

Dec. 25, 1962

R. CLIBORN

3,070,025

INJECTOR DISCHARGE PRESSURE REGULATOR FOR PUMPS

Filed March 3, 1958

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Fig. 1

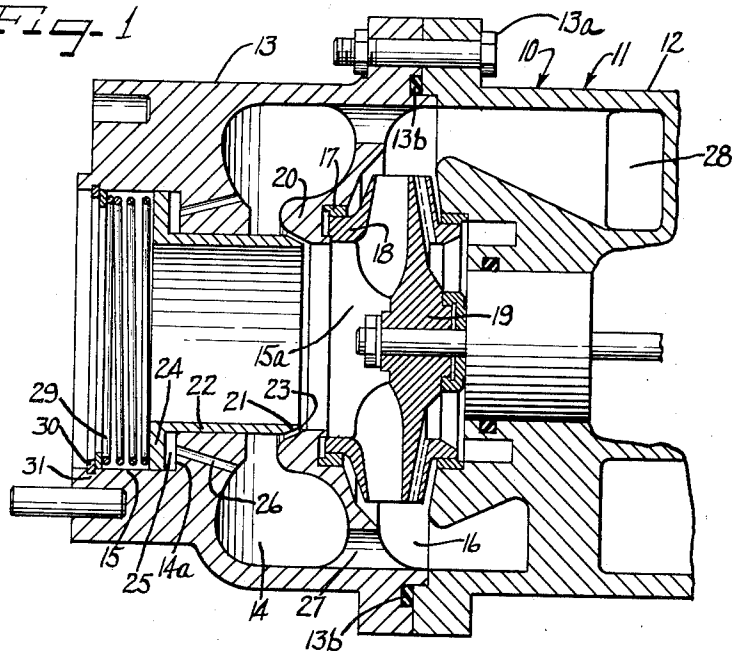
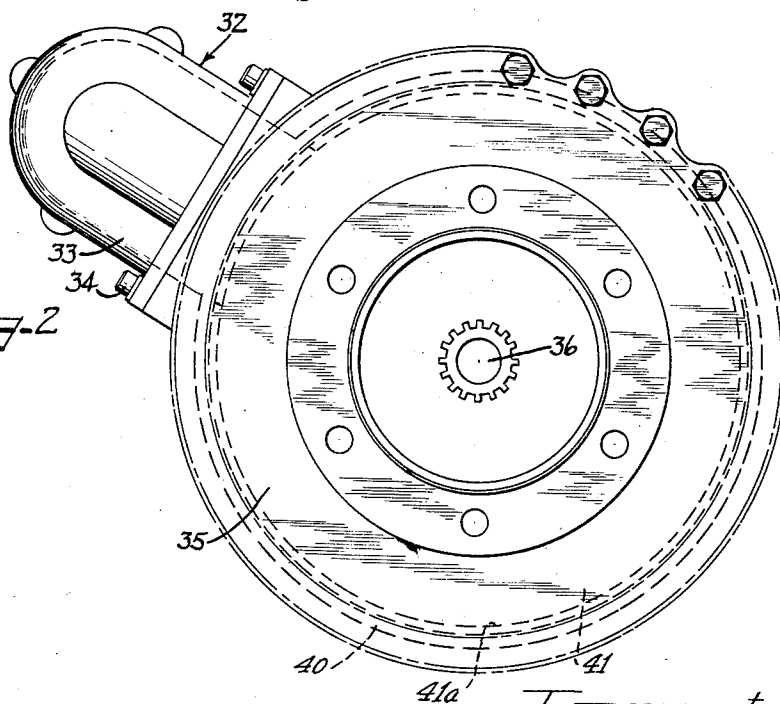


Fig. 2



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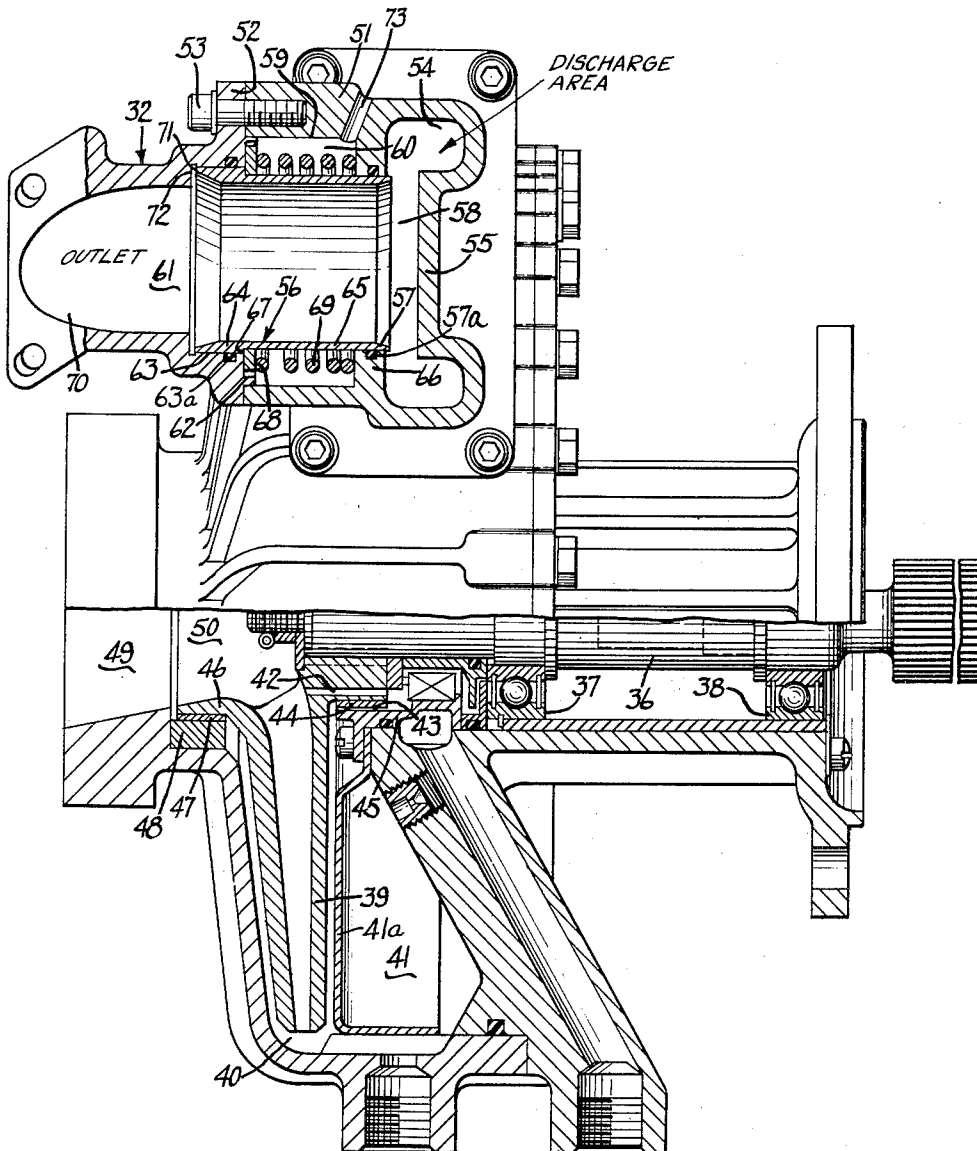
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Fig. 3



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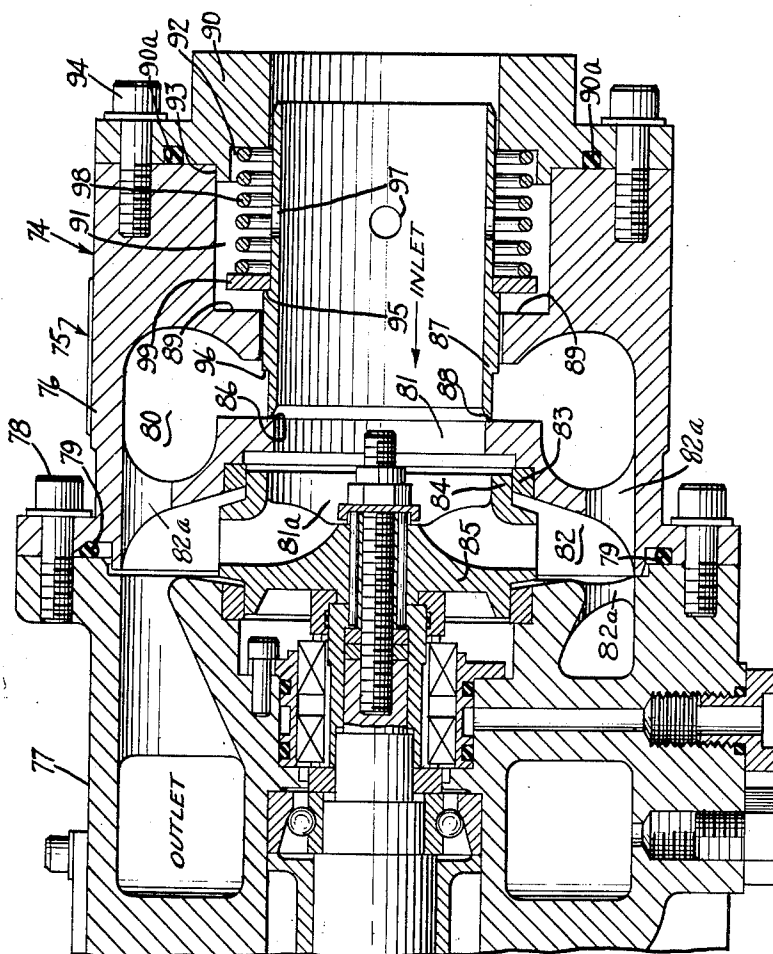
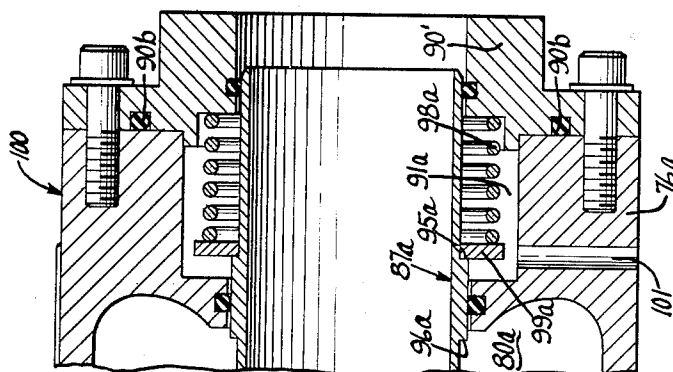
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INJECTOR DISCHARGE PRESSURE REGULATOR FOR PUMPS

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4 Claims. (Cl. 103—97)

This invention relates to pumping apparatus and more particularly to a pump having a shrouded impeller and a casing which provides a chamber in communication with the discharge portion of the pump, and which affords a gap adapted to control the flow of fluid from the chamber into the central area of the casing in accordance with the discharge pressure in the chamber.

According to the general principles of the present invention, and as set forth in applicant's copending application Serial No. 327,216, filed December 19, 1953, now Patent No. 2,865,297, of which the present application is a continuation-in-part, an impeller is provided which has a central inlet and includes a plurality of pumping passageways communicating with the central inlet and extending radially outwardly to the periphery of the impeller. A pump casing provides a volute pumping chamber for the impeller and a cover member on the end of the casing has an open ended inlet passageway adapted to lie in registry with the central inlet of the impeller.

In one form of the invention an annular lip is provided at one end of the passageway and is situated adjacent an annular chamber formed in the cover member. The annular chamber communicates with the pump discharge through a plurality of circumferentially spaced metering passages. A sleeve is received in the inlet passageway of the cover member and includes an end portion which provides a closure for the annular chamber. The end portion of the sleeve cooperates with the annular lip to form an injector gap which directs a sheet of fluid across the width under a high velocity into the inlet of the impeller. The injector action improves the fuel velocity distribution in the inlet by accelerating the slow moving particles of fluid in the boundary layer where the velocity of the impeller inlet is at a maximum. The injector action not only serves to prime the pump but also provides a radial velocity distribution corresponding with the linear velocities of the impeller vane. Cavitation is thus prevented and operation at lower fuel inlet heads is possible.

The width of the injector gap is controlled automatically by the pump discharge pressure which is introduced into the pressure control chamber to afford axial adjustment of the sleeve controlling the width of the injector gap.

In a second embodiment the width of a throttling orifice is controlled by the ambient pressure for the pump, in accordance with the pressure control principle of the invention.

Another embodiment of the invention provides for an automatically adjustable pressure gap as described, which is controlled by the inlet pressure for the pump but which is responsive thereto so as to throttle the flow of fluid through the pump.

In this embodiment, the control of the throttling action by the inlet pressure is effective to afford a predetermined substantially uniform pumping pressure and flow. Yet another embodiment provides for throttling the flow through the pump in response to the ambient pressure for the pump.

Accordingly, it is an object of the present invention to provide an integral discharge pressure regulator for pumps in which a pressure chamber of substantially annular configuration is disposed in a cover for the pump and has a gap whose width is determined in accordance with the

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pressure in the pressure chamber whereby to control the rate of flow to the pump.

Another object is to provide a structure as described which reduces cavitation in the pump, by providing a rate of flow directly determined in accordance with the requirements of the pump.

Another object is to provide a discharge control which in one embodiment thereof is adapted to maintain the flow of fluid to the pump with decreasing inlet pressure.

Another object is to provide a discharge control means as described which, in another embodiment, is regulated by the ambient pressure relative to the pump.

Another object of the invention is to provide a discharge control system in which, in another embodiment, the ambient pressure is effective to adjust the gap so as to throttle the system.

Yet another object of the invention is to provide a discharge control means as described in which the throttling action is responsive to the pressure condition at the inlet portion of the system.

Many other features, advantages and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the accompanying sheet of drawings, in which a preferred structural embodiment incorporating the principles of the present invention is shown by way of illustrative example.

In the drawings:

FIGURE 1 is a fragmentary cross-sectional view of an injector cover for a pump constructed in accordance with the principles of the present invention in affording automatic control of an injector gap structure;

FIGURE 2 is a front view of another embodiment of the invention in which the injector gap is controllable in accordance also with the ambient pressure relative to the pump;

FIGURE 3 is a sectional view of the pump shown in FIGURE 2;

FIGURE 4 is a sectional view of an embodiment controlled by inlet pressure to throttle the system so as to maintain substantially uniform flow; and

FIGURE 5 is an embodiment corresponding to that of FIGURE 4 in which the throttling action is controlled by the ambient pressure.

As shown on the drawings:

Referring now to FIGURE 1, a pump incorporating the principles of the present invention is indicated generally by reference numeral 10 and includes a casing 11 formed by a body member 12 and a cover member 13 suitably flanged and bolted together by a plurality of fasteners 13a and sealed by an O-ring 13b. As shown in FIGURE 1, the cover 13 has a by-pass chamber 14 and is provided with a central inlet passageway 15 opening into a volute pumping chamber 16 carrying a bearing ring 17 in which is journaled the hub portion 18 of a shrouded impeller 19. The cover member 13 also includes an annular lip 20 which co-operates with a tapered end portion 21 of a sleeve member 22 so as to provide an injector gap 23 arranged to direct a sheet of fluid across the lip 20 and into the central inlet 15a of the impeller 19, as hereinafter further described. The inlet passageway 15 is counterbored to provide an annular shoulder 14a, the counterbored portion of the inlet passageway 15 receiving a radially extending flange 24 forming an annular abutment shoulder for the sleeve member 22.

The flange 24 of the sleeve 22 and shoulder 14a of the cover member 13 together form opposite sides of a pressure control chamber 25. By introducing a pressure fluid into the pressure control chamber 25, an axial thrust will be imparted to the sleeve member 22 which will tend to move the sleeve member in one direction so

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as to increase the width of the injector gap 23. In order to conduct such a pressure fluid into the control chamber 25 a plurality of circumferentially spaced passageways 26 is provided in the cover member 13 which place the pressure control chamber 25 in communication with the chamber 14. The chamber 14 in turn communicates with the pumping chamber 16 through a plurality of circumferentially spaced passageways 27 opening to the discharge portion 28 of the said pumping chamber. To provide a control bias for the sleeve member 22, a coil spring 29 is bottomed against a retainer 30 which is carried in a recess 31 formed in the inlet passageway 15. The spring 29 engages the opposite face of the flange 24 on the sleeve member 22 at its other end, and there is thus exerted a continuous spring pressure on the sleeve member 22 tending to close the injector gap 23. By virtue of this arrangement, the position of the sleeve 22 will be variable with the pump discharge pressure and accordingly, the width of the injector gap will be automatically controlled as a function thereof, with consequent improvement in fuel velocity distribution and substantial elimination of cavitation.

Referring now to FIGURES 2 and 3, a second embodiment of the invention is seen and designated generally by reference numeral 32. A casing 33 is provided for the control means 32 which is mounted by bolts 34 on an impeller housing 35 in which is journaled an impeller drive shaft 36 for connection with an engine drive (not shown). The shaft 36 is supported in the housing 35 by bearings 37 and 38, a shrouded impeller 39 being fixed thereto within a chamber 40. The impeller 39 is provided with pressure equalizing passages 42 and 43 as shown, in the impeller 39 and between the impeller bearing ring 44 and the opposed ring 45 respectively, this structure forming no part of the present invention. The hub 46 of the impeller is sealed by bearings 47 and 48 within an inlet passageway 49 in the casing 35, which opens directly into the central pumping chamber 50 of the impeller. Thus the fluid is passed from the inlet 49 through the central pumping chamber 50 and the impeller 39 into the discharge area 41 around plate 41a and thence into the control system 32 the plate 41a preferably extending entirely in back of the face of the rotor or impeller 39 but being open in register with the control means 32 to place the control means in communication with the discharge area 41, as seen in FIGURES 2 and 3.

The casing 33 has a body portion 51 and an outlet portion 52 suitably flanged and bolted together by bolts 53, and in order to afford control of the discharge flow from the pump, the body portion 51 defines an annular flow chamber 54 in communication with the discharge area 41. The chamber 54 has an inset wall 55 which cooperates with a sleeve 56 having a tapered end 57, to define an annular throttling orifice 58, the casing having a counterbored portion 59 which cooperates with the sleeve 55 to define a pressure control chamber 60 in accordance with the invention. The discharge portion 52 is provided with a central bore 61 whose inner portion 62 is of relatively wide diameter to form part of the chamber 60, an intermediate portion thereof 63 receiving the relatively thickened sleeve portion 64, which at its other end 65 rides on an annular bearing wall 66 having a seal 57a. The sleeve thus provides a shoulder 67 against which a pressure ring 68 is biased by means of a spring 69 so as to urge the sleeve 56 toward the outlet end 70 of the bore, which is of reduced diameter in comparison with the intermediate area 63. As seen, the inner end 71 of the sleeve 56 is tapered and blunt, and is spaced from the shoulder 72 between portions 63 and 70 of the bore 61.

In order to throttle the fluid passing through the throttling orifice 58 to afford a uniform flow, the body portion 51 of the casing 33 defines a passage 73 which affords communication between the pressure control cham-

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ber 60 and the ambient pressure for the pump. The pressure acts on the pressure ring 68 in cooperation with the spring 69 to urge the sleeve 56 to the left. The ambient pressure thus acts on the area provided by the sleeve shoulder 67, which is of a predetermined dimension for this purpose. Balancing these forces, and effecting the desired differential throttling action, is the pressure from within the bore 61 and the intermediate portion 63, which also acts on a pressure area which is defined by the shoulder 67 of the sleeve 56. Thus the forces on the opposite ends of the sleeve 56 substantially balance out except for an area at the left hand extremity of the sleeve which corresponds to the dimensions of the shoulder 67. This pressure on the left hand extremity of the sleeve 56 serves to move the sleeve 56 toward the right to reduce the throttling gap or orifice 58 to an extent which will provide the desired continuously uniform discharge flow. An O-ring 63a may be provided in the discharge portion 63 to insure that a pressure differential will be maintained between the left hand extremity of the sleeve 56 and the portion of the sleeve 56 provided by the shoulder 67.

Referring now to FIGURE 4, a third embodiment of the invention is seen wherein a differential pressure sleeve controls the width of an injector gap as hereinbefore described, the discharge pressure being utilized in conjunction with the inlet pressure for this purpose. This system 74 has a casing 75 which is formed by a body member 76, as well as a cover member 77, elements 76 and 77 being suitably flanged and bolted together by a plurality of fasteners 78, and sealed by an O-ring 79. The body portion 76 has a by-pass chamber 80 and is provided with an inlet passageway 81 which opens into a pumping chamber 82 carrying a bearing ring 83 in which is sealed the hub portion 84 of a shrouded impeller 85, the by pass chamber 80 receiving fluid from chamber 82 through passages 82a, substantially as described with respect to the first embodiment of the invention. The body 76 also defines an annular lip 86 which co-operates with a tapered end portion of a sleeve 87 so as to provide an injector gap 88 arranged to direct a sheet of fluid across the lip 86 and into the central portion 81a of the impeller 85. The inlet passage 81 is counterbored to define an annular shoulder 89 which co-operates with the sleeve 87 and a cap 90, to provide a pressure control chamber 91, the cap 90 having a relatively wide bore 92 forming part of the chamber 91 and being fastened to the body portion 76 by means of a counterbore 93 and bolts 94, a seal 90a being disposed in the cap 90.

In order to provide a differential pressure control as described, the sleeve 87 defines a shoulder 95 within the chamber 91, and an opposed shoulder 96 adapted to receive pressure from the chamber 80. The sleeve also has formed therein a plurality of apertures 97 intermediate the ends of the chamber 91 whereby the inlet pressure in the passage 81 is transmitted to the said chamber and acts upon an area corresponding to that of the shoulder 95 to urge the sleeve 87 to the left, in cooperation with a spring 98 which bears against a pressure bearing 99 which is retained against the shoulder 95. This force is balanced by the pressure from the discharge portion of the pump unit in the chamber 80 to vary the width of the injector gap 88, whereby a desirable velocity distribution of the fluid is achieved in the boundary layer where the velocity of the impeller is at a maximum.

The embodiment of FIGURE 5 corresponds structurally to that of FIGURE 4, and similar parts are suitably indicated and otherwise designated by similar reference numbers, but the ambient pressure for the pump is utilized to make the pump discharge pressure control system 100 independent of the inlet pressure for the pump. This is accomplished by means of a passage 101 defined in the body portion 76a and affording communication between the chamber 91a and the fluid surrounding the pump.

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The action of the embodiments of FIGURES 1, 4 and 5 is thus the opposite of that of the embodiment of FIGURES 2 and 3, in the sense that the discharge pressure of the first and last embodiments tends to open the injector gap, while in the second embodiment it tends to close the gap to provide a uniform delivered pressure. However, in each of the embodiments the control is achieved in accordance with pressure sensitive means which afford a constantly adjusted flow metering action.

Although I have herein set forth and described my invention with respect to certain specific principles and details thereof, it will be obvious to those skilled in the art that these may be varied without departing from the spirit and scope of the invention as set forth in the hereunto appended claims.

I claim as my invention:

1. A pump construction comprising a pump having a housing,
 an impeller journaled in said housing,
 said housing having an inlet and an outlet for said impeller,
 a discharge pressure regulator for said pump including a casing mounted on said housing,
 said casing having an inlet communicating with the outlet of said housing,
 a control sleeve slidably mounted in said casing and registered with said inlet in said casing,
 said casing having a chamber around said sleeve and closed by said sleeve,
 said sleeve providing a passage therethrough and said passage normally communicating with the inlet in said casing,
 said casing having an outlet communicating with said passage,
 a throttling surface on said casing in register with said sleeve,
 said sleeve normally spaced from said surface in variably proximate relationship to adjustably throttle the casing inlet in response to movement of the sleeve,
 said sleeve having a relatively large pressure surface at the end thereof adjacent the outlet in said casing for urging the sleeve toward the throttling surface in response to fluid pressure in the passage,
 said sleeve having a relatively small pressure surface at the end thereof adjacent said inlet in said casing for urging the sleeve away from the inlet in response to pressure at the inlet,
 said sleeve having a shoulder within said chamber disposed to urge the sleeve away from the casing inlet in response to fluid pressure thereagainst,
 spring means in said chamber urging said sleeve toward the outlet in said casing,
 and a passageway in said casing communicating said chamber with the exterior of said casing for pressurizing said chamber and said shoulder in said chamber with ambient fluid whereby said pressure surfaces and said shoulder cooperate with said spring means to control said throttling as a function of the pressure of the ambient fluid and the pressure of the fluid entering said casing through said inlet in said casing.

2. The device according to claim 1 wherein said relatively large pressure surface on said sleeve has a cross sectional dimension equal to the cross sectional dimension

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of said relatively small pressure surface plus the cross sectional dimension of said shoulder on said sleeve to provide a sensitively adjusted throttling action.

3. A pump construction comprising a pump having a housing,

an impeller journaled in said housing,
 an inlet in said housing for said impeller and an outlet in said housing for said impeller,
 and a flow control device for said pump including a casing structure for said housing,
 a sleeve in said casing structure,
 an inlet in said casing structure in register with said sleeve,
 a throttling surface on said casing structure,
 said sleeve being in proximate adjustable register with said throttling surface.

means transmitting fluid from the impeller outlet past the throttling surface for controlling the flow of said fluid to a point of use,

said casing structure having a chamber surrounding said sleeve and substantially closed by said sleeve,

a pressure surface on one end of said sleeve pressurized by fluid in said inlet in said casing structure to urge the sleeve away from the inlet in the casing structure,

a pressure surface at the opposite end of the sleeve exposed to fluid from the impeller discharge to urge the sleeve in a direction opposite from the pressure surface on said one end of said sleeve,

a shoulder on said sleeve in said chamber disposed to urge the sleeve away from the inlet in response to fluid pressure thereagainst,

means communicating said chamber with a source of pressurized fluid to pressurize the shoulder,

and spring means acting against the sleeve to urge the sleeve away from the inlet in said casing structure,

said pressure surfaces, said shoulder and said spring means cooperatively effecting throttling of the inlet by reciprocation of the sleeve toward and away from said throttling surface as a function of the pressure of the source of pressurized fluid and fluid pressure at the inlet.

4. The pump construction of claim 3 wherein the flow control device for the pump is mounted in the inlet of said housing.

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