Sept. 2, 1958 L. H. REES ET AL 2,850,246

COLLOID MILL

Filed June 19, 1957 3 Sheets-Sheet 1

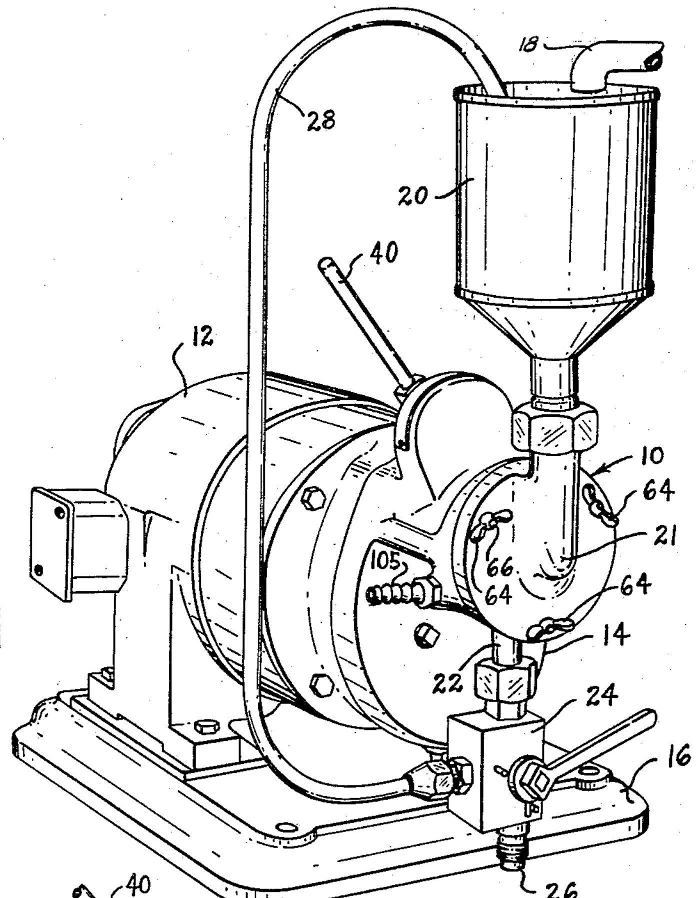


Fig. 1

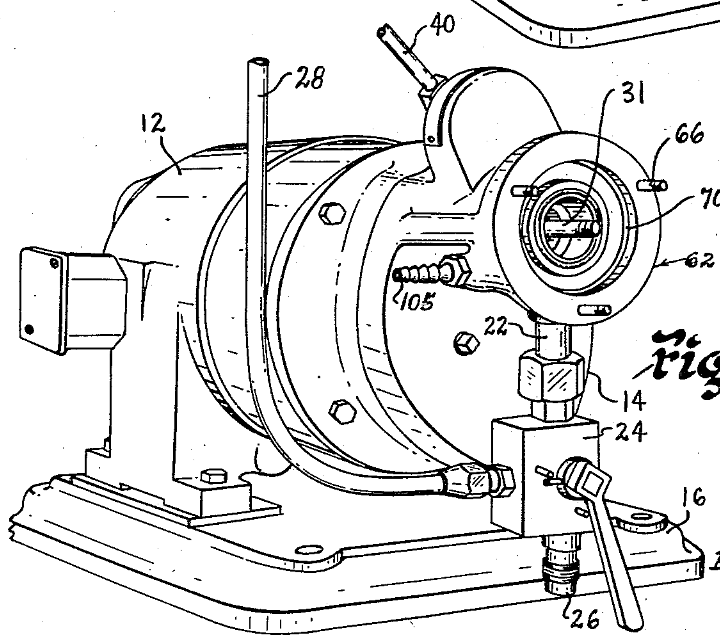


Fig. 2

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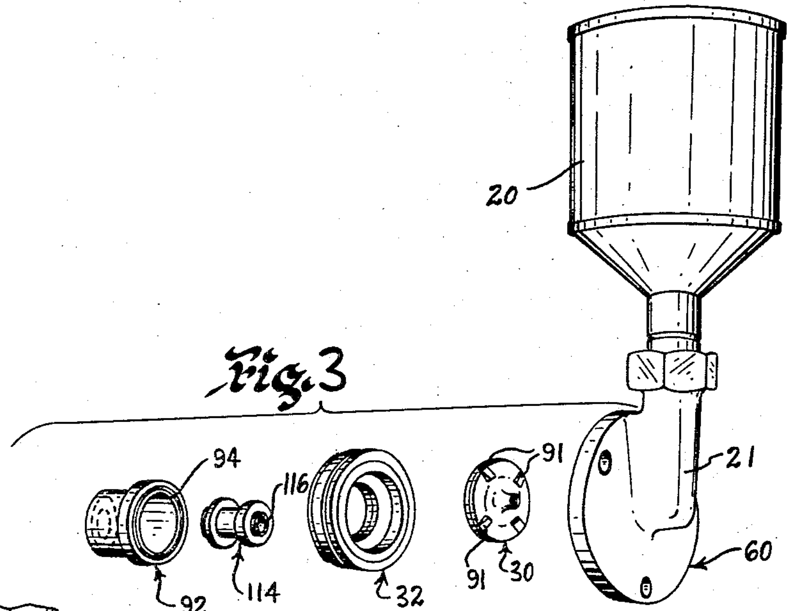
Fig. 3



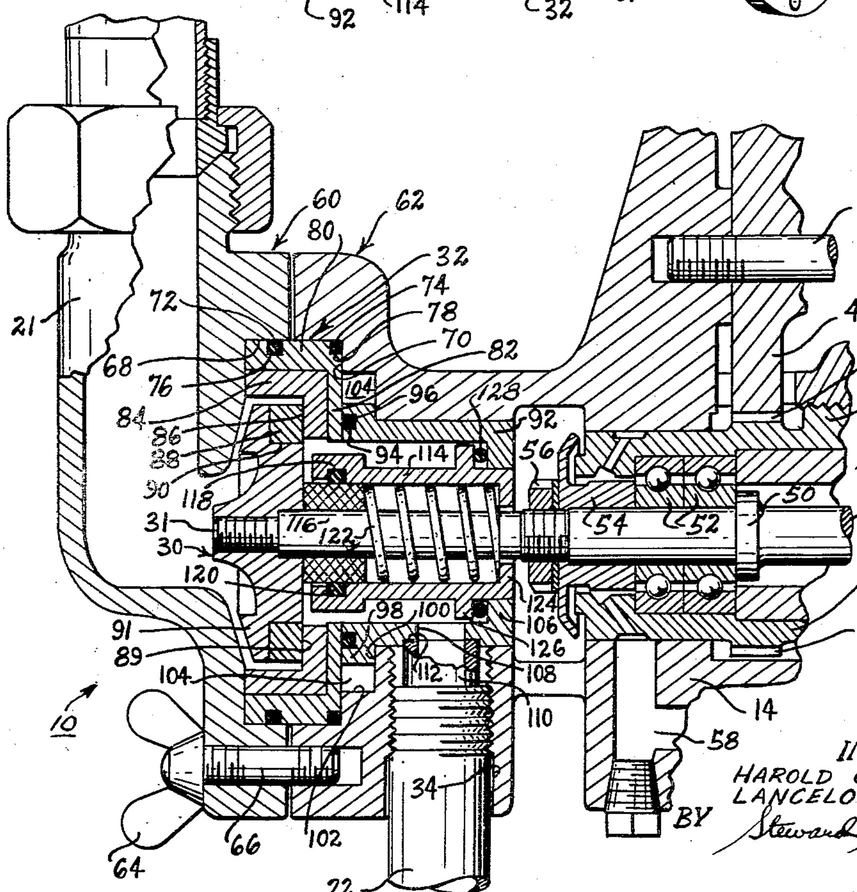




Fig. 4

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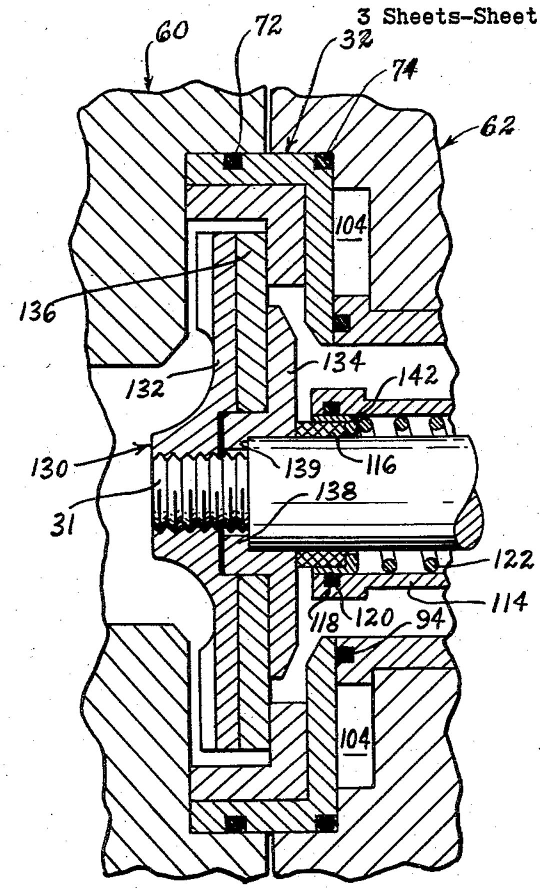


Fig. 5

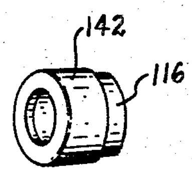


Fig. 7

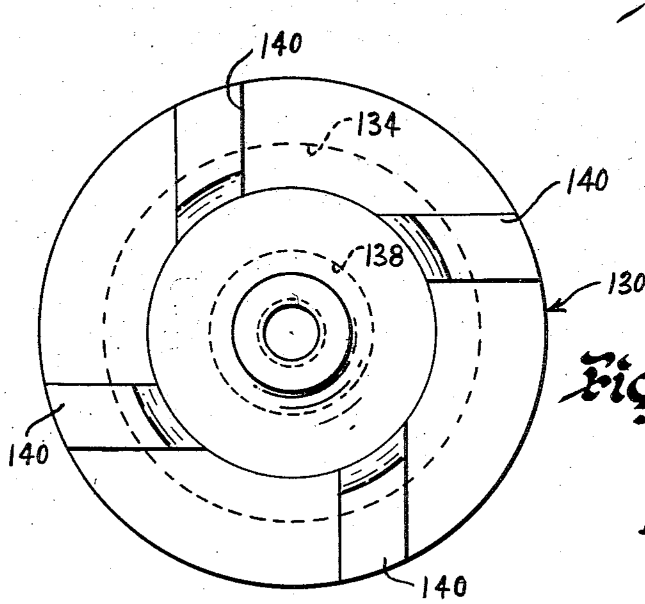


Fig. 6

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2,850,246

# COLLOID MILL

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Application June 19, 1957, Serial No. 666,605

9 Claims. (Cl. 241—244)

This invention relates to improvements in colloid mills, and more especially to a particular construction and arrangement of parts providing better operation and greater ease of assembly and disassemlby for cleaning and maintenance purposes.

The novel mill is of the general type in which the material to be treated is passed between closely spaced, opposed surfaces, at least one of which is rotative relative to the other and of which one most desirably is axially shiftable with respect to the other to vary the closeness of the spacing between them. As is well known, such mills are useful in processes of emulsifying and dispersing a wide variety of substances in homogeneous liquid or paste form, which substances are initially in relatively coarse powder, globular or other agglomerate condition and which therefore do not lend themselves readily to uniform and stable distribution in a vehicle or carrier into which it is desired to incorporate them. In passing through the mill, the substances undergoing treatment are ground, mixed and thoroughly comminuted by the milling and shearing action as the material is fed, by centrifugal force, between the aforesaid closely spaced working surfaces.

One of the chief problems encountered in the use of colloid mills of the type described is the high rate of wear of the working surfaces due to abrasive action. Many substances which it is desired to process in a colloid mill are immediately recognized as being highly abrasive in nature, and many more which are not generally considered abrasive under ordinary conditions evidence a high degree of this property under the processing conditions encountered in the mill, and it is accordingly desirable to use the hardest available metals or vitrified materials as working surfaces in the mill. However, almost all such hard surface materials are relatively brittle, which makes it difficult to design a mill of compact size having sufficient strength to withstand long, hard use under commercial processing conditions. On the other hand, if materials of greater tensile strength are employed, their surface hardness is insufficient to avoid excessive replacement cost due to rapid wear, and the uniformity of processing action is adversely affected by this wear.

Another problem somewhat related to the foregoing is the matter of proper maintenance, which requires maximum access to the various parts of the mill coming in contact with the substance undergoing treatment in order to clean the parts adequately or replace them if necessary. Incomplete removal from the mill of residual amounts of a processed substance not only causes difficulty because of sticking and gradual build-up of additional residue, but may also result in corrosion of the mill surfaces, or in contamination of subsequently processed materials. When mills of this type are used for different products, it becomes all the more essential of course to make sure that all residues of previous products are removed. Easy and complete disassembly of so



much of the mill as comes in contact with the substance being processed is therefore of vital importance.

The colloid mill of the invention has as its principal objectives the overcoming of the problems just mentioned. To this end, the design of the mill makes possible the use of replaceable inserts of hard facing material at the working surfaces, backed up by members having the necessary tensile strength and resistance to fracture to provide a commercially practicable mill. As will be discussed presently in conjunction with the description of a specific mill construction illustrative of the invention, replacement of the wear surfaces is readily accomplished by the user, eliminating expensive factory servicing and repair, and all parts coming in contact with the substance being processed in the mill may be quickly and simply removed for cleaning by him as well. This is achieved by a unique combination of rotor, rotor seal, liner and stator, all of which are interfitted in a mill housing which is partible along a plane transverse to the rotor axis of the mill. The stator, the liner and the seal are held in position solely by interaction with the rotor and the mill housing, and may be removed simply by axial withdrawal thereof upon opening the housing along its part line and removing the rotor. The stator, in addition to serving its normal function of providing a mating surface for the rotor's working surface or surfaces, forms a seal between the separable halves of the housing, while the liner adjoins the stator, forming a sealed joint therewith to isolate the material being processed from the wall of the discharge section of the housing. The seal in turn provides a liquid tight sleeve between the liner and the discharge side of the rotor, surrounding the rotor shaft and isolating it from contact with the material undergoing processing.

It is a further object of the invention to provide a mill of extreme versatility through the employment of rotor and stator parts of different design and materials which are readily interchangeable to meet the needs of particular processing problems. It is also an important feature of colloid mills embodying the invention that the design and mechanical construction of the several parts is simple, affording substantial economy in manufacture without sacrifice of strength or utility in the mill.

These and other objects and improvements will become more apparent from the following description of preferred embodiments of the invention illustrated in the accompanying drawings, in which:

Fig. 1 is a perspective view in front elevation of an assembled colloid mill incorporating an integral motor drive and mill housing assembly;

Fig. 2 is a similar view showing the interior of the mill housing after removal of the front or intake section of the housing and the rotor;

Fig. 3 is an exploded view showing the front housing section, rotor, stator, sealing sleeve and liner in their relative positions in the mill;

Fig. 4 is a sectional view in side elevation of the assembled mill;

Fig. 5 is a fragmentary view in side elevation, in section, of a modified rotor and rotor seal construction;

Fig. 6 is a plan view of the rotor impeller section of the rotor assembly shown in Fig. 5; and

Fig. 7 is a detailed perspective of the rotor seal shown in Fig. 5.

Referring more particularly to Figs. 1, 2 and 4 of the drawings, a self-contained colloid mill unit is shown comprising a mill portion 10 mounted on the forward end of a motor 12 and integral gear housing 14. The entire unit sits on a mounting base 16. The material to be processed is fed through a suitable conduit 18 to a hopper 20 from which it passes down through mill 10, emerging at the outlet 22. A valve 24 permits discharge of the processed material at the discharge outlet 26, or recirculation of any or all of the treated product through recirculating line 28 back into hopper 20. As seen best in Fig. 4, a rotor 30 mounted on a shaft 31 within the interior or working chamber of the mill is driven by motor 12 through suitable speed increasing gearing. Rotor 30 is positioned closely adjacent a stator 32 which encircles it, and the material undergoing treatment passes from inlet 21 between the rotor and stator as the former turns at high speed, and thence to discharge line 22. In order to control the amount of attrition or comminution of the material undergoing treatment, the respectively adjacent working surfaces of the rotor and stator are made relatively moveable toward and away from each other so as to reduce or increase the space between them through which the material must pass. To this end, rotor shaft 31 is arranged to be axially shiftable whereby the rotor 30 is moved toward or away from the stator 32 in the illustration seen in Fig. 4. This is accomplished by axially shifting a bearing cage 38 through rotation of this within the gear housing 14 of the unit. Such rotation is effected by means of handle 40 pivoted on a stub shaft 42 and having a gear segment 44 which meshes with teeth 46 on a peripheral flange of cage 38. The latter is also provided with a threaded shoulder 48 which is received in a threaded aperture of the housing whereby rotation of the cage in one direction or the other causes it to be screwed in or out of the housing. Rotor shaft 31 is shouldered at 50 and is confined within cage 38 against axial movement relative thereto by abutment of said shoulder 50 against the inner race of suitable ball bearing means 52, and the opposing abutment of a bushing 54 secured in position on shaft 31 by threaded engagement of nut 56 on the shaft. The inner face of bushing 54 abuts the opposite side of the inner race of the ball bearing means 52, whereby axial shifting of the cage 38 produces the corresponding movement of shaft 31. Lubrication of the cage and bearing assembly is provided by oil passages 58.

As is shown in Figs. 2, 3 and 4, the mill section of the unit is partible transversely of the axis of rotor shaft 31 to divide the mill housing into two work-chamber-forming sections which may be termed generally as inlet and outlet sections 60, 62, respectively. Outlet section 62 is formed integrally with the motor and gear housing assembly, whereas inlet section 60 is removable upon unscrewing the thumb screws 64 from studs 66. This condition is illustrated in Fig. 2 and rotor 30 has likewise been removed in this illustration. To permit this, the rotor is tapped, and the rotor shaft 31 is threaded at its outer end for engagement in the tapped hole of the rotor. The direction of threading is selected so that in normal operation rotation of the shaft tends to screw the rotor onto the shaft, in conventional manner.

It is an important feature of this invention that all of the component parts of the mill which come in contact with the material treated are readily removable so that the processor can perform routine cleaning or other maintenance with complete thoroughness and in a minimum amount of time. Previous mills permitting removal of the components in any comparable manner have embodied threaded engagement between the several parts in order to achieve proper sealing between them to prevent escape and contamination of the material being treated. Not only does this increase the difficulty of disassembly and reassembly, but even more, it increases the difficulty of thorough cleaning since it is difficult to remove residual amounts of material lodged in thread crevices. The construction and arrangement of the components of the novel mill here disclosed eliminate the necessity for threads on the components and thus materially simplifies the task of disassembly, cleaning and reassembly.

As seen more particularly in Fig. 4, stator assembly 32 is confined in an annular pocket formed jointly by complementary recesses 68, 70, in the inlet and outlet housing sections 60, 62, respectively, on opposite sides of the parting plane of those sections. In the assembled condition of the mill, stator 32 is confined in this pocket and forms a seal at each side of the parting line of the housing by means of O-rings 72, 74, retained in peripheral grooves 76, 78, respectively, in the circumference of the stator assembly. After removal of the inlet housing section and rotor, stator assembly 32 may then simply be withdrawn axially from the recess 70 in housing 62.

Stator assembly 32 comprises an outer retaining ring 80 having a radially disposed flange or wall 82 projecting inwardly towards shaft 31, and insert 84 is received within this retaining ring. Insert 84 is of hard material such as Alundum or a metal carbide, for example, and provides a working surface 86 cooperating with the working surface of the rotor presently to be described. Insert 84 may simply be annular or it may be flanged similar to the retaining ring 80 as specifically illustrated. In either event it is adapted to be withdrawn from the retaining ring in order to permit working surfaces of different materials to be employed to meet certain processing requirements or to permit its removal in case of wear or breakage without requiring the complete replacement of the entire stator assembly.

An insert 88 of annular configuration is carried in a conforming recess 90 on the inner fact of rotor 30, and is retained in that recess by reason of a relatively tight fit therewith. This insert, like that in the stator assembly, is formed of some suitably hard material and may be either the same as or different from the material of the stator insert. Face 89 of the insert is disposed opposite and in closely spaced relation to face 86 of stator insert 84. As already described, the distance between these opposed faces is controllable by means of adjusting handle 40. Impeller vanes 91 provided on the outer face of rotor 30 pump the fluid material being treated between the working surfaces of the mill.

Mill housing 62 is bored to receive a liner 92 which in the present instance takes the form of a flanged tubular sleeve concentric with rotor shaft 31 and spaced circumferentially therefrom. At its forward end face (i. e. to the left in Fig. 4), liner 92 is grooved to provide a retaining recess 94 within which is disposed a suitable sealing gasket 96. Liner 92 is also provided with an exterior flange or shoulder 98 which is adapted to abut against the rear face 100 of a counter bore 102 in housing 62. Abutment of shoulder 98 against the rear face of the counter bore is effected by engagement of gasket 96 against the radial wall 82 of stator retaining ring 80 in the assembled mill. The annular space 104 formed between the walls of the counter bore 102 in housing 62, liner 92 and stator retaining ring 80 permits a coolant to be introduced therein adjacent the working surfaces of the mill for greater efficiency thereof. The coolant is introduced by a flexible line (not shown) connected to a nipple 105 (see Figs. 1 and 2), and is withdrawn from a similar nipple and connecting line (neither of which are shown) at the opposite side of the mill.

At its inner or rear end, liner 92 is formed with an inwardly directed circumferential flange 106 for purpose which will be described presently. Sleeve 92 also has a port 108 registering with outlet port 34 in housing 62. To ensure this registration, liner 92 is provided with means for keying it in fixed rotated position within the housing, and in the specific illustration given in Fig. 4 this keying means comprises a collar 110 received in a counter bore 112 concentric with port 108 in the liner. Collar 110 is retained in engagement with the counter bore by means of outlet stub 22 and may be removed, to permit removal of liner 92, by unscrewing stub 22 from its socket in housing 62. In place of this arrangement, a simple axial rib and mating slot arrangement on the exterior of the liner and interior of the housing will serve to set the liner in predetermined angularly rotated position relative to the housing.

In order to provide a tight seal around the rotor shaft 31 where it enters the working chamber of the colloid mill, there is provided a sealing sleeve 114 which is spaced peripherally from the shaft adjacent rotor 30 and receives therein a sealing ring 116 making a close bearing fit on its inner circumference with the outer circumference of shaft 31, while the outer circumference of ring 116 fits closely within a sleeve 14 and makes a seal therewith. Sleeve 114 is recessed at 118 and a gasket 120 is carried in this recess to ensure a tight seal with ring 116. The latter ring is formed of a suitable bearing material, such as graphite, and its forward end wall abuts the inner face of rotor 30 and forms a rotary seal therewith. Abutment of the ring 116 against rotor 30 is occasioned by compression spring 122 confined within sleeve 114 between the rear wall of ring 116 and the forward face of an inwardly turned flange 124 of sleeve 114. Sleeve 114 also has formed on its periphery an external circumferential flange 126, and a gasket 128 is confined between flange 126 and flange 106 of liner 92 to provide a seal between the liner and the sleeve.

This completes the arrangement whereby the working chamber of the mill is completely sealed by means which permits the several parts to be easily removed for regular and thorough maintenance in very rapid manner. The disassembled relation of these parts is illustrated in detail in Fig. 3 of the drawings.

A modified form of rotor assembly, permitting the user of the mill to substitute easily different working surfaces on the rotor is shown in Fig. 5. In this instance rotor 130 is composed of an impeller section or hub plate 132, a flanged collar or bushing 134, and an annular ring 136 of hard material, as previously described, sandwiched between the impeller and bushing sections 132, 134, of the assembly. Impeller section 132 is threaded to receive the threaded end of rotor shaft 31 and bushing 134 is shouldered internally at 138 to seat upon shoulder 139 of shaft 31 adjacent its threaded portion. By this means, screwing impeller section 132 onto shaft 31 causes rotor insert 136 to be tightly clamped between the hub plate and bushing to prevent relative rotation between these members. The outer face of rotor 130 is shown in more detail in Fig. 6 from which it will be seen that the thickened outer annular portion of the rotor has slots 140 milled across it and part way through the thickness thereof to provide generally radial vanes for pumping the material undergoing processing between the closely spaced working surfaces of the mill.

There is also illustrated in Fig. 5 a modified form of rotary seal which in certain applications, notably where operating conditions are such that the product material is subjected to substantial back pressure, provides unique and quite unexpected improvement in operating results. Referring to Figs. 5 and 7, it will be noted that the carbon or graphite ring 116 in this instance is encased in a cupped retaining ring 142, preferably formed of stainless steel. This arrangement has been found to allow a mill having a rotor 8 inches in diameter to be run at speeds up to 5,000 R. P. M., a 4 inch diameter mill to run at 10,000 R. P. M., and a 2 inch mill to run at speeds up to 20,000 R. P. M. without leakage under back pressures up to 50 pounds per square inch. Such speeds are considerably in excess of operating speeds of mills of corresponding sizes heretofore known. Obviously, where the back pressure to which the mill is subjected is of a lower order, for example up to 15 pounds per square inch, it is preferable to use a spring 122 of light tension in order to reduce the wear of bearing ring 116.

Various changes in design will be apparent from the foregoing description and all such changes as come within the scope of the appended claims are therefore intended to be included, as the invention resides more especially in the concept of the arrangement of parts whereby all of them which come into direct contact with the product material may be quickly and easily removed from the mill for cleaning and replacement without necessity for employing threaded joints in order to provide a tight seal in the operating mill.

What is claimed is:

1. In a colloid mill provided with a housing which forms a working chamber having an inlet and an outlet port, and a rotor shaft extending through said housing into said chamber, said housing being split to form sections partible axially of said shaft for access to said working chamber, and means for releasably holding said sections together, a rotor removably secured to said shaft within said working chamber, an annular stator surrounding said rotor, said rotor and stator having opposing, closely spaced faces constituting the working surfaces of said mill, said stator being removably received in said housing between the sections thereof and forming a seal between them, a removable liner surrounding said shaft in spaced relation thereto and confined between said stator and said housing, a sleeve on said shaft within said liner and adjacent said rotor, said sleeve and liner being spaced peripherally and having oppositely directed circumferential flanges and sealing means confined between said flanges, said sleeve being formed to provide an annular space between it and said shaft adjacent said rotor, an annular bearing received in said space and forming a seal between said sleeve and shaft, said bearing being slidable axially of said shaft within said sleeve, and spring means biasing said bearing against said rotor to form a rotary seal therewith.

2. A colloid mill as defined in claim 1, wherein annular inserts are carried by said rotor and stator, respectively, said inserts having cooperating faces forming said opposing closely spaced working surfaces of said mill.

3. A colloid mill as defined in claim 2, wherein said rotor comprises a hub plate, a collar adapted to be disposed between said hub plate and rotor shaft, and said annular insert is clamped between said hub plate and collar, and fastening means for securing said hub plate, collar and annular insert together on said rotor shaft concentrically thereof.

4. A colloid mill as defined in claim 2 wherein said stator is composed of a radially flanged backing ring and said annular insert is similarly shaped and is removably nested within said flanged backing ring.

5. A colloid mill as defined in claim 4, wherein said rotor comprises a hub plate having a threaded aperture, said rotor shaft having a threaded portion adapted to be received in said aperture, and a bushing disposed between said hub plate and rotor shaft, said annular rotor insert being clamped between said hub plate and bushing by the threaded engagement of said hub plate with said rotor shaft.

6. A colloid mill as defined in claim 1, wherein said annular bearing comprises an externally flanged retaining collar and a tubular graphite sealing ring seated in said metal collar.

7. In a colloid mill having a rotor, a rotor shaft to which said rotor is demountably secured, a housing surrounding said rotor and forming a working chamber therefor, said housing comprising complementary inlet and outlet sections which adjoin at a parting plane disposed transversely of said shaft, inlet and outlet ports leading to said chamber in the respective housing sections, said housing sections having complementary annular recesses in the adjoining edges of the walls thereof which together form an annular pocket surrounding said rotor in peripherally spaced relation thereto, an annular stator removably fitted in said pocket astride said parting plane and making sealing engagement with the walls of each of said complementary recesses, said rotor and stator having closely spaced opposed surfaces constituting the working surfaces of said mill, a liner removably fitted in the outlet section of said housing and surrounding said rotor

shaft in spaced relation thereto and having a port coinciding with the port in said section, a shoulder on said liner and a cooperating shoulder on said housing section which abut and press said liner into sealing engagement with said stator, said liner having an internal circumferential flange, a sleeve surrounding said shaft and having a portion spaced radially therefrom and from said liner, said sleeve having a circumferential shoulder adapted and arranged to make sealing engagement with said internal flange of said liner, and an annular bearing forming a sealing fit as its inner and outer surfaces with said rotor shaft and sleeve, respectively, said sleeve having an internal shoulder, and spring means confined between said last shoulder and said bearing to urge the latter axially against said rotor to form a rotary seal therewith.

8. A colloid mill as defined in claim 7, wherein said outlet housing section is formed to provide a second annular recess substantially concentric with the first and axially set back therefrom, said second annular recess forming with said liner and said stator a peripherally sealed cooling water chamber or jacket adjacent the working surfaces of said mill, and cooling water inlet and outlet means communicating with said chamber.

9. A colloid mill having a rotor shaft, a rotor housing separable axially of said shaft along a part line to form individual housing sections, each section having a recess complementary to the other which together form a working chamber, means releasably securing said sections together, a rotor disposed within said working chamber and removably secured to said rotor shaft and having a working surface thereon, an annular stator surrounding said rotor and having a working surface complementary



to and in closely spaced relation to said rotor surface, an annular pocket formed in the wall of said working chamber and spanning said housing part line, said stator being removably seated in said pocket in sealing engagement with the walls thereof, an inlet port in one of said sections and an outlet port in the other, a liner disposed in said other section, said liner being removably received therein and having a port coinciding with the outlet port thereof, said liner abutting said stator and having peripheral sealing means thereat, a shoulder formed in said working chamber and an external flange on said liner which abuts against said shoulder to press said sleeve into endwise abutment with said stator, an internal flange on said liner and a sleeve disposed within said liner and surrounding said shaft, said sleeve being peripherally spaced from both and having an external flange for sealing engagement against said internal flange of said liner, a bearing ring received in said sleeve and making a close sliding fit therewith and with said rotor shaft, said sleeve having an internal shoulder, and spring biasing means confined between said interal shoulder of said sleeve and said bearing ring urging the latter axially against said rotor to form a rotary seal therewith.

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# UNITED STATES PATENT OFFICE
# CERTIFICATE OF CORRECTION

Patent No. 2,850,246 September 2, 1958

Lancelot H. Rees, et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, lines 34 and 35, after "opposing" insert a comma; line 43, after "2" insert a comma; column 7, line 11, for "as" read -- at --.

Signed and sealed this 9th day of December 1958.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents