring linkage in the following sequence:— linkage locking nut (5), linkage nut (6), pivot ball washer (7), linkage pivot ball (8), linkage spring washer (9), long linkage spring (10) and spring retainer (11) from the linkage hook.

## TWO STAGE AUTOMATIC START RETARD DEVICE

Invert fixture in vice as shown in Fig 4. Remove piston plug (1), piston plug seal (2), piston spring cap (3), seal (4), shim washers (5) and outer piston spring (6).

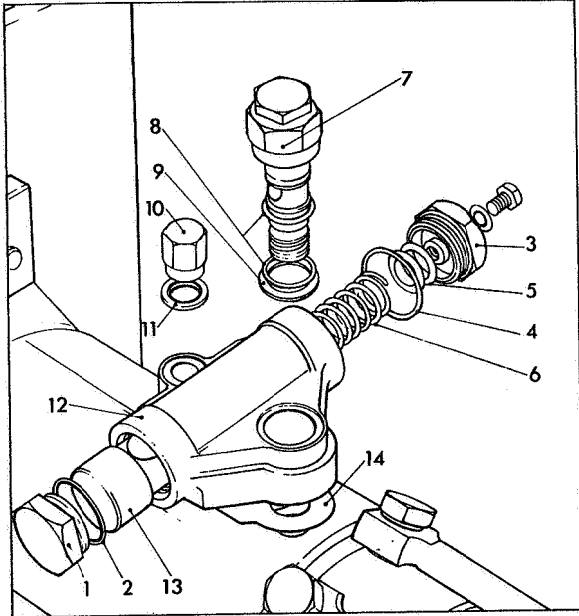


Fig 4 Dismantling auto advance device

Loosen and remove assembled head locating screw (7), stud seals (8) and 'Dowty' washer (9). Loosen and remove cap nut (10) and washer (11). Gently ease auto-advance housing (12) with piston (13) from pump housing. Remove piston for inspection. If condition is satisfactory re-assemble piston to auto-advance housing. Remove and discard housing gasket (14).

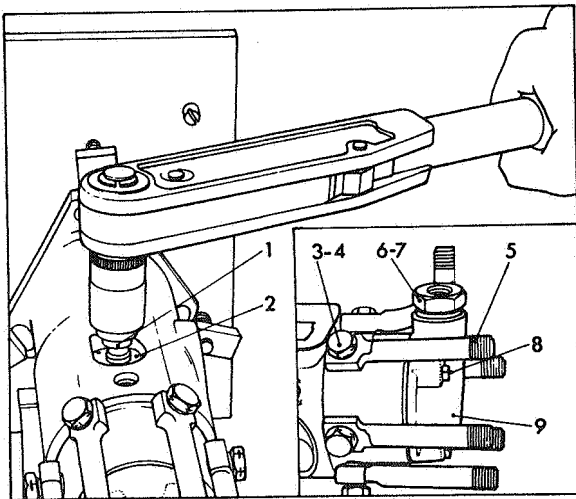


Fig 5 Loosening cam advance screw

Using Tool Part No 7144-14 as shown in Fig 5, slacken cam advance screw (1). If necessary, lightly tap cam advance screw to release cam ring (2). Invert the fixture in vice. Remove fuel connection studs and washers (3 & 4) and banjo connections (5) noting their position and type, also the letter identification against the outlet holes.

Remove end plate inlet connection and washer (6 & 7). Unscrew the end plate securing screws (8) and carefully withdraw end plate (9).

Remove from the end plate the retaining sleeve spring, filter, transfer pressure adjuster assembly, spring peg, regulating sleeve, regulating spring, regulating piston and piston retaining spring. Remove sleeve washer from regulating sleeve and discard washer.

Remove transfer pump blades and note the position of the slot in the transfer pump liner, ie, 3 o'clock or 9 o'clock when viewed from the transfer rotor end, then remove the transfer pump liner and transfer pump seal.

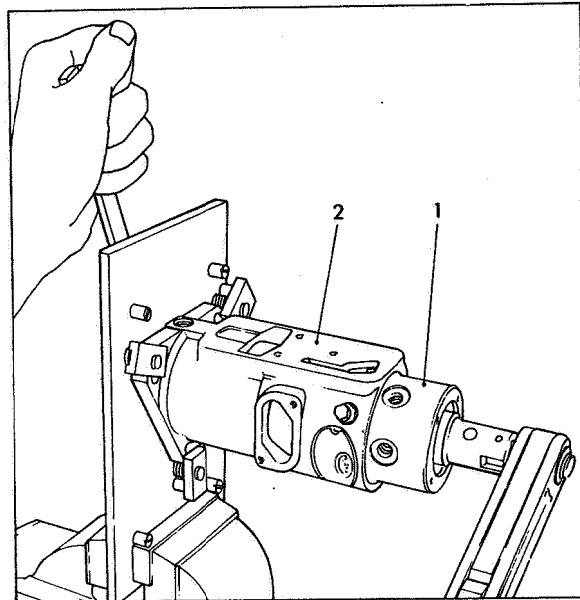
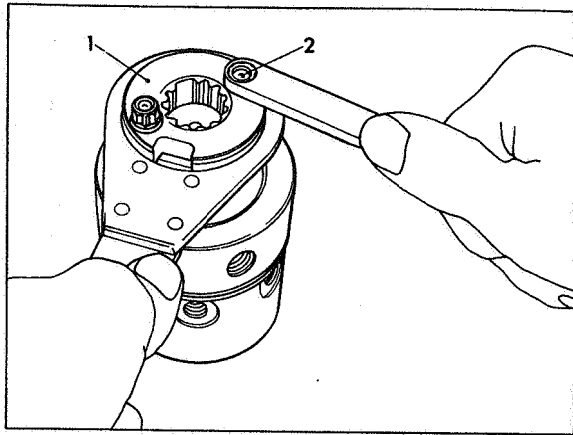


Fig 6 Loosening transfer pump rotor

Hold drive hub with Tool Part No 7144-773 and slacken transfer pump rotor with Tool Part No 7044-889 as shown in Fig 6. The direction in which the transfer pump rotor is slackened is indicated by an arrow marked on the face of the rotor.

Unmarked rotors are slackened in direction of pump rotation given in the Test Data for the pump. Remove tools, and then finger tighten transfer pump rotor.

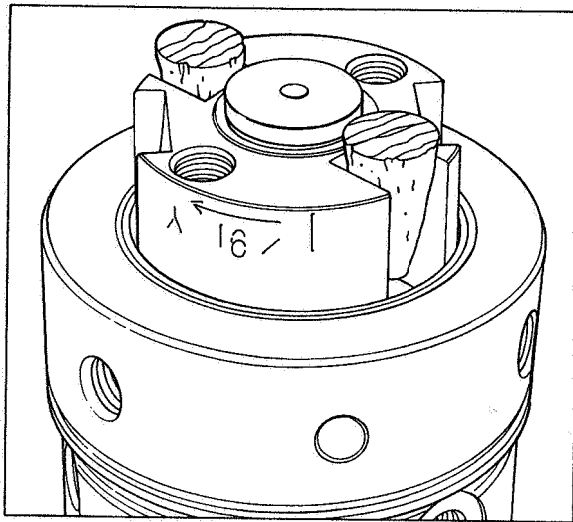
Note location of head locking screw and vent screw assembly, then unscrew and remove the head locking screw and its washer; and the vent screw assembly and washer. Withdraw head and rotor assembly (1) with a slight twisting motion in each direction from the pump housing (2). Remove and discard distributor head seal.



**Fig 7 Loosening drive plate screws**

Place the head and rotor assembly on the bench. As illustrated in Fig 7 hold drive plate (1) with Tool Part No 7144-744 and loosen drive plate screws (2) with Tool Part No 7144-511A.

Unscrew and remove transfer pump rotor. Position head on bench with drive plate uppermost. Remove drive plate screws, drive plate, top adjusting plate, cam shoes and roller assemblies. Immerse cam shoes and roller assemblies in clean test oil.



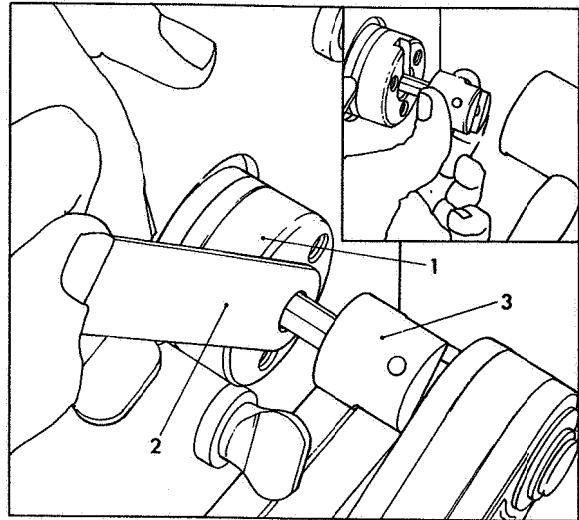
**Fig 8 Plunger retaining corks**

Fit corks into transverse rotor slots to retain plungers as shown in Fig 8. Remove distributor and detach bottom adjusting plate.

Insert distributor rotor into head to ensure protection of the bearing surfaces. Secure rotor in position with transfer pump rotor finger tightened.

Unscrew and remove cam advance screw. Note direction of arrow on cam ring then withdraw cam ring. Note positions of 'ears' on circlip and extract circlip using circlip pliers.

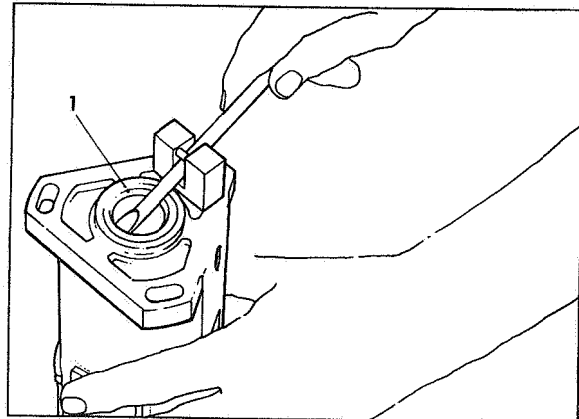
Reverse fixture endways in vice as shown in Fig 9. Hold drive hub (1) with Tool Part No 7144-773 (2) and using Tool Part No 7144-261 (3), loosen the drive shaft screw a couple of turns.



**Fig 9 Loosening drive shaft screw**

Gently tap the end of the tool holding the screw to ease drive shaft through seals as shown in inset, then unscrew and remove screw. Remove drive shaft screw spring washer. The support washer can be left inside the drive hub.

Reverse fixture endways in vice and withdraw drive shaft governor weight assembly. Stand drive shaft vertically with drive shaft seal uppermost. Remove drive shaft seal from annular groove. Lift weight assembly until the cush drive back plate is level with the annular groove. Holding the back plate still, turn the weight assembly until the three rivet heads can be lifted past the three notches in the back plate. Now lower the weight assembly. Turn the back plate until the internal lip is in line with the gap in the shaft splines, and lift off. Remove cush drive retainer, governor weights, thrust washer and thrust sleeve. Remove cush drive splined hub from cush drive retainer. Remove cush drive rubber inserts.



**Fig 10 Removing drive hub seal**

Withdraw drive hub from housing. Remove pump from fixture. Carefully note the way the drive hub seals are inserted then extract and discard drive hub seal (1) as shown in Fig 10 using Tool Part No 7044-893. Remove housing circlip with circlip pliers. Extract and discard second drive hub seal, again using Tool Part No 7044-893.

## ASSEMBLY

Immerse the two new replacement drive hub seals in clean test oil. The drive hub seals must be inserted in the same position noted prior to dismantling. Using Tool Part No 7244-154 in the manner shown in Fig 11, fit the inner drive hub seal. Next, assemble the housing circlip with its open end adjacent to tell-tale holes where provided and then fit outer drive hub seal, again using Tool Part No 7244-154.

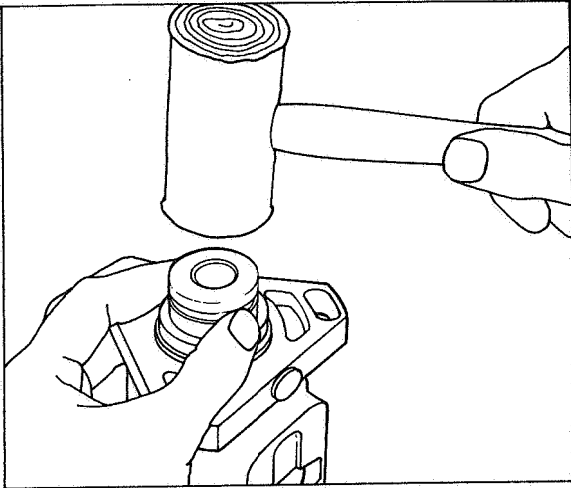


Fig 11 Fitting drive hub seal

Secure Fixture Part No 7044-888F in vice with thumbscrews towards vice handle. Secure the pump to the fixture with pump governor control machined face upwards. Moisten drive hub seals with clean test oil then insert drive hub through fixture into pump housing.

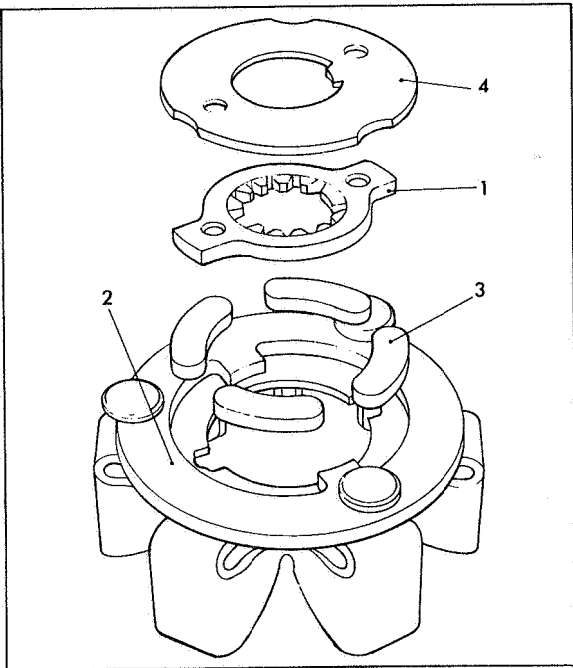


Fig 12 Assembling weights retainer

Assemble cush drive splined hub (1) Fig 12 small diameter end downwards, into cush drive retainer (2) and align holes with cut-outs in retainer. Assemble cush drive rubber inserts (3). Position cush drive back plate (4) so that the three notches slide over the three rivet heads, then rotate plate until the internal lip aligns with the lip on the cush drive splined hub.

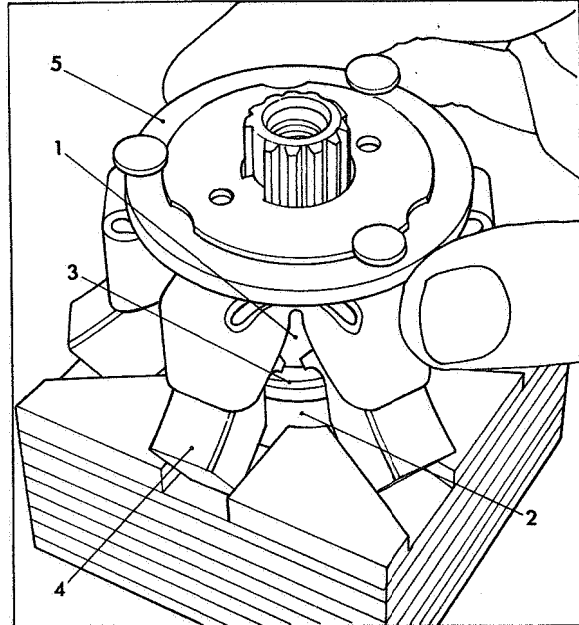


Fig 13 Assembling governor weight components

Place drive shaft (1) Fig 13 into fixture 7144-894, seal groove uppermost. Assemble thrust sleeve (2) stepped end downwards, then thrust washer (3). Offer up a governor weight (4) and adjust the height of the fixture until the lip of the governor weight sits on the thrust washer. Place remaining governor weights in a similar position around the drive shaft. Align drive shaft with cush drive hub splines and slide cush drive retainer assembly (5) onto weights. Using Protection Cap Part No 7144-900 assemble drive shaft seal. Take off protection cap and remove complete assembly from the fixture.

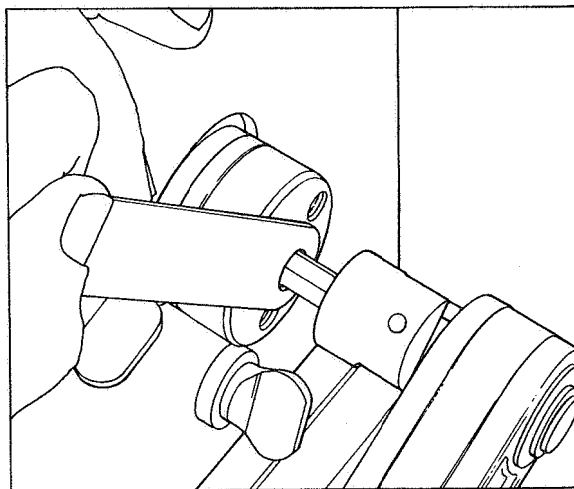
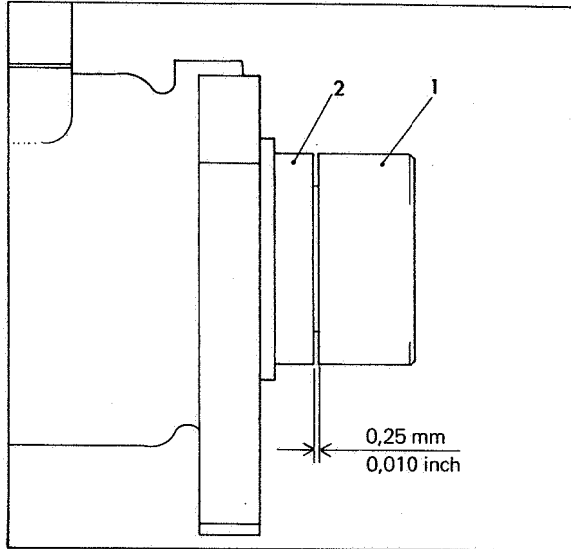


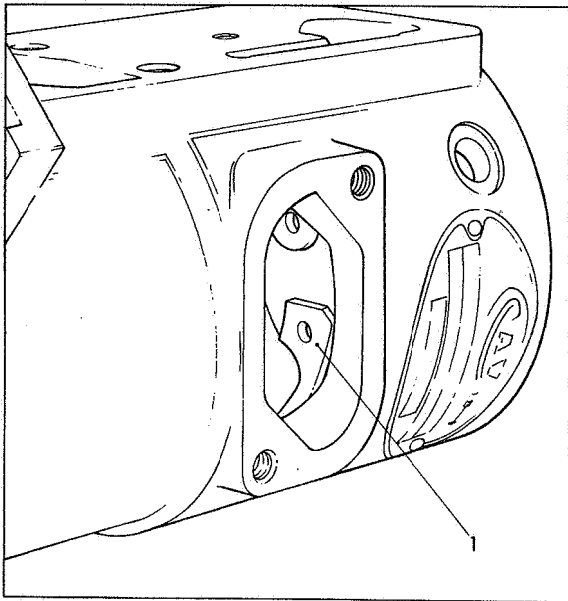
Fig 14 Tightening drive shaft screw

Insert drive shaft and weight assembly into hub, weight retainer end first. Secure assembly in place with support washer, spring washer and drive shaft screw. Tighten screw to correct torque value using Tool Part No 7144-261 while holding drive hub with Tool Part No 7144-773 as shown in Fig 14.



**Fig 15** Checking drive shaft end float

Check the drive shaft end float. This should not exceed 0,25 mm (0,010 in) measured between the rear face of the hub and the pump body as indicated in Fig 15. If this dimension is exceeded, the weight retainer or pump body must be renewed and the end float re-checked.

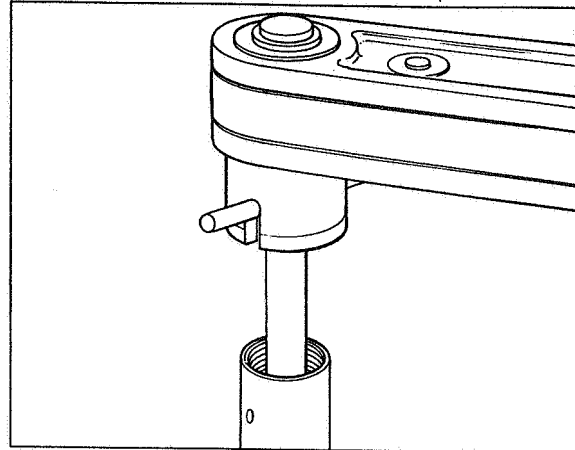


**Fig 16** Positioning circlip

Insert circlip (1) Fig 16 against the shoulder in pump housing bore, positioning the square ear of the circlip centrally in the housing inspection aperture as shown. Insert cam ring against

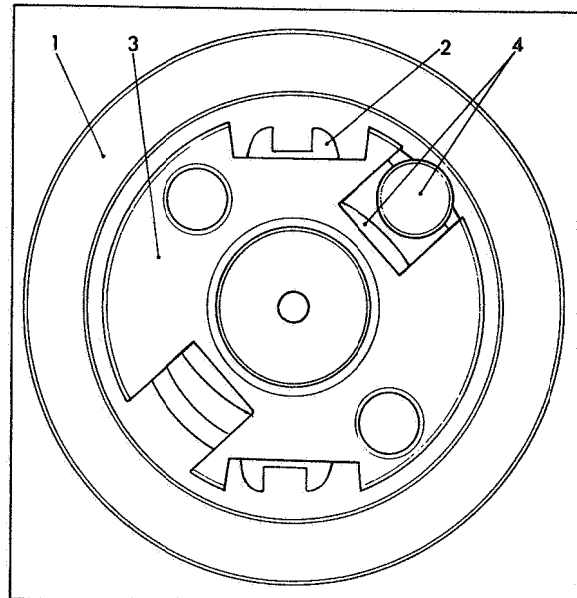
circlip with arrow facing the open end of the pump and in the same direction as the arrow on pump name plate.

Invert fixture in vice and screw cam advance screw into cam ring. Tighten to correct torque value using Tool Part No 7144-14. Remove tool and lightly tap cam advance screw to ensure cam ring is not binding in pump body.



**Fig 17** Tightening distributor head rotor screw

If the distributor head rotor screw has been removed or is loose, a new screw and washer is required. The method of fitting is as follows. Unscrew and remove the transfer pump rotor. Detach distributor rotor from hydraulic head. Screw the drive plate screws fully home into the distributor rotor. Mount the rotor vertically so that the heads of the screws only are gripped lightly by the jaws of a vice. Thoroughly degrease threads of rotor and screw, and lightly smear the threads of the screw with 'Araldite'. Using Tool Part No 7144-220 as shown in Fig 17 tighten rotor plug screw to correct torque value and allow 'Araldite' to harden for six hours at room temperature before putting pump into service.



**Fig 18** Roller & shoe assemblies

Position hydraulic head (1) on bench with machined surfaces uppermost as viewed from top in Fig 18. Position bottom adjusting plate (2) on hydraulic head with its chamfered edges uppermost. Insert distributor rotor (3) and line up the guide slots on the bottom adjusting plate with the tapered end cut-outs on the rotor head as illustrated.

Remove the corks retaining the twin pumping plungers in the rotor transverse bores. Insert the roller and shoe assemblies (4) with their ears inwards into the roller shoe guides as shown. The projecting ears on the shoes must be placed in the eccentric slots of the bottom adjusting plate so that the contour of the ears matches the contour of the slots.

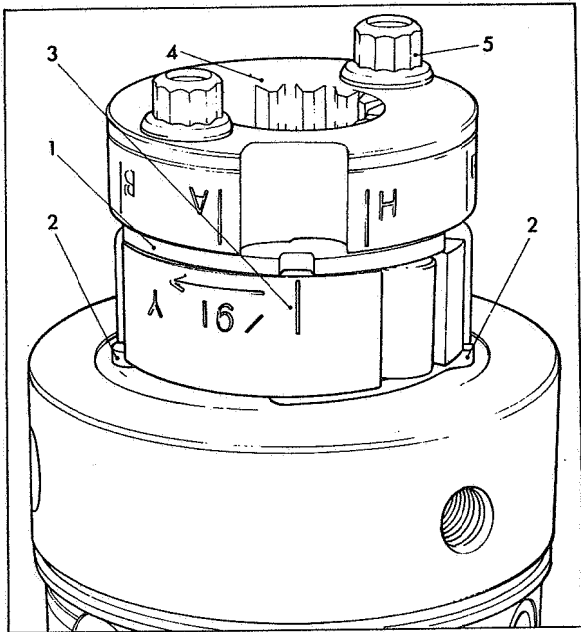


Fig 19 Top adjusting plate alignment

Fit the top adjusting plate (1) Fig 19 with its chamfered edges downwards and engage the legs of the plate in the guide slots of the bottom adjusting plate (2). Locate the two plates so that the fuel adjusting slot in the top plate coincides with the scribed line on the distributor rotor head (3) as shown. Assemble drive plate (4), machined recess downwards and align slot between letters 'A' and 'H' with the top adjusting plate slot as shown. Assemble drive plate screws (5) and finger tighten.

Lift head and rotor assembly and screw transfer pump rotor finger tight into distributor rotor body.

Fit the Stirrup Pipe Tool Part No 7144-262A (1) Fig 20 (part of Tool Part No 7144-262) to two of the high pressure outlet ports on the head as shown and connect it to a nozzle testing unit. Operate the nozzle testing unit to raise the pressure to the figure specified in the Test Data sheet (generally 30 atm).

Turn the pump rotor until the pumping plungers and rollers are forced outwards to the maximum fuel position. Measure the overall roller to roller dimension with a micrometer in the manner illustrated. The roller to roller dimension must be set to the correct test specification figure by movement of the adjusting plates.

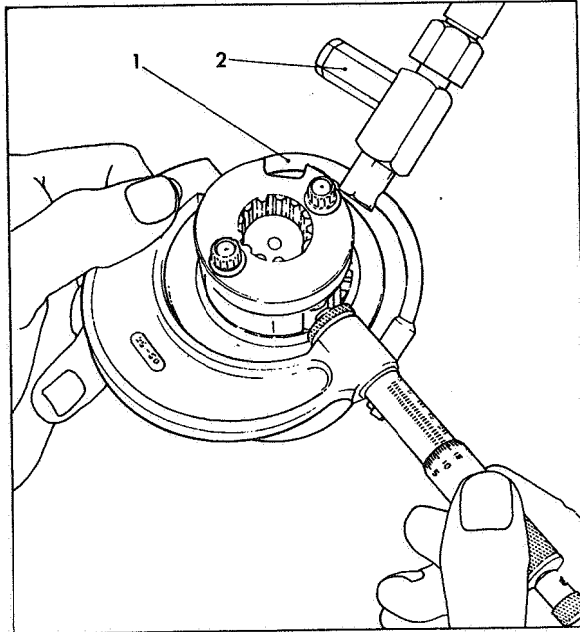


Fig 20 Measuring roller to roller dimension

**Note:** Relief Valve Part No 7144-155 (2) (part of Tool No 7144-262) must be fitted in the fuel line to ensure that the test pressure of 30 atm is not exceeded. When other test pressures are stated on test plans this relief valve can be omitted but care must be taken not to exceed the specified pressure. *Excess pressure can cause damage to the shoe assemblies and adjusting plates.*

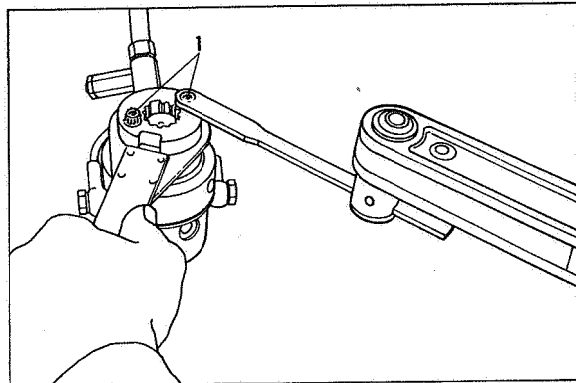


Fig 21 Tightening drive plate screws

Hold the drive plate with Tool Part No 7144-744 and tighten the drive plate screws evenly with Spanner Tool Part No 7144-511A to the correct torque value (see following note). Now slacken these screws and re-tighten to the same torque value. It is important that this procedure of tightening, slackening and re-tightening is followed. Tighten screws evenly to avoid rotor distortion which can cause sticking plungers.

**Note:** Drive plate screws (1) Fig 21 are tightened using a special technique with Spanner Tool Part No 7144-511A and an adaptor fitted in a torque wrench as illustrated. In use, the torque wrench handle and spanner must form a straight line

with the handle extending away from the spanner. The distance between the centre of the adaptor and the centre of the ring spanner is 127 mm (5,0 in). With superseded Spanner Tool Part No 7144-511 the distance is 66 mm (2,6 in). See list of Torque Values, Page 40. Certain designs of torque wrench are not suitable for this operation. If the tools are not kept in a straight line, the applied torque will be incorrect.

Disconnect the nozzle testing outfit and remove the stirrup pipe from the high pressure outlets on the head.

## TWO STAGE AUTOMATIC START RETARD DEVICE

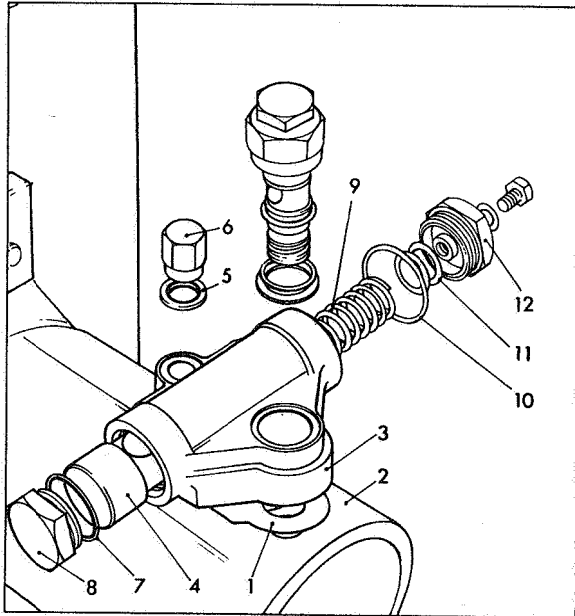


Fig 22 Assembling auto advance device

Offer up new housing gasket (1) Fig 22 to pump housing (2). Inspect piston housing (3) to ensure that blank end of piston (4) is towards the oil feed drilling end of piston housing. Assemble the housing and piston assembly to the pump housing, ensuring that the cam advance screw engages in the piston and lightly secure the assembly in place with cap nut washer (5) and cap nut (6).

Assemble piston plug seal (7) to piston plug (8) and screw into housing. Assemble outer piston spring (9). Assemble spring cap seal (10), insert shim washers (11) to piston spring cap (12) and screw it into piston housing.

Invert pump assembly and fixture in vice so that the governor housing face is uppermost as shown in Fig 23.

Assemble new seal (1) to hydraulic head and rotor assembly (2) and, after lubricating with clean test oil the portion of the head that fits into the pump housing, offer up the hydraulic head to the pump housing. Insert the head into position, with a rotating motion, so that the splines on the inner end of the drive shaft engage with the splines in the drive plate. Rotating the head on entry prevents damage to the distributor head seal.

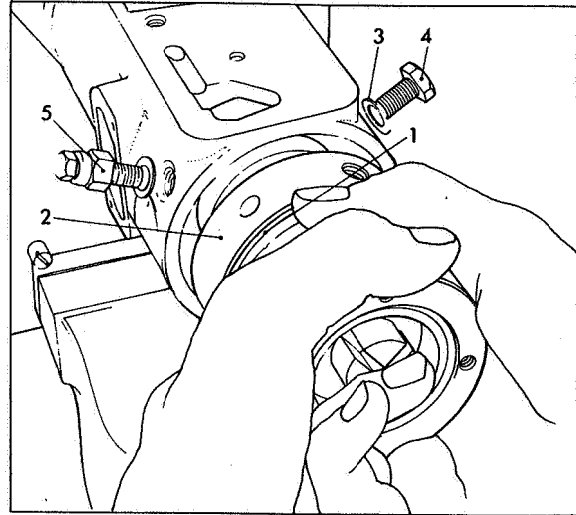


Fig 23 Inserting hydraulic head

Align the metering valve bore with contour in machine face of housing and when the head is in position secure with head screw washer (3), head locking screw (4) and head vent screw assembly and washer (5) finger tightened. Ensure that the head vent screw assembly and head locking screw are in the same location as noted when dismantling.

Invert fixture in vice and assemble new seals to head locating screw. Insert 'Dowty' washer and screw in head locating screw assembly thus securing auto-advance housing to pump housing. Progressively and evenly tighten cap nut, head locating screw, head vent screw assembly and head locking screw to correct torque values. Unscrew and remove piston plug and ensure piston is free; reassemble and tighten plug to correct torque value.

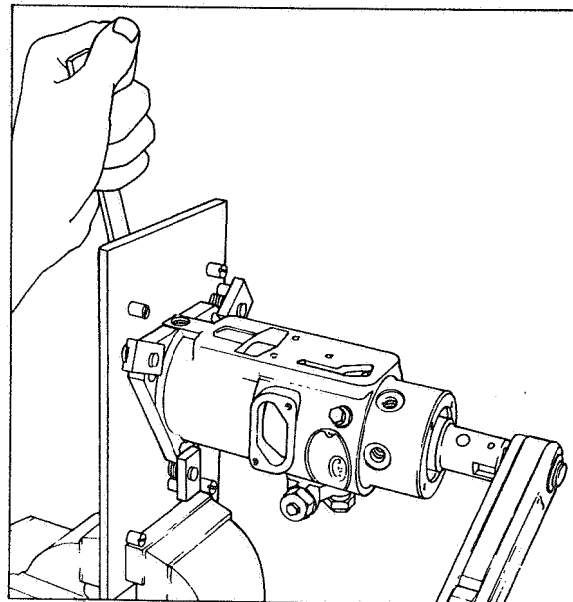


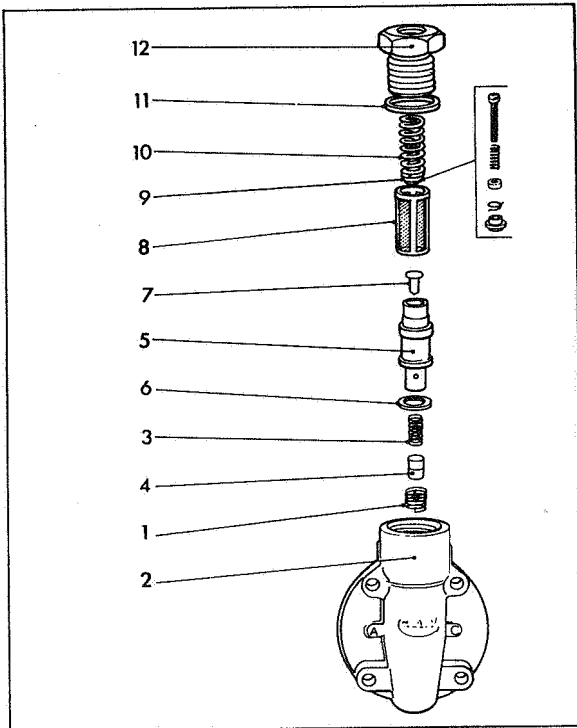
Fig 24 Tightening transfer pump rotor

As shown in Fig 24 hold the drive hub with Tool Part No 7144-773 and tighten transfer pump rotor with Tool Part No 7044-889 to the correct torque value. The transfer pump rotor must be tightened in the opposite direction of pump rotation.

Insert transfer pump seal and transfer pump liner into pump housing with the slot in the liner in same position it occupied prior to dismantling, see table.

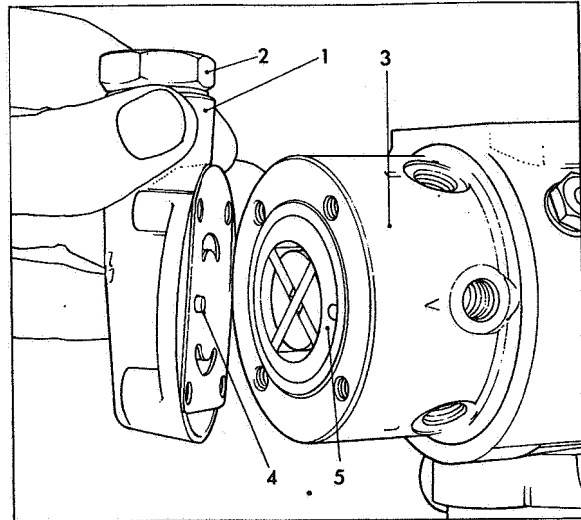
Pump rotation viewed from drive end	Transfer pump liner slot viewed from rotor end
Clockwise	3 o'clock
Anti-Clockwise	9 o'clock

Holding the transfer pump liner in position so the slot is located accurately, insert the transfer pump blades.



**Fig 25 End plate assembly**

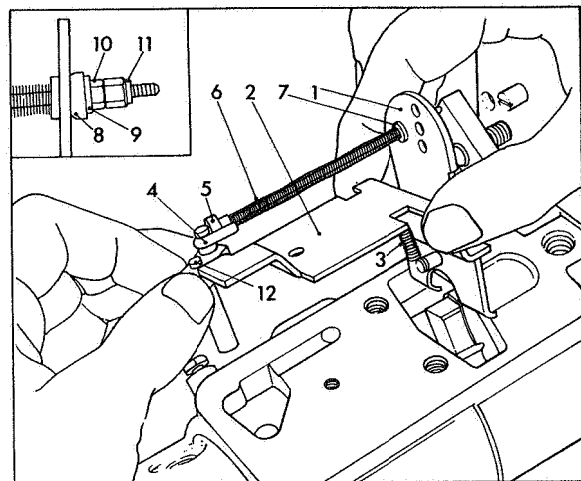
Place piston retaining spring (1) Fig 25 into end plate (2). Insert first, the piston regulating spring (3), then the regulating piston (4) into the small diameter end of the regulating sleeve (5) and assemble a new sleeve washer (6) to the same end of the regulating sleeve. Insert the small end of the spring peg (7) into the large diameter end of the regulating sleeve and slide the complete assembly into the end plate, spring peg uppermost. Assemble filter (8), transfer pressure adjuster assembly (9), sleeve retaining spring (10), then screw in inlet connection complete with washer (11 & 12).



**Fig 26 Fitting end plate assembly**

Place the end plate (1) Fig 26 with the inlet connection (2) uppermost onto the hydraulic head (3) ensuring that the dowel (4) on the inner face of the end plate engages in the slot in the transfer pump liner (5) as shown.

Secure the end plate with the four end plate screws. Tighten these screws and the inlet connection to the correct torque values.



**Fig 27 Assembling governor linkage**

Assemble governor arm (1) Fig 27 to control bracket (2) and fit governor arm spring (3). Assemble spring linkage components onto the linkage hook (4) in the following order:— Spring retainer (5) large end first, long linkage spring (6) and linkage spring washer (7). Pass the linkage hook through the correct hole in the governor arm and continue assembling linkage pivot ball (8) linkage pivot ball washer (9), linkage nut (10) and linkage locking nut (11). Assemble metering valve (12) to the hook linkage as shown.

Position the governor control linkage assembly into the pump

housing by engaging the toe on the lower end of the governor arm on top of the step of the thrust sleeve and at the same time insert metering valve into metering valve bore in the hydraulic head.

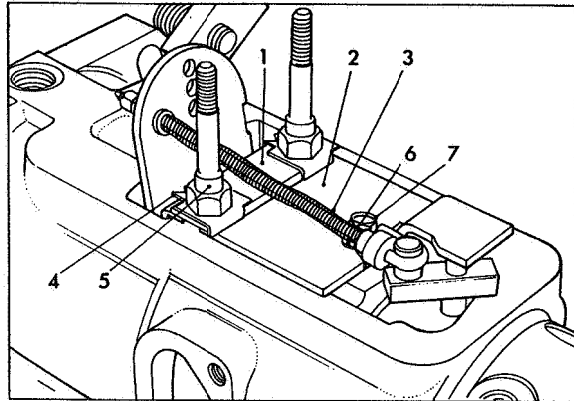


Fig 28 Fitting governor linkage

Position the keep plate (1) Fig 28 on the control bracket (2) so that the slotted end faces away from the linkage hook assembly (3). Position the two new tab washers (4) with the lips positioned nearest to the metering valve and engaging the long edge of the keep plate. Screw in the two governor control cover studs (5) and finger tighten. Place a new bracket screw tab washer (6) in the correct position shown with the tail bent down over that edge of the control bracket lying under the hook of the linkage assembly. Insert new bracket screw (7) and tighten bracket screw and control cover studs to correct torque values. Lock all tabs.

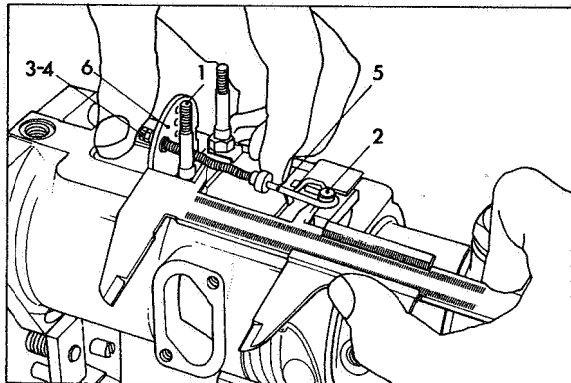


Fig 29 Setting governor linkage

Set the link length with a vernier gauge as shown in Fig 29 so that the correct internal dimension is obtained between the larger diameters of the governor control cover stud (1) and the metering valve lever pin (2). Adjustment is made by slackening the linkage locking nut (3) and tightening or loosening the linkage nut (4) on the end of the hook linkage (5). When setting, apply light pressure to the governor control arm (6) to hold the metering valve in the fully open position. Ensure that the vernier gauge is held parallel to the axis of the pump. After setting, tighten linkage locking nut.

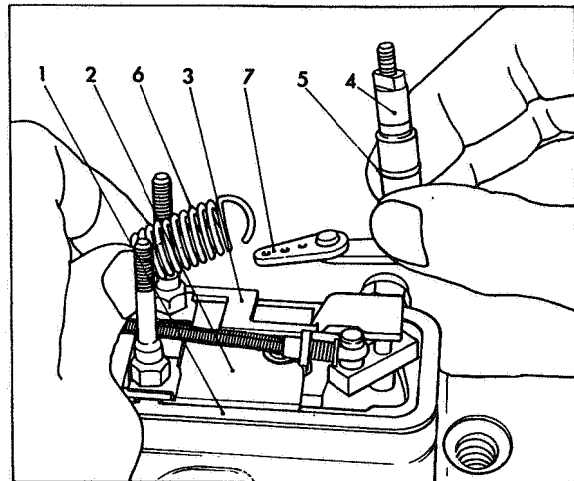


Fig 30 Assembling throttle link

Position housing gasket (1) Fig 30 on the governor housing face with the gasket tongues placed in the slots of the control bracket (2). Slide the shut-off bar (3) into the cut-out in the control bracket. Fit Protection Cap Part No 7144-459A to the end of the throttle shaft (4) and assemble new shaft seals (5). Place the idling spring onto the idling spring guide and insert into the correct hole in the governor arm. Attach the governor spring (6) to the idling spring guide and to the correct hole in the throttle shaft link (7) as stated in the Test Data or Code. The application of the setting code details is given in Fig 31.

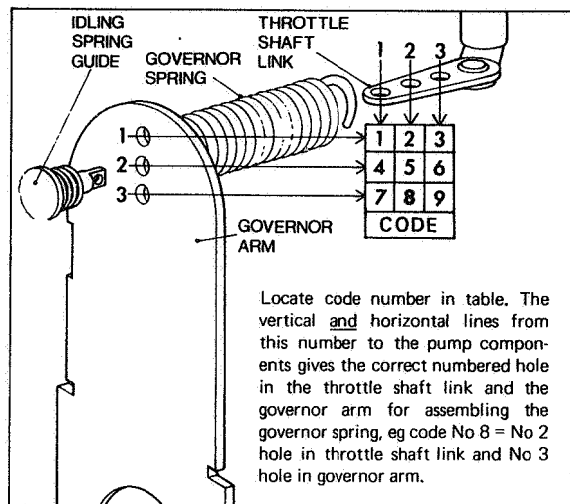
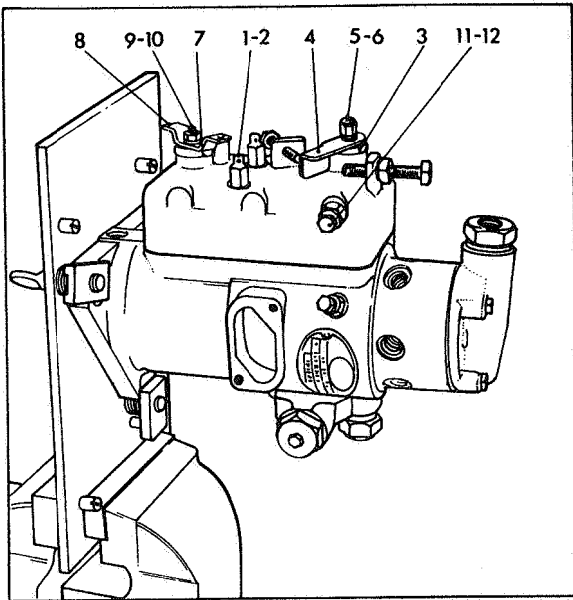


Fig 31 Application of setting code

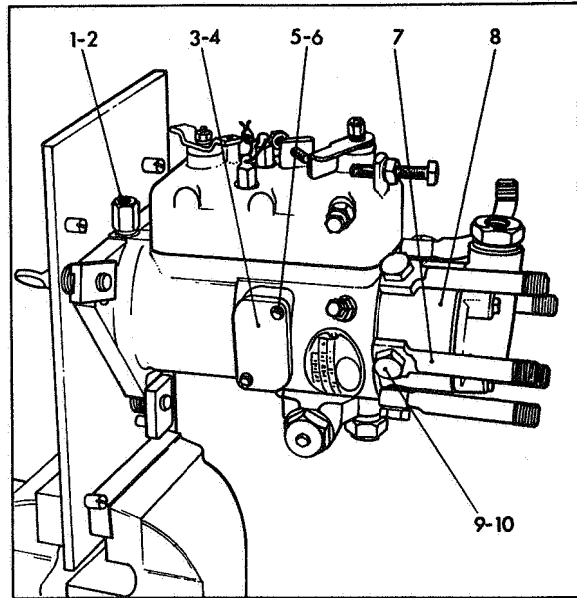
Fit Protection Cap Part 7144-459 and place new shaft seals onto shut-off shaft. Insert shaft into governor control cover then remove protection cap. Position the peg towards the edge of the cover. Insert throttle shaft into the governor control cover, and at the same time, locate the governor control cover onto the two control lever studs. While lowering the governor control cover into position onto the pump housing, engage the shut-off shaft peg in the crook of the shut-off bar. Remove protection cap.



**Fig 32 Fitting throttle arm**

Assemble cover stud washers and cover stud nuts (1 & 2) Fig 32 and tighten. Assemble throttle dust cap (3), throttle arm (4), throttle lever washer (5) and screw on the throttle lever nut (6). Assemble shut-off dust cap (7), shut-off lever (8), shut-off lever washer (9) and screw on the shut-off lever nut (10). Assemble washer (11) and screw in vent screw assembly (12) and tighten all nuts to correct torque values.

Assemble drain connection washer (1) Fig 33 to drain connection (2) and screw into pump housing. Assemble inspection cover plate and inspection cover plate gasket (3 & 4) to pump housing and secure with cover plate screws and washers (5 & 6).



**Fig 33 Assembled pump**

Tighten drain connection and screws to correct torque values. Assemble banjos (7) to hydraulic head (8) and secure with connection studs and washers (9 & 10) in their respective positions as noted when dismantling. Tighten all connection studs to the correct torque values.

Where possible, check that all other components have been tightened to the correct torque values. These are listed on Page 40.

Wire and seal cover stud nuts in accordance with Service Instructions. Ensure that a locking sleeve, a suitable length of locking wire with an unclenched seal is loosely attached to the pump for sealing the throttle adjusting screw after final setting on the engine.

## HEAVY DUTY PUMP WITH UPRATED DRIVE SHAFT

### DISMANTLING

Turn the pump on its side, inspection cover plate upwards. Remove cover plate securing screws and shakeproof washers. Detach cover plate and cover plate gasket. Discard gasket and drain pump oil into suitable receptacle.

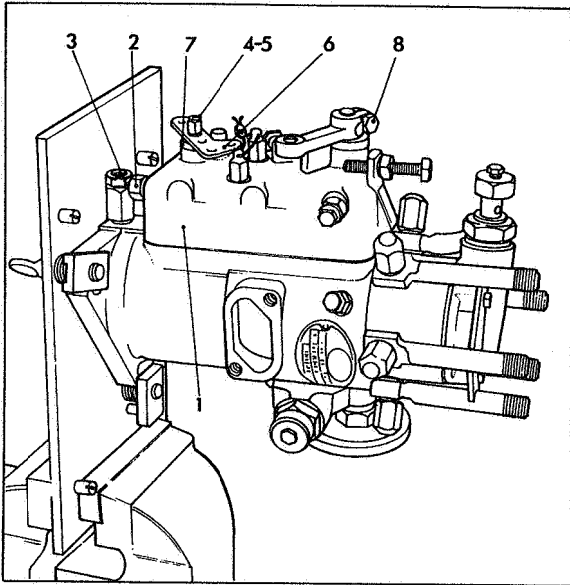


Fig 34 Pump & mounting fixture

Secure Fixture Part No 7044-888F in vice. Secure the pump to the fixture with governor control cover (1) uppermost as shown in Fig 34.

Undo locknut (2) and loosen anti-stall screw (3) about six turns. Remove lever nut and washer (4 & 5), shut-off lever (6) and dust cap (7). Slacken heavy duty screw nut (8).

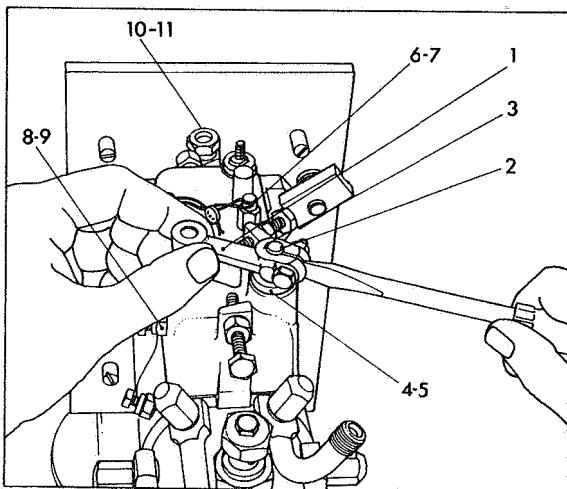


Fig 35 Removing throttle arm

Insert large screw driver blade as shown in Fig 35. Gently ease open and remove throttle arm (1) from throttle shaft (2). Remove shaft key (3), throttle shaft circlip and throttle cap (4 & 5). Remove lead seals and locking wire from cover stud nuts (6). Unscrew and remove cover stud nuts, stud washers (7), vent screw assembly and washer (8 & 9), and drain connection and washer (10 & 11).

Lift off the governor control cover and at the same time lightly press down the throttle shaft. The throttle shaft must be pressed through the cover and remain with the pump and connected to the governor spring.

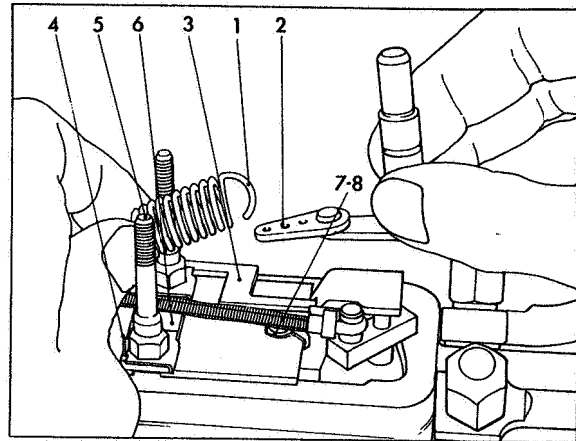


Fig 36 Dismantling throttle link

Unhook and remove governor spring (1) Fig 36 from idling spring guide and throttle shaft link (2). Remove idling spring and idling spring guide. Remove shut-off bar (3). Remove and discard governor control cover gasket.

Press down tabs on tab washers (4). Remove control cover studs (5), tab washers, keep plate (6), bracket screw and tab washer (7 & 8). As shown in Fig 37 lift off as an assembly, the control

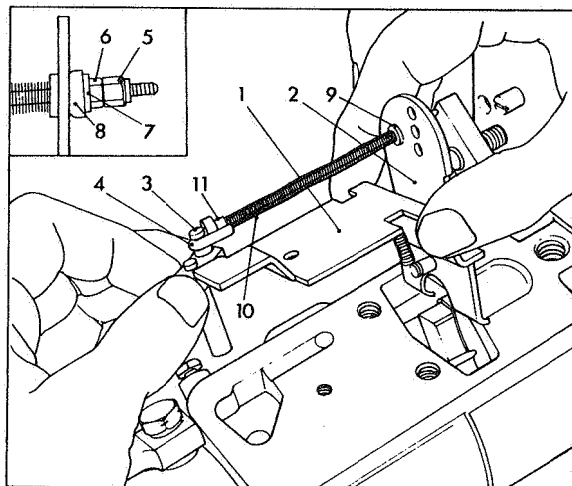
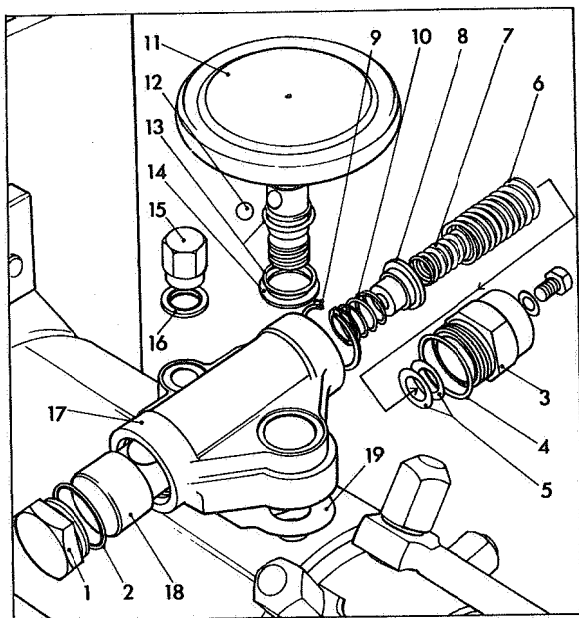


Fig 37 Removing governor linkage assembly

bracket (1) complete with governor arm (2), metering valve (3) and linkage hook assembly. Detach metering valve from linkage hook (4) and immerse it in clean test oil. Dismantle governor spring linkage in the following sequence:— linkage locking nut (5), linkage nut (6), pivot ball washer (7), linkage pivot ball (8), linkage spring washer (9), long linkage spring (10), and spring retainer (11) from the linkage hook.

### TWO STAGE AUTOMATIC START RETARD DEVICE



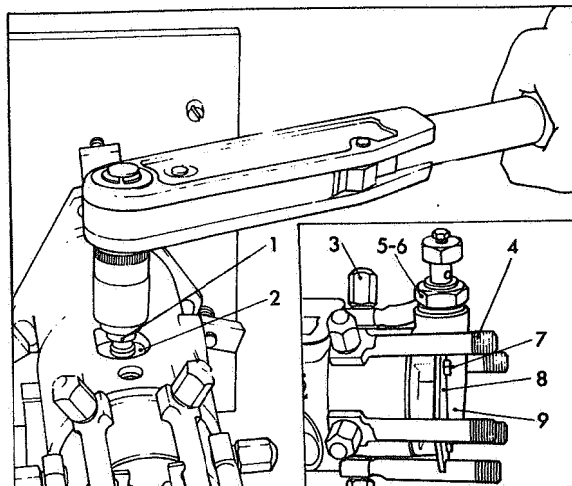
**Fig 38** Dismantling auto advance device

Invert fixture in vice as shown in Fig 38. Remove piston plug (1), piston plug seal (2), piston spring cap (3), seal (4), shim washers (5) and outer piston spring (6). Remove inner piston spring (7), spring plate (8), housing circlip (9) and short piston spring (10).

Loosen and remove damper assembly (11) complete with steel ball (12), stud seals (13) and washer (14). Remove cap nut (15) and washer (16). Gently ease auto-advance housing (17) with piston (18) from pump housing. Remove piston for inspection. If condition is satisfactory re-assemble piston to auto-advance housing. Remove and discard housing gasket (19).

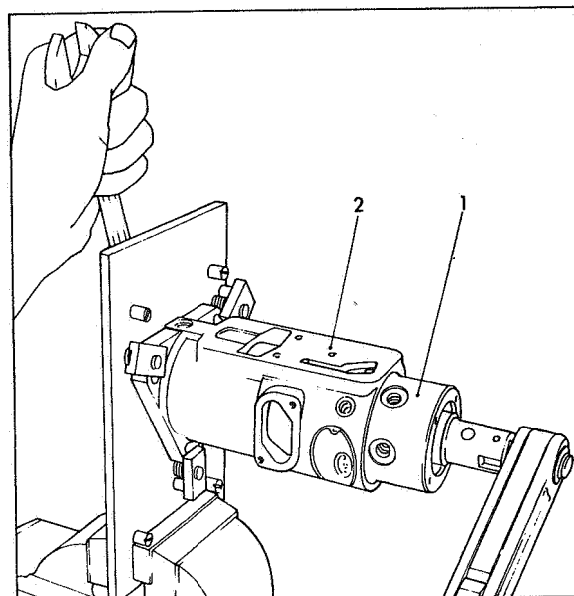
Using Tool Part No 7144-14 as shown in Fig 39, slacken cam advance screw (1). If necessary, lightly tap cam advance screw to release cam ring (2). Invert the fixture in vice. Remove pressurising valves (3) and banjos (4) noting both their position and type, and the letter identification against the outlet holes. Remove inlet connection and washer (5 & 6).

Unscrew the end plate securing screws (7), detach the clamping plates (8) and the end plate (9). Remove from the end plate the sleeve retaining spring, filter, regulating plug and regulating spring. Remove and discard sleeve washer from the regulating sleeve. Remove regulating piston and piston retaining spring.



**Fig 39** Loosening cam advance screw

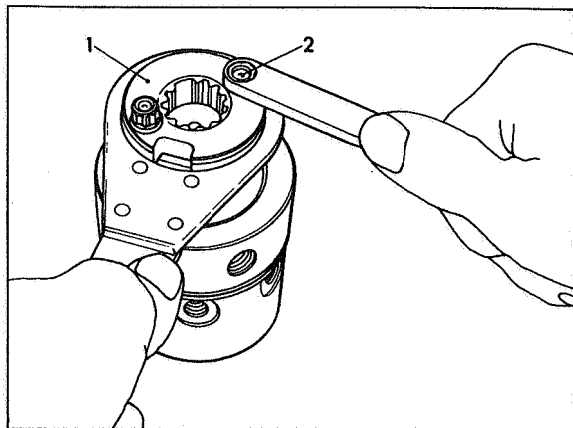
Remove transfer pump seal and transfer pump blades. Note the position of the slot in the transfer pump liner, ie, 3 o'clock or 9 o'clock when viewed from the transfer rotor end, then remove the transfer pump liner.



**Fig 40** Loosening transfer pump rotor

Hold drive hub with spanner and slacken transfer pump rotor with Tool Part No 7144-889 as illustrated in Fig 40. The direction in which the transfer pump rotor is slackened is indicated by an arrow marked on the face of the rotor. Unmarked rotors are slackened in direction of pump rotation given in the Test Data for the pump. Remove tools and then finger tighten transfer pump rotor.

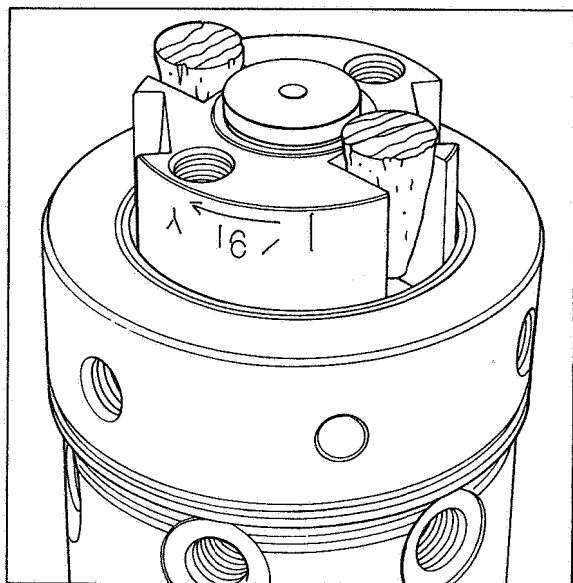
Note location of head locking screw, then unscrew and remove the screw and its washer. Withdraw head and rotor assembly (1) with a slight twisting motion in each direction, from the pump housing (2). Remove and discard distributor head seal.



**Fig 41 Loosening drive plate screws**

Place the head and rotor assembly on the bench. As illustrated in Fig 41, hold drive plate (1) with Tool Part No 7144-744 and loosen drive plate screws (2) with Tool Part No 7144-511A.

Unscrew and remove transfer pump rotor. Position head on bench with drive plate uppermost. Remove drive plate screws, drive plate, top adjusting plate, cam shoes and roller assemblies. Immerse cam shoes and roller assemblies in clean test oil.

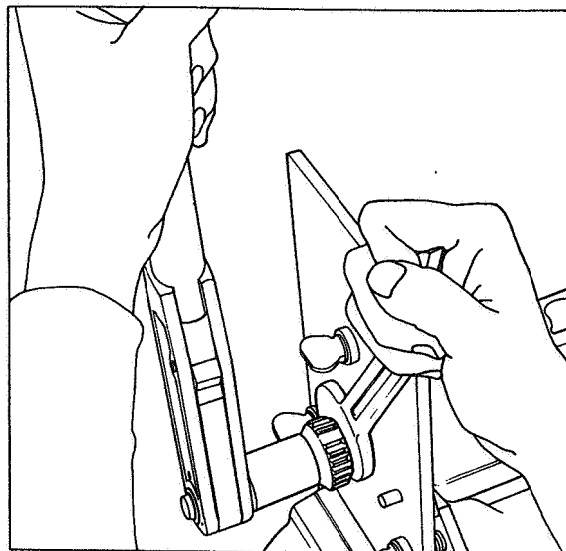


**Fig 42 Plunger retaining corks**

Fit corks into transverse rotor slots to retain plungers as shown in Fig 42. Remove distributor rotor and detach bottom adjusting plate. Insert distributor rotor into head to ensure protection of the bearing surfaces. Secure rotor in position with transfer pump rotor finger tightened.

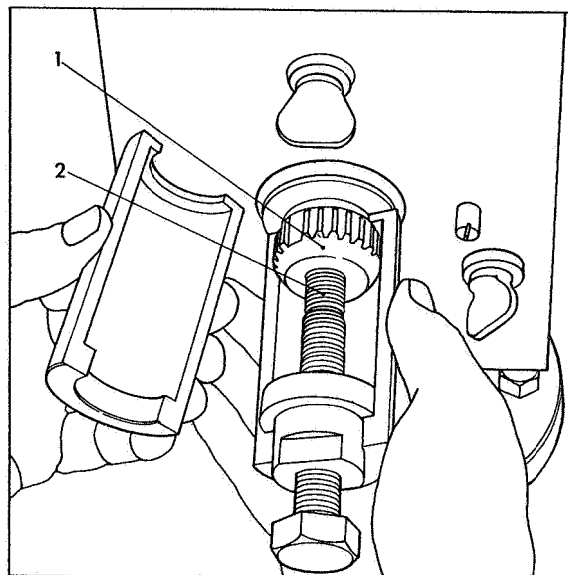
Unscrew and remove cam advance screw. Note direction of arrow on cam ring then withdraw cam ring. Note positions of

'ears' on circlip and extract circlip using circlip pliers.



**Fig 43 Loosening drive shaft nut**

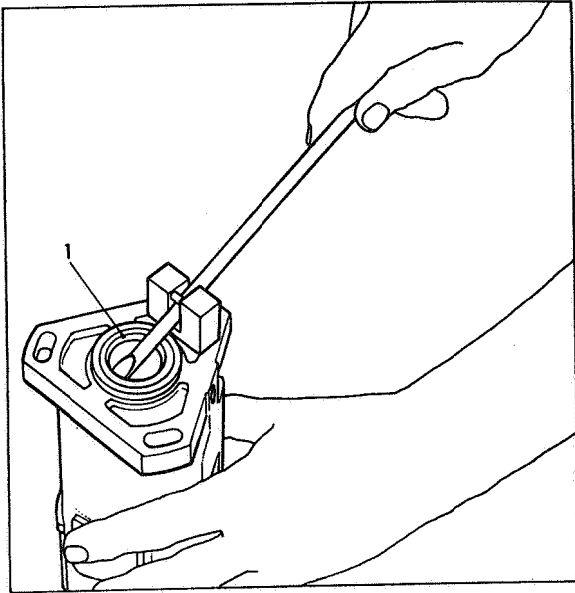
Reverse fixture endways in vice as shown in Fig 43. Hold drive shaft with spanner as illustrated and unscrew and remove drive shaft nut and spring washer.



**Fig 44 Withdrawing geared hub**

With Tool Part No 7244-105 as shown in Fig 44 withdraw geared hub (1) from drive shaft (2) and remove drive shaft key. Detach drive shaft circlip and hub drive thrust washer.

Reverse fixture endways in vice and withdraw drive shaft governor weight assembly. Remove shaft retainer and holding tapered end of shaft, detach thrust sleeve, thrust washer and governor weights.

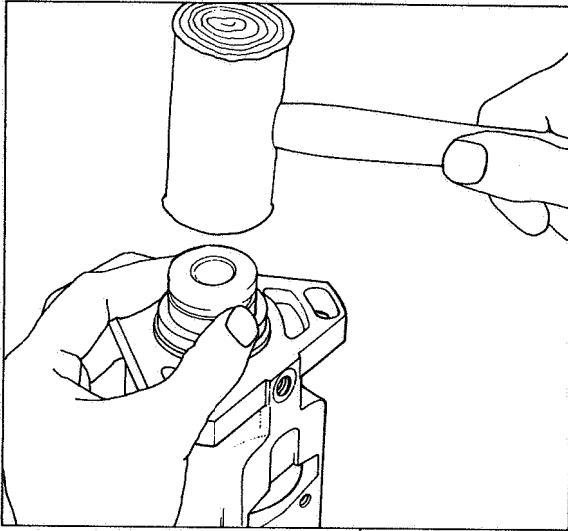


**Fig 45** *Removing drive hub seal*

Remove pump from fixture. Carefully note the way the drive hub seals are inserted then extract and discard drive hub seal (1) as shown in Fig 45 using Tool Part No 7044-893. Remove housing circlip with circlip pliers. Extract and discard second drive hub seal, again using Tool Part No 7044-893.

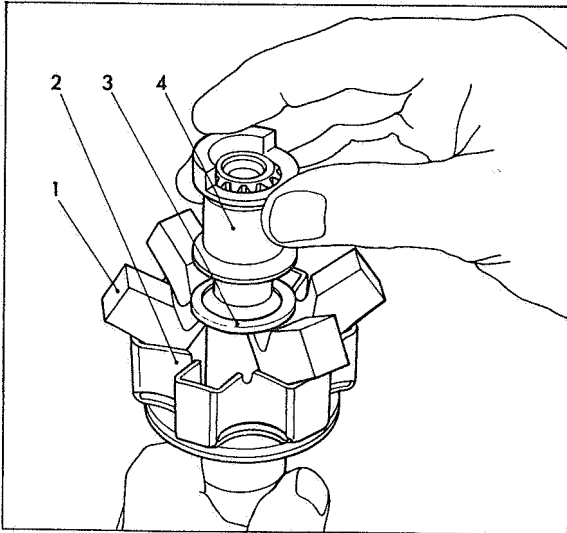
## ASSEMBLY

Immerse the two new replacement drive hub seals in clean test oil. These drive hub seals must be inserted in the same position noted prior to dismantling. Using Tool Part No 7244-154 in the manner shown in Fig 46, fit the inner drive hub seal. Next, assemble the housing circlip with its open end adjacent to tell-tale holes where provided and then fit outer drive hub seal again using Tool Part No 7244-154.



*Fig 46 Fitting drive hub seal*

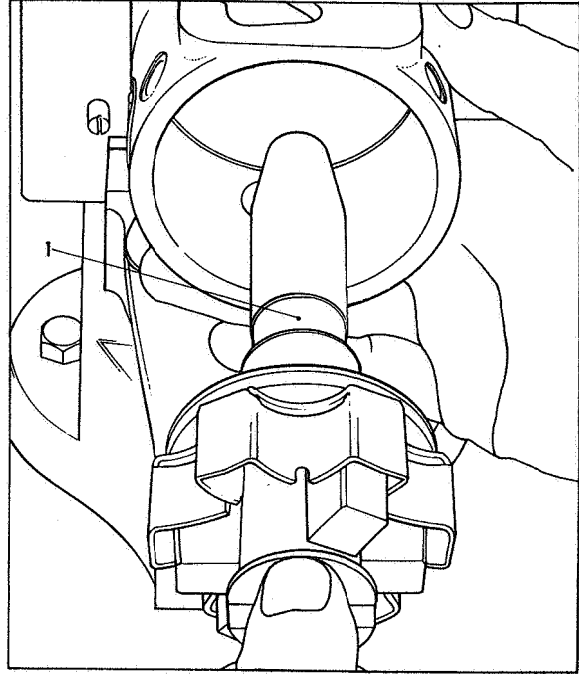
Secure Fixture Part No 7044-888F in vice. Secure the pump to the fixture with pump governor control machined face upwards.



*Fig 47 Assembling governor weight components*

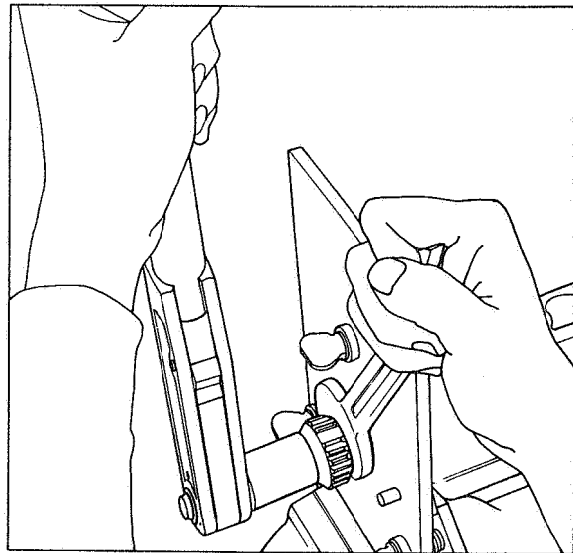
Screw drive shaft nut onto drive shaft and stand drive shaft, tapered end downward, on level surface with governor weight

retainer facing upwards as shown in Fig 47. Place governor weights (1) into governor weight retainer (2) as shown with lips resting against shaft. Assemble thrust washer (3) and thrust sleeve (4) over drive shaft, press down thrust sleeve and fit shaft retainer. Unscrew and remove shaft nut.



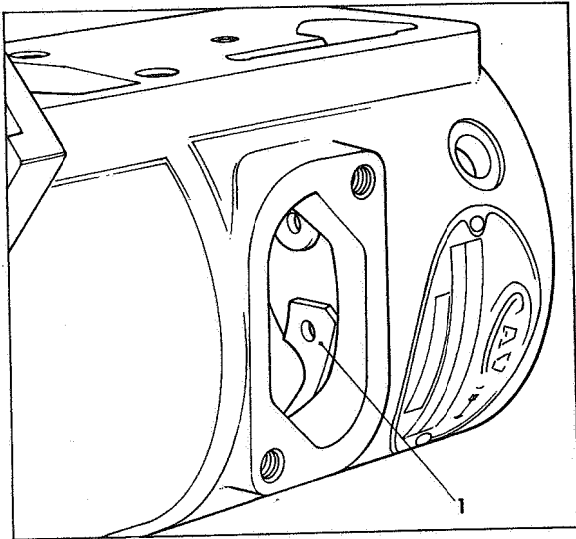
*Fig 48 Inserting drive shaft*

Fit Protection Cap Part No 7144-900 over tapered end of drive shaft (1) Fig 48. Dip protection cap in clean test oil and insert drive shaft with a rotating action through the drive hub seals in the manner shown. When the drive shaft is securely home, detach the protection cap and assemble drive hub thrust washer, drive shaft circlip, drive shaft key, geared hub, spring washer and drive shaft nut to the drive shaft.



*Fig 49 Tightening drive shaft nut*

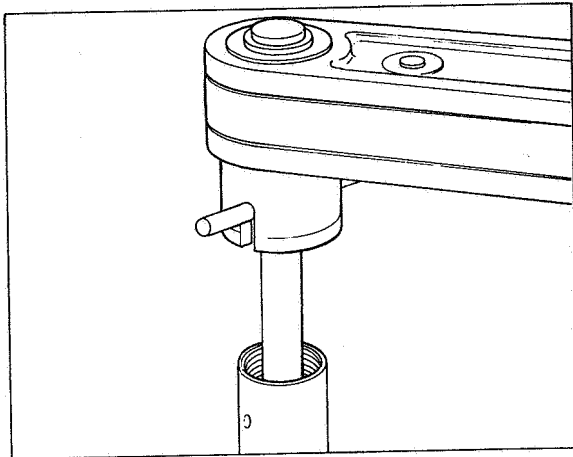
Tighten drive shaft nut as illustrated in Fig 49 to correct torque value while preventing drive shaft from turning by means of a suitable spanner.



**Fig 50** Positioning circlip

Insert circlip (1) Fig 50 against shoulder in pump housing bore, positioning the square ear of the circlip centrally in the housing inspection aperture as shown. Insert cam ring against circlip with arrow facing the open end of the pump and in the same direction as the arrow on pump name plate.

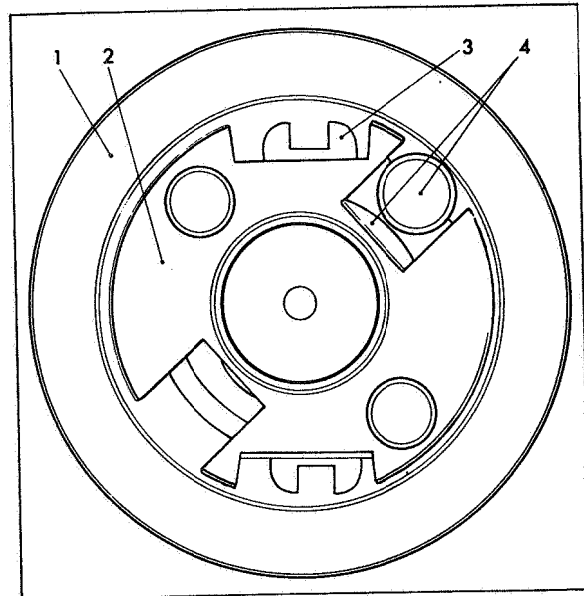
Invert fixture in vice and screw cam advance screw into cam ring. Tighten to correct torque value using Tool Part No 7144-14. Remove tool and lightly tap cam advance screw to ensure cam ring is not binding in pump body.



**Fig 51** Tightening distributor head rotor screw

If the distributor head rotor screw has been removed or is loose, a new screw and washer is required. The method of fitting is as follows. Unscrew and remove the transfer pump rotor. Detach distributor rotor from hydraulic head. Screw the two drive plate screws fully home into the distributor rotor. Position the rotor so that the heads of the screws only are gripped lightly by the jaws of a vice. Thoroughly degrease threads of rotor and screw

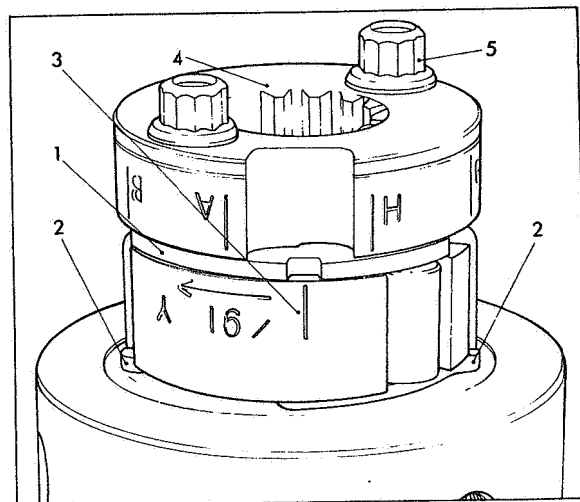
and lightly smear the threads of the screw with 'Araldite'. Insert screw and using Tool Part No 7144-220 as shown in Fig 51, tighten to correct torque value. Allow 'Araldite' to harden for 6 hours at room temperature before putting pump into service.



**Fig 52** Roller & shoe assemblies

Position hydraulic head (1) on bench with machined surfaces uppermost as viewed from top in Fig 52. Position bottom adjusting plate (3) on hydraulic head with its chamfered edges uppermost. Insert distributor rotor (2) and line up the guide slots on the bottom adjusting plate with the tapered end cut-outs on the rotor head as illustrated.

Remove the corks retaining the twin pumping plungers in the rotor transverse bores. Insert the roller and shoe assemblies (4) with their ears inwards into the roller shoe guides as shown. The projecting ears on the shoes must be placed in the eccentric slots of the bottom adjusting plate so that the contour of the ears matches the contour of the slots.



**Fig 53** Top adjusting plate alignment

Fit the top adjusting plate (1) Fig 53 with its chamfered edges downwards and engage the legs of the plate in the guide slots of the bottom adjusting plate (2). Locate the two plates so that the fuel adjusting slot in the top plate coincides with the scribed line on the distributor rotor head (3) as shown. Assemble drive plate (4), machined recess downwards and align slot between letters 'A' and 'H' with the top adjusting plate slot as shown. Assemble drive plate screws (5) and finger tighten.

Lift head and rotor assembly and screw transfer pump rotor finger tight into distributor rotor body.

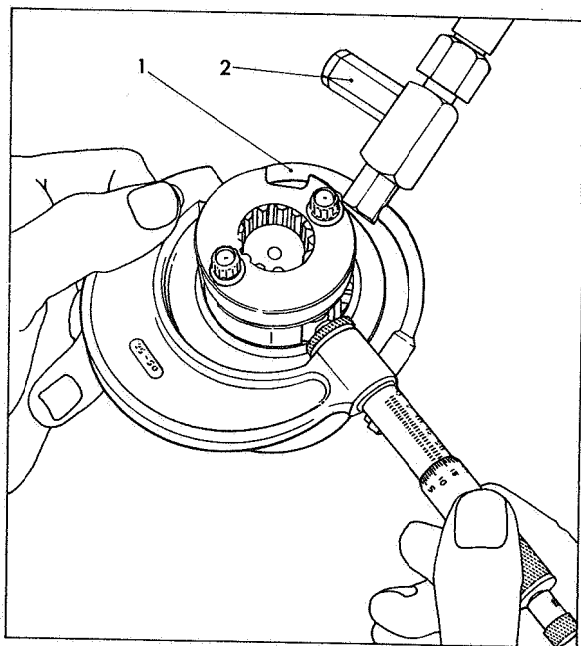


Fig 54 Measuring roller to roller dimension

Fit the Stirrup Pipe Tool Part No 7144-262A (1) Fig 54 (part of Tool Part No 7144-262) to two of the high pressure outlet ports on the head as shown and connect it to a nozzle testing unit. Operate the nozzle testing unit to raise the pressure to the figure specified in the Test Data sheet (generally 30 atm).

Turn the pump rotor until the pumping plungers and rollers are forced outwards to the maximum fuel position. Measure the overall roller to roller dimension with a micrometer in the manner illustrated. The roller to roller dimension must be set to the correct test specification figure by movement of the adjusting plates.

**Note:** Relief Valve Part No 7144-155 (2) (part of Tool Part No 7144-262) must be fitted in the fuel line to ensure that the test pressure of 30atm is not exceeded. When other test pressures are stated on test plans this relief valve can be omitted but care must be taken not to exceed the specified pressure. *Excess pressure can cause damage to shoe assemblies and adjusting plates.*

Hold the drive plate with Tool Part No 7144-744 and tighten the drive plate screws evenly with Spanner Tool Part No 7144-511A to the correct torque value (see following note). Now slacken these screws and re-tighten to the same torque value. It is important that this procedure of tightening, slackening and re-tightening is followed. Tighten screws evenly to avoid rotor distortion which can cause sticking plungers.

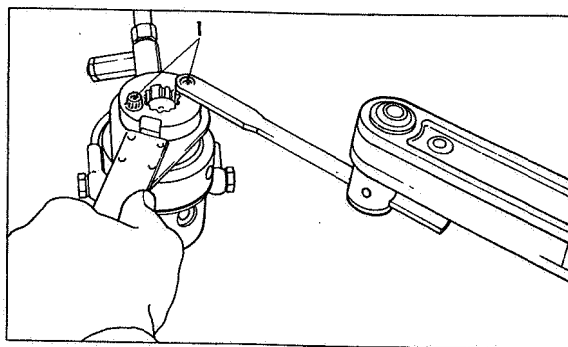


Fig 55 Tightening drive plate screws

**Note:** Drive plate screws (1) Fig 55 are tightened using a special technique with Spanner Tool Part No 7144-511A and an adaptor fitted in a torque wrench as illustrated. In use, the torque wrench handle and spanner must form a straight line with the handle extending away from the spanner. The distance between the centre of the adaptor and the centre of the ring spanner is 127 mm (5,0 in). With superseded Spanner Tool Part No 7144-511 the distance is 66 mm (2,6 in). See list of Torque Values, Page 40. Certain designs of torque wrench are not suitable for this operation. If the tools used are not kept in a straight line, the applied torque will be incorrect.

Disconnect the nozzle testing outfit and remove the stirrup pipe from the high pressure outlets on the head.

#### TWO STAGE AUTOMATIC START RETARD DEVICE

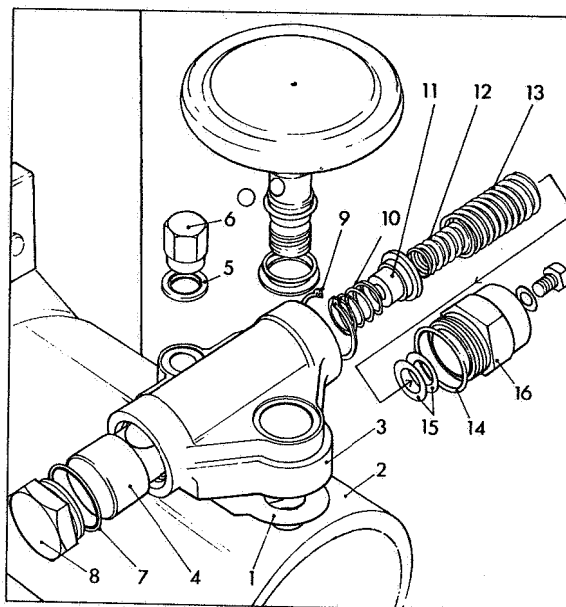


Fig 56 Assembling auto advance device

Offer up new housing gasket (1) Fig 56 to pump housing (2). Inspect piston housing (3) to ensure that blank end of piston (4) is towards the oil feed drilling end of piston housing. Assemble the housing and piston assembly to the pump housing ensuring that the cam advance screw engages with the piston and lightly secure it in place with cap nut washer (5) and cap nut (6).

Assemble piston plug seal (7) to piston plug (8) and screw into housing. Assemble housing circlip (9), short piston spring (10), spring plate (11), inner piston spring (12), and outer piston spring (13). Assemble spring cap seal (14), insert shim washers (15) to piston spring cap (16) and screw it into piston housing.

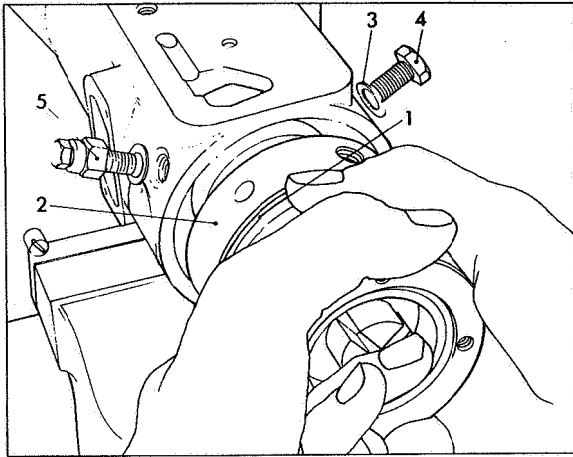


Fig 57 Inserting hydraulic head

Invert pump assembly and fixture in vice so that the governor housing face is uppermost as shown in Fig 57.

Assemble new seal (1) to hydraulic head and rotor assembly (2) and after lubricating with clean test oil, the portion of the head that fits into the pump housing, offer up the hydraulic head to the pump housing. Insert the head into position, with a rotating motion, so that the splines on the inner end of the drive shaft engage with the splines in the drive plate. Rotating the head on entry prevents damage to the distributor head seal. Align the metering valve bore with contour in machine face of housing and when the head is in position secure with head screw washer (3), head locking screw (4) and head vent screw assembly and washer (5) finger tightened. Ensure that the head vent screw assembly and head locking screw are in the same location as noted when dismantling.

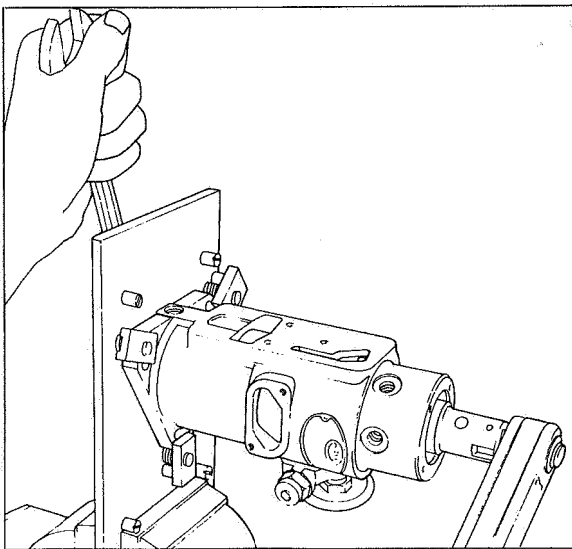


Fig 58 Tightening transfer pump rotor

Invert fixture in vice and assemble stud seals and steel ball to damper. Screw in damper thus securing auto-advance housing to pump housing. Progressively and evenly tighten cap nut, damper, head vent screw assembly and head locking screw to correct torque values. Unscrew and remove piston plug and ensure piston is free, reassemble and tighten the plug to correct torque value.

As shown in Fig 58 hold the drive hub with a spanner and tighten the transfer pump rotor with Tool Part No 7044-889 to the correct torque value. The transfer pump rotor must be tightened in the opposite direction of pump rotation.

Insert transfer pump liner into pump housing with the slot in the same position it occupied prior to dismantling. See table:

Pump rotation viewed from drive end	Transfer pump liner slot viewed from rotor end
Clockwise	3 o'clock
Anti-Clockwise	9 o'clock

Hold the transfer pump liner in position so the slot is located accurately and insert the transfer pump blades.

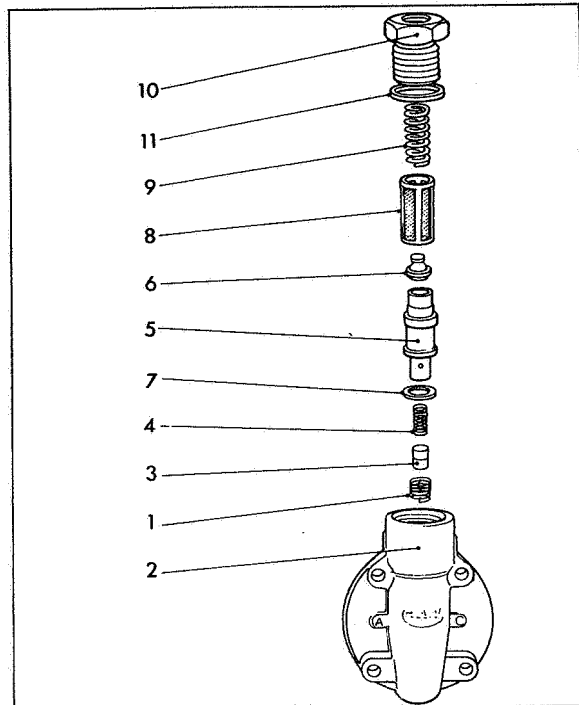
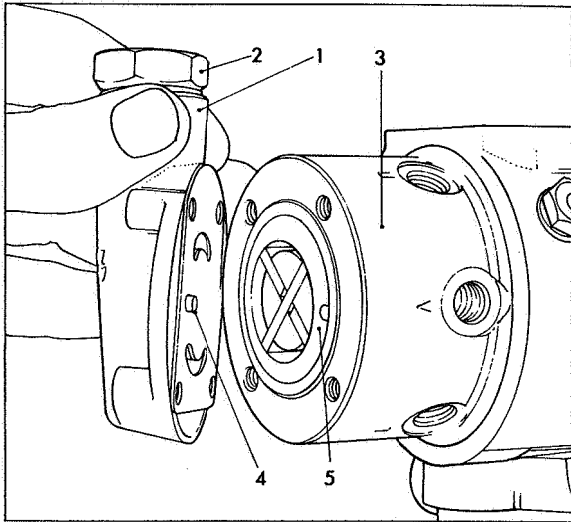


Fig 59 End plate assembly

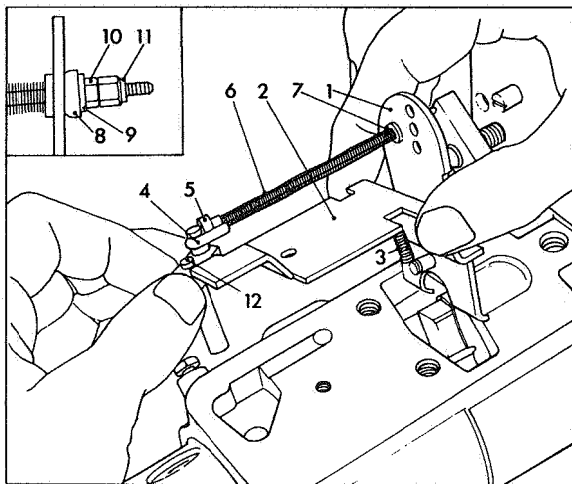
Place piston retaining spring (1) Fig 59 into end plate (2). Insert the regulating piston (3), then the piston regulating spring (4) into the large diameter end of the regulating sleeve (5). Insert the small end of the spring peg (6) into the same end of the regulating sleeve. Fit a new sleeve washer (7) onto the other end and place the complete assembly into the end plate, spring peg uppermost. Assemble the filter (8) and sleeve retaining spring (9) into the end plate and secure with the inlet connection (10) and inlet connection washer (11).



**Fig 60** Fitting end plate assembly

Place the end plate (1) Fig 60 with the inlet connection (2) uppermost onto the hydraulic head (3) ensuring that the dowel (4) on the inner face of the end plate engages in the slot in the transfer pump liner (5) as shown.

Secure the end plate and clamping plates with the four end plate screws. Tighten these screws and the inlet connection to the correct torque values.

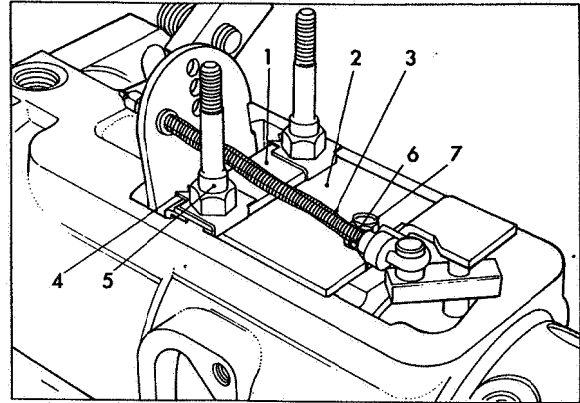


**Fig 61** Assembling governor linkage

Assemble governor arm (1) Fig 61 to control bracket (2) and fit governor arm spring (3). Assemble spring linkage components onto the linkage hook (4) in the following order:— Spring retainer (5) large end first, long linkage spring (6) and linkage spring washer (7). Pass the linkage hook through the correct hole in the governor arm and continue assembling linkage pivot ball (8), pivot ball washer (9), linkage nut (10) and locking nut (11). Assemble metering valve (12) to the hook linkage as shown.

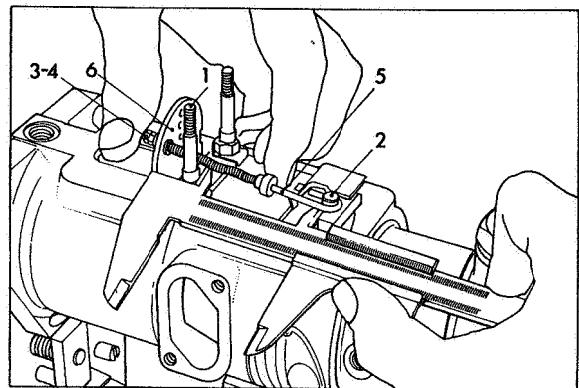
Position the governor control linkage assembly into the pump

housing by engaging the toe on the lower end of the governor arm on top of the step of the thrust sleeve and at the same time insert metering valve into metering valve bore in the hydraulic head.



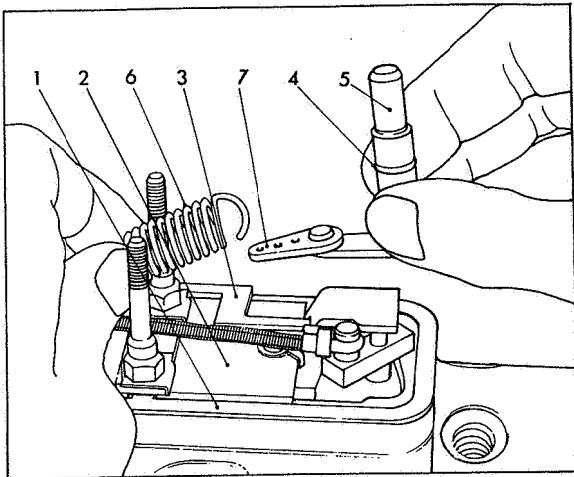
**Fig 62** Fitting governor linkage

Position the keep plate (1) Fig 62 on the control bracket (2) so that the slotted end faces away from the linkage hook assembly (3). Position the two new tab washers (4) with the lips positioned nearest to the metering valve and engaging the long edge of the keep plate. Screw in the two governor control cover studs (5) and finger tighten. Place a new bracket screw tab washer (6) in the correct position shown with the tail bent down over that edge of the control bracket lying under the hook of the linkage assembly. Insert new bracket screw (7) and tighten bracket screw and control cover studs to correct torque value. Lock all tabs.



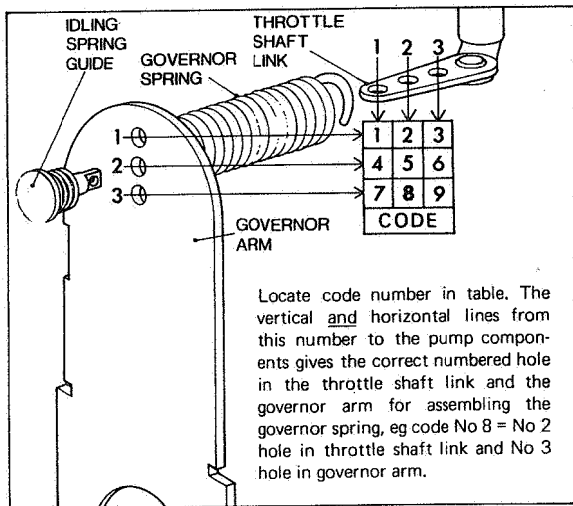
**Fig 63** Setting governor linkage

Set the link length with a vernier gauge as shown in Fig 63 so that the correct internal dimension stated on the Test Data is obtained between the larger diameters of the governor control cover stud (1) and the metering valve lever pin (2). Adjustment is made by slackening the linkage locking nut (3) and tightening or loosening the linkage nut (4) on the end of the hook linkage (5). When setting, apply light pressure to the governor control arm (6) to hold the metering valve in the fully open position. Ensure that the vernier gauge is held parallel to the axis of the pump. After setting, tighten linkage locking nut.



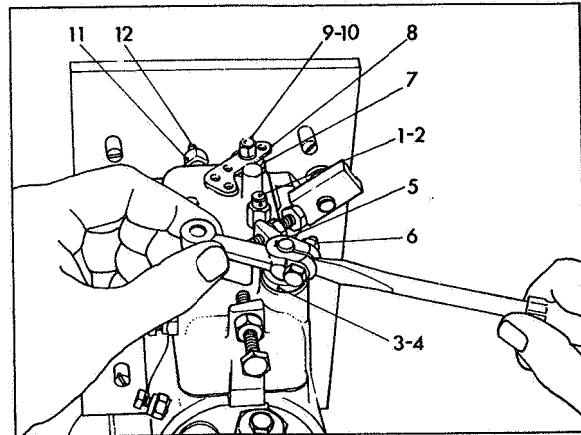
**Fig 64 Assembling throttle link**

Position housing gasket (1) Fig 64 on the governor housing face with the gasket tongues placed in the slots of the control bracket (2). Slide the shut off bar (3) into the cut-out in the control bracket. Fit Protection Cap Part No 7144-459A to the end of the throttle shaft (5) and assemble new shaft seals (4). Place the idling spring onto the idling spring guide. Insert the idling spring guide into the correct hole in the governor arm and attach the governor spring (6) to the correct hole on the throttle shaft link (7) and idling spring guide as stated in Test Data or Code. The application of the setting code details are given in Fig. 65.



**Fig 65 Application of setting code**

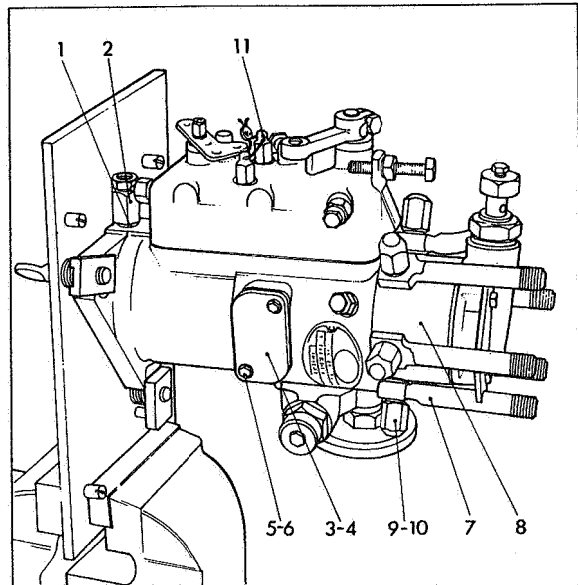
Place new shaft seals onto shut-off shaft and assemble into governor control cover. Position the peg towards the edge of the cover. Screw anti-stall screw into governor control cover approximately six turns and secure with locknut, finger tightened. Insert the throttle shaft into the governor control cover, and at the same time, locate the governor control cover onto the two control cover studs. While lowering the governor control cover into position onto the pump housing engage the shut-off shaft peg in the crook of the shut-off bar.



**Fig 66 Fitting throttle arm**

Assemble cover stud washers and cover stud nuts (1 & 2) Fig 66 and tighten. Assemble pad and throttle dust cap (3 & 4) and secure with throttle shaft circlip. Insert shaft key and whilst keeping a screwdriver blade wedged into the slot of the throttle arm (5) as shown, slide the throttle arm onto the throttle shaft, fully engaging the shaft key and tighten nut (6).

Assemble shut-off dust cap (7), shut-off lever (8), shut-off lever washer (9) and shut-off lever nut (10). Tighten all screws and nuts to the correct torque values. Slacken anti-stall screw locknut (11), screw in the anti-stall screw (12) approximately four turns and secure with locknut.



**Fig 67 Assembled pump**

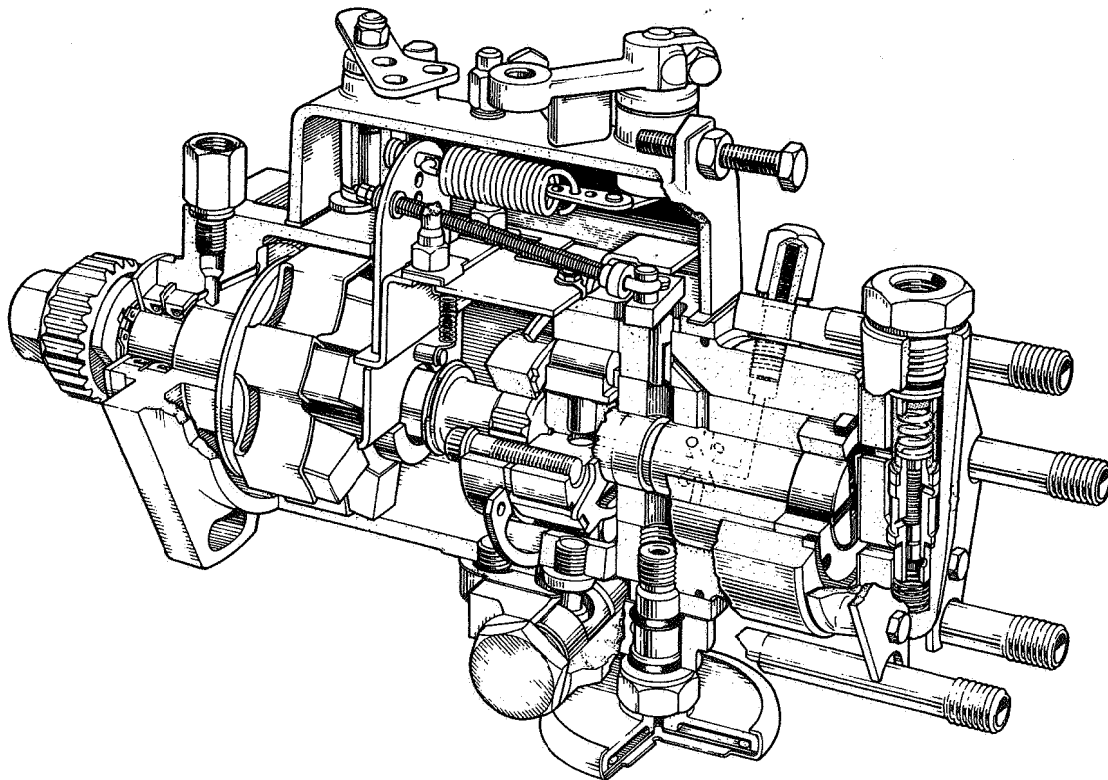
Assemble drain connection washer (1) Fig 67 to drain connection (2) and screw connection into pump housing. Assemble inspection cover plate and inspection cover plate gasket (3 & 4) to pump housing and secure with cover plate screws and washers (5 & 6). Tighten screws and connections to correct torque values.

Assemble banjos (7) to hydraulic head (8) and secure with pressurising valves and washers (9 & 10) in their respective positions as noted when dismantling. Tighten all pressurising valves to the correct torque values.

Where possible, check that all other components have been tightened to the correct torque values. These are listed on

Page 40.

Wire and seal cover stud nuts (11) in accordance with Service Instructions. Ensure that a locking sleeve, a suitable length of locking wire with an unclenched seal is loosely attached to the pump for sealing the throttle adjusting screw after final setting on the engine.



## PUMP WITH EXCESS FUEL & EXTERNAL MAXIMUM FUEL ADJUSTMENT

### DISMANTLING

Turn the pump on its side, inspection cover plate upwards. Remove cover plate securing screws and shakeproof washers. Detach cover plate and discard cover plate gasket. Drain pump oil into suitable receptacle.

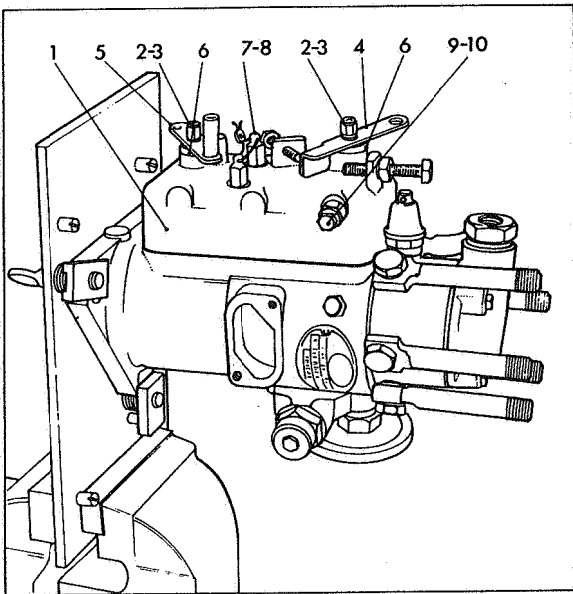


Fig 68 Pump & mounting fixture

Secure Fixture Part No 7044-888F in vice. Secure the pump to the fixture with governor control cover (1) uppermost as shown in Fig 68.

Unscrew and remove throttle arm and shut-off lever securing nuts and washers (2 & 3). Detach throttle arm (4), shut-off lever (5) and dust caps (6). Remove lead seals and locking wire and unscrew and remove cover stud nuts and washers (7 & 8). Unscrew and remove vent screw assembly and washer (9 & 10).

Fit Protection Cap Part No 7144-459A over throttle shaft. Lift off the governor control cover and at the same time lightly press down on the top of the throttle shaft protection cap. The throttle shaft must be pressed through the cover and remain with the pump and connected to the governor spring. Transfer the Protection Cap Part No 7144-459A to shut-off shaft and press the shaft out of the governor control cover. Remove and discard all shaft seals and the governor control cover gasket.

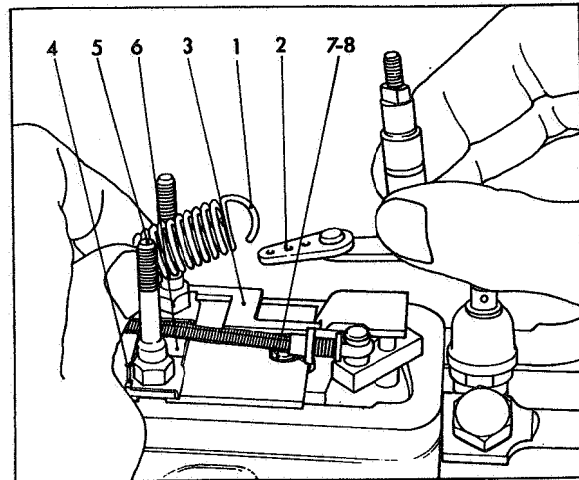


Fig 69 Dismantling throttle link

Unhook and remove governor spring (1) Fig 69 from idling spring guide and throttle shaft link (2). Remove idling spring and idling spring guide. Remove shut-off bar (3). Press down tabs on tab washers (4). Remove control cover studs (5), tab washers, keep plate (6), bracket screw and washer (7 & 8).

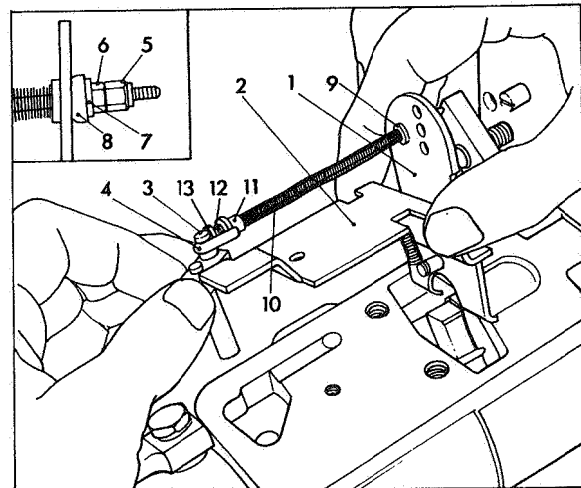
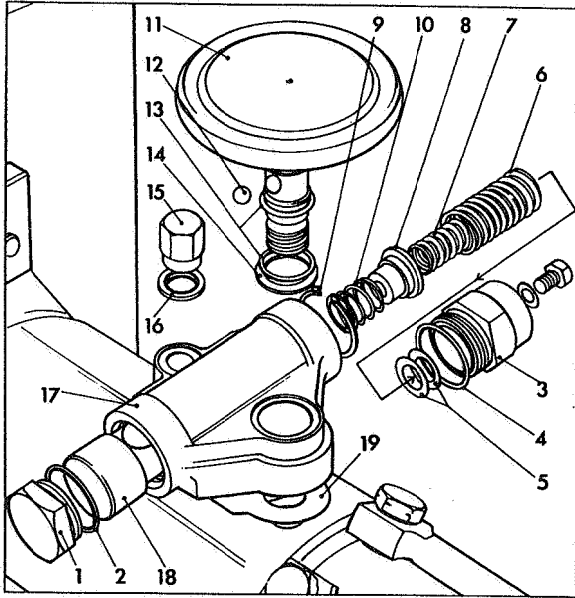


Fig 70 Removing governor linkage assembly

As shown in Fig 70 lift off as an assembly, governor arm (1) complete with control bracket (2), metering valve (3) and linkage hook assembly (4) and immerse in clean test oil. Dismantle governor spring linkage in the following sequence:— linkage locking nut (5), linkage nut (6), pivot ball washer (7), linkage pivot ball (8), linkage spring washer (9), long linkage spring (10), spring retainer (11), short linkage spring (12) and small spring retainer (13) from the linkage hook.

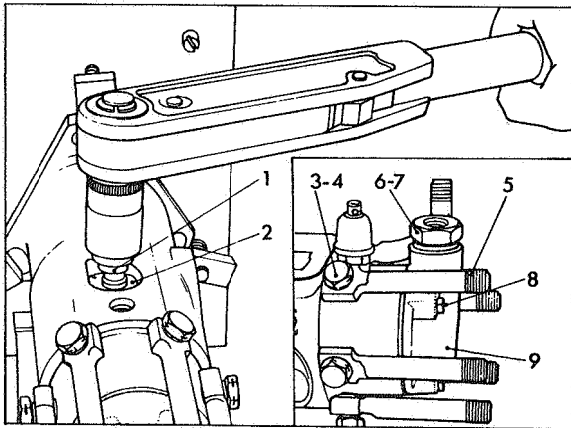
## TWO STAGE AUTOMATIC START RETARD DEVICE



**Fig 71** Dismantling auto advance device

Invert fixture in vice as shown in Fig 71. Remove piston plug (1), piston plug seal (2), piston spring cap (3), seal (4), shim washers (5) and outer piston spring (6). Remove inner piston spring (7), spring plate (8), housing circlip (9) and short piston spring (10).

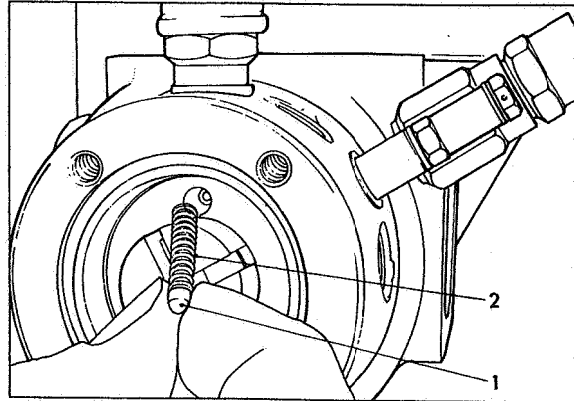
Loosen and remove damper assembly (11) complete with steel ball (12), stud seals (13) and washer (14). Remove cap nut (15) and washer (16). Gently ease auto-advance housing (17) with piston (18) from pump housing. Remove piston for inspection. If condition is satisfactory re-assemble piston to auto-advance housing. Remove and discard housing gasket (19).



**Fig 72** Loosening cam advance screw

Using Tool Part No 7144-125A as shown in Fig 72, slacken cam advance screw (1). If necessary, lightly tap cam advance screw to release cam ring (2). Remove cam advance screw. Invert the fixture in vice. Remove fuel connection studs and washers (3 & 4) and banjo connections (5) noting their position and type, also the letter identification against the outlet holes.

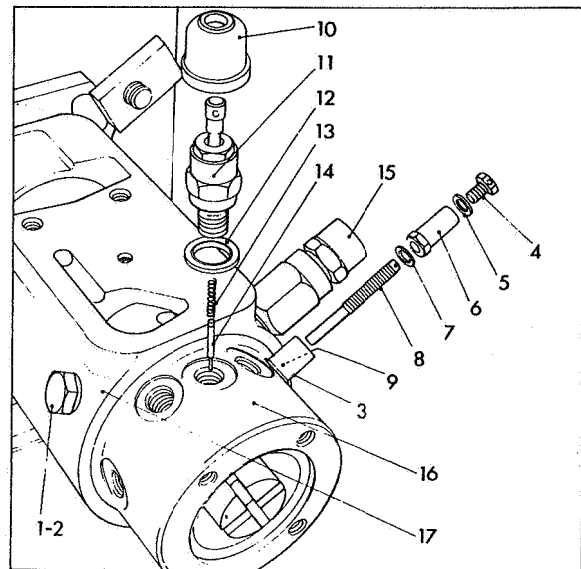
Remove end plate inlet connection and washer (6 & 7). Unscrew the end plate securing screws (8) and carefully withdraw end plate (9) while holding transfer pump liner in position. Remove transfer pump seal and transfer pump blades while still holding the spring loaded transfer pump liner in place.



**Fig 73** Removing dumb-bell valve spring

Carefully note the position of the locating slot in pump liner, ie, 3 o'clock or 9 o'clock when viewed from transfer rotor end, and gently remove liner. Remove dumb-bell valve pin (1) Fig 73 and dumb-bell valve spring (2). Remove from the end plate the retaining sleeve spring, filter, transfer pressure adjuster, spring peg, regulating sleeve, regulating spring, regulating piston and piston retaining spring. Remove and discard sleeve washer from regulating sleeve and discard washer.

Hold drive hub with Tool Part No 7144-773 and slacken transfer pump rotor with Tool Part No 7044-889. The direction in which the transfer pump rotor is slackened is indicated by an arrow marked on the face of the rotor. Unmarked rotors are slackened in direction of pump rotation given in the Test Data for the pump. Remove tools and then finger tighten transfer pump rotor.



**Fig 74** Dismantling shuttle valve assembly

Note location of, then unscrew and remove, the head locking screw and washer (1 & 2) Fig 74. Unscrew and remove from the shuttle valve body (3): shuttle plug screw (4), screw plug washer (5), shuttle tubular nut (6), tubular nut washer (7) and shuttle stop screw (8). The shuttle valve piston (9) can only be removed following extraction of the shuttle valve body.

**Note:** If it is necessary to remove the shuttle valve body, this can be done using Tool No 17 CSA manufactured and supplied by M Semet and Co of 27 Ashley Place London SW 1.

If required, the shuttle valve piston, latch pin spring, latch pin and dumb-bell valve can be taken out following the removal of the hydraulic head.

Remove cover (10), then slacken and remove excess fuel selector assembly (11) and washer (12), latch pin spring (13) and latch pin (14). Note location of, then unscrew and remove the proportional pressurising valve and washer (15) as an assembly. Withdraw head and rotor assembly (16) with a slight twisting motion in each direction, from the pump housing (17).

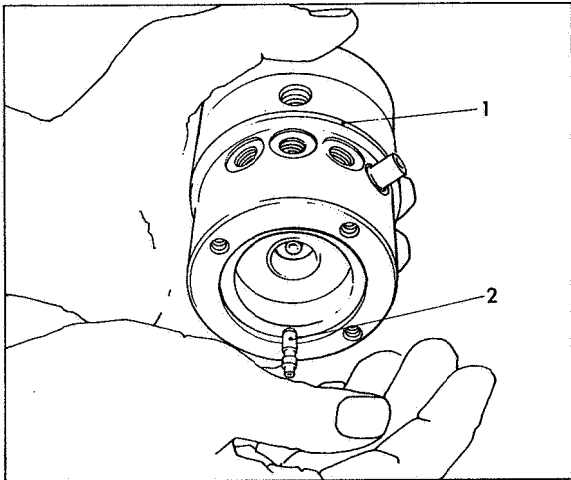


Fig 75 Removing dumb-bell valve

Remove and discard seal (1) Fig 75. Catch the dumb-bell valve (2) in the palm of the hand while tilting the hydraulic head vertically, drive end plate uppermost as shown. It may be necessary to shake the hydraulic head in order to dislodge the dumb-bell valve.

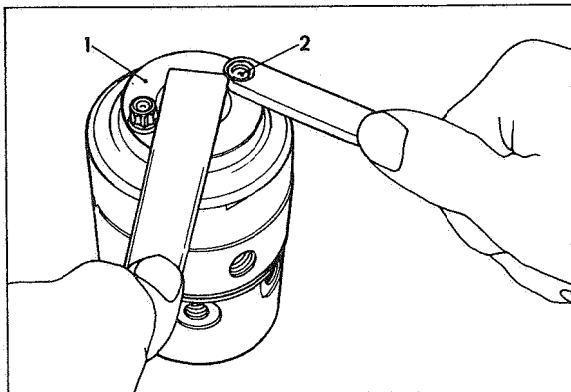


Fig 76 Loosening drive plate screws

Place the head and rotor assembly on the bench. As illustrated in Fig 76, hold drive plate (1) with Tool Part No 7144-939 and loosen drive plate screws (2) with Tool Part No 7144-511A.

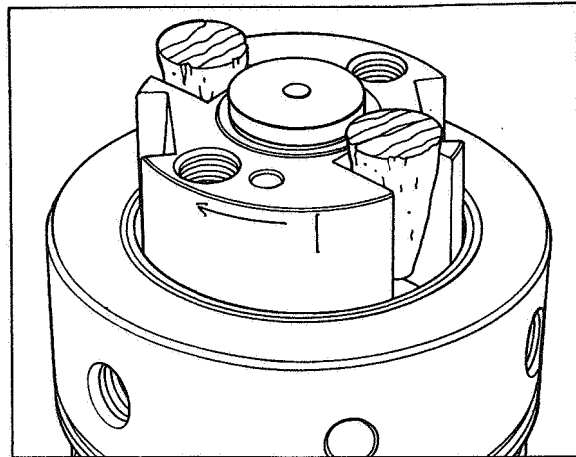


Fig 77 Plunger retaining corks

Unscrew and remove transfer pump rotor. Position head on bench with drive plate uppermost. Remove drive plate screws, drive plate, cam ring, top stop plate, cam shoes and roller assemblies. Immerse cam shoes and roller assemblies in clean test oil. Fit corks into transverse rotor slots to retain plungers as shown in Fig 77. Remove dowel pin and distributor rotor and detach bottom stop plate.

Insert distributor rotor into head to ensure protection of the bearing surfaces. Secure distributor rotor in position with transfer pump rotor finger tightened.

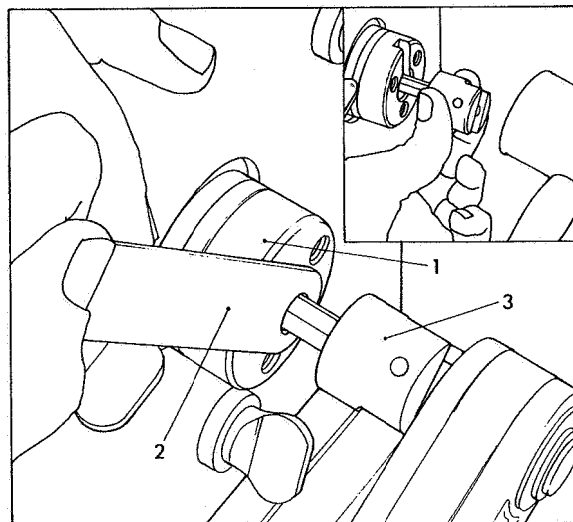


Fig 78 Loosening drive shaft screw

Reverse fixture endways in vice as shown in Fig 78. Hold drive hub (1) with Tool Part No 7144-773 (2) and using Tool Part No 7144-261 (3), loosen the drive shaft screw a couple of turns. Gently tap the end of the tool holding the screw to ease drive shaft through seals as shown in inset, then unscrew and remove screw. Remove drive shaft screw spring washer. The support washer can be left inside the drive hub.

Reverse fixture endways in vice and withdraw drive shaft governor weight assembly. Stand drive shaft vertically with drive shaft seal uppermost. Remove drive shaft seal from annular groove. Lift weight assembly until the cush drive back plate is level with the annular groove. Holding the back plate still, turn the weight assembly until the three rivet heads can pass the three notches in the back plate. Now lower the weight assembly. Turn the back plate until the internal lip is in line with the gap in the shaft splines, and lift off. Remove cush drive retainer, governor weights, thrust washer and thrust sleeve. Remove cush drive splined hub from cush drive retainer. Remove cush drive rubber inserts.

Extract drive hub from housing.

Remove pump from fixture. Carefully note the way the drive hub seals are inserted then extract and discard drive hub seal (1) as shown in Fig 79 using Tool Part No 7044-893. Remove housing circlip with circlip pliers.

Extract and discard second drive hub seal, again using Tool Part No 7044-893.

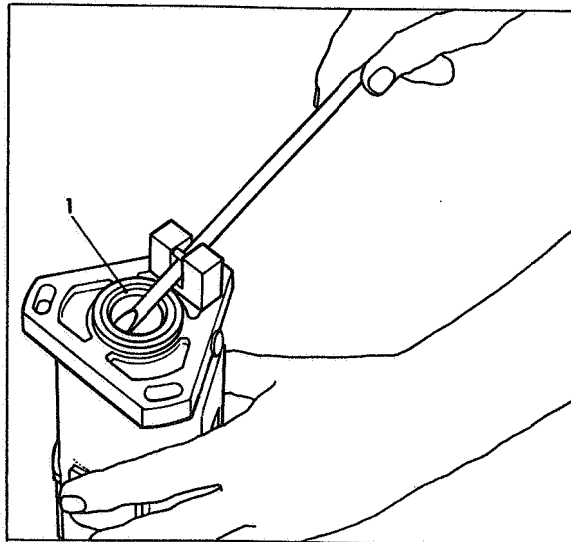
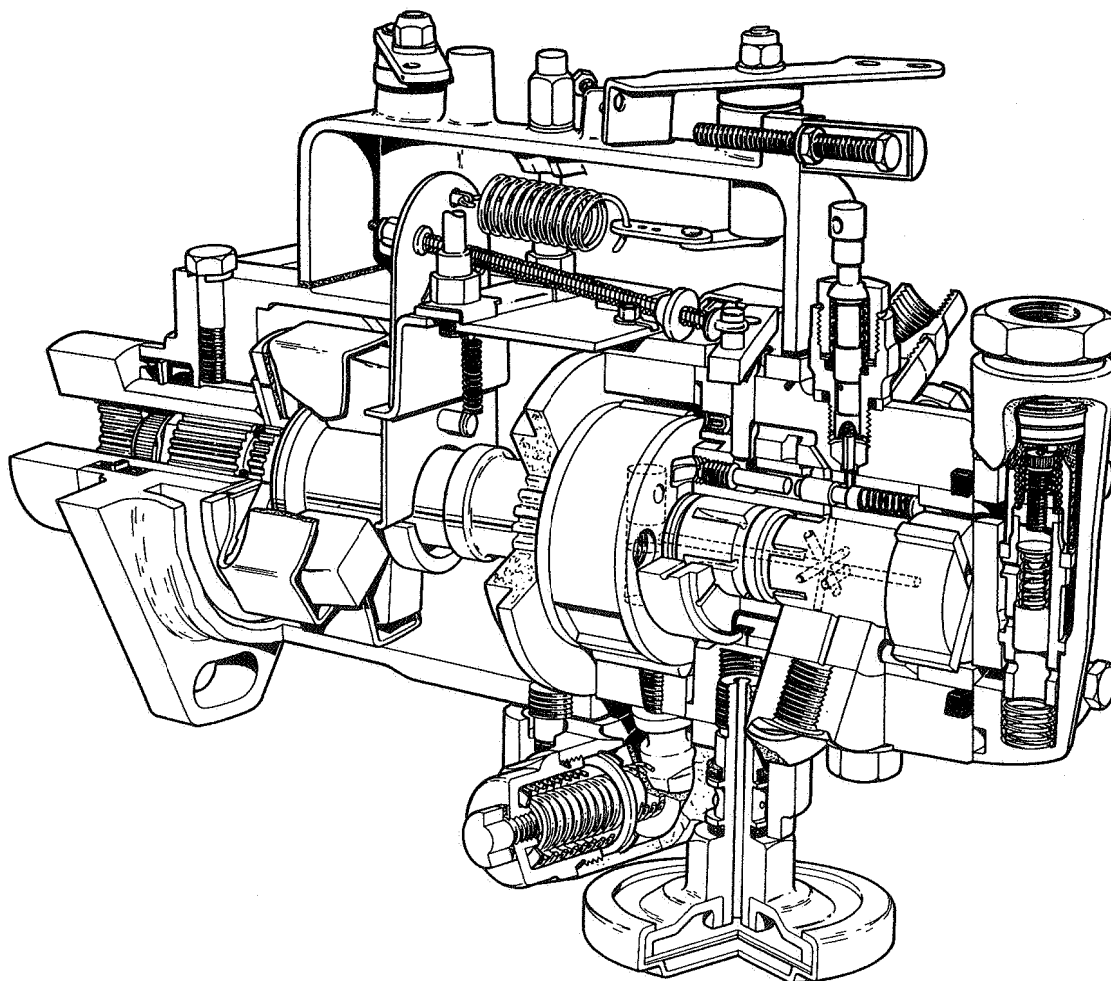


Fig 79 Removing drive hub seal



## ASSEMBLY

Immerse the two new replacement drive hub seals in clean test oil. The drive hub seals must be inserted in the same position noted prior to dismantling. Using Tool Part No 7244-154 in the manner shown in Fig 80, fit the inner drive hub seal. Next, assemble the housing circlip with its open end adjacent to tell-tale holes where provided and then fit outer drive hub seal, again using Tool Part No 7244-154.

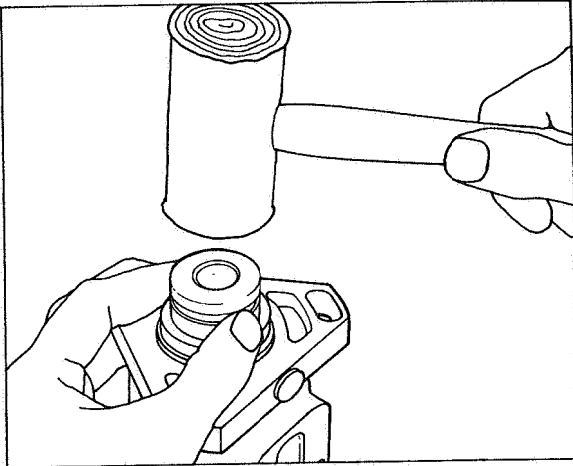


Fig 80 Fitting drive hub seal

Secure Fixture Part No 7044-888F in vice with thumbscrews towards vice handle. Secure the pump to the fixture with pump governor control machined face upwards. Moisten drive hub seals with clean test oil then insert drive hub through fixture into pump housing.

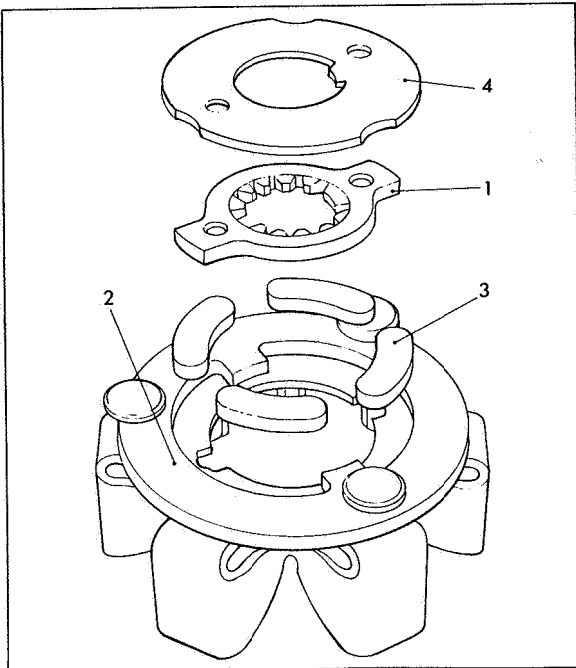


Fig 81 Assembling governor weight retainer

Assemble cush drive splined hub (1) Fig 81 small diameter end downwards, into cush drive retainer (2) and align holes with cut-outs in retainer. Assemble cush drive rubber inserts (3). Position cush drive back plate (4) so that the three notches slide over the three rivet heads, then rotate plate until the internal lip aligns with the lip on the cush drive splined hub.

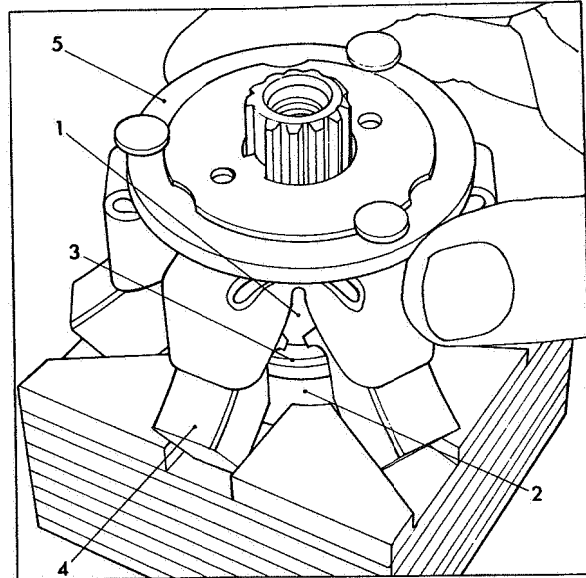


Fig 82 Inserting drive shaft & weight assembly

Place drive shaft (1) Fig 82 into fixture 7144-894, seal groove uppermost. Assemble thrust sleeve (2) stepped end downwards, then thrust washer (3). Offer up a governor weight (4) and adjust the height of the fixture until the lip of the governor weight sits on the thrust washer. Place remaining governor weights in a similar position around the drive shaft. Align drive shaft with cush drive hub splines and slide cush drive retainer assembly (5) onto weights. Using Protection Cap Part No 7144-900 assemble drive shaft seal. Take off protection cap and remove complete assembly from the fixture.

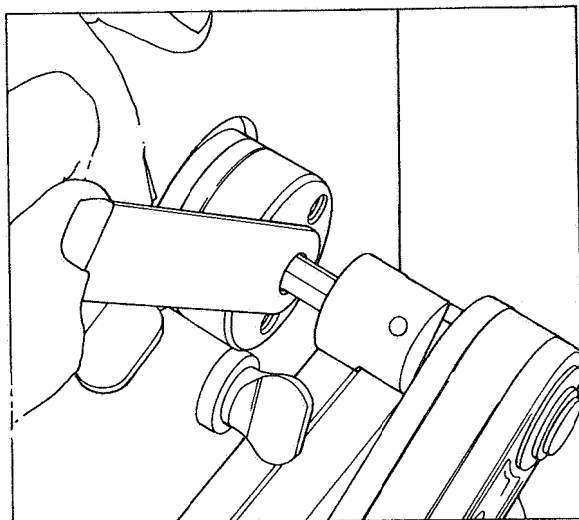
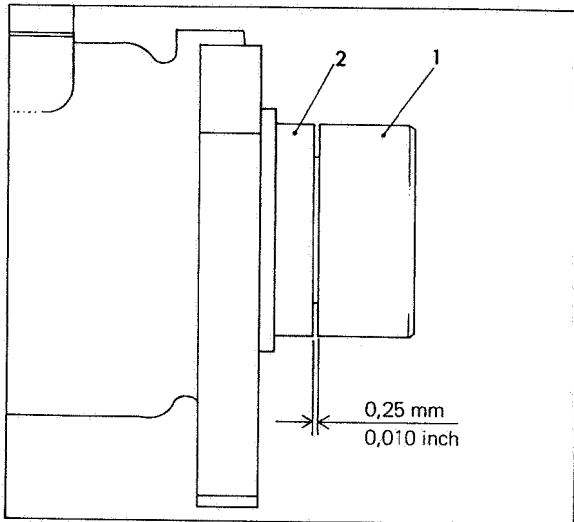


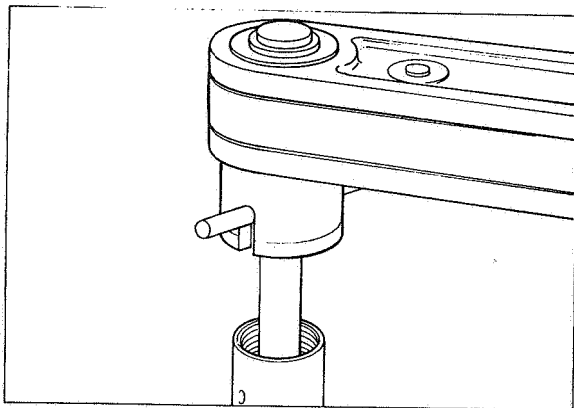
Fig 83 Tightening drive shaft screw

Insert drive shaft and weight assembly into hub, weight retainer end first. Secure with support washer, drive screw spring washer and drive shaft screw and tighten to correct torque value using Tool Part No 7144-261 while holding drive hub with Tool Part No 7144-773 as shown in Fig 83.



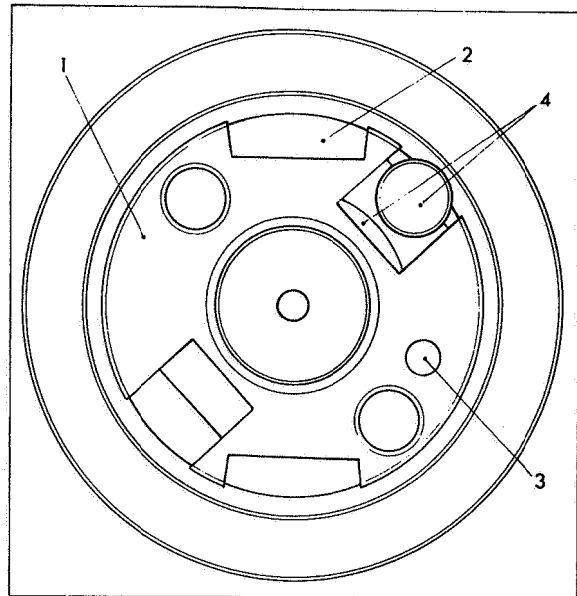
**Fig 84** Checking drive shaft end float

Check the drive shaft end float. This should not exceed 0,25 mm (0,010 in) measured between the rear face of the hub (1) and the pump body (2) as indicated in Fig 84. If this dimension is exceeded, the weight retainer or pump body must be renewed and the end float re-checked.



**Fig 85** Tightening distributor head rotor screw

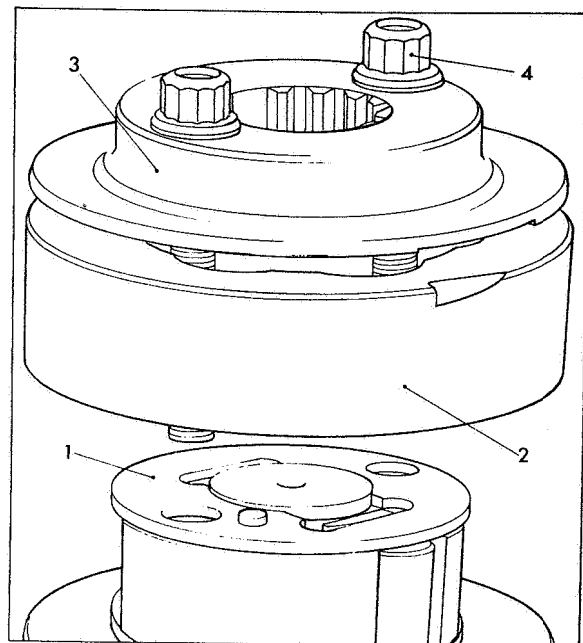
If the distributor head rotor screw has been removed or is loose, a new screw and washer is required. The method of fitting is as follows. Unscrew and remove the transfer pump rotor. Detach distributor rotor from hydraulic head. Screw the drive plate screws fully home into the distributor rotor. Mount the rotor vertically so that the heads of the screws only are gripped lightly by the jaws of a vice. Thoroughly degrease threads of rotor and screw and lightly smear the threads of the screw with 'Araldite'. Using Tool Part No 7144-220 as shown in Fig 85 tighten rotor plug screw to correct torque value and allow 'Araldite' to harden for six hours at room temperature before putting pump into service.



**Fig 86** Roller & shoe assemblies

Position hydraulic head on bench with machined surfaces uppermost as viewed from top in Fig 86. Remove distributor rotor (1) and place bottom stop plate (2) with its chamfered edges uppermost on hydraulic head. Replace distributor rotor, align dowel holes in distributor rotor and bottom stop plate and insert stop plate dowel (3).

Remove the corks retaining the twin pumping plungers in the rotor transverse bores. Insert the roller and shoe assemblies (4) with their ears inwards into the roller shoe guides as shown. The projecting ears on the shoes must be placed in the slots of the bottom stop plate.



**Fig 87** Top adjusting plate alignment

Locate the top stop plate (1) Fig 87 with its chamfered edges downwards over the dowel and the projecting ears of the shoes. Assemble cam ring (2) notch uppermost. Position drive plate (3) with its slot over the dowel and secure with drive plate screws (4).

Hold drive plate with Tool Part No 7044-894E and tighten drive plate screws to correct torque value using Tool Part No 7144-511A. Now slacken these screws and re-tighten to the same torque value. It is important that this procedure of tightening, slackening and re-tightening is followed. Tighten screws evenly to avoid rotor distortion which can cause sticking plungers.

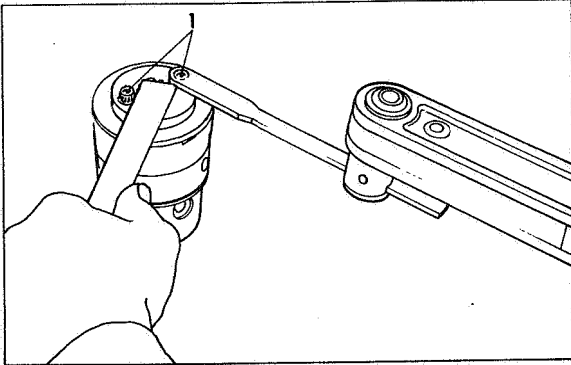


Fig 88 Tightening drive plate screws

**Note:** Drive plate screws (1) Fig 88 are tightened using a special technique with Spanner Tool Part No 7144-511A and an adaptor fitted in a torque wrench as illustrated. In use, the torque wrench handle and spanner must form a straight line with the handle extending away from the spanner. The distance between the centre of the adaptor and the centre of the ring spanner is 127 mm (5,0 in). With superseded Spanner Tool Part No 7144-511 the distance is 66 mm (2,6 in). See list of Torque Values, Page 40. Certain designs of torque wrench are not suitable for this operation. If the tools used are not kept in a straight line, the applied torque will be incorrect. Lift head and rotor assembly and screw transfer pump rotor finger tight into distributor rotor body.

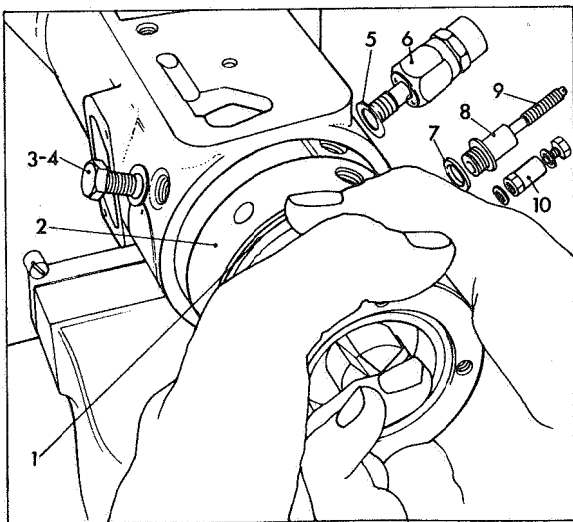


Fig 89 Inserting hydraulic head

Assemble new seal (1) Fig 89 to hydraulic head and rotor assembly (2), lubricate with clean test oil the portion of the head that fits into the pump housing, offer up the hydraulic head to the pump housing. Insert the head into position with a rotating motion so that the splines on the inner end of the drive shaft engage with the splines in the drive plate. Rotating the head on entry prevents damage to the seal. Align its metering valve bore with contour in machined face of housing and when the head is in position, secure with head locking screw and washer (3 & 4) and cambox proportional pressurising valve and washer (5 & 6) finger tightened and in the same positions as noted when dismantling.

If the shuttle valve piston has been removed, it should be inserted, cone end first, into shuttle valve body bore in the hydraulic head. Fit new seal (7) and screw shuttle valve body (8) into hydraulic head, tightening it to the correct torque value with Tool No 17 CSA manufactured by M Semet and Co of 27 Ashley Place London S W 1. Insert shuttle stop screw (9) with slot to the top and screw in three or four turns, then screw on shuttle tubular nut assembly (10) finger tight.

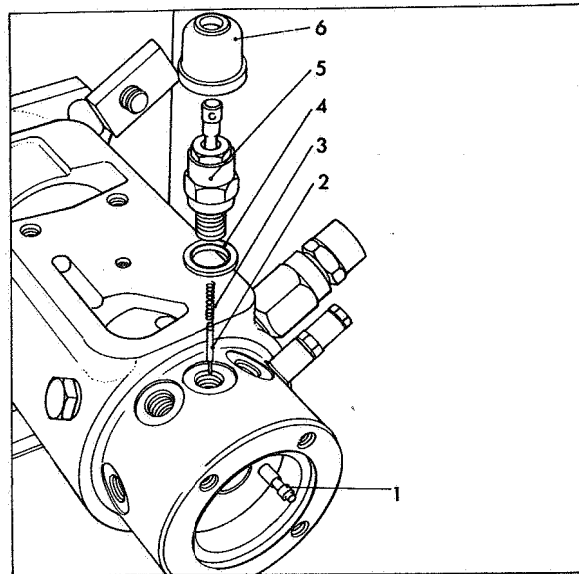


Fig 90 Inserting dumb-bell valve

Holding the grooved end, insert the dumb-bell valve (1) into its bore as shown in Fig 90. Looking down the excess fuel device bore, gently push dumb-bell valve along until the groove lines up with the latch pin hole. Assemble latch pin (2) with the small spigot end engaging in the groove of the dumb-bell valve.

Assemble latch pin spring (3) excess fuel adaptor washer (4) and excess fuel assembly (5). After tightening the excess fuel assembly to correct torque value, place excess fuel cover (6) in position.

Invert fixture in vice and screw cam advance screw into cam ring. Tighten to correct torque value using Tool Part No 7144-14. Remove tool and lightly tap cam advance screw to ensure the cam ring is not binding in the pump body.

## TWO STAGE AUTOMATIC START RETARD DEVICE

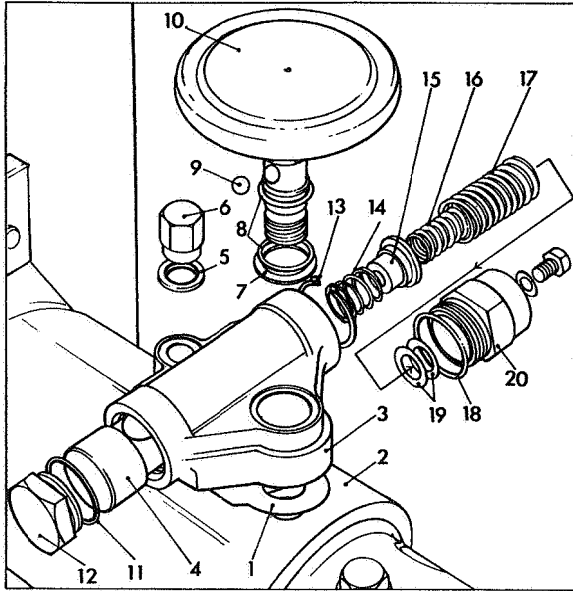


Fig 91 Assembling auto advance device

Offer up new housing gasket (1) Fig 91 to pump housing (2). Inspect piston housing (3) to ensure that the blank end of piston (4) is towards the oil feed drilling end of piston housing. Assemble the housing and piston assembly to the pump housing. Ensure that the cam advance screw engages with the piston and lightly secure the assembly in place with cap nut washer and cap nut (5 & 6). Assemble washer (7) into piston housing, stud seals (8), and steel ball (9) to damper (10). Screw in damper to pump housing and progressively and evenly tighten cap nut, damper, head locking screw and cambox proportional pressurising valve to correct torque values. Ensure the piston moves freely.

Assemble piston plug seal (11) to piston plug (12) and screw into housing. Assemble housing circlip (13), short piston spring (14), spring plate (15), inner piston spring (16), and outer piston spring (17). Assemble spring cap seal (18), insert shim washers (19) to piston spring cap (20) and screw into piston housing. Tighten plug and cap to correct torque values.

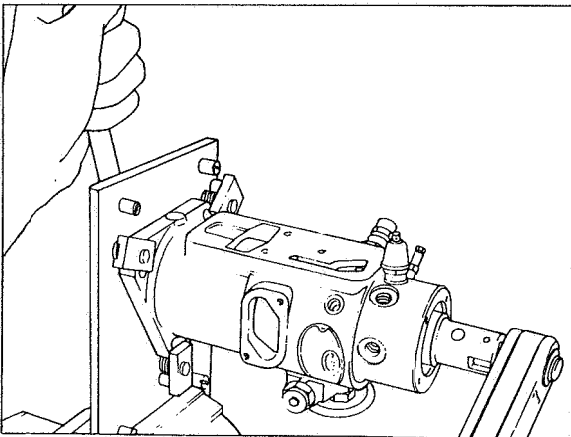


Fig 92 Tightening transfer pump rotor

Invert pump assembly and fixture in vice so that the governor housing face is uppermost as shown in Fig 92.

Hold the drive hub with Tool Part No 7144-773 and tighten the transfer pump rotor with Tool Part No 7044-889 to the correct torque value. The transfer pump rotor must be tightened in the opposite direction of pump rotation.

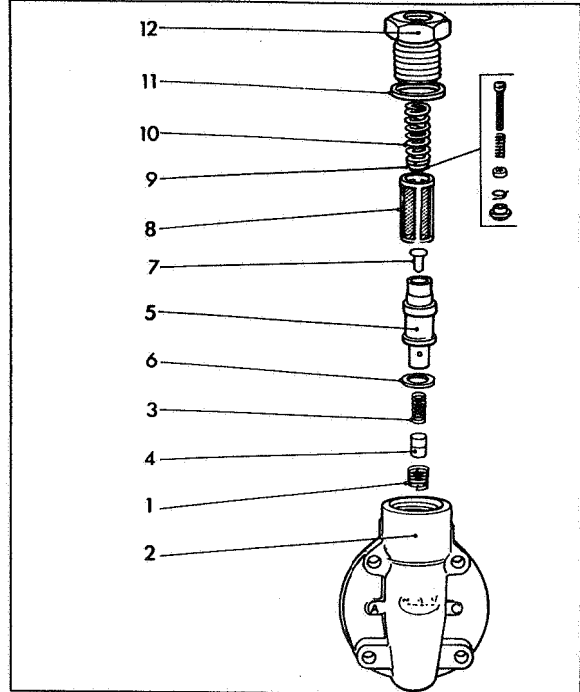


Fig 93 End plate assembly

Place piston retaining spring (1) Fig 93 into end plate (2). Insert first, the piston regulating spring (3), then the regulating piston (4) into the small diameter end of the regulating sleeve (5) and assemble a new sleeve washer (6) to the same end of the regulating sleeve. Insert the small end of the spring peg (7) into the large diameter end of the regulating sleeve and slide the complete assembly into the end plate, spring peg uppermost. Assemble filter (8), transfer pressure adjuster (9) and sleeve retaining spring (10) into the end plate and secure with inlet connection and washer (11 & 12).

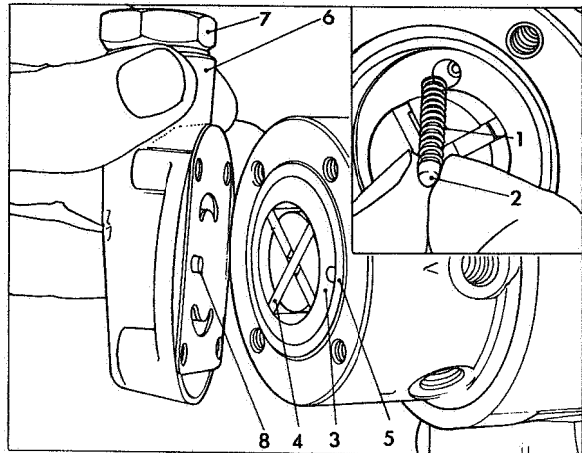


Fig 94 Fitting end plate assembly

Insert dumb-bell valve spring and pin (1 & 2) Fig 94 into hydraulic head as shown. Before assembling transfer pump liner (3) into pump housing ensure that the slot is in the same position it occupied prior to dismantling. See table:

Pump rotation viewed from drive end	Transfer pump liner slot viewed from rotor end
Clockwise	3 o'clock
Anti-clockwise	9 o'clock

Insert the transfer pump liner into the pump housing and hold in position while inserting the transfer pump blades (4). Insert transfer pump seal (5) and ensure that it holds the transfer pump liner in position in the hydraulic head.

Place the end plate (6) with the inlet connection (7) uppermost onto the hydraulic head ensuring that the dowel (8) on the inner face of the end plate engages in the slot in the transfer pump liner.

Secure the end plate with the four end plate screws. Tighten these screws and the inlet connection to the correct torque values.

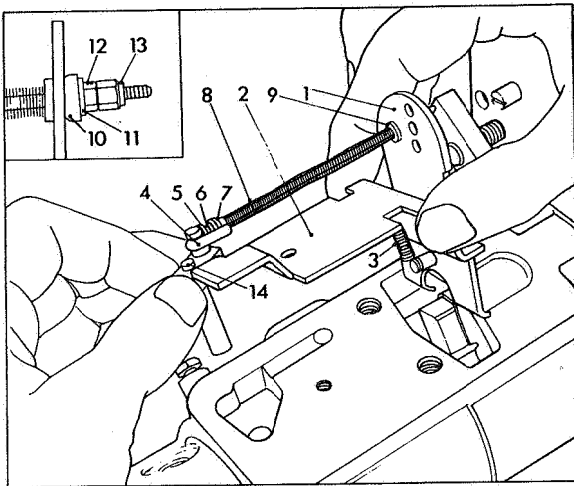


Fig 95 Assembling governor linkage

Assemble governor arm (1) Fig 95 to control bracket (2) and fit governor arm spring (3). Assemble spring linkage components onto the linkage hook (4) in the following order:— small spring retainer (5) large end first, short linkage spring (6), spring retainer (7) large end first, long linkage spring (8) and linkage spring washer (9). Pass the linkage hook stem through the correct hole in the governor arm and continue assembling linkage pivot ball (10), pivot ball washer (11), linkage nut (12) and locking nut (13). Attach metering valve (14) to hook linkage as illustrated.

Position the governor control linkage assembly into the pump housing by engaging the toe on the lower end of the governor arm on top of the step of the thrust sleeve and, at the same

time, insert metering valve into the metering valve bore in the hydraulic head.

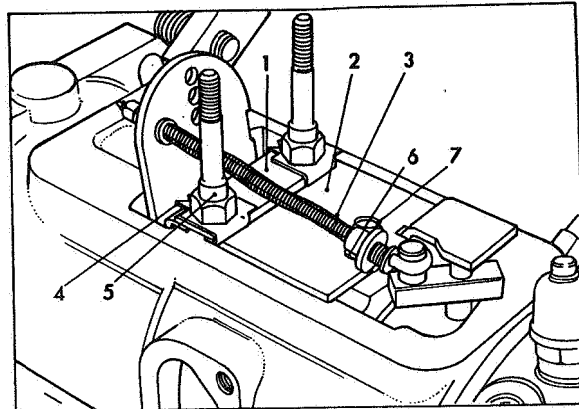


Fig 96 Fitting governor linkage

Position the keep plate (1) Fig 96 on the control bracket (2) so that the slotted end faces away from the linkage hook assembly (3). Position the two new tab washers (4) with the lips positioned nearest to the metering valve and engaging the long edge of the keep plate. Screw in the two governor control cover studs (5) and finger tighten. Place the bracket screw tab washer (6) in the correct position shown with the tail bent down over that edge of the control bracket lying under the hook of the linkage assembly. Insert new bracket screw (7) and tighten bracket screw and control cover studs to correct torque values. Lock all tabs.

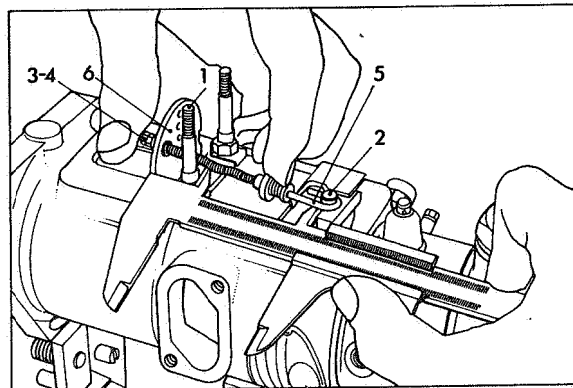


Fig 97 Setting governor linkage

Set the link length with a vernier gauge as shown in Fig 97 so that the correct internal dimension is obtained between the larger diameters of the governor control cover stud (1) and the metering valve lever pin (2). Adjustment is made by slackening the linkage locking nut (3) and tightening or loosening the linkage nut (4) on the end of the hook linkage (5). When setting, apply light pressure to the governor control arm (6) to hold the metering valve in the fully open position. Ensure that the vernier gauge is held parallel to the axis of the pump. After setting, tighten linkage locking nut.

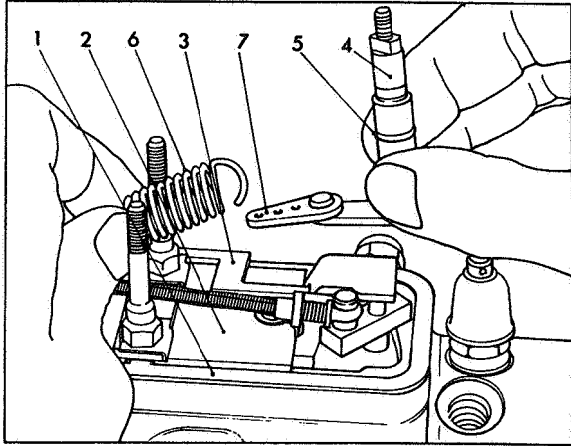


Fig 98 Assembling throttle link

Position housing gasket (1) Fig 98 on the governor housing face with the gasket tongues placed in the slots of the control bracket (2). Slide the shut-off bar (3) into the cut-out in the control bracket. Fit Protection Cap Part No 7144-459A to the throttle shaft (4) and assemble new shaft seals (5). Place the idling spring onto the idling spring guide and insert into the correct hole in the governor arm. Attach the governor spring (6) to the idling spring guide and to the correct hole in the throttle shaft link (7) as stated in the Test Data or Code. The application of the setting code details is given in Fig 99.

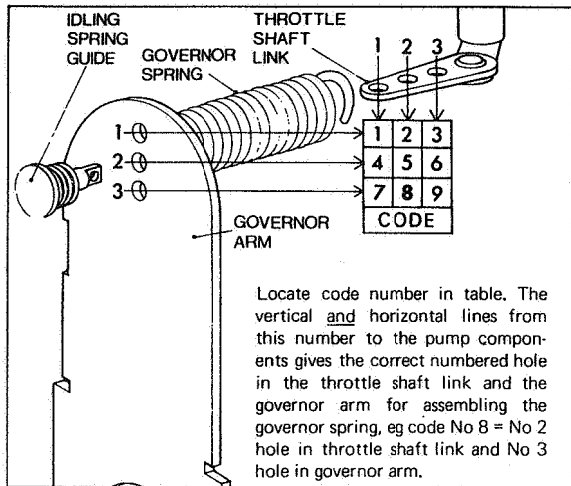


Fig 99 Application of setting code

Fit Protection Cap Part No 7144-459 and place new shaft seals onto shut-off shaft. Insert shaft into governor control cover then remove protection cap. Position the peg towards the edge of the cover.

Insert throttle shaft into the governor control cover, and at the same time, locate the governor control cover onto the two control lever studs.

While lowering the governor control cover into position onto the pump housing engage the shut-off shaft peg in the crook of the shut-off bar. Remove protection cap.

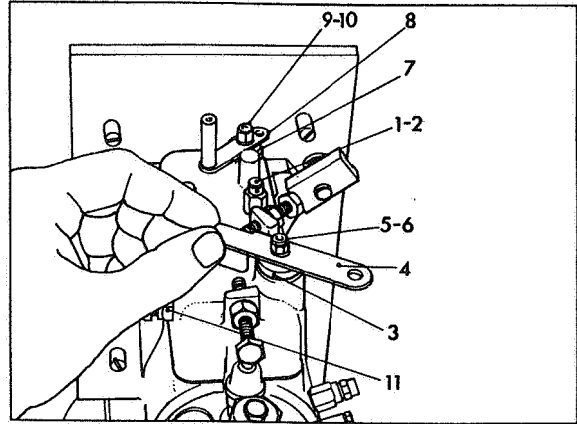


Fig 100 Fitting throttle arm

Assemble cover stud washers and cover stud nuts (1 & 2) Fig 100 and tighten. Assemble throttle dust cap (3), throttle arm (4), throttle lever washer (5) and screw on the throttle lever nut (6). Assemble shut-off dust cap (7) shut-off lever (8), shut-off lever washer (9) and screw on the shut-off lever nut (10). Assemble vent screw assembly (11) and tighten all nuts to correct torque values.

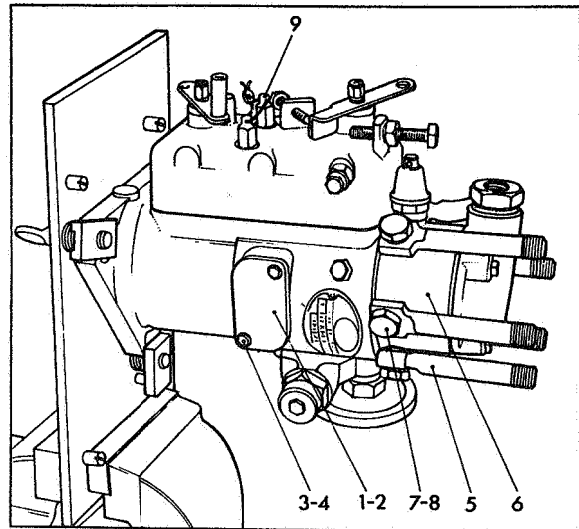


Fig 101 Assembled pump

Assemble inspection cover plate and inspection cover plate gasket (1 & 2) Fig 101 to pump housing and secure with cover plate screws and washers (3 & 4). Tighten screws to correct torque values. Assemble banjos (5) to hydraulic head (6) and secure with connection studs and washers (7 & 8) in their respective positions as noted when dismantling. Tighten all connection studs to the correct torque values. Where possible, check that all other components have been tightened to the correct torque values. These are listed on Page 40.

Wire and seal cover stud nuts (9) in accordance with Service Instructions. Ensure that a locking sleeve, a suitable length of locking wire with an unclenched seal is loosely attached to the pump for sealing the throttle adjusting screw after final setting on the engine.

## PRE-TEST PROCEDURE

### PRESSURE TESTING

All pumps must undergo a pressure test **BEFORE** and **AFTER** machine test, using the following method:

- 1 Drain all fuel from the pump and connect an air line to the pump inlet connection. Ensure the air supply is clean and free from water.
- 2 Seal off the low pressure outlet connection on the pump and completely immerse pump in a bath of clean test oil. On pumps fitted with the proportional pressurizing valve, which must be sealed off when pressure testing, do not disturb the joint between the outer connection and body of the valve which is sealed with 'Loctite'.
- 3 Raise the air pressure in the pump to 1,41 kg cm<sup>2</sup> (20 lb in<sup>2</sup>). Leave the pump immersed in oil for 10 minutes to allow any trapped air to escape.
- 4 Observe for leaks after pump has been immersed for 10 minutes, if the pump is not leaking reduce the air pressure to 0,14 kg cm<sup>2</sup> (2 lb in<sup>2</sup>) for 30 seconds; if there is still no leak increase the pressure to 1,41 kg cm<sup>2</sup> (20 lb in<sup>2</sup>) and if the pump is still leak free after 30 seconds it can be passed as satisfactory.
- 5 On pumps without a drive shaft oil seal it is necessary to

stop the oil leaking past the drive shaft during pressure testing. Tool Part No 7144-760 can be used but it is necessary to blank off the 12 x 1,5 mm threaded connection.

- 6 All leaks must be rectified before testing and setting the pump.

### SEAL TESTING

Certain pumps have a single-piece drive shaft with two inward-facing lipped oil seals. The gap in the circlip between the seals lines up with a tell-tale hole in the pump body. The inner seal, nearest to the governor sleeve, is checked by the normal pressure test, leakage being indicated at the tell-tale hole.

A special tool Part No 7144-760 is used for testing the outer seal, and this consists of a flanged cylinder with three fixing studs, an air pressure connection and a sealing gasket. The tool is attached to the pump mounting flange, and a supply of filtered air applied to the connection. The DPA pump and the tool are immersed in a bath of clean test oil, and air pressure applied at 0,28 kg cm<sup>2</sup> (4 lb in<sup>2</sup>) for 20 seconds. Bubbles at the tell-tale hole normally indicate an oil seal failure but first ensure that these are not caused by a faulty gasket.

## TEST PROCEDURE

An individual test plan, quoting the despatch numbers of the range of pumps to which it may be applied, is published for each different model manufactured. The sequence of operations listed in the test data for the particular type of pump gives the test performance requirements at various pump speeds, the timing procedure and any special precautions necessary to safeguard the pump.

**Note:** All pump tests, calibrations and settings must be made using the specified test oils given in the CAV Test Plans. Where the word 'fuel' is used in the following test instructions this means the approved test oil and **NOT** diesel fuel.

### TEST MACHINE

A typical test machine, adapted for use with DPA pumps, is shown in Fig 102. A suitable test machine must incorporate the following features:

- 1 A mounting bracket, with or without a distance piece, for holding the pump.
- 2 A splined drive coupling for rotating the pump in either direction at all speeds specified in the test data.

**Note:** The pump **MUST** be rotated in the direction given in the test data and indicated on the pump nameplate. Incorrect rotation will cause serious damage.

- 3 A set of high pressure pipes, 863,6 mm long x 2 mm bore x 6 mm outside diameter, for coupling the pump outlet connections to a matched set of injectors (type BDN 12SD12, set at 175 atm opening pressure).
- 4 An automatic trip mechanism that directs test oil from the injectors into graduated glasses during the period stated in the test data and then diverts the oil into a drain.
- 5 A set of graduated glasses for measuring the output from each injector, and one glass of larger capacity to measure the volume of back-leakage oil.
- 6 An oil feed system giving an adequate supply at constant pressure at the pump inlet. Required maximum flow at the pump inlet is 1,000cm<sup>3</sup> (61 in<sup>3</sup>) per minute. If this figure is not obtainable with a gravity feed, a pressure feed of 0,14 kg cm<sup>2</sup> (2 lb in<sup>2</sup>) can be used.
- 7 One pressure gauge and one vacuum gauge for testing the output and efficiency of the transfer pump.

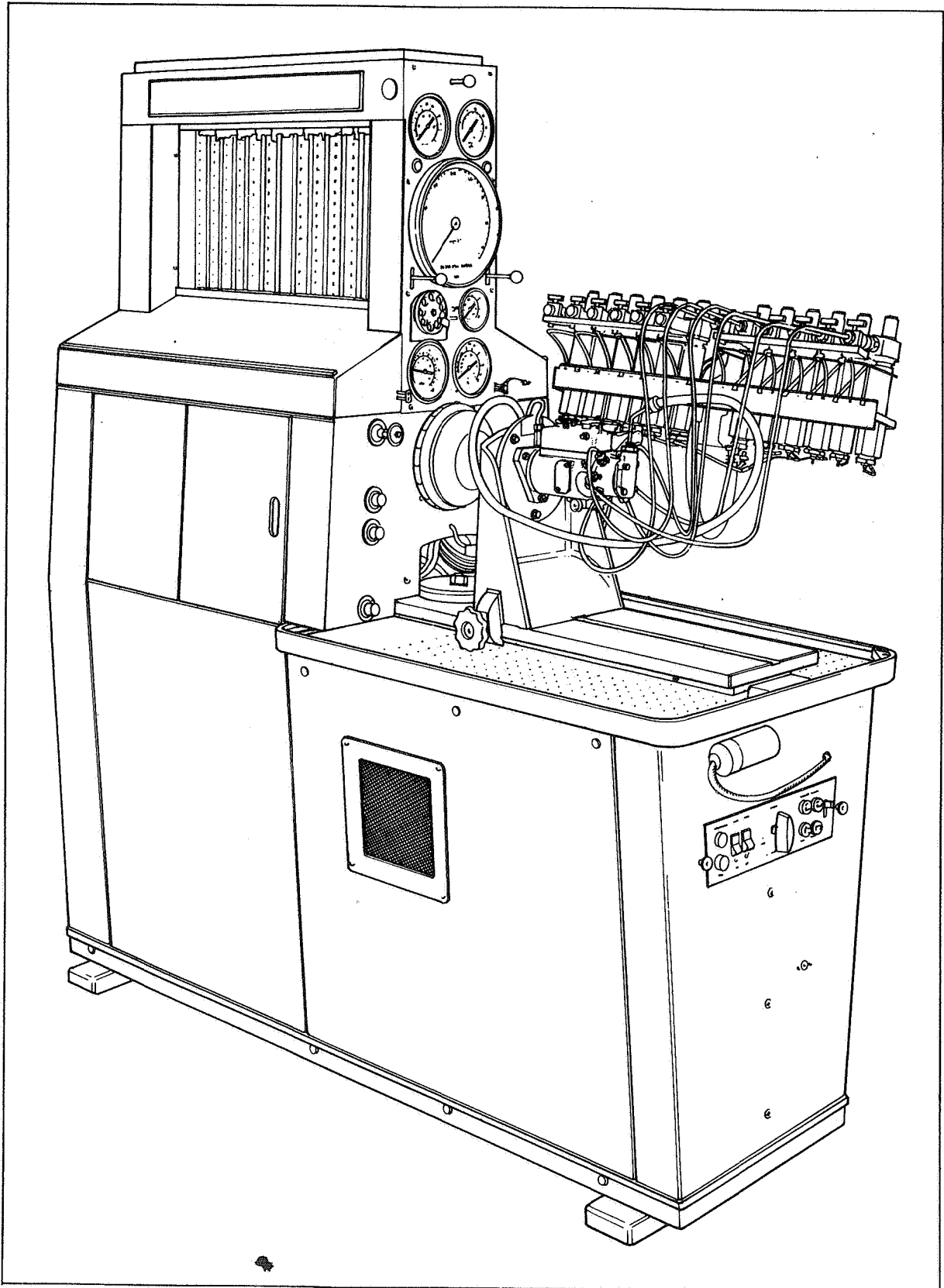


Fig 102 Test machine with DPA pump

## DRIVES for UP-RATED PUMPS

With pumps of this type, ascertain the type of drive shaft fitted. This can be either a supported or a floating drive shaft. Supported drive shafts are identified by a shallow counterbore at the drive end, or on some early pumps by a line machined on the end of the shaft. Floating shaft drives have no identifying mark.

On a supported drive shaft pump, a flexible drive is necessary to avoid misalignment between the bearing in the pump and the machine drive bracket causing bearing failure or seizure.

On a floating drive shaft pump a rigid or supported drive is required.

Certain up-rated pumps require a special drive hub instead of the normal hub for the tests, but after testing and before flange timing, the normal hub must be refitted on the pump.

## GENERAL PROCEDURE

The following precautions must be observed:

- 1 The test machine must be set to run in the correct direction of rotation for the pump under test.
- 2 The pump must not be run with a low output for long periods at high speed.
- 3 The pump must not be run for long periods with shut-off control in the closed position.
- 4 The correct test machine adaptor plate must be used. A plate with a 50 mm hole must **NEVER** be used for a pump with 46 mm spigot.
- 5 Unless otherwise stated, standard radial high pressure connections must be fitted prior to testing. Information is given in the test data and explanatory notes.
- 6 Prime the pump thoroughly before testing also at all times indicated in the test plan.

## PRIMING

Variations for certain pumps are explained in test data.

- 1 Slacken both the vent valve on the governor control casing and the head vent screw.
- 2 Connect the oil feed pipe to the pump inlet and connect the back leakage pipe.
- 3 Turn on the oil supply to feed pressure 0,14 kg cm<sup>2</sup> (2 lb in<sup>2</sup>) to fill the pump. Run pump at 100 rpm. When test oil free from bubbles, issues from the vents, retighten the vent valve and the head locking screw.
- 4 Slacken the connections at the injector end of the high pressure pipes or if fitted on the test machine open the bleeder valves at the injectors.
- 5 Run the pump at 100 rpm. When test oil free from bubbles issues from all high pressure pipes, retighten the connections or close the bleeder valves.
- 6 Examine the pump after priming for oil leaks at all jointing

faces, connections and oil seals. Pumps must be free from leaks both when running and when stationary.

## TESTING

### PUMP OUTPUT

Fuel delivery is checked at full throttle setting at one or more speeds of rotation by measuring the volume passing through each injector during 200 pump cycles. The pump test data quotes the maximum fuel delivery, overall tolerance and the maximum permissible delivery variation spread between injectors.

### SHUT-OFF CONTROL

This is checked by running the pump at a specified speed, see test plan, with the shut-off control closed. The maximum fuel delivery permitted on this setting is quoted.

### MAXIMUM FUEL SETTING

#### Pumps with Internal Maximum Fuel Adjustment

On internally adjusted pumps, the maximum fuel delivery is checked at a specified speed, with throttle and shut-off controls fully open.

If output is not within the specified limits, adjust as follows:

- 1 Slacken the screws securing the inspection cover and drain the pump.
- 2 Remove the inspection cover.
- 3 Slacken the two drive plate screws.
- 4 Engage Tool Part No 7144-875 with the slot in the periphery of the adjusting plate.
- 5 Adjust the plate by lightly tapping the knurled end of the tool. The direction in which the drive plate is turned to increase or to decrease fuelling depends on the type of adjusting plates fitted.
- 6 Tighten the drive plate screws **EVENLY** to the listed torque value, using the Adaptor Tool Part No 7144-482, Spanner Tool Part No 7144-511A and a torque wrench.

**Note:** When the Adaptor Tool Part No 7144-482 is used with the superseded Spanner Tool Part No 7144-511, the centre of the spanner must be 66 mm (2,6 in) from the centre of the adaptor. When using the recommended Spanner Tool Part No 7144-511A the distance between spanner and adaptor centres is 127 mm (5,0 in). The torque spanner and the ring spanner must form a straight line when tightening the screws and care must be taken to ensure that the spanner does not contact the side of the inspection aperture.

- 7 Replace and secure the inspection cover, refill the pump, vent as necessary and re-check the maximum fuel delivery. Repeat until the volumes are within the specified limits.

#### Pumps with External Maximum Fuel Adjustment

To meet test requirements, adjust the maximum fuel setting by removing the shuttle plug screw, slacken the shuttle tubular nut and screw the shuttle stop screw inwards to reduce delivery, or outwards to increase delivery. After adjustment,

retighten shuttle tubular nut and replace shuttle plug screw.

To check excess fuel delivery, set pump in excess fuel position by moving the toggle lever while the pump is stationary or running at low speed.

### GOVERNOR TESTING

Run the pump at more than half the maximum permissible speed of the engine to which it will be fitted, and adjust the maximum speed stop until the specified fuel delivery is obtained. This specified volume is less than that at the maximum fuel setting. Reduce the speed of rotation, whereupon the fuel delivery should increase to a specified volume approximately equal to the maximum fuel delivery.

**Note:** Final governor setting must be carried out with the pump fitted to the engine, and in accordance with the engine manufacturer's instructions.

### TRANSFER PUMP SETTING

Transfer pump vacuum is checked while the pump is running at a low speed, with the two-way cock in the fuel feed line turned to the position that cuts off the fuel supply and connects the pump inlet to the vacuum gauge. A given depression must be obtained in a specified time.

**Note:** The pump may need repriming after this test.

Transfer pressure is checked at one or more specified speeds. One head locating screw is removed, and adaptor Tool Part No 7044-892 is screwed into the hydraulic head, and a pipe fitted between the pump and the pressure gauge of the test machine. Transfer pressure is read directly from the gauge.

### Transfer Pressure Adjustment

Transfer pressure is controlled by the regulating valve in the end plate. To adjust the transfer pressure the operation of the regulating valve is modified as follows:

On certain pumps with aluminium end plates, the transfer pressure can be adjusted within the limits of an individual specification in one or both of two ways: (a) by changing the end plate sleeve plug, and (b) by the adjustment of the screw passing through the plug.

Several plugs with different step thicknesses are available; the stepped portion in contact with the regulating spring determining the spring compression. The screwed transfer pressure adjuster limits the movement of the regulating piston and so controls the maximum uncovered area of the sleeve port. Method (a) modifies transfer pressure characteristics over the lower and middle speed ranges; method (b) controls the pressure rise over the upper speed range.

There is a third type of transfer pressure adjuster which varies the pre-loading of the regulating spring and maximum lift of the piston. It has a spring peg fitted between the adjusting screw and regulating spring. This has the same effect as method (a), but allows more variation and gives easier adjustment.

Additional information is given in the individual pump test data.

Tools are available for setting the screwed adjuster in the end plate while the pump is running. If a change of end plate sleeve

plug is necessary to comply with the test plan, the appropriate part numbers and the item designation are given in the Parts List.

### PRESSURISED CAM BOXES

The test pressure gauge is fitted to the governor housing vent screw hole. On self-venting pumps this must allow the pressure to be read without restricting the permanent bleeding operation. This can be carried out by using the requisite tools from Service Kit Part No HF 531. Available from Leslie Hartridge Ltd Buckingham Bucks.

On some pumps the cam box is pressurised during running by a spring-loaded ball pressurising valve located in the back leakage connection in the inspection cover. On pumps designed to provide an excess fuel facility this operation is carried out by the proportional pressurising valve.

Pressure limits are given in the appropriate test data. If pressure is incorrect, check that the pump is not leaking and there is no restriction in the back leakage passages. If the pressurising valve is faulty, a new inspection cover complete with valve must be fitted; or on pumps with excess fuel facility a new proportional valve must be fitted.

### TESTING of ADVANCE DEVICES

The appropriate test plan for the individual pump specifies the type of advance device fitted and details the tests for the particular unit.

All advance devices are tested using special Tool Part No 7244-59 which consists of a gauge with a scale covering 0 to 18° and a feeler pin Tool Part No 7244-70. To fit this tool, proceed as follows:

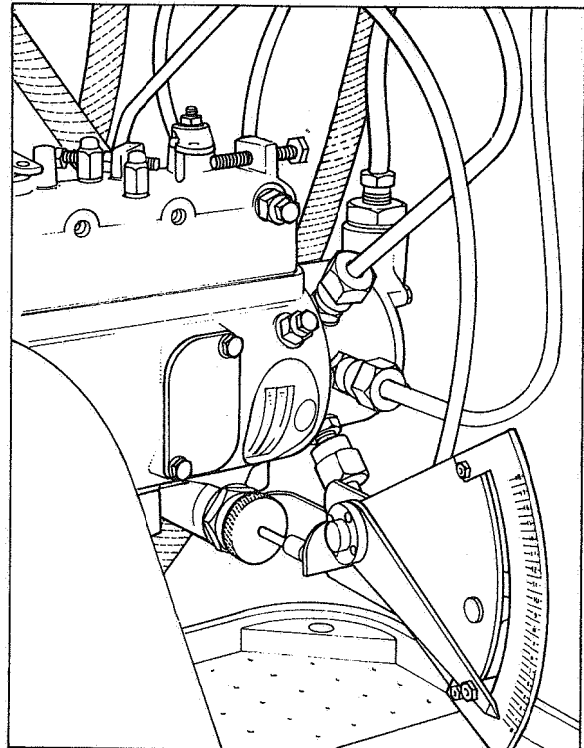


Fig 103 Cam advance checking tool

- 1 Remove the small screw from the piston spring cap on the advance device.
- 2 Pass the threaded bush of the feeler pin assembly through the hole in the tool bracket.
- 3 Insert the end of the plunger into the hole in the spring cap and screw the bush into the spring cap hole. This will clamp the bracket between the spring cap and the shoulder on the threaded bush, Fig 103.
- 4 Zero the gauge by moving the scale relative to the pointer.

**Note:** The pump must be reprimed after fitting the tool. After priming operate the throttle and press inwards and release the advance gauge pin a few times with the pump running at 100 rpm.

#### Speed Advance Device

The tests outlined in the test data must be applied to ensure that the degree of advance obtained is within the stated limits at the speeds specified. To adjust the degree of advance, increase or decrease the thickness of the shims between the piston spring and the spring cap, see test data. When the tests are satisfactory, remove the special tool and prime the pump.

#### Light Load Advance

As the light load advance is sensitive to load, it responds to changes of fuelling and therefore to changes in the position of the metering valve. The pump test plan lists the checks to be made at various speeds, with specified fuel deliveries at different shut-off lever settings. These are set with the shut-off lever adjuster Tool Part No 7144-559. At each setting, a specified advance should be obtained. Adjustment is made by moving the angular adjustment screw on the governor housing, and by varying the thickness of shims fitted between spring and spring cap in the auto-advance device. When the tests are satisfactory, remove the special tool and prime the pump.

#### Combined Load and Speed Advance

These tests, at different speeds and fuel deliveries, check the movement of the outer piston in response to changes of speed, and of the inner piston to changes of load. Adjustment is made by altering the thickness of the shims beneath inner and outer piston springs. When the tests are satisfactory, remove special tool and prime the pump.

#### AFTER TESTING

On completion of all previous tests, the drive shaft screw must be slackened and retightened three times to the correct torque value.

#### TIMING

All pumps require timing. See test plan for relevant details.

After completion of tests remove the pump from the test machine and drain by slackening the inspection cover screws. Remove the inspection cover. For internal or external timing connect the stirrup pipe Tool Part No 7144-262A (part of Tool Part No 7144-262) to the fuel outlet specified on the test plan and to the outlet diametrically opposite. Fit the relief valve Tool Part No 7144-155 (part of Tool Part No 7144-262) to the

stirrup pipe, and connect the complete tool through a high pressure pipe to a nozzle testing unit.

For 3-cylinder pumps, connect one branch of the stirrup pipe to the specified outlet, and arrange the other branch to face away from the pump and seal it off with blanking plug.

Normally a pressure of 30 atm with a relief valve fitted in the system is specified in the test data but sometimes a higher pressure is quoted. To obtain the higher pressures, connect the stirrup pipe direct to the nozzle testing unit, omitting the relief valve. **Do not exceed the specified pressure. Excess pressure can cause damage to the shoe assemblies and adjusting plates.**

Turn the pump drive shaft in the direction indicated on the nameplate until resistance to further movement is felt. This is the timing position. Access to the timing ring may be obtained through the inspection cover aperture. Move the timing ring until the straight edge of the timing circlip – or the line scribed on the ring in the case of old type clips – aligns with the mark on the drive plate as specified in the test plan. Circlips with two straight ears are only for spacing and the circlip ends are positioned remote from the inspection aperture. After carrying out this operation refit the inspection cover and tighten screws.

On pumps with an excess fuel device, the timing marks are machined on the drive plate and the cam ring and are not adjustable. To set the pump in the timing position, remove the inspection cover and turn the rotor until these marks are in alignment. After carrying out this operation refit the inspection cover and tighten screws.

The test data gives specific information about the timing mark on the pump flange. A flange marking gauge Tool Part No 7244-27 is available, and this consists of a cast aluminium body with a lock screw, around which slides a ring carrying the scribing plate. The ring is held in position by a scale plate on which direct readings in degrees are taken from the edge of the scribing plate. Interchangeable spigot plates, one with a 46 mm bore and one with a 50 mm bore, are held in position by a cap-head screw, and these accommodate the different pump spigots. Four interchangeable inserts adapt the gauge to any type of pump drive. The inserts are held by two screws and positioned relative to the scale zero by a dowel pin.

Tools required for flange marking:	Tool Part No
Flange marking gauge with 46 mm and 50 mm spigot plates	7244-27
Insert for standard DPA pump	7244-28
Spacer for 7244-28 on pumps with 50 mm spigot and standard drive	7244-29
Items 7244-27-28-29 as a collective tool assembly	7244-26
Insert for tapered drive shaft for up-rated pumps with gear mounted direct on pump shaft	7244-30
Insert for pump with gear hub	7244-31
Insert for pump with splined hub	7244-32

When using the insert, Tool Part No 7244-30, the gauge is fitted to the tapered shaft, located with the Woodruff key, and clamped in position by a 9/16 in UNF nut, fully tightened to ensure the correct location of the gauge on the drive shaft. A bar through the ¼ in hole in the insert holds it when tightening or removing the nut. A special extractor, Tool Part No 7044-690, fitted into the thread of the insert, permits withdrawal of the gauge after use.

The shafts and hubs normally used with the pumps must be used for flange mounting and timing. On uprated pumps when the gear hub is mounted on the drive shaft, or must be removed before fitting the pump to the engine, the drive shaft taper and the keyway are used as a datum.

To mark the flange, the pump is held in the timed position and the marking gauge, with the appropriate insert and spigot plate, is fitted to the pump drive and set to the indexing figure specified in the test data. Using the gauge as a template, scribe a line on the flange between the plates of the scribing gauge.

The quill drive where normally fitted to the pump must be used,

to allow for possible wear and machining tolerances. In certain instances it may be only necessary to check that the existing flange marking is accurate. If incorrect, the existing line is erased and the flange re-marked.

#### SEALING PUMPS

After test, the inspection cover of all pumps, with the exception of those with external maximum fuel setting adjustment and those internally timed, should be made tamper proof by passing wire through the two securing screws and affixing a lead seal. A sleeve should be fitted over the maximum fuel adjusting screw on externally adjusted pumps and secured with wire and lead seal. Governor maximum speed screws cannot be locked until the governor is set on the engine, so the cover, the wire and the lead seal should be attached to the pump in order that the pump can be made tamper proof after final adjustment.

#### TEST OILS

Approved test oils are given in the Test Data Explanatory Notes.

### LIST OF TORQUE VALUES

The torque values are correct at the time of printing. Any variations made necessary by modifications or changes in design will be published in the relevant Service Instruction Notes and the latest information must be followed.

ITEM	TORQUE			REMARKS
	Nm	Kg m	lb in	
End plate securing screws	5,1	0,52	45	Aluminium and steel end plates
Regulating valve plug	7,9	0,81	70	Steel end plate fitting only
Fuel inlet connection	50,8	5,18	450	Aluminium end plate
Fuel inlet connection	47,6	4,85	420	Steel end plate
Fuel inlet connection	13,5	1,38	120	On connection with olive
Fuel inlet adaptor	81,4	8,30	720	Steel end plate
Distributor rotor plug screw	3,1	0,32	28	Secured with 'Araldite'
Transfer pump rotor	7,3	0,75	65	Male thread
Head locating screw	32,4	3,30	285	Advance device not fitted
Head locking screw	19,1	1,95	170	With or without vent screw
Cam locating screw	29,9	3,05	265	Advance device not fitted
Head locating stud	39,5	4,03	350	Two-bolt advance device with Permanite gasket
Head locating stud, with or without start retard	39,5	4,03	350	Single bolt type, cork gasket
				<b>NOTE:</b> After securing a single-bolt advance device mounted on a cork gasket some settlement takes place. Five minutes after first tightening, give the fitting a sharp tap with a ½ lb hammer and tighten to the correct torque
Head locating stud, with or without start retard	39,5	4,03	350	Single-bolt type, Permanite gasket. No settlement.
Head locating stud, with or without start retard	33,8	3,45	300	Single-bolt type, rubber gasket
Cap nut	14,7	1,50	130	} { Two-bolt type with additional nut and stud. Lubricate stud prior to insertion
Housing stud	6,8	0,69	60	
Blanking plug, head locating fitting assembly	33,8	3,45	300	

ITEM	TORQUE			REMARKS
	Nm	Kg m	lb in	
Screw, cam advance 7123-289	33,8	3,45	300	*Advance cam screws can be distinguished by a tapered collar (3,8 mm thick) the major diameter of which bears against the cam ring. These should not be confused with the cam screws (7123-289 and 7123-623), which have an untapered collar of similar thickness
Screw, cam advance 7123-623	33,8	3,45	300	
Screw, cam advance 7123-383	33,8	3,45	300	
Screw, cam advance 7123-666	33,8	3,45	300	
Screw, cam advance 7123-936	33,8	3,45	300	
Screw, cam advance 7123-947	33,8	3,45	300	
Screw, cam advance 7123-945 (tapered collar)	50,6	5,18	450*	
Screw, cam advance 7123-975 (tapered collar)	50,6	5,18	450*	
Spring cap	28,4	2,90	250	
Spring cap screw	4,5	0,46	40	
Piston plug	28,4	2,90	250	Automatic advance device
Drive plate screw, direct torque	18,1	1,85	160,	Automatic advance device Plungers diameter up to and including 7,5 mm
Drive plate screw, direct torque	28,4	2,90	250	Plungers diameter 8,00 mm and above
Drive plate screw (A)	15,7	1,60	140	Plungers diameter up to and including 7,5 mm
Drive plate screw (A)	24,3	2,48	215	Plungers diameter 8,00 mm and above
Drive plate screw (B)	13,0	1,33	115	Plungers diameter up to and including 7,5 mm
Drive plate screw (B)	20,6	2,10	180	Plungers diameter 8,00 mm and above

(A) obtained with spanner 7144/511 and adaptor 7144/482  
(B) obtained with spanner 7144/511A and adaptor 7144/482

**NOTE:** Drive plate screws are tightened using a special technique with Spanner Tool Part No 7144-511A and an adaptor fitted in a torque wrench. In use, the torque wrench handle and spanner must form a straight line with the handle extending away from the spanner. The distance between the centre of the adaptor and the centre of the ring spanner is 127 mm (5,0 in). If superseded Spanner Tool Part No 7144-511 is used, this distance is 66 mm (2,6 in). Certain designs of torque wrench are not suitable for this operation. The tools used must be kept in a straight line to ensure that the applied torque is correct.

Control cover stud	6,8	0,69	60	
Control cover cap nut	4,5	0,46	40	Governor cover with Permanite gasket
Control cover cap nut	3,4	0,35	30	Governor cover with cork gasket
Throttle shaft nut	3,4	0,35	30	
Shut-off shaft nut	3,4	0,35	30	
Control bracket screw	2,3	0,24	21	
Throttle stop screw nut	2,2	0,23	20	
Drive shaft screw, 28,5 mm long	32,3	3,30	285	} { Slacken and tighten to the correct torque value. Carry out this operation three times.
31,7 mm long	36,3	3,70	320	
Backleak connection	20,6	2,10	180	
Governor vent body, screw	7,3	0,75	65	
Governor vent screw	4,5	0,46	40	
Banjo bolt, permanent vent orifice	27,1	2,76	240	Governor cover self-venting pump
Banjo bolt, backleak connection	40,7	4,15	360	Self-venting pump
Cambox proportional pressurising valve assembly	27,1	2,76	240	Pump with excess fuel and external maximum fuel adjustment
Shuttle stop body	19,1	1,95	170	External maximum fuel adjustment device
Adaptor body, excess fuel control device	14,7	1,50	130	Excess fuel type pumps
Gear attachment bolt	20,6	2,10	180	Secures gear to drive hub on pump with excess fuel device. <b>NOTE:</b> Bolt not supplied by CAV
Sealing bolt	10,2	1,04	90	On housing of some pumps with excess fuel device
Splined hub nut	81,4	8,30	720	} Heavy duty, up-rated drive. <b>NOTE:</b> Tighten using plain washer under nut. Remove plain washer, substitute spring washer and tighten
Gear hub nut	30,4	3,10	270	
High pressure connection, radial and banjo, or with pressurising valve	40,7	4,15	360	With steel washer
	30,4	3,10	270	With copper or 'Armco' iron washer

## SPECIAL TOOLS

Description	Part No
TOOL KIT in polished wood box 358 x 330 x 60 mm comprising:	7144-158Q
SOCKET, insert torque spanner, cam advance screw	7244-125A
TORQUE ADAPTOR, drive plate screw (used with 7144-511A)	7144-482
GAUGE, auto advance, complete with feeler assembly	7244-59
PIN, feeler for gauge (if required separately)	7244-70
TOOL, adjusting max fuel and extractor end plate sleeve, steel plate only	7144-875
SPANNER BOX, transfer pump rotor	7044-889
SPANNER, drive plate, slotted type	7144-744
SPANNER, rotor plug	7144-220
PROTECTION CAPS for:	
Auto advance cap and plug seals	7044-898
Head locating fitting seal (nearest bolt head)	7044-897
Head locating fitting seal (top seal)	7144-18
End plate sleeve seal (steel plates only)	7144-11
ADAPTOR, assembly, timing, complete with:—	
Valve, relief	7144-262
Pipe, stirrup	7144-155
Bolt, blank-off	7144-262A
GUIDE, drive hub oil seal 28,6 mm (1,25 inch) inside diameter 38 mm (1,5 inch) outside diameter	7144-558
ASSEMBLY FIXTURE, governor weight	7144-260A
DRIVE SHAFT, holding tool	7144-894
EXTRACTOR, drive hub oil seal	7144-773
TORQUE ADAPTOR, drive shaft screw	7044-893A
	7144-261
PROTECTION CAPS for:	
Throttle and shut-off shaft upper seal ( 2 off per set)	7144-459A
Throttle and shut-off shaft lower seal	7144-458A
Drive shaft seal (push drive type)	7144-900
Metering valve pinion seals	7144-8B
Idling stop and maximum speed stop seals	7144-124
Drive shaft seal, standard	7144-820
ALIGNMENT TOOL, metering valve	7144-508B
ALIGNMENT TOOL, oversize metering valve	7144-508C
SPANNER, drive plate screw	7144-511A
ASSEMBLY ROD, metering valve	7044-895
<b>ADDITIONAL TOOLS NOT INCLUDED IN TOOL KIT Part No 7144/158Q</b>	
ADAPTOR, transfer pressure gauge	7044-892
TESTING TOOL, outer seal, (For pressure testing mechanical governor pumps with two drive shaft seals separated by tell-tale hole)	7144-760
INSPECTION PLUG for seal	7144-13
PLATE, pump mounting	7244-155
ADJUSTMENT TOOL, shut-off lever for pumps fitted with light load advance device	7144-559A
KEY, regulator plug (steel end plates only)	7144-465
SPANNER, drive plate (Ford pump)	7144-939
PROTECTION CAP, single piece drive, shaft seal	7244-23A
GASKET, for 7144-760	7144-763
GAUGE FLANGE MARKING, for use on standard DPA pumps includes 7244-28 and 7244-29 and spigots for 46 and 50 mm dia pump mountings	7244-26
GAUGE FLANGE MARKING, basic gauge (less inserts) includes spigots for 46 and 50 mm dia pump mountings	7244-27
INSERT, for standard pumps (use with 7244-27)	7244-28
SPACER, long spigot pumps (use with 7244-27)	7244-29
INSERT, for uprated drive pumps, tapered shaft drive (use with 7244-26 or 7244-27)	7244-30
INSERT, for uprated drive pumps fitted with gear hub (use with 7244-26 or 7244-27)	7244-31
INSERT, for uprated drive pumps fitted with splined hub (use with 7244-26 or 7244-27)	7244-32
EXTRACTOR, for uprated pump drive hubs	7244-105
GUIDE, drive hub oil seal 22 mm (0,875 inch) inside diameter, 35 mm (1,375 inch) outside diameter	7244-154
PROTECTION CAPS for:	
Road speed limiting device	7244-3
Drive shaft seals (uprated type drive)	7244-15
SPANNER, slotted nut (uprated type drive) and spacer	7244-25
SPANNER, holding drive hub (uprated type drive)	7244-24