

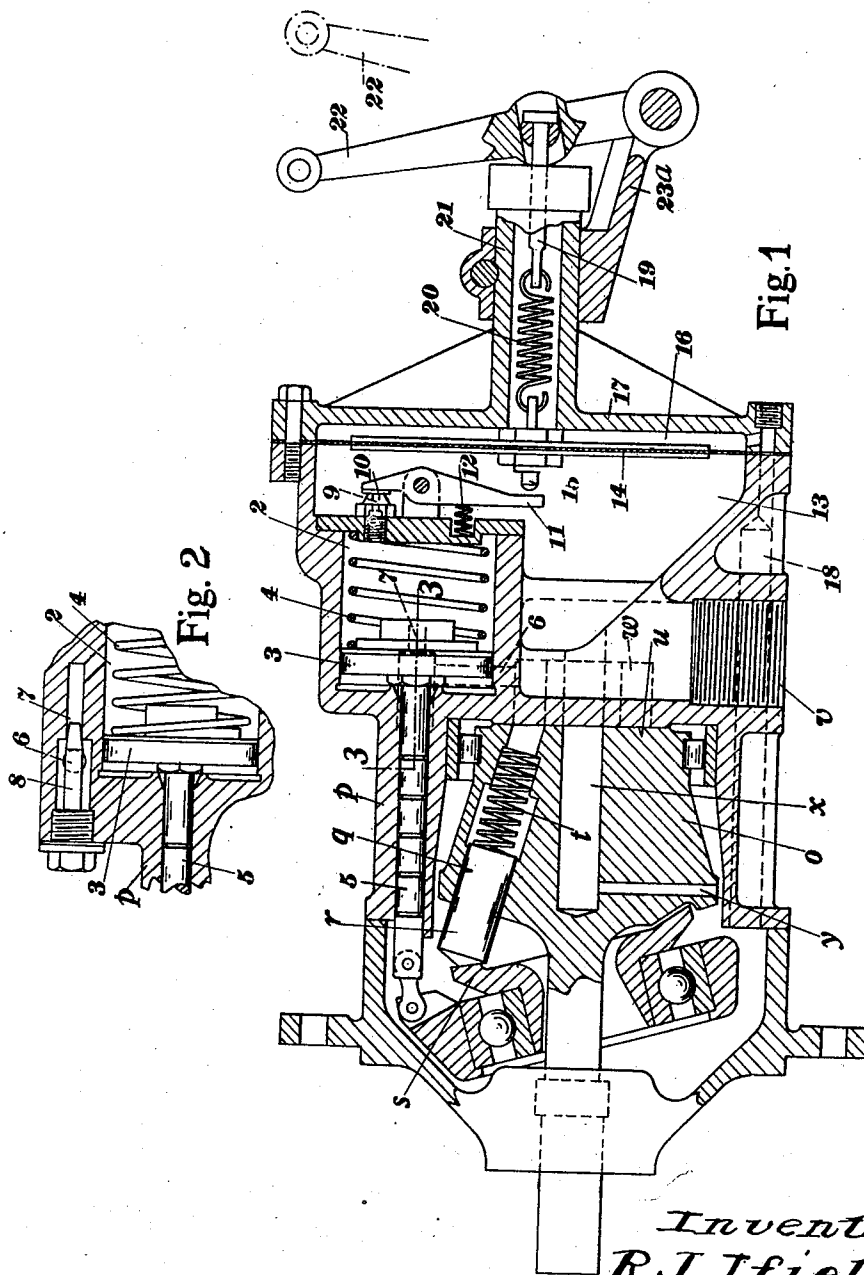
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R. J. IFIELD ET AL
VARIABLE OUTPUT PUMP

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3 Sheets-Sheet 1



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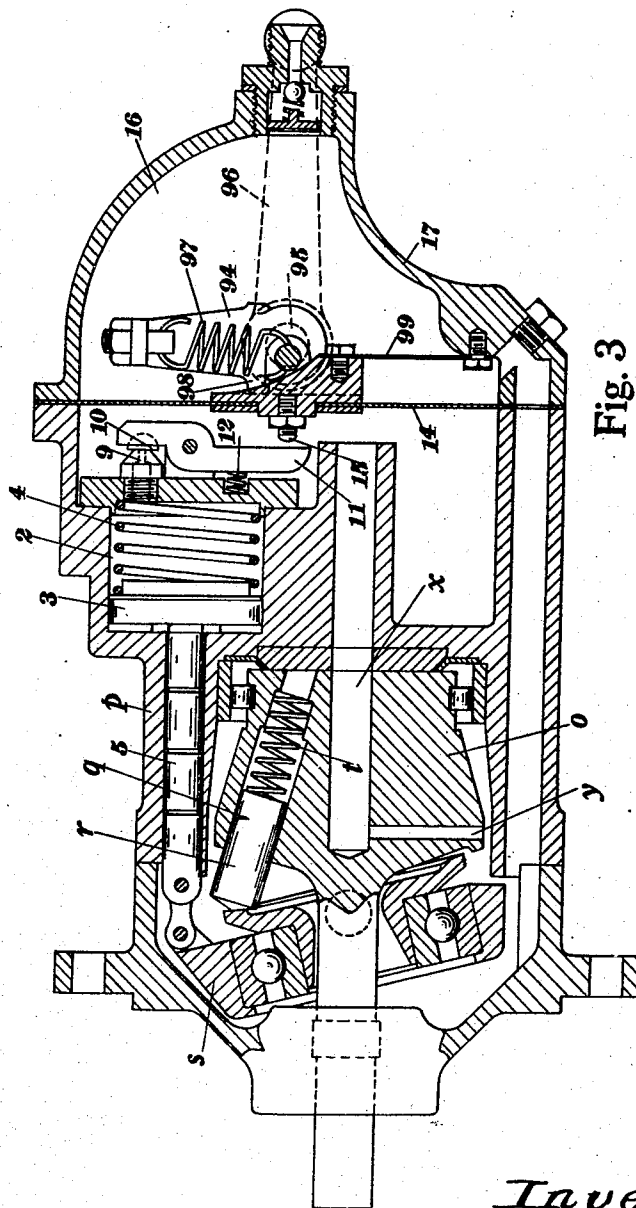
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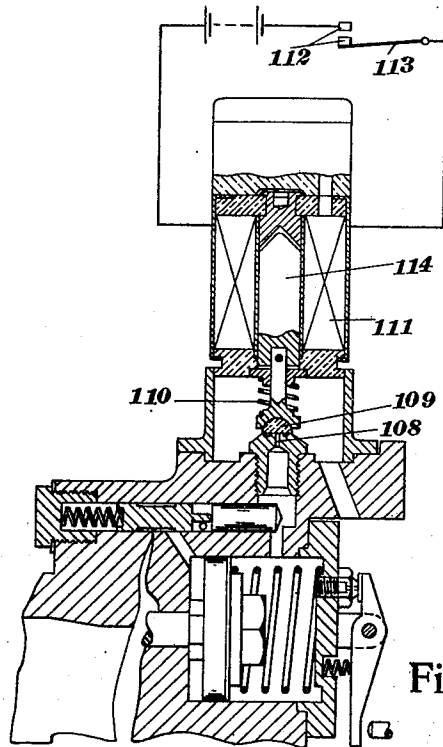


Fig. 6

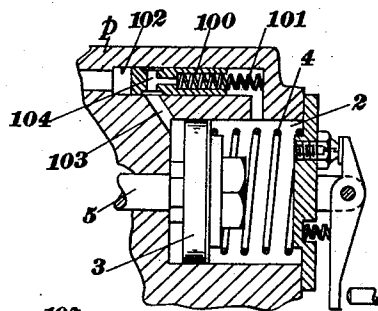


Fig. 4

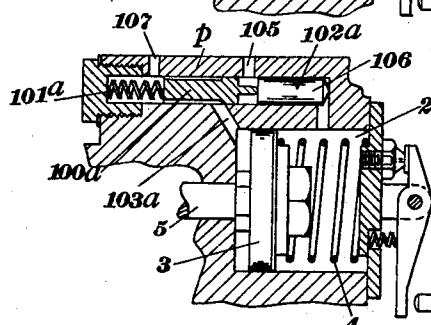


Fig. 5

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UNITED STATES PATENT OFFICE

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VARIABLE OUTPUT PUMP

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This invention relates to variable-output pumps of the swash-plate type, and has for its object to enable such a pump to be controlled in a simple and convenient manner.

The invention comprises a variable-output pump of the above mentioned type having in combination with it a cylinder which at one end is adapted to communicate with the delivery side of the pump, a fluid vent at the other end of the cylinder, a spring-loaded piston slidable in the cylinder under fluid pressure and adapted to vary the position of the swash plate of the pump, means for effecting a restricted communication between the two ends of the cylinder, a movable closure member for controlling the vent, and means responsive to fluid pressure for actuating the closure member.

In the accompanying sheets of explanatory drawings:

Figure 1 is a sectional side elevation of a variable-output pump embodying the invention and adapted to supply liquid fuel to a prime mover.

Figure 2 is a section on the line 3—3 of Figure 1.

Figure 3 is a similar view to Figure 1 illustrating a modification.

Figures 4 to 6 are sectional views illustrating modified details of the pump shown in Figure 1 or Figure 3.

The pump shown in Figures 1 and 2 comprises a rotary body *o* arranged in a casing *p* and having formed around its axis a plurality of bores as *q* in each of which is arranged a reciprocating plunger as *r*. When the body *o* is rotated the plungers *r* are moved in one direction by an angularly adjustable swash plate *s* and in the other direction by springs as *t*, the latter being situated within the body bores *q*, and serving to hold an end face of the body in contact with an end face *u* of the casing *p*. The end face *u* of the casing is formed with an arcuate inlet port (not shown) communicating with a liquid inlet *v* in the casing, and is also formed with an arcuate outlet port *w* communicating with a liquid outlet (not shown) in the casing.

The purpose of the invention as applied to the pump shown in Figures 1 and 2 is to control the output of the pump in response to fluid pressure determined by the speed of rotation of the pump body *o*. For developing this fluid pressure a centrifugal pump may be formed in or combined with the rotary body *o*. Thus, the body *o* may be formed as shown with an axial bore *x* which at one end communicates with the inlet *v*, and at the other end communicates with a plurality

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of radial passages as *y* in the body. Liquid from the inlet *v* flows through the bore *x* and is expelled by centrifugal action through the radial passages *y* into the interior of the pump casing *p* around the pump body *o*.

In carrying the invention into effect as shown in Figures 1 and 2, we provide on one end of the pump casing *p* a cylinder 2 having closed ends. Arranged in the cylinder 2 is a controlling piston 3 loaded by a spring 4, and extending from one side of this piston and through a bore in the inner end of the cylinder is a rod 5 connected to the swash plate *s*. The inner portion of the cylinder 2, that is the portion at the piston-rod side of the piston 3, is in free communication with the outlet port *w* through a passage 6 in the casing *p*, and this portion of the cylinder is in communication with the other or outer portion of the cylinder (which contains the spring 4) through a restricted passage 7, the restriction being effected by a fixed or adjustable plug 8 (Figure 2). The outer end of the cylinder 2 is provided with a small vent 9 which at its outer end forms a seating for a closure member 10 provided on a lever 11, the latter being pivoted on the outer end of the cylinder 2. This lever 11 is acted on by a spring 12 which tends to hold the closure member 10 on its seating. The cylinder 2 is contained in a chamber 13 formed or secured on the adjacent end of the pump casing *p*, and this chamber communicates with the pump inlet *v* or with a sump. The outer side of the chamber 13 is bounded by a diaphragm 14 having at its centre an abutment 15 which is adapted to bear on the end of the lever 11 remote from the closure member 10. At the outer side of the diaphragm 14 is another chamber 16 which is bounded in part by the diaphragm and in part by an end cover 17, the latter chamber being in communication with the above-mentioned centrifugal pump through a passage 18 and the interior of the pump casing *p*. Also a rod 19 is attached to the diaphragm 14 by a spring 20, the latter being situated in a tubular housing 21 on the centre of the end cover 17, and the rod being arranged to extend through a gland in the outer end of the spring housing. The rod 19 is operable by the attendant through a lever 22 carried by a bracket 23^a on the spring housing 21.

Assuming the swash plate *s* to be in the position of maximum output as shown in Figure 1, it will remain in this position so long as the pressure in the chamber 16, and thus acting on the diaphragm 14, is below some predetermined amount. In this condition the vent closure mem-

ber 10 is in its closed position and the liquid pressures at the two sides of the controlling piston 3 are equal. But when the pressure acting on the diaphragm 14 exceeds the predetermined amount the diaphragm (in response to the pressure acting on it) will move the closure member 10 off its seating. The liquid pressure in the outer portion of the cylinder 2 will now fall and the piston 3 will be moved by the fluid pressure in the inner portion of the cylinder against the action of the spring 4, so moving the swash plate s in the direction for reducing the pump output until a new condition of equilibrium is reached. When it is required to vary the speed at which the pressure acting on the diaphragm 14 becomes effective, the lever 22 can be appropriately actuated by the attendant. In Figure 1 the lever 22 is shown in full lines in one extreme position, and in broken lines in the other extreme position.

Any convenient means may be provided for enabling the closure member 10 to be moved by the attendant away from its seating on the vent 9, and an example of such means is shown in Figure 3. In this example we employ a lever 94 for varying the speed at which pressure acting on the diaphragm 14 becomes effective, this lever being situated on a shaft 95 at the outer side of the diaphragm, and being operable under the control of the attendant through another lever 96 on the shaft at a position outside the chamber 16. The lever 94 is connected to the diaphragm 14 by a spring 97, and the arrangement is such that the effect of the spring on the diaphragm can be varied by angular movement of the lever. Also we form on or otherwise combine with the lever 94 an abutment 98 adapted by acting on the diaphragm 14 to move the lever 11 carrying the closure member 10 into a position in which the closure member is separated from its seating. This condition, which is useful when it is required to allow the prime mover to operate idly, releases the liquid in the outer portion of the cylinder 2. The controlling piston 3 in the cylinder 2 is then capable of being moved against the action of its loading spring 4 by pressure of the liquid in the inner portion of the cylinder until it reaches a position of equilibrium in which the opposing fluid and spring pressures are balanced. This action of the controlling piston 3 is such that it moves the swash plate s to a position in which the pump gives a suitably reduced output. The piston 3 will then remain in this position and the pump will give a constant output sufficient to keep the prime mover in action.

When it is required to restore the normal action of the pump the attendant releases the lever 96 and the lever 11 then responds to the action of the liquid pressure acting on the diaphragm 14.

When the lever 94 is moved out of the position in which the spring 97 has its maximum effect, any tendency for the spring to distort the diaphragm is opposed by a spring strip 99, one end of the latter being connected to the diaphragm 14 at a position near its centre, and the other end being connected to the end cover 17.

In other respects the pump shown in Figure 3 is essentially similar to that shown in Figures 1 and 2 and is indicated by the same reference characters.

Figure 4 illustrates means for enabling the pump shown in Figures 1 and 2 or Figure 3 to operate automatically as a constant-delivery pump in the event of the fluid pressure acting

on the controlling piston 3 falling below a predetermined amount. In this example we replace the fixed or adjustable plug 8 shown in Figure 2 by a small piston valve 100 which is loaded by a helical compression spring 101 of appropriate strength. This valve 100 is slidable in a bore 102 in the pump casing p, and is subject at one end to the pressure of liquid discharged by the pump, which pressure tends to move the valve against the action of its loading spring 101.

When the pump is in action and the pressure of the liquid delivered by the pump exceeds a predetermined amount, the pressure overcomes the spring 101 acting on the valve 100 and moves the latter to its open position. In this position the valve 100 is clear of the adjacent end of a passage 103 leading to the inner end of the cylinder 2, and thus establishes free communication between this end of the cylinder and the delivery side of the pump. Should a condition occur in which the pressure of the fluid delivered by the pump falls below the predetermined limit, the valve 100 is returned by its spring 101 to the position shown in which it interrupts the supply of liquid from the pump to the cylinder 2. In this position of the valve 100 the piston 3 is caused by its loading spring 4 to move the pump adjusting rod 5 into a position in which the pump gives its maximum output and operates as a constant delivery pump.

For enabling the required movement of the piston 3 to take place, the valve 100 is provided with bores 104 through which the two ends of the cylinder 2 communicate freely when the valve is closed. Also the diameters of the valve 100 and the bore 102 are such that there is provided around the valve a restricted or leakage path through which fluid can flow between the ends of the cylinder 2 when the valve is open.

Instead of the valve 100 shown in Figure 4, we may employ the piston valve 100^a shown in Figure 5. The valve 100^a is movable against the action of a loading spring 101^a by the pressure fluid from the pump to establish free communication between the adjacent end of the cylinder 2 and the delivery side of the pump through an inlet port 105 and a passage 103^a in the pump casing. But the required restricted or leakage path through which fluid can flow between the ends of the cylinder 2 is provided around a fixed or adjustable plug 106 in the bore 102^a containing the valve 100^a. Further the valve 100^a when closed puts the adjacent end of the cylinder 2 into communication with the suction side of the pump or any other convenient part of the pump system in which the pressure is relatively low, this communication being effected through a port 107 in the pump casing.

If desired the pump shown in Figures 1 and 2, with or without any of the modifications shown in Figures 3 to 6, may be provided with means whereby the output of the pump is subject to a temperature control such that in the event of an excessive temperature being attained in any part of the system supplied by the pump the output of the latter is reduced. An example of such means is shown in Figure 6. In this example we provide in the same end of the controlling cylinder 2 as the vent above described, another vent 108 which is normally closed by a spring-loaded closure member 109. It is desired that the latter shall be opened against the action of its loading spring 110 when an excessive temperature condition exists in the prime mover supplied by the pump, and so cause the controlling means to

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move the swash plate of the pump in the direction for reducing the pump output to any desired extent. We therefore employ for actuating the valve 109 an electromagnet having a winding 111 arranged in an electric circuit containing a pair of normally open contacts 112 responsive to a thermostatic device (such as a bi-metal strip 113) situated in the position in which the excessive temperature is liable to occur. The electromagnet is also provided with a movable core 114 which is connected to and adapted to actuate the closure member 109. When a predetermined temperature above the normal is reached the contacts 112 are closed by the strip 113 and the closure member 109 is opened, causing the desired reduction of the pump output. Alternatively we may control the circuit of the electromagnet by a relay energised by a thermo-couple located in the said position.

In a modification of the means shown in Figure 6 we may make use of the first mentioned vent, by combining with the lever which is responsive to the action of the diaphragm, an over-riding device such as an electromagnet as above described, this electromagnet being normally inactive and being adapted to open the vent when the circuit of the electromagnet is closed by the temperature-responsive means.

The invention is not limited to the examples described as subordinate details of construction or arrangement may be varied to suit different requirements.

Having thus described our invention what we claim as new and desire to secure by Letters Patent is:

1. A variable-output pump of the swash plate type having in combination with it a cylinder which at one end is adapted to communicate with the delivery side of the pump, a fluid vent at the other end of the cylinder, a spring-loaded piston slidable in the cylinder under fluid pressure and adapted to vary the position of the swash plate of the pump, means for effecting a restricted com-

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munication between the two ends of the cylinder, a movable closure member for controlling the vent, and means responsive to fluid pressure for actuating the closure member.

2. A variable-output pump as claimed in claim 1, in which the means for actuating the closure member comprises a diaphragm having associated with it a spring whereby a variable loading can be exerted on the diaphragm, and a lever operable by an attendant and adapted by acting on the diaphragm to move the closure member away from the vent, the lever serving also to control the spring loading of the diaphragm.

3. A variable-output pump as claimed in claim 1 and having controlling means for enabling the pump to operate automatically as a constant-delivery pump in the event of the fluid pressure acting on the piston falling below a predetermined amount.

4. A variable-output pump as claimed in claim 1 and having controlling means for enabling the pump to operate automatically as a constant-delivery pump in the event of the fluid pressure acting on the piston falling below a predetermined amount, the said controlling means comprising a fluid-operable and spring-loaded valve adapted to interrupt communication between the delivery side of the pump and the cylinder.

5. A variable-output pump as claimed in claim 1 and having in association with the cylinder, a relief valve which when opened enables the piston to move the swash plate in the direction for reducing the pump output.

6. A variable-output pump as claimed in claim 1 and having in association with the cylinder, a relief valve which when opened enables the piston to move the swash plate in the direction for reducing the pump output, the relief valve having in combination with it an actuating electromagnet, and a thermostatic device controlling the electromagnet.

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