

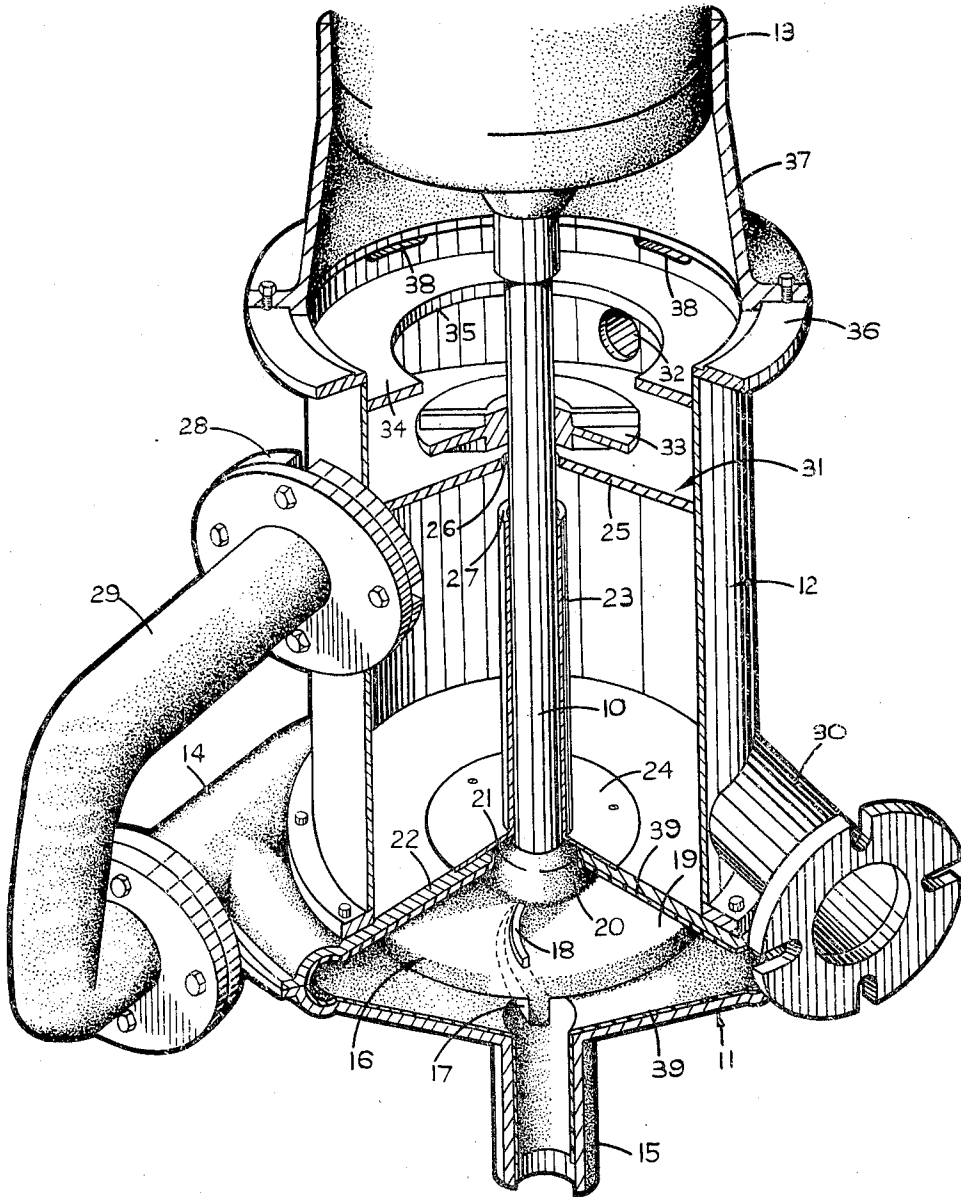
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PUMPS

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3,211,101
PUMPS

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This invention relates to pumps and more particularly to centrifugal pumps for liquid of the type in which the running joint between the impeller shaft and the impeller housing is effected by means of a hollow cylinder of liquid in a clearance between the exterior of the shaft and the internal surface of a sleeve through which the shaft passes.

Such pumps are used for pumping liquids containing abrasive material and two examples of such pumps are disclosed in British Patent No. 840,671 and co-pending patent application Serial No. 262,980 filed by Stewart Ives Ashworth on March 5, 1963, now U.S. Patent No. 3,160,106.

In both these prior arrangements, the liquid used to make the running joint is the liquid which is being pumped. In the arrangement described in British Patent No. 840,671 the liquid for the joint is drawn directly from the impeller casing and is not substantially clarified, although blades are provided on the back face of the impeller which throw out any large abrasive particles in the liquid flowing towards the sleeve. In the arrangement described in application Serial No. 262,980, means is provided for substantially clarifying the liquid which is to be used to make the running joint. This means comprises a vortex chamber in which a vortex is obtained by means of small blades on the back face of the impeller. Liquid flows from the centre of the vortex up the clearance between the sleeve and the shaft into an overflow chamber. While this arrangement is generally satisfactory it does have certain limitations. The secondary flow of liquid from the vortex chamber back into the impeller housing causes undesirable turbulence within the impeller housing and to some extent impedes the separation of abrasive from the liquid which is intended to be used as the seal within the sleeve. A further limitation of the arrangement described in said co-pending application is that, since the vortex chamber is open to the impeller, the speed of the vortex in the vortex chamber is controlled by the speed of the impeller and cannot rotate faster than the impeller, this can impede abrasive separation.

It is an object of the present invention to provide a centrifugal pump for liquid of the type in which the running joint between the impeller shaft and the impeller housing is effected by means of a hollow cylinder of liquid in the clearance between the exterior of the shaft and the internal surface of a sleeve through which the shaft passes and of which substantially overcomes the above disadvantages.

According to the invention, there is provided a pump comprising an impeller housing having a central inlet and a peripheral outlet but being otherwise closed, a vortex chamber having a peripheral inlet and an outlet, means for connecting the outlet of the impeller housing to the inlet of the vortex chamber, an impeller rotatable

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in the housing to draw liquid through the housing inlet and deliver it through the housing outlet to said connecting means, an impeller shaft secured to the impeller and extending therefrom through an aperture in the wall of the housing and through the centre of the vortex chamber, and a sleeve surrounding the shaft with clearance and secured at one end to the impeller housing around said aperture and opening at the other end in the vortex chamber centrally thereof and in a position such that liquid flows from the centre of the vortex along the sleeve into the impeller housing forming a liquid seal between the shaft and the sleeve.

The important distinction of the pump according to the present invention from the previously proposed pumps mentioned above, is that in pumps embodying the present invention the liquid forming the seal flows from the vortex chamber into the impeller housing whereas in the previously mentioned pumps the liquid forming the seal flows out of the impeller housing into the sleeve. In the majority of cases, the whole of the output of liquid from the impeller housing will be fed through the vortex chamber. Since the vortex chamber is not open to the impeller, the speed of the vortex in the chamber will not be retarded by the impeller. Moreover, there will be no secondary circulation in opposition to the main circulation. The main circulation is from the inlet of the impeller housing centrifugally outwardly to the outlet thereof and the liquid which passes down the clearance between the sleeve and the shaft will also move centrifugally outwardly in the impeller housing when it reaches the housing. It follows that the main flow and the auxiliary sealing flow will be in the same direction within the impeller housing. This will reduce unnecessary turbulence within the impeller housing and will cut down the wear in the housing.

The invention will now be described by way of example with reference to the accompanying drawing which is a cut-away perspective view of a pump embodying the invention.

Referring now to the drawing, the pump is arranged with its impeller shaft 10 vertical and with its impeller housing 11 at the bottom of an assembly comprising the impeller housing, a vortex chamber 12 and a driving motor 13 for the pump. The vortex chamber 12 is interposed between the impeller 11 housing and the driving motor 13. The impeller housing is of conventional form and is a volute with a peripheral tangential outlet 14 and an inlet 15 co-axial with the axis of the shaft 10. A main impeller 16, having main vanes 17 on one face thereof, is secured to the lower end of the impeller shaft 10 for rotation within the housing 11, the main vanes 17 face the inlet 15. On the face of the impeller remote from the inlet are auxiliary vanes 18 which are of approximately half the length of the main vanes 17 and about a quarter of their depth. In operation of the pump, the action of the auxiliary vanes 18 oppose the action of the main vanes 17 for reasons which will be discussed hereinafter.

The upper face 19 of the main impeller is provided with a boss 20 which is received with clearance in an aperture 21 in the upper wall 22 of the impeller housing. The clearance communicates with the inner ends of the auxiliary vanes 18 at its lower end and at its upper end the clearance communicates with the lower end of a sleeve 23 which extends upwardly from the upper wall of the impeller housing. At its lower end the

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sleeve is formed with a flange 24 which is secured to the upper wall of the impeller housing.

Secured to the exterior of the upper wall of the impeller housing 22 is the generally cylindrical vortex chamber 12 and this surrounds, and is co-axial with the sleeve 23. The vortex chamber is closed at its lower end by the upper wall 22 of the impeller housing and is closed at its upper end by an annular wall 25 having a central aperture 26 therein through which the shaft 10 passes with clearance. The upper end 27 of the sleeve 23 is adjacent to but spaced below the upper wall 25 of the vortex chamber.

The vortex chamber is generally cylindrical and is of an internal diameter substantially equal to the diameter of the impeller. The vortex chamber has a peripheral tangential inlet 28 adjacent its upper end and this tangential inlet is connected by a U-tube 29 to the outlet 14 from the impeller housing so that all the liquid which leaves the impeller housing passes through the U-tube into the vortex chamber. A tangential outlet 30 from the vortex chamber is provided adjacent to the lower end thereof.

Above the vortex chamber is provided an overflow chamber 31 which is of a diameter equal to the vortex chamber and has a peripheral outlet 32. Mounted on the shaft 10 within the overflow chamber is a four-bladed scavenging impeller 33. The upper wall 34 of the overflow chamber is annular and the aperture 35 in said wall is of greater diameter than the scavenging impeller 33. At the top of the overflow chamber is a flange 36 to which the lower end of a conical sleeve 37 supporting the motor is bolted. Ventilation openings 38 are provided in the peripheral wall of the overflow chamber above the wall 34. The impeller housing 11 is provided with a rubber lining indicated at 39 and the main impeller is also covered with rubber.

The operation of the pump is as follows, as the motor 13 is energised, it will rotate the shaft 10 thus rotating the scavenging impeller 33 in the overflow chamber 31 and the main impeller 16 in the impeller housing 11. Liquid containing abrasive will be drawn into the inlet 15 of the impeller housing and will be flung outwardly by the main vanes 17 of the impeller and will move outwardly in the volute and out of the tangential outlet 14. The liquid will then pass around the U-tube 29 into the inlet 28 to the vortex chamber 12. Since the inlet 28 to the vortex chamber is tangential, the liquid in the vortex chamber will swirl around the chamber in the form of a vortex having the sleeve 23 at the centre thereof and will then flow out of the chamber through the outlet 30 at the bottom thereof.

A substantial clearance is left between the exterior of the shaft 10 and the internal surface of the sleeve 23 and liquid from the centre of the vortex passes down this clearance into the impeller housing 11. The vortex is such that the majority of any abrasive particles carried in the liquid are flung to the outer wall of the vortex chamber and pass through the outlet 30 thereof. The inner core of the vortex will consist of substantially clear liquid and it is this clear liquid which passes down the clearance to form the running joint between the shaft 10 and the sleeve 23.

The liquid in the vortex is forced to whirl in circles of decreasing diameter which not only separates the abrasive from the liquid as mentioned above but also generates by centrifugal action a back pressure which is only a little less than the pressure of the liquid discharged from the impeller housing. This back pressure effectively regulates the flow of liquid through the clearance between the shaft 10 and the sleeve 23. The upper end 27 of the sleeve is so positioned, relative to the inlet to the vortex chamber and to the upper wall thereof, that it will lie in the central column of clear liquid of the vortex and will not be exposed to air.

Some of this clear liquid will, unavoidably flow through

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the aperture 26 in the upper wall of the vortex chamber into the overflow chamber 31. The scavenging impeller 33 in the overflow chamber effectively prevents the liquid flowing further up the shaft into the motor and the bearings thereof and the blades of the scavenging impeller 33 fling the liquid in the overflow chamber to the outer wall thereof so that the liquid passes through the outlet 32.

The auxiliary vanes 18 on the upper face of the impeller oppose the main vanes 17 and thus maintain the necessary pressure difference for the clear liquid to pass down the clearance between the sleeve 23 and the shaft 10 and enter the impeller housing.

The exterior of the shaft is given a smooth finish so as to eliminate, so far as possible, secondary whirl of the liquid in the clearance and this liquid helps to reduce vibration of the long impeller shaft.

The arrangement described has the advantages enumerated above that the flow of the sealing liquid is substantially free from abrasive particles which cause unnecessary wear. Moreover, since the vortex chamber is not in communication with the impeller, there is no brake on the speed of whirl of the vortex in the chamber. It is thus possible to obtain very efficient separation of the abrasive from the liquid.

The liquid discharged from the overflow chamber may be returned to the inlet of the pump or otherwise disposed of. In the embodiment described where all the liquid discharged from the impeller housing passes through the vortex chamber, the effective outlet of the pump is the outlet 30 from the vortex chamber. In an alternative arrangement it would be possible to pass a substantial part of the output from the impeller housing through the vortex chamber and to take the remainder of the output directly from the impeller housing.

What we claim then is:

1. A pump comprising, an impeller housing having a central inlet and a peripheral outlet but being otherwise closed, a vortex chamber having a peripheral inlet and an outlet, means for connecting the outlet of the impeller housing to the inlet of the vortex chamber, an impeller rotatable in the housing to draw liquid through the housing inlet and deliver it through the housing outlet to said connecting means and impeller shaft secured to the impeller and extending therefrom through an aperture in the wall of the housing and through the centre of the vortex chamber, and a sleeve surrounding the shaft with clearance and secured at one end to the impeller housing around said aperture and opening at the other end in the vortex chamber centrally thereof and in a position such that liquid flows from the centre of the vortex along the sleeve into the impeller housing forming a liquid seal between the shaft and the sleeve.

2. A pump as claimed in claim 1, including main and auxiliary vanes on the impeller, the main vanes facing the inlet of the housing to impel liquid from said inlet to the outlet of the housing and the auxiliary vanes facing said aperture to assist flow of liquid from the chamber to the housing through the sleeve.

3. A pump as claimed in claim 1, including means for securing one end of the vortex chamber to the impeller housing so that the chamber and housing are co-axial, and wherein the outlet from the chamber is adjacent said one end and the inlet to said chamber is adjacent to the end of the chamber remote from said one end.

4. A pump as claimed in claim 3, including an overflow chamber at said remote end of the vortex chamber, said overflow chamber communicating with the vortex chamber through a clearance surrounding the shaft, and deflector means on the shaft in the overflow chamber to prevent liquid flowing along the shaft past the deflector means.

5. A pump as claimed in claim 4 including a bladed impeller forming part of said deflector means to direct

liquid flowing along the shaft to the periphery of the over-flow chamber.

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DONLEY J. STOCKING, *Primary Examiner.*