Nov. 26, 1935. C. I. LONGENECKER 2,022,624

SELF PRIMING ROTARY PUMP

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Fig. 1.

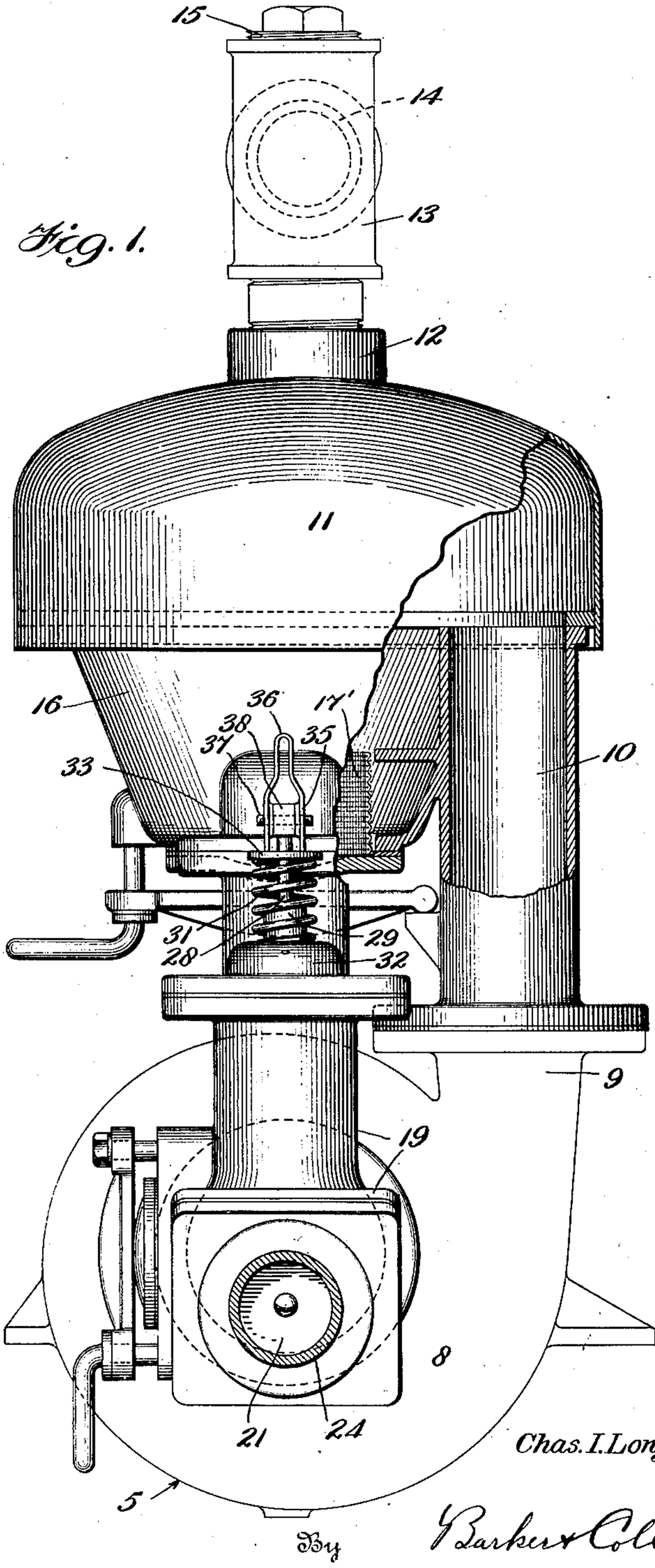

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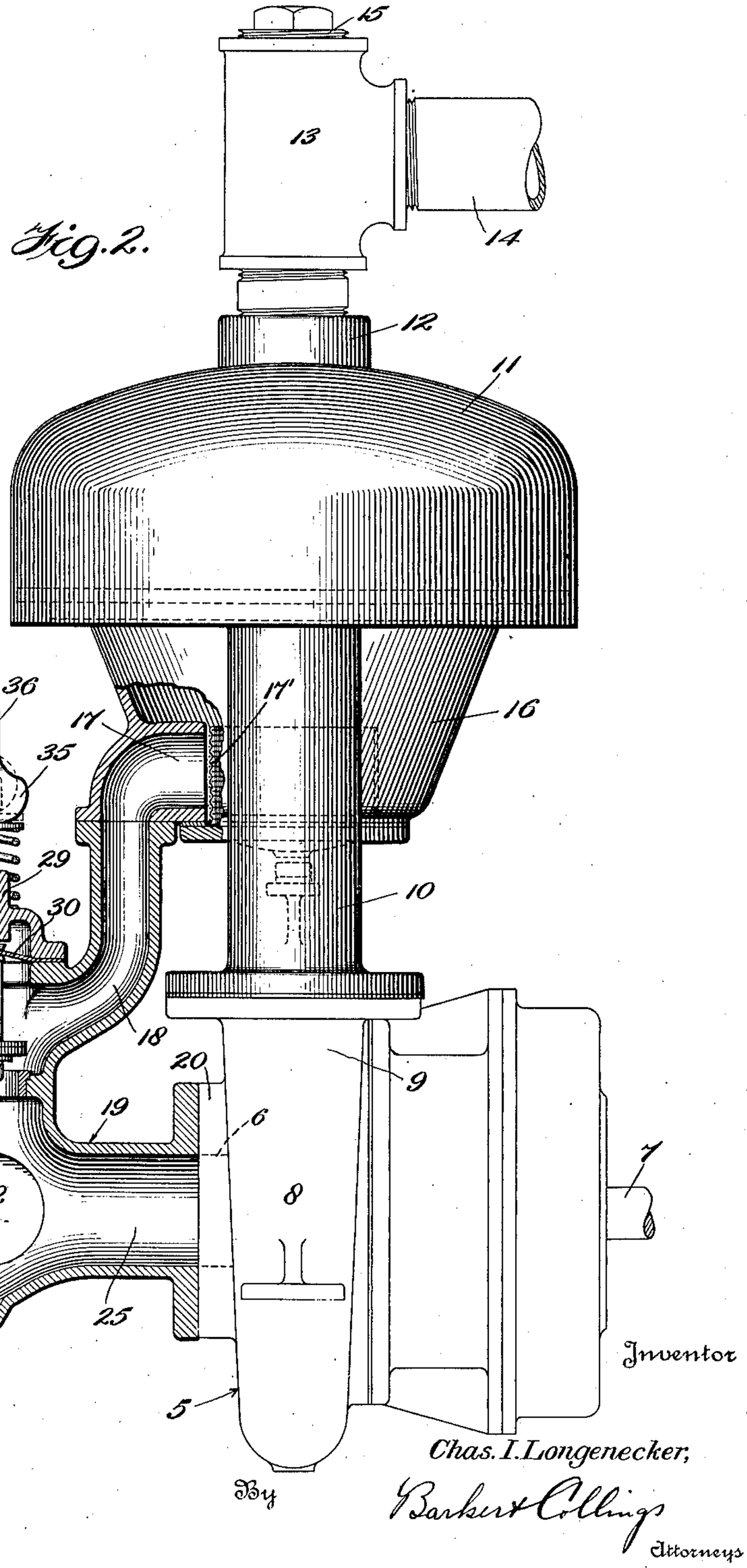
Fig. 2.



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SELF-PRIMING ROTARY PUMP

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4 Claims. (Cl. 103—113)

This invention relates to self-priming rotary pumps of the recirculating type and to methods of operating the same and has for one of its objects to improve and simplify the construction of such pumps and their methods of operation.

By a self-priming rotary pump is meant one in which the action of the pump impeller in circulating a relatively small quantity of priming liquid in a closed circuit through the pump automatically and as often as necessary places the pump in condition to raise liquid from a level below that of the pump, or in other words, the action of the pump itself in recirculating the priming liquid through the circuit within the pump produces sufficient vacuum in the influent passage to lift liquid from a lower level up to that of the pump.

Such pumps are widely used where the supply of liquid to be pumped varies so greatly and/or so rapidly, that the pumps frequently exhaust the supply and lose their prime; for example, in keeping building and other similar excavations free of water. Because of the self-priming feature, they may be permitted to run continuously without attention, and if the supply falls below the intake, the discharge of course stops, but the pump automatically becomes operative again as soon as the supply rises above the intake of the influent pipe.

They are to be distinguished from those rotary pumps which must be primed by hand upon each failure of the liquid, as well as from those designed to operate at a level below that of the liquid being pumped and which may therefore be primed, or maintained in primed condition, by gravity flow of such liquid to the pump. They are also differentiated from those rotary liquid pumps which are provided with separate air pumps or other similar auxiliary vacuum creating means.

In order that the invention may be better understood it may be said that actual experiments with rotary pumps of the centrifugal type have developed the fact that in the use of such pumps for lifting water or other similar fluid, when the pump is primed there is an increase in the negative pressure over that required to raise the water to the intake orifice of the pump. While the amount of increase may vary with the characteristics of the individual pump or with pumps of different manufacture, roughly it may be said that where the pump is located from 18 to 27 feet above the source of supply, a negative pressure or partial vacuum of approximately from 7.69 to 11.69 pounds is set up upon the suction side of the pump during the priming operation. When the water flows into the pump casing and is picked up by the pump runner, this negative pressure builds up quite rapidly to between 12 to 14 pounds, which increase of negative pressure is accounted for by the pressure required to establish and maintain the velocity head of the water through the pump. The present invention has for one of its objects to take advantage of this increase in the vacuum upon the suction side of the pump to cut off the flow of the recirculating fluid substantially simultaneously with the completion of the priming, thereby securing the full efficiency of the pump.

It has also been found by actual experiment that when a centrifugal pump is operated under conditions where a suction lift of less than 8 pounds is required, the vacuum pressure increase at the instant of the completion of priming is not as great as it is under the higher lifts first referred to, and it is therefore desirable in order to obtain the most efficient results under all operating conditions to provide means whereby adjustments may be made in the control means for the recirculating fluid to compensate for such differences in vacuum conditions on the suction side of the pump. The present invention therefore also includes the provision of such adjustments, as will appear more fully below.

With the above and other objects in view which will appear as the description proceeds, the invention consists in the novel details of construction and combination of parts constituting the apparatus, and in the novel steps and combinations of steps constituting the method of operation, all as will be more fully hereinafter described and particularly pointed out in the appended claims.

Referring to the accompanying drawings forming a part of this specification in which like reference characters designate like parts in all the views:—

Figure 1 is an end elevational view, partly broken away, of a rotary pump of the centrifugal type, embodying priming means and controls therefor constructed in accordance with the present invention; and

Figure 2 is a side elevational view, partly in section, of the apparatus shown in Figure 1, as seen from the right of the said figure.

Referring more particularly to the said drawings, the rotary pump 5 may be of any conventional type, here shown as a centrifugal pump having an intake passage 6 and an impeller, not shown, driven by a shaft 7 from any suitable

source of power. The pump casing 8 is also provided with the usual outlet 9, which discharges into a pipe or conduit 10 leading into the priming tank or receptacle 11, substantially as shown in the drawings. The said priming tank or receptacle is provided with a main discharge outlet 12, which is preferably connected by means of a T-connection 13 to the discharge pipe 14. The said T-connection is provided with a plug 15 which may be readily removed for the purpose of initially introducing the priming liquid into the priming tank and pump casing at the commencement of operations.

The priming tank or receptacle 11 is provided with a lower extension or bowl 16 which is, or may be formed as, an integral part with the pipe or conduit 10, as shown in Figure 1, and the lower portion of the said bowl 16 is provided with a recirculating fluid outlet 17, the intake of which is preferably protected by a screen or strainer 17' substantially as shown. The said recirculating fluid outlet 17 connects with a recirculating fluid conduit or passage 18, which may be formed as an integral part of a valve body 19, secured to and carried by the intake flange 20 of the pump housing 8. Said valve body 19 houses a check valve 21, here shown as a conventional flap valve, which is normally urged to the closed position indicated in Figure 2 by means of a weight 22 carried by the valve disk 23. The said check valve controls the flow of fluid from the supply pipe 24, which is connected with the valve body as shown, thereby permitting the liquid to flow to the valve body 19, but preventing reverse flow thereof as will be readily understood. The said valve body is provided with a conduit or passageway 25 communicating with the intake passage 6 of the pump as will be clear from Figure 2.

The valve body 19 also houses a valve 26 for controlling the flow of the recirculating fluid from the tank 11 to the pump, which valve 26 coacts with a valve seat 27 as will be readily understood from Figure 2. Said valve 26 is adapted to be controlled by the variations in the vacuum conditions within the valve body 19 in accordance with the above general description, and to this end the valve may be of any suitable fluid pressure controlled type. As a practical example of one form of valve found suitable in this connection, the valve head 26 may be carried by a valve stem 28 passing through a valve stem guide 29 and suitably secured to a diaphragm or membrane 30 which is subject to pressure conditions within the valve body 19. A helical spring 31 for moving valve 26 to open position surrounds the valve stem 28, being interposed between the cap member 32 which carries the valve stem guide 29, and a disk or washer 33 which slidably fits the upper portion of the said valve stem 28; see Figure 2. The cap member 32 is vented to the external atmosphere as by the passageway 32'.

Means for adjusting the pressure exerted by the spring 31 are provided in order that the valve 26 may be rendered responsive to various vacuum conditions upon the suction side of the pump as above described, such means being here shown as comprising an eccentric or cam member 35 provided with an operating handle 36 and pivotally connected at 37 to the head 38 rigidly carried by the upper end of the valve stem 28.

When the cam member 35 is in the position shown in full lines in Figure 2 the disk 33 is forced downwardly upon the valve stem 28, thus somewhat compressing the spring 31 and causing it to exert a somewhat greater pressure tending to maintain the valve 26 in the open position shown. On the other hand, if the cam member 35 is moved to the dotted line position shown in Figure 2, the disk 33 will be permitted to rise slightly as indicated in dotted lines, thereby relieving to some extent the pressure exerted by the spring 33 and thus rendering the valve 26 responsive to a lesser degree of vacuum in the suction side of the pump than when the parts are in the full line positions.

The under side of diaphragm 30 is of course subject to the positive pressures in conduit 18 when the priming water is circulated therethrough, and since the upper side of said diaphragm is open to external atmospheric pressure by reason of the passageway 32', the diaphragm acts to oppose closing movement of the valve 26. The said valve is also subject to the pressure and velocity of the priming water as it is forced through conduit 18, which tend to move the valve to its seat 27. The valve is further subject to any vacuum or negative pressure condition in the supply pipe 24 and/or intake passage 25, which also tends to seat the valve, and were it not for the diaphragm 30, the two sets of forces tending to seat the valve would be additive. However, the effective area of the diaphragm 30 is so chosen that the said diaphragm, in response to the pressures acting upon it, will substantially counterbalance the tendency of the priming fluid pressure and velocity to seat the valve 26, leaving the latter in effect subject only to the action of the vacuum condition in the intake passage.

Since, as above explained, the vacuum in the intake builds up quite rapidly as priming is completed, the present structure provides an extremely sensitive control of the priming fluid, cutting off the flow thereof substantially simultaneously with the completion of priming without chattering of the valve, and without waiting for pressure to build up on the discharge side of the pump, as is the case where the priming fluid valve is controlled by positive pressure conditions on the discharge side.

Again, because of the balancing of the valve 26, insofar as positive pressure conditions in conduit 18 are concerned, no difficulty is experienced by reason of sticking of the valve in closed position when the pump loses its prime, due to said positive pressures. That is to say, if the discharge pipe 14 extends say 25 or 30 feet above the pump, as it frequently does in practice, so that the pump is operating against a considerable discharge head, upon loss of prime the pressure resulting from the weight of the water in said discharge pipe is of course transmitted to conduit 18, with the result that unless valve 26 be balanced with respect to said pressure, the forces holding the valve upon its seat may be so great that they can not be overcome by any spring 31 which it is practical to use, so long as the pump impeller is rotating. By balancing valve 26 with respect to these positive pressures, as herein described, the said valve will open under the influence of a comparatively light spring 31, irrespective of how great such positive pressure may be.

The operation of priming the present pump is substantially the same as that in the self-priming rotary pumps heretofore proposed, in that after the priming tank 11 and the pump chamber have been filled with priming water, manually introduced into the T-connection 13 after removing the plug 15, it will be circulated through the recirculating port 17, passage 18, past the valve 26

and through the passage 25 into the pump housing, from whence it will be forced upwardly by the impeller through the conduit 10, back to the priming tank 11. The circulation thus set up creates a partial vacuum within the valve body 19 which serves to open the check valve 21 and to draw air from the supply pipe 24 past the said valve 21, which air is entrained with the recirculating water and forced into the tank 11, where it separates from the water and passes out through the discharge passage 12, T—13, and discharge pipe 14. As above stated, where the pump is being employed to lift water from a supply located some 18 to 27 feet below the pump, a suction of from approximately 8 to 12 pounds below normal atmospheric pressure will be set up within the valve body 19 and the spring 31 is designed and constructed to normally overcome such suction and to maintain the valve 26 in its open position so long as the suction does not exceed say 12 pounds.

When the air has been completely exhausted from the pipe 24 by the operation above described, and the pump is completely primed, suction within the valve body will build up rapidly to approximately 14 pounds, which, acting upon the diaphragm 30 will be sufficient to overcome the action of the spring 31 and thereby move the valve 26 downwardly to its seat 27 and thus shut off the flow of recirculating water through the passages 18 and 25. In this condition the pump will continue to operate as an ordinary centrifugal pump so long as liquid is supplied to the intake of pipe 24. Should the supply fail, however, the vacuum within the valve body 19 will fall, the valve 26 will be opened by the spring 31, and the recirculation of priming fluid through the passages 18 and 25 will again take place until such time as liquid is again supplied to the intake of pipe 24, whereupon the pump will again automatically prime itself and continue pumping, in the well known manner.

In the event the pump is being employed for lifting water where a suction lift of less than 8 pounds is required, the cam member 35 will be moved to its dotted line position shown in Figure 2, thereby relieving some of the pressure exerted by the spring 31 and permitting the valve 26 to close when the suction pressure in the valve body 19 reaches somewhat less than 14 pounds, since under these conditions, as above described, the suction pressure at the instant of priming is reduced over what it would be if the pump were operating with greater suction lifts. By properly choosing and constructing the spring 31 and the cam or eccentric member 35, it is possible to provide a self-priming pump which will be adaptable to all conditions of operation and varying suction lifts.

It is obvious that those skilled in the art may vary the precise details of construction and arrangements of parts constituting the apparatus, as well as the precise steps and combinations of steps constituting the method of operation, without departing from the spirit of the invention, and therefore it is not wished to be limited to the above disclosure except as may be required by the claims.

What is claimed is:

1. In a self-priming rotary pump of the recirculating type, having a conduit for supplying priming fluid to the intake passage of said pump, the combination of a valve for controlling the flow of priming fluid through said conduit, said valve being directly subject to pressure conditions in said intake passage, and also to pressure conditions in said priming-fluid conduit, both of said pressure conditions tending to close said valve; means for loading said valve to a predetermined degree against the action of said pressure conditions; and a diaphragm in said conduit, arranged to render the action of the pressure conditions in said priming-fluid conduit upon said valve wholly ineffective, thereby leaving said valve responsive solely to pressure conditions in said intake passage.

2. In a self-priming rotary pump of the recirculating type, having a conduit for supplying priming fluid to the intake passage of said pump from the discharge passage thereof, the combination of a valve for controlling the flow of priming fluid from said conduit to said intake passage, said valve being directly subject to vacuum conditions in said intake passage, and also to positive pressure and velocity conditions in said priming-fluid conduit, both of which conditions tend to close said valve; means for loading said valve to variable degrees against the action of said vacuum conditions; and a diaphragm in said conduit arranged to automatically continuously render wholly ineffective the action of said positive pressure and velocity conditions on said valve, whereby the latter is responsive solely to said vacuum conditions.

3. In a self-priming rotary pump of the recirculating type, having a conduit for supplying priming fluid to the intake passage of said pump, the combination of a valve for controlling the flow of priming fluid from said conduit to said passage, said valve being directly subject to pressure conditions in said intake passage, and also to pressure conditions in said priming-fluid conduit, both of which conditions tend to close the valve; a diaphragm in said conduit also subject to said pressure conditions therein, arranged to continuously balance said valve against the closing action of said conduit pressure conditions; and means for automatically opening said valve when pressure conditions in said intake passage reach a predetermined value.

4. In a self-priming rotary pump of the recirculating type, having a conduit for supplying priming fluid to the intake passage of said pump, the combination of a valve for controlling the flow of priming fluid from said conduit to said passage, said valve being directly subject to vacuum conditions in said intake passage, and also to positive pressure conditions in said priming-fluid conduit, both of which conditions tend to close the valve; a diaphragm also directly subject to said positive pressure conditions, arranged to substantially balance said valve at all times against the closing action of said positive pressure conditions; and adjustable means arranged to open said valve against the action of said vacuum conditions when the latter reach variable predetermined values.

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