CENTRIFUGAL PUMP CONSTRUCTION

FIG. 2

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2 Sheets—Sheet 2

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CENTRIFUGAL PUMP CONSTRUCTION

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This invention relates in general to a centrifugal pump used for the transportation of fluids and in particular to a new and improved type of impeller for use therein.

Centrifugal pumps are widely used in the transportation and/or pressurization of liquids and normally consist of a casing having inlet and outlet openings and having an impeller rotatively mounted therein. Such an impeller is generally a flat circular plate, on at least one face of which are disposed a plurality of vanes. These vanes usually extend outwardly from a center inlet channel in the impeller to its periphery to form flow channels through which the pumped fluid flows. Inasmuch as the vanes forming the channels are generally of a uniform cross section from the central inlet channel, or eye as it is sometimes referred to, to the outer periphery, the channels themselves are generally wedge shaped, expanding from a relatively narrow width at the eye to a relatively large width at the outer periphery.

These pumps have been found satisfactory for the transportation of single phase fluids, but when fluidized gas-solid mixtures are pumped it has frequently been found that the solids portion tends to separate out on the back side of the impeller vanes and eventually plug the pump. Multi-phase transfer systems may be found in the chemical industry where suspensions of very finely divided solid catalysts are fluidized in gaseous suspensions. Often, due to the segregation described above, such suspensions are separated into light and heavy components, are transported separately, and then subsequently recombined. Unfortunately, it is rather difficult to establish and maintain a continuous flow of a finely divided solid in a suspension gas in a closed circuit with this type of transport.

The present invention is based on the discovery that in a centrifugal pump this separation or segregation is caused by the wedge shaped channels formed on the impeller wheel by the outwardly extending vanes, with the vanes, which permit recirculation within the channels of the fluid being pumped as it passes from the center inlet to the peripheral discharge. It was found that the separation of the entrained solids from the entraining gas during flow of material is effectively prevented when the impeller is provided with a plurality of grooves in one face rather than a plurality of vanes.

Accordingly, the present invention provides a centrifugal pump having a substantially circular casing with a central fluid inlet at one side thereof, a fluid outlet at a point on the periphery, and an impeller means comprising a circular disc member rotatably mounted in the casing having a central passage which communicates with the fluid outlet.

Further, the present invention provides an impeller in which the above recited grooves have a substantially uniform, narrow cross section extending from the circular channel to the outer periphery of the disc member.

Additionally, the present invention provides a centrifugal pump wherein the impeller means is rotatably mounted in a horizontal position within the casing having a central fluid inlet providing a downward flow into the central circular channel of the impeller means.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described preferred embodiments of the invention.

Of the drawings:

FIG. 1 shows a cross section of the pump of the present invention taken along the centerline of the impeller shaft; and

FIG. 2 is a plan view of a portion of the impeller taken along line 2—2 of FIG. 1.

The centrifugal pump 10 of the present invention is shown in FIG. 1 and consists of a generally circular casing having a central fluid inlet 14 disposed in one side thereof and a peripheral fluid outlet 16. This casing is comprised of an upper and a lower, generally flat, mounting circular plates 18 and 20 adapted to be secured to their peripheries, as by bolts 22, to form a central cavity 24. A gasket 25 may be provided at the bolted joint to make the casing tight. The fluid inlet 14 is coaxial with the cavity 24 and extends through the upper plate 18 into the cavity. The lower plate 20 has a shaft opening 26 extending therethrough coaxial with the inlet 14 and the cavity 24. Extending outwardly from the lower plate 20 and coaxial with the shaft opening 26 is a shaft bearing housing 28, of a type well known in the art, in which a shaft 30 is rotatably mounted. This shaft extends from the outer end of the bearing housing 28 into the cavity 24 of the casing and is provided with a means for receiving motive power, such as pulley 32, at its outer end.

The fluid impeller means comprising a circular disc 34, is mounted on the end of the shaft 30 within the cavity 24 so as to be rotatably movable therein by the rotation of the shaft and thus to pump a fluid from the inlet 14 to the outlet 16. As may be seen in FIG. 2, the cavity 24 is preferably of volute shape, although its contour may be of the diffuser type (not shown). Both types are well known in the pump art. With the volute, the fluid outlet 16 is located in the portion of the volute having the largest cross section.

The circular disc impeller 34 is provided with a central circular inlet channel 36 on the side adjacent the fluid inlet 14 so that the inlet channel is in communication therewith to receive the incoming fluid that is to be pumped. Extending outwardly from the inlet channel, and on the same face of the impeller disc, there is a plurality of angularly spaced grooves 38 which extend to the outer periphery of the impeller disc so they are in communication with the fluid outlet 16. The impeller disc may also be provided with central conical portion 40 which extends into the central fluids inlet 14 so as to provide an annular flow path 42 of substantially constant cross section from the inlet to the circular inlet channel 36.

As seen in FIG. 2, the grooves 38 in the face of the impeller disc 34 are backward pitched as they extend from the center of the disc to the outer periphery, i.e. are inclined in a direction opposite to the rotation of the disc, which rotation is indicated by arrow 44. However, radial grooves may also be used. In either case, the grooves in the impeller disc are characterized by the fact that they are relatively narrow in cross section and have a substantially uniform cross section throughout their length, it has been possible to pump a homogeneus gas-solids suspension continuously for extended periods without phase separation within
the impeller. It is believed this advantageous result is due to the substitution of narrow, uniform cross section grooves for the usual wedge shaped flow passages of an ordinary pump impeller which are relatively wide, with respect to depth, and of varying cross section from the center to the periphery of the impeller. Wide flow passages are thought to permit the suspension which is being pumped to be recirculated within the passages in a plane transverse to the flow proceeding from the center to the periphery of the impeller, so that the more dense solids fraction separates from the lighter gaseous fraction and obstructs the flow passage, the accumulation of solids particles finally plugging the entire passage rendering the pump inoperable.

A specific example of the pump of the present invention is one which has an impeller disc with an outside diameter of 16¾ inches and 32 grooves each having ⅛” x ⅛” cross sectional flow areas extending from the central inlet channel to the impeller periphery. When this impeller is driven at a speed of 3600 r.p.m. the pump has a capacity of 8 cubic feet per minute and develops a 6 p.s.i. differential head. For this performance the average particle size of the fluidized solids, which in this case was graphite, ranged from 0.05 micron to 20 microns, and with the carrier gas, carbon dioxide, produced a mixture density of 6 pounds per cubic foot. After a three week run an inspection of the impeller disc, upon disassembly, disclosed no trace of phase separation or plugging.

It has also been found that in pumping a gas-solids suspension it is advantageous to arrange the pump with the axis of the drive shaft vertical and the impeller disc horizontal, with the central inlet extending vertically through the upper casing. With this arrangement there is little possibility of the solid particles separating out of suspension and causing pump seizure during stop and start operation, as might be possible were the impeller disposed vertically.

While the above description contains reference to one particular embodiment of the present invention, different capacity pumps could require impeller discs of other diameters with varying numbers of grooves. Moreover, while the grooves also may have dimensions different than those given above, the use of narrow grooves of substantially uniform cross section will produce the results hereindescribed.

While in accordance with the provisions of the statutes I have illustrated and described herein the best form and mode of operation of the invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

What is claimed is:

1. A centrifugal pump for pumping a gas-solids suspension having a substantially circular casing with a centrally disposed gas-solids suspension inlet arranged in one side thereof and a peripherally disposed gas-solids suspension outlet, a fluid impeller means comprising a generally flat imperforate circular disc member rotatably mounted in said casing and having a flat face thereof substantially in contact with one side of said casing, said disc member having a centrally disposed annular inlet channel formed in said flat face thereof communicating with said fluid inlet, a multiplicity of angularly spaced substantially straight open grooves formed in said flat face of said disc member and extending from said annular inlet channel to the periphery of said disc member and communicating with said casing peripheral outlet, said grooves having a substantially constant narrow width from said inlet channel to the outer periphery of said disc member constructed to minimize separation of the solids from the gas.

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