Dec. 28, 1965 P. VAN RIEL 3,225,934

CENTRIFUGE

Filed May 14, 1962 2 Sheets-Sheet 1

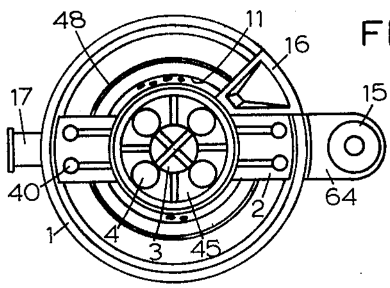


FIG. 4

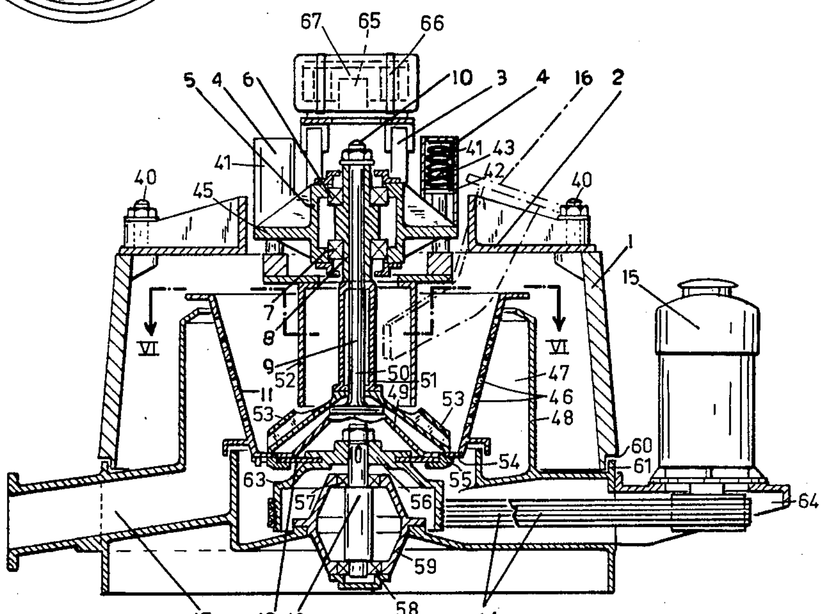


FIG. 1

FIG. 5

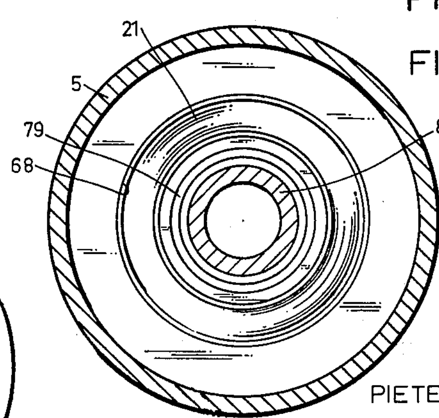
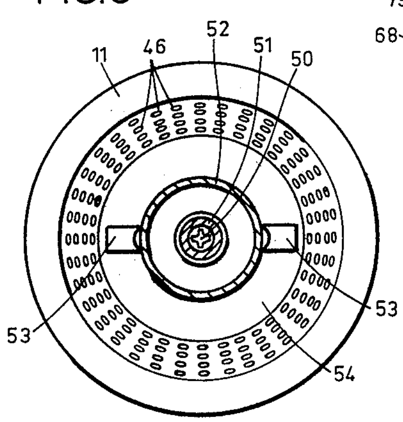


FIG. 6



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Dec. 28, 1965 P. VAN RIEL 3,225,934

CENTRIFUGE

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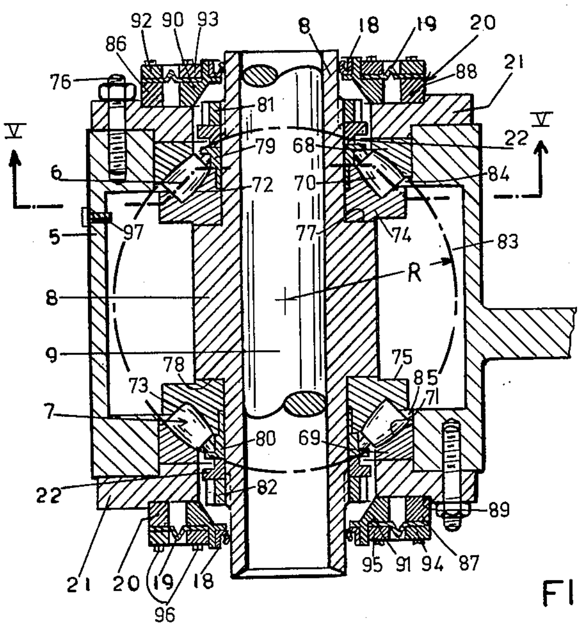

FIG.2

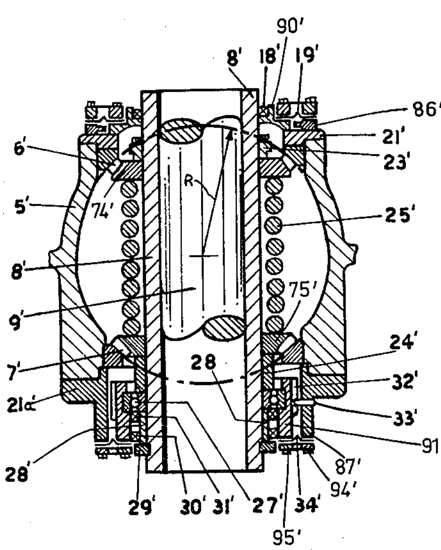

FIG.3

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CENTRIFUGE

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Claims priority, application Germany, May 13, 1961, M 49,052

3 Claims. (Cl. 210—370)

My present invention relates to a centrifuge and, more particularly, to a centrifugal separator having an axially vibrating rotary drum for the extraction of liquids from solids.

In the past it has been difficult, if not impossible, to combine an axial oscillation with a high-speed rotation of a centrifuge drum for the separation of liquids from solids. It has been necessary heretofore to journal the centrifuge drum in precisely machined supporting elements within the centrifuge housing and to position exactly with, say, little deviation from the vertical, the supporting parts of the housing; even the use of such highly expensive machining techniques did not entirely obviate binding of relatively moving parts. Moreover, the supporting elements oftenwere a pair of bearings rotatably carrying the centrifuge shaft, which had to be limitedly spaced owing to the possibility of bending of the shaft between its supported locations. This arrangement resulted in the application of extremely large forces to the closely spaced bearings.

It is an object of the present invention, therefore, to provide an improved centrifuge having an axially-vibrating rotary drum adapted to obviate the aforementioned disadvantages.

A more specific object of my invention is to provide improved means for supporting a centrifuge drum of the character described.

These objects have been realized in a centrifuge comprising a housing and a drum or basket rotatably and resiliently mounted therein. The mounting means supporting the drum advantageously comprises a rotary central support member to which the drum is connected via a resiliently deformable annular membrane extending transversely to the axis of rotation of the drum and which permits limited axial displacement thereof in the course of its vibration. The support member is rotated about its common axis with the drum by suitable drive means. The drum may according to a more specific feature of the invention be provided with an axially extending shaft which is journaled for rotation relative to a stationary vibrator (e.g. a mechanical oscillator of known type).

According to still another feature of the invention, the shaft of the centrifuge drum is provided with self-aligning bearings at two axially spaced locations within the vibrating head to compensate for slight curvature of the shaft and any misalignment thereof with respect to the axis of the housing. The bearings may have their roller axes inclined toward the axis of the shaft so as to constitute thrust bearings adapted to withstand the oscillation forces imparted to the massive drum as well as the usual radial forces applied to the head. Advantageously the bearings are provided with spherical segmental raceways extending generally transversely to the axis of the shaft for permitting free running of their rollers in spite of any misalignment of the races of each bearing. One race of each bearing is rigidly secured to the shaft which may be hollow and formed with an intermediate portion of enlarged diameter between the bearings for preventing relative axial displacement of the bearing races secured to the shaft. The other race of each bearing is secured to a bearing casing which forms part of the vibrator head. The housing forms an annular chamber around the en-

larged portion of the shaft adapted to accommodate a lubricant. At each longitudinal extremity of the housing and outwardly of a respective bearing, I provide sealing means designed to prevent the escape of the lubricating fluid from the chamber. The bearing housing thus constitutes with the drum shaft a unit which may be removed without loss of oil.

In a preferred construction of the device, the drum shaft is secured to the drum by an axially extending stud which is supported on the shaft so that the thrust bearings take up a substantial part of the load of the drum. The sealing means at each end of the bearing housing may include a bushing rotatable with respect to the shaft and entrained by the housing by being provided with sealing surfaces in engagement with the shaft. Thus, the sealing support is nonrotatable but positively positioned with respect to the transverse motion of the shaft so that no loosening of the seal will result even though the latter is displaceable relatively to the housing. I, further, provide stops to limit the axial play of the shaft within the housing to prevent loosening of the seals at either end thereof.

I have also found that it is desirable to provide resilient means urging the bearing races on the shaft outwardly into engagement with the races carried by the vibrating head. In this case the enlarged portion of the shaft, previously described, can be omitted and a coil spring surrounding the shaft employed. It will be necessary, however, to design the coil spring so that the force exerted by it upon the races engaging the shaft is greater than the counteracting force owing to the vibration of the centrifuge drum. The resilient mounting avoids the hammering which would otherwise be present as a result of the oscillation-producing means.

The above and other objects, features and advantages of the instant invention will become more readily apparent from the following description, reference being made to the accompanying drawing wherein:

FIG. 1 is an axial cross-sectional view of a centrifuge according to the invention;

FIG. 2 is a detail view, drawn to enlarged scale, of a portion of the centrifuge shown in FIG. 1;

FIG. 3 is a view similar to FIG. 2 but of a modified bearing casing for the centrifuge drum adapted to be employed in place of the bearing means shown in FIG. 2;

FIG. 4 is a reduced-scale plan view of the centrifuge shown in FIG. 1;

FIG. 5 is a cross-sectional view taken along line V—V of FIG. 2 with the rollers of the bearing housing removed; and

FIG. 6 is a cross-sectional view taken along line VI—VI of FIG. 1.

In FIGS. 1, 2 and 4–6 of the drawing I show a centrifuge comprising a housing 1 provided with a transverse supporting member 2 bolted thereto at 40. The transverse member 2 carries the pistons 42 of a pluarlity of shock absorbers 4 of a conventional type. These shock absorbers may, as illustrated, comprise a piston 42 vertically reciprocable within the casing 41 against a compression spring 43 so as to constitute vibration-damping buffers between the support member 2 and the resiliently supported vibrating head 45 of the centrifuge. The head 45 comprises a bearing housing 5 secured to the casings 41 of the buffers 4 and suspended upon the plungers 42 thereof via the springs 43. A vibration- or oscillation-producing device 3 is mounted upon the head 45 for imparting to the shaft 8 of a centrifuge drum 11 an axial reciprocation in order to settle the solids contained within the drum. The latter has a generally frusto-conical configuration with upwardly diverging walls formed with perforations 46 through which liquid can escape into an annular chamber 47 formed by a cylindrical mantle 48 surrounding the drum 11. The drum is provided with a floor 49 converging axially upwardly and formed with an axially extending shank or stud 9 which is carried by a hollow shaft 8 journaled in bearing housing 5. The stud 9 extends upwardly beyond the shaft and rests thereon via a nut 10 which constitutes a shoulder resting upon shaft 8. Stud 9 is provided with a plurality of axially extending ribs 50 received in a transverse flange 51 at the lower end of shaft 8. The housing 1 is formed with a sleeve 52 coaxially surrounding shaft 8 and opening downwardly into a pair of distributor chutes 53 which are joined to shaft 8 at its flange 51.

A resilient membrane 12 extends transversely to the axis of drum 11 and is peripherally secured thereto at its bottom 54 by a clamping ring 55. The membrane 12 is also secured to a central supporting member 56 along its inner edge. The supporting member 56 is keyed to a shaft 13 journaled in the usual bearings 57, 58 within the base 59 of the centrifuge. This base, which may be integral with mantle 48 carries the upper housing portion 1 which is formed with a recess 60 receiving an annular lip 61 of the base. The central member 56 forms part of a pulley 63 which is rotated about its vertical axis with shaft 13 via a plurality of V-belts 14 by means of a motor 15 carried by a bracket 64 affixed to the base of the centrifuge. The oscillation generator 3 may be of any of the several types conventionally employed for vibrating the basket 11 or may comprise a ferromagnetic mass 65 axially reciprocable by a solenoid coil 66 against an anvil 67 to jolt repeatedly the head 45 and the basket or drum 11.

In FIG. 2 I show in greater detail the bearing in which the basket 11 is suspended via its shaft 8. Within the housing 5, a pair of axially spaced self-aligned bearings 6, 7 are provided. These bearings are adapted to withstand considerable axial thrust as well as the normal radial forces due to high-speed rotation of shaft 8 and basket 11. Thus, each bearing comprises a plurality of rollers of generally conical configuration whose axes of rotation are inclined to the axis of shaft 8 and include with the latter an angle of approximately 45°. It should be noted that this angle may be altered somewhat depending upon conditions but should be substantially intermediate 0° and 90° if considerable radial and axial forces are to be taken up by the bearing. As indicated in FIG. 2, the outer races 68, 69 of the bearings 6, 7 are formed with raceways 70, 71 conforming generally to spherical segments whereby the arcuate surfaces of rollers 72, 73 of the bearings may engage them with line contact along the arc of a circle. This renders the bearings free-running regardless of slight axial misalignment of the inner races 74, 75 and the respective outer races 68, 69. The suspended vertical basket 11 thus does not require a precise vertical positioning of the head 45 or the upper portion 1 of the housing.

While the outer races are secured to the housing 5 by covers 21 bolted thereto at 76, the inner races bear against shoulders 77, 78 formed by a boss on the shaft 8. This boss, which constitutes the portion of enlarged diameter retains the inner races 74, 75 against axial displacement toward each other. A pair of rings 79, 80 prevent displacement of the rollers 72, 73 relative to their inner races. Nuts 81, 82 clamp respective shims against the rings 79 and 80 to lock the bearing rollers 72, 73 against their seats in the respective inner rings 74, 75 so that a minimum of play is possible in the bearings. Advantageously, the rollers 72, 73 which have surfaces complementary to the spherical surfaces of their races (i.e. intersect axial planes along circular arcs), have tangents to their surfaces midway between their extremities intersecting their respective axes substantially at the point of intersection between the latter and the axis of shaft 8.

Covers 21 carry sealing rings 20 which prevent oil leakage from the annular chamber 83 surrounding the boss. The bearings 6, 7 are provided with channels 84, 85 communicating with chamber 83 for conducting lubricating oil from the latter to the rollers 72, 73. Sealing rings 20 each comprise an outer annular element, 86, 87, seated in recesses 88, 89 of the covers 21, and an inner element 90, 91, which is radially displaceable along with the shaft 8 since their respective sealing members 18 bear upon the shaft. A membrane 19 is interposed between the annular elements of each sealing ring and is clamped to the respective element via rings 92, 93; 94, 95 by bolts 96. Thus, the lubricating chamber is sealed even though the axis of casing 5 and shaft 8 may not be coextensive. A plug 97 closes an oil-filling opening in the wall of casing 5. It should be noted, however, that it is also possible to fill the chamber by removal of sealing element 90 and the axial addition of oil. Upon the removal of nut 10, the shaft 8 and the bearing casing 5 may be lifted off the centrifuge drum together with the head 3 without loss of lubricant. Membranes 12 and 19 may be of highly resilient elastomeric material (e.g. rubber) or may be metallic and provided with corrugations as shown for membrane 19.

In FIG. 3 I show another bearing arrangement generally similar to that shown in FIG. 2 with similarly functioning parts indicated with primed reference numerals. In this modification, however, the boss of shaft 8′ is dispensed with and the inner races 74′, 75′ of the self-aligned bearings, which are otherwise identical to the bearings 6 and 7, are biased axially outwardly by a compression spring 25′. Spring 25′ urges these inner races against stop washers 23′, 14′. The spring is precompressed so that it exerts a force upon each race 74′, 75′ equal to or greater than the reaction on these races owing to the vibration action of the oscillation generator 3; hammering is thus avoided because the races 74′, 75′ are not materially withdrawn from contact with their respective rollers although the spring 25′ takes up a portion of the reaction force. Advantageously, the sealing of casing 5′ is accomplished by means of sealing rings 21′, 21a′. The latter is formed with an annular axial projection 87′ and engages an inner element 91′ which is connected to the shaft 8′ via a ball bearing 27′. Gaskets 30′, 31′ are interposed between confronting surfaces of inner element 91′ and a bushing 28′ on shaft 8′. The bushing 28′ is prevented from axial movement relative to the shaft by a retaining ring 29′. A membrane 34′, similar to the membranes 19 described above, bridges the elements 87′, 91′ and is clamped thereto via rings 94′, 95′ in the manner previously described. The inner element 91′ is formed with axially extending grooves 32′ into one of which a pin 33′ extends to prevent rotary entrainment of the inner element of the shaft.

The sealing ring 21′ at the upper end of casing 5′ is formed with a first or outer element 86′ and a second or inner element 90′ which are bridged by a membrane 19′. The inner element 90′, which is shiftable along with shaft 8′ bears thereagainst via a gasket 18′. The sealing arrangement shown in FIG. 3 has been found to be highly effective for the vibration-type centrifuge described above; upon removal of the ring 29′, the casing 5′ may be lifted from shaft 8′ together with bushing 28′ without loss of lubricant.

The invention described and illustrated is believed to admit of many modifications and variations within the ability of persons skilled in the art and deemed included within the merit and scope of the appended claims.

I claim:

1. A centrifuge for the separation of liquids from solids, comprising:

a housing;

a centrifuge drum mounted in said housing for rotation about a generally vertical axis;

a head resiliently mounted on said housing and rotatably supporting said drum;

a shaft connected with said drum and extending into said head;

a pair of axially spaced bearings within said head for journaling said shaft therein, said bearings each being provided with an inner race entrained by said shaft and an outer race entrained by said head, said outer races both being formed with raceways conforming to segments of a common spherical surface, said bearings each being provided with a plurality of angularly spaced rollers having surfaces complementary to the respective raceways and axes inclined to the axis of said shaft;

spacing means within said head and surrounding said shaft while engaging said inner races for maintaining mutual axial spacing between said inner races of said bearings, said head forming a bearing casing surrounding said bearings and said spacing means while defining an annular lubricant chamber therewith;

a pair of sealing means surrounding said shaft at opposite ends of said casing axially outwardly of said bearings for retaining lubricant in said chamber, at least one of said sealing means including an annular first element proximal to said shaft and radially shiftable therewith, an annular second element secured to said casing, and a resiliently deformable annular sealing membrane transverse to said axis and interconnecting said elements;

support means in said housing axially spaced from said shaft and connected with said drum at a location remote from said head for centering said drum, said support means including a central member, means journaling said central member in said housing for rotation about a generally upright axis normally aligned with that of said shaft, and an axially deformable annular resilient centering membrane surrounding said central member and connected with said drum for permitting limited axial displacement of said drum while centering same; and

oscillating means on said head for axially reciprocating said shaft and said drum.

2. A centrifuge as defined in claim **1** wherein said spacing means is a sleeve surrounding said shaft and having a pair of axially spaced oppositely facing shoulders abutting the respective inner races of said bearings.

3. A centrifuge as defined in claim **1** wherein said spacing means includes a compression-type coil spring surrounding said shaft and bearing axially upon the inner races of said bearings.

References Cited by the Examiner

UNITED STATES PATENTS

1,175,317	3/1916	Stephens	210—365 X
1,789,007	1/1931	Leon	308—194 X
2,012,974	9/1935	Penniman.	
2,048,972	7/1936	Scheffler	308—194 X
2,082,390	6/1937	Gibbons	308—194 X
2,107,035	2/1938	Hall.	
2,240,141	4/1941	Lindgren.	
2,734,758	2/1956	Schanke	308—194 X
2,767,037	10/1956	Williams	308—194 X
2,782,930	2/1957	Heckmann	210—370
2,861,691	11/1958	Link et al.	210—385 X
2,870,913	1/1959	Heckmann	210—370
2,908,186	10/1959	Meyer	308—194 X
3,010,582	11/1961	Buizert	210—370
3,069,016	12/1962	Kiesskalt et al.	210—370

FOREIGN PATENTS

136,705	3/1950	Australia.
833,910	5/1960	Great Britain.
884,768	12/1961	Great Britain.

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REUBEN FRIEDMAN, *Examiner.*