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(54) Title: IMPROVEMENTS IN OR RELATING TO CENTRIFUGES

(57) Abstract: A centrifuge (500) for separating feed material into solid and fluid parts, which centrifuge comprises a conveyor (540) rotatably mounted in a rotatable housing (520), the conveyor having at least one impeller (572) and the rotatable housing having a separating region comprising a pool area and a drying area between the conveyor and a rotatable housing, the arrangement being such that, in use, on entry to the centrifuge said feed material has an axial velocity substantially parallel to the longitudinal axis thereof, the feed material passing through the interior of said conveyor (540) with rotational speed being imparted thereto by said at least one impeller (572) prior to treatment in said separating region, said at least one impeller also imparting radial speed to said feed material whilst it moves with axial velocity such that feed material is spread onto the drying area adjacent the length of the at least one impeller, part of the conveyor (540) being liable to wear by feed material moving from the at least one impeller onto the drying area, characterised in that said conveyor comprises a mounting apparatus (580) for (1) providing mechanical integrity to the conveyor and (2) providing a portion to be sacrificed by said wear, the arrangement being such that, in use, the mechanical integrity of the centrifuge is substantially unimpaired by sacrifice of said portion.

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Improvements in or relating to Centrifuges

The present invention relates to a centrifuge, a mounting apparatus for use in the centrifuge, a method of manufacturing the mounting apparatus, an accelerator apparatus, a method of separating feed material and to a base for a centrifuge.

Many different industries use decanter centrifuges in varied applications. For example they are used in the petro-chemical, rendering, environmental, wastewater, mining and drilling industries. They are used in the oil industry to separate undesired drilling solids from the drilling mud. It is advantageous to recover, clean and re-use drilling mud because it is expensive.

The prior art discloses a variety of decanter centrifuges (or "decanters" as they are known in the art) that, in many embodiments, include a rotating housing (or "bowl" as it is known in the art) rotating at one speed and a conveyor (or "scroll" as it is known in the art) rotating at a different speed in the same direction. The housing normally comprises a hollow tubular member having a cylindrical portion and a conical portion. The conveyor normally comprises an auger type screw, mounted inside the housing, whose thread complements the shape of the housing. Such centrifuges are capable of continuously receiving feed in the housing and of separating the feed into layers of light and heavy phase materials (e.g. liquids and solids) that are discharged separately from the housing. The conveyor, rotating at a differential speed with respect to the bowl, moves or "scrolls" an outer layer of heavy phase or solids slurry material to a discharge port or ports usually located in a tapered or conical end portion of the housing. Addition of feed material causes the fluid level to rise in the bowl until the depth is such that further addition of feed material causes displacement and discharge of light phase material
through a discharge port (or ports) usually located at an opposite end of the housing. The light phase material must pass around a path defined by the thread before it can be discharged through these ports. Typically the housing is solid. Some housings have port(s) to reject the heavier solids phases.

Centrifugal separation results, preferably, in a discharge containing light phase material with little or no heavy phase material, and heavy phase material containing only a small amount of light phase material. When the light phase material is water and the heavy phase material contains soft solids, it is preferred that fairly dry solids and clean water be separately discharged.

WO02/18055, co-owned by the present applicant, discloses a centrifuge in accordance with the preamble of claim 1.

One particular problem associated with such a centrifuge is that feed material (particularly abrasive slurries e.g. drilling mud with drilling solids therein) moving from the tips of the impellers to the drying area tends to wear portions of the conveyor. Such a problem has not been encountered with prior centrifuges as the outlets for feed material on the conveyor have been between the flights of the screw only. Thus, once out of the conveyor, there is nothing to restrict passage of feed material into the pool area in the prior art centrifuges and therefore there is no wear.

A further problem is that such wear is located on the longitudinal metal rods that provide structural rigidity to the conveyor. Repairs to the rods by welding are difficult as the heat tends to distort the shape of the conveyor. This amount of distortion has been found to affect the dynamic balance of the centrifuge, which is unacceptable considering the very high speeds of rotation.
in use (e.g. 1000-3200rpm). Furthermore due to the nature of construction i.e. rods surrounded by flights, it is very difficult to attach suitable heat sinks that might otherwise mitigate this problem, without dismantling the centrifuge and taking the conveyor apart. This is undesirable as the centrifuge would be out of use for some time and may even have to be taken off site for repair.

A further problem with which the present invention is concerned relates to base structures for supporting centrifuges. Prior bases are fabricated from several parts. Once the base has been made, a centrifuge case is bolted to the base for supporting a centrifuge therein. A separate base portion is then bolted on to the main base for supporting the motor that drives the centrifuge. All of this renders manufacture time consuming and expensive.

It is an aim of the various aspects of the present invention to mitigate the aforementioned disadvantages.

According to the present invention there is provided a centrifuge for separating feed material into solid and fluid parts, which centrifuge comprises a conveyor rotatably mounted in a rotatable housing, the conveyor having at least one impeller and the rotatable housing having a separating region comprising a pool area and a drying area between the conveyor and a rotatable housing, the arrangement being such that, in use, on entry to the centrifuge said feed material has an axial velocity substantially parallel to the longitudinal axis thereof, the feed material passing through the interior of said conveyor with rotational speed being imparted thereto by said at least one impeller prior to treatment in said separating region, said at least one impeller also imparting radial speed to said feed material whilst it moves with axial velocity such that feed material is spread onto the drying area adjacent the length of the at
least one impeller, part of the conveyor being liable to wear by feed material moving from the at least one impeller onto the drying area, characterised in that said conveyor comprises a mounting apparatus for (1) providing mechanical integrity to the conveyor and (2) providing a portion to be sacrificed by said wear, the arrangement being such that, in use, the mechanical integrity of the centrifuge is substantially unimpaired by sacrifice of said portion. The at least one impeller may comprise said portion. The mounting apparatus may comprise mounting means whereby a separate part that carries or is otherwise provided with the at least one impeller may be mounted thereon.

In certain aspects the impellers (and related parts such as a nose member) are made of material from the group of cast iron, steel, stainless steel, hardfaced or carbide covered metal, plastic, molded polyurethane, fiberglass, polytetrafluoroethylene, aluminum, aluminum alloy, zinc, or zinc alloy, stellite, nickel, chrome, boron and/or alloys of any of these. The impellers (and related parts) may be removable and/or replaceable. Any part of a conveyor or centrifuge disclosed herein, especially parts exposed to fluid flow, may be coated with a protective coating, hardfaced, and/or covered with tungsten carbide or similar material.

Preferably, said mounting apparatus is such that, after said portion has been worn, repair of said body can be effected substantially without impairing the mechanical integrity of the conveyor.

Advantageously, said mounting apparatus comprises a lobe member providing said portion for sacrifice, the heat capacity of the remaining portion of the lobe member providing a heat sink for absorbing heat during repair of the lobe member to inhibit damage to mechanical integrity of the conveyor.
Preferably, said mounting apparatus comprises a substantially solid outer surface other than at least one elongate slot along the mounting apparatus for accommodating a part of the at least one impeller, the elongate slot permitting said feed material to pass from the impeller to the drying area in use. Preferably the width of the at least one elongate slot adjacent the impeller tip is between approximately 0.05m and 0.08m. In one embodiment the width is approximately 0.06m.

Advantageously, a tip of the at least one impeller is positioned substantially centrally in the width of the at least one elongate slot.

Preferably, said tip lies on a circumference of diameter substantially the same or greater than a diameter of a circumference defined by a part of the mounting apparatus.

Advantageously, said mounting apparatus comprises a first portion of a first diameter and an axially spaced second portion of a second diameter less than the diameter of the first portion, and the at least one elongate slot extends across part of the first and second portions whereby the accelerator apparatus maybe inserted into and/or removed from the mounting apparatus during manufacture and/or repair.

Preferably, said at least one impeller is mounted on the mounting apparatus.

Advantageously, said at least one impeller is mounted on an accelerator apparatus that is mountable on the mounting apparatus.

Preferably, accelerator apparatus is a separate and distinct part to the mounting apparatus.

Advantageously, said accelerator apparatus comprises a nose member and a base that has a plane substantially perpendicular to the longitudinal axis of the nose member. In one embodiment the mounting apparatus
comprises a substantially central bore into which the nose member is insertable. Axially opposite the end of the nose member there is bore in the mounting apparatus for accommodating a feed tube for supplying feed material to the nose member and at least one impeller.

Preferably, said base comprises means for releasably mounting the accelerator apparatus on said mounting apparatus. In one embodiment said means is a bore for receiving the shaft of a bolt.

Advantageously, said portion is adjacent a tip of the at least one impeller.

Preferably, said portion is behind relative to the intended direction of rotation of the conveyor.

Advantageously, a volume of the mounting apparatus is between approximately 40% and 60% of a volume enclosed by that portion of the mounting apparatus of length substantially equal to the length of the at least one impeller. In one embodiment the volume of the mounting apparatus is approximately 50%.

Preferably, said mounting apparatus comprises a metal and/or metal alloy.

In one embodiment said metal comprises iron.

Advantageously, the centrifuge further comprises a substantially helical thread mounted around an external surface of said conveyor.

Preferably, said helical thread defines a space between said external surface and an inner surface of the thread for accommodating a part of the at least one impeller.

Advantageously, said helical thread defines a space between said external surface and an inner surface of the thread for permitting flow of fluid with along the centrifuge with an axial component of velocity during separation of feed material.

According to another aspect of the present invention
there is provided a mounting apparatus for use in a centrifuge as set out above.

According to another aspect of the present invention there is provided a method of manufacturing such a mounting apparatus, which method comprises the steps of casting the mounting apparatus from metal and/or a metal alloy.

According to another aspect of the present invention there is provided an accelerator apparatus for use in a centrifuge as set out above.

According to another aspect of the present invention there is provided a method of separating feed material into solid and fluid parts, which method comprises the steps of:

1. feeding feed material to a centrifuge as set out above; and
2. rotating the conveyor and rotatable housing to separate the feed material.

According to yet another aspect of the present invention there is provided a method of repairing a centrifuge as set out above, which method comprises the step of replacing the portion of sacrificial material.

Preferably, said step of replacing comprises welding sacrificial material to the mounting apparatus.

According to another aspect of the present invention there is provided a method of manufacturing a conveyor for use in a centrifuge as set out above, which method comprises the steps of securing a thread around a conveyor body comprising a mounting apparatus as set out above. Preferably, the method further comprises the step of forming the conveyor body by securing one end of a mounting apparatus to one end of a substantially cylindrical section. Advantageously, the substantially cylindrical body has a hollow interior, the method further comprising the steps of inserting an accelerator
apparatus as set out above through said hollow interior and releasably mounting the accelerator apparatus on the mounting apparatus.

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According to another aspect of the present invention there is provided a centrifuge comprising a bowl and a mount for mounting the bowl on a base, the bowl and the mount being spaced apart by spacing means so as to provide a plurality of openings adjacent an end of the centrifuge for discharge of fluid or solids from the centrifuge.

Advantageously, said bowl and said mount define an internal space adjacent said end, which internal space is an extension of the interior of said bowl and into which, in use, solids or fluids are ejected from the centrifuge for passage through said openings.

Preferably, said spacing means comprises a plurality of projections projecting either from said mount or from said bowl.

Advantageously, said spacing means comprises means for releasably mounting the mount on the bowl.

Preferably, said means comprise a bore for receiving a bolt.

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According to another aspect of the present invention there is provided a base for a centrifuge, which base comprises an integral support structure for, in use, supporting both a centrifuge and motor means for powering the centrifuge.

Advantageously, the base further comprises an integral first housing part for receiving a centrifuge.

Preferably, the base further comprises a second
housing part that co-operates with the first housing part for enclosing a centrifuge during use. The second housing part may be mounted via hinges on the first housing part.

According to another aspect of the present invention there is provided a method of manufacturing a base as set out above, which method comprises the step of casting the base from metal and/or a metal alloy.

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According to another aspect of the present invention there is provided a centrifuge for separating feed material into solid and fluid parts, the centrifuge comprising

a conveyor rotatably mounted in a rotatable housing, the conveyor having a longitudinal axis and an interior and at least one impeller, said at least one impeller having an impeller length,

the rotatable housing having a separating region comprising a pool area and a beach area between the conveyor and the rotatable housing so that feed material is passable through the interior of the conveyor and rotational speed is impartable to said feed material by said at least one impeller prior to treatment in said separating region, and so that said at least one impeller spreads feed material onto said beach area, the beach area having a beach length, and

the at least one impeller spreading feed material onto the beach area adjacent the length of the at least one impeller.

Preferably, the at least one impeller is a plurality of spaced-apart impellers.

Advantageously, the centrifuge further comprises a central nose member and wherein each impeller has a central end connected to the central nose member mounted
in the conveyor.

Preferably, the at least one impeller is of curved cross section.

Advantageously, the at least one impeller is a plurality of interconnected impellers comprising accelerator apparatus, the accelerator apparatus removably disposed within the conveyor.

Preferably the centrifuge further comprises a central nose apparatus having an end plate and a central nose member projecting from the end plate, the central nose member positioned within the plurality of interconnected impellers, and the end plate secured to the plurality of interconnected impellers.

Advantageously, the centrifuge further comprises mounting apparatus within the conveyor, the accelerator apparatus and central nose apparatus mounted within the mounting apparatus.

Preferably, the mounting apparatus has a plurality of spaced-apart lobes defining therebetween a plurality of flow channels through which is flowable material flowing from the plurality of interconnected impellers.

Advantageously, the lobes of the mounting apparatus include at least a portion of sacrificial mass for wearing away by the feed material.

Preferably, each impeller is of curved cross-section and a portion of each impeller extends between two of the spaced-apart lobes of the mounting apparatus.

Advantageously, the at least one impeller is of generally uniform thickness throughout.

Preferably, the impeller length is at least fifty percent of the beach length.

Advantageously, the impeller length is at least seventy-five percent of the beach length.

Preferably, the centrifuge further comprises helical screw apparatus on the conveyor with multiple openings
through which material is flowable, the helical screw apparatus for moving material toward an end of the rotatable housing.

Advantageously, the at least one impeller is a plurality of spaced-apart impellers, and each impeller traverses a plurality of openings of the multiple openings of the helical screw apparatus.

Preferably, the centrifuge further comprises head apparatus with a plurality of spaced-apart spokes, the rotatable housing secured to the head apparatus with bolts passing through the plurality of spaced-apart spokes into portions of the rotatable housing.

Advantageously, the centrifuge further comprises first motor apparatus interconnected with the rotatable housing for rotating the rotatable housing, second motor apparatus interconnected with the conveyor for rotating the conveyor, and an integral centrifuge housing for both supporting the motor apparatuses and for accessibly enclosing the rotating housing.

Preferably, integral centrifuge housing includes an integral base support.

Advantageously, in use the feed material has an axial velocity in the direction of the longitudinal axis of the conveyor and the at least one impeller directs the feed material imparting radial speed to said feed material.

Preferably, the at least one impeller is configured and positioned to also spread feed material onto a portion of the pool area adjacent a portion of the at least one impeller.

Advantageously, the rotatable housing has an interior length and the impeller length is substantially equal to said interior length of the rotatable housing.

According to another aspect of the present invention
there is provided a centrifuge for separating feed material into solid and fluid parts, the centrifuge comprising

- a conveyor rotatably mounted in a rotatable housing,
- the conveyor having a longitudinal axis and an interior and at least one impeller, said at least one impeller having an impeller length,
- the rotatable housing having a separating region comprising a pool area and a beach area between the conveyor and the rotatable housing so that feed material is passable through the interior of the conveyor and rotational speed is impartable to said feed material by said at least one impeller prior to treatment in said separating region, and so that said at least one impeller spreads feed material along a portion of said conveyor,
- the feed material having an axial velocity in the direction of the longitudinal axis of the conveyor and the at least one impeller spreading feed material onto the beach area adjacent the length of the at least one impeller,

wherein the at least one impeller is a plurality of interconnected spaced-apart impellers each with of curved cross section,

- and end plate connected to the conveyor,
- a central nose member connected to or formed integrally of the end plate and projecting therefrom,
- each impeller having a central end connected to the central nose member mounted in the conveyor,

wherein the plurality of interconnected impellers comprises accelerator apparatus, the accelerator apparatus removably disposed within the conveyor,

- the central nose member positioned within the plurality of interconnected impellers, and
- mounting apparatus within the conveyor,

- the accelerator apparatus and central nose apparatus
mounted to the mounting apparatus,
the mounting apparatus having a plurality of spaced-apart lobes defining therebetween a plurality of flow channels through which is flowable material flowing from
the plurality of interconnected impellers,
wherein each impeller has a portion extending between two of the spaced-apart lobes of the mounting apparatus, and
helical screw apparatus on the conveyor with multiple openings through which material is flowable, the helical screw apparatus for moving material toward an end of the rotatable housing.
Preferably, the centrifuge further comprises power apparatus for rotating the conveyor and the rotatable housing.
Advantageously, said at least one impeller spreads feed material onto said beach area.
Preferably, said at least one impeller is configured and positioned to spread feed material onto a portion of the pool area adjacent a portion of the at least one impeller.
For a better understanding of the present invention reference will now be made by way of example to the accompanying drawings in which:

Figs. 0A' and 0A'' are a schematic side cross-section of a prior art centrifuge of the applicant useful for understanding the present invention;

Fig. 1A is a schematic side cross section of a part of a centrifuge according to the present invention;

Fig. 1B is a schematic end view of the centrifuge of Fig. 1A including a part of the centrifuge not visible in Fig. 1A;

Fig. 1C is a schematic cross section of a first embodiment of a mounting apparatus in accordance with the present invention for use in the centrifuge of Fig. 1A;

Fig. 1D is a schematic cross section of a second embodiment of a mounting apparatus in accordance with the present invention with a first embodiment of an accelerator apparatus mounted therein;

Figs 1E is a schematic end view of a second embodiment of an accelerator apparatus in accordance with the present invention;

Fig. 1F is a schematic cross-section of a third embodiment of a mounting apparatus in accordance with the present invention with an end view of a third embodiment of an accelerator apparatus mounted therein;

Fig. 1G is a schematic side cross section of a part of the centrifuge of Fig. 1A including a head for mounting the centrifuge on a base;

Fig 1H is a schematic end view of the centrifuge and head of Fig. 1G, with some parts shown in cut-away;

Fig. 2A is a schematic first perspective view of a mounting apparatus in accordance with the present invention;

Fig. 2B is a schematic end view of the mounting apparatus of Fig. 2A;
Fig. 2C is a schematic second perspective view of the mounting apparatus of Fig. 2A;

Fig. 3A is a schematic side view, partly in cross section, of a fourth embodiment of an accelerator apparatus according to the present invention;

Fig. 3B is a schematic end view of the mounting apparatus of Fig. 3A;

Fig. 3C is a schematic end view the mounting apparatus of Fig. 13A, the view of the opposite end to that shown in Fig. 3A;

Fig. 4A is a schematic end view of a base for a centrifuge according to the present invention;

Fig. 4B is a schematic top plan view of the base of Fig. 4A with the lid removed to reveal a centrifuge mounted therein; and

Fig. 4C is a schematic front view of the base of Fig. 4A.

Referring to Fig. 0A, a centrifuge generally identified by reference numeral 210 has an outer housing 20 within which is rotatably mounted a bowl 20 with a hollow interior 23. Within the hollow interior 23 of the bowl 20 is rotatably mounted a conveyor 40 that has a continuous helical thread or screw 41 that extends from a first end 21 of the bowl 20 to a second end 22 of the bowl 20. Supports 105 on a base 105a support the centrifuge (bowl, conveyor, outer housing, and other components). The supports 105 may themselves be supported on a skid.

A plurality of support rods 49 are disposed within the continuous helical thread 41 and are connected at points of contact to flights 42 of the continuous helical thread 41, e.g. by bolting and/or welding. The flights 42 are sized so that they are separated a desired distance from the interior surface of the bowl 20 along the bowl's length. The edges of the flights may be lined with side-
by-side pieces or tiles made of sintered tungsten carbide or the edges themselves may be hard-faced (as may any part of the apparatus). An end plate (not shown) is at one end of the continuous helical thread 41, connected e.g. by welding, and an end plate 47 is at the other end.

Baffles (not shown) are attached to the rods 49 to provide support and attachment points for the shafts (trunnions) that support the conveyor. Additional baffles may be used at any point in the conveyor for added strength and/or for apparatus attachment points.

Areas 51 between the rods 49 and the flights 42 (between each rod part and each flight part) are open to fluid flow therethrough. Alternatively portions of the conveyor may be closed off (i.e. areas between rod parts and flights are not open to fluid flow), e.g. but not limited to, closing off the left one quarter or one-third and/or the right one-quarter or one-third thereof; i.e., all or only a portion of the conveyor may be "caged". Due to the openness of the caged conveyor (and the fact that, in certain aspects, fluid is fed in a non-focused manner and is not fed at a point or points adjacent the pool in the bowl or prior to the beach, and fluid is not fed from within the conveyor through a number of ports or orifices - as in the prior art fluid is fed out through several ports or areas that tend to focus fluid flow from the conveyor), solids in this fluid do not encounter the areas of relatively high turbulence associated with certain of the prior art feed methods and solids tend more to flow in a desired direction toward solids outlet(s) rather than in an undesired direction away from the beach and toward liquid outlets.

The bowl 20 has a conical or "beach" end with a beach section. The beach section may be (and, preferably, is) at an angle, in certain preferred embodiments, of between 3 and 15 degrees to the longitudinal axis of the
bowl 20.

A flange 26 of the bowl 20 is secured to a bowl head 27 that has a channel 28 therethrough. A flange 29 of the bowl 20 is secured to a bowl head 30 that has a channel therethrough. A shaft 32 is drivingly interconnected with a gear system 81 of a transmission 80. A shaft 31 has a channel 35 therethrough through which fluid is introduced into the centrifuge 10. A motor M (shown schematically) interconnected (e.g. via one or more belts) with a driven sheave 110 selectively rotates the bowl 20 and its head 27 which is interconnected with the gear system 81 of the transmission 80 (and turning the bowl 20 thus results in turning of a shaft 34).

A shaft 32 projecting from the transmission 80 is connected to the shaft 34. The transmission 80 includes a gear system 81 interconnected with pinion shaft 82 which can be selectively backdriven by a Roots XLP WHISPAIR® blower (not shown -- available from Roots Blowers and Compressors: see www.rootsblower.com), or other suitable pneumatic backdrive device connected thereto via a coupling (not shown) to change, via the gear system 81, the rotation speed of the shaft 32 and, therefore, of the conveyor 40. The blower has an adjustable air inlet valve and an adjustable air outlet valve (the conveyor speed is adjustable by adjusting either or both valves). The amount of air intake by the blower determines the resistance felt by the pinion shaft 82 that, via gear system 81, adjusts the speed difference between the conveyor 40 and the bowl 20. Alternatively a non-pneumatic backdrive may be used. The gear system 81 (shown schematically by the dotted line in the transmission 80) may be any known centrifuge gear system, e.g. but not limited to a known two-stage planetary star and cluster gear system.

Optionally, the shaft 82 is coupled to a throttle
apparatus (not shown) that, in one aspect includes a pneumactic pump, e.g. an adjustable positive displacement pump (e.g. air, pneumatic, or non pneumatic) connected to the shaft 82 to provide an adjustable backdrive.

Solids exit through four solids outlet 36 (two shown) in the bowl 20 and liquid exits through liquid outlets 37 in the bowl 20. There may be one, two, three, four, five, six or more outlets 36 and 37. There are, in one aspect, four spaced-apart outlets 37 (two shown).

The shaft 34 extends through a pillow block bearing 83 and has a plurality of grease ports 84 in communication with grease channels 85, 86 and 87 for lubrication of the bearings and shafts. Bearings 100 adjacent the shaft 34 facilitate movement of the shaft 34. Internal bearings can be lubricated, ringed, and sealed by seals 102 (that retain lubricant).

An end 109 of the shaft 31 extends through the driven sheave 110.

Mount rings 120, 121 secured at either end of the bowl 20 facilitate sealing of the bowl 20 within the housing 12. Two ploughs 148 (one, two, three four or more) on the bowl 20 scrape or wipe the area around solids outlets 36 so the outlets are not plugged and maintain or increase product radial speed as the bowl rotates to facilitate solids exit. The ploughs 148 also reduce bowl drag on the housing by reducing solids accumulation around solids exit points.

A feed tube 230 with a flange 147 extends through the interior of the input shaft 31. The feed tube 230 has an outlet end 231. Fluid to be treated flows into an inlet end (left side in Fig. 2) of the feed tube 230.

 Optionally, one or a plurality of spaced-apart pool surface diffusers 125 are secured to the conveyor and diffuse or interrupt the unwanted flow of floating solids away from the beach area. Solids may tend to move in
upper layers (slurry-like material with solids therein) of material flowing away from the beach area and toward the liquid outlets 37. Diffusers 125 extend into these upper layers so that the solids in the upper slurry layer are pushed down by the diffusers and/or hit the diffusers and fall down and out from the upper flowing slurry layer into lower areas or layers not flowing as fast and/or which are relatively stable as compared to the layers so that the solids can then continue on within the bowl toward the inner bowl wall and then toward the beach.

Optionally, a plurality of spaced-apart traction strips or rods 126 facilitate movement of the solids to the beach and facilitate agglomeration of solids and solids build up to facilitate solids conveyance.

Material to be processed exits and enters into a conical portion of a chamber 240 through an entrance opening 241. Although the chamber 240 is generally conical, it may be any desired cross-sectional shape, including, but not limited to cylindrical (uniformly round in cross-section from one end to the other) or polygonal (e.g. square, triangular, rectangular in cross-section). Items 230, 240, 242 and 244 may be welded together as a unit.

The end of the feed tube 230 within the conveyor 40 extends through a mounting plate 242 and a hollow pipe 243. The pipe 243 and a portion of the chamber 240 are supported in a support member 244. A support ring 246, connected to rods 49 (three shown; four spaced-apart around the conveyor as in Fig. 2), supports the other end of the chamber 240. Impellers 250 secured to (welded, or bolted) (or the impellers and nose member are an integral piece, e.g. cast as a single piece) nose member 260 have forward end portions 252 that abut an end of the chamber 240 and project into a fluid passage end 247 of the chamber 240 from which fluid exits from the chamber 240.
In one particular aspect the distance from the exit end 231 of the feed tube 230 to the fluid passage end 247 of the chamber 240 is about 36 inches (0.91m). In other embodiments this distance is at least 19 inches (0.48m) and preferably at least 20 inches (0.51m). It is also within the scope of this invention for the exit end of the feed tube to be within the pipe 243. The nose member 260 has a solid plate portion 262 and a nose 264. In one aspect all parts 240 - 260 are bolted or otherwise removably connected to the conveyor for easy removal and replacement. Alternatively, they may be welded in place.

In use, feed material is fed through the feed tube 230 into the centrifuge. The feed material passes through the chamber 240 and impinges on the impellers 250 with a component of velocity substantially parallel to the longitudinal axis of the centrifuge 210. Whilst moving with this velocity the impellers 250 impart a component of velocity in the radial direction (i.e. transverse to the longitudinal axis of the centrifuge) so as to spread the feed material onto the beach section. This enables the feed material to be spread from along substantially the length of the impellers over the beach section, which reduces the turbulent effect that this has on the existing feed material on the beach. Furthermore, feeding the feed material onto the beach has the additional advantage that heavy solids are filtered almost immediately, leaving the fluid and solids in suspension to be treated by the pool area of the centrifuge. In this way, the efficiency of the centrifuge is enhanced as there is a greater amount of time for the pool area to separate solids in suspension as the heavy solids are present to a lesser extent in this region. The contamination effect of heavy solids on the liquid is reduced; additionally, the energy required to drive the centrifuge is reduced.
One particular difficulty that the applicant has encountered with a centrifuge as shown in Figs. OA’ and OA’’ is that the high feed rates (e.g. 0.032m$^3$s$^{-1}$ - 500 gallons per minute) combined with the high speed of rotation (e.g. 1000 to 3200 rpm) can cause wear to that part of the metal support rods 49 and metal flights 42 adjacent the impellers 250. Such wear can be a particular problem when separating slurry such as mud from the drilling of an oil well. After a period of operation it becomes necessary to repair or replace the conveyor for structural integrity considerations and to maintain the dynamic balance of the centrifuge. Repair is usually attempted by welding to restore the mass that has been worn away. However, repair of the support rods 49 and flights 42 is problematic as the heat from welding can distort them. This is unacceptable as the dynamic balance of the centrifuge may be altered. Because of their relatively close disposition and the structure they form, the inner surfaces (which are worn) are hard to access. Furthermore the applicant has not found it possible to attach a suitable heat sink for the same reason.

Referring to Fig. 1A a centrifuge generally identified by reference numeral 500 comprises a rotatable bowl 520 within which is rotatably mounted a conveyor 540. The bowl 520 may be mounted within any suitable housing or case, including those disclosed or referred to herein. A shaft 544 projecting from the conveyor 540 is driven by motor and gearing apparatus (not shown; e.g. like that in Fig. OA’ and OA’’). Referring to Fig 1B an end view (from the left in Fig. 1) shows a gearing apparatus connected with the shaft 544 for driving the same.

The conveyor 540 comprises two parts: a substantially cylindrical first section of 0.465m length and 0.341m external diameter located in the pool region
of the bowl 520, and a second section of 0.695m length, 0.341m external diameter at its wide end and 0.258m external diameter at its narrow end with varying reduction in diameter along its length (to be described below). One end of the substantially cylindrical first section is welded to the wide end of the second section during construction to form the conveyor 540. The cylindrical section comprises a tubular section of cast iron with a solid outer surface, and the second section comprises a cast iron mounting apparatus that will be described in greater detail below.

A helical screw apparatus 543 is then secured (e.g. by welding) to the outside of the conveyor 540. The helical screw apparatus 543 provides a space between the conveyor 540 and the main body of the helical screw apparatus 543 that, other than the attachment points to the conveyor 540, substantially surrounds the conveyor 540. In this way fluid in the centrifuge 500 can move predominantly axially toward the fluid outlets, rather than having to move predominantly radially around the path defined by the screw apparatus to reach the fluid outlets. This space is provided along substantially the entire length of the conveyor 540 and in particular along the second section of the bowl 520. In this second section this space accommodates part of an accelerator apparatus as will be described in greater detail below.

Referring additionally to Figs. 2A to 2C the mounting apparatus generally identified by reference numeral 580 has a body 582 comprising two sections of different but constant external diameter and two sections of tapering diameter, the arrangement being such that the mounting apparatus has a greater external diameter at one end than at the other. The body 582 is cast from iron. Casting of the mounting apparatus 580 allows it to be made relatively quickly, easily and cheaply compared to
fabrication methods. A first end of the mounting apparatus 580 comprises a first portion of constant external diameter substantially equal to the external diameter of the cylindrical section with a lip at one end to accommodate the same. A first tapered section joins the first portion to a second portion of constant external diameter less than the first portion, which second portion occupies the majority of the length of the mounting apparatus 580. The second portion joins a second tapered portion at a second end of the mounting apparatus.

The body 582 has a central axial bore (of between about 0.013m and 0.15m diameter) in communication with four slots 585 disposed equi-circumferentially around the circumference of the body at 90° intervals. Thus the body 582 has a substantially solid outer surface but for the slots 585. Each slot 585 has a width of 0.067m. Four lobes 584, each of which is formed in the second portion of the body 582 and extends for the same length therealong i.e. approximately 0.43m, define the slots 585 and axial bore. Each lobe 584 has a shape in end cross-section (see Fig. 2B) comprising: a radially inner curved surface defining part of the central axial bore; a radial surface lying on a radius of the body 582 and extending between the inner curved surface and the outer surface of the body; a tangential surface substantially perpendicular to the radial surface but not lying a radius of the body 582, and extending between the inner curved surface and the outer surface of the body; and an outer curved surface formed by the curved outer surface of second section of the body 582. Thus each slot 585 is defined by a radial surface of one lobe 584 and a tangential surface of an adjacent lobe 584. The end cross-sectional area of each lobe is approximately 0.012m² and therefore the volume of each lobe 584 is
approximately 0.005m³. The total volume enclosed by the second portion of the mounting apparatus is about 0.04m³ and the volume of the four lobes 584 is approximately 50% of the volume enclosed by the second portion. Each lobe 584 is provided with a bolt hole for receiving a bolt for mounting an accelerator apparatus to the mounting apparatus as described in greater detail below.

Each slot 585 extends from the second portion of the body, over the first tapered portion of the body and onto the first portion of the body. In this way the slot comprises two portions of differing diameter whereby a component having parts of a larger external diameter than the second portion of the body may be inserted axially into the mounting apparatus 580 via the first portion, with the larger diameter parts being accommodated in and projecting out of the slots 585 in the second portion. It will be appreciated that the internal diameter of the first portion of the body 582 determines the larger diameter that can be accommodated in the second portion.

The forward end of the mounting apparatus 580 comprises a flange on the inner diameter of the body 582, which flange has an axial opening 586 for receiving a feed tube (not shown). The flange permits the mounting apparatus to be mounted to a shaft (not shown) that supports the conveyor 540 in the bowl 520. The flange leads to a portion that provides support for a feed tube (see Fig. 1A).

The internal diameter of the cylindrical section is such that, during manufacture/repair, the accelerator apparatus 570 can be inserted through an open end 545 of the cylindrical section of the conveyor 540 and into the mounting apparatus 580 (from left to right as shown in Fig. 1A). The accelerator apparatus 570 is secured with bolts 592 passing into holes 587 of the mounting apparatus 580.
The accelerator apparatus 570 comprises a nose 590 integral with a base 591 through which the aforementioned bolts pass. The integral nose 590 projects substantially perpendicularly to the plane of the base and centrally therefrom. The accelerator apparatus also comprises four impellers 572, the tips of which are disposed equi-circumferentially around the nose. Each impeller 572 comprises a body that is attached to the nose member at a point not radially opposite the tip of the impeller. The shape of the body in end cross-section is similar to an elongated “S” with the upper part of the “S” being more elongated than the lower part. The impellers 572 extend forwardly of the nose 590 to define an opening (in side view—see Fig. 3A). As shown in Fig. 1A the impellers 572 are relatively long (particularly as compared to parts of accelerating apparatus in various prior art centrifuges) and the impellers 572 span multiple openings (about five as shown in Fig. 1A) between the flights of the helical screw apparatus 543.

The accelerator apparatus 570 is inserted into the mounting apparatus 580 such that the tip of each impeller is accommodated in a respective slot 585. As is apparent from the description of the construction of the mounting apparatus as described above, the tips of the impellers can lie on a diameter greater than that part of the mounting apparatus in which they are accommodated, whilst the accelerator apparatus can still be inserted into and removed from the mounting apparatus. Thus, after a period of use, the accelerator apparatus 570 can be removed from the conveyor 540 and replaced if necessary.

The bolt holes 587 in the lobes 584 and the corresponding bolt holes in the base of the nose 590 are such that the tips of the impellers 572 are positioned substantially centrally in the slots 585 to define a first channel 576 and a second channel 577 (see Fig. 1D).
Figs. 1C, 1D and 1F show alternative constructions for the mounting apparatus. In Fig. 1C the longer straight side of each lobe 584 (the tangential side as described with reference to Figs. 2A-2C) is 0.12m in length, and the shorter straight side (the radial side as described with reference to Figs. 2A-2C) is 0.10m in length. The length of the outer curved side is approximately 0.16m. The join between each straight side and the curved outer side is rounded with a radius of curvature of approximately 0.02m. The width of each slot is 0.08m.

Referring to Figs. 1E and 1F the tips of the impellers lie on a circumference of greater diameter than the diameter of the base of the nose 590a. When inserted into the mounting apparatus, the tips of the impellers project out of the slots 585 and are accommodated in the space defined by the helical screw apparatus 543 as described above. As shown in Fig. 1D the impellers may lie on a circumference that is smaller in diameter than body 582 of the mounting apparatus 580. Another possibility is for the tips of the impellers to be on a circumference of substantially the same diameter as the body 582.

As shown in Fig. 1A a fluid exit end 501a of the feed tube 501 is spaced apart from an end 593 of the nose member 590. The end 593 is in the form of a truncated cone. Any desired distance may be used for the spacing between the end 593 and the fluid exit end 501a. However, it is preferred that the length of the feed tube 501 is a short as possible. In one particular aspect the fluid exit end 501a is within the impellers 572. In another aspect the end 593 of the nose member 590 projects into the fluid exit end 501a of the feed tube 501. In certain aspects the impellers 572 are at least 15% of the length of the bowl 520 and may be up to 95% of this length.

In use, the bowl 520 and conveyor 540 are rotated at
slightly different speeds. The bowl may be rotated a speed of 1000-3200rpm for example and the conveyor slightly slower. Referring to Fig. 1D the bowl and conveyor are rotated in an anti-clockwise sense. Feed material (e.g. drilling mud with a proportion of solids therein) to be separated by the centrifuge 500 is fed into the conveyor 540 through the feed tube 501. The feed material enters the centrifuge 500 with a velocity that is mainly substantially parallel to the longitudinal axis of the centrifuge. The majority of the feed material initially impinges on the end 593 of the nose 590. Feed material is dispersed around and along the nose by the end 593 and is split between the impellers 572. Due to the rotational speed of the conveyor 540 radial and rotational speed is imparted to the feed material whilst it is still moving axially and the feed material is moved outwardly along one surface of each impeller 572. This surface is the leading surface of each impeller 572 such that feed material is caused to leave the impeller through the channel 576 (Fig. 1D). No feed leaves the accelerator apparatus through the channel 577. The applicant has noticed that after a period of use a leading edge 577' of the lobes 584 behind (in the rotational sense) each impeller 572 becomes worn (the worn area being shown in solid shading in Fig. 1D). No wear is caused to the trailing edge 577'' of the lobe 584 in front of the impeller 572. It is believed that this wear is due to feed material slowing down after leaving the tip of the impeller 572, whilst the mounting apparatus 580 continues to rotate. Thus a portion of the feed material impinges on the lobe 584 immediately behind the impeller 572 and wears it away over a period of time. To counter this the applicant has adapted the apparatus such that the impellers 572 have the same or greater diameter than the mounting apparatus 580 (see. Figs. 1E,
1F, 3A-3C). It was found that the rate of wear is reduced, but wear still occurred to the leading edge 577' of each lobe. It is inadvisable to leave to this wear unrepairsld. The wear can disrupt the dynamic balance of the centrifuge as, resulting from the wear, weight may not necessarily be evenly distributed around the mounting apparatus.

As the lobes 584 are comparatively large, they provide firstly an element of durability and mechanical integrity, extending intervals between repairs. The lobes 584 also provide an element of sacrificial mass that can be worn away by feed material substantially without disrupting the dynamic balance of the centrifuge 500. Secondly, when the centrifuge must be repaired the lobes 584 have sufficient heat capacity (in this case each lobe has a heat capacity of approximately 17700 JK\textsuperscript{-1}, assuming the density of cast iron is 7870 kgm\textsuperscript{-3} and the heat capacity is 449 JKg\textsuperscript{-1}K\textsuperscript{-1}) to permit repair by welding substantially without distorting the conveyor 540 or the flights. Furthermore, the centrifuge can be repaired in situ.

The position of the impeller tip in gap between the lobes 584 is such that (1) the feed material can pass off the leading face of each impeller 572 through the channel 576; and (2) define the space 577 which provides time for most of the feed material to move away from the mounting apparatus once it has left the tip of the impeller 572, whereby wear on the lobe 584 is reduced. If the tip of the impeller 572 is flush with or at a greater diameter than the mounting apparatus, the gap 577 can be smaller in width than the arrangement shown in Fig. 1D. However, the applicant has found that it is still beneficial for there to be some gap 577 present. Ideally the tip of the impeller 572 is positioned substantially centrally in the gap between lobes 584 and is flush with or at a greater
diameter than the external diameter of the mounting apparatus 580. The applicant has found that a larger gap between lobes 584 adjacent the impeller tips increases the frequency of repairs needed to the conveyor. This is because there is less sacrificial mass to be worn down just behind the impeller tips. Therefore it is ideal to have the impeller tips positioned substantially centrally and a small size of gap e.g. 0.06m, with 0.05-0.08m being preferable.

As described above feed material entering the centrifuge 500 from the feed tube 501 is moving at a high velocity in a generally axial direction. The accelerator apparatus 570 forces a gradual change in velocity of the feed material. If this change in direction is done abruptly and in a forced manner (as occurs in various prior art centrifuges) material may be subjected to an undesirable shear force. By using the relatively long impellers 572, the long nose 590, and relatively large channels through the mounting apparatus 580, feed material from the feed tube 501 moves along the nose apparatus 590 and its axial flow direction is gradually changed to a radial (outward) flow direction by the impellers 572. These features also insure that no pool or volume of liquid is formed within the mounting apparatus 580. Undesirable coriolis forces formed within the pools in the conveyor hubs of the systems disclosed in the prior art are not encountered within the conveyor and mounting apparatus described herein.

As fluid moves down along the nose apparatus 590 it moves outwardly and is directed radially by the impellers 572. The S-curved shape of the impellers 572 (as viewed, e.g. in Fig. 1D) efficiently and smoothly accelerates the fluid radially. The large surface area provided by both the "S" shape and the length of the impellers 572 leads to a greater retention time of feed material on the
impellers, thereby increasing the opportunity and time for the feed material to be accelerated to the rotational speed of the bowl. Since the change in direction (axial to radial) is more gradual due to the relatively extended length of the impellers 572, shearing of material in the fluid is reduced. This can be important when shearing of material in the fluid is undesirable, e.g. the shearing of polymers in a feed slurry.

The relatively long length of the impellers 572 also provides for spreading out of feed material along a relatively longer length of the bowl. As shown in Fig. 1A, feed material flows out from the conveyor along a substantial part of a bowl beach area 521 with a length 521a within the bowl, i.e., the impellers 572 of the accelerator apparatus 570 spread the feed material out along the beach area.

During use of the centrifuge 500, a liquid pool region forms radially inwardly of solids that accumulate against the inner wall of the bowl 520. Fluid is able to move with an axial component of velocity along the centrifuge toward ports 506 through the space defined between the flights and the conveyor. Liquid (e.g. drilling mud) is discharged from the bowl 520 through the ports 506 (five present, one shown). Solids are discharged from solids discharge ports (not shown in Fig. 1A). The bowl 520 may be used with a head like the head shown in Fig. 1G described below).

Referring to Figs. 3A - 3C a fourth embodiment of an accelerator apparatus identified by reference numeral 570g comprises impellers 572h and a nose member 590a.

Referring to Fig. 1G and 1H a mount generally identified by reference numeral 530 is used to mount the centrifuge 500 to a base or skid (not shown). The mount 530 comprises a body provided with eight projections 531 (shown in cut-away in Fig. 1H). The projections 531 are
spaced equi-circumferentially around the edge of the base and project substantially perpendicularly to plane of the base. Openings 543 are defined between the projections 531. Each projection 531 has a hole 532 therethrough for receiving a respective bolt 533 that passes through a corresponding hole 529 in a flange of the bowl part 528 to secure the bowl 520 to the head 530. An interior space is thus defined by the head 530 which is an extension of the space defined within the bowl 520. In use, solids are pushed up the beach 521 by the conveyor 540 and exit through ports 534. The head 530 is interconnectable with suitable apparatus (not shown) for rotating the bowl 520.

Figs. 4A-4C show a centrifuge system generally identified by reference numeral 600 that has a centrifuge 602 (like the centrifuge 500 of Fig. 1A; but which may be any suitable bowl and conveyor) housed within a removable cover 611 of a housing 610. The housing 610 includes a base portion 612 and a motor support portion 614. A motor 620 drives a bowl 604 via belts 621 and a motor 622 drives (or brakes) a gear device 625 via a belt 623. Pillow blocks 624 are used as supports. Suitable gear apparatus 625 is used with the motors 622. Optionally a grate 616 is provided on the motor support portion 614 of the housing 610. A cover 611 encompasses a top portion of the bowl 604 and is secured in place with securement devices 615. Alternatively, it is hingedly connected to the housing 610.

Rather than being fabricated from sheet metal, the base portion 612 and support portion 614 are cast integrally, considerably reducing manufacturing time and cost.

In various prior art apparatuses a separate centrifuge case is bolted to a skid base or other support and supports for motor(s) are also bolted to such a skid or support. According to the present invention various
pieces are part of the integral housing 610 in which the mass required (as compared to the compound prior art apparatus) is reduced resulting in more efficient assembly and ease of transport. Due to reduced overall weight, transport is facilitated and is less expensive.

It is within the scope of this invention to configure and dimension the accelerator apparatus 570 and the space 542 to provide feed anywhere along the length of the conveyor.

In one aspect, the space 542 of the substantially cylindrical section is deleted and the impellers of the accelerator apparatus extend along substantially the entire length of the conveyor. In one particular aspect in a conveyor that is about 1.23m (4 feet) long and 0.46m (1.5 feet) in diameter, the empty space is about 0.61m (2 feet) long and about 0.30m (1 foot) in diameter.

The accelerator apparatus can be welded to the mounting apparatus and/or to the conveyor. Optionally, the portion of the nose apparatus 590 projecting from an end plate 591 can be deleted.

All or part of the body 582 may be substantially in the form of a truncated cone.

The channels 585 are sized to facilitate the flow of fluid from the impellers 572 and out from the mounting apparatus 580. In one aspect with a conveyor 1.22m (4 feet) long, impellers 0.46m (1.5 feet) long, and a beach 0.61m (2 feet) long, the channels 585 are 0.46m (1.5 feet) long.

Although the mounting apparatus 580 as shown in Fig. 2B has four lobes 584 and four channels 585 (and a corresponding accelerator apparatus 570 with four vanes 572 may be used with it), it is within the scope of this invention to use one, two, three, four, five, six, seven, eight or more impellers and a corresponding number of lobes within the mounting apparatus. For example Fig 1E
shows an accelerator apparatus 570s with three vanes 579a extending from a nose member 579b. An arrow indicates direction of rotation of the accelerator apparatus 579. Optionally, flow diverters 579c are used on the impeller ends.

In one aspect, the impellers 572 have a relatively uniform width along their entire length and ends 574 of the impellers 572 are as wide as a body 575 of the impellers 572. In other aspects the impellers gradually widen as they project out from the nose 590. The impellers 572 may be any desired width. As viewed in Figs. 1D, 1E and 1F the impellers 572 have a generally "S" curved shape that facilitates directing accelerated fluid out of channels 576. Fluid does not flow out through channels 577 and, in one aspect, the channels 577 are closed off and/or the impellers are positioned against surfaces of the mounting apparatus, enlarging the channels 576 and eliminating the channels 577, e.g. as shown in Fig. 1F in which impellers 570b of an accelerator 570a according to the present invention contact lobes 580b of a mounting apparatus 580a. The impellers 570b are connected to a nose 570d. The lobes 580b, optionally, have a curved surface 580c.

In one particular aspect with a conveyor 540 that is about 1.22m (4 feet) long, the impellers 572 are about 0.46m (1.5 feet) long, and the beach 521 is about 0.61m (2 feet) long. In certain aspects the length of the impellers 572 is at least 50%, at least 75% or is between 50% and 95% of the length of the beach 521. However, it is also within the scope of the present invention to position the accelerator apparatus adjacent portions of the bowl other than (or in addition to) adjacent a beach area of a bowl.

In certain aspects the impellers 572 accelerate fluid to 90%, to 95%, or up to 99%, or up to more than
100% (e.g. up to 105%, 110%, 115%, 120% or more) of the rotating speed of the bowl 520. Thus the fluid enters the bowl 520 at a speed greater than, equal to or almost equal to the speed of the bowl 520. By introducing fluid into the bowl at such velocities, fluid slippage (fluid rotating at less than bowl speed) within the bowl itself is reduced and the fluid is processed more efficiently receiving the benefit of forces generated within the bowl by fluid movement; separated solids moving within the bowl to a discharge outlet are not as disturbed by fluid exiting the conveyor (as can occur due to the focused feed and jetting effects of fluid with various prior art systems); and solids within the pool that have not yet been efficiently separated are relatively undisturbed.

Any suitable known motor, transmission, gear apparatus, housing, supports, etc. may be used with the centrifuge 500 including, but not limited to, those disclosed and referred to herein. Also, the accelerator apparatus 570 may be used in centrifuges that have either a generally vertical or generally horizontal orientation in use; or in any suitable centrifuge, including, but not limited to, those disclosed and referred to herein.
CLATMS:

1. A centrifuge for separating feed material into solid and fluid parts, which centrifuge comprises a conveyor rotatably mounted in a rotatable housing, the conveyor having at least one impeller and the rotatable housing having a separating region comprising a pool area and a drying area between the conveyor and a rotatable housing, the arrangement being such that, in use, on entry to the centrifuge said feed material has an axial velocity substantially parallel to the longitudinal axis thereof, the feed material passing through the interior of said conveyor with rotational speed being imparted thereto by said at least one impeller prior to treatment in said separating region, said at least one impeller also imparting radial speed to said feed material whilst it moves with axial velocity such that feed material is spread onto the drying area adjacent the length of the at least one impeller, part of the conveyor being liable to wear by feed material moving from the at least one impeller onto the drying area,

   characterised in that said conveyor comprises a mounting apparatus for (1) providing mechanical integrity to the conveyor and (2) providing a portion to be sacrificed by said wear, the arrangement being such that, in use, the mechanical integrity of the centrifuge is substantially unimpaired by sacrifice of said portion.

2. A centrifuge as claimed in claim 1, wherein said mounting apparatus is such that, after said portion has been worn, repair of said body can be effected substantially without impairing the mechanical integrity of the conveyor.

3. A centrifuge as claimed in claim 1 or 2, wherein said mounting apparatus comprises a lobe member providing said portion for sacrifice, the heat capacity of the remaining portion of the lobe member providing a heat
sink for absorbing heat during repair of the lobe member to inhibit damage to mechanical integrity of the conveyor.

4. A centrifuge as claimed in claim 1, 2 or 3, wherein said mounting apparatus comprises a substantially solid outer surface other than at least one elongate slot along the mounting apparatus for accommodating a part of the at least one impeller, the elongate slot permitting said feed material to pass from the impeller to the drying area in use.

5. A centrifuge as claimed in claim 4, wherein a tip of the at least one impeller is positioned substantially centrally in the width of the at least one elongate slot.

6. A centrifuge as claimed in claim 4 or 5, wherein said tip lies on a circumference of diameter substantially the same or greater than a diameter of a circumference defined by a part of the mounting apparatus.

7. A centrifuge as claimed in claim 6, wherein said mounting apparatus comprises a first portion of a first diameter and an axially spaced second portion of a second diameter less than the diameter of the first portion, and the at least one elongate slot extends across part of the first and second portions whereby the accelerator apparatus maybe inserted into and/or removed from the mounting apparatus during manufacture and/or repair.

8. A centrifuge as claimed in any preceding claim, wherein said at least one impeller is mounted on the mounting apparatus.

9. A centrifuge as claimed in any preceding claim, wherein said at least one impeller is mounted on an accelerator apparatus that is mountable on the mounting apparatus.

10. A centrifuge as claimed in claim 9, wherein said accelerator apparatus is a separate and distinct part to
the mounting apparatus.

11. A centrifuge as claimed in claim 9 or 10, wherein said accelerator apparatus comprises a nose member and a base that has a plane substantially perpendicular to the longitudinal axis of the nose member.

12. A centrifuge as claimed in claim 11, wherein said base comprises means for releasably mounting the accelerator apparatus on said mounting apparatus.

13. A centrifuge as claimed in any preceding claim wherein said portion is adjacent a tip of the at least one impeller.

14. A centrifuge as claimed in claim 13, wherein said portion is behind relative to the intended direction of rotation of the conveyor.

15. A centrifuge as claimed in any preceding claim, wherein a volume of the mounting apparatus is between approximately 40% and 60% of a volume enclosed by that portion of the mounting apparatus of length substantially equal to the length of the at least one impeller.

16. A centrifuge as claimed in any preceding claim wherein said mounting apparatus comprises a metal and/or metal alloy.

17. A centrifuge as claimed in claim 16, wherein said metal comprises iron.

18. A centrifuge as claimed in any preceding claim, further comprising a substantially helical thread mounted around an external surface of said conveyor.

19. A centrifuge as claimed in claim 16, wherein said helical thread defines a space between said external surface and an inner surface of the thread for accommodating a part of the at least one impeller.

20. A centrifuge as claimed in claim 18 or 19, wherein said helical thread defines a space between said external surface and an inner surface of the thread for permitting flow of fluid along the centrifuge with an axial
component of velocity during separation of feed material.
21. For use in a centrifuge as claimed in any preceding claim, a mounting apparatus having the mounting apparatus features of any of claims 1 to 8 and/or 13 to 17.
22. A method of manufacturing a mounting apparatus according to claim 21, which method comprises the steps of casting the mounting apparatus from metal and/or a metal alloy.
23. For use in a centrifuge as claimed in any of claims 1 to 18, an accelerator apparatus having the accelerator apparatus features of any of claims 9 to 12.
24. A method of separating feed material into solid and fluid parts, which method comprises the steps of:
   (1) feeding feed material to a centrifuge as set out in any of claims 1 to 20; and
   (2) rotating the conveyor and rotatable housing to separate the feed material.
25. A method of repairing a centrifuge according to any of claims 1 to 20, which method comprises the step of replacing the portion of sacrificial material.
26. A method as claimed in claim 25, wherein said step of replacing comprises welding sacrificial material to the mounting apparatus.

* * *

27. A centrifuge comprising a bowl and a mount for mounting the bowl on a base, the bowl and the mount being spaced apart by spacing means so as to provide a plurality of openings adjacent an end of the centrifuge for discharge of fluid or solids from the centrifuge.
28. A centrifuge as claimed in claim 27, wherein said bowl and said mount define an internal space adjacent said end, which internal space is an extension of the interior of said bowl and into which, in use, solids or
fluids are ejected from the centrifuge for passage through said openings.

29. A centrifuge as claimed in claims 27 or 28, wherein said spacing means comprises a plurality of projections projecting either from said mount or from said bowl.

30. A centrifuge as claimed in claim 27, 28 or 29, wherein said spacing means comprises means for releasably mounting the mount on the bowl.

31. A centrifuge as claimed in claim 29, wherein said means comprise a bore for receiving a bolt.

*   *   *

32. A base for a centrifuge, which base comprises an integral support structure for, in use, supporting both a centrifuge and motor means for powering the centrifuge.

33. A base as claimed in claim 32, further comprising an integral first housing part for receiving a centrifuge.

34. A base as claimed in claim 33, further comprising a second housing part that co-operates with the first housing part for enclosing a centrifuge during use.

33. A method of manufacturing a base as claimed in claim 32, which method comprises the step of casting the base from metal and/or a metal alloy.