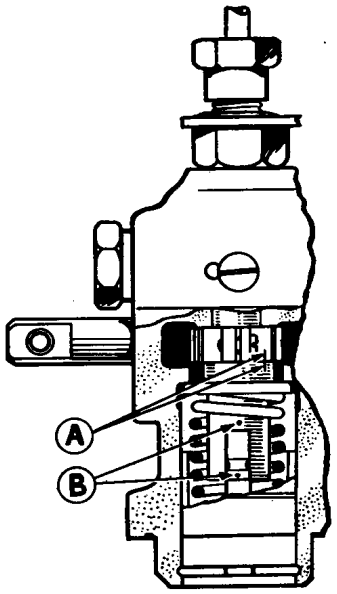
(*continued from page* 16)



A. Timing marks on quadrant and regulating sleeve (multi-cylinder pumps only).

B. Punch marks on regulating sleeve and plunger lug.

Fig. 13. *Position of timing marks*

4. Insert upper spring plate 11 and plunger 10 fitted with lower spring plate 13 and spring 12 into the pump barrel, taking care that the lug on the lower end of the plunger is fitted into the slot in the regulating sleeve 20 for which it is marked.
5. Insert plunger guide 8 and push up until a service pin may be fitted through the hole provided in the flange spigot, so that the spring ring 9 may be fitted into its groove.

To facilitate dismantling and reassembling of the pumps, a special delivery valve seat extractor is recommended, in addition to ordinary spanners and screwdrivers.

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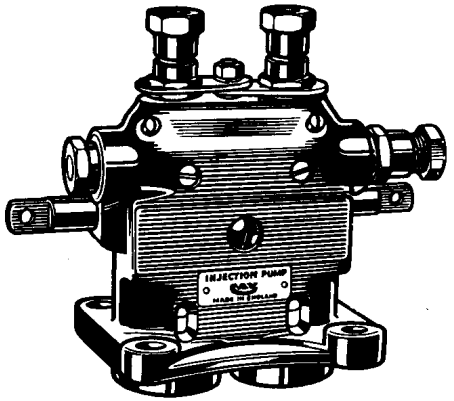
FUEL INJECTION PUMPS

FLANGE MOUNTED TYPE MODELS BPF



INSTRUCTION BOOK

PRICE 1/-

CONTENTS

FUEL INJECTION PUMPS
TYPE BPF

IT is well known that the performance of all internal combustion engines depends largely upon some device for converting the fuel whether liquid or gas, into a condition suitable for consumption in the combustion chamber of the engine.

In this respect the modern high speed oil engine is no exception since the injection system is an integral part of the engine design. For maximum efficiency in operation it is essential that the engine not only be provided with fuel in quantities proportional in the most minute degree to the amount of work it is required to do, but also that each injection be timed with the utmost accuracy This, briefly, is the function of the fuel injection pump, which having metered and delivered the correct quantity of fuel, must then discharge it through a nozzle orifice at such a high pressure that the fluid is atomised and delivered into the combustion chamber in a form which will enable it to ignite and burn without smell or smoke.

As this process may have to be repeated many hundreds of times per minute, the unerring precision necessary in the production of the fuel injection equipment will be appreciated

GENERAL DESIGN

The C.A.V. Fuel Injection Pump is a cam-operated spring return plunger pump of the constant-stroke one pump element per cylinder type. Normally, it is offered as a one-cylinder unit, so that for multi-cylinder engines it is necessary to provide one pump per cylinder.

The "A" series of pumps, however, can also be supplied as two-cylinder models, and the " B " series in two, three, or four cylinder units, in a common housing (i.e., Models BPF2A, BPF2B, BPF3B and BPF4B, but the " Z," " C," " X " and " D " series are only supplied as one-cylinder units. Model BPF pumps are provided with a flange mounting, to facilitate fitting them over the engine-builder's own cam-driving gear.

OPERATION

The system of operation of the pump element, which is comprised of the plunger and barrel, is shown in fig. 1. When the plunger is at b.d.c. as at (*a*) oil can enter through the barrel ports either by gravity flow from an overhead tank, or force feed from a fuel feed pump, the latter being the most usual arrangement. In a primed system, of course, the barrel and the pipes leading from the pump to the injectors are full of oil. As the pump plunger rises, a certain amount of fuel is pushed back through the barrel ports, until the plunger reaches the position (*b*) where the top land of the plunger has closed both ports. The fuel above the plunger is then trapped, and its only outlet is via the delivery valve 2 (see fig. 3) which is mounted on top of the pump barrel. The pressure exerted by the rising plunger upon the oil

SERIES "A"

In one or two cylinder units, i.e., BPF1A and BPF2A.
Plunger stroke: 7 mm. Weight: BPF1A with one pump element = 1 lb. 5 oz. (·5 kg.)

Maximum useful output per stroke of each element :

Plunger diameter .. .. mm.	5·0	6·0	6·5	7·0
Output, approx. .. .. mm.³	40	60	87	102
Output, approx. .. .. ins.³	·0024	·0038	·0053	·0062

SERIES " B "

In one, two, three and four cylinder units, i.e., BPF1B, BPF2B, BPF3B and BPF4B.
Plunger stroke : 10 mm. Weights : BPF1B with one pump element = about 4 lb. (1·8 kg.)
BPF2B with two pump elements = about 5½ lb. (2·5 kg.)
BPF3B with three pump elements = about 7½ lb. (3·4 kg.)
BPF4B with four pump elements = about 10 lb. (4·5 kg.)

Maximum useful output per stroke of each element :

Plunger diameter .. mm.	5·0	6·0	6·5	7·0	7·5	8·0	9·0	10·0
Output, approx. .. mm.³	65	100	125	135	160	180	230	280
Output, approx. .. ins.³	·0041	·0061	·0076	·0082	·0098	·0109	·0143	·0171

SERIES " Z "

In single cylinder units only, i.e., BPF1Z.
Plunger stroke : 12 mm. Weight : BPF1Z with one pump element = about 7 lb. (3.2 kg.)

Maximum useful output per stroke :

Plunger diameter .. mm.	10·0	11·0	12·0	13·0
Output, approx. .. mm.³	500	650	800	950
Output, approx. .. ins.³	·0305	·0396	·0488	·0578

SERIES " C"

In single cylinder units only, i.e., BPF1C.
Plunger stroke : 15 mm. Weight : BPF1C with one pump element = about 10 lb. (4·5 kg.)

Maximum useful output per stroke :

Plunger diameter .. mm.	10·0	11·0	12·0	13·0	14·0	15·0	16·0	18·0
Output, approx. .. mm.³	550	650	800	950	1100	1250	1400	1800
Output, approx. .. ins.³	·0336	·0396	·0488	·0518	·0670	·0762	·0854	·110

SERIES "X "

In single cylinder units only, i.e., BPF1X.
Plunger stroke : 22 mm. Weight : BPF1X with one pump element = about 23 lb. (10·5 kg.)

Maximum useful output per stroke :

Plunger diameter mm.	12·0	14·0	16·0	17·0	18·0	20·0
Output, approx. .. mm.³	1200	1800	2400	2800	3200	4000
Output, approx. .. ins.³	·073	·11	·147	·171	·196	·244

SERIES " D "

In single cylinder units only, i.e., BPF1D.
Plunger stroke : 30 mm. Weight : BPF1D with one pump element = about 28 lb. (12·6 kg.)

Maximum useful output per stroke :

Plunger diameter .. mm.	14·0	16·0	18·0	20·0
Output, approx. .. mm.³	2300	3000	4000	5000
Output, approx. .. ins.³	·1400	·1830	·2440	·3050

N.B.—Pumps of larger output are available to special order.
Dimension drawings of all types are available on request.

causes this to lift the valve and to enter the pipe which connects the pump to the injector. As this is itself already full of oil, the extra oil which is being pumped in at the pump end, causes a rise in pressure throughout the line and lifts the nozzle needle (or injector valve). This permits oil to be sprayed into the engine combustion chamber. Thus, at this moment we have oil being pumped into the line at the pump end, and an equal quantity being pushed out at the nozzle end. This continues until the plunger reaches the position shown at (c).

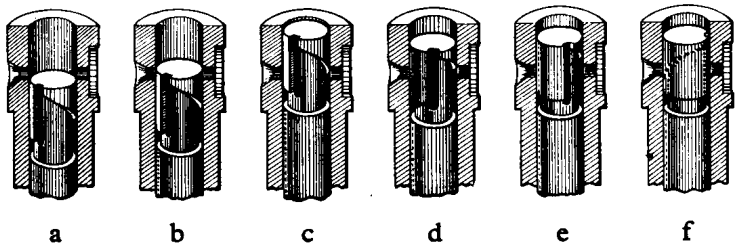


Fig. 1. *Barrel with various plunger positions*

Here the lower edge of the control helix has uncovered the barrel port, thus allowing fuel to be by-passed back to the suction chamber (which is under a very much lower pressure than the fuel oil above the plunger) by way of the vertical slot. This causes the delivery valve to shut under the action of its spring, and with the consequent collapse of pressure in the pipe line, the nozzle valve also shuts. The plunger stroke is always constant, but that part of it which is actually pumping, is variable. By means of the helical edge which runs around the plunger, which itself can be rotated within the barrel (see fig. 3) it is possible to make this point of cut-off occur earlier, or later, in the stroke —compare positions shown at (c), (d) and (e) which show full load, half load and idling respectively. To stop the engine, the plunger is turned so that the vertical slot coincides with the barrel port (see f) during the whole of the plunger stroke ; thus no fuel is delivered. The position of the plunger stroke at which the helical edge will uncover the port is adjustable by rotating the plunger axially by means of a toothed quadrant 6 (see fig. 3) which is clamped to a sleeve 7, having slots engaging the lugs of the plunger at its lower end.

The toothed quadrant 6 meshes with a rack provided on the control rod 5 which similarly actuates all the pump elements in the unit, and is externally connected either to the governor or other controls by suitable linkage.

ANTI-DRIBBLE DEVICE

When the helical edge of the pump plunger uncovers the port in the pump barrel near the end of the delivery stroke, the pressure of fuel is immediately reduced so that the delivery valve at once drops on its seating, thus cutting off communication between the pump and the nozzle until the next delivery stroke takes place. In coming to its seat to act as a non-return valve, the delivery valve is, however, made to perform the other highly-important function of pressure unloading.

The double function is obtained by means of the novel, but entirely simple, construction of the delivery valve unit, and reference to fig. 2 will show that it is an ordinary mitre-faced valve with a guide which has a circular groove cut in it, dividing the guide into two parts. The lower part has four longitudinal grooves communicating with the circular groove. The upper part of the guide forms a small piston, which is an accurately ground plunger fit for the valve seating which is also internally ground. When the pump is on its delivery stroke, the pressure of the fuel rises and the delivery valve is pushed up until the fuel can escape through the longitudinal grooves over the valve face to the nozzles. Immediately the pump plunger releases the pressure in the barrel, the delivery valve (under the influence of its spring and the great difference in pressures between the pump barrel and the delivery pipe) resumes its seat, causing the small piston part of the guide to sweep down the valve seating with a plunger action, thus increasing the space in the delivery pipe (by an amount equal to the volume of the small piston part of the valve guide) before the valve actually seats itself. The effect of this increase of volume in the delivery pipe system is, of course, that of suddenly reducing the pressure of the fuel therein so that the nozzle valve in the nozzle can " snap " to its seat, thus instantaneously terminating the spray of fuel in the cylinder entirely without " dribble."

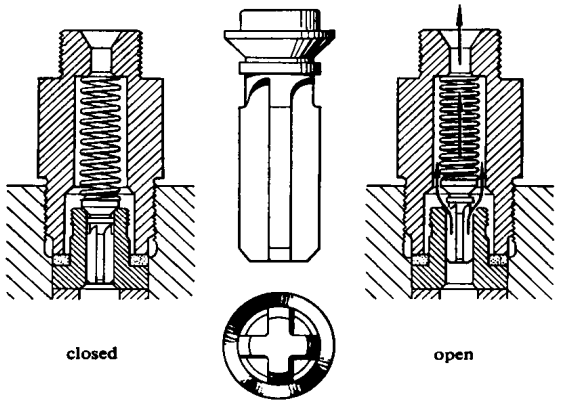


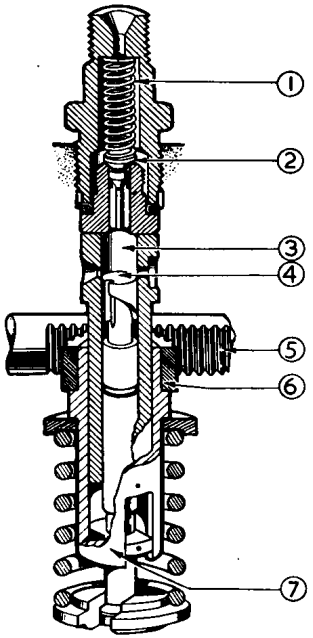
Fig. 2. *Delivery valve*

CONTROL OF OUTPUT

The word " Stop " and an arrow engraved on the top of one end of the control rod 5, indicate which way the control rod should be moved to stop the engine. A pump element at no output or " Engine stopped" position is shown at f (fig. 1), when the control rod 5 will be in " Stop " position and the vertical channel of the pump plunger will be opposite the right-hand port in its pump barrel, so that even if the engine is moved no fuel will be pumped.

When the engine is to be started, the control rod 5 is moved over from the stopped position to the starting position. The elements are then at maximum output or engine starting, when they are capable

of pumping more fuel than normally required with the engine at full load. This condition is generally required at starting to facilitate priming of the fuel pressure piping, etc., so that the engine will start readily. Thus, to prevent sooting up of the engine care should be taken to make it impossible to adjust the pump to give maximum output WHILE THE ENGINE IS RUNNING by fitting a " trip " collar on the control rod. When moving the control rod into its starting position this collar must be temporarily " tripped " out of use but should automatically come into use again immediately the engine starts. The actual position of the control rod at normal load can only, of course, be found by experiment on the particular engine concerned.



1—Valve spring
2—Delivery valve and seat
3—Pump barrel
4—Pump plunger
5—Control rod
6—Toothed quadrant
7—Control sleeve

Fig. 3
Pump element in section

The control rod 5 can be connected to the governor at one end and to the hand control or accelerator at the other. In linking these up, however, care should be taken that no transverse or rotational forces are transmitted to the control rod, which might be hindered or even

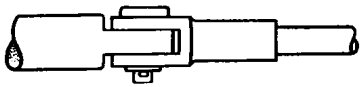


Fig. 4. *Connection of control rod by means of a forked link*

jammed with a resultant faulty control of the engine. Therefore, a forked link as shown in fig. 4 should be used for this purpose.

MOUNTING AND DRIVE

Model BPF pumps are provided with a flange for mounting, while the cam, camshaft, tappet, etc., are supplied by the engine builder.

These pumps are designed to operate in a vertical position (when the pump is to be fitted horizontally or at an angle, special air vent screws are necessary) and should be fitted over the driving cam in such a way that a simple light-weight adjustable tappet and roller can be used with a hand-priming and " cut-out " lever, if required.

Model BPF1A single-cylinder pumps can be provided with the fixing flange in three different positions as follows :—

1. BPF1A../00. Horizontal flange with its long axis parallel to control rod—fig. 6.
2. BPF1A../03. Horizontal flange with its long axis at right angles to control rod—fig. 6A.
3. BPF1A../05. Horizontal flange rectangular in shape and the inlet plug parallel with the control rod—fig. 7.

BPF1B single-cylinder pumps have also got three different flange positions as follows :—

1. BPF1B../00. Arranged as for BPF1A../00—fig. 6.
2. BPF1B../03. Arranged as for BPF1A../03—fig. 6A.
3. BPF1B../04. Provided with a vertical flange parallel to control rod—fig. 7A.

Model BPF1C, BPF1X and BPF1D pumps are offered with two positions of mounting flange, as shown in figs. 8 and 8A—the type designations being :—

1. BPF1Z../00. BPF1C../00. BPF1X../00 and BPF1D../00. Horizontal flange with its long axis parallel to control rod—fig. 8.
2. BPF1Z../03. BPF1C../03. BPF1X../03 and BPF1D../03. Horizontal flange with its long axis at right angles to control rod—fig. 8A.

These pumps should be fitted, by means of their flange, at such a height over the camshaft that the plunger may be moved through its full stroke without actually touching either the delivery valve 15 at the top of the stroke or the spring ring 9 (fig. 12) at the bottom. Thus the cam should be designed with a maximum lift of 7 mm. for model BPF1A pumps, 10 mm. for model BPF..B pumps, 12 mm. for model BPF1Z pumps, 15 mm. for model BPF1C pumps, 22 mm. for model BPF1X pumps, and 30 mm. for model BPF1D pumps—a diagram showing the profile of a cam suitable for these pumps will be supplied on request.

When a properly designed cam is used with a pump correctly mounted, there must still be a clearance at the top of the stroke between the plunger end and the delivery valve.

Fig. 5. *Sight window marks*

In the case of BPF1A and BPF1B pumps this clearance is approximately half a millimetre, in the case of BPF1Z and BPF1C pumps 1 millimetre, BPF1X pumps 1·2 millimetres, and BPF1D pumps

1·5 millimetres. Thus, to facilitate accurate mounting and setting, a small sight window is provided in the pump casing corresponding with a horizontal mark on the plunger guide 8. This mark and a similar line mark on the sight window are engraved before the pumps leave the factory. Fig. 5 above indicates the three principal positions of the guide relative to the housing.

The point in the plunger stroke at which delivery of fuel commences is shown at (a) where the mark on the guide 8 (see fig. 12) is in line with the mark on the sight window.

Views (b) and (c) show, respectively, the mark on the guide just visible in the sight window at the top and at the bottom of the plunger stroke. These are the limits beyond which the guide must not move after final adjustment of the tappet. On X series pumps the line mark indicates the theoretical spill point.

LUBRICATION

The only lubrication required is that of putting a little engine oil on to the plunger guide 8, from time to time, through the inspection window. The pump plunger needs no lubrication as sufficient is derived from the fuel.

PIPING CONNECTIONS, ETC.

The inlet piping recommended is copper tubing of 8 mm. bore x 10 mm. outside diameter for models BPFA, BPFB and BPF1Z pumps, 12 mm. bore x 14 mm. o/d for model BPF1C, 16 mm. bore x 18 mm. o/d for model BPF1X, and 19 mm. bore x 22 mm. o/d for model BPF1D. It should be laid from the tank to the filter and from the filter to the inlet connection on the pump in a falling plane without sharp bends, i.e., the bending radius should never be less than 50 mm.

For delivery piping between pump and nozzle, steel tubing of 1·5 mm. bore x 6 mm. o/d (or 2 x 6) is suitable for models BPFA and BPFB pumps, while for model BPF1C pumps, 3 mm. bore x 6 mm. o/d (or 3 x 8) and for model BPF1Z, BPF1X and BPF1D pumps 3 mm. bore x 8 mm. o/d (or 3 x 10) is recommended. The nipples for the delivery pipes can either be separate nipples, silver soldered to the pipe, or made of the pipe material "swelled" at the end. Any C.A.V. Depot will supply a tool for forming "swelled" nipples if size of piping to be used is quoted.

Note : All finished fuel inlet and delivery pipes, in addition to being thoroughly washed out with clean fuel oil, should be blown through with high-pressure air, to ensure that they are absolutely clear and clean before being fitted.

AIR VENTING THE FUEL SYSTEM

If the fuel system has been opened at any time, say, for an overhaul, it is necessary to ensure that all air has been removed before attempting to start the engine. This may be done as follows :—

1. If no special vent cock is provided for venting the suction system, set the control rod in the "Stop" position and slack back the inlet piping connection a little until fuel flows freely without air bubbles. Tighten up again.

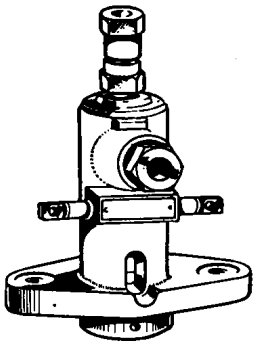


Fig. 6. *Type BPF1A..*/00
Type BPF1B../00

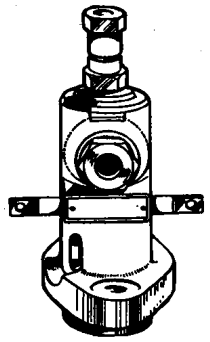


Fig. 6*A*. *Type BPF1A..*/03
Type BPF1B../03

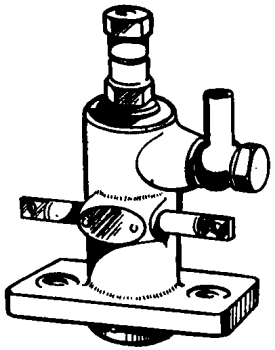


Fig. 7. *Type BPF1A..*/05

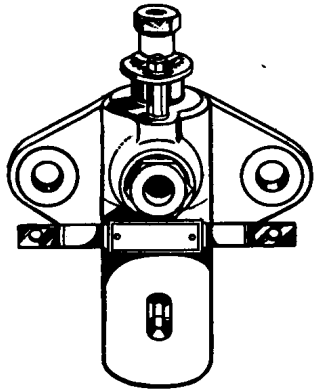


Fig. 7*A*. *Type BPF1B..*/04

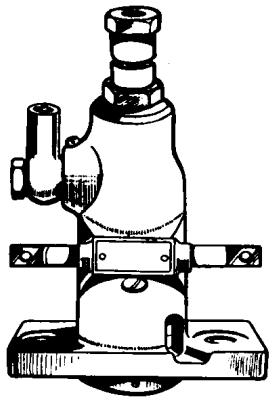


Fig. 8. *Type BPF1Z..*/00
Type BPF1C../00
Type BPF1X../00
Type BPF1D../00

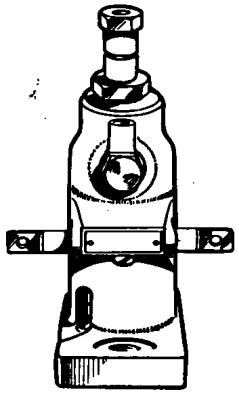


Fig. 8*A*. *Type BPF1Z..*/03
Type BPF1C../03
Type BPF1X../03
Type BPF1D../03

2. Set the control rod at "Maximum Output" position, and give a few strokes with the hand priming lever (or turn the engine by hand) until the pressure pipes are full, when the engine should be ready for starting.

FUEL STORAGE

Whenever possible, fuel oil should be purchased and stored in bulk, large tanks being used for the latter purpose, so arranged that they can be periodically emptied and cleaned out. It is preferable to use twin tanks connected in such a way that one can serve as a settling tank in which the heaviest particles of sludge can gravitate from the fuel during storage. The fuel oil should then be drawn through suitable large capacity filters into the container of the engine, care being taken to eliminate the possibility of the ingress of dirt during the process.

FILTRATION

It will be appreciated that the C.A.V. fuel injection pump is designed to operate against very high pressure at varying speeds and in order to meet these exacting conditions requires a very high standard of workmanship and the utmost precision in manufacture. Consequently, the internal mechanism must be protected from the abrasive effects of dirt and other kinds of foreign matter present in all types of fuel oil. For this reason, special attention is directed to the fitting and frequent inspection of a suitable filter.

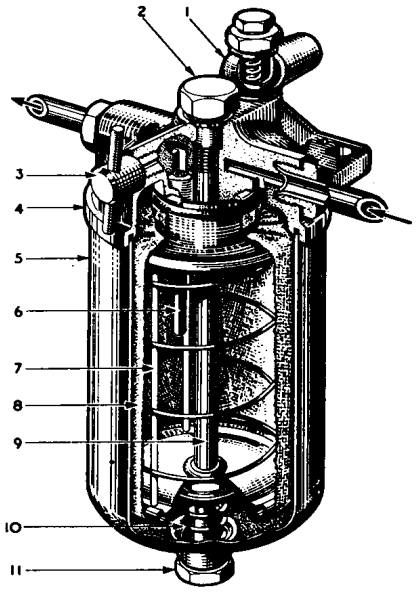
Several types of filter are available to suit varying conditions of operation, including cloth element, felt element and combined cloth and felt element types.

Cloth Type Filter. The filter illustrated in fig. 9 is of the cross-flow, cloth element type and consists of a steel container 5, with cover 4, which carries the closing plug and air vent screw. It has a capacity of flow with a 3 ft. head of 3.5 to 4.5 pints/minute with a relatively clean condition of fabric and fuel.

The oil on entering through the inlet connection in the cap, filters through the finely woven cloth 8, which is stretched over a spiral wire framework. The oil then flows through the standpipe 6 and out into the main pipe line through the outlet connection fitted on the opposite side of the cap to the inlet connection.

When the filter is assembled, the element is held tightly pressed against the spring 10 in the base of the housing, so that there is no possibility of fuel issuing without having passed through the filter cloth. The filter can be dismantled with ease for cleaning and inspection by unscrewing the cap nut 2 and removing the cover 4. The filter element can then be easily withdrawn from its housing.

No attempt should be made to clean the filter cloth as this invariably results in some of the impurities being transferred to the clean side of the filter. Used filter cloths should therefore be discarded, and new ones fitted as described in our published instructions.



1—Closing plug
2—Cap nut.
3—Air vent screw.
4—Cover.
5—Housing.
6—Standpipe.
7—Wire framework.
8—Fine filter cloth.
9—Centre tube.
10—Pressure spring
11—Sludge plug.

Fig. 9 C.A.V. Cloth Element Type Filter sectioned to show Internal Construction

Felt Type Filter. The felt element filter as shown in fig. 10 is of the down-flow type and comprises a metal housing with oil-tight cover, provided with inlet and outlet connections. Pressure relief valves are incorporated where necessary, as when a fuel feed pump is fitted. The element consists of a series of felt pads built up on a perforated support tube, the fuel flow being from the outside to the inside of the element.

1. Closing plug.
2. Air vent screw.
3. Cap nut.
4. Filter cover.
5. Filter housing.
6. Felt pads.
7. Gauze tube.
8. Centre tube.
9. Pressure spring.

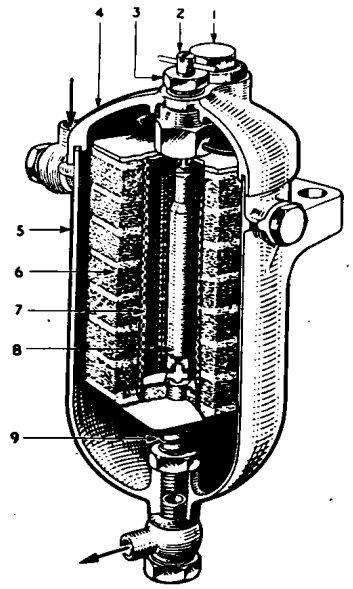


Fig. 10. C.A.V. Felt Element Type Filter sectioned to show Internal Construction

The filter element can be cleaned, using petrol, paraffin or carbon tetrachloride, but it is not recommended that an element be cleaned more than three or four times before replacement. When servicing this element, particular care must be taken to seal the exposed orifices with clean corks, and to use a soft brush to remove dirt during immersion in the cleaning fluid.

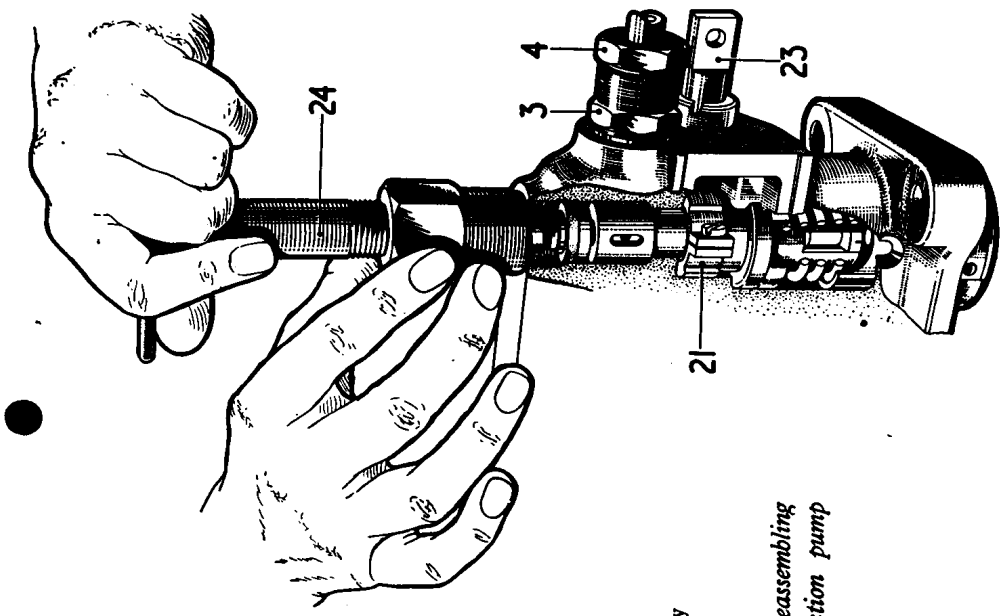
On no account should the felt pads be removed or separated during the cleaning operation, as this would result in spreading the dirt across the pads and would increase the possibility of it getting through to the injection pump. When required, new felt pads (obtainable from C.A.V. depots) should be fitted to the filter frame. This operation, of course, demands a suitable dust-free workshop.

Combined Cloth and Felt Type Filter. These filters are basically similiar in design to the felt type, but in this case the felt pads are surrounded by a cloth element, through which the fuel has first to pass before reaching the felt element.
In servicing this type of filter, the dirty filter cloth, as in the case of the cloth type filter, must not be cleaned and should be thrown away. The felt element should be cleaned as described above, replacing the felt pads if necessary. Finally a new filter cloth should be fitted and assembled on to the filter frame.

Choice of Filter Types. Before making a final decision as to the type of filter to be fitted, it is necessary to consider the method of fuel feed to the injection pump. If the fuel feed is pressure fed to the injection pump by means of a fuel pump or a similiar arrangement, the filter employed should be fitted with a relief valve in order to provide a leak-off should the pressure become excessive. If a gravity method of fuel feed is employed, the relief valve is considered unnecessary.

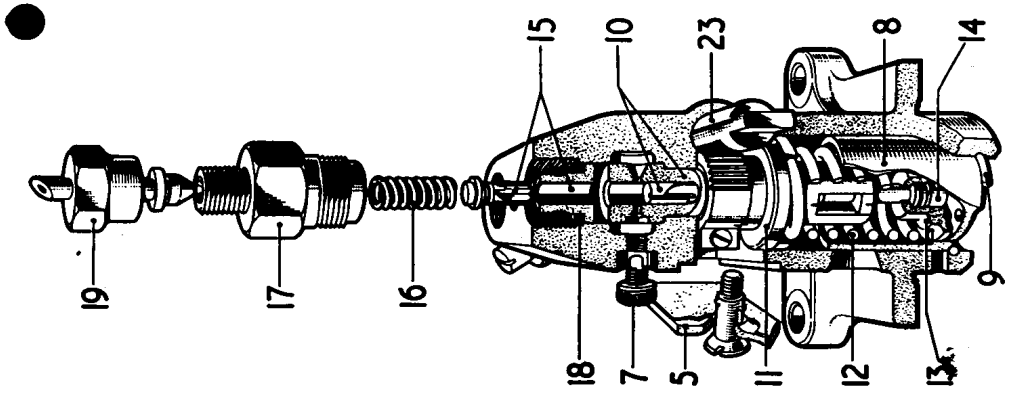
DISMANTLING

When preparing to dismantle pumps (fig 11), the bench on which the work has to be done should be thoroughlv cleaned (particular care being taken that all iron filings, dirt, grit, etc., have been removed) and a number of small clean containers, for the various parts of the pumps, provided. It is also advisable to have a thoroughly clean vessel available with a supply of fresh fuel oil for washing the parts. In dismantling the pump, the parts of each pump element should be kept entirely separate, a specially important point being to take care that the pump plungers are never fitted except into the barrels with which they originally worked (i.e., the same pump plunger and its barrel should always work together as a pair). In overhauling pumps, the pump plunger or its barrel should never at any time be touched with a file or other hard tools. Should these parts be damaged, the pump should be sent to the nearest C.A.V. Depot for attention. The delivery valve and its seating should also be kept together as a pair always and should never be ground in with grinding powder of any kind, as this will ruin them entirely. If, when they are cleaned and rubbed together, trouble is still experienced, the pair should be replaced from spares. If, in multi-cylinder block pumps, it is considered necessary



3—Inlet Connection Stud.
4—Fuel Inlet Nipple Nut.
5—Inspection Cover Plate.
7—Locking Pin and Joint.
8—Plunger Guide.
9—Spring Ring.
10—Pump Element (Plunger and Barrel).
11—Spring Plate, Upper.
12—Helical Spring for Plunger.
13—Spring Plate, Lower.
14—Press Bolt.
15—Delivery Valve and Seating.
16—Delivery Valve Spring.
17—Delivery Valve Holder.
18—Joint for Delivery Valve Holder.
19—Delivery Nipple Nut.
21—Regulating Toothed Quadrant.
23—Control Rod.
24—Tool for extracting Delivery Valve 15.

Fig. 11. Dismantling and reassembling C.A.V. Type BPF fuel injection pump



to dismantle the pump element control sleeves and control rod, these parts have to be readjusted together after reassembling with great accuracy to ensure that all pump elements will deliver identical quantities of fuel to all engine cylinders.

1. Push the plunger guide 8 (fig. 11) up until a service pin can be inserted into the dowel hole provided in the spigot of the pump flange, when it will be an easy matter to remove the spring ring 9. On removing the service pin, plunger guide 8, lower spring plate 13, plunger spring 12, and the plunger 10 can then be easily withdrawn.

2. Unscrew the delivery valve holder 17, withdraw spring 16 and delivery valve 15. The valve seating, and its joint 18 can now be removed by means of the special lifting tool. (This tool can be obtained from any C.A.V. Depot).

3. To remove the pump barrel 10, uncrew the locking pin 7 and push the barrel from below by means of a clean fibre or soft brass bolt.

Note : On multi-cylinder pumps the relative position of toothed quadrant and regulating sleeve is marked by two adjusting marks A (see fig. 13).

REASSEMBLING

In reassembling the pumps, great care should be taken that all joints and other parts are entirely clean. These should be (1) rinsed in clean fuel oil, (2) allowed to drip, (3) smeared with a little lubricating oil, and finally brought together entirely WITHOUT THE USE OF COTTON WASTE OR RAGS.

In the following notes, the word " PUMP " should be read to mean each pump element in a multi-cylinder block pump.

1. Refit the barrel carefully, taking care that the slot in it is opposite the hole for locking screw 7. Tighten down locking screw 7 after making sure that its joint is in place.

2. Refit valve seating 15 with joint 18, place cleanly and securely in position. Place delivery valve and its spring 16 in position. Fit delivery valve holder 17 with its joint 18 in place and screw down tightly.

3. Insert from below regulating sleeve 20 (fig. 12) with toothed quadrant 21 and make it mesh with regulating rod in such a way that the centre punch marks B (Fig. 13) and the clamp cheeks of the quadrant are pointing towards the front. Timing marks on multi-cylinder pumps must coincide.

(*continued on page* 20)

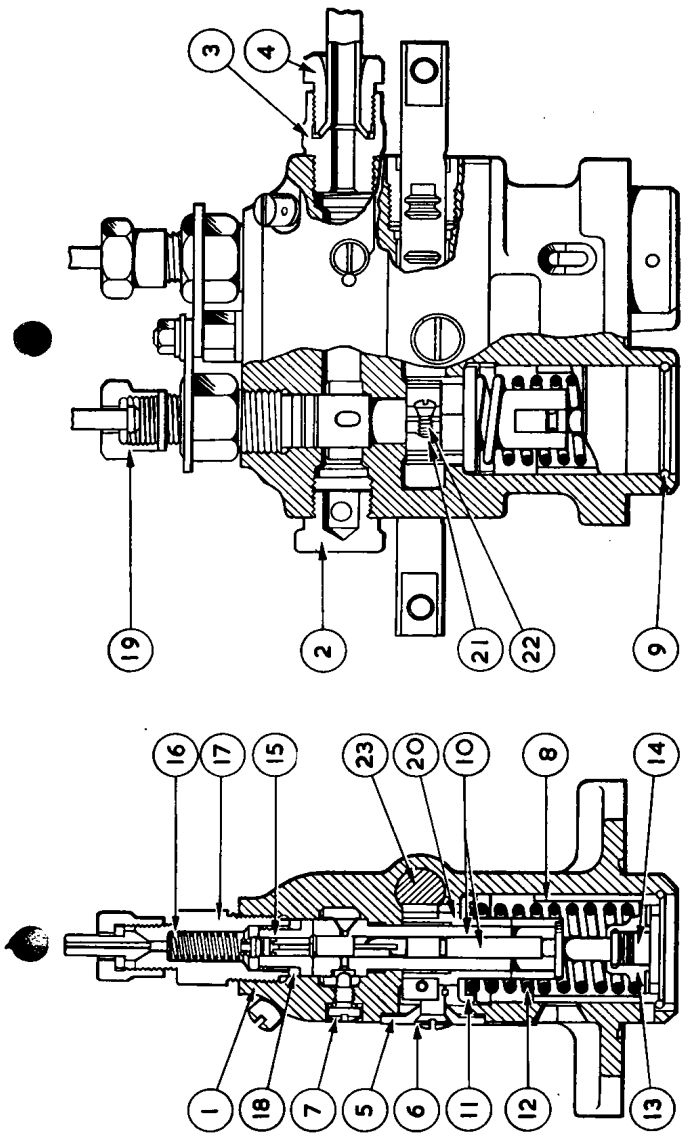


Fig. 12. C.A.V. fuel injection pump Type BPF sectioned to show internal construction

1. Housing
2. Inlet closing plug
3. Inlet connection stud
4. Fuel inlet nipple nut
5. Inspection cover plate
6. Screw with spring ring for cover plate
7. Locking pin and joint
8. Plunger guide
9. Spring ring
10. Pump element (plunger and barrel)
11. Spring plate, upper
12. Helical spring for plunger
13. Spring plate, lower
14. Press bolt
15. Delivery valve and seating
16. Delivery valve spring
17. Delivery valve holder
18. Joint for delivery valve holder
19. Delivery nipple nut
20. Regulating sleeve
21. Regulating toothed quadrant
22. Clamp screw
23. Control Rod

ENGINE TROUBLES AND THEIR REMEDIES

Fuel injection difficulties can arise on the engine from several causes which may be traced to the pumps. Such difficulties, with the probable cause and suggested remedy, are set out in the following tables.
The first move when the pumps are suspected should be to uncouple the piping between the pump and the nozzles. If the engine is then rotated with the pump control rod set at full load position, it will be readily seen if the pump is delivering fuel or not. Observe each discharge outlet on the pump to see if all the pump elements are in order. In the following table the word " Pump " applies either to the pump unit block as a whole or to individual elements, and the part numbers referred to are shown and named on fig. 12.

Possible Cause	*Location*	*Condition or suggested remedy, for correction*
1.—ENGINE WILL NOT START, OR STOPS AFTER A SHORT TIME		
Pump does not deliver fuel.	(*a*) Fuel cock.	Must be open.
	(*b*) Fuel tank.	Must contain an adequate supply.
	(*c*) Fuel inlet pipe or filter elements.	Clean—examine, and if choked replace cloth or clean filter pad.
	(*d*) Air in pump.	Air vent filter and pump (see section "Air Venting.")
	(*e*) Pump plunger 10.	If worn, replace element 10. Inspect filter and if necessary insert new cloth or felt.
	(*f*) Delivery valve 15.	Clean and inspect. If worn or damaged replace both valve and seating.
Pump does not deliver fuel uniformly.	(*g*) Air in pump.	Air vent filter and pump (see section "Air Venting.")
	(*h*) Delivery valve spring 16	Replace if broken.
	(*j*) Delivery valve 15.	If damaged on face or guide, replace complete.
	(*k*) Plunger spring 12.	If broken, replace.
	(*l*) Pump plunger 10.	If sticking, clean and refit. If trouble continues replace element 10 complete.
	(*m*) Fuel inlet pipes or filter elements.	Proceed as (*c*).
The moment of injection commencement has altered	(n) Head between tank and pump.	Increase if too small.
	(*o*) Tappet adjusting screw	If loose, readjust and well tighten nut.
	(*p*) Cam profiles.	If badly worn, replace cam.
2.—ENGINE DOES NOT PULL		
Quantity of fuel delivered per stroke is insufficient	(*a*) Delivery valve 15.	If leaking, scored or damaged, replace both valve and seating.
	(*b*) Pressure system joints	If leaking, clean joint faces and tighten.
3.—ENGINE " CARBONISED " BADLY		
Quantity of fuel delivered per stroke excessive.	(*a*) Regulating quadrant 21.	If moved, due to screw 22 being loose, adjust to mark and tighten screw thoroughly.
4.—MAXIMUM SPEED OF ENGINE TOO HIGH		
Control rod 23 has jammed.	(*a*) Pump plunger 10.	If seized, dismantle and clean. Replace if damaged.
	(*b*) Control rod 23.	Clean toothed rack if coated with dirt or other foreign matter.