

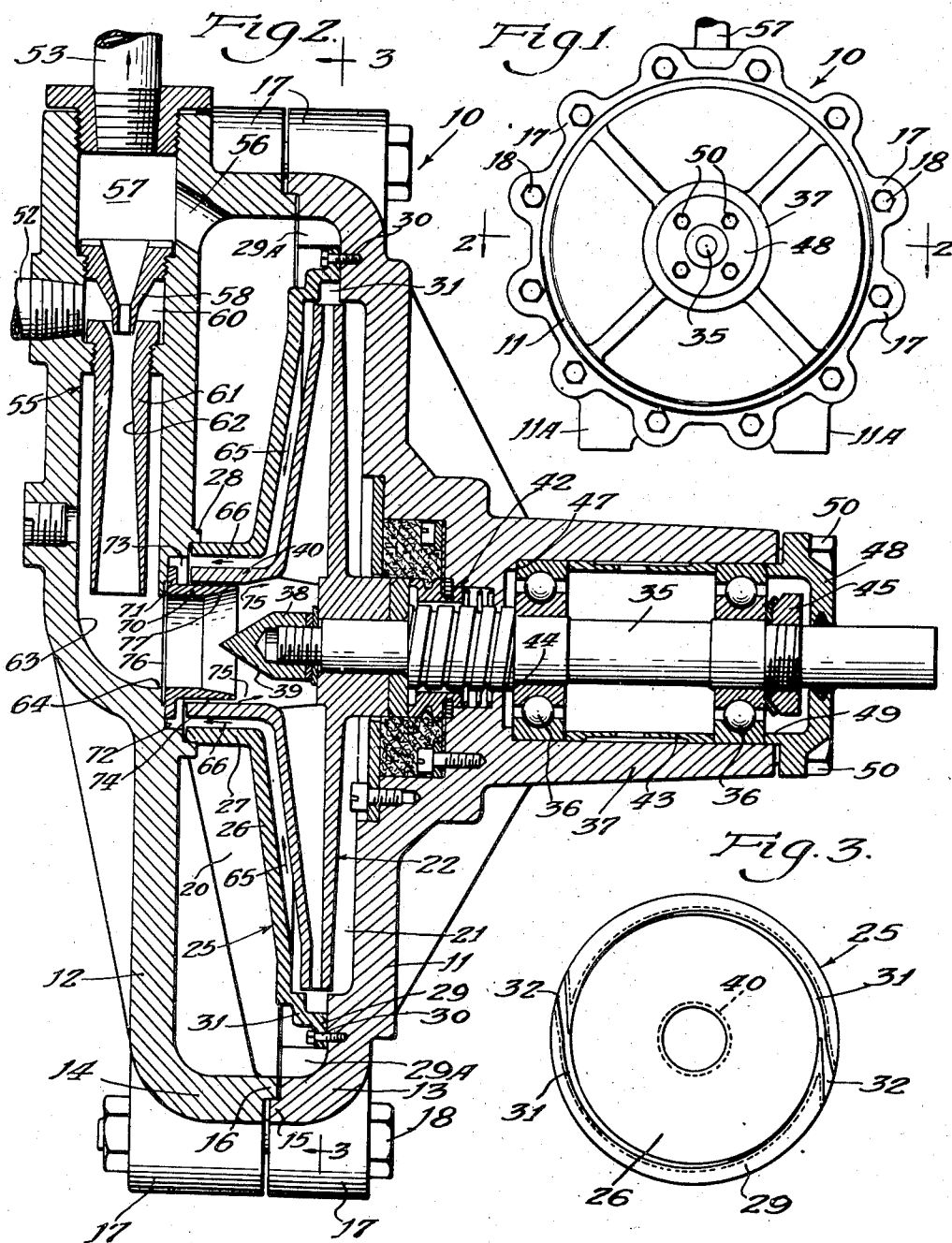
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R. H. HILL

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Inventor:
Robert H. Hill
By Wallace and Cannon
Attorneys

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PUMP

Robert H. Hill, Elgin, Ill., assignor to The Marlison Company, Elgin, Ill., a corporation of Illinois

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This invention relates to pumps and particularly to pumps of the centrifugal type.

While the problem of attaining maximum operating efficiency is of primary importance in centrifugal pumps, regardless of the specific use of such pumps, it is, of course, particularly important in those instances where the pumped liquid embodies critical characteristics which tend to disturb the desired continuity of the pumping operation. Thus, in those cases where a centrifugal pump is being used to handle a saturated liquid and to raise such liquid to a relatively high pressure, it is necessary to operate the pump at relatively high speed. Under such circumstances, the saturated liquids or other liquids are in most pumps subjected to an area or zone of reduced or relatively low pressure at the intake of the pump, and when the liquid passes from this zone of relatively low pressure and is suddenly subjected to the forces applied by the rapidly moving vanes of the impeller, the static pressure of such liquid falls to an appreciable extent. Where the liquid is in or near a saturated state, such pressure reduction may often cause a part of such liquid to vaporize and such vaporization is commonly known as cavitation. The vapor bubbles in the liquid then move with the balance of the liquid through the passages of the impeller and as the bubbles reach some point of higher pressure within the impeller or impeller chamber, the bubbles collapse quite violently so as to cause vibration of the impeller which results in a relatively short life for such impellers.

In view of the foregoing, it is an important object of this invention to enable such objectionable zones of reduced pressure at the impeller intake of centrifugal pumps to be avoided, and an object related to the foregoing is to enable this to be accomplished in a simple and expeditious manner which increases the efficiency of the pump as a whole and which does not require undue sacrifice of pump output.

It is recognized that in centrifugal pumping systems the elimination of such zones of low pressure at the impeller intake might be attained through the provision of means for feeding the supply or intake liquid to the pump impeller at a somewhat elevated pressure. One widely known expedient for attaining increased inlet pressure has been the provision of a fluid operated jet pump or injector disposed in the intake line of the centrifugal pump and operated by high pressure liquid by-passed or recirculated from the main output of the centrifugal pump. The extent of the increase in the intake pressure of the liquid

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is, in such instances, governed in a large measure by the proportion of the centrifugal pump output which is by-passed to the jet pump, but this, of course, involves sacrifice of a relatively high proportion of the output of the centrifugal pump. It is therefore a further and more specific object of this invention to minimize the extent to which the pump output must be thus sacrificed in such instances in order to attain proper fluid flow into and through the impeller of a centrifugal pump.

Other and further objects related to the foregoing are to enable the pressure of the intake liquid to be fully and efficiently utilized in causing flow of such liquid into operative relation to the pump impeller; to avoid objectionable zones of back pressure or reduced pressure in or near the intake throat of centrifugal pump impellers; and to utilize the high pressure leakage fluid within the main housing of a centrifugal pump to attain improved operation and increased efficiency of such a pump.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show a preferred embodiment and the principle thereof and which I now consider to be the best mode in which I have contemplated applying that principle. Other embodiments of the invention embodying the same or equivalent principle may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

In the drawings:

Fig. 1 is an end elevational view of a centrifugal pump embodying the features of the invention;

Fig. 2 is a plan sectional view taken substantially along the line 2—2 of Fig. 1; and

Fig. 3 is a view taken substantially along the line 3—3 of Fig. 2 and showing the plate which forms the one side of the impeller chamber and the outlets for such a chamber.

In the form chosen for disclosure herein, the invention is embodied in a centrifugal pump 10 having a sectional casing formed from a bearing or supporting section 11 and a closure section 12. The sections 11 and 12 are generally disc-like in form and have edge flanges 13 and 14 respectively formed thereon so that a narrow rim 15 on the flange 13 may fit about a narrow rim 16 formed on the flange 14 of the casing section 12. The sections 11 and 12 are provided with

a plurality of clamping lugs 17 about their outer edges and clamping bolts 18 are extended through the lug 17 to clamp the casing sections 11 and 12 together. Mounting lugs 11A are preferably provided on the lower edge of the section 11 of the pump casing. When the casing sections 11 and 12 are thus secured together, an internal pressure chamber 20 is afforded, and it should be noted that the chamber 20 might in many instances serve as an impeller chamber. In the present instance, however, the efficiency of the pump is increased and it is adapted for high pressure use through the provision of a separate or internal impeller chamber 21 located inside of the pressure chamber 20 and within which a centrifugal pump impeller 22 is rotatably supported. The impeller chamber 21 has one of its sides provided by the wall of the casing section 11, and the other wall of the impeller chamber 21 is provided by a generally plate-like member 23 which is supported upon the inner face of the casing section 11. Thus the member 23 has a main wall portion 26 thereon having a central opening therein which is defined by an axial sleeve 27, and this axial sleeve has its end engaged snugly within an annular flange 28 formed on the inner face of the casing section 12. At its outer edge, the wall 26 of the member 23 is flanged as at 29, so that this flange will fit within positioning lugs 29A formed on the inside of the casing section 11, and a plurality of cap screws 30 are passed through the extreme portion of this flange to hold the same against the inner face of the main wall of the casing section 11. The flange portion 29 is, in the present instance, arranged to have two volute portions 31 which terminate in discharge passages 32 disposed at diametrically opposite positions in flange section 29 so that as liquid under pressure is moved through the volute portions 31 and the discharge passages 32, such liquid moves into the pressure chamber 20 of the pump casing.

The impeller 22 is mounted upon the inner end of a shaft 35 which is supported by means such as ball bearings 36 in a bearing sleeve 37 extended from the outer face of the casing section 11. The impeller 22 is secured on the inner end of the shaft 35 by means including a nut 38, this nut being tapered as at 39 on its outer end so as to extend into the intake end of the impeller as this intake end is afforded by a projecting intake sleeve 40. The mounting of the shaft 35 is preferably such as to provide sealing means 42 which may take many different forms, this sealing means being located between the impeller 22 and the adjacent one of the ball bearings 36. The outer races of the ball bearings 36 are separated by a spacer sleeve 43, and a shoulder 44 on the shaft 35 adjacent to the inner one of the ball bearings engages the inner race of this bearing. A nut 45 on the shaft 35 engages the inner race of the other ball bearing so as to fix the shaft in a predetermined position with respect to the bearings 36, and these bearings are held in a predetermined position within the bearing sleeve 37 so as to accurately position the impeller in an axial sense. Thus the outer race of the inner one of the two bearings 36 engages a shoulder 47 within the sleeve, while a cap ring 48 has an internal axial flange 49 engaging the outer surfaces of the outer race of the other bearing 36. The cap plate 48 is held in place on the end of the bearing sleeve 37 by cap screws 50.

As hereinbefore pointed out, the pump of the

present invention is particularly adapted for the pumping of saturated liquids so as to deliver such liquids at a relatively high pressure, and this is best accomplished by supplying the saturated liquid to the intake sleeve 40 of the impeller at a somewhat elevated pressure, so as to minimize vaporization of the liquid at the intake of the impeller 22. For this purpose, a jet type of means may be provided for feeding the liquid from the main pump inlet to the intake of the impeller. Thus, as shown in Fig. 2 of the drawings, the liquid is supplied to the pump by an inlet pipe 52, while liquid under pressure is discharged from the pressure chamber 20 to a discharge pipe 53, and a part of the liquid from the pressure chamber 20 is by-passed and utilized in a jet type of pump or injector 55 to raise the pressure of the incoming liquid as it passes from the inlet 52 to the impeller 22. In the present instance, the jet pump or injector 55 is located directly upon the pump casing, but it will be recognized that in some circumstances the jet may be remotely located with respect to the centrifugal pump. Thus, in the present instance, the liquid under pressure in the pressure chamber 20 is discharged through a passage 56 into an outlet chamber 57 formed in the casing section 12 adjacent to the outlet pipe 53. One wall of the outlet chamber 57 is afforded by a jet member 58 which discharges into an inlet chamber 59 which is supplied with liquid from the inlet pipe 52. In the opposite wall of the inlet chamber 59 a Venturi fitting 61 is provided, and this fitting is so positioned that the jet 58 discharges into the intake throat of the Venturi passage 62 thereof. The Venturi passage 62 extends longitudinally through an initial pressure chamber 63 formed in the wall of the casing section 12, and adjacent the discharge end of the Venturi passage 62 the initial pressure chamber 63 is formed to provide a lateral outlet opening 64 which is co-axial with and directed toward the inlet sleeve 40 of the impeller 22. Thus a part of the high pressure output of the pump impeller 22 acts through the jet 58 and the venturi 61 to increase the pressure of the liquid as it passes from the inlet chamber 59 to the initial pressure chamber 62, and because of this, the tendency of the saturated liquid to change in part to its gaseous form at the intake sleeve 40 of the impeller may be reduced and in many instances eliminated.

It will be evident, however, that in centrifugal pumps of the kind herein disclosed, there is necessarily a relatively large clearance within the impeller chamber 21 and about the impeller 22, and because of this, there is an inevitable leakage flow of high pressure liquid along the radially inward path indicated by the arrow 65 in Fig. 2 of the drawings. Such flow of high pressure liquid continues in a radially inward direction to a point where the liquid flows along the path indicated by the arrow 66 and longitudinally in the annular space between the sleeve 27 and the intake sleeve 40 of the impeller. Such high pressure leakage liquid is thus directed generally toward the low pressure intake of the pump impeller, and in centrifugal pumps as heretofore provided, this flow of liquid has been in a direction opposite to the direction of flow of the incoming liquid flowing to the intake sleeve 40 of the pump impeller. This has necessarily resulted in turbulence at the intake end of the pump impeller, with the resultant loss of considerable energy and with a tendency to create areas or zones of low pressure within which a saturated liquid

may return at least in part to its gaseous or vapor state.

In accordance with the present invention, these objectionable results of the leakage of high pressure liquid are avoided, and such liquid is effectively utilized to increase the efficiency of the pump as a whole. To this end, control means are provided for so governing and directing the flow of high pressure leakage liquid that it avoids turbulence and acts as a jet to increase the pressure of the incoming liquid as it enters the impeller sleeve 40. Thus, as shown in Fig. 2 of the drawings, this control means takes the form of a deflecting and control sleeve 70 which is extended from the opening 64 into the inlet sleeve 40 of the impeller 22. The sleeve 70 has an outwardly directed annular flange 71 at one end thereof which is seated loosely in a counterbore 72 formed about the opening 64, and the sleeve 70 extends from the counterbore into the sleeve 40 for a substantial distance. The flange 71 is so proportioned that when it is seated against the bottom of the counterbore 72, a relatively large clearance space 73 is provided between the flange 71 and the adjacent end of the sleeve 40. Thus the high pressure leakage liquid may pass radially inwardly to the outer surface of the sleeve 70, and by reason of the loose fit of the sleeve 70 in the sleeve 40, an annular passage 74 is afforded therebetween through which the liquid may pass toward the right in Fig. 2 so as to be discharged within the impeller sleeve 40 in the direction indicated by the arrows 75 in Fig. 2. The pressure of the leakage liquid in the space 73 and against the adjacent face of the flange 71 serves to seat the flange firmly in the bottom of the counterbore 72, and this action is aided by an annular recess 76 formed in the bottom of the counterbore 72 so as to expose a substantial portion of the other face of the flange 71 to the relatively lower pressure afforded at the opening 64.

The flow of the high pressure leakage liquid through the annular passage 74 between the sleeves 70 and 40 serves of course to automatically center the loosely mounted sleeve 70 with respect to the rotating intake sleeve 40 of the impeller, and hence an annular jet of high pressure leakage liquid is discharged within the inlet sleeve 40 in the same direction of flow as the lower pressure intake liquid from the opening 64. The action of this jet is to increase the pressure of the incoming liquid, and this is facilitated by the provision of an outward taper 77 on the inner surface of the sleeve 70, thereby affording a narrow inner end edge on the sleeve. The action of the annular jet of liquid, which is thus afforded, not only obviates the pressure or energy losses which were incident to the turbulence normally created at this point in prior centrifugal pumps, but even more important, it results in the efficient utilization of such high pressure leakage fluid so as to increase the pressure of the intake fluid and produce smooth flow of such intake fluid into and through the impeller. Hence the efficiency of the pump as a whole is materially increased.

The action of the flow control means in eliminating turbulence and energy losses at the impeller intake, and in increasing the flow and pressure of the intake liquid at this point is of particular utility in a jet supplied centrifugal pump, for in such a case the beneficial action of the flow control means makes it possible to reduce the amount of the pump output used for operation of the jet. Moreover, in those instances where a jet

pump is not employed in the intake line, the flow control means of the present invention materially increases the efficiency of the pump.

From the foregoing, it will be evident that the present invention enables the efficiency of centrifugal pumps to be increased, and that this increase of efficiency is attained in such a manner that high pressure and high speed pumping of saturated liquids is facilitated. Moreover, the elimination of flashing or vaporization in the high pressure pumping of saturated liquids results in increased life of the pump impeller.

Thus, while I have illustrated and described a selected embodiment of my invention, it is to be understood that this is capable of variation and modification and I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

I claim:

1. In a centrifugal pump, a housing including walls having inlet and outlet openings and providing an impeller chamber with an elongated axial opening extended thereto from one side thereof and having at least one discharge opening therein spaced radially outwardly from said axial opening, bearing means associated with said housing on the side thereof opposite from said axial opening, a drive shaft supported by said bearing means and extended into said chamber, a centrifugal impeller fixed on said shaft within said impeller chamber and having an axial inlet sleeve extended into said axial opening and also having outwardly extended passages originating in said inlet sleeve and discharging into said impeller chamber adjacent to the outer edge thereof, said impeller having an axial nose with a cylindrical portion disposed opposite and in inwardly spaced relation to the inner ends of said outwardly extended passages and said nose terminating in a tapered end disposed within said inlet sleeve, means affording a liquid supply passage and for supplying liquid to said inlet sleeve of said impeller, and a flow directing sleeve extending from said axial opening and into said inlet sleeve beyond said tapered end of said nose to afford an annular jet of high pressure liquid within said inlet sleeve and flowing in the same direction as the liquid flowing through said flow directing sleeve from said axial opening.

2. In a centrifugal pump, a housing including walls providing an impeller chamber with an elongated axial opening extended thereto from one side thereof and having at least one discharge opening therein spaced radially outwardly from said axial opening, bearing means associated with said housing on the side thereof opposite from said axial opening, a drive shaft supported by said bearing means and extended into said chamber, a centrifugal impeller fixed on said shaft within said impeller chamber and having an axial inlet sleeve extended into said axial opening and also having outwardly extended passages originating in said inlet sleeve and discharging into said impeller chamber adjacent to the outer edge thereof, means affording a liquid supply passage terminating in a discharge end face disposed in a plane normal to the rotature axis of said impeller, and loosely mounted deflecting sleeve extended axially into said inlet sleeve of said impeller to deflect any high pressure leakage liquid flowing from said chamber so that such liquid passes into said inlet sleeve of said impeller in the same direction as the low pressure liquid

supplied thereto from said liquid supply passage, said deflecting sleeve having an outwardly extended annular flange at the inlet end thereof and subjected to the pressure of said high pressure leakage liquid to seal said flange against said discharge end face of said liquid supply passage.

3. In a centrifugal pump, a housing including walls providing an impeller chamber with an elongated axial opening extended thereinto from one side thereof and having at least one discharge opening therein spaced radially outwardly from said axial opening, bearing means associated with said housing on the side thereof opposite from said axial opening, a drive shaft supported by said bearing means and extended into said chamber, a centrifugal impeller fixed on said shaft within said impeller chamber and having an axial inlet sleeve extended into said axial opening and also having outwardly extending passages originating in said inlet sleeve and discharging into said impeller chamber adjacent to the outer edge thereof, means affording a liquid supply passage and for supplying liquid to said inlet sleeve of said impeller, and a loosely mounted sleeve substantially registered with said supply passage and extending into said inlet sleeve to direct high pressure leakage fluid passing through said axial opening from said impeller chamber and form such high pressure leakage fluid into an annular jet of high pressure liquid within said inlet sleeve and flowing in the same direction as the liquid from said supply passage.

4. In a centrifugal pumping system, a housing including walls having an inlet opening and an outlet opening and providing an impeller chamber with an axial inlet passage extended thereinto from one side thereof and terminating in an end face disposed normal to said inlet passage and also having at least one discharge opening therein spaced radially outwardly from said axial opening and connected to said outlet opening, bearing means formed on said housing on the side thereof opposite from said axial inlet passage, a drive shaft supported by said bearing means and extended into said chamber, a centrifugal impeller fixed on said shaft within said impeller chamber and having an axial inlet sleeve extended toward said axial inlet passage and

having outwardly extended passages originating within said inlet sleeve and discharging into said impeller chamber adjacent to the outer edge thereof, and a loosely mounted controlling and deflecting sleeve extended axially from said inlet passage into said inlet sleeve of said impeller to deflect any high pressure leakage liquid flowing from said chamber so that such liquid passes into said inlet sleeve of said impeller in the same direction as the low pressure liquid supplied thereto from said liquid supply passage, to thereby minimize the volume of by-passed high pressure liquid required by said jet pump to produce the desired flow of liquid into said impeller, said deflecting sleeve having an outwardly extended annular flange at the inlet end thereof and subjected to the pressure of said high pressure leakage liquid to seal said flange against said discharge end face of said liquid supply passage, said end face having a rabbeted groove cut therein to expose a substantial portion of the adjacent face of the flange to the low pressure liquid in said inlet passage.

ROBERT H. HILL.

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