July 12, 1949. A. J. GRANBERG 2,475,703

AUTOMATIC PUMP CONTROL

Filed Dec. 27, 1943

2 Sheets-Sheet 1

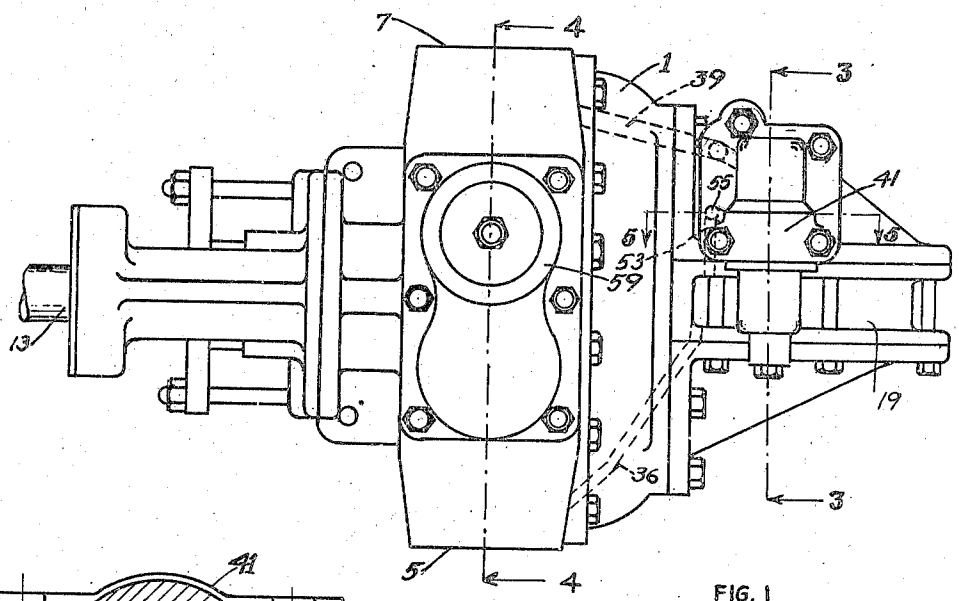


FIG. 1

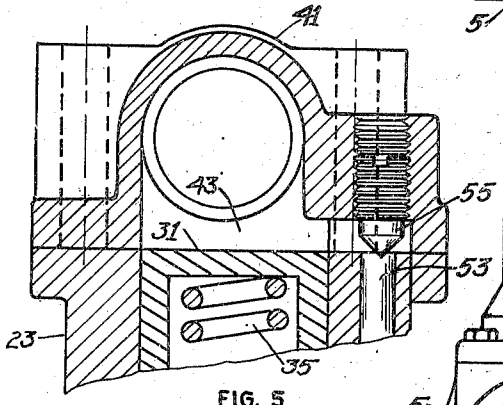


FIG. 5

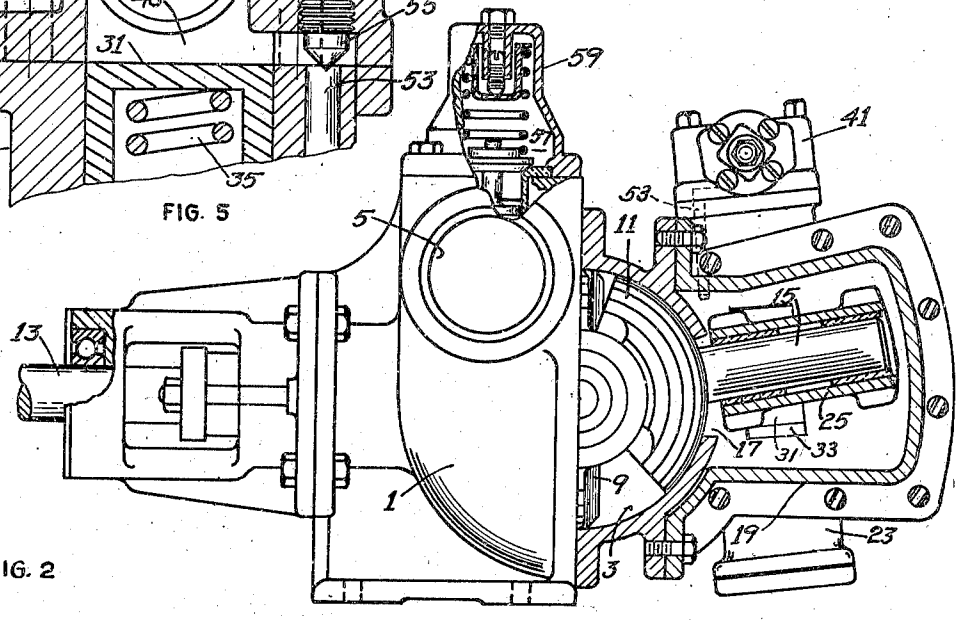


FIG. 2

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2 Sheets-Sheet 2

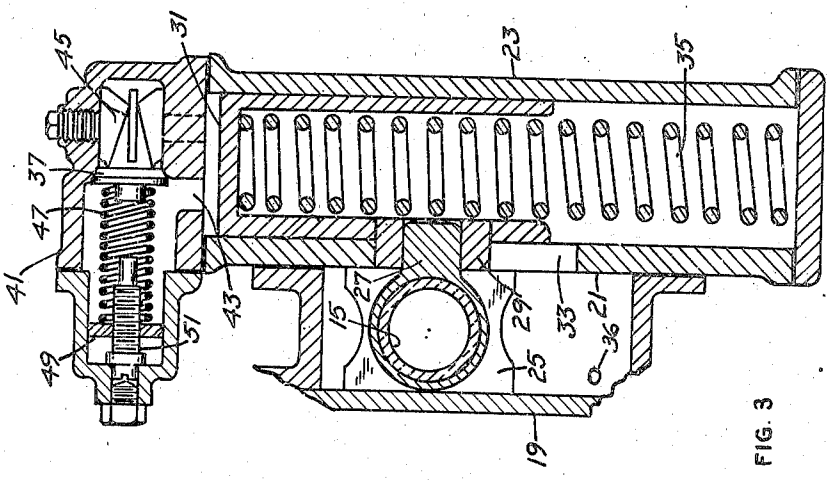


FIG. 3

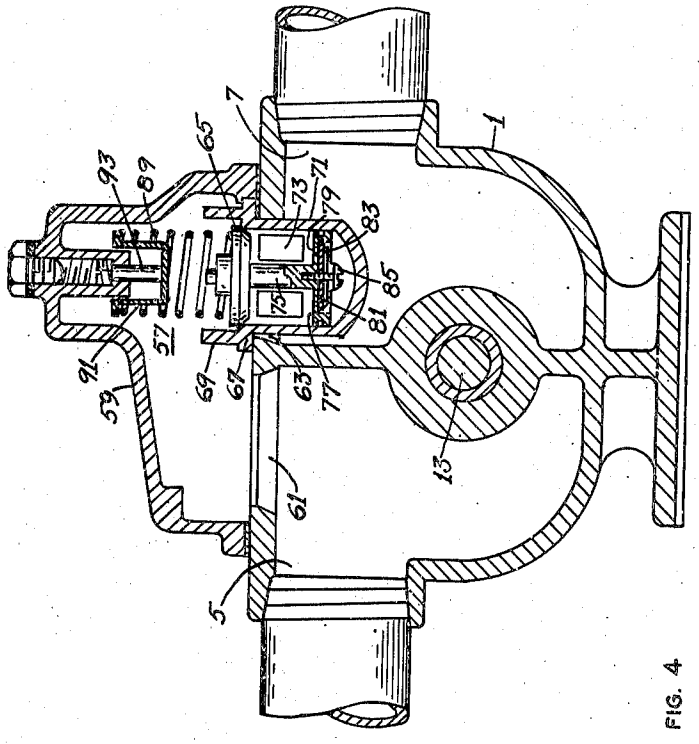


FIG. 4

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AUTOMATIC PUMP CONTROL

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Application December 27, 1943, Serial No. 515,848

2 Claims. (Cl. 103—38)

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My invention relates to pumps and more particularly to pumps of the variable displacement type.

Among the objects of my invention are:

1. To provide a new and improved pump whose capacity range may be adjusted in conformity with the load to be handled by the pump.

2. To provide a new and improved pump of the variable displacement type whose capacity range may be adjusted without resorting to an interchanging of control springs.

3. To provide a new and improved pump capable of automatically adjusting its output capacity in accordance with changing demands on the pump.

4. To provide a new and improved pump of the variable displacement type, capable of meeting load demands thereon without by-passing, churning of liquid, or waste of power.

5. To provide a new and improved pump capable of automatically adjusting its output in accordance with changing demands on the pump and which is protected against excessive surges without reliance upon surge tanks.

Additional objects of my invention will be brought out in the following description of a preferred embodiment of the same, taken in connection with the accompanying drawings wherein:

Figure 1 is a top plan view of a pump of my improved type;

Figure 2 is a side elevational view, partly in section, exposing some of the internal construction;

Figure 3 is a view in section in the plane 3—3 of Figure 1;

Figure 4 is a view in section in the plane 4—4 of Figure 1;

Figure 5 is a fragmentary section through the valve and piston chamber of Figure 3, taken on the line 5—5 of said figure.

The present invention is an improvement upon the type of pump disclosed in my Patent No. 2,260,805 of Oct. 28, 1941, and except for the improvement features constituting the present invention, the structure of the two pumps could be identical.

In common with the pump of my prior patent, my improved pump comprises a casing 1 having a substantially spherical interior chamber 3 provided with an inlet passage 5 thereto and a discharge passage 7 therefrom.

The interior working elements of the pump include a discoidal piston 9 hingedly connected to a spherical segment 11, both the discoidal piston and the spherical segment being rotatably driven

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through a corresponding spherical segment (not exposed) connected to an end of a drive shaft 13 and hingedly connected to the discoidal piston 9 at right angles to the hinge axis of the driven spherical segment 11.

The capacity of such pump is determined by the relative angular relationship between the axes of the spherical segments. With such axes in line, the piston 9 will rotate in a fixed plane, and the output of the pump will be zero. As soon as one of these spherical segments, however, is angularly displaced with respect to the other spherical segment, the discoidal piston will be caused to wobble out of its aforementioned plane as it rotates, thus causing the chambers between the piston and spherical segments to alternately increase and decrease in volume, whereby the pump will take in liquid through the inlet passage 5 and discharge the same through the discharge passage 7. The capacity of the pump will increase as the angular position of one of the spherical segments is increased with respect to the other spherical segment.

In the pump of my earlier patent previously referred to, the driven spherical segment is fixed at that angular position which determines the maximum output of the pump, and a return by-pass valve is provided to recirculate such excess discharge as is not demanded by the load on the pump.

In accordance with the present invention, instead of maintaining such angular position fixed, I automatically adjust the angular position of the driven spherical segment in accordance with the load demand on the pump, whereby the pump will be caused to discharge only so much liquid as the load calls for.

To accomplish this, I provide the driven spherical segment 11 with a stub shaft 15 extending through an opening 17 in the pump casing, and apply a downward force to this shaft in response to existing pressures at the discharge end of the pump, it being noted that the pressure on the discharge side of the pump will tend to rise as the demand on the pump decreases below the full capacity of the pump.

A housing 19 having an open side is attached to the casing 1, the open side being closed by a wall 21 of a piston block 23 bolted thereto. The stub shaft 15 is surrounded by a bearing 25 having parallel sides adapted to engage the walls of the housing in sliding relationship thereto, the housing serving to guide the permissible movement of the driven segment 11 and stub shaft 15 in a fixed plane.

The stub shaft bearing 25 is formed with an integral laterally extending stud 27 journaled in a bearing 29 carried by a piston 31 in the piston block 23, such bearing extending into an elongated opening 33 through the wall 21 of the piston block.

The piston 31 is hollow, and is biased by a coil spring 35 disposed in the piston block and urging the piston to its uppermost position.

The calibration of this spring is such as to be just sufficient to raise the stub shaft 15 and its associated spherical segment 11 to its position of greatest angularity with respect to the drive shaft 13 and its associated spherical segment, during stationary or non-operating periods of the pump. Any pressure against this piston 31, therefore, will tend to reduce the angularity of the stub shaft and associated spherical segment toward a position of reduced capacity for the pump.

A passage 36 from the interior of housing 19 through the casing 1 to the suction side of the pump exposes the rear of the piston 31 to the suction line pressure thereby providing for quick response of the piston when the piston is exposed to pressures against its work surface.

This piston is exposed by way of a pressure-responsive shut-off valve 37 and a passage 39 through the casing 1, to the pressure conditions existing at the discharge end 7 of the pump, the piston thereby being made responsive to such pressures above that pressure at which the shut-off valve may be set to open.

Such shut-off valve is enclosed within a valve housing 41 mounted on the upper end of the piston block and having communication with the interior of the piston block by way of an opening 43. The valve is disposed horizontally, and is maintained in proper alignment with its valve seat in the housing by means of guide fins 45 whose edges contact the inner walls of the housing on the intake side of the valve.

The valve 37 is biased to seating position by a coil spring 47 disposed between the valve and an adjustable back-stop 49 slidably supported within the valve housing by an adjusting screw 51 threaded therethrough. By means of this adjusting screw and back-stop, the effective calibration of the spring may be altered to change the opening pressure of the valve at will, within the limits permitted by the spring.

The opening pressure of the valve is preferably set at a value approaching the pressure in the discharge of the pump when operating at substantially full capacity. Under these conditions, the valve will be open for practically all periods of operation during which the demands on the pump are below a predetermined full load value. Below such discharge volumes, the pressure on the discharge side of the pump will tend to rise and this in turn will tend to reduce the angular position of the stub shaft and associated spherical segment with respect to the drive shaft in accordance with the rise in pressure. Such reduction in angular position will, in reducing the capacity of the pump, tend to reduce the pressure on the discharge side, and this in turn will tend to relieve the pressure somewhat on the piston 31. Accordingly, one effect compensates the other and the stub shaft and associated spherical segment will assume a position of stable equilibrium at an angle to the drive shaft in accordance with the load demands on the pump.

Upon shutting down of the pump, the liquid trapped in the valve housing 41 and piston block 23 would normally tend to preclude restoration

of the piston 31 and consequently the stub shaft 15 and its associated spherical element 11 to their normal positions, which they should occupy during non-operating periods of the pump. I take advantage of the presence of such trapped liquid in assuring a relatively slow restoration of these elements to their normal positions, by providing a slight clearance between the piston 31 and the piston block 23 to thereby establish a by-pass for such liquid as the piston is forced upwardly to displace the same.

In connection with different pumps and installations, the amount of clearance between the piston 31 and the piston block 23 would ordinarily have to be changed. To maintain standardization of such parts and avoid the necessity of having to vary such clearance with different installations, I provide a passage 53 in the wall of the piston block connecting the work side of the piston with the interior of housing 19 and adjust its effective cross section by a tapered set-screw 55. Inasmuch as the upward movement of the piston will under these conditions force some of the liquid from the work side of the piston through the passage 53 to the rear of the piston, the rapidity of restoration of the piston to its uppermost position can thus be, to a certain extent, controlled through adjustment of the set-screw 55, thus eliminating the necessity of changing the original clearance to obtain a desired restoration velocity of the piston.

The pump thus far described is admirably suited for operation under conditions where the load demand on the pump may vary over a wide range of output values, such, for example, as would occur in an airport fueling installation, where the pump may be called upon to supply gasoline for the refueling of a single plane or a large number of planes simultaneously.

A problem encountered in such an installation, arises in connection with pressure surges generated by the inertia of the moving parts of the pump and driving motor at such times as when the demand on the pump is rapidly reduced, and such surges are particularly bad when a number of outlets are shut off simultaneously. Such pressure surges develop within a split second and prior to the ability of the automatic volume control to respond sufficiently to hold such pressure surges down to safe values.

Accordingly, in cooperation with this automatic volume control feature, I provide the pump with a surge valve 57 whose construction may be identical to that disclosed in my aforesaid earlier patent, though its function and purpose are entirely different, in that the operation of the surge valve is cooperatively tied in with the automatic volume control feature as a protective feature whereas in my earlier patent it functions as a sort of discharge or volume control. Consequently while the surge valve 57 in the present invention does not necessarily differ in structure from that disclosed in my earlier patent, its calibration and operating pressure are correlated to the pressure characteristics of the shut-off valve 37 and, as will be pointed out, differ from what they would be when such valve is employed in the manner of my earlier patent.

This surge valve is mounted in a valve chamber 59 which spans two openings 61 and 63 in the upper part of the pump casing 1, the opening 61 communicating with the suction side 5 of the pump and the other opening 63 connecting with the discharge side 7 of the pump. The valve 57 is mounted in opening 63 which exposes it to

the pressures on the discharge side of the pump.

This valve comprises a circular valve head **65** having a frustoconical surface adapted to seat upon a valve seat formed by a circular opening in a seating member **67** resting in the opening **63** on the pressure side of the pump, and retained in place by the valve housing **59** which spans the valve seat member and clamps it to the pump casing.

This valve seat member has integrally formed therewith valve guide means in the form of upstanding posts **69** disposed about the valve seat opening and a depending cylindrically shaped dash pot **71**, the wall of which adjacent the valve seat being provided with openings **73** therein, enabling the admission of liquid thereto from the discharge side of the pump. The valve head **65** has depending therefrom an integral shank **75** extending into the dash pot **71** and terminating in a circular peripherally grooved flange **77**, the flange making a rather snug fit with the inner wall of the dash pot below the openings **73** therein to enable said flange to act as a piston. Such flange **77** has a perforation **79** or a plurality of such perforations therethrough, and such openings are covered by a distortable disc **81**, spring biased against the under surface of the flange by a conical coil spring **83**, which itself is maintained in position by a machine screw **85** extending through the center of the spring and threaded into the shank **75**. The compression of the conical coil spring may be varied by adjusting the machine screw, thereby altering the pressure of the disc **81** against the under surface of the flange **77**. The dash pot **71** is rounded out at its lower end to provide a chamber **87** in the dash pot below the flange.

The valve when closed, is maintained in its seated position by a valve spring **89** which bears at one end against the upper surface of the valve head **65** and at its other end, against the under surface of the lip of a flanged cup **91**. A valve spring adjusting screw **93**; threaded through an opening in the housing **59** directly above the flanged cup **91**, is adapted to enter and engage the flanged cup and maintain the valve spring **89** under compression. The degree of compression of the valve spring may thus be controlled by manipulation of the adjusting screw.

With the spring **89** of the surge valve **57** adjusted to a pressure just slightly above that of the spring **47** of the control valve **37**, the surge valve will remain unaffected by normal pressures created in the discharge line with varying load. Upon the generation of a surge in the line, however, the surge valve will respond immediately as the surge pressure passes the pressure responsive value of the spring **47**, and with a rapidity sufficient to hold the surge pressure down to a safe value while the automatic control is responding to adjust the pump in the direction of reduced output.

Thus, it becomes apparent that my invention fulfills the objects previously set forth. While I have disclosed my invention in its preferred form and as applied to a particular type of pump, it is apparent that these features of my invention may be incorporated in pumps of other designs wherein the capacity of the pump may

be varied by altering the position of one of the working elements thereof with respect to other elements of the pump.

Therefore, while I have described my invention in detail with respect to a specific embodiment thereof, I do not desire to be limited in my protection to such specific embodiment, except as may be necessitated by the appended claims.

I claim:

1. A variable displacement pump comprising a casing; piston means therein including a driven member disposed for angular adjustment with respect to another member and cooperative therewith to effect an intake of liquid at one point in said casing and a discharge thereof at another point in said casing in accordance with the angular position of said driven member; a stub shaft extending from said driven member through said casing; a housing enclosing said stub shaft and providing a bearing guide for angular movement of said stub shaft with said driven member; and control means responsive to pressure on the discharge side of the pump for adjusting the angular position of said stub shaft accordingly, said control means including a piston coupled to said stub shaft and exposable to pressures on the discharge side of said pump, and a shut-off valve between said piston and the discharge side of said pump, set to open at a predetermined pressure on the discharge side of the pump to expose said piston to such pressures above said predetermined value.

2. A variable displacement pump, a casing; piston means therein including a driven member disposed for angular adjustment with respect to another member and cooperative therewith to effect an intake of liquid at one point in said casing and a discharge thereof at another point in said casing in accordance with the angular position of said driven member; a stub shaft extending from said driven member, through said casing; a housing enclosing said stub shaft and providing a bearing guide for angular movement of said stub shaft within said driven member; control means responsive to pressure on the discharge side of the pump for adjusting the angular position of said stub shaft accordingly, said control means including a piston coupled to said stub shaft and exposable to pressures on the discharge side of said pump, and a shut-off valve between said piston and the discharge side of said pump, set to open at a predetermined pressure on the discharge side of the pump; and a surge valve exposed to pressure on the discharge side of said pump and set to open at a value slightly above the opening pressure of said shut-off valve.

ALBERT J. GRANBERG.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,148,277	Rose	Feb. 21, 1939
2,248,076	Harrington	July 8, 1941
2,299,234	Snader et al.	Oct. 20, 1942
2,333,422	Higgins	Nov. 2, 1943
2,260,805	Granberg	Oct. 28, 1941