Oct. 12, 1948. F. C. JONES 2,451,030

CENTRIFUGAL PUMP

Filed Nov. 29, 1946 2 Sheets-Sheet 1

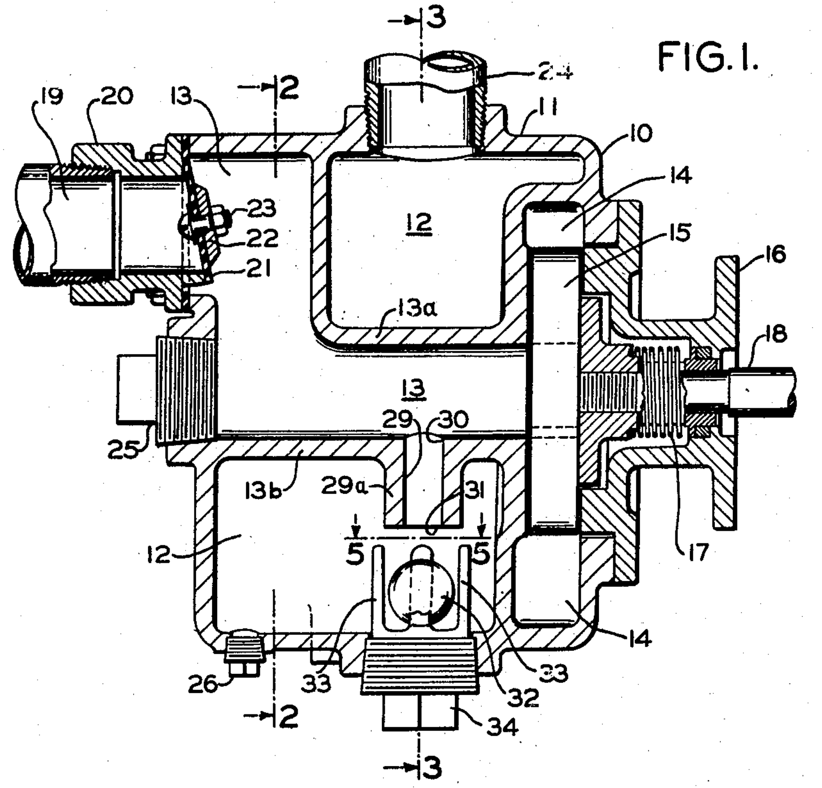

FIG. 1.

FIG. 2.

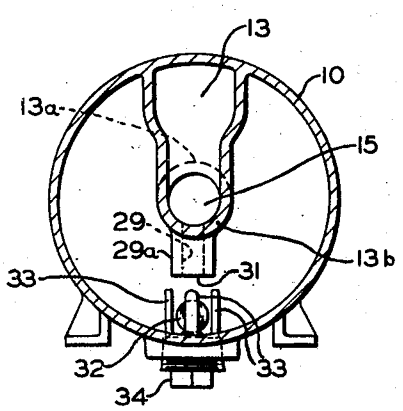

FIG. 3.

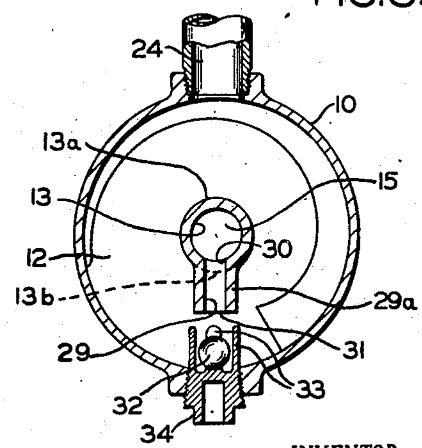

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FIG. 4.

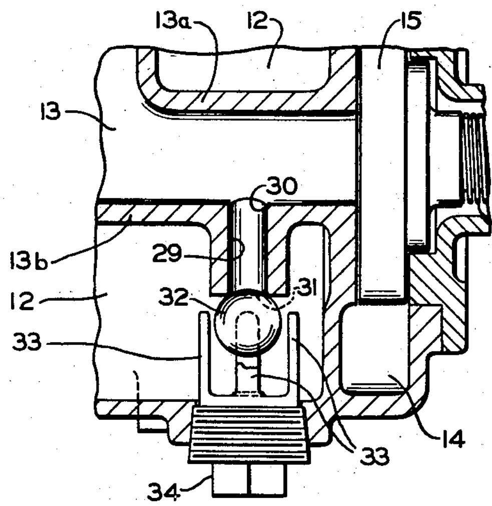


FIG. 5.

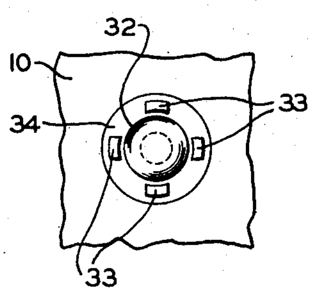
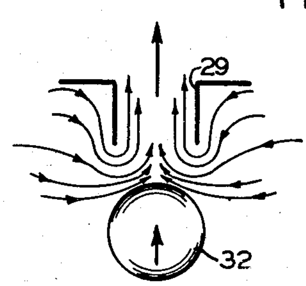


FIG. 6.



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CENTRIFUGAL PUMP

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1 Claim. (Cl. 103—113)

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This invention relates to pumps and more particularly to self-priming pumps and to a new method of priming.

It has for its principal objects the accomplishing of a faster prime; a more positive control of the bypassed priming liquid; completely automatic control of bypassed liquid to provide and maintain maximum overall pump capacity and efficiency; a self-cleaning, non-clogging type of liquid bypass control valve of great advantage when pumping liquids containing foreign matter; and a more compact arrangement of the casing.

The invention consists of a casing having a centrally disposed tubular wall forming a suction passage communicating with the eye of an impeller, and supplied by the source of liquid supply, surrounded by a discharge chamber formed by the casing walls to receive the liquid from the impeller, communicating with the discharge pipe, the tubular wall having a passage with an orifice at one end communicating with the suction passage, and an orifice at the other end communicating directly with the discharge chamber, with a spherical member disposed at a distance from the last named orifice, said distance and the weight of the spherical member being such that the spherical member is moved towards and against said last named orifice upon a predetermined quantity and velocity of flow of the liquid from the last named orifice to the other orifice, and is held in sealing position against said orifice during the pumping action of the pump when the liquid is free from air or gas, the said sealing position being interrupted during the priming action of the pump, when the discharge chamber liquid entrains gas or air, the respective pressures in the suction passage and in the dicharge chamber cooperating to hold the spherical member in sealing position or not.

The invention includes also a cylindrical velocity conduit extending below the suction passage wall and into the discharge chamber to induce a conoidal liquid flow within the sphere of action of which the spherical member is drawn, when the discharge chamber liquid is substantially free of entrained gas or air, that is when the pressure of the discharge chamber liquid is such as to bring the conoidal flow within the contour of the sphere, the sphere is drawn along by the flow.

The invention will be more fully described hereinafter, embodiments thereof shown in the drawings, and the invention will be finally pointed out in the claim.

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In the accompanying drawings,

Fig. 1 is a side elevation view of a pump, constructed in accordance with my invention, to the shaft of which a prime mover such as an electric motor (not shown) may be connected;

Fig. 2 is an end sectional view of the same, taken on line 2—2 of Fig. 1;

Fig. 3 is a vertical section taken on line 3—3 of Fig. 1; Figs. 2 and 3 are of reduced size.

Fig. 4 is a sectional view of the bypass valve portion of said pump with the valve in a closed position;

Fig. 5 is a sectional view looking down on the bypass ball valve and valve guides only, taken on line 5—5 of Fig. 1; and

Fig. 6 is a diagrammatic view showing the operation of the valve.

Similar characters of reference indicate corresponding parts throughout the various views.

Referring to said drawings, the casing 10 has a priming chamber 11 of which volute 14, suction inlet 13, and discharge chamber 12, may or may not be integral parts. As shown in the drawings, the above parts are cast integral.

An impeller 15 is rotated by a shaft 18 within the volute case section 14. A section of suction pipe or hose 19 leading from the source of supply for conducting liquid to the pump, is connected with a suction connection 20 suitably bolted to the casing 10. This connection 20 has a seat for a check valve assembly 21, 22, and 23, as known, which assembly extends into the suction inlet 13.

A section of discharge pipe or hose 24 for conducting liquid and gas or air away from pump is at the upper part of the casing 10. A seal arrangement 17 prevents the entrance or escape of air or gas or liquid to the interior of the casing 10, from the shaft side.

Suction inlet 13 is arranged within the casing 10 for conducting gas and liquid from the pipe 19 to the eye of the impeller 15.

Discharge chamber 12 is arranged for storage of priming liquid and for conducting gas and liquid from discharge opening of volute 14 to and out of discharge pipe 24. The discharge chamber 12 extends around the walls 13a and 13b forming the horizontal portion of the suction passage 13, and extends to the lower part of the casing 10.

Suction passage 13 and discharge passage 12 are interconnected by bypass port passage 29. This passage 29 may be of the straight tubular type opening as shown or of any other design, such as nozzle jet, venturi, etc. which might aid in entrapping more gas with liquid at point of entrance to impeller.

Resting at some point below the bypass passage 29 is a ball valve 32 within the influence of liquid passing from the lower part of the chamber 12 thru the bypass passage 29 into the suction passage 13. The ball 32 is guided by a guide or series of guides 33 to assure its remaining in the sphere of influence of the bypassing liquid.

It has been found that on certain types and sizes of pumps, a bypass passage arranged as a nozzle with whole bypass and ball valve assembly arranged at an angle, gives greater gas handling ability. In the embodiment shown the bypass passage is formed by a tubular projection 29a depending from the wall 13b, the upper orifice 30 being in the wall 13b and the lower orifice 31 being at the lower end of the projection. Both orifices are circular. The axes of the bypass passage 29 passes through the center of the ball or approximately thereto.

The important improvement is the arrangement of the orifice 30 of the bypass passage 29 in line with the wall 13b of the suction passage 13 and the arrangement of the other orifice below the wall 13b, with the center of the ball substantially co-axially disposed with the axis of the passage between these two orifices, and with the weight of the ball subject to stream flows of liquid entering orifice 31 and discharging at orifice 30, the velocity forces of such stream flows causing the gravity and weight of the ball to be overcome, so that the ball is raised against orifice 31 in order to close the same. The ball is constructed of sufficient weight and allowed to rest at a distance away from bypass passage orifice 31 so that these two factors (weight and distance) combine to hold it in position shown in Fig. 1 on all priming conditions, up to and including the "maximum priming pressure differential," but the weight and distance is not great enough to hold ball 32 in this position when pumping (even under minimum pumping pressure differential which is always greater than maximum priming pressure differential). When priming ends and pumping begins, the ball 22 follows the line of flow and is carried upward closing bypass passage 29 and taking the position shown in Figure 4. It will remain in this position under all pumping conditions, completely closing the bypass, orifice 31, thus preventing all recirculation, and maintaining maximum pump efficiency and capacity. As soon, however, as the pump "loses its prime" and priming conditions again prevail, ball 32 immediately drops away from bypass passage 31, thus opening it to liquid flow and allowing recirculation to accomplish a repriming of the pump. As an example of the weight and distance, for a pump of 77 G. P. M. capacity, the weight is 2½ ounces and the distance from the center of the ball to the center of the orifice 31 is one inch.

Plugs or covers 25, 28, and 34 are screwed in or attached to the casing 10 to facilitate inspection, assembly and drainage.

The operation is as follows:

Let us first take pump as shown in Fig. 1. The entire casing 10 is filled with liquid which automatically fills all parts thereof, including volute 14 and passages 12, 13 and 29. The suction pipe 19 is extended downward to and submerged in liquid to be pumped. The discharge pipe 24 is lead away to a point of liquid discharge. Shaft 18 is then rotated by motive power attached thereto, rotating impeller 15. The action at this point is the same as any centrifugal pump, and some of the gas in the suction line is entrained. This mixture of gas and air is thrown by the impeller out into the discharge line where the gas or air separates and passes off thru the discharge line, and the gas or air free liquid again is bypassed to the suction passage. This recirculation process is continued until all gas is exhausted from the pipe 19 and suction passage 13 and therefore liquid from the supply source drawn to and into the pump impeller. Pump is then said to be "primed" and continues to pull liquid from source of supply pipe 19 and throws it out into discharge pipe 24 without recirculation (until suction line becomes "uncovered," or until gas or air is allowed to enter suction line), when recirculation again takes place until the gas or air is removed, and the pump is again primed.

The above described is the known action of a centrifugal pump, and the reference to bypassed, is made generally as bypass recirculation is also known.

However, without control of the bypass passage a continuous recirculation of a portion of the liquid takes place materially lowering the pump capacity and efficiency. Various pumps at present on the market control and attempt to close this bypass passage when pump is pumping and open it when pump is priming by various types of automatic and manual control.

The present invention provides a positive trouble-free control of this passage, to wit: as long as the pump is priming, the ball valve 32 rests of its own weight at the bottom of the permitted valve travel and liquid freely passes thru bypass passage 29. Under all conditions of pump and priming, a pressure differential exists between the discharge chamber 12 and the suction passage 13 when the pump is running, and pressure is always greater in the discharge chamber 12 than in the suction passage 13. This causes varying quantities and at varying velocities of liquid to pass upward thru the bypass passage 29. The greater the pressure differential, the greater the quantity of liquid bypassed. For practical purposes, the maximum pressure differential, when priming, can be said to be when the partial vacuum in the suction line approaches the maximum of which the pump design is capable of pulling. We shall call this for purposes of description "maximum priming pressure differential." Also the maximum pressure differential when priming is approached, is when the suction lift is at or near the maximum of which the pump design is capable and the pump discharge is near its "shutoff" design point. We shall call this again for purposes of description "maximum pumping pressure differential."

Conversely minimum pressure differentials are approached when minimum suction lifts and zero discharge heads are encountered. It has been found that in a properly designed pump of this general type, the minimum pumping pressure differential is always greater than the maximum priming pressure differential. This fact permits the new and positive method of bypass control.

It means in fact that the quantity and velocity of liquid bypassed upward thru the bypass passage 29 is under all conditions greater when pumping liquid than when priming, and in consequence the ball is raised to close the orifice 31, when the pumping action begins after the priming action ends.

With an understanding of a sphere characteristic action in a flow of liquid, of interest here only to the extent that the sphere attempts to get into and stay in the line of flow, the action of the ball valve control becomes quite evident.

I have described several forms of my invention, but obviously various changes may be made in the details disclosed without departing from the spirit of the invention as set out in the following claim.

I claim:

In a centrifugal pump having a casing with a central cylindrical chamber formed of walls in the casing, forming a suction passage, a supply pipe at one end thereof, an impeller at the other end thereof having its eye aligned with said suction passage, and a discharge chamber in said casing communicating with said impeller, and surrounding said central cylindrical chamber, and having a discharge opening, one of said walls of the central chamber having an opening therethrough, providing an orifice spaced between the ends of the central chamber and spaced from the impeller, subject to the suction action of the flow in the central chamber, a cylindrical extension having one end in registration with said orifice, and having its other end in communication with the fluid in the discharge chamber, forming a velocity conduit bypass passage, a spherical member of larger diameter than the open end of the extension, a cage for the spherical member for holding it spaced from said open end, within the velocity flow of the bypass passage during priming and moved to close the open end, when the pressure in the central chamber is sufficiently less than the pressure in the discharge chamber to draw the spherical member to said open end, until priming again becomes necessary, the closed position of the spherical member on the extension preventing recirculation and the open position permitting recirculation of the discharging fluid.

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