July 26, 1955 F. R. HOOP 2,713,827

HYDRAULIC COMPRESSOR

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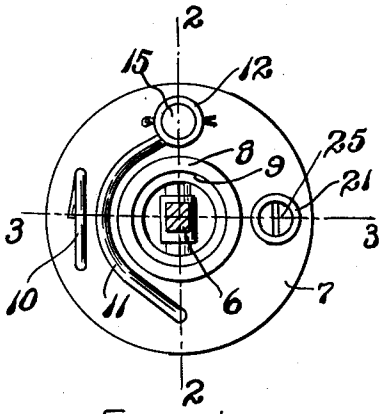

FIG. 1.

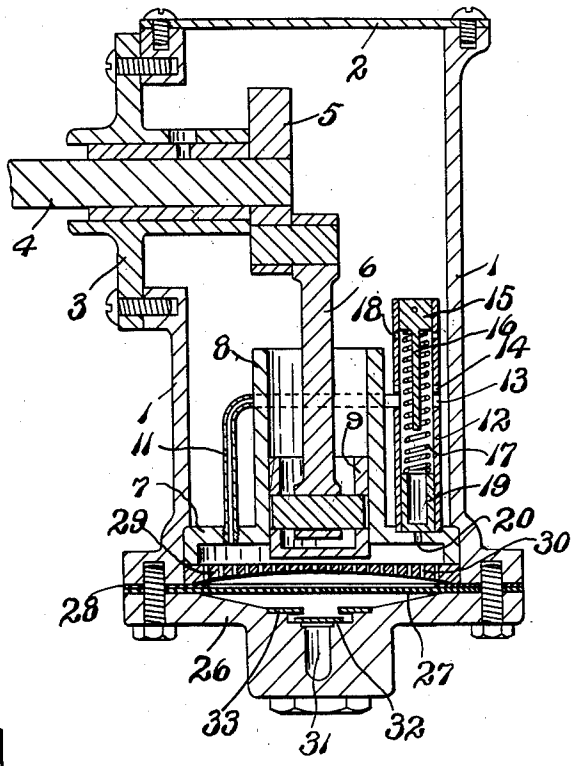

FIG. 2.

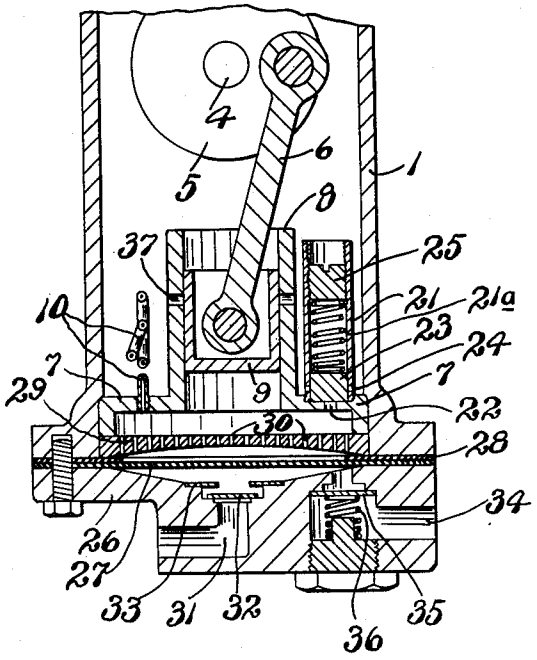

FIG. 3.

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HYDRAULIC COMPRESSOR

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5 Claims. (Cl. 103—44)

The present invention relates to a particularly novel and effective compressor pump by means of which a fluid, gaseous or liquid, may be pumped into a container or the like, the compressed gaseous fluid or a fluid of mixed gaseous and liquid constituents reaching a very high pressure. The pump is also usable for pumping liquids against strong back pressure or heads, that is, the liquid can be pumped to high elevations against the back pressure of the head, the pump being usable from a standing start against heavy pressures without danger of stalling or otherwise becoming inoperative. In many cases where the pump is driven by an electric motor, any blocking or stalling taking place in the pump with the current being supplied to the electric motor would result in serious damage to the motor. With the pump which I have invented it can be started under low torque against high pressure and will start and be driven by an electric motor even though the back pressure against which it is operating is high, reaching to more than 250 pounds per square inch.

It is an object and purpose of my invention to provide a simple, effective, relatively low cost, sturdy and durable pump having the desirable characteristics and advantages stated, an understanding of which may be had from the following description, taken in connection with the accompanying drawing, in which,

Fig. 1 is a plan view of a pump unit which is located within a surrounding housing or casing therewith and is associated with an inlet and outlet fluid control underneath it in the completed pump.

Fig. 2 is a generally central vertical section through the assembled pump, the plane of the section being substantially that shown on the line 2—2 of Fig. 1, and

Fig. 3 is a similar vertical section substantially on the plane of line 3—3 of Fig. 1.

Like reference characters refer to like parts in the different figures of the drawing.

In the construction of the pump, a hollow housing or casing 1 of generally cylindrical form, vertically positioned and open at both ends is closed at its upper end by a flat closure plate 2, screw connected thereto. At a side and adjacent the upper end of the housing or casing 1 is an opening closed by a vertical plate 3 which has a journal bearing therethrough for a driving shaft 4, rotatably mounted in and extending through the bearing and which is adapted to be driven by an electric motor.

At the inner end of the shaft, a disk 5 is permanently secured and to it a connecting rod 6 is pivotally mounted off-center from the shaft 4, there being formed a crankshaft which will vertically reciprocate a piston secured to the lower end of the connecting rod 6 when the shaft 4 is driven.

In the lower end portion of the casing or housing 1, a pumping unit is located having a horizontal base 7 with a downturned annular flange at its edges from the central portion of which a vertical cylinder 8, open at both ends, extends upwardly and within which a valveless piston 9 is mounted for reciprocation. The piston 9 is operatively connected to the lower end of the connecting rod 6 and

moves up and down in the cylinder 8 upon rotation of the shaft 4.

A somewhat elongated tube 10 is secured at one end to the base 7 of the pumping unit at a side of the cylinder 8 having a capillary passage therethrough, that is, a passage of small diameter not in general exceeding approximately .020". The free end of this tube terminates within the casing 1 above the plate 7. The tube is bent and curved so as to supply the requisite length thereof within the space limits provided. This tube is a restrictor tube for low starting torque as will hereafter appear.

A second tube 11 is connected at one end with and passes through the base plate 7, it having a passage therethrough which may approximate .070" in diameter leading to and connecting with a vertical tubular member 12, the lower end of which is to one side of the cylinder 8 opposite where the tube 11 is connected to the base 7, and is secured to said base as shown in Fig. 2. The tube 12 is in effect a cylinder. It has an opening in its side directly opposite where the tube 11 is connected with such cylinder 12 and above the tube 11 and the opening 13 two openings 14, opposed to each other are made through the tubular cylinder 12. A plug 15 closes the upper end of the cylinder 12 from which a long central spring guide 16 extends downwardly around which is a coiled compression spring 17. The tubular cylinder 12 immediately below the upper end of the plug 15 has other openings or passages 18 through its sides as shown.

In the lower end of the tubular cylinder 12 is a piston 19 the lower end of spring 17 bearing thereagainst. Plate 7 has an opening 20 of restricted size, in practice approximately .040" in diameter, directly under the piston 19.

At another place at the upper side of the plate 7, shown as diametrically opposite the capillary tube 10, a short cylinder 21 is secured at its lower end to said plate 7, which plate has a vertical opening 22 therethrough located generally centrally of the cylinder 21. A loose valve 23 is located in the cylinder 21 and is normally held in down position by a coiled spring 21*a* pressing thereagainst at its upper side. In its lower position the valve 23 closes openings 24 made through the sides of the cylinder 21, but when the piston is elevated above said openings they are uncovered. The spring 21*a* is compressed by a screw plug 25 threaded into the upper end of the cylinder 21, it being evident that the pressure force of the spring 21*a* may be adjusted by changing the position of the plug 25.

The pump housing or casing 1 is closed at its lower end by a lower end plate 26 secured thereto, between which and the lower end of the housing 1 is a diaphragm 27 and above it a flat washer or ring gasket 28, such gasket 28 having a large central opening therethrough. Between the inner edge portions of the gasket 28 and the lower edges of such downturned edge flanges of the plate 7 a transverse plate 29, having a large number of closely spaced small vertical openings 30 therethrough, is located being clamped in place when the closure 26 is assembled with the rest of the structure. The perforated plate 29 at its under side has a substantially large shallow concave recess therein reaching at its edges to and beyond the adjacent edge portions of the gasket 28, the upper side of the end closure plate 26 is recessed downwardly so that the diaphragm 27, when not in use, traverses a chamber divided into two sections, one above and one below the diaphragm as shown in Figs. 2 and 3.

The lower closure plate 26 has a fluid inlet passage at 31 leading to the chamber below the diaphragm with a valve 32 at the inner end of the passage 31 which is adapted to have movement between its lowermost position, when it closes such passage, and an upper stop plate 33 (Fig. 3). It is evident when the pump 9 is moving on its upstroke and the diaphragm is flexed upwardly

there will be a vacuum created below the diaphragm so that the valve **32** is lifted by fluid, gaseous or liquid, which may pass through the passage **1** and fill the chamber below the diaphragm.

The plate **26** is also provided with a fluid outlet or exhaust passage **34** which has a second valve **35** across it normally actuated to close it by the spring **36**, as in Fig. 3. On the upstroke of the piston the valve closes the passage **34** to the chamber below the diaphragm **27** but on the downstroke of the piston **9**, valve **32** being automatically closed, the compressed fluid will act against the valve **35** to open it for its outward passage through the exhaust passage **34**.

In the operation the pump casing is filled with a suitable liquid, generally oil, to a level above the upper end of the cylinder **8**. The cylinder **8** has transverse passages **37** through its walls which are located at a level such that when the piston **9** reaches its uppermost point of travel its lower end is above said openings **37**. The space or chamber below the piston **9** and above and below the plate **29** and above the diaphragm **27** is also filled with oil or equivalent liquid.

In many cases, for example, in refrigeration apparatus, the fluid pumped will be against an initial heavy pressure. The automatic control of the motor which drives the shaft **4** will result in the pump being operated at times with periods of no operation when the electric motor is at rest. The initial starting up of the pump will require that the piston shall reciprocate irrespective of the relatively heavy back pressure against which it must work. In the operation of the pump with incompressible liquid being acted upon by the piston **9** above the diaphragm **27**, when back pressure is low there will be a downward flexing of the diaphragm **27** to force liquid out through the passage **34** with a limited flow of liquid through the tube **11** and outwardly through the openings at **13**. Practically no liquid will flow through the tube **10** because of the capillarity of the passage through it. Of course the length of the tube **10** may be varied so that flow of liquid through the tube will start at increasing higher pressures the longer the tube may be. As the initial pressure against which the pump starting must act is raised, the piston **19** will act against a relatively light coiled spring **17** so as to cover the ports at **13**, **14** and if the motor is not stopped, stalling the pump, the valve at **23** acting against a much heavier spring **21***a* will be lifted to uncover the openings at **24**.

By adjusting the adjusting nut at **25** a higher pressure can be reached, this after the pump is in full operation, and the motor running freely, though there would be a stalling if there was a heavy back pressure against which the stationary motor would have to work on starting. Such heavy back pressure is relieved in part by the flow through the tube **11** until such time as the piston **19** is lifted to its position to close the ports at **13**. If the tube at **11** had no connection whatsoever with the cylinder **12** the flow of liquid through it would continue all of the time instead of only a very short time of momentarily releasing of pressure.

When the pump starts at very high pressure initially, the piston at **19** is lifted rapidly. But if that was all there was to the structure, when the pressure was initially high there would not be sufficient time of relief for the motor to pick up speed. However, with the additional flow through the capillary tube **11**, operating at high pressures, but practically not operating at all at lower pressures because of the fineness of the capillary tube through it, there is a sufficient relief to the incompressibility of the liquid acted upon by the piston **9** that the motor will continue to move and not be stalled because of liquid incompressibility, as it otherwise would be in the absence of the relief afforded by the capillary tube **11**. The valve at **23** is a limit valve to the ultimate pressure of liquid passing outwardly at the outlet passage **34**, against back pressure therein.

When any pump of the hydraulic type operates against low pressure, or practically that of the atmosphere at start, it can get under way and its momentum carry it over dead center positions; and the pressure builds up, the motor running faster and attaining its full speed long before the highest limit of pressure is reached. To provide a limit of pressure valve **23** will open at greater or less pressures dependent upon the adjustment of spring **21***a*. The initial getting under the way and building up a momentum in the pump is through the flow of liquid through the pipe **11** freely into the tube **12** and out through the ports above the valve **19**. This however would be defective and not secure the results if such flow continued indefinitely. For if the flow was sufficient so that the motor could start right off aaginst heavy back pressure the flow would stay continuous and no pumping result but mere circulation within the pump. The getting under way and the momentum obtained occurs as though the motor was starting against a relatively low pressure and not the full back pressure which there may be in the outlet at **34** and against which the pump must eventually work, when, with the increasing rapidity of movement of the motor and piston **9**, pressure will be built up. As such pressure builds flow from the pipe **11** is closed by the lifting of the piston valve **19**. Thereupon any further relief needed, if the back pressure is sufficiently high, is afforded by the capillary tube **11** and, finally, when the pressure to which the pump is adjusted by the nut **25** against the spring **25***a* is reached, that is the ultimate pressure of the pump and it will maintain such pressure though there is a minor or continuous flow of liquid through the capillary tube **10**.

The pump shown and described has been built and fully tested and tried and is exceptionally satisfactory. One place of very desirable use for the pump is in conjunction with the compressor of refrigerating systems in household and other refrigerators. It eliminates the sealing-in of parts which is now an expensive and unsatisfactory structure. The pump is safeguarded against stalling as previously stated, and is sure and certain in its operation under all conditions of pressure, under all torque conditions, in fact under all of the conditions which are met with in its use and operation.

The invention is defined in the appended claims and is to be considered comprehensive of all forms of structure coming within their scope.

I claim:

1. In a pump having a casing with a chamber therein for fluid to be pumped, said chamber having inlet and outlet passages with inlet and outlet valves therein, and a diaphragm comprising the upper side of said casing over said chamber, the improvement comprising, a hollow, vertical housing, adapted to contain liquid, located over said diaphragm and against its peripheral edge portions, a vertical cylinder within said housing, a horizontal base at the lower end of said cylinder over said diaphragm, means between said base and diaphragm for providing a chamber communicating with the lower end of said cylinder, for liquid over the diaphragm, a piston in the cylinder, means for reciprocating the piston, spring loaded valve means mounted on and above said base normally closing against passage of liquid from said last mentioned chamber through the base to said housing, said base having an opening for said passage when the valve is moved against its spring by liquid pressure a predetermined distance, a second vertical cylinder connected at its lower end to said base having liquid passage thereinto at its lower end through the base, a piston valve within said second cylinder, yielding spring means normally moving said valve downwardly to stop liquid passage through said base, and a tube connected at its ends to said base and upper portion of said second cylinder for liquid passage therethrough on downward movement of said reciprocating piston, said piston valve being elevated on increasing liquid pressure against it and stopping liquid passage through said tube

when elevated to the point of connection of said tube to the second cylinder.

2. The improvement having the elements in combination defined in claim 1, said first cylinder having a liquid passing opening in a vertical side thereof normally covered by said reciprocating piston, above which said piston is lifted on upward reciprocating movement thereof to its uppermost position.

3. Structure having the elements in combination defined in claim 1, and a tube having a capillary passage lengthwise thereof connected at one end to said base and located above the base within said housing, providing limited passage for liquid from said liquid chamber to said housing.

4. In a pump having a casing with a chamber therein for fluid to be pumped, said chamber having inlet and outlet passages with inlet and outlet valves therein, and a yielding diaphragm comprising the upper side of said chamber, the improvement comprising a hollow vertical housing adapted to contain liquid, located over said diaphragm and against its peripheral edge portions, a vertical cylinder extending upwardly from said housing, said housing having a horizontal top at the lower end of said cylinder over and spaced from said diaphragm, thereby providing a liquid chamber communicating with the lower end of said cylinder, a piston in the cylinder, means for reciprocating said piston, a second vertical cylinder

connected at its lower end to the top of said housing, said top having an opening therethrough to the lower end of said second cylinder, a piston valve in the second cylinder, spring means acting against said piston valve to normally move it to lower position, and a tube connected at one end to said housing top and at its other end to said second cylinder at a point above the normal lower position of said piston valve, and below positions to which said piston valve may be lifted by liquid pressure.

5. The improvement having the elements in combination defined in claim 4, said first cylinder having a liquid passing opening in a vertical side thereof normally covered by said reciprocating piston, above which said piston is lifted on upward reciprocating movement thereof to its uppermost position.

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