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Weiland

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[54] **JET CENTRIFUGE**

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[52] **U.S. Cl.** ..... **233/38,** 233/7, 233/19 R, 233/23 R

[51] **Int. Cl.** **B04b 1/00**

[58] **Field of Search** ..... 233/7, 19 R, 20 R, 233/29, 30, 35, 36, 39, 23 R, 38, 3

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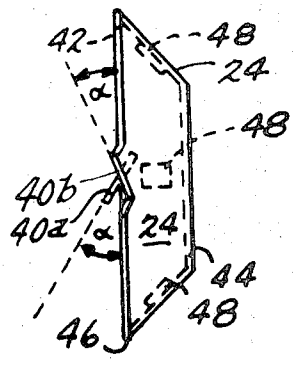
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[57] **ABSTRACT**

A high speed bowl centrifuge of the type having a rotatably mounted bowl and an independently, rotatably mounted central support member which is enclosed thereby upon which a plurality of disks are coaxially mounted for rotation therewith. The periphery of the disks and the inner surface of the bowl define therebetween a substantially annular space, into which, in the preferred embodiment, at least one pitched extension protrudes from at least one disk. Under normal centrifuging operations, the central support member and bowl are rotated in a common direction at a common rotational speed and thus sludge builds up at the inner surface of said bowl. During the cleaning operation the central support member is rotated in such a direction as to urge sludge towards said sludge outlet due to the pitch of said extension. The bowl may also be rotated in the opposite direction as to apply a stripping force to the sludge. Furthermore, both of the above-mentioned rotations are at a substantially lower rotational speed than the centrifuging speed so that the extension encounters less compacted sludge.

1 Claim, 3 Drawing Figures



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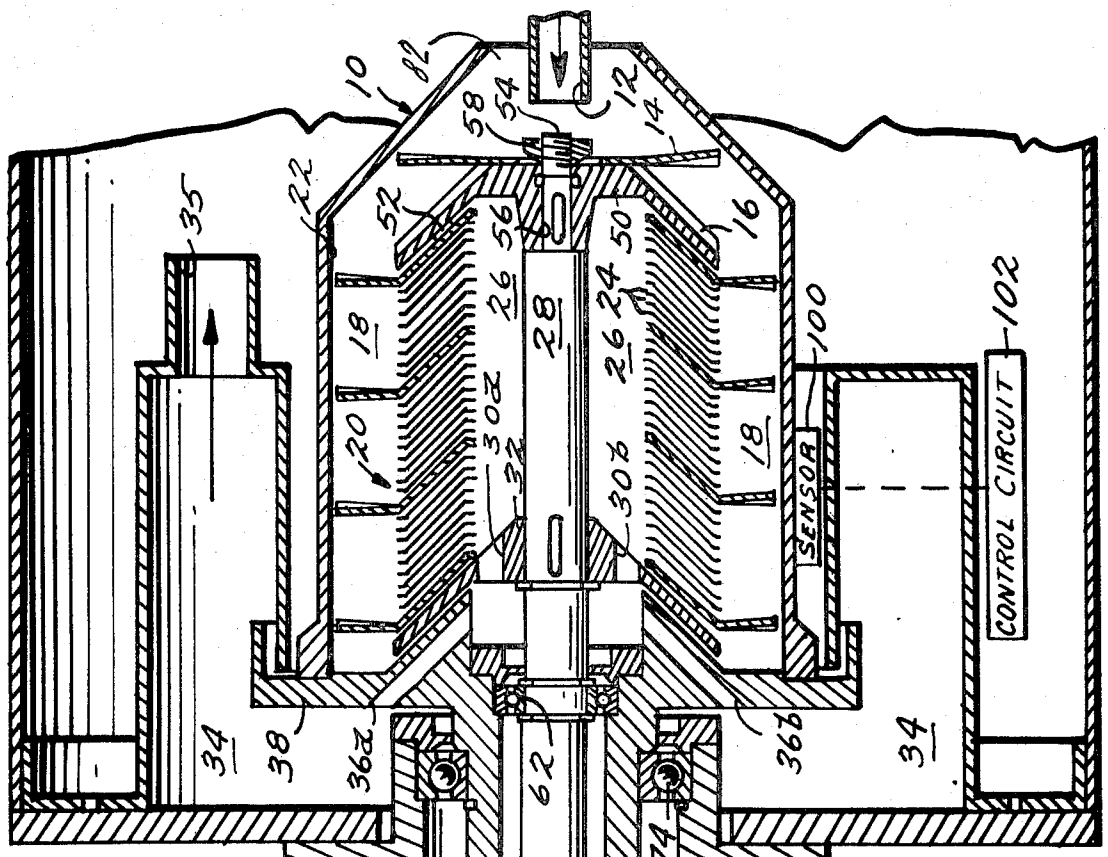


Fig. 3.

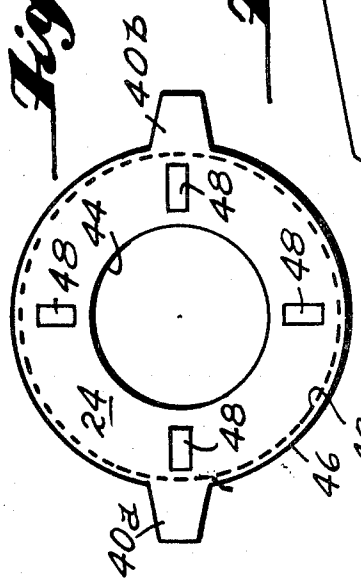


Fig. 2.

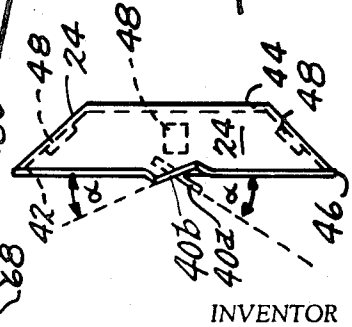


Fig. 1.

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JET CENTRIFUGE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention pertains to high speed bowl centrifuges into which an input fluid containing foreign matter is introduced and from which the relatively pure fluid and the relatively pure foreign matter, or sludge, exit at different outlets.

More particularly, this invention pertains to devices associated with the disk assembly of a bowl centrifuge for urging sludge towards a sludge opening.

2. Description of the Prior Art

Bowl centrifuges are commonly provided with a plurality of disks separated by spacing plates and rigidly mounted to a rotatably mounted central support member. The disk assembly is also commonly enclosed by a closed bowl or outer jacket to form therewith an annular space. Finally, it is also well known to provide a converging spiral mounted to a perforated drum, or the like, which encloses the disk assembly and urges sludge, which has collected in the annular space due to the centrifugal force created by the centrifuge, towards a sludge outlet.

There are two major problems with this type sludge removal system. First, the perforated drum or the like collects a quantity of sludge due to its positioning at the outer periphery of the disk assembly. Secondly, since the spirals are not integral with the disks, the great centrifugal forces which act in the annular space when the central support member undergoes rapid rotation cannot be efficiently counteracted. Thus, either the centrifuge must be operated at a lower speed, or the connections between the spirals and their mounting means will be subjected to a tearing stress.

Furthermore, this tearing effect is aggravated in known centrifuges wherein the sludge removal takes place at normal operating speeds because the sludge becomes caked at higher speeds and the spirals are bent in pushing against the sludge.

The U.S. Pat. to Hiller, No. 3,275,230, issued Sept. 27, 1966, partially overcomes the first of the above-mentioned difficulties but not the latter one.

In Hiller, the perforated drum is dispensed with and, instead, as shown in FIGS. 3 and 4, the spiral segments are supported by extensions from spacing plates which separate the disks of the disk assembly. Furthermore, in the embodiment shown in FIGS. 1 and 2 of Hiller the extensions from the spacing plates form an interrupted spiral and no spiral segments are used.

While the above Hiller embodiments overcome the problem of sludge buildup on the spiral mounting means, such as perforated drums, they are still subject to the other problem discussed above, namely the problem of tearing stress, since the spiral support means or extensions are removably secured to the disks through the relatively small and thin spacing plates, in each embodiment of Hiller. These points of attachment to the disks form points of attack when the spiral means is subjected to strong centrifugal forces.

In addition, since the outer jacket of Hiller is rotated at its normal speed during the scraping operations, the sludge deposited thereupon is tightly compacted by the centrifugal forces and this causes bending stress against the spiral means. Finally, since the Hiller spiral means is continually rotated relative to the outer jacket (as is also the case in the other prior art systems) there is continual wear as the spiral means engages the tightly compacted sludge.

SUMMARY OF THE INVENTION

It is the object of this invention to provide a sludge removal system associated with a disk assembly which is free from the disadvantages of the prior art discussed above. More specifically, it is one object of the invention to provide a scraper means which is integral with the disks which can efficiently transfer the centrifugal forces acting upon the scraper means to the central support means to thus allow very high centrifuging speeds without the danger of the scraper means separating from the disk assembly.

It is another object of the invention to provide a sludge removal scraper means which removes sludge at a low rotational speed which thus exposes the scraper means to less compacted sludge.

It is yet another object of the invention to provide a sludge removal scraper means which does not move relative to the outer jacket during the centrifuging operation to thus avoid a constant wear upon said scraper means.

The above, and other objects, are accomplished by the applicant's high speed bowl centrifuge in which a first support means rotatably supports an outer jacket or bowl and a first power means rotates the outer jacket about its longitudinal axis while a second support means rotatably supports a disk assembly comprised of plural disks coaxially disposed within and completely enclosed by said outer jacket. At least one of the disks has at least one integral, pitched extension which extends into the annular area defined by the disks' peripheries and the inner surface of the outer jacket. Since the extension is integral with the disk the centrifugal forces acting thereupon find no easily attachable point of discontinuity but, on the contrary, are efficiently transferred to the central support means.

During the centrifuging operation, the central support member and outer jacket move in a common direction at a common high rotational speed and thus there is no relative movement between the extension and the jacket to cause wear on the extension. Further, when it is desired to remove sludge from the centrifuge, the rotational speed of both the outer jacket and the central support member are reduced and then their relative directions of rotation are reversed. The extension or extensions are so pitched that their direction of rotation of the central support during the sludge removal step urges the sludge towards the sludge outlet.

Since the sludge removal takes place at comparatively low rotational speeds the extensions do not encounter tightly caked sludge. Furthermore, the different directions of rotation of the central support member and outer jacket during the cleaning operation create eddy currents in the annular space which help to strip sludge from the inner surface of the outer jacket which enhances the sludge removal action.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a center line sectional side view of a bowl centrifuge in accordance with the invention;

FIG. 2 is a front view of a disk having extensions in accordance with the invention; and

FIG. 3 is a side view of the disk shown in FIG. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment of the invention will now be described with regard to the drawings in which the same elements are indicated by the same reference numerals throughout.

In FIG. **1**, it is seen that liquid containing sludge or the like enters the centrifuge bowl **10** by means of an inlet pipe **12** which is coaxially disposed with respect to the outer jacket.

The contaminated liquid then encounters and is deflected by the vanes **14** and the impeller **16**, which are fastened to the central support shaft **28** by nut **58** and thus are rotating with shaft **28** in the range of 4,000 to 5,000 rpm with respect to the inlet pipe **12**, into the annular region **18** which is defined between the circumference of the cylindrical disk assembly **20** and the cylindrical inner surface **22** of the bowl **10**.

In this region the sludge contained in the contaminated liquid is forced outwards towards the inner surface **22** while the less dense pure liquid is drawn between disks **24** into the annular space **26** defined between the inner edges of disks **24** and the central support shaft **28**.

The pure liquid then exits from the annular space **26** through apertures **30***a* and **30***b* in the rear disk assembly support **32**. The apertures **30***a* and **30***b*, in turn, communicate with the annular compartment **34** via channels **36***a* and **36***b* which have been formed in the bowl support member **38**. Finally, the pure liquid exits from compartment **34** via clear liquid outlet **35**.

The disk assembly **20** is comprised of a plurality of disks **24** which are identical in construction to the disk shown in FIGS. **2** and **3** except that at least one of the disks has the integral extensions **40***a* and **40***b* which are shown in FIGS. **2** and **3**. Thus each disk **24** has a generally disk-like configuration in which a larger circular aperture **42** tapers to form a frusto-conical annulus having a radially inwardly extending integral flange defining aperture **44** and a radially outwardly extending integral flange **46** surrounding aperture **42**. Each disk **24** also has four rectangular spacer pieces **48** attached thereto on a single face thereof which are disposed at 90° with respect to one another's longitudinal axes. Furthermore, the longitudinal axes of these spacer pieces are each bisected by a circle concentric with apertures **42** and **44**, i.e., they are located at a uniform radial distance from the longitudinal axis. Thus, the spacer pieces **48** act to separate each disk from its neighboring disks when said disks are assembled into disk assembly **20** without overly disrupting liquid flow between the disks. It is also noted from FIG. **3** that the extensions **40***a* and **40***b* are disposed at the angle of incidence with respect to flange **46** but that extension **40***a* is disposed at an angle of $180° - 2\alpha$ from extension **40***b*. In other words, the extensions **40***a* and **40***b* are pitched as in a propeller blade.

The disks **24** as described above are rigidly supported by shaft **28** by means of the rear disk assembly support **32**, and the front disk assembly support **50** which is formed on the back of impeller **16**. In other words forces applied to the tips of the disks are directly transferred to said shaft. The front disk support **50** also includes spacers **52** which are identical in construction, location, and operation to spacers **48**. The rear disk assembly support **32** is keyed to shaft **28** while the impeller **16** and front disk assembly support **50** are fastened thereto by means of spindle **54** which protrudes through the axial aperture **56** in impeller **16**. The free end of spindle **54** is threaded and nut **58** is screwed thereupon to complete the disk assembly **20** as well as to fixedly support vanes **14**.

It is noted that in FIG. **1** only those disks **24** having extensions are shown in full section while the other disks are indicated schematically.

The central shaft **28** and thus the disk assembly **20** are rotatably mounted by ball bearings **62** and **64** and powered through pulley **66** which is keyed to said shaft **28**, and endless belts **68** by a motor (not shown).

Similarly, the bowl support member **38** (and thus the bowl **10**) are rotatably mounted by means of the tubular shaft **72** which forms an extension of support **38**.

The shaft **72** which coaxially surrounds shaft **28** is supported by ball bearings **74** and **76** and is powered through the pulley **78** which is keyed thereto and endless belts **80** by a second motor (also not shown).

The entire centrifuge is supported by frame **84** in a known manner.

In the centrifuging mode of operation the two shafts **28** and **72** rotate in a common direction with a common rotational speed in the range of about 4,000 to 5,000 rpm.

Thus, in this mode, sludge is driven against the inner surface **22** of bowl **10** where it is tightly compacted by centrifugal force. However, since there is substantially no relative movement between the inner surface **22** and the extensions **40***a* and **40***b*, these extensions are not subjected to continuous wear during normal, centrifuging operations. Furthermore, these extensions are not subjected to great bending stress by pushing against tightly compacted sludge. Further, since the centrifugal forces to which the extensions **40***a* and **40***b* are subjected are transferred by the integral disk **24** to disk assembly **20** and thus shaft **28**, there is no danger of shear at a point of attachment as in the prior art.

When it is desired to remove sludge from the annular space **18** the motor driving shaft **72** is controlled to slow the rotational speed of shaft **72** to a slower speed in the range of about 0–250 rpm, while the motor driving shaft **28** is first slowed and then reversed in direction so that shaft **28** now rotates opposite to shaft **72** with a speed of about **250** rpm.

The counter rotation produced in the annular space **18** by the counter rotation of the shafts **28** and **72** helps to loosen the sludge from said inner surface **22**. Also, the extensions **40***a* and **40***b* are so pitched that they drive the sludge towards tapered end of the bowl **10** where vanes **14** which are pitched in a manner identical to extensions **40***a* and **40***b* force the sludge through sludge outlet **84**.

Once the annular space **18** is freed from sludge, the above described centrifuging mode may be resumed.

While the above description fully covers the preferred embodiment of the invention, many modifications are possible within its scope.

Thus, for example, the number of extensions supported on a given disk and the number of disks having extensions will vary with the amount and density of sludge which must be removed and, similarly the materials of construction of the disks and heat treatment etc. thereof may be varied to meet process requirements.

Similarly, the sludge buildup may be electronically or otherwise monitored as by sensor **100** and the motors driving shafts **28** and **72** automatically shifted between modes of operation as by control circuit **102.**

In addition, only a single motor is required to operate both shafts if appropriate gearing is interposed between that motor and the shafts.

Finally, it makes no difference whether the rotation of the disk assembly **20** or the outer jacket **10** is reversed so long as when the centrifuge operates in the cleaning mode, the sludge is driven by the pitch of extensions toward the sludge outlet.

What is claimed is:

1. In a high speed bowl centrifuge including a bowl having a central longitudinal axis, a first support means for rotatably mounting said bowl, a first power means for rotating said bowl about its longitudinal axis, a central support member coaxially disposed within and completely enclosed by said bowl, a second support means for rotatably mounting said central support member independent from said bowl, a second power means for rotating said central support member, and a set of disks, rigidly and coaxially mounted upon said central supporting member so as to define an annular space between the periphery of said disks and the inner surface of said bowl, and a sludge outlet from said bowl, the improvement comprising that at least one of said disks includes at least one radial extension which extends into said annular space and is pitched to urge sludge therein toward said outlet on relative rotation between said bowl and said one disk, that at least one of said first and second power means is capable of various speeds of rotation, and including means for changing the mode of operation of said one power means so that, in the centrifuging mode, said bowl and said central support member may be rotated at a common rotational speed but, in the cleaning mode, said bowl and said central support member may be operated at different rotational speeds so that said extension urges sludge towards said sludge outlet, said changing means comprising a sludge sensor for measuring sludge buildup on the inner surface of said bowl and a control circuit connected to said sensor for controlling the operation of said one power means.

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