Nov. 17, 1970 R. W. ALLERTON 3,540,834

APPARATUS FOR PUMPING LIQUIDS CONTAINING SOLIDS

Filed Sept. 12, 1968 2 Sheets-Sheet 1

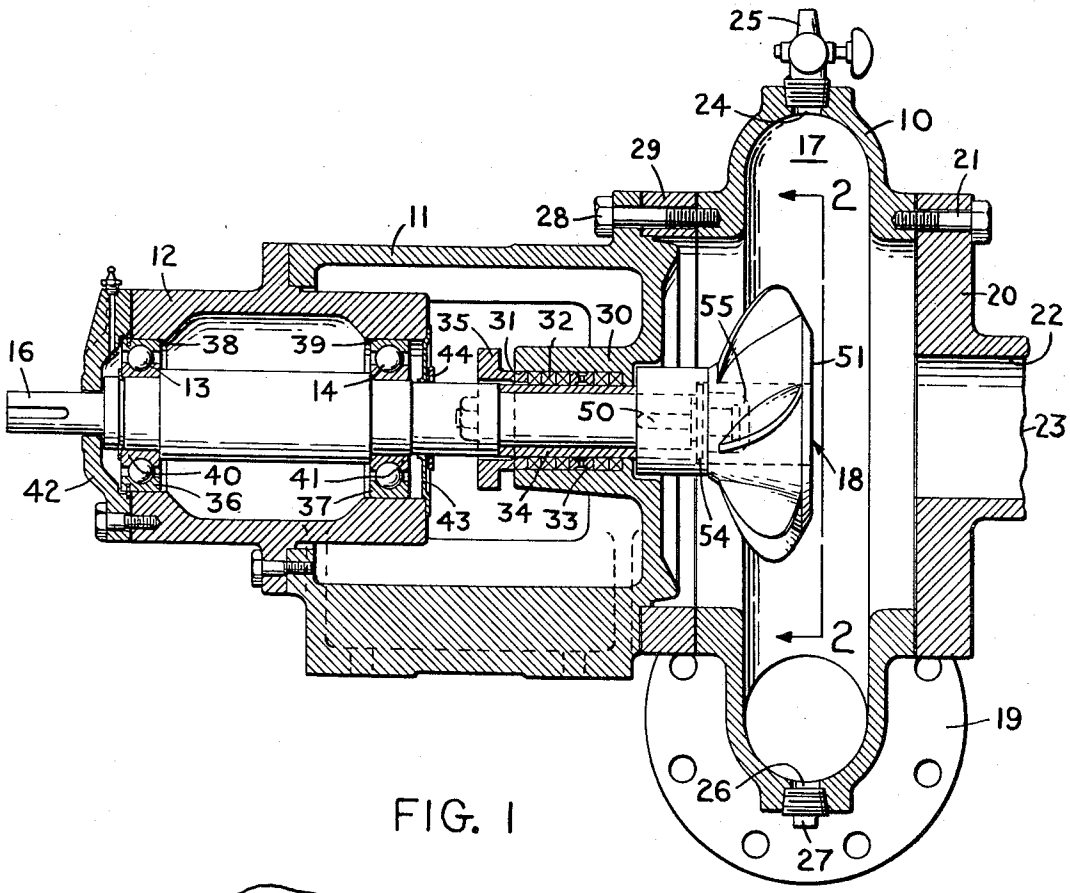


FIG. 1

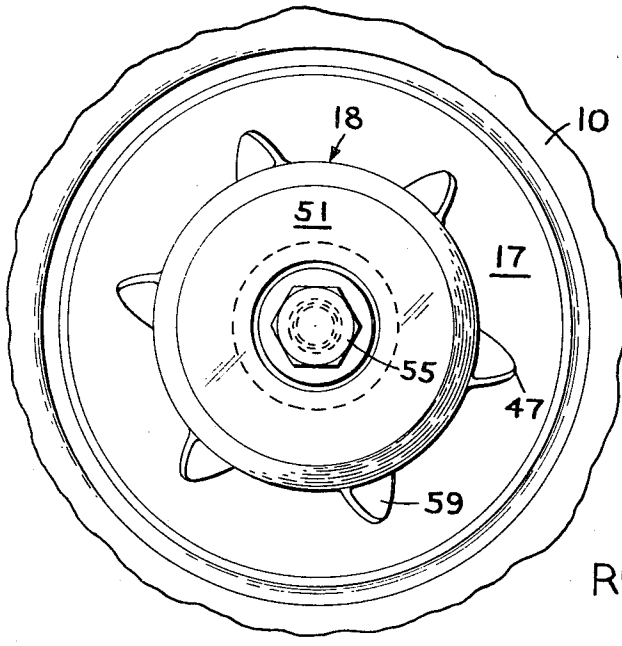


FIG. 2

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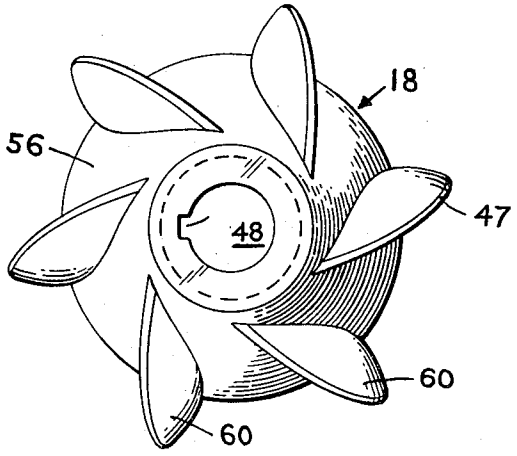


FIG. 4

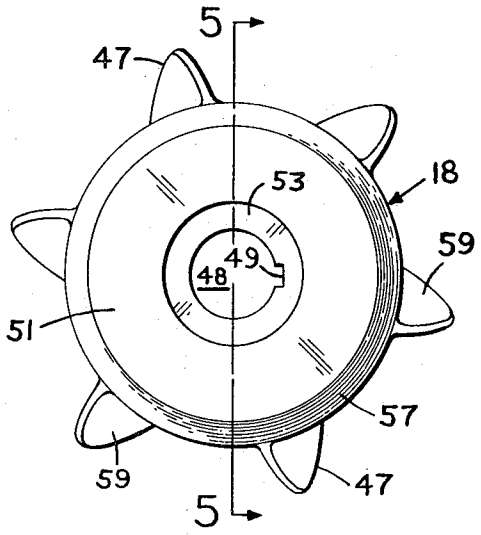


FIG. 3

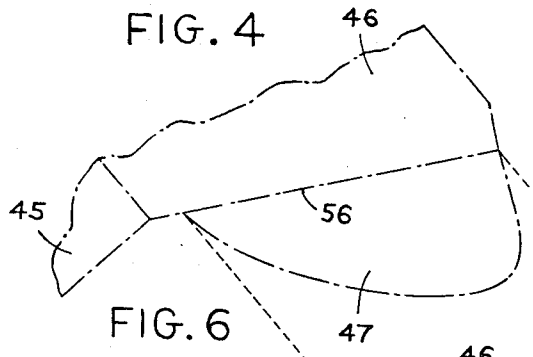


FIG. 6

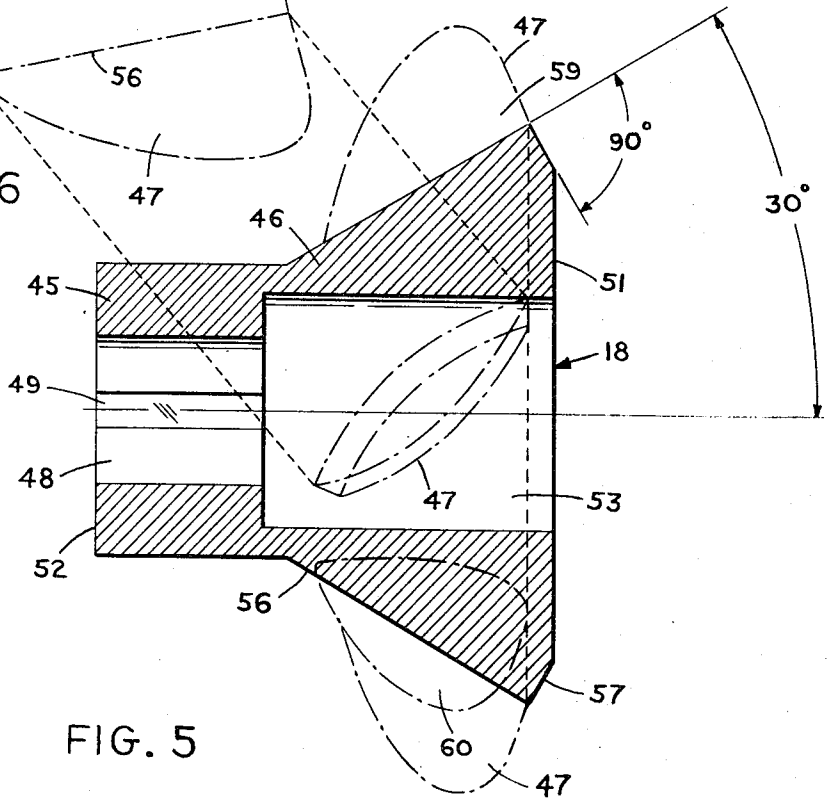


FIG. 5

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APPARATUS FOR PUMPING LIQUIDS CONTAINING SOLIDS

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Int. Cl. F04d 1/00, 29/18
U.S. Cl. 415—204 12 Claims

ABSTRACT OF THE DISCLOSURE

A pump for handling fluid containing solids wherein the pump impeller has vanes formed on the backside thereof and therefor takes its suction from the backside of the pump casing. Solids, heavier than the fluid, are centrifuged outward in the pump casing and passed through the pump discharge without contacting the impeller vanes. The discharge from the pump impeller is directed in a whirling motion into the stream containing solids providing momentum to this stream and further preventing solids from contacting the impeller.

BACKGROUND OF THE INVENTION

This invention relates generally to centrifugal pumps and more particularly to pumps handling fluids containing solids.

The problems encountered heretofore in pumping fluids containing solids are essentially as follows:

Solids become entrapped in the pump casing or between the pump casing and the impeller; and

Solids contacting the impeller and the impeller vanes cause erosion and damage to the impeller,

In a system where the fluid acts merely as a carrier for the solids, the solids may be damaged.

When solids become entrapped in the pump casing, the pumping capacity is reduced, or in some instances, may result in no flow through the pump thereby causing overheating and eventual pump failure.

Where the solids become entrapped between the impeller and the pump casing thereby preventing the impeller from rotating, the pump capacity will drop to 0, the impeller may break off from the impeller hub, or the drive means for the pump may stall and overheat.

Constant impingement on the impeller and impeller vanes of solids such as stones, gravel, sticks, etc. and the eroding effect of the impingement will obviously cause an eventual loss in capacity, head and efficiency of the pump.

Where the fluid acts merely as a carrier for solids which have an end use after being pumped, the solids may become damaged in the pump casing by contacting the impeller or by becoming wedged between the impeller and the pump casing.

The present invention overcomes the above outlined problems by providing an impeller with vanes and an impeller inlet on the backside of the impeller such that the impeller takes its suction from the rear of the pump casing away from the main stream containing solids, and discharges a stream of fluid, in a whirling motion, into the stream of liquid containing solids thereby providing momentum to impart pumping action to the stream.

Solids, heavier than the liquid are centrifuged outward and are promptly passed out through the pump discharge nozzle.

PRIOR ART

Pertinent prior art patents are U.S. Pats. 3,171,357; 2,635,548; and 2,785,930.

Patent No. 3,171,357 discloses a solids handling pump wherein an annular vortex is created in front of the impeller positioned at the rear of the pumping chamber. A shroud, on the impeller, or as part of the pump casing wall, is required to direct the liquid leaving the impeller back towards the center of rotation.

Patent No. 2,635,548 discolses a solids handling pump in which an impeller, positioned in the rear wall of the pump housing substantially outside the swirl chamber, does not produce a vortex but merely imparts energy to a revolving liquid mass.

Patent 2,785,930 has a pumping chamber construction similar to Patent No. 2,635,548 but feeds liquid to be pumped through an axial bore in the impeller.

None of the above listed prior art patents discloses the unique structure of the present invention whereby an impeller is provided with impeller vanes and an impeller inlet on the back of the impeller away from the pump inlet, and whereby the discharge from the impeller is into the solids bearing stream thereby providing momentum and pumping action to this stream.

SUMMARY OF THE INVENTION

Thus, the present invention covers an effective means for pumping liquids containing solids including a pump casing having a pumping chamber formed therein, a shaft rotatably mounted and extending through the pump casing into the pumping chamber, and an impeller, having impeller vanes and an impellere inlet on the backside thereof, rotatably mounted on the shaft and disposed within the pumping chamber such that solids are prevented from impinging on the impeller vanes. Solids, which are heavier than the liquid, are, by centrifugal force, centrifuged outward in the pumping chamber, and are passed out through the discharge nozzle aided by the momentum imparted to this stream by the stream of fluid discharging from the impeller.

Accordingly, it is an object of this invention to provide means for effectively pumping liquids containing solids.

Another object of the invention is to provide a solids handling pump wherein the impeller is not contacted by the solids being pumped.

Another object of the invention is to provide a pump wherein solids cannot become entrapped in the pump casing.

Still another object of the invention is to provide a pump wherein solids cannot become entrapped between the pump casing and the impeller.

These and other objects and advantages of the invention are believed made clear by the following description thereof taken in conjunction with the accompanying drawings wherein:

IN THE DRAWINGS

FIG. 1 is a sectional elevation of the present invention diseclosing the pump casing, impeller, shaft, stuffiing box head, and the bearing support frame.

FIG. 2 is a section taken on line **2—2** of FIG. 1.

FIG. 3 is a front elevation of the impeller of the invention.

FIG. 4 is an elevation of the rear of the impeller shown in FIG. 3.

FIG. 5 is a section taken on line **5—5** of FIG. 3.

FIG. 6 is a projected view of the vane shown in phantom in FIG. 5.

Referring now to FIGS. 1 and 2 the pump assembly employing the novel impeller of the invention is seen comprising essentially a pump casing **10**, a stuffing box head **11** associated with the pump casing to prevent leakage of pumped fluid therefrom, a bearing frame **12** for supporting bearings **13** and **14**, secured to stuffing box head **11**, and a drive means (not shown) such as an elec-

tric motor or gasoline engine, operatively associated with a shaft **16** for driving the shaft which extends through bearing frame **12**, stuffing box head **11**, and pump casing **10** into a pumping chamber **17** where it rotatably supports the impeller **18**.

Pump casing **10**, of the volute type and generally circular in cross-section, is designed to pass large diameter solids through a discharge nozzle **19** formed integrally thereon tangent to the casing circumference and vertically spaced from the casing horizontal center line. The suction flange **20** is secured to the pump casing **10** in any suitable manner, in this instance by a plurality of bolts **21**, and has an opening **22** extending therethrough for receiving a suction pipe **23** which is operatively associated at its other end with a source of fluid containing solids to be pumped (not shown).

An opening **24** on top of pump casing **10** is threaded to receive a petcock **25** for venting the casing when required, such as for priming of the pump, and a similar opening **26** is provided at the lowest point of the casing for receiving a plug **27** to provide a means for draining the casing when required, for instance prior to storage.

Formed within pump casing **10** and bounded by suction flange **20** and the inboard end to stuffing zox head **11** is a pumping chamber **17** in which impeller **18** is rotatably supported by shaft **16** for imparting pumping action to the fluids having solids entrained therein as will be described under "Operation."

Stuffing box head **11**, shown as being secured to pump casing **10** by a plurality of through bolts **28**, is axially displaced from the casing by means of a casing spacer **29** disposed therebetween. The axial position of the impeller **18** in pumping chamber **17** is determined by the thickness of this spacer which can be made thicker or thiner or entirely omitted depending upon the desired axial position of the impeller.

Formed as part of stuffing box head **11** is an axially extending, generally cylindrically shaped member **30** disposed about the shaft **16** and having an annular space **31** formed therein for receiving a plurality of packing rings **32** and a split seal cage **33** to prevent leakage along the shaft of fluid being pumped. A shaft sleeve **34** rotatably disposed about the shaft **16** between the shaft and the packing rings to prevent scoring of the shaft by the packing, and a packing gland **35** dimensioned to slidably engage annular space **31** to further contain the packing rings, are also provided, all as will be familiar to those skilled in this art.

Referring again briefly to bearing frame **12**, the outer races **36** and **37** of bearings **13** and **14** are secured, as by press fit, in annular spaces **38** and **39** thereof and inner races **40** and **41** are disposed about shaft **16** for rotation therewith. Bearing covers **42** and **43** are provided at the respective ends of bearing frame **12** for protecting the bearings from outside contamination such as dirt, dust, and moisture, and in addition, a water shield **44** is provided outboard of bearing **14** for further protecting this bearing against any leakage of fluid that may occur past packing gland **35**.

Bearing frames such as described above are well known to persons skilled in this art and therefore will need no further explanation.

Referring now to FIGS. 3–6 the unique impeller of the invention, of the single suction, fixed flow type, is shown generally at **18** comprising a hub portion **45**, a generally conical shaped member **46** extending axially forward of the hub, integral therewith, and six arcuately spaced vanes **47** formed on conical shaped member **46** for imparting pumping action to the fluids in pumping chamber **17**.

Hub portion **45**, cylindrical in shape, has an axial bore **48** extending therethrough for mounting the impeller on shaft **16** for rotation therewith in pumping chamber **17**. A keyway **49** formed in bore **48** extends the axial length thereof for receiving a key **50** to lock the impeller in rotative assembly with shaft **16** as best seen in FIG. 1.

Formed integrally with hub portion **45** and extending axially forward thereof is generally conically shaped member **46** terminating in a radial planar face **51** parallel to and remote from the rear face **52** of hub portion **45**. An axially extending cylindrical bore **53** symmetrical about the impeller horizontal center line, and of larger diameter than axial bore **48** of hub portion **45** extends through conical member **46** terminating at one end at radial planer surface **51** and at the other end communicating with axial bore **48**. As clearly shown in FIG. 1 this construction allows for the assembly of impeller washer **54** and impeller nut **55** on shaft **16** after impeller **18** is mounted thereon and locked in position by key **50**.

As best seen in FIG. 5, slant surface **56** of conical member **46** makes an angle of 30° with the horizontal center line of impeller **18** and slopes from the hub portion **45** towards the radial planar face **51**. Planar face **51** in turn is chamfered as shown at **57** sloping rearward and making an angle of 90° with slant surface **56**.

Formed on slant surface **56** are six arcuately spaced vanes **47** for providing impelling action to fluid entering the impeller from the hub end remote from suction flange **20** of pump casing **10**. Vanes **47** can be formed integrally with conical member **46** or can be welded or attached thereto by any other suitable means.

As seen in FIGS. 5 and 6 vanes **47** are of generally wing shape or air foil shape and extend substantially the entire axial length of slant surface **56** having a slightly concave surface **59** as the leading surface in the direction of rotation and a slightly convex surface **60** as the trailing surface and are so positioned on slant surface **56** as to provide a mixed flow, i.e. combined axial and radial discharge therefrom into the pumping chamber.

OPERATION

In operation, after the pump has been primed, the fluid to be pumped, containing solids, enters pumping chamber **17** through opening **22** in suction flange **20** where, due to an annular vortex created by the rotating impeller, and due to their being heavier than the fluid, the solids are centrifuged outward in the pumping chamber and are promptly passed out through the discharge nozzle **19**. Fluid, now relatively free of solids, is drawn into the impeller **18** at the backend or stuffing box end of the pumping chamber **17**, remote from radial planar face **51** of impeller **18**, and is discharged from the impeller vanes **47** into the solids carrying stream in a whirling motion in a mixed flow, i.e. combined axial and radical direction, thereby imparting momentum to the stream and thus further preventing solids from impinging on the impeller vanes.

Thus, what has been disclosed is a solids handling pump wherein the solids in a fluid stream being pumped are prevented from impinging on the impeller vanes.

It will be understood that the invention is not to be limited to the specific construction or arrangement of the parts shown and that they may be modified widely within the invention defined by the claims.

What is claimed is:

1. A centrifugal pump for pumping fluids containing solids, comprising:

(a) a casing;

(b) a generally circular pumping chamber formed in said casing and having an inlet and an outlet, said inlet being arranged to deliver fluid containing solids approximately centrally of said pumping chamber and said outlet being arranged to receive said fluid containing solids from the circumference of said pumping chamber;

(c) a shaft extending through said casing and into said pumping chamber;

(d) an impeller rotatably mounted on said shaft and disposed in said pumping chamber, said impeller

comprising a body portion and vanes on said body portion, said body portion terminating in a generally planar end face spaced from and facing said inlet, and said vanes extending axially away from said inlet and the generally planar end face and inclined about the body portion whereby on the rotation of said impeller produces a fluid flow directed axially towards said inlet and radially towards the circumference of said pumping chamber to simultaneously prevent solids from striking the vanes and centrifuge the fluid containing solids towards the outlet; and,

(e) means for rotating said shaft to thereby rotate said impeller.

2. A pump according to claim **1**, wherein said body portion of said impeller is generally frustoconically shaped and the larger end of said generally frustoconically shaped body portion is disposed adjacent said generally planar end face.

3. A pump according to claim **2**, wherein said impeller further includes a chamfered portion connecting said planar end face with said generally frustoconically shaped portion.

4. A pump according to claim **1**, wherein said generally planar end face of said impeller is circular, the inlet is circular, the diameter of said planar end face is greater than the diameter of the inlet, and said impeller is arranged so that it is generally coaxially disposed with respect to the central axis of the inlet.

5. A pump according to claim **4**, wherein the impeller is mounted on the end of the shaft.

6. A pump according to claim **5**, wherein the shaft is horizontally disposed.

7. A pump according to claim **1**, wherein said generally planar end face defines an area larger than the inlet opening, and the impeller is disposed so that the inlet is entirely directed towards the area defined by said generally planar end face.

8. A pump according to claim **1**, wherein said impeller further comprises a hub portion, said body portion of said impeller is tapered in a downstream direction and is connected at its smaller end to said hub portion, and said impeller is mounted on the end of said shaft.

9. An impeller for a centrigual pump, comprising a body portion which terminates in a generally planar end face forming the upstream end of said impeller, and vanes on said body portion disposed downstream from said generally planar end face, said vanes being shaped to provide fluid flow directed axially away from said generally planar end face and radially outwardly.

10. An impeller according to claim **9**, wherein said body portion is tapered in the downstream direction.

11. An impeller according to claim **10**, wherein said body portion is frustoconically shaped.

12. An impeller according to claim **11**, further comprising a chamfered portion connecting said planar end face to the larger end of said generally frustoconically shaped portion.

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U.S. Cl. X.R.

415—219; 103—115