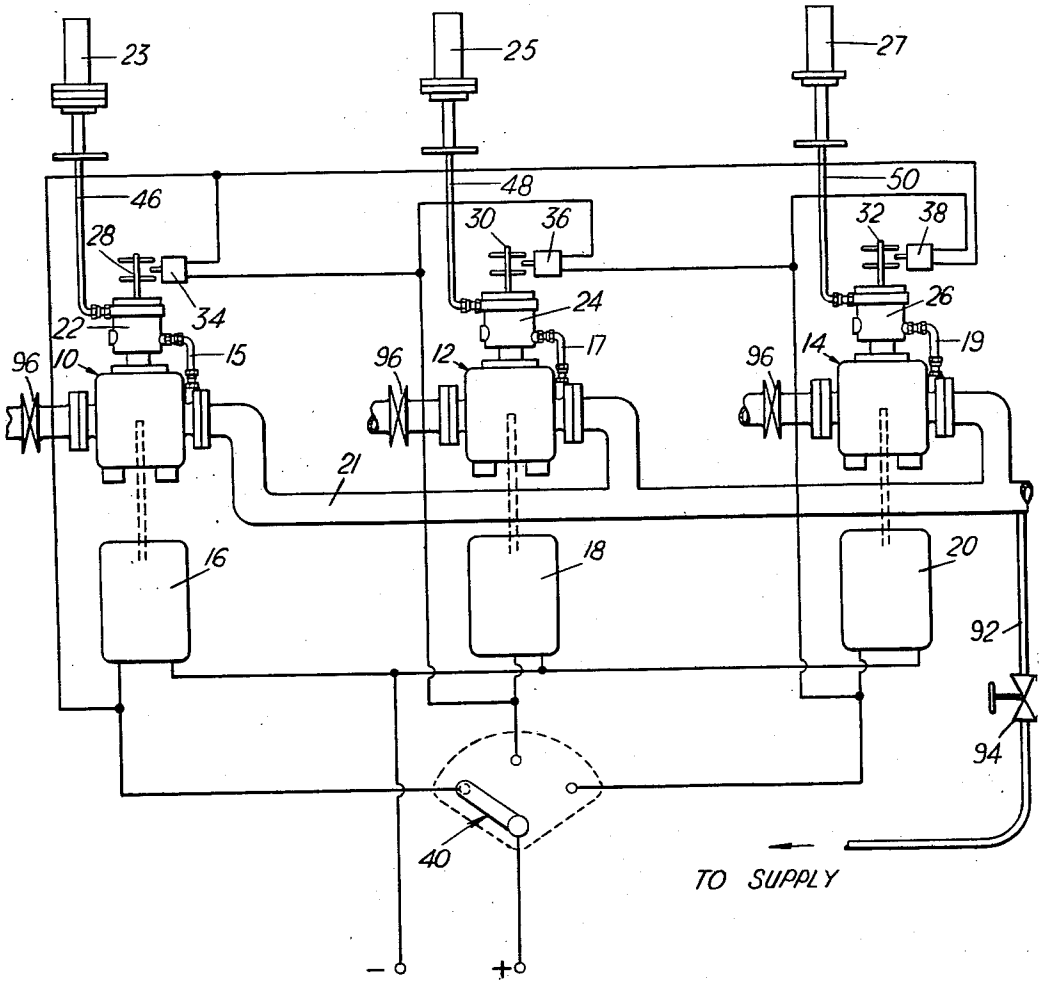
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PUMP INSTALLATION

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Fig. 1.



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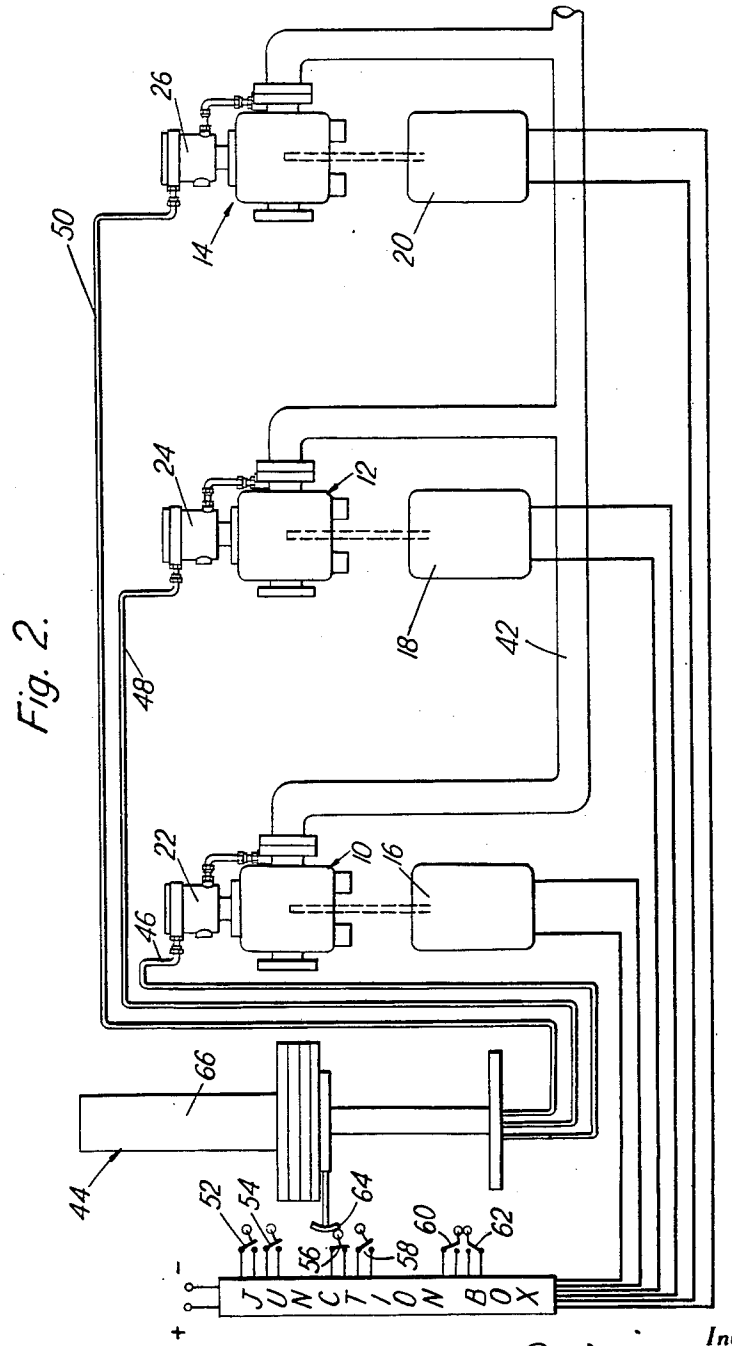


Fig. 2.

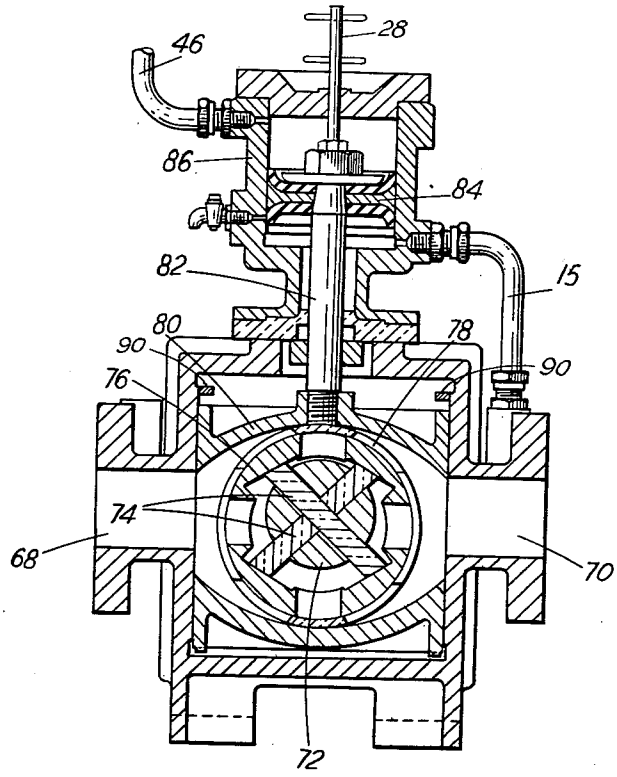
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Fig. 3.



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PUMP INSTALLATION

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5 Claims. (Cl. 103—11)

This invention relates to pumps and is in part a continuation of the invention disclosed in application Serial No. 623,892 filed on November 23, 1956, now abandoned. More specifically, the invention relates to pump installations comprising two or more variable-capacity pumps arranged to share a common load.

The load imposed on many pump installations varies over a wide range. Thus, for example, an electricity-generating station having two or more variable-capacity pumps for supplying fuel oil to the boiler-house demands a high output from the pumps during peak periods and a low output during off-peak periods. Because the pumps are of variable capacity, they are, of course, able to accommodate these changes of load. It is, however, inefficient to continue to operate both or all the pumps during off-peak periods when, for example, one pump is perfectly able to cope with the limited demand.

The main object of the invention is to obviate the inefficient operation described above.

Another object of the invention is to provide a pump installation wherein the pumps are brought into and out of operation automatically in accordance with load requirements.

A further object of the invention is to provide a pump installation which includes an hydraulic accumulator serving both to control the delivery pressure of the pumps and to operate switches which bring the pumps into and out of operation as required.

According to the invention, the pumps of the installation are electrically controlled so as to be brought individually into or out of operation in accordance with load requirements, the electrical control circuit comprising a limit switch mechanism for each pump which is automatically controlled in accordance with the instant position of the capacity-varying means of the pump. The arrangement is such that, when the capacity-varying means of the pump or pumps actually operating reaches one of two positions, at least one of the limit switch mechanisms is operated automatically so as to bring in another pump if the load is increasing or cut out a pump if the load is decreasing.

Thus, for example, a power station pump installation in accordance with the invention and comprising two pumps can be operated as follows.

In the normal way, one pump only is required for supplying all the fuel oil necessary to meet, say, up to 60% of the maximum load. As the load increases, the capacity of the pump increases correspondingly until it is delivering about 80% of its maximum output. At this stage the capacity-varying means of the pump reach a position where a member attached to them operates a limit switch in an electrical circuit. The operation of the switch causes a prime mover drying the second pump to be started up, with the result that the load is shared between the two pumps which are both delivering about 40% of their maximum output.

As the load continues to increase the two pumps continue to share it between them. If, however, the load begins to fall so that the two pumps are delivering only 30% of their maximum output, the capacity-varying means of the first pump reach a position where the member attached to them operates the limit switch in the opposite sense so as to shut down the prime mover driving the second pump. The output of the first pump then automatically increases to 60% of its maximum output as it takes over the duty of supplying all the fuel oil required.

The electrical control of the present invention can, of course, be applied to any number of pumps so that two, three, four or more pumps can be switched in or cut out in sequence as the load increases or decreases. The invention is not, moreover, limited to any particular type of variable-capacity pump.

In order that the invention may be thoroughly understood, two pump installations in accordance with it will now be described with reference to the accompanying drawings, in which:

FIGURE 1 illustrates the layout and electrical control circuit of one of the installations;

FIGURE 2 illustrates the layout and electrical control circuit of the other installations; and

FIGURE 3 is a part-sectional view through one of the pumps used in the installation of FIGURE 2.

The installation shown in FIGURE 1 comprises three variable-capacity pumps **10**, **12** and **14** of the sliding vane type driven by separate electric motors **16**, **18** and **20**. The delivery side of each pump is connected to a delivery line **21** which is common to all three pumps. Each pump is provided with a pressure-sensitive device connected by individual passages **15**, **17** and **19** to the delivery side of the pump for varying the capacity of the pump automatically according to load requirements. These pressure-sensitive devices are located in housings **22**, **24** and **26** provided on top of the pumping chambers and comprise an hydraulic cylinder and piston of essentially the same construction as the cylinder **86** and the piston **84** shown in FIGURE 3. The upper portions of these three hydraulic cylinders are connected by three separate pipe-lines **46**, **48** and **50** to three separate hydraulic accumulators **23**, **25** and **27** which apply in hydraulic load to the upper surfaces of the pistons in the housings **22**, **24** and **26**. However, the load applied by the three accumulators is not the same in all three hydraulic cylinders, for a reason which will be mentioned later.

Connected to the piston of each pressure-sensitive device is a switch-actuating rod **28**, **30** and **32** having a pair of cross pieces arranged to switch on and off a limit switch **34**, **36** and **38**. The limit switches are connected in electrical circuit to the electric motors **16**, **18** and **20** and to a selector switch **40** the position of which determines which motor is to be started up first.

It will thus be seen that the limit switches control the supply of current to the motors and that the switches are themselves controlled by the rods **28**, **30** and **32** which move vertically in accordance with the capacity of the pump. The sequence in which the motors come into and out of operation follows that already outlined in the introductory part of the specification except that the maximum load is shared between three pumps instead of two. Thus, when the selector switch **40** is moved into the position in which it is shown in FIGURE 1, the motor **16** driving the pump **10** is started up. As the load increases the limit switch **34** is actuated by the switch-actuating rod **28** so as to start up the motor **18** driving the pump **12**. A further increase in load causes the switch-actuating rod **30** to operate the switch **36** with the result that the motor **20** driving the pump **14** is also energised. All three pumps are now operating.

As the load falls, the sequence in which the pumps **12** and **14** will be cut out depends on the setting of their respective accumulators **25** and **27**. Assuming that the pressure exerted by each accumulator is greatest in the accumulator **23** and lowest in the accumulator **27**, then the switch-actuating rod **32** will rise more rapidly than the rods **28** and **30** and will actuate switch **38**. This will not however have the effect of shutting down the motor **16** because the circuit to this motor is in fact complete irre-

spective of the position of the switch **38**. A further decrease in the load causes the switch-actuating rod **30** to operate the switch **36** with the result that the motor **20** is de-energised. A still further decrease in the load then causes the rod **28** to operate the switch **34**, and this stops the motor **18**. The sole remaining pump now operating, namely, the pump **10**, continues to operate until the switch **40** is turned to its "off" position (not shown in the drawings).

There is no automatic connection between the selector switch **40** and the three accumulators **23**, **25** and **27**. In operation, the loading applied by the accumulators is adjusted manually after a decision has been made as to which pump will be started up first. Further, although the switch **38** apparently has no function when the switch **40** is used to start up the motor **16**, it will of course come into operation whenever the switch **40** is used to start up the motor **18** or the motor **20**. In these two cases, one or other of the switches **34** or **36** will be rendered unnecessary instead of the switch **38**.

A modification of the installation shown in FIGURE 1 consists in omitting the switch **38** so that the switch **40** is used solely to bring the motor **16** of the pump **10** into and out of operation. Thus, the first pump **10** is started up through the manually-controlled switch **40**, and the second and third pumps **12** and **14** are brought in thereafter as the load increases by the actuation of limit switch mechanisms **34** and **36** associated with the first and second pumps only. Preferably, the limit switch mechanism **34** associated with the first pump **10** is arranged to bring in the second pump when the first pump **10** is working at about 90% capacity, and the limit switch mechanism **36** associated with the second pump brings in the third pump **14** when the second pump **12** likewise reaches its 90% flow position.

As already stated above, the three hydraulic accumulators **23**, **25** and **27** apply three different pressures to the pressure-sensitive devices **22**, **24** and **26**. For example, the hydraulic accumulator **23** applies a pressure of about 155 p.s.i. to the device **22**, while the two other accumulators **25** and **27** apply pressures of 150 p.s.i. and 145 p.s.i. respectively to the devices **24** and **26**. This means that, with all three pumps running, a decrease in load causes the flow capacity of the third pump **14** to drop first. A further decrease in load results in a reduction of the capacity of the second pump **12**, and the limit switch mechanism **36** associated with the second pump cuts out the third pump **14** directly the capacity of the second pump **12** has fallen to about 80%. Eventually, as the load continues to decrease, the capacity of the first pump **10** will drop to 80%, and the limit switch mechanism **34** associated with it will then cut out the second pump **12**. The first pump **10** continues to operate until it is stopped by the manually-actuated switch **40** controlling the pump.

The variable-capacity pumps shown in the drawings are capable of running at zero capacity. However, prolonged running of such pumps with no flow taking place through them can cause over-heating and subsequent carbonisation of the oil or other liquid being handled by the pumps. To overcome this possibility, the capacity-varying means of each pump are so arranged that the capacity of the pump cannot fall below 3%, for example, by providing stops **90** (see FIGURE 3) within the pump casing which limit movement of the cage **80**. This ensures that there is always some flow of liquid through the pump while it is running. When the first pump **10** only is operating and no liquid is being drawn from the installation at all, the flow of liquid is allowed for in the installation by providing a bleed-line **92** regulated by a valve **94** and leading from the common delivery main back to the source of supply on the suction side of the pumps.

The suction side of each pump is provided with a non-return valve **96** (see FIGURE 1) to ensure satisfactory operation of the installation, and it is also advisable for the manually-actuated switch **40** controlling the first pump **10** to be so designed that, when the switch is actuated to shut down the first pump, the circuits containing the limit switches **34** and **36** are also broken to prevent unintentional starting-up of the second and third pumps.

The pump installation illustrated in FIGURE 2 is basically the same as that shown in FIGURE 1, the same reference numerals being used for like parts, and the common delivery line to which the pumps are connected being shown at **42**. However, in this installation the limit switch mechanisms are not operated by switch-actuating devices mounted on the pumps; instead they are actuated by a part of an hydraulic accumulator **44** which is connected by three pipe-lines **46**, **48** and **50** to the hydraulic cylinder of each pump. The hydraulic accumulator serves to apply a common adjustable constant load to the piston in each hydraulic cylinder, the piston being, of course, part of the capacity-varying means of the pump.

The limit switch mechanisms are shown at **52**, **54**, **56**, **58**, **60** and **62** in FIGURE 2, the part of the hydraulic accumulator **44** which actuates them comprising an abutment **64**. This abutment moves up and down with the weighted upper part **66** of the accumulator in response to up and down movements of the capacity-varying means in the pumps. FIGURE 3 shows one of the pumps in greater detail. The pumps each have an inlet **68** and an outlet **70**, and comprise a slotted rotor shaft **72** having sliding vanes **74** which bear at their ends on surfaces formed on the rotor proper **76**. The rotor **76** rotates within a sleeve **78** carried in a cage **80** which can be moved up and down to vary the eccentricity of the shaft **72** relatively to the rotor **76**, and, therefore, the capacity of the pump. The means for varying the capacity of the pump comprise a rod **82** connected to the cage **80** at one end and to a piston **84** at the other end, the piston **84** being arranged for sliding movement in a cylinder **86**. The upper part of the cylinder is connected to the hydraulic accumulator **44** while the lower part is connected by a pipe-line **15** to the delivery side of the pump, this arrangement ensuring that the pump delivers at substantially constant pressure.

From a consideration of FIGURE 3, it will be seen that the position of the piston **84** in the cylinder **86** will vary in accordance with the load on the pump. This is true of all three pumps in the installation. Accordingly, the position of the movable part **66** of the accumulator will also vary in accordance with the total load on the pumps.

The operation of the installation shown in FIGURE 2 is as follows:

When the three pumps shown in FIGURE 2 are running full out to meet full load conditions, the accumulator **66** will be at the bottom of its travel and switches **54**, **60** and **62** will all be shut so as to keep all three pumps running. If now the load on the installation gradually decreases, the fluid pressure in the common delivery pipe will tend to rise. This in turn reduces the stroke or capacity of all three pumps so that fluid is forced back into the accumulator through the pipes **46**, **48** and **50**. The accumulator therefore starts to rise and first of all opens switch **58** so as to cut out one of the pumps, then opens switch **56** so as to cut out the second pump, and finally opens switch **52** so as to cut out the third pump. The accumulator is now in the position which it adopts for no load operation.

Directly a new load demand on the installation arises, the fluid pressure in the common delivery pipe will drop which allows the accumulator to return fluid back to the pumps through the pipes **46**, **48** and **50**. In so doing the accumulator begins to drop and first closes switch **54** so as to bring in pump **10**, then closes switch **60** so as to bring in pump **12**, and finally closes switch **62** so as to bring in pump **14**. The installation is now working on high load or full load operation.

Thus, the switches **52, 54, 56, 58, 60** and **62** have the following functions:

Operation of switch **52** cuts out pump **10**
Operation of switch **54** brings in pump **10**
Operation of switch **56** cuts out pump **12**
Operation of switch **58** cuts out pump **14**
Operation of switch **60** brings in pump **12**
Operation of switch **62** brings in pump **14**

It therefore follows that, in the position of the accumulator abutment **64** shown in FIGURE 2, pump **10** only is operating. As the load increases, the abutment **64** will move downwards until it actuates switch **60** so as to bring in pump **12**. If the load increases still further, the abutment will actuate switch **62** so as to bring in pump **14**. A decrease in the load will result in the abutment **64** moving upwards so as to operate switches **58, 56** and **52** successively and thus cut out in turn pumps **14, 12** and **10** respectively.

I claim:

1. A pump installation comprising a first variable-capacity rotary pump and a second variable-capacity rotary pump connected respectively to first constant-speed driving means and to second constant-speed driving means for driving said pumps independently of each other, a rotor surrounding a slotted rotor shaft in each of said pumps, said slotted rotor shafts in said two pumps carrying sliding vanes arranged to bear on surfaces formed on said rotors, said rotors being supported in sliding blocks for relative movement to said rotor shafts so as to vary the eccentricity of said rotors relatively to said rotor shafts, fluid delivery outlets from said pumps leading into a single delivery passage whereby said pumps share a common load, electrical control means operatively connected to said first driving means and to said second driving means for bringing said pumps individually into and out of operation by the actuation of at least one limit switch mechanism forming part of said electrical control means, switch-actuating means arranged to actuate said limit switch mechanism and operatively connected to said sliding block of said first pump so as to move in accordance with movements thereof whereby said limit switch mechanism is operated when said sliding block of said first pump reaches one of two positions, pressure-sensitive power means on each pump connected by a passage to said fluid delivery outlet thereof and adapted to move said sliding block in accordance with variations in the pressure in said single delivery passage, said electrical control means including an electrical connection between said limit switch mechanism and said second driving means to ensure starting up of said second driving means as the pressure in said single delivery passage decreases and shutting down of said second driving means as the said pressure increases.

2. The pump installation as claimed in claim 1, wherein said electrical control means also including a manually-actuated switch for maintaining said first driving means under manual control.

3. A pump installation as claimed in claim 1, wherein a single hydraulic accumulator is connected by pipelines to said power means on each of said pumps whereby a movable part on said accumulator is moved in accordance with movements of said sliding blocks in said pumps, said movable part being arranged to actuate said limit switch mechanism.

4. A pump installation as claimed in claim 1, wherein hydraulic accumulator means are provided for applying hydraulic loads to said power means on each of said pumps through separate pipeline connections between said accumulator means and said power means.

5. A pump installation as claimed in claim 1, wherein at least two separate hydraulic accumulators are provided for applying different hydraulic loads to said power means on each of said pumps through separate pipeline connections between said hydraulic accumulators and said power means.

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