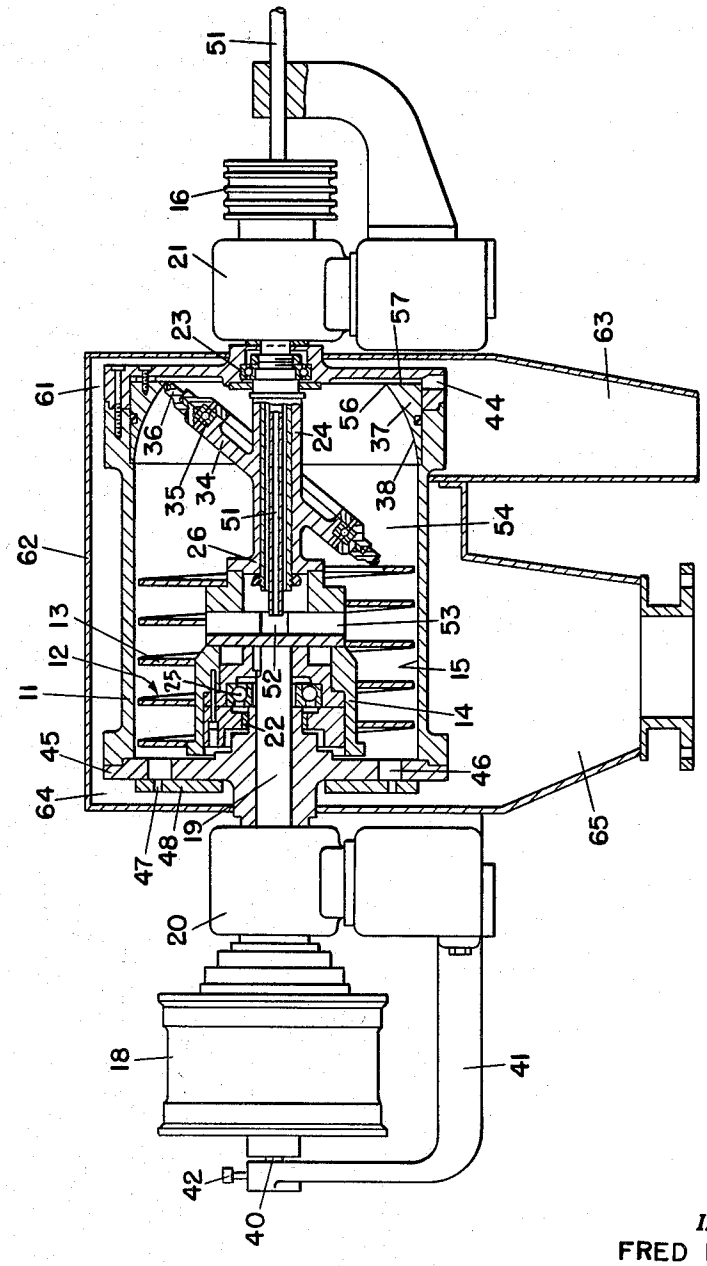
July 23, 1963 F. P. GOOCH 3,098,820

CENTRIFUGE

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Fig. 1



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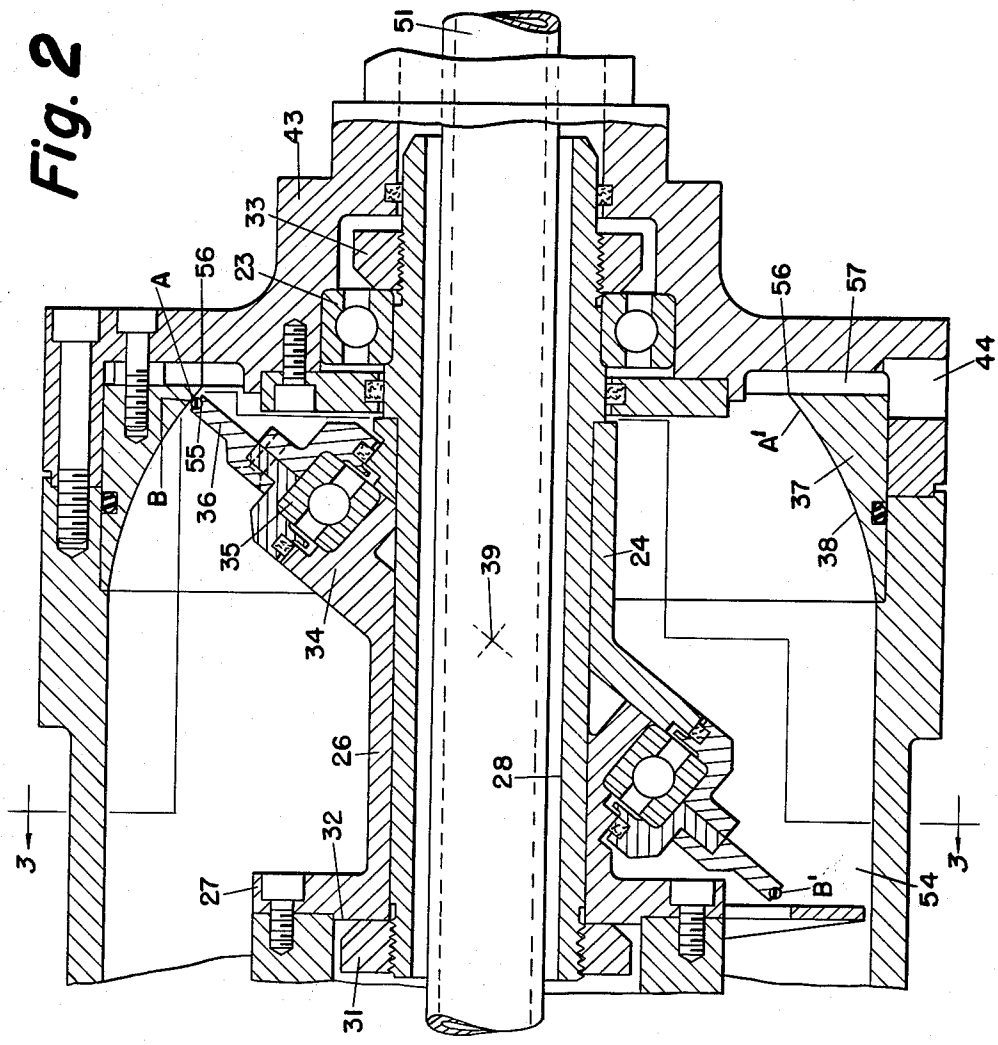
BY Hugo G Kemman
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CENTRIFUGE

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Fig. 2



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CENTRIFUGE

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Fig. 3

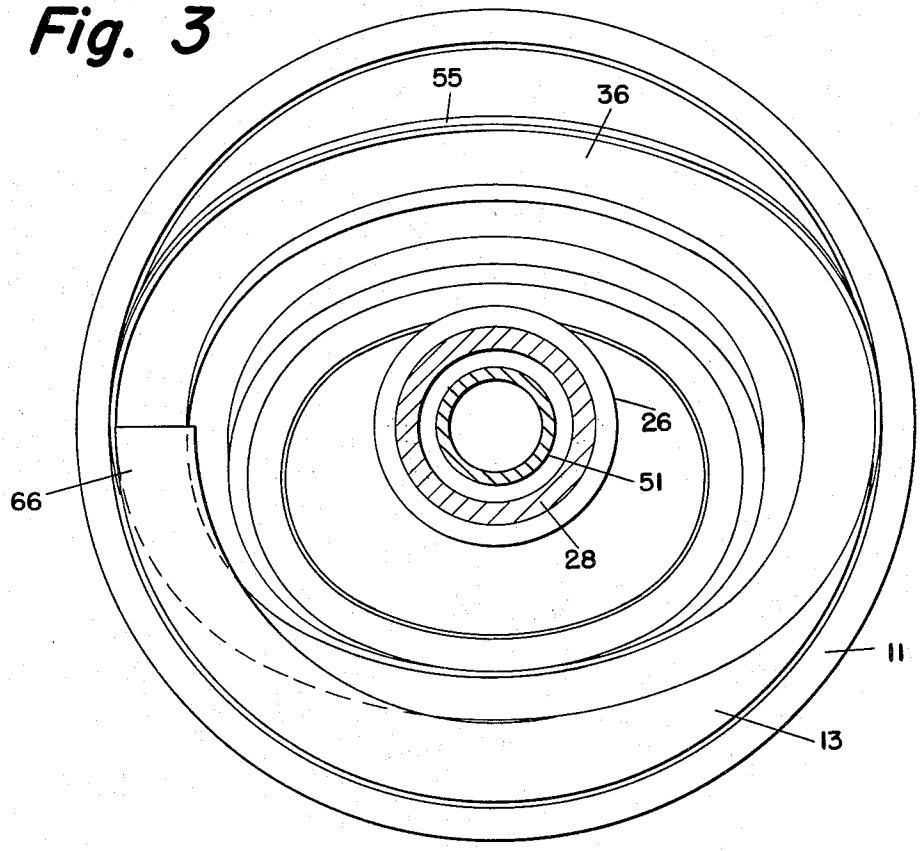
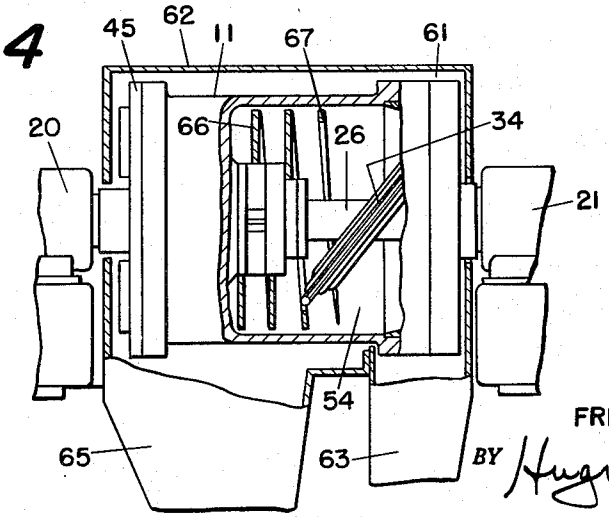


Fig. 4



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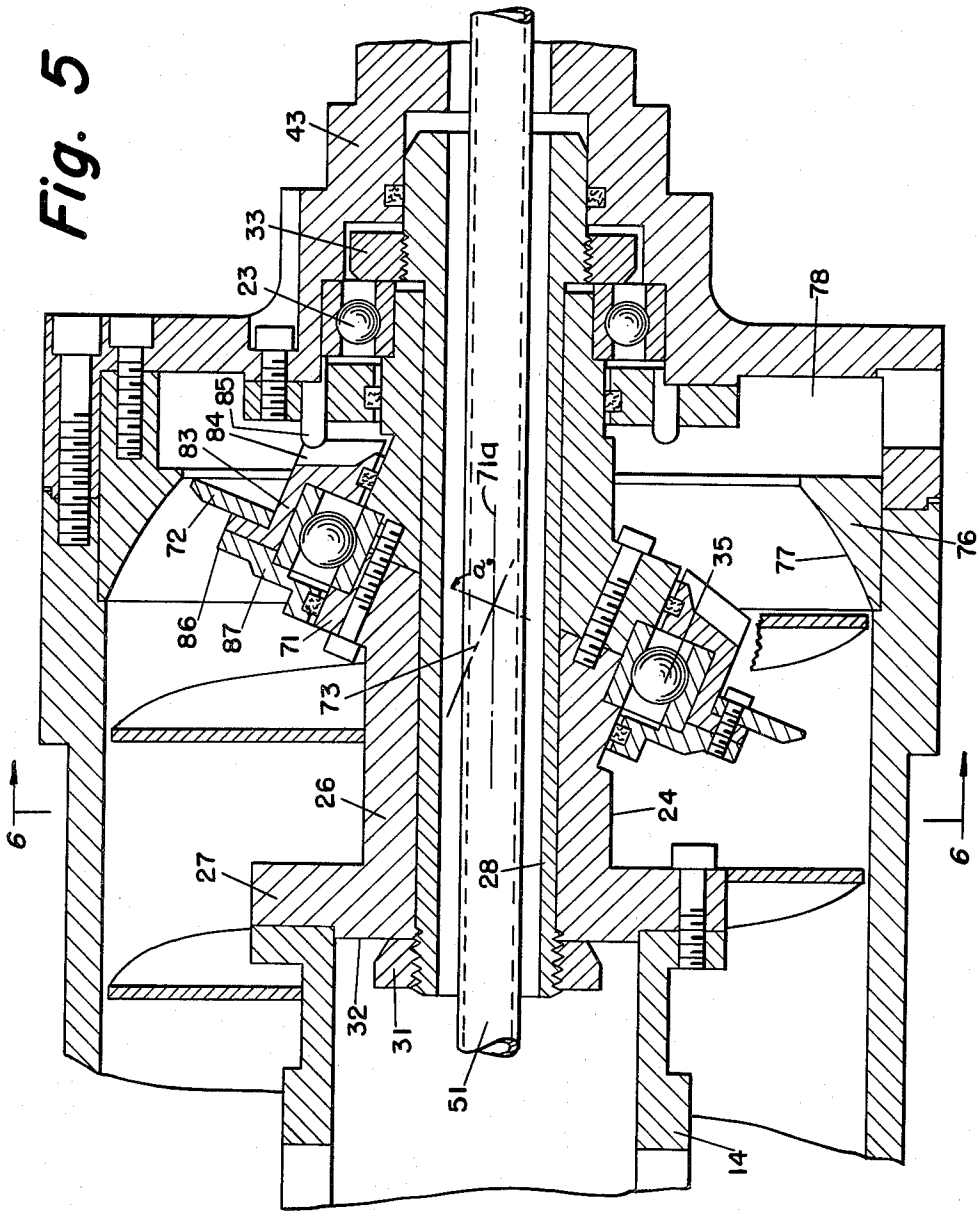
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CENTRIFUGE

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Fig. 5



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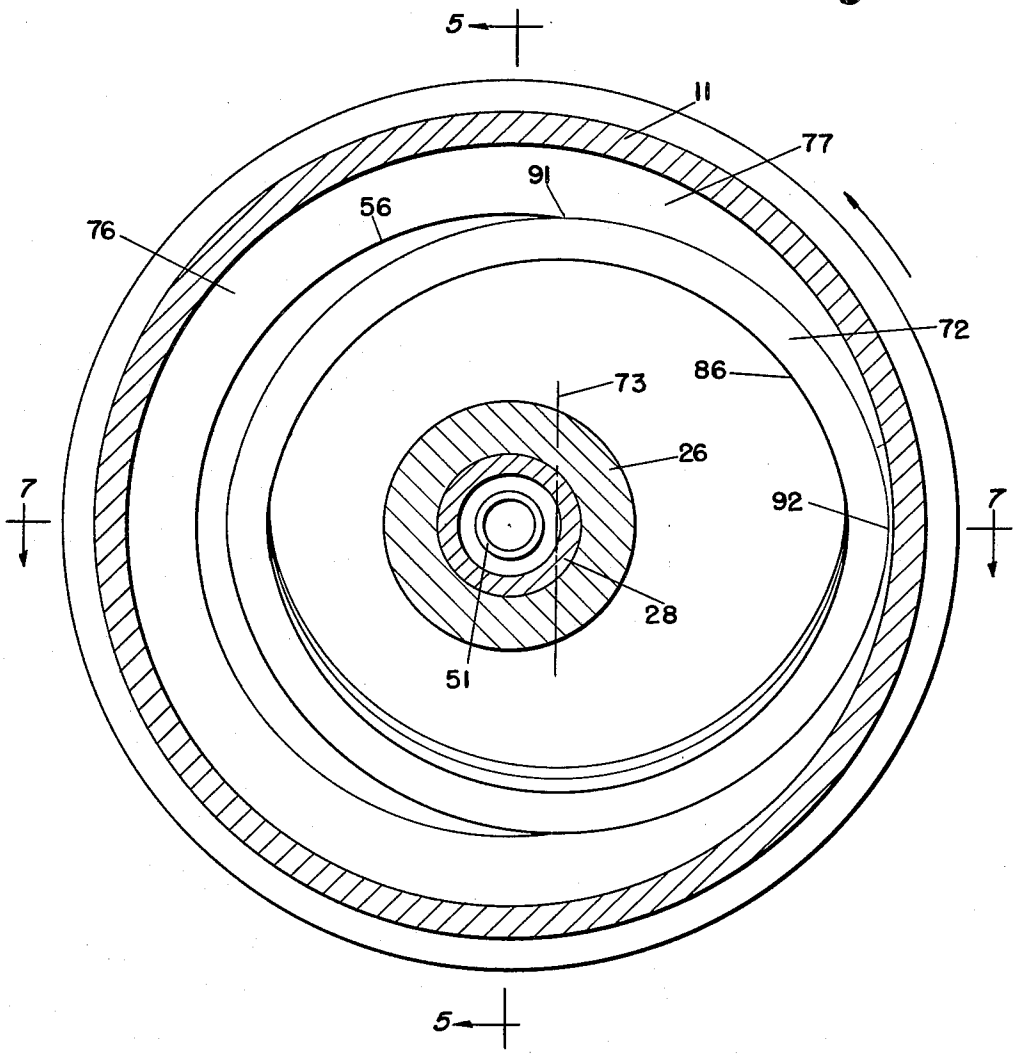
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CENTRIFUGE

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Fig. 6



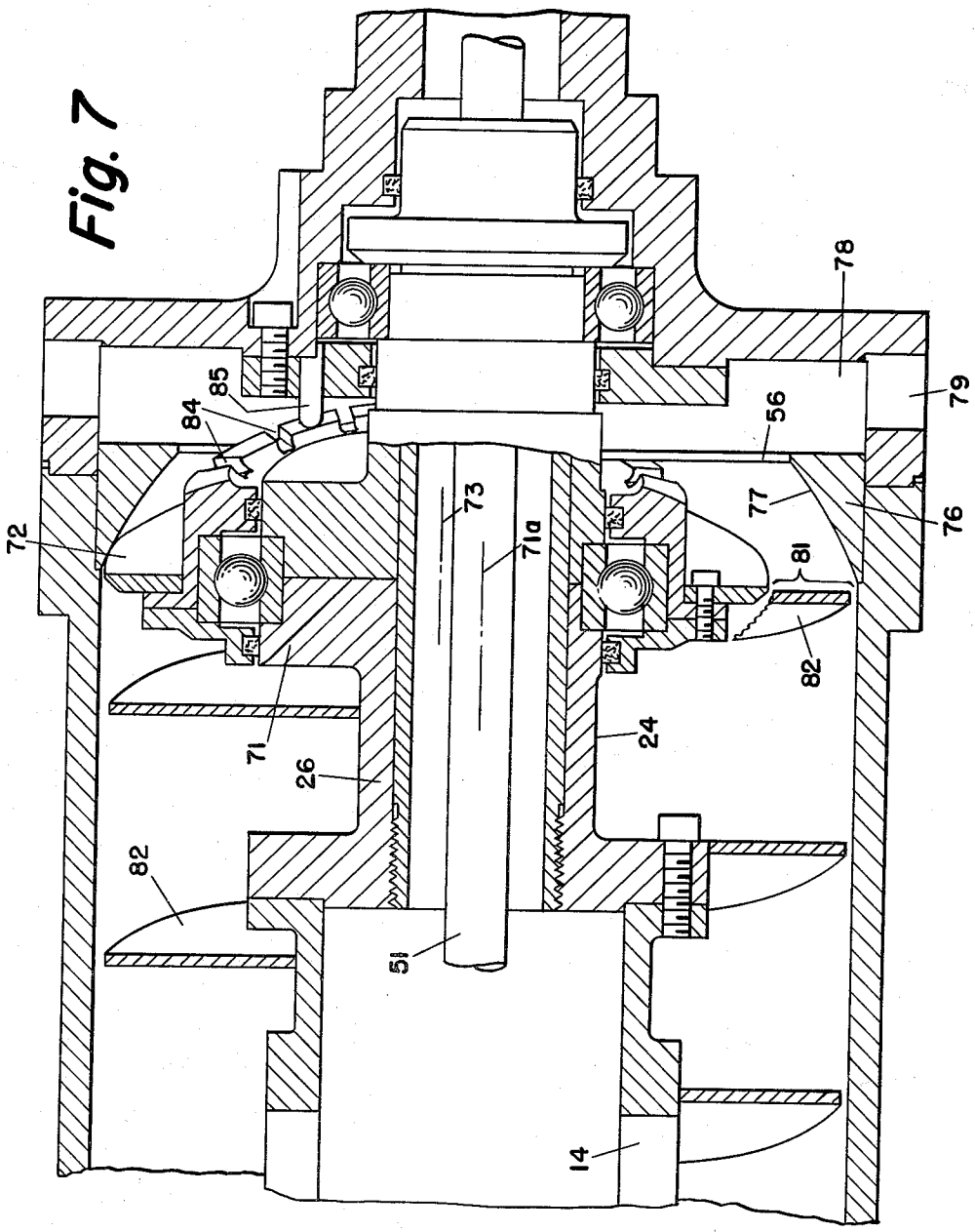
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CENTRIFUGE

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Fig. 7



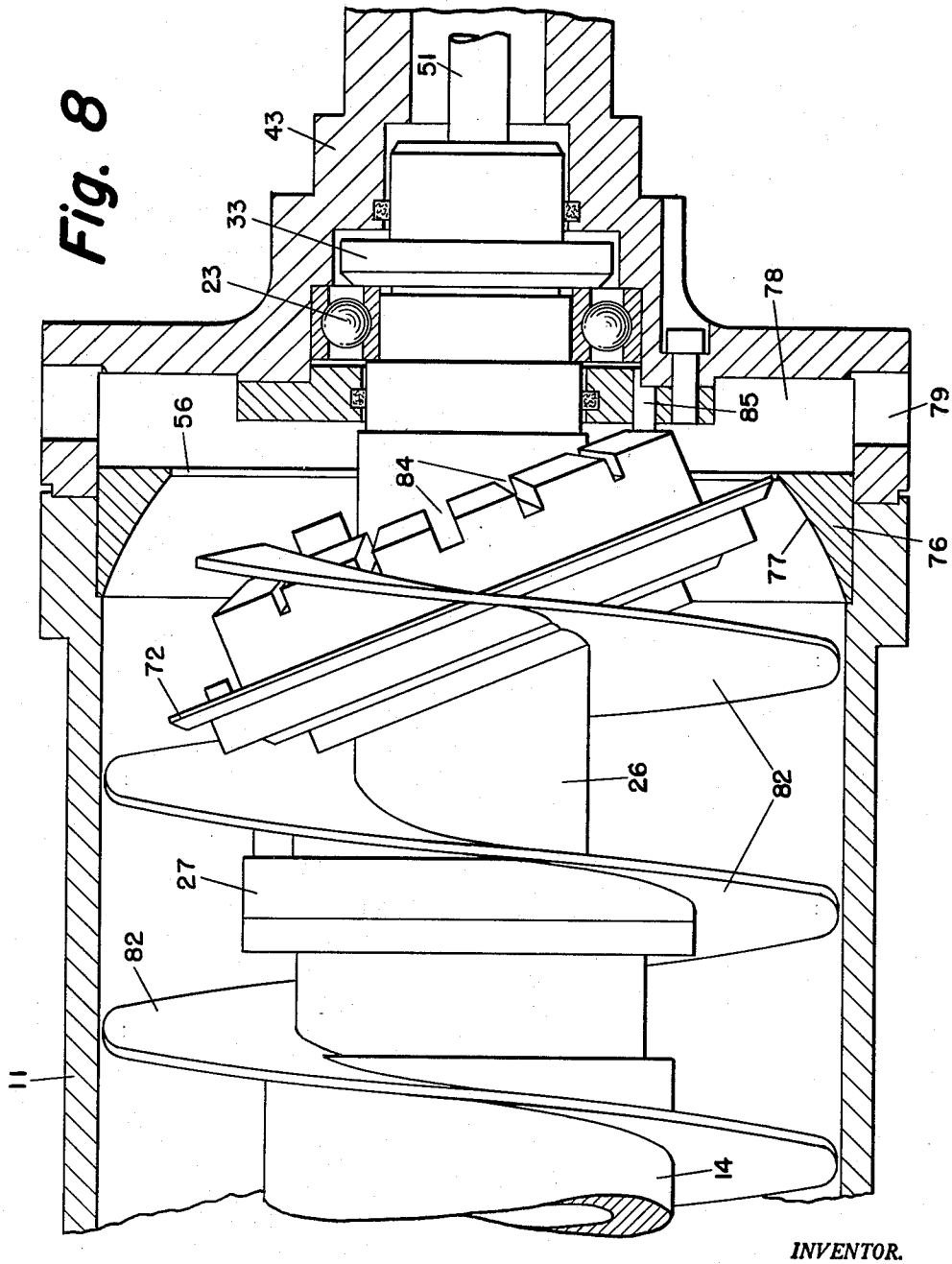
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Fig. 8



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United States Patent Office 3,098,820 Patented July 23, 1963

3,098,820

CENTRIFUGE

Fred P. Gooch, Pine Ridge, Media, Pa., assignor to The Sharples Corporation, a corporation of Delaware

Filed Nov. 23, 1960, Ser. No. 71,239
4 Claims. (Cl. 233—7)

This application is a continuation-in-part of my copending application Serial No. 856,521, filed December 1, 1959, and now abandoned.

This invention pertains generally to centrifuges of the solids-discharge type, and particularly to centrifuges provided with mechanical means for the movement of solids through the rotor, eventually effecting their discharge therefrom.

Typical of centrifuges of this type are those which are provided with helical and/or spiral screws or scrolls for the movement of separated solids through a zone of centrifugation having an imperforate periphery, and finally to a locus of discharge of lesser radial distance from the axis of rotation than the locus of discharge of the liquid from which the solids are separated.

Any such screw, scroll or plow mechanism, whether comprised of a single member, or a plurality of members, customarily operates by way of sliding the separated solids along the interior wall of the centrifuge rotor, the general direction of movement of the solids relative to the rotor wall being along more or less curved lines, e.g. with the movement of solids following a helical and/or spiral pattern.

The interior wall of the rotor may have a variety of geometrical shapes, typical of which are cylindrical and frusto-conical shapes, and combinations thereof. Since the separated solids deposited on the inner wall of the rotor are subjected to relatively high pressures due to centrifugal force, with consequent high resistance to movement of solids due to friction between the solids and the inner wall of the rotor, the torque required to drive the screw, scroll or plow relative to the rotor is relatively high. This is particularly true with respect to the movement of the solids after being lifted radially inwardly out of the liquid upon being conveyed to their locus of discharge, said locus being positioned radially inwardly of the locus of discharge of separated liquid. Various theories may be advanced for this increase in torque requirements, among which is that the solids as they move radially inwardly of the radial level of the liquid in effect travel uphill against the centrifugal force, this being accompanied by the solids becoming drier by being drained of liquid, with the result that there is less lubrication, and, therefore, greater friction between the solids and the rotor wall.

The conventional manner of effecting relative movement between the rotor and its solids-impelling mechanism is to drive the rotor directly, and to drive the solids-impelling mechanism from the rotor by connecting it to the rotor through a planetary gear train. The stresses on the gears of the gear train increase with increase in the torque required to effect relative movement between the solids-impelling mechanism and the rotor, and such torque increases with increase in the rate at which it becomes necessary to move solids through the rotor to their locus of discharge. For any given mixture of solids and liquid, the rate at which it becomes necessary to impel solids through the rotor increases with increase in the rate of feed of said mixture to the rotor, and since there is a limit to the stresses to which the gears may be subjected, the torque required for the movement of solids becomes a limit on the capacity of any given machine. It follows, therefore, that, generally speaking, the solids-handling capacity of a given machine may be increased by reducing

the torque required for the movement of solids therethrough.

As pointed out above, when the solids-impelling mechanism takes the form of a screw, scroll or plow, the separated solids slide on the rotor wall not only axially, but also circumferentially, and while it is preferred to hold the latter movement to a minimum, for which purpose longitudinal ribs on or channels in the rotor wall are sometimes provided, such movement apparently cannot be entirely avoided. This appears to be due to the fact that solids-impelling mechanism of the character under consideration engages the solids on the rotor wall at angles which lie in planes which intersect the axis of rotation at acute angles, i.e. at other than right angles. As a result there is considerable slippage of solids which increases with the slimy or mushy character of the solids, as well as with the rate at which the solids are moved radially inwardly to their locus of discharge.

The present invention is directed to a new construction, arrangement and combination of parts whereby slippage of solids, after separation from liquid upon movement radially inward, in being discharged from the rotor, is materially reduced, in very large part irrespective of their slimy or mushy nature, with corresponding reduction in the torque required to discharge said separated solids from the rotor.

Another feature of the invention resides in increased efficiency of operation in the discharge of solids from the rotor, including solids of a slimy or mushy character.

A further feature of the invention resides in materially increasing the solids throughput capacity of centrifuges of the kind described without corresponding increase in the stresses to which the gears are subjected.

A further feature of the invention resides in reducing the stresses to which said gears are subjected for a given rate of solids feed to the centrifuge.

A further feature of the invention resides in a solids-discharge mechanism for screw-type centrifuges which is simple in construction and operation and which is highly efficient and reliable in performance.

Further features of the invention will become apparent to persons skilled in the art as the specification proceeds, particularly in connection with the accompanying drawings in which:

FIGURE 1 is an elevation partly in section of a centrifuge embodying the invention;

FIGURE 2 is an elevation shown broken and partly in section of the solids-discharge mechanism of FIGURE 1;

FIGURE 3 is a view taken on line 3—3 of FIGURE 2;

FIGURE 4 is an elevation shown broken and partly in section illustrating a modification;

FIGURE 5 is an elevation shown broken and partly in section illustrating another embodiment, and taken on line 5—5 of FIGURE 6;

FIGURE 6 is a view taken on line 6—6 of FIGURE 5;

FIGURE 7 is a view taken on line 7—7 of FIGURE 6; and

FIGURE 8 is an elevation partly in section, illustrating a manner in which solids may be delivered to the solids-discharge chamber.

Referring now more particularly to FIGURE 1 of the drawings, centrifuge **10** is of the solids-impelling type. As shown, its rotor **11** is imperforate and cylindrical in shape, and is provided in its solids-separating section with an impeller member **12** which, as shown, is comprised of a continuous screw **13** attached along its inner edge to a supporting member **14**, with its outer edge of helical shape and conforming to the inner periphery **15** of rotor **11**.

As illustrated, a pulley **16** is connected to the rotor

11, and rotor 11 and impeller 12 are caused to rotate at a slightly different speed, such as at a difference of from 10 to 60 r.p.m., by virtue of being interconnected through a planetary gear box 18, the design, construction, operation and function of which are well known in centrifuges of this general type. A typical gear box, for instance, is shown and described in U.S. Patent 2,703,676.

As illustrated, the casing of gear box 18 is connected to rotor 11, and a driving connection between gear box 18 and member 14 is effected through shaft 19 which extends from the interior of gear box 18 and connects with member 14, in a conventional manner. In couplings of this type, it is customary to hold a sun gear, not shown, in gear box 18 stationary. This may be done in any desired manner, e.g. by mounting the sun gear on a shaft 40 held stationary in a bracket 41 by means of a screw 42. It is, of course, well known to rotate shaft 40, if desired, at a controlled and desired rate, in either direction, to afford a wider control of the differential in speed of rotation between rotor 11 and impeller member 12.

Any other suitable coupling between rotor 11 and impeller member 12 to effect relative rotation therebetween may be substituted, as is well understood in the art. Then too, and as is also well known, rotor 11 and member 14 may be driven separately, but at slightly different speeds.

20 and 21 are pillow blocks containing bearings in which extensions on rotor 11 are journaled. 22 and 23 are bearings between rotor 11 and member 14, the latter being journaled in bearing 23 by means of an extension 24. 25 is a thrust bearing for member 14.

As more clearly seen in FIGURE 2, extension 24, as illustrated, is comprised of an outer member 26 connected to the main portion of member 14 as by flange 27, and an inner tubular member or sleeve 28 having one end journaled in bearing 23. Inner tubular member 28 at one end is threadedly engaged by a nut 31 which abuts shoulder 32 on outer member 26. Member 28 at its other end is threadedly engaged by a nut 33 which abuts a face of bearing 23, bearing 23 thus serving also as a thrust bearing.

Member 26 is provided with a transverse annular projection 34 upon which is rotatably mounted, as by annular bearing 35, an annular plow 36, the construction and arrangement being such that the axis of rotation of annular plow 36 for practical purposes lies in the same plane as and intersects at an acute angle, e.g. between 5° and 45°, preferably between 10° and 20°, the axis of rotation of member 14 and its extension 24, which axis of rotation is for practical purposes the same as that of rotor 11.

Rotor 11 is shown provided with a filler ring 37 which preferably has a spherical-shaped inner surface 38 of equal radial distance from a point of intersection 39 of the axes of rotation of plow 36 and extension 24, i.e. the center of rotation of plow 36. It will be noted that filler ring 37 is spaced from end 43 of rotor 11 which provides an annular access channel 57 to a plurality of discharge holes 44 spaced circumferentially in the periphery of rotor 11 for the discharge of solids from rotor 11.

The other end 45 of rotor 11 (see FIGURE 1) has liquid discharge holes 46 spaced circumferentially, each of which leads to a discharge port 47 in a plate 48 which is preferably adjustably secured to end 45.

In operation, the mixture of liquid and solids to be separated is fed into rotor 11 through a conduit 51, and reaches a chamber 52 inside of member 14. It then passes into the zone of centrifugation which is situated primarily between member 14 and the inner wall 15 of rotor 11 on the one hand, and between the ends of screw 13 on the other, the feed being through a plurality of outlets from chamber 52 formed by a plurality of circumferentially spaced vanes 53. Due to centrifugal force generated by the rapid rotation of rotor 11 and associated parts, and to the relative rotational movement of the screw 13 with respect to rotor 11, solids are sedimented radially outwardly onto inner wall 15, and are moved to the right as seen in FIGURE 1 into solids-discharge chamber 54.

The separated solids fed into solids-discharge chamber 54 are conveyed radially inwardly by plow 36 out of the level of liquid in rotor 11, any liquid impelled along with the solids flowing back into the layer of liquid.

Plow 36 preferably accommodates its rotation insofar as reasonably practical to that of rotor 11, or more particularly to that of surface 38 of filler ring 37, and any desired means may be employed for accomplishing this purpose. A preferred means is illustrated at the periphery of plow 36 and includes an O-ring 55 of resilient material, e.g. rubber or other similar material, retained around the circumference of plow 36, such as in a circumferential groove. O-ring 55 projects outwardly from plow 36 and engages surface 38. The contact between O-ring 55 and surface 38 preferably is sufficient to cause plow 36 to rotate about its bearing 35. Thus friction losses which would result from a greater degree of relative rotation between plow 36 and rotor 11 are eliminated. Plow 36, however, sweeps back and forth over surface 38 with a wobbling movement relative to surface 38 which results from the relative rotation movement between rotor 11 and extension 24, the latter being secured to member 14. This wobbling movement of plow 36 relative to surface 38 plows solids over circular lip or tip 56 of filler ring 37 into annular channel 57, O-ring 55 retarding or preventing back flow of semi-solids underneath the edge of plow 36. The solids (which term includes semi-solids) are discharged from rotor 11 outwardly through discharge ports 44. Ports 44 preferably are at equal radial distance from the axis of rotation, and may of any desired number spaced circumferentially.

It will be noted that circular lip 56 on filler ring 37 is closer to the axis of rotation than ports 47. This causes the separated liquid to be discharged through ports 47 instead of over lip 56. Otherwise stated, lip 56 is of a lesser radial distance from the axis of rotation of rotor 11 than ports 47, which causes separated liquid to be discharged through ports 47.

Discharge ports 47, or their equivalent, are preferably made adjustable to increase or decrease their distance from the axis of rotation, as desired. This decreases and increases respectively the radial depth of the liquid layer in rotor 11, but in no event is the radial depth of the liquid layer increased to the point where liquid would be discharged from the rotor over lip 56.

Solids discharged from rotor 11 through ports 44 are caught in section 61 of rotor housing 62, and are removed from section 61 through hopper 63.

Liquid discharged from rotor 11 through ports 47 is caught in section 64 of housing 62, and is removed from section 64 through hopper 65.

Plow 36 is caused to sweep with a wobbling movement over surface 38 in the following manner. It will be recalled that there is relative rotation between screw 13 and rotor 11, that screw 13 is mounted on member 14 having an extension 24, and that member 26 on which plow 36 is mounted is a part of extension 24. Thus screw 13, member 14, and its extension 24, including member 26, rotate together. Projection 34 on which plow 36 is mounted rotates with member 26. Thus the only movement of plow 36 relative to member 26 is by rotation around bearing 35 on projection 34, and then only when bearing 35 is provided which is highly preferred.

The effect of relative rotation between rotor 11 and member 14 including member 26 may be illustrated by considering member 14, including member 26, as if held stationary while rotor 11 is rotated, e.g. counterclockwise as viewed from the right end of FIGURE 2. Consider now point A (see FIGURE 2) on filler ring 37, and point B on O-ring 55 opposite point A, and, for convenience in description, let it be assumed that plow

36 rotates at the same rate as rotor 11. Upon a half revolution of rotor 11 from the position shown in FIGURE 2, member 26 remaining stationary and plow 36 rotating around bearing 35, point A on filler ring 35 will move to position A', and point B on O-ring 55 will move to position B'. During such half revolution of rotor 11, point A will remain in a plane perpendicular to the axis of rotation of rotor 11, but due to the fact that plow 36 rotates about an axis positioned at an angle to the axis of rotation of rotor 11, point B on plow 36 will move axially of rotor 11 to point B'. During such half revolution of rotor 11, the point on plow 36 diametrically opposite point B, and originally occupying the position B', will move to the position originally occupied by point B, thus sweeping solids forwardly to the right over surface 38, and into annular channel 57, to be discharged through ports 44.

Thus during each full revolution of rotor 11 relative to screw 13, point B on plow 36 travels to position B' and back to plow solids forwardly to the right as seen in FIGURE 2, irrespective of the direction of such relative travel. The direction of rotation of plow 36, however, must be coordinated with that of screw 13, so that screw 13 may function to move solids to the right as seen in FIGURE 2. Since any point on the periphery of plow qualifies as poin B, each such point sweeps solids to the right as seen in FIGURE 2 a part of the time during continuous relative rotation between rotor 11 and screw 13, i.e. during the time that the point is moving to the right as seen in FIGURE 2, which is throughout one-half of a full revolution, assuming, of course, that the layer of solids in rotor 11 is sufficiently deep to be engaged immediately upon such movement to the right.

Otherwise considered, plow 36 is caused to sweep over surface 38 by virtue of the fact that there is relative rotational movement between the inner peripheral of rotor, 11 and the axis of plow 36, said axis rotating around the axis of rotor 11.

Plow 36 is preferably of a diameter equal to or slightly less than the inner diameter of rotor 11.

It is recognized that should the right hand end of screw 13 terminate short of overlapping plow 36 at the left thereof as seen in the FIGURES 1 and 2 and thus not enter discharge chamber 54, the movement of point B to position B', as seen in FIGURE 2, might plow some solids to the left, but in view of the plowing of solids to the right by screw 13, any such solids plowed to the left would be plowed back to the right by screw 13 and into discharge chamber 54, said solids passing into chamber 54 underneath the rearmost edge, i.e. the left hand end, of the plow structure as seen in FIGURE 2, the same as all other solids. It will be noted that this entrance to chamber 54 revolves with respect to rotor 11 in view of the differential rotation of rotor 11 and screw 13.

However, since the only relative movement between plow 36 and screw 13 is by rotation of plow 36 around bearing 35, it is highly preferred that screw 13 extend into discharge chamber 54, in an overlapping relationship with respect to the peripheral edge of plow 36, e.g. a fraction of a turn as illustrated at 66 in FIGURE 3, such as up to 90° turn, or more if desired for any reason including a full turn or more of screw 13 as illustrated at 67 in FIGURE 4, although up to a 90° turn or less is quite sufficient.

Also screw 13, or its equivalent, may extend into discharge chamber 54 any desired distance, by increase in pitch or otherwise, e.g. up to a plane at right angles to the axis of rotation of screw 13 and passing through point of intersection 39 of the axes of rotation of plow 36 and screw 13, sufficient clearance being provided to permit rotation of plow 36.

The entry of screw 13 into discharge chamber 54 not only assures the efficient delivery of solids into chamber 54 and their discharge therefrom, but also provides, through the combined action between screw 13 and plow 36, means whereby otherwise difficultly dischargeable solids, such as those of a mushy or slimy nature, are readily discharged from the rotor.

Thus, while the invention in its broad concept includes structure wherein the solids impeller means, e.g. screw 13, stops short of overlapping plow 36 so as not to enter discharge chamber 54, an improved combination of greatly increased efficiency is provided by such entry of the impeller means into discharge chamber 54.

Screw 13 may be either right-hand or left-hand in shape, that is it may advance along member 14 either clockwise or counterclockwise, and may be a single screw, a double screw or other plurality of screws, and/or it may, through its coupling to rotor 11, rotate either faster or slower than rotor 11. Furthermore, screw 13 and rotor 11 may rotate together in either direction, that is, either clockwise or counterclockwise, as seen from gear box 18. However, the shape of screw 13 and its relative rotation with respect to rotor 11, by virtue of the characteristics of the coupling employed between screw 13 and rotor 11, are coordinated so as to impel the separated solids in the zone of centrifugation to the right as seen in FIGURE 1, that is toward and into solids-discharge chamber 54.

As brought out above, rotor 11 may have any other suitable shape, a frusto-conical rotor provided with a spiral screw being common in centrifuges of this general type, as are rotors having spaced cylindrical sections of decreasing diameter joined by frusto-conical sections, as is well known in the art.

While rotor 11 has been provided with ports 47 for purposes of maintainng a layer of liquid in rotor 11, it will be understood that rotor 11 may be peripherally perforated opposite screw 13, if desired, to discharge separated liquid directly into hopper 65, as is done in certain prior art centrifuges of this general type. In such cases the rotor wall acts as a screen, or may be provided with a screen, through which the separated liquid escapes, in which case there is no need for ports 47 for the escape of separated liquid. Such rotors may be of a cylindrical and/or frusto-conical shape, but in view of the use of a perforated or screen-like rotor wall instead of a solid wall, rotor strength is reduced, accompanied by a reduction in the maximum permissible speed of rotation when in use.

Filler ring 37 may have any desired longitudinal dimension in the direction toward screw 13 from annular channel 57. This longitudinal dimension may be no more than that of the thickness of a conventional ring dam, in which case surface 38 will be provided not by a filler ring but by a surface formed on deposited solids. On the other hand filler ring 37 may extend further to the left as seen in FIGURES 1 and 2, although it is preferred that it should not extend beyond a plane at right angles to the axis of rotation of rotor 11 and passing through point 39. This is to avoid possible interference with the feeding of separated solids into discharge chamber 54 by screw 13.

FIGURES 5 and 6 are similar to FIGURES 2 and 3, respectively, like parts bearing like numerals, but, together with FIGURES 7 and 8, illustrate another embodiment of the invention.

In the embodiment of FIGURES 5 to 8 transverse annular bearing mount 71 is eccentric relative to the axis of rotation 71*a* of the rotor 11 and of member 14, i.e. it projects further to one side than to the opposite side. Annular plow 72 has a circular periphery the same as annular plow 36, but due to the eccentricity of transverse annular bearing mount or hub 71, it is of lesser diameter relative to associated parts.

The construction and arrangement preferably is such that the axis of rotation of annular plow 72 (illustrated at 73 in FIGURE 7 as a projection into the plane of the paper), within practical approximation or for practical purposes, lies in a plane which is parallel to a plane passing through the axis 71*a* of rotor 11. Axis 73, however, is not parallel to axis 71*a*, but is inclined with respect there-

to, as better seen in FIGURE 5, so that, within practical approximation or for practical purposes, the plane of the operative surface of plow 72, intersects axis 71*a* at an acute angle "*a*," e.g. between 45° and 85°, preferably between 70° and 80°. The axis of rotation of member 14 and its extension 24 are, within practical approximation or for practical purposes, the same as that of rotor 11. However, whereas, in the preferred embodiment of FIGURES 1 to 4, the point of intersection 39 of the axes of rotation of plow 36 and of extension 24, as illustrated in FIGURE 2, lies, within practical approximation or for practical purposes, in a plane bisecting annular plow 36 (or in other words at the center of rotation of plow 36), in the preferred embodiment of FIGURES 5 to 8, there is no intersection between the axes of rotation of plow 72 and of rotor 11.

Filler ring 76 has an inner surface 77 which preferably takes the shape of a surface of revolution generated by rotating a curved line about the axis of rotation of rotor 11, said line falling in a plane intersecting said latter axis. This line takes the shape of the line illustrating inner surface 77 in FIGURES 5 and 7. The corresponding shaping of surface 77 is a mere matter of machine shop practice. However, what has been said hereintofore in connection with filler ring 37 applies equally here, e.g. a mere ring dam is sufficient in many instances, though ordinarily not preferred.

It will be noted that filler ring 76 is spaced from end 43 of rotor 11, the same as filler ring 37 in FIGURE 2, to provide an annular access channel 78 to a plurality of discharge holes 79, spaced circumferentially in the periphery of rotor 11, for the discharge of solids from rotor 11.

The other end of rotor 11 may be the same as illustrated at the left in FIGURE 1.

The operation of the embodiment illustrated in FIGURES 5 to 8 is similar to the operation of the embodiments of the invention heretofore described. The mounting of the plow 72 eccentrically relative to the axis of rotation of rotor 11 affords an increase in clearance between plow 72 and the inner wall of rotor 11 as shown at 81 in FIGURE 7. This not only facilitates bringing impeller member 82 into the solids discharge chamber 54, as more clearly illustrated in FIGURE 8, but also considerably increases the solids handling capacity of the centrifuge, and generally avoids possible plow back of solids. In FIGURE 8 bearing mount 71 occupies a position resulting from a half turn thereof from its position shown in FIGURE 5, and in FIGURE 7 a quarter turn, which brings plow 72 into the respective positions shown. As illustrated, rotation of rotor 11 is counterclockwise in FIGURE 6, as is that of bearing mount 71, the latter at a somewhat slower rate, e.g. between 10 and 60 r.p.m., say when the rotor 11 rotates at a speed of approximately 3000 r.p.m. As illustrated in FIGURE 6, plow 72 engages filler ring 76 from point 91 adjacent lip 56 on filler ring 76, to point 92 adjacent the opposite circumferential edge of filler ring 76.

As in the previous embodiments, it is preferred that the plow 72 be mounted rotatably, and that it rotate at the same or at a velocity close to that of rotor 11. For this purpose, mount 83 for plow 72 is shown provided with a plurality of circumferentially spaced elongated notches 84 which are engaged by a plurality of circumferentially spaced pins 85 secured to end 43 of rotor 11, pins 85 upon their engagement with mount 83, by virtue of projecting into notches 84, causing plow 72 to rotate along with rotor 11. Any suitable other means may be provided, such as a gear arrangement, which notches 84 and pins 85 simulate.

For purposes of clarification, circumferential edge 86 on portion 87 of mount 83 is shown in FIGURE 6.

The invention affords outstanding advantages in the processing of solid-liquid mixtures of all types with a substantial reduction in the torque required for the longitudinal movement and discharge of the solids. Other advantages include the processing of mixtures containing solids of relatively low density and/or of relatively low internal friction which cannot be handled by conventional centrifuges of the prior art. The outstanding reduction in the torque required for the movement and discharge of the solids results in a corresponding reduction in the generation of heat, which makes possible the separation from solids-liquid mixtures of materials which tend to polymerize or otherwise set up into a solid mass with heat and/or pressure.

Thus there has been provided a centrifugal machine with a rotor having outlets for liquid and solids, respectively, with the outlet for solids spaced inwardly from the inner periphery of the rotor, means for feeding a mixture of liquid and solids into the rotor, and means for conveying solids longitudinally of the rotor and radially inwardly to the solids outlets, in which the final radially inward movement, at least, of the solids is brought about by a plow positioned transversely of, and at an angle to the axis of rotation of, the rotor, and in which means is provided for relative rotational movement between said rotor and the axis of said plow, i.e. the axis of the plow is rotated about the axis of the rotor.

The new combination and structure provided by the invention has yielded a centrifuge in which, as shown by comparative tests, the torque required to drive the solids impeller mechanism is surprisingly reduced, e.g. down to one-third under the conditions of a particular comparative test, permitting a corresponding increase in feed rate, e.g. in the particular test, up to three-fold. Moreover, mixtures which are extremely difficult to discharge, such as slimy mixtures containing yeast have been successfully and readily separated and discharged by the use of the invention.

While as brought out above, it is highly preferred to provide a bearing 35 between plow 36 or plow 72 and its supporting structure, some of the advantages of the invention may be realized by eliminating bearing 35 thereby supporting plow 36 or plow 72 directly and rigidly on bearing mount 34 or bearing mount 71, respectively, thereby converting the structure of the plow and mounting into a swash plate. Other variations are possible. Thus, if desired, the solids impelling face of plow 36 or plow 72 may be provided with any desired surface to reduce or avoid any tendency to slippage of solids, such as roughening, knurling, or the like, or even with vanes or other protuberances, as will be understood by persons skilled in the art upon becoming familiar herewith.

Therefore, it is to be understood that the above particular description is by way of illustration and not of limitation, and that changes, omissions, additions, substitutions, and/or other modifications may be made without departing from the spirit of the invention. Accordingly, it is intended that the patent shall cover, by suitable expression in the claims, the various features of patentable novelty that reside in the invention.

I claim:

1. A centrifugal separator comprising:

(*a*) a hollow rotor having outlets for the discharge from said rotor of liquid and solids at opposite ends of the rotor respectively, the outlet for solids being inward from the outlet for liquid,

(*b*) a plow mount positioned in the rotor for rotation about the axis of the rotor in a posture oblique to the axis of the rotor and disposed adjacent the solids outlet,

(*c*) screw flight means having a leading and a trailing terminal and mounted for rotation in the rotor about the axis of the rotor and disposed on the opposite side of the plow mount from the solids outlet,

(*d*) feed means for delivering feed mixture into the rotor at a point spaced from the plow mount and intermediate the leading and trailing terminals of the screw flight means,

(*e*) driving means for driving the screw flight means and the plow mount at one speed and the rotor at a different speed, and

(*f*) a solids plow mounted for rotation on and about the plow mount to permit the plow to move at substantially the same speed as the adjacent portion of the rotor to reduce torque required of the driving means as the plow moves the solids inward to the solids discharge outlet.

2. A centrifugal separator as described in claim 1 wherein the center of the solids plow is offset from the axis of the rotor.

3. A centrifugal separator as described in claim 2

wherein the trailing terminal of the screw flight means is disposed outward of the plow.

4. A centrifugal separator as described in claim 1 including means to assure rotation of the plow at substantially the speed of the adjacent portion of the rotor.

References Cited in the file of this patent

UNITED STATES PATENTS

1,804,108	Pardo et al.	May 5, 1931
2,414,421	Small	Jan. 14, 1947
2,600,372	Milliken et al.	June 10, 1952
2,733,856	Kjellgren	Feb. 7, 1956
2,766,930	Schmiedel	Oct. 16, 1956
2,856,124	Cook et al.	Oct. 14, 1958