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SELF-PRIMING CENTRIFUGAL PUMP

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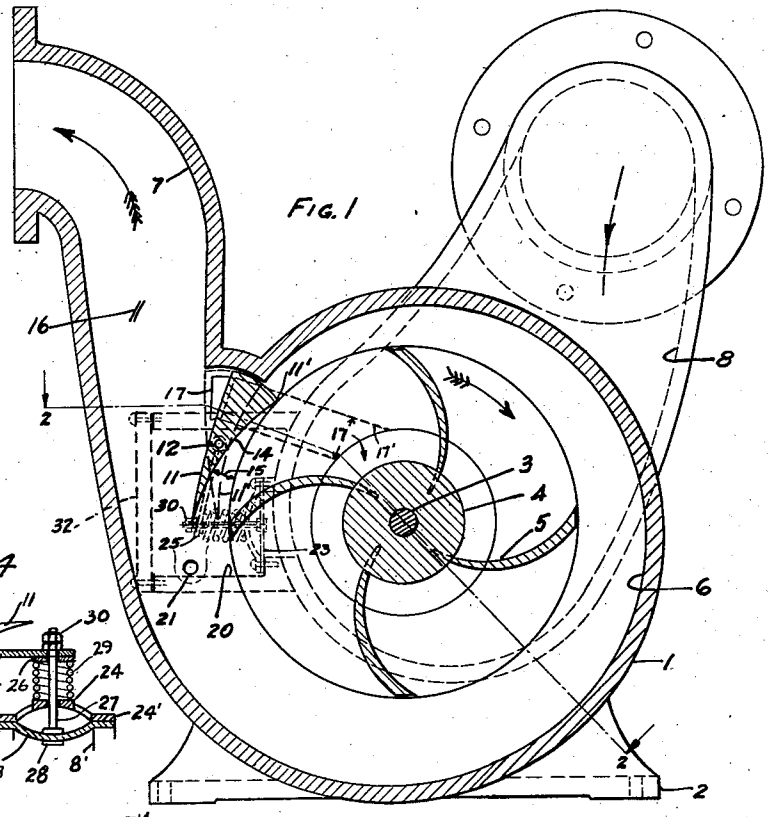


FIG. 1

FIG. 4

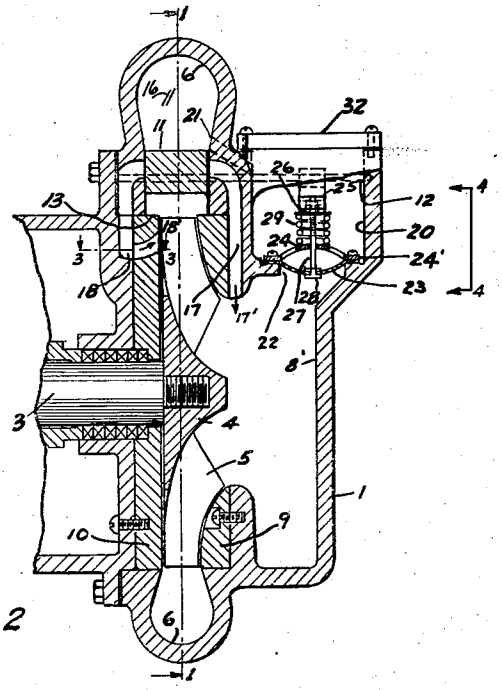


FIG. 2

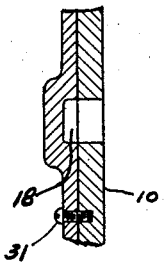


FIG. 3

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SELF-PRIMING CENTRIFUGAL PUMP

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18 Claims. (Cl. 103—113)

This invention relates to self-priming centrifugal pumps and the principal object of the invention is to provide improvements in such pumps whereby the "self-priming" or automatic re-priming of the pump after each time of stopping the pump and/or falling of the suction column of water or other liquid being pumped will be quick and more reliable than prior pumps of this type.

One of the features is to provde an inspirator jet of liquid entrapping air for ejection by the impeller, while another feature is a cooperating recirculation flow directed toward the impeller, thus forming a dual system of priming which hastens this operation as well as insuring its being effected even if one of these cooperating features failed for any reason, particularly the clogging of the recirculation passage.

Another feature is the automatic control of the recirculation passage by liquid pressure responsive means kept out of the flow channels of the liquid and thus away from mud and solid foreign materials.

Another object is to provide such recirculation and inspirator jet means which is rendered dormant when the pump is running and presents no obstruction or influence in any way on the efficiency of the pump as against a similar pump without the re-priming features.

Other features and advantages of my improved construction will appear in the following description and accompanying drawing.

In the drawing,

Fig. 1 is a vertical cross section of a centrifugal pump incorporating my improvements. The section is taken from the line 1—1 of Fig. 2.

Fig. 2 is a cross section of Fig. 1 taken from the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary section taken along the line 3—3 of Fig. 2.

Fig. 4 is a detached assembly view of the pivotally mounted cut-off tongue, its shaft, operating crank, and connection to the stem of the diaphragm, generally as these parts would appear from the arrows 4—4 of Fig. 2.

In the drawing, the centrifugal pump itself is substantially conventional and therefore only the body portion and impeller are shown, and the usual details of mounting and drive have been omitted. The pump shown is of the volute type with a four bladed impeller, tho the invention is not limited to size or type of centrifugal pump.

The pump body or casing is designated 1, its supporting frame or pedestal 2, its shaft 3, impeller hub 4, blades 5, volute surrounding the impeller 6 merging at its large end at the point of cut-off of the liquid into an upwardly extending discharge passage or pump outlet 7, while extending downwardly to the pump casing 1 is an inlet or suction passage 8 preferably formed of a casting either integrally or secured to the casing, and the upper end of which inlet passage is adapted to be connected at its upper end to any desired downwardly extending suction pipe as from a well, sump or other body of water to be elevated.

It is evident that by having the inlet and outlet passages extend upwardly for a short distance before being directed to their desired points of operation, that upon stopping the pump its casing will remain full of liquid for re-priming purposes. This arrangement is old in self-priming pumps, as is the further provision of a flap check valve on the suction passage to prevent siphoning out of the residual or re-priming liquid when the suction column falls upon stopping the pump, and accordingly such a valve is not shown.

In the present construction, the impeller blades are not shown shrouded, tho this is optional, but are shown as secured to or formed integral with the hub 4 and extending freely between closely fitting side walls 9 and 10 either or both of which may be renewable wearing plates as well understood, and the volute passage 6 is preferably wider than the blades and extends radially beyond them as indicated in the drawing.

At the smallest end or beginning of the volute generally termed the point of cut-off where the liquid diverts to the tangential discharge passage I provide a pivoted blade or tongue 11. This tongue has a cross section equal to or preferably greater than the width of the volute at this point (see Fig. 2) and the tongue is secured to a rocker shaft 12 so that it may be rocked from the normal dotted line position to the full line position shown in the drawing, and when in the latter position it is stopped by shoulders 13 (see Fig. 2) with the thick or inner end of the tongue 11' just clearing the outer ends of the impeller blades.

The inner side of the tongue is curved as at 14 so as to form an unbroken continuation of the volute outer wall when the tongue is in the dotted position 11'' so as to take the place of the fixed tongue or cut-off blade of a common pump, and it may be given any desired clearance from the impeller when in such dotted position as desired by adjustment for the particular service desired, but when in the full line position it forms successively with each advancing impeller blade a

funnel shaped inspirator passage 15 which draws in a quantity of liquid such as water being pumped and shoots it under pressure as a jet into the impeller to entrap air to be carried outward into the volute as the blades advance. Thus, there is produced an extremely rapid succession of inspirator jets which rapidly entrap the air for ejection with the water to the outlet passage, or separator chamber as commonly used, for separation and escape therefrom as the vacuum is being established in the suction side of the pump.

When the pump is primed again the inspirator tongue is automatically swung to the dotted line position 11'' so as to re-establish the normal running efficiency of the pump.

The means which automatically swings the tongue to operative position as an inspirator and back to position of a normal cut-off blade, is here shown as cooperating with the opening and closing of the recirculation channels as will now be described.

There are two water recirculating channels or passages leading from the pressure or discharge space or passage 16 back to the impeller space. These passages are shown best in Fig. 2 at 17 and 18. The first one discharges inwardly at 17' in direction of the arrow adjacent the center of the impeller, while the second discharges inwardly at 18' in direction of the arrow adjacent the outer end of the impeller blades but sufficiently inward to entrap any air and carry it outward through the condensed water ring (when the priming water is low) and into the volute.

These two recirculation passages open from the pressure space 16 at opposite sides of the volute as shown in Fig. 2 and are normally closed by the thick rear end of the tongue 11 when the pump is primed and running, and opened when the pump is stopped or in process of priming. This is carried out by provision of a separate or static water chamber 20 ported as at 21 to the pressure side of the pump or space 16 so as to have the same pressure while being out of the line of flow of water, and which chamber is formed with a relatively large opening 22 at one end communicating with the suction side 8' of the pump but closed off by a flexible diaphragm 23 clamped water-tight around its margin by the annular flange 24' of a spider 24.

Shaft 12 which operates the tongue 11 for the inspirator action extends across and into the static water pressure chamber 20 and has bearing support in the walls thereof as indicated in Fig. 2. A crank arm 25 is secured to the shaft and extends above the center of the diaphragm where it pivotally connects as at 26 to a pin or bolt 27 which is connected to the center of the diaphragm by a suitable sealed connection 28 so that as the diaphragm is flexed outwardly of the chamber 20 (as shown) by reason of superior pressure in the static chamber, vs. the suction side of the pump, it will pull on the bolt 27 and the crank arm 25 so as to turn the rock shaft 12 slightly and swing the tongue 11 from full line position of Fig. 1 to dotted position closing off both recirculation passages 17 and 18, and as indicated in full lines in Fig. 2. However, when the pressure in the chamber falls or becomes the same as the suction side, as when the pump stops, the diaphragm tends to return to flat position and a compression spring 29 reacting between the spider 24 and the crank arm resiliently swings the crank upward to reverse the rock shaft, open both passages 17 and 18 and swing the tongue 11 to inspirator jet forming position. Thus the connections illustrate one way of automatically and simultaneously bringing both the two recirculation passages and the inspirator jet forming device into and out of operative position actuated by the relation of the water pressure at opposite sides of diaphragm 23, which exercise a push-pull effect on it, tho it is manifest that the diaphragm control as described will operate if the upper and lower sides are exposed respectively to pressure and suction of the pump and the opposite sides of the diaphragm are vented to atmosphere, but the more efficient push-pull effect of using both positive and negative pressures is preferable.

The tongue 11 being but yieldingly moved by the spring to inspirator position is, of course, free to back away from any hard foreign substances, such as stones, which might come into the pump with the water, and thus protect both the tongue as well as the impeller blades from injury.

To be noted is that the approach of the thick end of the tongue to the impeller may be accurately controlled by adjusting nuts 30 on bolt 27, and also that in case it is desired to equip the pump with a smaller diameter impeller the adjustment described will care for this, tho shoulders 13 will have to be cut back to suit, or can be made initially with sufficient clearness to permit the use of smaller diameter impellers.

It should also be noted that while I show the recirculation valve and inspirator forming device connected together, or rather combined as a single element 11 this is optional as it is obvious they may be separate and similarly controlled, and that the pivotally mounted tongue permits it to be set for any desired clearance from the impeller.

Since the recirculation passages could conceivably become clogged with stones, or other matter, it is preferable to make one or both of the side plates 9, 10 embracing the impeller as separate renewable wearing plates as indicated in Fig. 3 and where it will be seen that they are held in place as by screws 31 for easy removal when the pump casing is taken apart, and which removable liner plates are arranged to form at least one wall of the recirculation channel 17 and/or 18, as indicated, so that when removed it will expose the channel open for easy cleaning.

The static pressure chamber 20 is preferably provided with an easily removable lid 32 to facilitate inserting and adjusting of the diaphragm and operating parts.

From the above description of the construction and functioning of the various parts, it is thought the general operation will be clear to anyone skilled in the art, for it is manifest that when the pump stops there is no difference in pressure at opposite sides of diaphragm 23 with a result that both recirculation passages 17, 18, are at once opened and the inspirator tongue 11 is swung to operating position, so that as the pump is started the dual system of priming by recirculation and rapid jet inspirator action at once begins to operate, also that the recirculation is directed through two separate channels, one adjacent the center of the impeller and the other adjacent its periphery, both in excellent positions for entrapping air as their streams of water head for the impeller blades. Also that as soon as re-priming is effected the superior pressure in the static chamber or relative lower pressure in the suction side of the pump deflects the diaphragm and at once withdraws the dual priming devices and re-

establishes the pump with an unobstructed flow of maximum effectiveness.

Since, as above set out, the diaphragm may be operated by either negative or positive pressure, or by both to get the more effective push-pull effect, my use of the word "pressure" in the claims where not otherwise qualified is intended to cover either a positive or negative pressure (with respect to atmospheric).

Having thus described my improved construction in a self-priming centrifugal pump, what I claim is:

1. In a centrifugal impeller pump having a housing arranged to hold a quantity of residual water accessible to the impeller for priming the pump by recirculation of said residual water, and including a recirculation passage from the discharge to the intake side of the pump, the improvement which comprises a movable valve arranged to open and close said passage, spring means normally moving said valve toward open position, and diaphragm means exposed on one side to pressure developed in the discharge side of the pump and exposed on the other side to vacuum developed in the intake side of the pump for closing said valve in opposition to said spring means when the pump is primed.

2. In a centrifugal impeller pump having a housing arranged to hold a quantity of residual water accessible to the impeller for priming the pump by recirculation of said residual water, and including a recirculation passage from the discharge to the intake side of the pump, the improvement which comprises a movable valve arranged to open and close said passage, spring means normally moving said valve toward open position, and diaphragm means exposed on one side to pressure developed in the discharge side of the pump and exposed on the other side to vacuum developed in the intake side of the pump for closing said valve in opposition to said spring means when the pump is primed, the outlet of said recirculation passage being directed near to the periphery of the pump impeller.

3. In a centrifugal impeller pump having a housing arranged to hold a quantity of residual water accessible to the impeller for priming the pump by recirculation of said residual water, and including a recirculation passage from the discharge to the intake side of the pump, the improvement which comprises a movable valve arranged to open and close said passage with spring means normally moving said valve toward open position, and diaphragm means exposed on one side to pressure developed in the discharge side of the pump and exposed on the other side to vacuum developed in the intake side of the pump for closing said valve in opposition to said spring means when the pump is primed, the outlet of said recirculation passage being adjacent to the point of cut-off and directed towards the periphery of the impeller.

4. In a centrifugal impeller pump arranged to hold a quantity of residual water accessible to the impeller for priming the pump by recirculation of said residual water, and including a recirculation passage from the discharge to the intake side of the pump, the improvement which comprises a movable valve arranged to open and close said passage with spring means normally moving said valve toward open position, and means responsive to pressure developed by the pump closing said valve in opposition to said spring means, and means associated with said movable valve cooperating successively with each blade of the impeller forming an inspirator injecting a jet of water adjacent the periphery of the impeller.

5. In a structure as set out in claim 4, said last mentioned means connected for movement with said valve so as to be moved to operative relation to said impeller when said passage is open and vice versa.

6. In a structure as set out in claim 4, said last mentioned means formed as an extension of said valve so as to be moved to operative relation to said impeller when said passage is open and vice versa.

7. In a recirculating self-priming centrifugal pump of the character described, inspirator means cooperating successively with the blades of the impeller as they come around arranged to inject a jet of water adjacent the impeller for entrapping air, and means mounting the inspirator means for swinging out of operative position upon impact of any foreign material carried by the liquid being pumped.

8. In a recirculating self-priming centrifugal pump of the character described, inspirator means cooperating successively with the blades of the impeller as they come around arranged to inject a jet of water adjacent the impeller for entrapping air, and means mounting the inspirator means for swinging out of operative position upon impact of any foreign material carried by the liquid being pumped, and spring means resiliently holding said inspirator means in operative position.

9. In the construction set out in claim 1, said means responsive to pressure comprising a separate chamber off of the normal flow of water through the pump and ported to the suction side of the pump and the port closed by a flexible diaphragm, and which separate chamber is openly ported to the pressure side of the pump, means connecting said diaphragm for operating said valve toward closing position upon flexing of the diaphragm, and spring means tending to restore the diaphragm and open the valve when the pressure in the chamber falls upon stopping the pump.

10. In a recirculating self-priming centrifugal pump of the character described, inspirator means cooperating successively with the blades of the impeller as they come around arranged to inject a jet of water adjacent the impeller for entrapping air, means mounting the inspirator means for swinging out of operative position, and means responsive to the difference in pressure between the intake and output side of the pump when operating arranged to so swing said inspirator means.

11. In a recirculating self-priming centrifugal pump of the character described, inspirator means cooperating successively with the blades of the impeller as they come around arranged to inject a jet of water adjacent the impeller for entrapping air, means mounting the inspirator means for swinging out of operative position, and means responsive to the difference in pressure between the intake and output side of the pump when operating arranged to so swing said inspirator means and vice versa.

12. In a recirculating type of self-priming centrifugal pump of the character described and having a recirculating passage extending from the pump outlet space back to the inlet space, a fixed wearing plate with one side close to the impeller, means making said wearing plate removable, said plate positioned to form one wall of said recirculation passage, whereby when the

plate is removed said passage is accessible for cleaning.

13. In a recirculating type of self-priming centrifugal pump of the character described, dual means for effecting the entrapping air for exhausting the suction side comprising a recirculation passage extending from the discharge side to the intake side of the pump and means for injecting air-entrapping jets of water adjacent the impeller, and means responsive to the difference of pressures in the discharge and suction sides of the pump arranged to render said dual means ineffective when the pump is running and vice versa.

14. In a recirculating self-priming centrifugal pump having an impeller and a cut-off tongue at the point where the liquid passes from the impeller to the pump outlet, the improvement which comprises pivotally mounting said tongue for movement toward and from the pump impeller, and pump pressure actuated means moving the point of said tongue toward the impeller when the pump is primed and vice versa.

15. In a recirculating type of self-priming centrifugal pump of the character described having an impeller operating within a housing, the improvement which comprises providing two water recirculating passages formed in said housing leading from the pressure side of the pump to points in the intake side of the pump respectively adjacent opposite sides of the pump impeller for direct entry of recirculation liquid into the impeller vanes, and means operated by the difference in pressure between the intake and discharge side of the pump closing said passages when the pump is primed.

16. In a recirculating type of self-priming centrifugal pump of the character described having an impeller operating within a housing, the improvement which comprises providing two water recirculating passages formed in said housing leading from the pressure side of the pump to points in the intake side of the pump respectively adjacent the periphery of the pump impeller and adjacent the center of the impeller for direct entry of recirculation liquid into the impeller vanes, and means operated by the difference in pressure between the intake and discharge side of the pump closing said passages when the pump is primed.

17. In a recirculating self-priming centrifugal pump having an impeller and a cut-off tongue at the point where the liquid passes from the impeller to the pump outlet, the improvement which comprises pivotally mounting said tongue for movement toward and from the pump impeller, and pump pressure actuated means moving the point of said tongue toward the impeller when the pump is primed and vice versa, said last mentioned means embodying a yielding element adapting the tongue to back away from any hard object entering between the tongue and the impeller.

18. In a recirculating self-priming centrifugal pump having an impeller and a cut-off tongue at the point where the liquid passes from the impeller to the pump outlet, the improvement which comprises pivotally mounting said tongue for movement toward and from the pump impeller, and means moving the point of said tongue toward the impeller when the pump is primed and vice versa, the pivotal point of mounting said tongue being at an intermediate point in the length of said tongue so that as the point of the tongue is swung away from the impeller the opposite or rear end of the tongue will move toward the impeller.

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