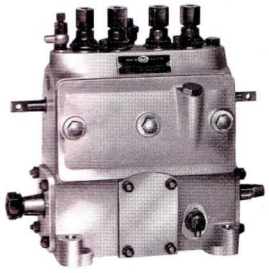
'N' & 'NN' TYPE FUEL INJECTION PUMPS



WORKSHOP MANUAL

'N' & 'NN' TYPE FUEL INJECTION PUMPS

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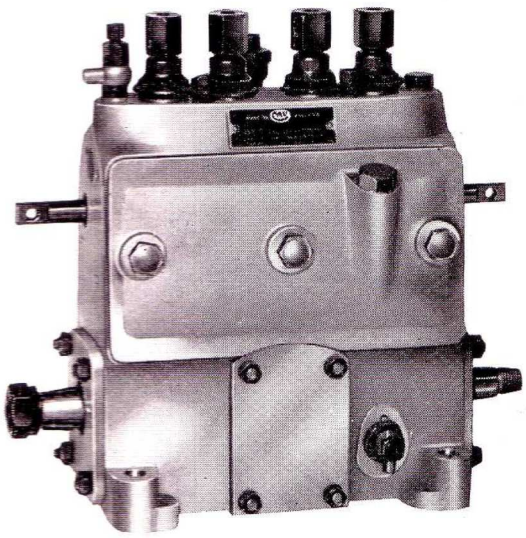


CONTENTS

'N' & 'NN' TYPE FUEL INJECTION PUMPS

INTRODUCTION

C.A.V. 'N' and 'NN' fuel injection pumps are cam operated, spring return, plunger pumps, with separate pumping elements for each engine cylinder, and are available for multi-cylinder engines. The elements are arranged in-line and operated by the camshaft and tappet arrangement within the pump housing. A pneumatic, mechanical, or hydraulic governor can be fitted, also an excess fuel device.

The type number is shown on the plate on the pump housing and indicates the following features:

N or NN	Basic Type Pump
L	Camshaft assembly
4	Number of pumping elements
A	Design change letter
75	Plunger diameter in tenths of mm (75 = 7·5 mm)
/	Dividing stroke
56	Individual features number
E	Standard excess fuel device fitted
EL	Non-standard excess fuel device fitted (The letter 'A' instead of 'L' indicates automatic excess fuel device fitted.)
	Camshaft assembly letter 'L' or 'R' indicates notched end of camshaft at left or right hand end, looking on the inspection cover side of pump. Element plungers with L.H. or R.H. helix, are available in the following diameters. 6·0 mm : 6·5 mm : 7·0 mm : 7·5 mm 8·0 mm : 9·0 mm : and 10 mm.

Lubrication of the pump is carried out initially, by removing the inspection plate filler and filling the camshaft chamber to the prescribed level with best quality lubricating oil (same oil as is used in the engine). During operation of the pump, a slight back-leakage of diesel fuel past the plunger takes place and drains into the camshaft chamber to maintain the lubricating oil level. As dilution of the lubricating oil takes place it is essential to drain the camshaft chamber periodically and refill with fresh lubricating oil. The frequency of this operation will depend upon the application, conditions under which the pump is operating, type of diesel fuel employed etc. and will vary in different parts of the world. Because of the variation in operating conditions it is impossible to lay down any specific draining period and experience alone is the deciding factor.

Some later type pumps are fitted with a drain plug and oil filler/breather cap to facilitate draining and refilling, whilst pumps installed in highly-rated applications use a force-feed lubrication system.

Any queries in connection with the lubrication of the fuel pump, or concerning the fuel injection equipment, should be referred to the C.A.V. agent or service depot who will gladly advise on any fuel injection problem.

The pump is of high precision manufacture and must be handled with great care and scrupulous cleanliness at all times. Good quality fuel correctly stored and filtered, should always be used, for even small amounts of foreign matter will be detrimental to the efficient performance of the pump, and will shorten its working life.

MECHANICAL DETAILS

Except where otherwise stated, all reference numbers quoted in this chapter refer to Fig. 1 which is an annotated sectional view of the 'NN' type fuel pump.

The Pumping Element

Each element is comprised of a plunger and a plunger barrel lapped together to form a mated assembly. The parts are not interchangeable and damage to either will necessitate the renewal of the complete element. The upper portion of the plunger element (8) Fig. 1 is in the form of a shoulder which seats against a corresponding shoulder in the pump housing. It is prevented from turning by the locking screw (6) which passes through the pump housing and engages in the groove machined on the barrel surface. The upper portion of the barrel, located within the common fuel chamber, is provided with two oppositely drilled holes, permitting the fuel to flow from the fuel chamber into the element. The countersunk hole is known as the inlet port and the other the spill port. The upper surface of the barrel has been ground flat and square to the axis to produce an oil-tight jointing face against the base of the delivery valve seating (5).

Inside the barrel is the plunger (7) which is actuated by the cam and tappet and has a constant stroke of 9 mm for 'N' type pumps and 10 mm for 'NN' type, but to enable the pump to vary the quantity of fuel delivered to the engine per stroke, each plunger is provided with a vertical channel extending from its top edge to an annular groove cut in the form of a helix. The function of this groove is described later.

External means whereby the plungers can be rotated in their barrels are provided by control rod (21) acting in conjunction with control quadrant (20) mounted on the control sleeve (23).

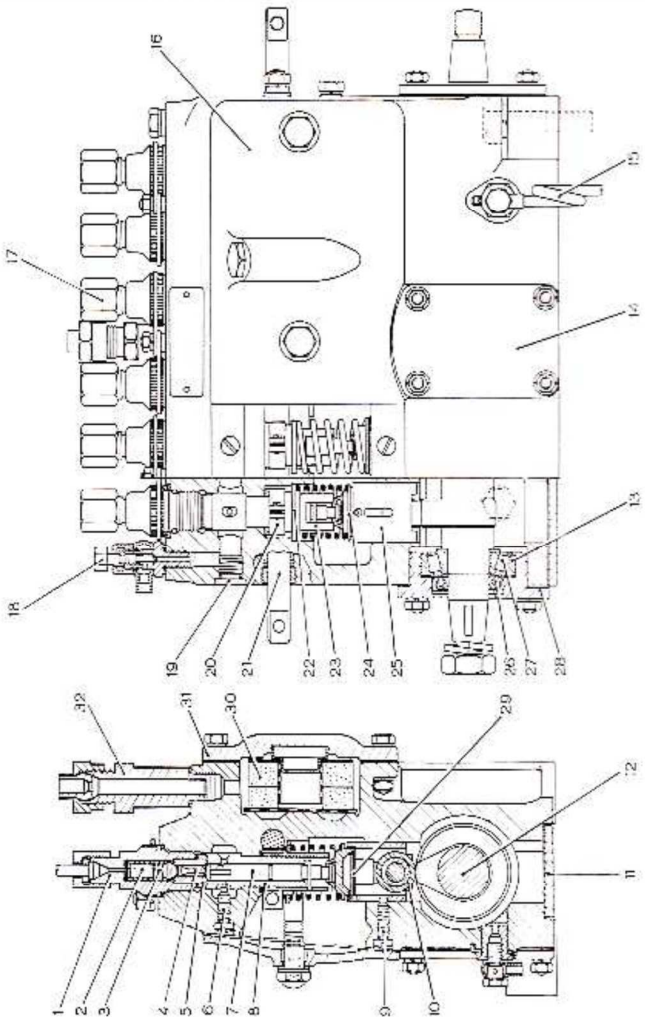


FIG. 1. ANNOTATED SECTION VIEW OF 'KN' TYPE PUMP

A return spring, located between the upper plate (22) and the lower plate (24) fitted to the plunger bottom, gives a positive plunger return.

A part section of the complete pumping element and delivery valve is shown at Fig. 4.

The Tappet Arrangement

Each tappet assembly slides in a bore machined in the pump housing and is located by the locating screw (9) which passes through the housing and engages a groove milled in the tappet assembly wall. It is provided with a hardened steel roller (10) which is held in contact with the operating cam by the action of the plunger return spring.

The lower spring plate (24) which fits over the bottom end of the plunger, seats against a shoulder in the hollow upper end of the tappet block and is retained by a spring clip which engages a hole drilled in the tappet wall. A phasing washer (29) is fitted between the lower spring plate and the shoulder in the tappet block to provide a means of phasing adjustment.

The Camshaft

The camshaft is carried in the lower portion of the pump housing and each end is supported by a tapered roller bearing, the outer tracks of the bearings being housed in the detachable end plates (28) secured to each end of the 'N' type pump housing. On the 'NN' type pump the bearings are located in steel sleeves pressed into the housing. End float adjustment is controlled by shims fitted between the race and the camshaft shoulder on 'N' type pumps and between the race and end plate on 'NN' pumps.

Individual cams with hardened surfaces are provided for each pumping element and the eccentric drive for operating the fuel lift pump, if fitted.

The camshaft ends are tapered and keyed and a threaded portion provided to enable the governor or the drive coupling to be mounted at either end of the shaft.

Some pumps, usually those of 8 mm or smaller element size, are fitted with ball races in place of the standard tapered roller bearings.

On the eight cylinder version of the pump, an additional camshaft, centre bearing, is fitted.

A notch or small saw cut will be found at one end of the camshaft, and care must be taken to ensure that the camshaft is reassembled after overhaul with this notched end at the specified end of the pump housing.

The Delivery Valve

This assembly consists of a delivery valve (4), delivery valve seating (5) complete with high pressure seal, spring (3), spring peg (2), delivery valve holder (1) and a low pressure seal fitted between a washer and the pump housing beneath the delivery valve holder.

The delivery valve and seating are of highly ground steel, finished to the finest limits and lapped together to ensure efficient operation at high speed and pressure. As with the pumping elements they must be regarded as a mated pair and never interchanged with similar components. The operation and function of the delivery valve is explained under the heading 'Operation'.

The Control System

Movement of the control rod (21), which is controlled by the pump governor, is transmitted to the plungers (7) through the quadrants (20) and control sleeves (23) in the following manner.

Mounted on each control sleeve and secured by a clamping screw is a toothed quadrant which is in constant engagement with the rack on the control rod. The lower portion of the control sleeve has a slot into which the lug on the plunger fits.

As the control sleeve is a sliding fit over the plunger barrel, movement of the control rod rotates the control sleeve and alters the position of the plunger helix in relation to the fuel ports in the plunger barrel.

Vertical location of the control sleeve is provided by the plunger spring, which acts between the upper plate bearing against the underside of a shoulder on the control sleeve, and the lower plate which seats over the bottom end of the plunger, and is locked to the tappet assembly by means of a retaining spring.

The control rod slides in press-fitted bushes retained in position by the screwed-in locking rings. These bushes are line-reamed in position to ensure accuracy of alignment.

A locating plate, secured externally to the end of the pump housing, registers with a flat machine face on the control rod, thus preventing rotational movement which could cause seizure between the control rod and quadrants.

The Pump Housing

The pump housing is an aluminium casting, machined to accommodate the pump components. The upper portion carries the delivery valve holders, and is shaped to form a common fuel chamber for the pump elements. A cover plate (16) fitted to the front of the housing gives access to the control quadrants and the upper end of the tappet gear, so that adjustment can be made during calibration and phasing of the pump. The filter cover (31) mounted on the rear of the housing, encloses a felt pad final filter (30). A blanking plate (14) fitted on the front of the housing is removed when it is required to fit a feed pump operated by the pump camshaft. Oil seals (26) are fitted in each of the detachable end plates to prevent leakage of oil. The base is closed by a plate (11) which can readily be removed by unscrewing the retaining screws.

OPERATION

Fuel can be supplied to the pump by a gravity system incorporating a fuel filter in the feed line to the pump; but the forced feed system employing a low pressure fuel feed pump, driven from the camshaft eccentric drive, is the system more generally employed. Fuel from the gravity or forced feed system enters the injection pump common fuel chamber and is then drawn into each pump element through the ports provided in the element barrel.

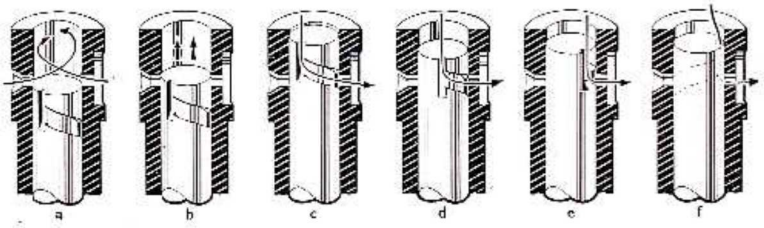


FIG. 2. PRINCIPLE OF FUEL METERING

Pumping (Fig. 2)

In a primed system, the barrel and pipe lines from the pump to the injector nozzles are full of fuel, and with the plunger head below the level of the two ports in the plunger barrel, fuel is fed in from the common chamber as shown in A Fig. 2. As the plunger rises, a certain amount of fuel is pushed back through the two ports until the plunger reaches position B Fig. 2 when the top land closes the two ports. This is known as the 'spill cut-off' point.

The fuel on top of the plunger is now trapped and its only outlet is via the delivery valve mounted on top of the barrel. The pressure of this fuel increases as the plunger continues to rise under the influence of its cam until it causes the delivery valve to lift from its seating, allowing the fuel to pass into the pipe line leading to the injector nozzle. As this pipe line is full of fuel, the extra charge delivered by the pump plunger causes a further pressure rise, sufficient to lift the injector nozzle needle from its seat. This permits the fuel to be sprayed into the engine cylinder combustion chamber in a form most ready to ignite.

As soon as the lower edge of the control helix uncovers the port, as in C Fig. 2, the fuel on top of the plunger, being at a much higher pressure than that in the common feed chamber, immediately returns via the vertical channel and annular groove. This results in a reduced fuel pressure under the delivery valve which returns to its seating by spring pressure. Similarly, as the injector pipe line pressure collapses the injector needle returns to its seat by spring action. Thus fuel injection into the combustion chamber is terminated.

When the plunger passes top dead centre it commences its downward stroke under the action of the return spring.

It will be appreciated that the actual pumping part of the plunger stroke is the distance travelled by the plunger from the moment its top edge closes the ports (and compresses the fuel above) until the bottom edge of the control helix uncovers the port and reduces the fuel pressure via the vertical channel.

The plunger stroke is always constant, but that part of it which is pumping can be varied by rotation of the plunger helical edge within the barrel in order to make the cut-off point occur earlier or later in the stroke and thereby permit a larger or smaller quantity of fuel to be delivered.

Fig. 2 Diagrams C, D and E show the approximate position of the helical edge for full load, half load and idling conditions.

The plunger is rotated by means of the toothed quadrant clamped to the control sleeve, slotted to engage the plunger toe. The quadrant meshes with a rack on the control rod which operates simultaneously all the pumping element quadrants in the pump assembly. Any movement therefore of the control rod causes all the plungers to rotate simultaneously and ensure an equal fuel delivery to each engine cylinder.

Diagram F Fig. 2 shows the vertical channel opposite the right hand port and in this position the fuel is by-passed to the common fuel chamber during the plunger stroke. This is the engine 'STOP' position.

FUNCTION OF THE DELIVERY VALVE (Fig. 3)

When the pump is on its delivery stroke, the plunger pressure of the fuel rises until the delivery valve is lifted from its seat allowing the fuel to pass through the delivery valve seat and into the injector pipe line.

As soon as the pump plunger releases the pressure on its return stroke, the delivery valve resumes its seat and the injector in the engine cylinder head closes and shuts off the cylinder fuel supply.

OVERHAUL AND REPAIR

To facilitate dismantling and reassembly of fuel injection pumps it is essential that the correct tools are used. A complete list is given in the C.A.V. Publication No. 1067—Service Tools for Fuel Injection Equipment.

Overhaul of fuel injection pumps can only be undertaken by skilled personnel equipped with the special tools and test apparatus referred to in this chapter. If these conditions cannot be met the pump should be sent to the nearest C.A.V. agent who will have workshops fully equipped for this highly specialised work.

Scrupulous cleanliness must be maintained at all times in workshops where pump overhaul is carried out, since the presence in a pump of even minute particles of dirt or grit can result in damage and wear and will considerably shorten the pump working life.

The surface of the work bench must be thoroughly clean and covered with grease-proof paper. If the bench is specially reserved for fuel injection work, it should be covered with zinc sheeting or similar easily cleaned material.

Receptacles must be provided for the storage of dismantled components so that the parts can be arranged systematically and protected from damage or corrosion.

Great care must be taken not to mix the dismantled components. All components must be reassembled to their original position in the pump

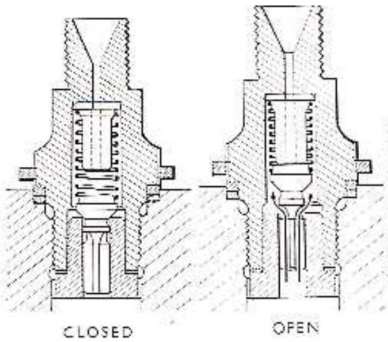


FIG. 3. SECTION VIEW OF DELIVERY VALVE

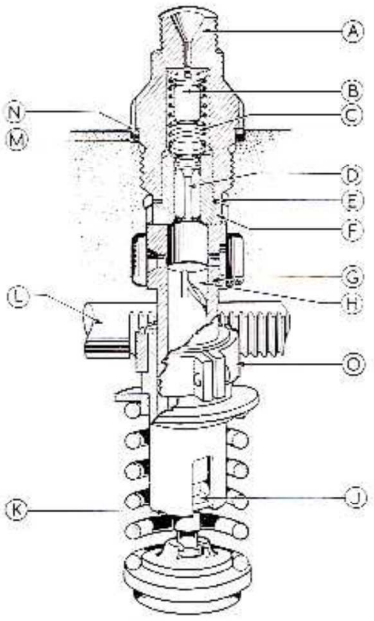


FIG. 4. SECTION VIEW OF PUMPING ELEMENT AND DELIVERY VALVE

A – DELIVERY VALVE HOLDER
B – PEG
C – SPRING
D – DELIVERY VALVE
E – HIGH PRESSURE SEAL
F – DELIVERY VALVE SEATING
G – PLUNGER BARREL
H – PLUNGER
O – QUADRANT
J – PLUNGER SPUT
K – CONTROL SLEEVE
L – CONTROL ROD
M – LOW PRESSURE SEAL
N – STEEL WASHER

because plungers and barrels, delivery valves and seats are mated components and are not interchangeable. Damage to either part of these components will necessitate replacement of the complete assembly.

Plungers and barrels, delivery valves and delivery valve seatings are NOT supplied as separate items, i.e. a delivery valve is NOT supplied without a seat, and no attempt must be made to lap or grind these parts, since such treatment will only result in damage.

The pump is correctly phased and calibrated before leaving the works and the original setting is indicated by the scribed lines on the quadrants and sleeves. The quadrants should be left locked to the sleeves during removal but if for any reason a quadrant screw is loosened, the setting lines on quadrant and sleeve must be aligned before the screw is tightened.

Before removing the pump half coupling note the camshaft position relative to the pump. A small notch will be found at either the L.H. or R.H. end of the threaded portion of the camshaft and the camshaft must be reassembled with this notch in the same position otherwise the firing order will be altered.

Dismantling Sequence

(Annotations refer to Fig. 1, page 4.)

1. Remove the base plate (11) and gasket and drain the fuel oil from the lower portion of the pump housing.
2. Remove the filter cover (31) and sealing gasket from the seat of the pump housing and drain the fuel oil from the filter chamber. Discard the felt filter pads, and lift out the filter support plate and gasket.
3. Remove the cover plate (16) from the front of the housing.
4. Remove the feed pump, or blanking plate (14) and the excess fuel device if fitted.
5. Mount the pump on the base plate (part no. 7044/650) and secure in a bench vice with the pump vertical. For eight cylinder pumps use base plate part no. 7144/510.
6. Turn the camshaft (12) and as each tappet is lifted insert a tappet holder between the lower spring plate and the upper surface of the tappet block (Fig. 5). Right and left handed holders are used, part nos. 7044/648 and 7044/649 respectively for 'N' pumps, whilst part no. 7144/480 is used on 'NN' pumps.
7. Remove the nuts which secure both camshaft bearing end plates. On eight cylinder pumps remove the centre bearing locating bolt or securing bolts as the case may be. Tap one end of the camshaft lightly with a hide-faced hammer and dislodge one bearing end plate (28).
8. Withdraw the dislodged end plate from the securing studs, and tap the free end of the camshaft to dislodge the remaining end plate.

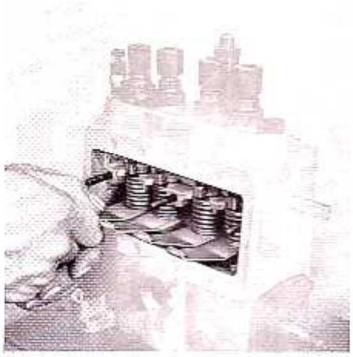


FIG. 5. INSERTING TAPPET HOLDERS

On eight cylinder pumps secure camshaft withdrawal tool 7144 474 to free end of camshaft and withdraw complete with centre bearing and races.

9. Withdraw the camshaft complete with races (27) and end plate from the pump housing (Fig. 6).

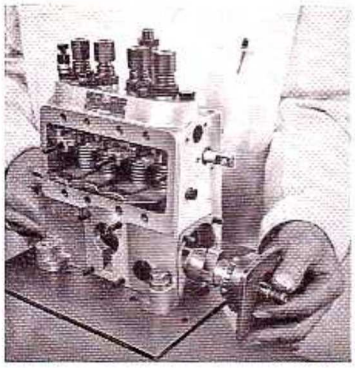


FIG. 6. REMOVING CAMSHAFT

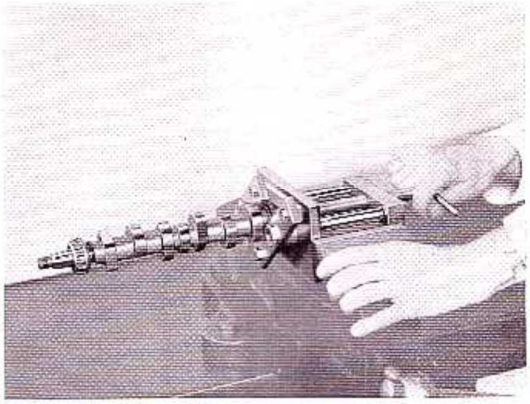


FIG. 7. WITHDRAWING ROLLER RACE FROM CAMSHAFT USING TOOL 7144/436A

10. Remove the races and inner tracks of the bearings from the camshaft, using tool part no. 7144/436A, as illustrated in Fig. 7.
11. Extract the outer track from each end plate using the collet type extractor part no. 7144/436B for ball bearings or 7144/436C for roller bearings

FIG. 8. REMOVING OUTER RACE TRACK FROM END PLATE USING TOOL 7144/436C

and lift out the large shims. Remove and discard the oil seals (Fig. 8).

NOTE—'N' type pumps fitted with the smaller sized elements are sometimes fitted with ball bearings in place of the roller bearings. The dismantling procedure, however, remains unaltered.

12. Remove the tappet assembly locating screws (9).
13. Turn the pump to the horizontal position.
14. Holding the tappet assembly with the forceps, part no. 7044/859, exert upward pressure and remove the tappet holder.
15. Withdraw the tappet assembly (25), together with the phasing washer (29), lower spring plate (24) and plunger (7) through the aperture in the base of the pump housing.
16. Separate the plunger from the lower spring plate and remove the spring plate, retaining spring, and phasing washer from the tappet block. Immerse the plunger in a bath of clean test oil to protect the lapped surface from damage.
17. Withdraw the plunger spring, and after disengaging the control quadrant (20) from the control rod (21), slide the control sleeve (23) from the plunger barrel.
18. Repeat items 14-17 for each element, keeping the components of each element assembly together, so that they can be reassembled in the same position from which they were taken.
19. Turn the pump to the vertical position.
20. Remove the locking plates securing the delivery valve holders and using the serrated hex spanner

part no. 7044/861 unscrew and carefully remove the delivery valve holders from the pump housing. The delivery valve spring and spring

FIG. 9. REMOVING THE DELIVERY VALVE HOLDERS

peg are released as the valve holder is removed and will be dislodged if the holder is not removed with care (Fig. 9).

21. Remove each delivery valve spring (3) and peg (2), also the steel washers and low pressure seals.
22. Remove the delivery valve (4) and seating (5) complete with the high pressure seal.

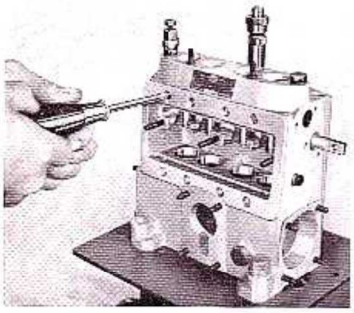


FIG. 10. UNSCREWING THE BARREL LOCKING SCREWS

23. Remove the barrel locking screws (6) and pushing the barrels upwards, withdraw them from the pump housing (Figs. 10 and 11).

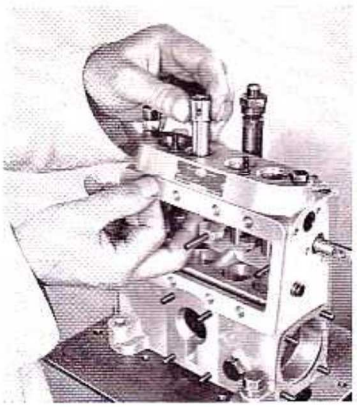


FIG. 11. LIFTING OUT THE ELEMENT BARRELS

24. Reassemble each plunger to its mated barrel and immerse in clean test oil to prevent any possibility of damage to the lapped surfaces.

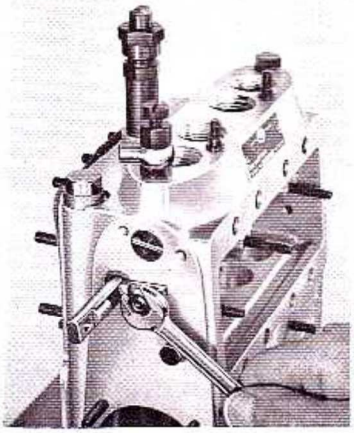
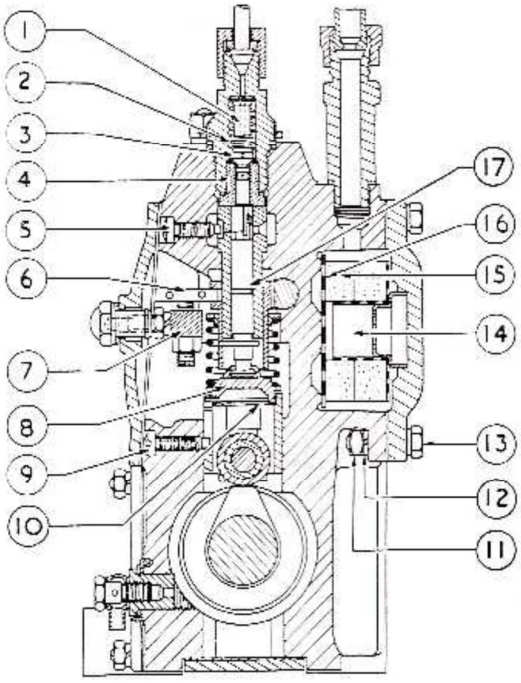


FIG. 12. REMOVING THE CONTROL ROD LOCATING PLATE



1. Delivery Valve Spring Peg
2. Delivery Valve Spring
3. Delivery Valve Pin
4. Delivery Valve Seat
5. Barrel Locking Screw
6. Calibrating Bar Screw
7. Calibrating Bar
8. Lower Spring Plate
9. Tappet Locking Screw
10. Phasing Shims
11. Nut
12. Spring Washer
13. Bolt
14. Filter Support Tube
15. Filter Pads
16. Perforated Plate
17. Element Assembly
18. Nut
19. Spring Clip
20. Control Rod Guide

FIG. 13.
ANNOTATED SECTION VIEW OF 'N' TYPE D CHANGE PUMP

25. Remove the control rod locating plate, and slide the control rod from the pump housing (Fig. 12).

NOTE—Pumps of design change letter D incorporate a control rod and control sleeves provided with a helical gear.

Output adjustment is made by raising or lowering the control sleeves by means of adjusting screws which engage a slot in each control sleeve.

Each adjusting screw is screwed into a bar which is mounted on studs and secured to the pump housing by nuts and spring washers.

When dismantling pumps of this type, remove bar and adjusting screws as an assembly immediately before removing the control sleeves.

INSPECTION AND REPAIR

When a pump is completely dismantled all components must be thoroughly cleaned in clean test oil. Abrasive or fluffy cleaning materials are forbidden.

The pump components should be inspected for signs of scoring, pitting, corrosion, and excessive wear, and any defective part discarded.

All oil seals, jointing gaskets and sealing washers, must be renewed at each overhaul.

The faces in the pump housing, against which the plunger barrels seat, must be inspected for pitting or other signs of damage, and if found to be unsatisfactory the surface should be lightly skimmed with the

special cutter part no. 7044/718, shown at Fig. 14. A minimum of material should be removed during this operation.

The cutter also skims an equal amount of material from the low pressure delivery valve holder seating face so that the vertical dimension between the two seating faces is maintained.

FIG. 14.
SPECIAL SEAT CUTTING TOOL 7044/718

Control rod bushes must be checked for wear and ovality, by fitting a new control rod. Comparing the fit of the new rod against the fit of the one removed will give a good indication of the state of the bushes.

If necessary, worn bushes can be extracted after removing the locking rings with tool part no. 7044/658 and by using the special extractor tool part no. 7144/312. New bushes can now be pressed in and reamed out in position as detailed below.

A special long-shanked reamer part no. 7044/563 is used in conjunction with two reamer guides part no. 7044/562 and 7044/562A. These guides differ only in external diameter, 7044/562A being a snug fit in the new bush before reaming and 7044/562 a snug fit after reaming.

Guide 7044/562A is fitted to one control rod bush and the shank of the reamer is then passed through the remaining bush and into the core of the guide. After securing a wrench to the reamer shank, the reamer is then drawn through the bush. This operation is repeated on the remaining bush, using the larger reamer guide 7044/562 fitted in the newly reamed out bush (Fig. 15). Take care to remove all swarf from the pump housing (especially in the corners) when reaming of the bushes has been completed.

Great care must be exercised when reaming control bushes as complete freedom of the control rod is dependent on the perfect alignment of the bushes. The final fit must permit the control rod to slide easily in the bushes without being 'loose'.

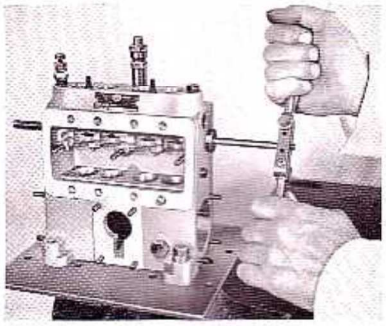


FIG. 15. REAMING THE CONTROL ROD BUSHES

ASSEMBLY SEQUENCE

1. Mount the pump on the base plate, part no. 7044/650, and secure in a bench vice with the pump in the horizontal position and the filter chamber upwards. For eight cylinder pumps use base plate part no. 7144 510.
2. Fit the filter support plate gasket and then the filter support plate in position in the filter chamber.
3. Fit a new sealing gasket on the filter cover jointing face.
4. Fit new filter pads on the support tubes, push the cover on to the securing studs and secure with nuts and spring washers.
   Tighten down all nuts evenly and securely.
5. Turn the pump to the vertical position.
6. Slide the control rod into the control rod bushes, and fit the locating plate. There must be 0·002 in. (0·07 mm) clearance between the locating plate and the flat on the control rod on pumps fitted with a hydraulic governor, or 0·005 in. (0·13 mm) if a pneumatic or mechanical governor is fitted. Clearance must be checked over the full travel of the control rod.
7. Fit each plunger barrel in the pump housing, ensuring that the vertical groove is in alignment with the barrel locating screw hole.
8. Fit the barrel locating screws, ensuring that they engage the grooves in the plunger barrels before tightening. When tightened it should still be possible to move the barrel vertically until the locating screw contacts the end of the groove.

9. Fit each delivery valve to its mated seating and place a new delivery valve washer against the flange on the seat.
   Place each assembly in position against the upper face of the plunger barrel.
10. Dealing with each delivery valve in turn, fit the spring and spring peg.
11. Fit the delivery valve holder washers and seals and screw down each delivery valve holder by hand.
12. Using a torque spanner, tighten all delivery valve holders to a torque of 40 lb ft (5·5 kg m). Turn the pump to the horizontal position, front uppermost.
13. Using forceps part no. 7944 J608 insert each plunger into its barrel and gently rotate several times. Dip each plunger in clean fuel before inserting into the barrel.
    Each plunger must rotate freely without any 'binding'.
    Place a piece of plastic or other suitable material over the tappet bores to prevent the plungers falling out.
    At this stage the pressure test for element barrel seat leakage can be carried out.

Testing Barrel Seat Leakage and Pump Housing Porosity

To check the pump for barrel seat leakage and housing porosity an air line is connected to the pump at this stage of the assembly.

a. Connect the fuel inlet connection to the air line.
b. Blank off any openings in the common fuel gallery which would allow air to escape to atmosphere.
c. Turn on the air and make sure the pressure does not exceed 45 lb/in² (3·1 kg cm-²).
d. Immerse the pump in a clean bath of testing oil and examine the pump for leakage.
   Air bubbles forming will indicate where the leakage is occurring and any leaks should be stopped before proceeding further. A slight leak past the plunger can be ignored.

Should an air supply not be available the C.A.V. nozzle testing outfit can be used as an alternative method of testing.

a. Wipe off oil from the housing.
b. Change the testing outfit standard gauge for a 0-200 lb/in² (14·06 kg/cm-²) gauge.
c. Connect up the housing to the nozzle testing outfit by means of a suitable adaptor fitted to the housing fuel gallery. The other end of the gallery should be blanked off.
d. Pump up the outfit until a pressure of 30 lb in² (2·1 kg/cm-²) is indicated on the gauge.
e. Examine the housing for signs of leakage and repair as necessary.

NOTE—The barrel seats can be recut with the aid of tool 7044/718. Do not over-cut. Take only a light skimming sufficient to cure the leak.
On completion of this test remove the piece of plastic and withdraw all plungers.

14. Mount pump horizontally in the vice with the front of the pump uppermost.
15. Centralise the control rod by aligning the centre punch mark at both ends of the rod with the ends of the pump housing.
16. If the control quadrants have been removed from the control sleeves they should be re-assembled, taking care that the scribed line on the sleeve is aligned with that on the quadrant before the clamping screw is tightened. Note:—New quadrants will not have scribe marks and the clamping screws should be positioned accordingly to suit R.H. or L.H. governor fitting and governor type.
17. Slide the control sleeves on the plunger barrels, engaging the teeth on the control rod so that the quadrant is in the mid-travel position. Check that the control rod has complete freedom of movement after fitting each control sleeve.
18. Slide the upper spring plates on the control sleeves and seat them against the shoulders in the pump housing and place each plunger spring in position against each upper spring plate.
19. Fit the phasing washer to the upper end of each tappet assembly and place the lower spring plate complete with retaining spring in position above the phasing washer, engaging the retaining spring with the hole drilled in the wall of the tappet assembly.
20. Dip the plunger in clean test oil and engage it with the lower spring plate.
21. Using forceps part no. 7044/859 hold the tappet assembly in the horizontal position, with the spring locating hole and the lug on the plunger marked with the part number uppermost. (See Fig. 16.) NOTE—If correctly fitted the plunger helix should be at the front.
    Slide the plunger into the barrel and engage the lug on the plunger with the slot in the control sleeve. Force the tappet assembly upwards against the plunger spring until it is possible to insert a tappet holder between the lower spring plate and the pump housing, and then withdraw the forceps.
22. Fit the tappet assembly locating screw.
    NOTE—Operations 16-22 are repeated for each element, care being taken that the plungers are assembled to their mated barrels.
23. Fit new oil seals to the bearing end plates, replace the larger shims and press in the outer track of the races.
24. Fit the races to the camshaft, making certain that end float adjustment shims of equal thickness are placed at each end of the camshaft.

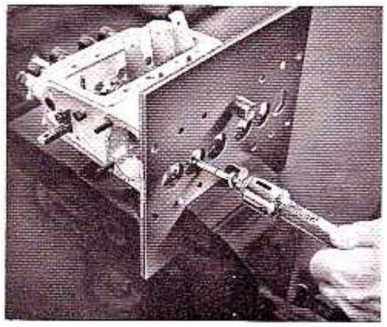


FIG. 16. INSERTING PLUNGER AND TAPPET BLOCK USING FORCEPS 7044/859

NOTE—On 'N' pumps these shims are placed between the camshaft shoulders and the race but on 'NN' type pumps they are fitted externally, i.e. between the race and end plate.

25. Fit the bearing end plate to one end of the pump housing and secure with the spring washers and nuts. For eight cylinder pumps see section 'Fitting the Camshaft Centre Bearing'.

26. Fit the protection cap part no. 7044/884 to the appropriate end of the camshaft to protect the oil seal when the camshaft is pushed through the end plate.
Make certain that the end of the camshaft marked with the small notch on the threaded portion is at the specified end of the pump housing.

27. Pass the camshaft through the pump housing and guide it through the oil seal in the end plate.

28. Remove the protection cap and fit to the other end of the camshaft.

29. Fit the remaining end plate over the camshaft and secure with spring washers and nuts.
Remove the protective cap from camshaft.

30. Check the camshaft end float using gauge part no. 7044/634 (Fig. 17). End float must be 0·05 to 0·1 mm with either ball or tapered roller bearings and 0·1 to 0·2 mm when parallel roller bearings are fitted. The amount of end float is controlled by the thickness of the shims. Turn camshaft by hand several times to ensure that it is free.
NOTE 1—If shimming is required it must be carried out equally to each end of the shaft.
NOTE 2—Take care to settle the shaft after each adjustment to an 'NN' pump otherwise false readings will occur because the outer bearing is a tight fit in the housing.

31. Withdraw the tappet holders.

32. Turn the camshaft by hand, at the same time move the control rod over its full travel distance. There must be no sign of tightness or binding with the control rod or camshaft in any position.

33. Remove the pump from the assembly plate and fit the base plate complete with new gasket.

34. Fit feed pump or blanking plate, also the excess fuel device as required.

35. Fit front cover plate using new gasket if necessary. If a new gasket is fitted, a good adhesive of the fish glue type should be used to position the gasket to the cover prior to assembly.

PUMP TESTING

The injection pump must accurately measure minute quantities of fuel under all conditions of engine load and speed, and it must deliver this minute quantity of fuel into each cylinder at the exact point at which the engine requires it.

To ensure that these functions are carried out efficiently, each C.A.V. fuel injection pump is accurately tested and adjusted before it leaves the works. The final setting is indicated by the scribed line across each quadrant and control sleeve as shown in Fig. 21.

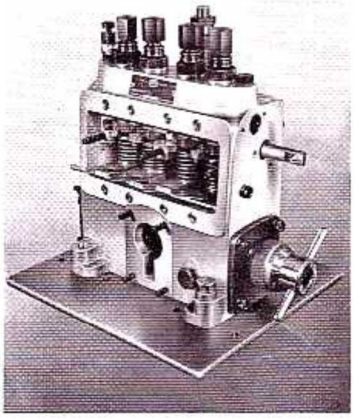


FIG. 17. CHECKING CAMSHAFT END FLOAT USING GAUGE 7044/634

Resetting should only be necessary to compensate for wear after several hundred hours running, or if quadrants and sleeves have been replaced.

After a pump has been overhauled, it should be tested, and readjusted before it is refitted to the engine.

Special equipment is required if the tests are to be carried out correctly and it is recommended that such testing is carried out by an authorised C.A.V. agent.

Pump testing is divided into two parts: 'Phasing' and 'Calibration'.

It is essential that the pumping elements commence to inject at the correct interval in camshaft degrees. The interval on in-line pumps is 360° camshaft angle divided by the number of elements in the pump. The only exceptions to this rule are certain twin-cylinder engines or two pumps coupled together in line, when the firing order and the total elements of the tandem unit will have to be considered. This adjustment for correct timing interval is known as phasing or adjusting the phase angle of the pump and is carried out as described in the paragraph 'PHASING'.

It is also necessary to determine the point at which the adjustment has to be made. This is generally referred to as the 'port closed position' which occurs when the rising plunger closes the ports through which the fuel has entered the element barrel.

The commencement of injection into the engine cylinder occurs after the port closes, the interval depending mainly upon the plunger diameter, cam profile, pipe length and the setting of the injector spring. Finally, adjustment is made for the balance of fuel output. This is known as calibrating the pump.

When the pump is working, the output of an element depends upon the position of the helical edge of the plunger in relation to the spill port of the barrel and this position can be varied by turning the plunger in the barrel.

During running the governor moves the control rod, thereby turning the quadrants, control sleeves and plungers together. For calibration adjustments, however, it is necessary to calibrate each element separately.

PHASING THE INJECTION PUMP

Adjustment of the phase angle of 'N' and 'NN' type pumps is effected by increasing or decreasing the head clearance of the plunger in its barrel by means of the shims fitted between the lower spring plate and the tappet assembly. Care must be taken during phase adjustment to prevent the plunger striking the underside of the delivery valve seating as the plunger reaches the top of its stroke, otherwise considerable damage will result to the pump.

The adjustment is correctly set when the plunger at top dead centre has a head clearance of 0·5 mm unless otherwise stated on the test plan. To achieve correct clearance a range of shims from 0·3 mm to 1·4 mm in thickness, in steps of 0·1 mm, are available to increase or decrease the clearance.

Special hook tool part no. 7044/654 is used for removing the shims and gauge part no. 7044/714 for checking the shim dimensions.

To Remove or Replace Shims

To alter the plunger head clearance proceed as follows:

Raise the cam to top dead centre and insert tappet holder between the lower spring plate and tappet assembly.

Turn the cam back to bottom dead centre and insert a pin drift in the hole in the tappet assembly wall. Push back the retaining spring and press the tappet assembly downwards to separate it from the lower spring plate. The shims can now be altered as required.

With the correct shims fitted, push back the retaining spring in the lower spring plate. Raise the cam to top dead centre.

The lower spring plate should now sit inside the tappet assembly. Remove the tappet holder and make certain that the retaining spring is now located in the hole drilled in the tappet assembly wall.

Phasing the Injection Pump

1. Turn the pump camshaft until the camshaft taper line is in line with the vertical line on the pump end plate. No. 1 plunger will now be at top dead centre.
2. Remove the front cover of the pump.
3. Using gauge 7144/166 check the plunger head clearance of No. 1 element and if necessary adjust this by varying the thickness of the shims (Fig. 18).

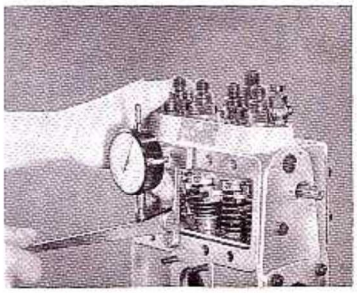


FIG. 18. CHECKING HEAD CLEARANCE USING GAUGE 7144/166

The point of injection must now be found and the complete phasing operation carried out in the following manner:—

1. Remove the delivery valve holder and lift out the spring, spring peg, and delivery valve. (Not the seating.)
2. Replace the delivery valve holder. A short length of piping, vent into the form of a swan neck, should now be connected to the delivery valve holder (Fig. 19).

   The extremity of this pipe should be chamfered to enable better observation of the fuel cut-off point.
3. Secure the pump to a suitable test bench and fit a graduated degree disc to the pump camshaft. Mount a pointer in a convenient fixed position in relation to this disc.
4. Ensure No. 1 cam is at top dead centre, then confirm plunger head clearance by inserting a screwdriver in the slot in the tappet assembly and gently raise the assembly until the crown of the plunger touches the underside of the delivery valve seating.

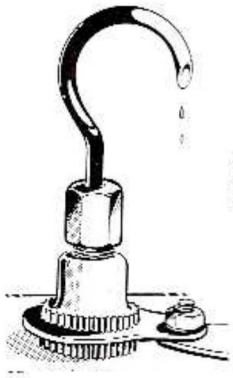


FIG. 19. SWAN NECK TUBE

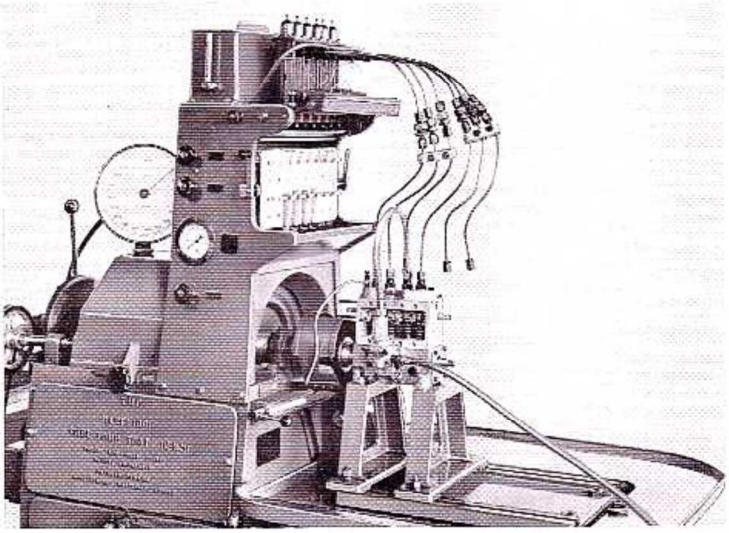


FIG. 20. TYPICAL TEST MACHINE

5. Connect the pump inlet to the fuel supply of the test bench and air vent the pump by loosening one of the air vent plugs situated on the fuel chamber.

   Turn on the fuel and allow it to flow past this plug until there are no more air bubbles.

   Tighten air vent plug and turn off fuel.

6. Place control rod in mid-position.

7. Rotate camshaft until No. 1 plunger is at bottom dead centre and turn on the fuel. Fuel will now flow from the fuel chamber into No. 1 element and out through the swan neck pipe.

   No fuel can pass through the remaining elements as their delivery valves are in position.

8. See test plan to check camshaft rotation and turn the camshaft in the direction of rotation until No. 1 plunger starts to lift.

   As the plunger closes the barrel ports, the flow of fuel from the swan neck pipe will gradually diminish. Continue to rotate the camshaft gently, until the flow of fuel ceases completely. This is the port closed position.

   Take care that the plunger is rising at this point and not descending, otherwise a false reading will be obtained.

9. Align the zero on the graduated disc with the pointer, taking care not to disturb the camshaft. Check that the camshaft has not turned by repeating the operation detailed in paragraph 8.

10. Remove the swan neck pipe, wash No. 1 valve, spring and spring peg in clean fuel and replace. Tighten delivery valve holder to 40 lb ft (5·5 kg m) torque with torque spanner.

    The camshaft is now set at the point on No. 1 element to which all adjustments are co-related and the remaining elements must now be set to inject at their correct intervals.

    Presuming the pump to be a six cylinder type with an injection sequence of 1, 5, 3, 6, 2, 4 proceed as follows:—

11. Remove valve holder, spring peg, spring and valve (not the seating) from No. 5 element.

    Replace the valve holder and fit the swan neck pipe, turn on the fuel which will now flow from the pipe end.

12. Turn camshaft through 60° and check point of port closure on this element. This should be within a few minutes of 60°, but if in excess of 0·5° (1° on two stroke units) adjustments must be made by altering the shim as previously described. Check port closed position against the test plan. If the point of port closure is early, reduce the thickness of the shims; if late, the thickness must be increased.

    When standard cams are fitted, a 0·1 mm change in shim thickness will alter the 'point of cut-off' by a little less than 0·5°.

13. Remove swan neck pipe and holder.

    Replace delivery valve, spring and spring peg, also the holder. Tighten this down to 40 lb ft torque (5·5 kg m).

14. Check the head clearance (0·5 mm ± 0·15 mm) unless otherwise stated on Test Data Sheet.

    NOTE—On No. 1 element, the head clearance is first determined and then the point of port closure found, but on the other elements, the correct phasing point is set and the head clearance checked afterwards.

    Should the head clearance of any element not be within the required limits after phasing, it will be necessary to increase, or decrease, the clearance on No. 1 element within the tolerance of ± 0·15 mm and then completely rephase the pump.

15. Phase and check the head clearance on the other elements as detailed for No. 5 element in paragraph 11.

16. Finally, recheck the setting of No. 1 element in relation to the disc marking. Any discrepancy here will indicate that the pointer or disc has moved during the phasing operation, and the phasing will have to be completely rechecked again.

    At this point check the engine manufacturer's handbook for the timing setting and mark the setting on the pump coupling in order to facilitate correct fitting of the pump to the engine.

CALIBRATION OF THE PUMP

Pump calibration is carried out by slackening the screw which clamps the quadrant to the sleeve, and moving the sleeve with the plunger into the required position. This adjustment is accurately carried out at the factory before the pump is despatched and the final setting is indicated by the line scribed across each quadrant and sleeve as shown in Fig. 21. After several hundred hours running, wear on the elements may necessitate some slight alteration to this setting but the setting should not deviate very much from the original.

The actual quantities of fuel delivered by each element and the points at which these are balanced and checked will depend upon the pump specification for the particular installation. As accurate measurement and adjustment of the output of each pump element can only be effected by highly skilled and trained personnel using a suitable power driven calibrating machine, it is strongly recommended that this work be undertaken by the nearest C.A.V. agent.

The test machine must be capable of driving the pump at the speeds given in the test specification and should be able to maintain any selected speed within very close limits. It must also supply filtered fuel or test oil to the injection pump either by gravity or pressure feed, and a filter must be incorporated which will provide the necessary standard of fuel filtration to give complete protection to the pump.

Test nozzle type BDN12SD12 set at 175 atmospheres should be mounted above the measuring glasses which are graduated in cubic millilitres. These test nozzles are connected to the high pressure connections on the pump by pipes 6 mm outside diameter x 2 mm internal diameter and 500 mm long.

When calibrating, the output from each pumping element is measured during 100 pumping strokes unless otherwise stated on the test plan. To enable this to be done with accuracy, the test machine is fitted with an automatic trip mechanism which diverts the fuel away from the measuring glasses on completion of 100 strokes.

As each pump has a specific output, according to the particular application, care must be taken to ensure that the correct test plan is to hand before calibrating.

Study of the test plan will show that definite outputs must be obtained at different control settings for specified speeds.

Before setting the control rod to any given position, it must first be placed in the fully closed position and then moved the required amount. Before calibrating, the pump, injectors and injector pipes must be thoroughly vented, an operation normally carried out with the pump turning at 200 r.p.m.

After venting, set the control rod to the first position given in the test plan and clamp the rod in position.

The pump is now driven at the prescribed r.p.m. and the individual element outputs checked over 100 strokes. Minor adjustments to individual elements must be followed by a complete check at the same control rod opening r.p.m. and over 100 strokes.

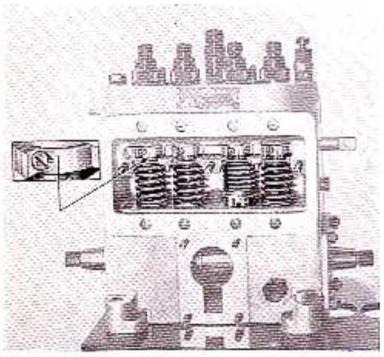


FIG. 21. SETTING LINES ON QUADRANT AND SLEEVES

Calibration is now carried out at the other specified control rod openings as given in the test plan and adjustments are made as necessary. Individual element output is adjusted by slackening the quadrant screw and moving the control sleeve, so that it alters the position of the plunger control helix in relation to the fuel port.

The quadrant clamping screw must be re-tightened after adjustment has been made, and a line scribed on the control sleeve and quadrant to indicate the relative position of these two parts. Before scribing, existing marks must be erased.

Maximum fuel output must now be set in accordance with the test plan and the pump application. The method of doing this varies with the type of governor and reference must be made to the C.A.V. publication dealing with the type of governor fitted to the pump.

Finally, fit the front inspection cover plate securely.

NOTE—Pumps of early manufacture ('N' type D change) have helical teeth on the control rod and control sleeves and pump output is adjusted by raising or lowering the control sleeve by means of the individual calibration screws. These screws are secured by locknuts which must be unscrewed before adjustment is made, and retightened after completion of adjustment.

FITTING THE CAMSHAFT CENTRE BEARING ON EIGHT CYLINDER 'N' AND 'NN' TYPE PUMPS

All eight cylinder pump camshafts are provided with a centre bearing. Several types of bearings are at present in service, the main differences being in the material used and the method of location. The bearing illustrated at Fig. 22 is made of brass, the

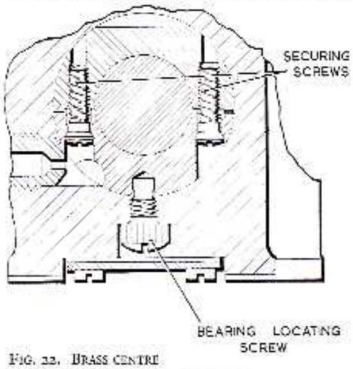


FIG. 22. BRASS CENTRE BEARING FOR 8 CYL. PUMP CAMSHAFTS

two halves being held together by the setscrews and location is determined by the locking screw in the pump base which engages in the hole provided in the lower half of the bearing. Fig. 23 illustrates a similar type bearing but in this case the material is a bronze alloy and location is determined by the locking screw passing through the front of the pump housing to engage in the hole provided in the upper half of the bearing. These bearings are used on 'N' type pumps.

Fitting Centre Bearings

1. Fit the camshaft and end plates to the pump housing in the normal manner BUT WITHOUT CENTRE BEARING.
2. Check and adjust camshaft end float in the normal manner.
3. Remove one end plate, also the camshaft.
4. Place pump in bath of warm oil (60 -65 C) in order to expand the centre bearing tunnel slightly.

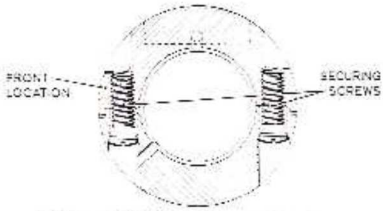


FIG. 23. BRONZE ALLOY CENTRE BEARING FOR 8 CYL. PUMP CAMSHAFTS

5. Fit centre bearing to camshaft, ensuring that the bearing lead is entered first. The lead is denoted by the line around the periphery of the bearing.
6. Remove pump (after allowing sufficient time to warm up) and invert. Place camshaft in pump body, making certain that the centre bearing locating hole (bottom or side as the case may be) is in line with the corresponding one in the pump housing.
7. Fit camshaft bearing assembly tool 7144 474 to end of camshaft and pull the camshaft and bearing into the final position, i.e. the bearing locating bolt hole is in line with the one in the pump housing.
8. Fit bearing locking screw. Remove tool 7144 474.
9. Fit end plate. Turn camshaft several times to ensure that it is free.
10. Recheck camshaft end float.

Continue pump assembly in the normal manner.

ALUMINIUM TIN ALLOY TYPE CENTRE BEARING

This bearing is fitted to 'NN' and a few 'N' type housings only. The two halves are held together by the dowels pressed into the lower half of the bearing, whilst two long bolts, which pass through the base of the pump and the bearing and screw into the pump body, provide location.

Two alignment grooves are machined on the exterior surface of the lower portion to facilitate fitting.

Fitting the Aluminium Tin Alloy Bearing

NOTE—ENSURE THAT THE CORRECT SIZE BEARING, ACCORDING TO THE TABLE GIVEN, IS USED.

1. Fit the camshaft and end plates to the pump housing in the normal manner, BUT WITHOUT THE CENTRE BEARING.
2. Check and adjust camshaft end float in the normal manner.
3. Remove one end plate, also the camshaft.
4. Place pump in bath of warm oil (60°-65°C) in order to expand the centre bearing tunnel slightly.
5. Assemble centre bearing on camshaft, ensuring that the bearing lead is drawn in first. The lead is denoted by a line around the periphery of the bearing.
6. Remove pump from bath and turn upside down, insert camshaft in pump body. Fit camshaft bearing assembly tool 7144/474 to end of camshaft.
7. Locate bearing aligning tool 7144/479 by placing the two pins in the bolt holes in the base of the pump and the single pin in one of the bearing alignment grooves as shown in Fig. 24. See Note after item 13.

   Using tool 7144/474, pull the camshaft and bearing in until the alignment tool pin is almost in contact with the closed end of the groove. Now turn the aligning tool over so that the pin is located in the second groove of the bearing and continue to pull the camshaft and bearing in until the final position is almost reached.

   At this stage remove the aligning tool.

   Continue to pull the camshaft in gently; at the same time, by looking down through the locating holes, note carefully when the bearing has reached its final position, i.e. the bearing bolt holes are in line with those in the pump housing.
8. Remove the camshaft tool 7144/474.
9. Insert the two bearing securing bolts.

   If the bolt holes in the bearing do not align

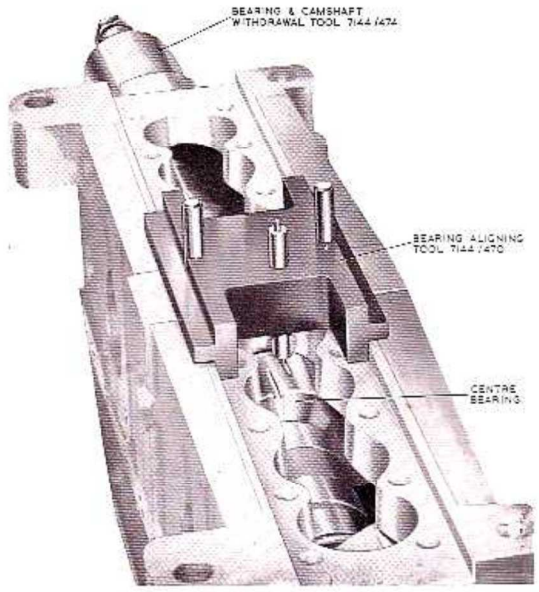


FIG. 24. FITTING ALUMINIUM TIN ALLOY TYPE CENTRE BEARING

exactly with those in the pump housing it may be necessary to ream them out with a 6 mm reamer. During the reaming operation make sure that swarf does not enter the pump. Upon completion of reaming lay the pump on its side and clean the bearing bolt holes out with a jet of compressed air.

10. Fit the camshaft end plate.
11. Tighten down the centre bearing bolts.
12. Recheck camshaft end float.
13. Turn camshaft several times to ensure that it is free.

Continue pump assembly in the normal manner.

NOTE– Aligning tool 7144/470 has been manufactured to fine limits and is a precision tool. It must be treated and stored as such and not subjected to rough handling or left lying around on the workshop bench. If not treated carefully legs or alignment pins are likely to get bent and make the tool unfit for use. When pulling the bearing in, do not allow the alignment pin to butt against the closed end of the alignment groove. Similarly, care must be taken to avoid pulling the bearing in beyond its correct position. Should this occur, remove tool 7144/474 from end of camshaft and fit to the other end, then pull camshaft and bearing back as necessary.

Use aligning tool 7144 470 when fitting the aluminium tin alloy type bearing.

NEVER use a hammer or drift of any description.

'NN' TYPE HOUSINGS CENTRE BEARING FITS

All centre bearings have their diameter stamped on one face. Aluminium tin alloy type bearings are a

selective fit in their housings and the bore size, for example 51·81 mm, is normally stamped in full on the pump housing. In a few cases, only the last figure was stamped on the pump housing e.g. bore size 51·82 mm then 2 was stamped. If the size is not readily seen on the pump housing, remove the nameplate which covered the stamping on a few of the earlier pumps.

FOR HOUSING STAMPED	FIT BEARING	PART No.
(1) or 51·81 mm	51·81	7122 41A
(2) or 51·82 mm	51·82	7122 41B
(3) or 51·83 mm	51·83	7122 41C
(4) or 51·84 mm	51·84	7122 41D
51·90 mm	51·90	7122 41E

C.A.V. 'N' AND 'NN' STAGE II TYPE PUMPS FOR MULTI-FUEL ENGINES

With the introduction of multi-fuel engines which operate on Diesel or Petroleum fuels, the conventional type fuel injection pump (already described) requires modification.

When using the low viscosity petroleum fuels it was found that the increased rate of back leakage past the plungers, could, unless prevented, result in excessive dilution of the lubricant within the camshaft chamber. This could lead to failure of cams, tappets or camshaft bearings. It was also found when the pump was standing idle for long periods, that the fuel film on the lower exposed surface of the pumping plunger might dry off, resulting in the plunger sticking when next required to operate. To overcome these difficulties Stage II Type pumps incorporating the following modifications, as illustrated in Fig. 25, were introduced.

The increased rate of back leakage past the plungers has been minimised by the provision in the plunger barrel of a relief groove connected by suitable drillings to the low pressure supply system or fuel tank, whilst a sealing ring is fitted to the external diameter of the plunger barrel. By introducing lubricating oil under pressure to a second groove, positioned in the pumping element between the fuel relief groove and the free end of the plunger, all back leakage is prevented, and the lubricating oil film on the exposed surface of the plungers gives complete protection during idle periods.

This arrangement permits the cam and tappet mechanism to operate in any suitable lubricant without danger of dilution.

Force feed lubrication is supplied from the engine to the cambox, through a drilling in the tappet bore at mid-point of the tappet lift, in this way the tappet assembly clearance meters the oil feed.

Oil return to the engine sump is via the overflow connection positioned on the pump housing to suit the installation.

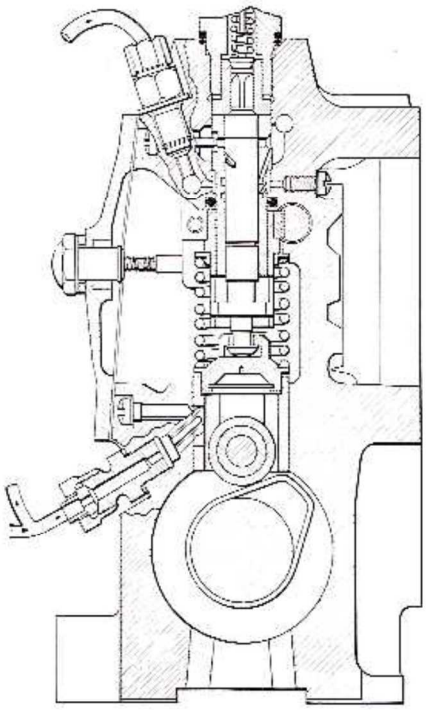


FIG. 25. SECTION VIEW OF STAGE II TYPE PUMP

C.A.V. 'N' AND 'NN' STAGE III TYPE PUMPS FOR HIGHLY RATED APPLICATIONS

Stage III type pumps are used in diesel fuel engines with high pumping loads and incorporate the following modifications as shown in Fig. 26. A groove is machined in the circumference of each plunger whilst a small hole is drilled in each plunger barrel. These holes are in line with transverse drillings in the pump housing, thus fuel oil relief from each element back to the unfiltered side of the filter pack is provided. Additionally, a rubber sealing ring is fitted

externally to each plunger barrel. In this way, back leakage of fuel oil to the cambox is reduced to an absolute minimum. Force feed lubrication is supplied from the engine to the cambox, through a drilling or special orifice in one of the tappet bores at mid-point of the tappet lift, so that the tappet assembly clearance meters the oil feed. This oil is then returned to the engine sump via the drain level connection positioned on the pump housing to suit the installation.

If excess fuel should be found in the engine sump, the element barrel sealing ring must be examined and replaced as necessary.

DISMANTLING AND REASSEMBLY OF STAGE II AND STAGE III TYPE PUMPS

Stage II and Stage III type pumps differ from the normal 'N' and 'NN' pumps by the use of modified plunger barrels and the fitting of the plunger barrel sealing rings. They can be dismantled and reassembled in accordance with the instructions already given.

If the seals are correctly fitted, they should not normally require renewing except during pump overhauls.

Fitting new Sealing Rings

When fitting new sealing rings the following procedure must be carried out:—

1. Carefully examine the ring grooves in the housing and ensure that they are thoroughly clean and free from all dirt, swarf, etc. If necessary, clean them out using a small brush dipped in clean fuel or petrol. Never use a hard scraper as this is liable to damage the grooves, making the sealing ring useless when fitted.
2. Examine each sealing ring carefully for moulding 'flash'. If present, this 'flash' must be always on the outside surface of the ring, leaving the inner bore smooth and clean.
3. Lightly smear each ring with silicon grease and insert into the grooves.
4. When fitted, each ring must seat squarely in the groove and not be twisted or distorted in any way.

Sealing Ring Pressure Test

The seals fitted to Stage II and Stage III pumps are subjected to an air pressure test of 45 lb/in² (3·1 kg/cm²) with the pump immersed in a bath of clean test oil.

For checking, the pumps are partly assembled with the barrels, locking screws, plungers, delivery valves and holders, the filter pack and cover fitted; but the 'O' sealing rings are left out of the assembly. A piece of plastic or other suitable material is used to retain the plungers in the barrels.

One air vent is sealed off and the other vent plug is connected to the 45 lb/in² (3·1 kg/cm²) air supply line.

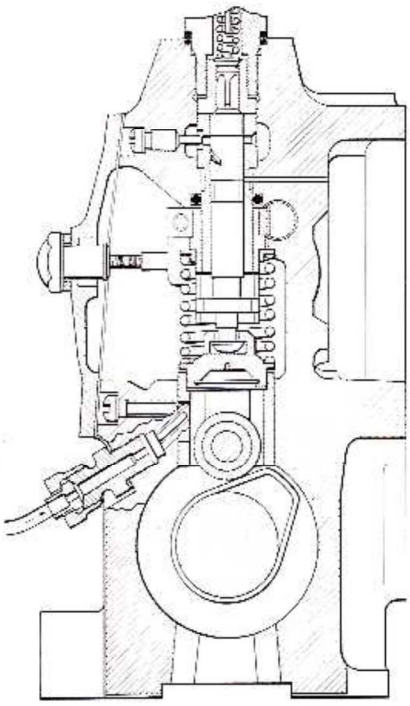


FIG. 26. SECTION VIEW OF STAGE III TYPE PUMP

Immerse the complete assembly in a bath of clean oil and examine the barrel seal for leaks in the normal way. If there are no leaks release the air pressure and strip down the partly assembled pump and rebuild, fitting the 'O' sealing rings during rebuilding.

Again test the assembly as detailed in the preceding paragraphs and rectify any leaks discovered. A slight leak between the plunger and barrel can be ignored.

TWO POSITION MAXIMUM FUEL STOPS FOR USE ON STAGE II PUMPS FITTED TO MULTI-FUEL ENGINES

With Stage II pumps it is necessary to use a maximum fuel stop which can readily be adjusted to suit the type of fuel being employed, i.e. diesel fuel oil or petroleum mixture. Figs. 27 and 28 illustrate two position maximum fuel stop devices used on Stage II pumps with either a mechanical or pneumatic governor.

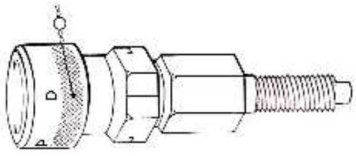


FIG. 27. TWO POSITION MAXIMUM FUEL STOP FOR MULTI-FUEL ENGINES (PNEUMATIC GOVERNOR)

Both these devices are similar in operation and consist of a spring-loaded spindle which can be set at either of two fixed positions by depressing the spring and turning the spindle through 90° movement thus altering the amount of control rod travel.

In the pneumatic governor version, the letters 'D' and 'P' (DIESEL-PETROLEUM) are engraved on the surface of the knurled cap and it is only necessary to remove the locking wire—depress this cap and turn it until 'D' or 'P', as required, is in line with the register on the hexagonal nut.

On the mechanical governor type it is first necessary to remove the locking wire and protective cap before depressing the small plunger and turning it through 90° with a screwdriver. This stop is correctly set for diesel fuel when the plunger is fully depressed, and for petroleum when the plunger is protruding from the body.

After setting, replace the protective cap and lock in position with wire.

Fitting and Removing Two Position Fuel Stops

After overhauling a pump it must be calibrated and the maximum fuel stop set to give the correct amount of fuel according to the particular application. With two position maximum fuel stops as described above, the following procedure must be carried out:—

Pneumatic Governors

On pneumatic governors the two position maximum fuel device is locked in position by the serrations in the governor breather cap.

To remove the device from the governor proceed as follows:—

Remove locking wire.

Unscrew setscrew holding the governor breather cap.

Lift the breather cap so that it is free of the small filter.

The maximum fuel device complete with breather cap can now be unscrewed and removed. To replace, set 'D' on knurled cap in line with the register.

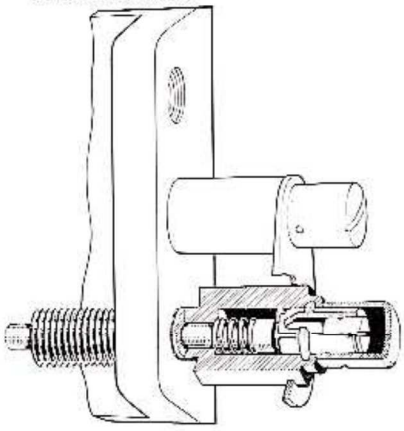


FIG. 28. TWO POSITION MAXIMUM FUEL STOP FOR MULTI-FUEL ENGINES (MECHANICAL GOVERNOR)

Pass the stop device through the serrations in the breather cap.

Hold the breather cap clear of the small filter on the governor housing so that it can rotate with the stop device.

Screw the stop device into the governor housing until the normal maximum fuel position is reached. This position must be set with the pump on the test machine. Position breather cover by means of the serration and tighten in position with setscrew.

The stop device will now be locked in the correct setting.

Maximum fuel stop position for 'P' will automatically be set correctly.

After setting, relock with wire, and seal to prevent interference.

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