Dec. 6, 1955 M. K. TUDOR 2,726,070

HOMOGENIZER

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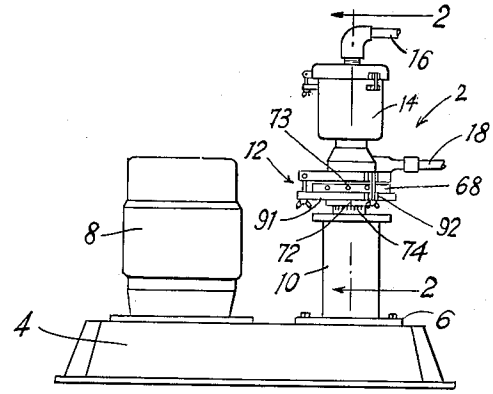


FIG. 1

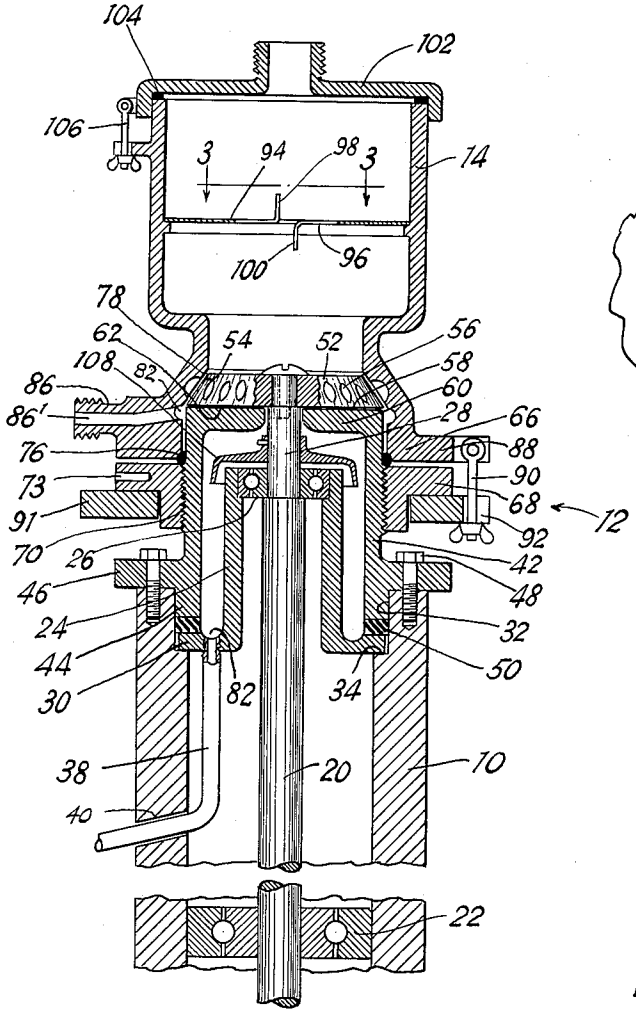


FIG. 2

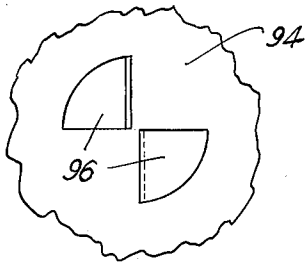


FIG. 3

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HOMOGENIZER

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12 Claims. (Cl. 259—107)

This invention relates to an improved homogenizer and colloid mill, and more particularly to a high speed, centrifugal, homogenizer adapted to operate upon liquid or liquid-solid mixtures.

The homogenizer of the present invention is of the rotary type wherein a high speed rotor has one or more of its surfaces close to but not contacting similar surfaces of a stator, the liquid or liquid-solid mixture to be homogenized being introduced between such rotating and non-rotating surfaces. The shearing forces to which the liquid or liquid-solid is thus exposed, when there is a proper difference in speed between the rotating and non-rotating surfaces, results in a disintegration or deflocculation of the materials contained in the film between such surfaces. In such action the particles of solid material are broken up to very small particle size and are dispersed uniformly throughout the liquid.

Prior homogenizers or colloid mills of the type with which the invention is concerned have had several disadvantages inherent in their construction, such disadvantages arising primarily from the high speed at which the rotor must necessarily be run. Thus such prior homogenizers have been prone to vibrate badly, and ease of disassembly of the homogenizer for the purpose of cleaning it or for repair has been sacrificed for ruggedness of construction.

It is among the objects of the present invention to provide an improved homogenizer and colloid mill which, although run at high speed, is comparatively free from vibration.

A further object of the invention resides in the provision of an improved colloid mill incorporating a simple rugged and positive means for adjustment of the clearance between the rotor and stator parts.

Another object of the invention lies in the provision of a homogenizer and colloid mill which although rugged in construction is composed of a relatively few, easily disassembled, parts, whereby the mill may be disassembled and cleaned with a minimum amount of labor.

Yet another object of the invention resides in the provision of a novel rotor shaft supporting structure whereby the upper end of the rotor shaft is free to "float" radially to a small degree under frictional restraint, thereby damping vibrations in the rotor and rotor shaft, and also rendering the rotor self-centering within the stator under operating conditions.

The above and further objects of the invention will be more readily apparent upon consideration of the accompanying drawings forming a part of the specification.

In the drawings:

Fig. 1 is a view in side elevation of the homogenizer or colloid mill of the invention, the mill being shown in combination with the presently preferred driving and mounting means therefor;

Fig. 2 is a view in vertical axial section through the homogenizer of the invention, the section being taken along the line 2—2 in Fig. 1; and

Fig. 3 is a view in horizontal cross-section through the

hopper of the mill, the section being taken along the line 3—3 in Fig. 2.

The homogenizer or colloid mill of the invention, as shown in Fig. 1 where it is designated generally by the reference character 2, is shown mounted on the downwardly open base member 4, such base member being of inverted trough shape. The mill is retained on the base through the medium of the flange 6 on the bottom of the main housing body 10 of the mill. The vertically mounted electric motor 8 is similarly mounted on the base member 2, the motor driving the main rotor shaft of the colloid mill through the medium of a speed-multiplying pulley and belt combination which is shown and described in my prior application Serial No. 278,799, filed March 27, 1952, now abandoned, the driving pulley on the motor and the driven pulley on the bottom end of the rotor shaft of the mill, as well as the belt entrained over both, being located in the space within the base 2. It is to be understood that such manner of mounting of the mill and also the manner of its drive are not parts of the present invention, and that the mill of the present invention may be mounted and driven in a variety of ways, as by being mounted on top of a vertically positioned motor with the rotor shaft of the mill coaxial with the upwardly extending main shaft of the motor, the two shafts being connected as by a coupling.

The mill 2 of the invention has as main portions thereof the central, working, portion, generally designated 12, the hopper 14 above it, and the described main housing body 10, in the form of a vertically positioned tube, which furnishes the support for the rotor shaft, the stator, the working section 12, and the hopper. In the embodiment shown, the homogenizer is adapted to be mounted as a permanent part of a production line, so that the inlet pipe 16 which continually supplies material to be homogenized is shown as connected to the top of the hopper 14. The outlet pipe 18, through which the mill 2 discharges the material worked upon, may similarly be connected permanently to a production unit as, for example, a bottling or canning machine.

The structure of the mill 2 will be more fully understood by a consideration of Figs. 2 and 3. As shown in Fig. 2, the rotor shaft 20 is mounted axially within the housing member, the lower end of the shaft being carried by the bearing 22 which extends between the shaft 20 and the housing 10. Bearing 22 is of the high speed type which allows slight angular deviations of the shaft carried thereby without damage to the bearing or the introduction of vibration into the system.

As mentioned above, the upper end of the rotor shaft is so mounted that it and the rotor carried thereby may "float" in a radial direction to a small degree, whereby the rotor is self-centering within the stator under operating conditions. The structure whereby such floating action at the upper end of the rotor shaft is achieved consists of the inner, upper, bearing supporting, sleeve 24, such sleeve carrying the upper bearing 26, the inner race of which is affixed to the upper, reduced diameter, end 28 of the rotor shaft 20. The lower end of sleeve 24 is provided with the radially outwardly extending horizontal flange 30 which is positioned in the counterbore 32 in the upper end of the housing 10, the outer circumferential face of flange 30 having a small radial clearance between it and the inner surface of the counterbore, such clearance being on the order of .005 inch. The bottom surface of the flange 30 rests, as shown, on the shoulder 34 at the bottom of the counterbore. The radially inner upper surface of the flange 30 is concave, as shown, so as to provide an annular overflow trough. Such trough is drained through the pipe 38 which extends upwardly through the flange 30 to communicate with the trough,

the pipe 38 extending loosely through the opening 40 in the side of the main housing 10 of the mill.

The operating homogenizing section 12 and the hopper 14 of the mill are carried upon the removable upper housing part 42 which is tubular in shape and which is mounted upon the upper end of the main housing 10 as an extension thereof. The lower end 44 of part 42 telescopes accurately into the upper end of the counterbore 32. Part 42 is retained on main housing 10 by means of the radial flange 46 which rests upon the upper end of the housing 10 and is secured thereon by the studs 48 threaded into the housing 10. Compressed between the lower end of the portion 44 of part 42 and the upper outer annular surface of the flange 30 is the annular rubber cushion member 50. Such cushion member has the function of tending frictionally to retain the flange 30 and thus the sleeve 24 in accurately centered position, and also has the function of serving as a seal at the outer edge of the above described overflow trough. Still further, the annular rubber cushion 50, by reason of its inherent internal friction, serves to damp the vibrations of the sleeve 24 in a radial direction and thus to cause the rotor shaft 20, as effected by the interaction of the rotor and stator and the interposed film of material upon which they operate, to seek at all times a position which is truly axial of the housing 10 and the bearings 22 and 26. The rotor and stator of the homogenizing mill, in action upon the material in the hopper, tend to form a film of uniform thickness entirely about the rotor and between it and the stator, thus tending to center the rotor and the rotor shaft.

The rotor 52 is in the form of a frusto-conical disc which is axially affixed to the upper end of the rotor shaft 20, as shown. The frusto-conical working face 54 of the rotor is provided with a series of alternating flat-faced ribs or teeth 56 and axially disposed grooves of curved cross-section which form sharp edges with the faces of the teeth, said grooves terminating a short distance from the ends of the working surface 54. The bottom surface 58 of the rotor is disposed spaced from, but very close to, with a clearance on the order of .005 inch, the upper surface 62 of the radially inwardly extending flange 60 on the upper end of the member 42. The clearance between the surfaces 58 and 62 is such as to furnish an effective "centrifugal seal" therebetween.

The upper housing member of the mill, with which in this instance is integrally formed the hopper 14, has a lower portion 66 having a cylindrical opening therethrough, the opening in part 66 accurately telescoping over the upper end of the element 42. The raising and lowering of part 66 relative to element 42, by which clearance between the rotor and the stator, to be described, may be varied, is effected by the calibrated adjusting ring 68, upon which the element 66 is supported. Ring 68 is threadedly mounted upon element 42 by means of the cooperating screw threads 70 on such parts. An index mark 72 is disposed on the ring 68, as shown in Fig. 1, such index or zero mark cooperating with the indicia 74 on the outer surface of element 42. Rotation of the ring 68 relative to element 42, depending upon the direction of rotation, will raise or lower the part 66 and thus increase or decrease, respectively, the clearance between the stator, carried on the inner surface of part 66, and the rotor with which it cooperates. An annular packing member 76 is disposed between the bottom inner corner of element 66 and the upper inner corner of ring 68, so that the liquid being treated in the mill is prevented from seeping downwardly into the screw threads 70.

The stator surface 78, which constitutes a part of the described element 66, is also provided with teeth and grooves similar to those on the rotor surface 54. The stator surface 78 is located on the frustum of a cone having the same apex angle as that of the rotor, the stator and rotor lying coaxial of each other. The clearance, as measured normal to the surfaces 54 and 78, is very slight, ranging generally between .003 and .010 inch, the narrow working gap so formed constituting the zone of intense disintegrating and dispersing action into which the materials are introduced in liquid film form. The clearance between stator and rotor is, of course, adjusted by the ring 68 in the manner heretofore described.

It will, of course, be apparent that the liquid or liquid-solid mixture introduced into the hopper 14 will, under the influence of gravity, flow downwardly into the gap between the stator and rotor and be subjected to the intense disintegrating action thereof at the working zone. The homogenized material is then thrown from the mill, after having been acted upon thereby, into the annular collecting trough 82 in element 64 positioned to surround the bottom outer edge of the rotor. Delivery from the mill is effected through the side extension 86 on the housing element 64, such extension housing the passage 86' therethrough, the delivery pipe 18 being attached to such side extension. Housing element 64 is attached to the main supporting structure of the mill by the angularly spaced hinged bolts 90 which depend from the outer end of the radially outwardly extending flange 88 on part 64. The hinged bolts 90 cooperate with the radially spaced slots 92 in the radially outer edge of retaining ring 91, which lies beneath ring 68 and closely embraces the lower, smaller diametered, portion of ring 68 so that the housing portion 64 may be firmly held upon adjusting ring 68 and thus upon housing 10. Adjustment of the working gap between the stator and rotor of the mill may be effected, by the turning of ring 68, with housing part 64 held from rotation, as by the insertion of a manipulating rod into one of the radial holes 73 in the outer upper portion of ring 68 and turning the ring 68 to bring the mark 72 into coincidence with the proper indicium 74 on housing part 42. This may be accomplished without substantial or any loosening of the hinged bolts 90, since the sliding friction between rings 68 and 91 is not unduly large.

In order to prevent foaming of the contents of the hopper, there is preferably disposed in the hopper approximately midway vertically thereof the horizontal baffle plate 94. As shown, such baffle plate has therein two diametrically opposed openings 96, one such opening having been formed by piercing the plate and bending up the flange 98, and the other such opening having been formed by the piercing of the plate and the bending down of the flange 100. The thus formed flanges or vanes interpose considerable restraint upon the liquid or liquid-solid mixture in the hopper, tending to prevent their being impelled circumferentially to any degree by following the motion of the rotor. As a result, agitation of the contents of the hopper, except in the zone thereof immediately adjoining the rotor, is effectively prevented. Thus the contents of the rotor are not beaten or whipped into a foam prior to their being operated upon in the working zone proper of the mill.

As above explained, in the embodiment of the apparatus shown the homogenizer or colloid mill is incorporated as a permanent element in a production line. To prevent splashing of the material being worked upon and to preserve it in as sanitary a condition as possible, the hopper is provided with the cover 102 which, during normal use, is sealed to the upper edge of the hopper by the packing 104, the wing bolts 106 on the cover securely attaching it to the hopper by cooperating with the radially extending slotted flange members on the outer surface of the hopper, as shown.

Because of the "centrifugal seal" between the bottom surface 58 of the rotor and the upper surface 62 of part 42, but little liquid or liquid-solid mixture from the mill seeps downwardly into the overflow trough. In order fully to protect the upper bearing 26 from contact with such material, however, there is affixed to the rotor shaft above the upper bearing the downwardly flanged member 108 which may be termed an "overflow flinger."

Member 108 is in a position to intercept any such seepage down the upper part of the rotor shaft and, having intercepted it, throws it radially onto the inner wall of the element 42 from which it drips into the overflow trough. As a result, it is impossible for any such material to fall upon or otherwise come into contact with the upper bearing 26.

It will be apparent from the above description of a preferred embodiment of the improved homogenizer or colloid mill of the invention that it is characterized by its simplicity, its ease of disassembly and of cleaning, and, by reason of the novel floating bearing structure for the upper end of the rotor, by its substantial freedom from vibration even when operated at extremely high speeds on the order of twelve to eighteen thousand R. P. M. The device is further characterized by the ease of adjustment of the clearance between the working parts of the mill and also by the nicety with which such adjustment may be achieved and maintained. The mill is further characterized, by reason of the provision of the novel baffle plate in the hopper and also by the substantial enclosing of the hopper, by the freedom from foaming or undue agitation of the contents prior to their being operated upon by the elements of the mill and by the lack of exposure of such contents to any contaminating influences during the storage thereof in the hopper and during their being worked upon in the mill.

Whereas for purposes of illustration I have shown and described a preferred embodiment of the homogenizer or colloid mill of my invention, it will be understood that the invention is capable of considerable variation as to details. The invention is, therefore, to be defined by the scope of the claims appended hereto.

I claim as new the following:

1. A high speed centrifugal colloid mill comprising a housing, a rotor shaft rotatably supported in such housing, a rotor having a working surface frusto-conical in shape mounted on the rotor shaft, a stator having a frusto-conical working surface on the housing cooperating with the rotor, and means journalling the rotor shaft in the housing, such last named means comprising a first bearing between the housing and shaft remote from the rotor, means mounting such first bearing, a second bearing between the housing and shaft located closer to the rotor, and means mounting the second bearing in the housing, the means mounting at least one of the bearings being so constructed and arranged that such bearing is free to move radially to a limited degree.

2. A high speed centrifugal colloid mill comprising a housing, a rotor shaft rotatably supported in such housing, a rotor having a working surface frusto-conical in shape mounted on the rotor shaft, a stator having a frusto-conical working surface on the housing surrounding and cooperating with the rotor to form a working gap therebetween, and means journalling the rotor shaft in the housing, such last named means comprising a first bearing between the housing and shaft remote from the rotor, a second bearing between the housing and shaft located closer to the rotor, and means mounting the second bearing in the housing, said last named means being so constructed and arranged that the second bearing is free to move radially to a limited degree.

3. A high speed centrifugal colloid mill comprising a housing, a rotor shaft rotatably supported in such housing, a rotor having a working surface frusto-conical in shape mounted on the rotor shaft, a stator having a frusto-conical working surface on the housing cooperating with the rotor, and means journalling the rotor shaft in the housing, such last named means comprising a first bearing between the housing and shaft remote from the rotor, a second bearing between the housing and shaft located closer to the rotor, and means mounting the second bearing in the housing, said last named means being so constructed and arranged that the second bearing is free to move radially to a limited degree, and resilient means retaining the second bearing in the housing.

4. A high speed centrifugal colloid mill comprising a housing, a rotor shaft rotatably supported in such housing, a rotor having a working surface frusto-conical in shape mounted on the rotor shaft, a stator having a frusto-conical working surface on the housing surrounding and cooperating with the rotor to form a working gap therebetween, and means journalling the rotor shaft in the housing, such last named means comprising a first bearing between the housing and shaft remote from the rotor, a second bearing having an inner and an outer race mounted between the housing and shaft located closer to the rotor, a sleeve mounting the outer race of the second bearing, the end of the sleeve remote from the second bearing having a flange resting in an annular seat in the housing, said last named means being so constructed and arranged that the second bearing is free to move radially to a limited degree, a resilient washer overlying the flange of the sleeve, and means to press the washer downwardly against such flange.

5. A high speed centrifugal colloid mill comprising a housing, a rotor shaft rotatably supported in such housing, a rotor having a working surface frusto-conical in shape mounted on the rotor shaft, a stator having a frusto-conical working surface on the housing cooperating with the rotor, and means journalling the rotor shaft in the housing, such last named means comprising a first bearing between the housing and shaft remote from the rotor, a second bearing between the housing and shaft located closer to the rotor, and means mounting the second bearing in the housing, said last named means comprising a sleeve surrounding the rotor shaft at the end adjacent the rotor, such second bearing being mounted in the sleeve, sleeve mounting means on the sleeve remote from the second bearing, the housing having a seat receiving such last named means, the connection between the housing and the sleeve mounting means being such that the sleeve may tip slightly from a position coaxial with the housing.

6. A high speed centrifugal colloid mill comprising a housing, a rotor shaft rotatably supported in such housing, a rotor having a working surface frusto-conical in shape mounted on the rotor shaft, a stator having a frusto-conical working surface on the housing surrounding and cooperating with the rotor to form a working gap therebetween, and means journalling the rotor shaft in the housing, such last named means comprising a first bearing between the housing and shaft remote from the rotor, a second bearing between the housing and shaft located closer to the rotor, and means mounting the second bearing in the housing, said last named means comprising a sleeve surrounding the rotor shaft at the end adjacent the rotor, such second bearing being mounted in the sleeve, sleeve mounting means on the sleeve remote from the second bearing, the housing having a seat receiving such last named means with radial clearance therebetween, the connection between the housing and the sleeve mounting means being such that the sleeve may both shift radially and tip slightly from a position coaxial with the housing.

7. A high speed centrifugal colloid mill comprising a housing, a rotor shaft rotatably supported in such housing, a rotor having a working surface frusto-conical in shape mounted on the rotor shaft, a stator having a frusto-conical working surface on the housing surrounding and cooperating with the rotor to form a working gap therebetween, and means journalling the rotor shaft in the housing, such last named means comprising a first bearing between the housing and shaft remote from the rotor, a second bearing between the housing and shaft located closer to the rotor, and means mounting the second bearing in the housing, said last named means comprising a sleeve surrounding the rotor shaft at the end adjacent the rotor, such second bearing being mounted in the sleeve, a flange on the sleeve remote from the second bearing, the housing having a seat receiving such flange with radial clearance therebetween, and elastomeric means to thrust the flange into the seat, whereby

the sleeve may both shift radially and tip slightly from a position coaxial with the housing.

8. A high speed centrifugal colloid mill comprising an elongated vertical housing, a rotor shaft rotatably supported in such housing, a rotor having a working surface frusto-conical in shape mounted on the rotor shaft, a stator having a frusto-conical working surface mounted on the housing cooperating with the rotor, the rotor shaft being spaced appreciably from the inner wall of the housing and means journalling the rotor shaft in the housing, such last named means including a sleeve surrounding the end of the rotor shaft adjacent the rotor and located between the shaft and the inner surface of the housing, a radially outwardly extending flange on the sleeve adjacent the lower end thereof, a seat in the housing receiving such flange, the outer surface of the sleeve, the upper surface of the flange thereon, and the inner surface of the housing above the flange constituting an overflow trough, and means to drain such trough.

9. A high speed centrifugal colloid mill comprising an elongated vertical housing, a rotor shaft rotatably supported in such housing, a rotor having a working surface frusto-conical in shape mounted on the rotor shaft, a stator having a frusto-conical working surface mounted on the housing cooperating with the rotor, the rotor shaft being spaced appreciably from the inner wall of the housing and means journalling the rotor shaft in the housing, such last named means including a sleeve surrounding the end of the rotor shaft adjacent the rotor and located between the shaft and the inner surface of the housing, said sleeve carrying a bearing mounted thereon adjacent the upper end thereof, said bearing journalling the rotor shaft, a radially outwardly extending flange on the sleeve at a point below such bearing, a seat in the housing receiving such flange, the outer surface of the sleeve, the upper surface of the flange thereon, and the inner surface of the housing above the flange constituting an overflow trough, and means to drain such trough.

10. A high speed centrifugal colloid mill comprising a vertical housing, a rotor shaft rotatably supported in such housing, a rotor having a working surface frusto-conical in shape mounted on the rotor shaft, a stator having a frusto-conical working surface on the housing cooperating with the rotor, and means journalling the rotor shaft in the housing, such last named means comprising a first bearing between the housing and shaft remote from the rotor, a second bearing between the housing and shaft located closer to the rotor, and means mounting the second bearing in the housing, said last named means comprising a sleeve surrounding the rotor shaft at the end adjacent the rotor, such second bearing being mounted in the sleeve, a flange on the sleeve remote from the second bearing, the housing having a seat receiving such flange with radial clearance therebetween, means to thrust the flange into the seat and to form a seal therewith while allowing the sleeve to shift radially from a position coaxial with the housing, the outer surface of the sleeve, the upper surface of the flange, and the inner surface of the housing constituting an overflow trough, and means to drain such trough outwardly of the housing.

11. A high speed centrifugal colloid mill comprising a vertical housing, a rotor shaft rotatably supported in such housing, a rotor having a working surface frusto-conical in shape mounted on the rotor shaft, a stator having a frusto-conical working surface on the housing cooperating with the rotor, and means journalling the rotor shaft in the housing, such last named means comprising a first bearing between the housing and shaft remote from the rotor, a second bearing between the housing and shaft located closer to the rotor, and means mounting the second bearing in the housing, said last named means comprising a sleeve surrounding the rotor shaft at the end adjacent the rotor, such second bearing being mounted in the sleeve, a flange on the sleeve remote from the second bearing, the housing having a seat receiving such flange with radial clearance therebetween, and elastomeric means to thrust the flange into the seat and to form a seal therewith while allowing the sleeve both to shift radially and to tip slightly from a position coaxial with the housing, the outer surface of the sleeve, the upper surface of the flange, and the inner surface of the housing constituting an overflow trough, and means to drain such trough outwardly of the housing.

12. A high speed centrifugal colloid mill comprising a vertical housing, a rotor shaft rotatably supported in such housing, a rotor having a working surface frusto-conical in shape mounted on the rotor shaft, a stator having a frusto-conical working surface on the housing cooperating with the rotor, and means journalling the rotor shaft in the housing, such last named means comprising a first bearing between the housing and shaft remote from the rotor, a second bearing between the housing and shaft located closer to the rotor, and means mounting the second bearing in the housing, said last named means comprising a sleeve surrounding the rotor shaft at the end adjacent the rotor, such second bearing being mounted in the sleeve, a flange on the sleeve remote from the second bearing, the housing having a seat receiving such flange with radial clearance therebetween, and elastomeric means to thrust the flange into the seat and to form a seal therewith while allowing the sleeve both to shift radially and to tip slightly from a position coaxial with the housing, a downwardly cupped flange mounted on the rotor shaft so as to cover the second bearing-containing end of the sleeve, the outer surface of the sleeve, the upper surface of the flange, and the inner surface of the housing constituting an overflow trough and means to drain such trough outwardly of the housing.

References Cited in the file of this patent

UNITED STATES PATENTS

1,727,417	Soule	Sept. 10, 1929
1,809,363	Teare	July 9, 1931
1,874,079	Black	Aug. 30, 1932
2,083,171	Nester	June 8, 1937
2,160,220	Leister	May 30, 1939
2,162,400	Heath	June 13, 1939
2,534,738	Scott	Dec. 9, 1950