

June 12, 1962

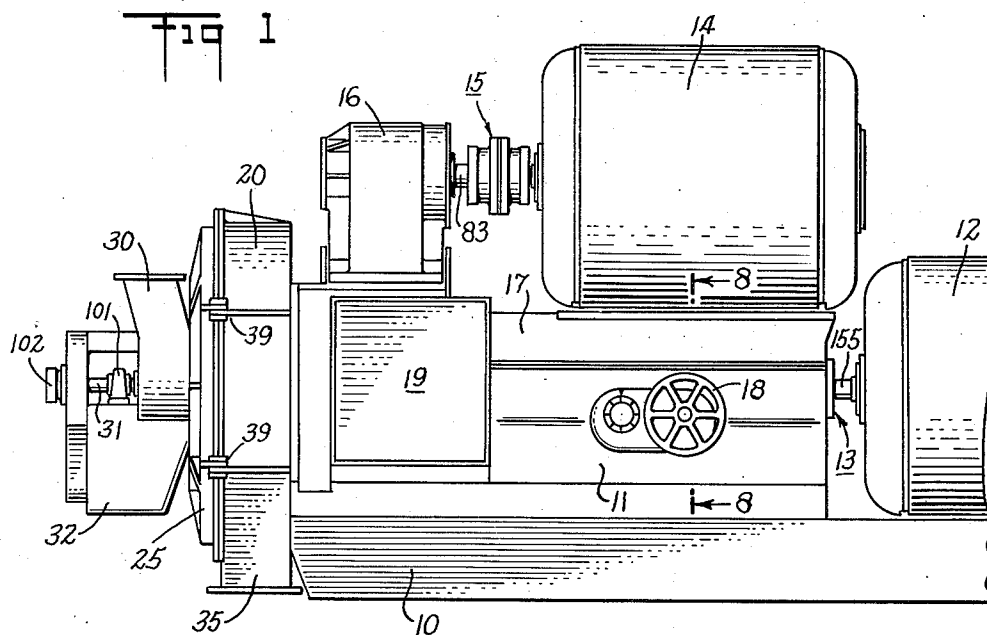
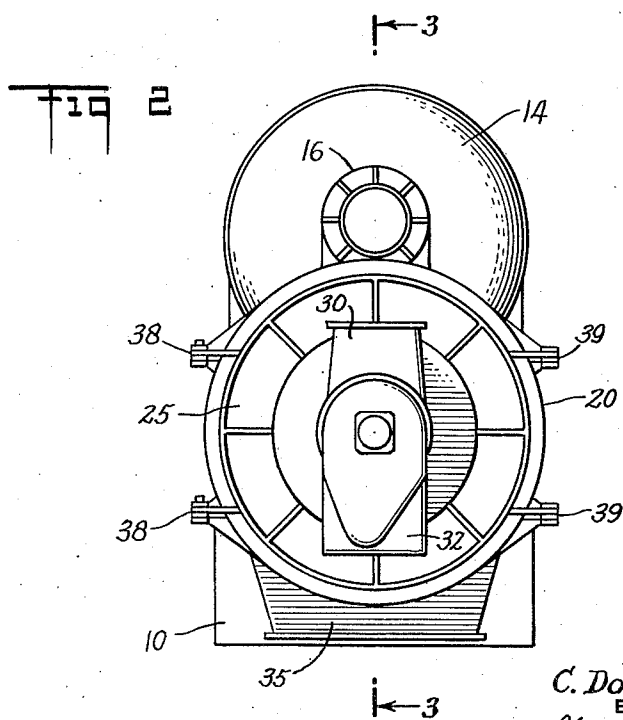
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3,038,673

ATTRITION MILL APPARATUS

Filed Feb. 19, 1960

5 Sheets-Sheet 1



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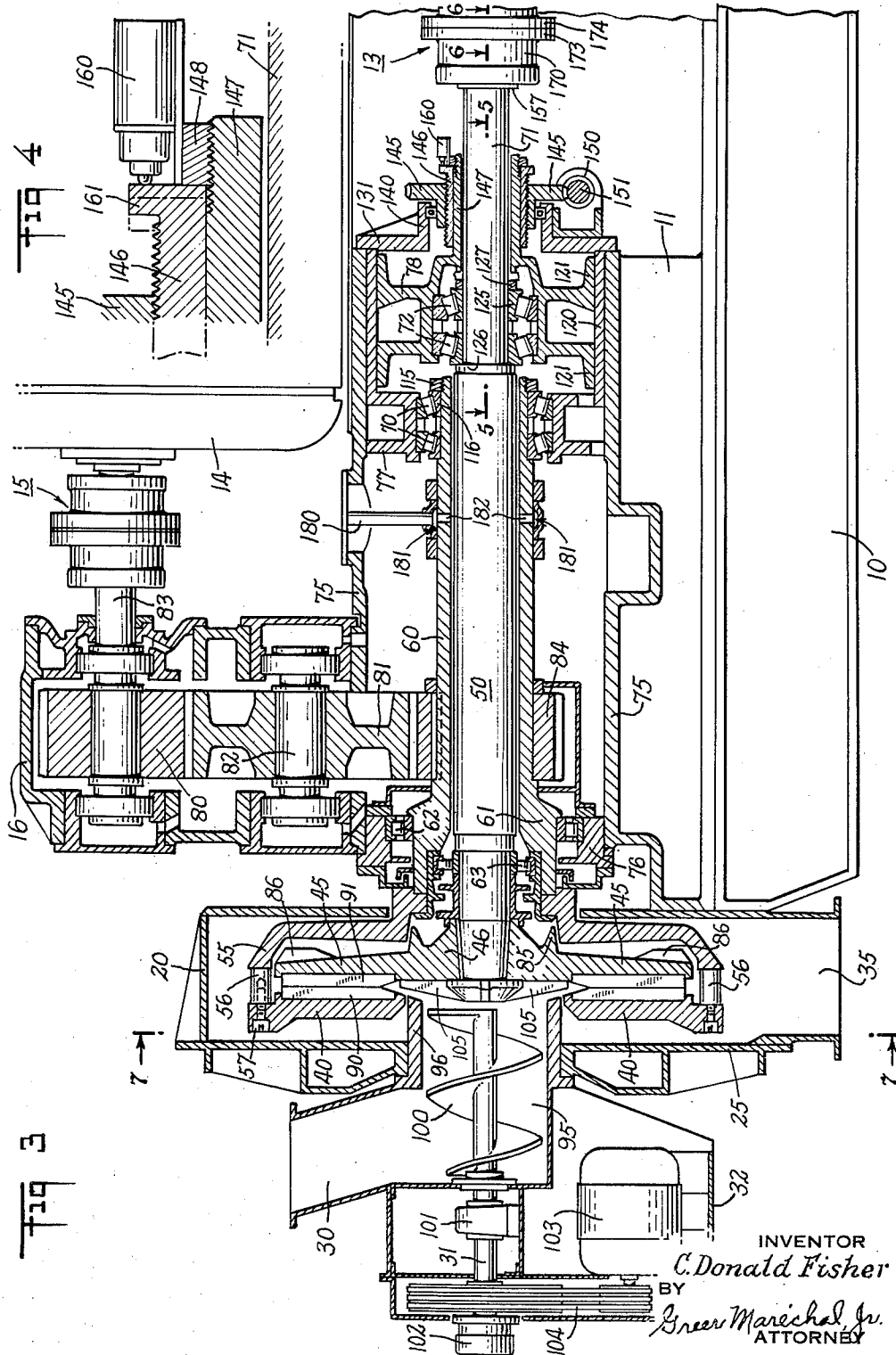
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ATTRITION MILL APPARATUS

Filed Feb. 19, 1960

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June 12, 1962

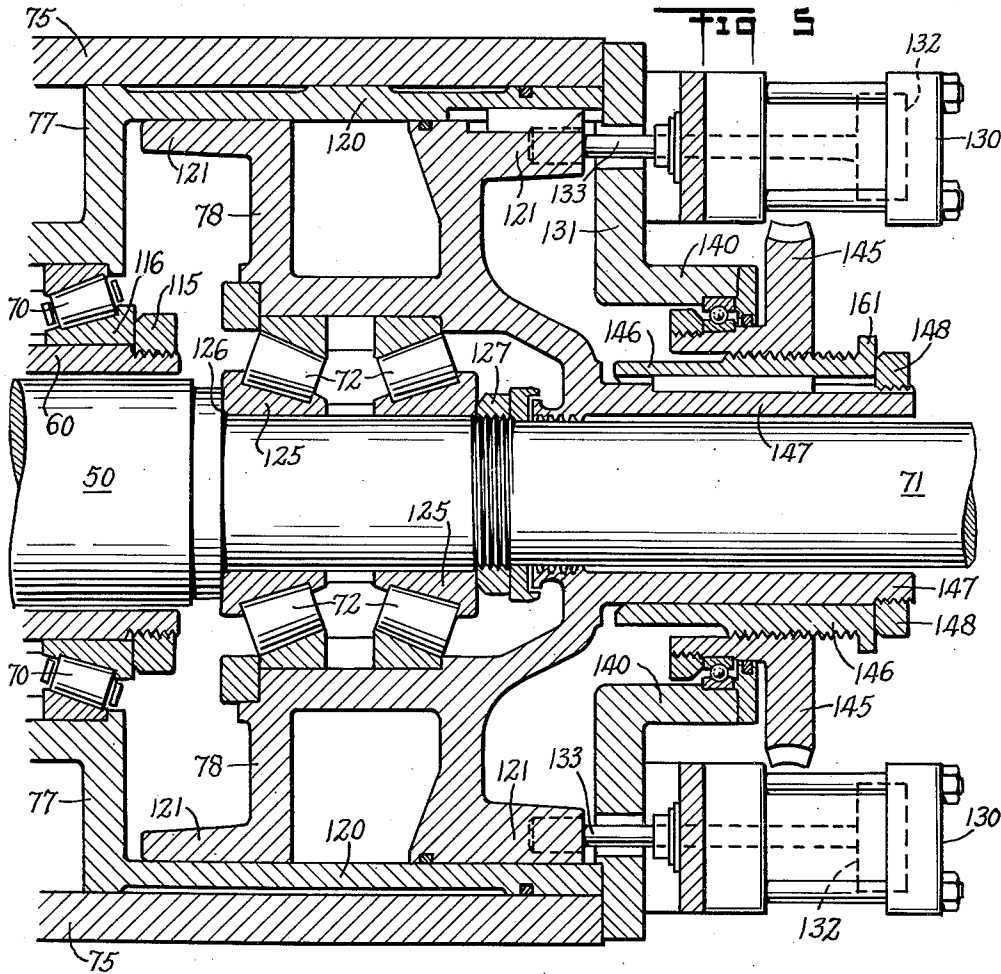
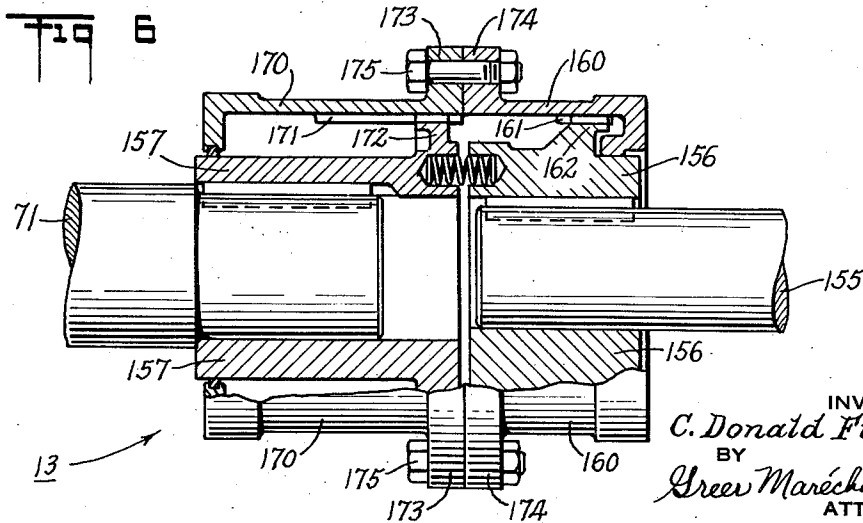
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ATTRITION MILL APPARATUS

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5 Sheets-Sheet 3



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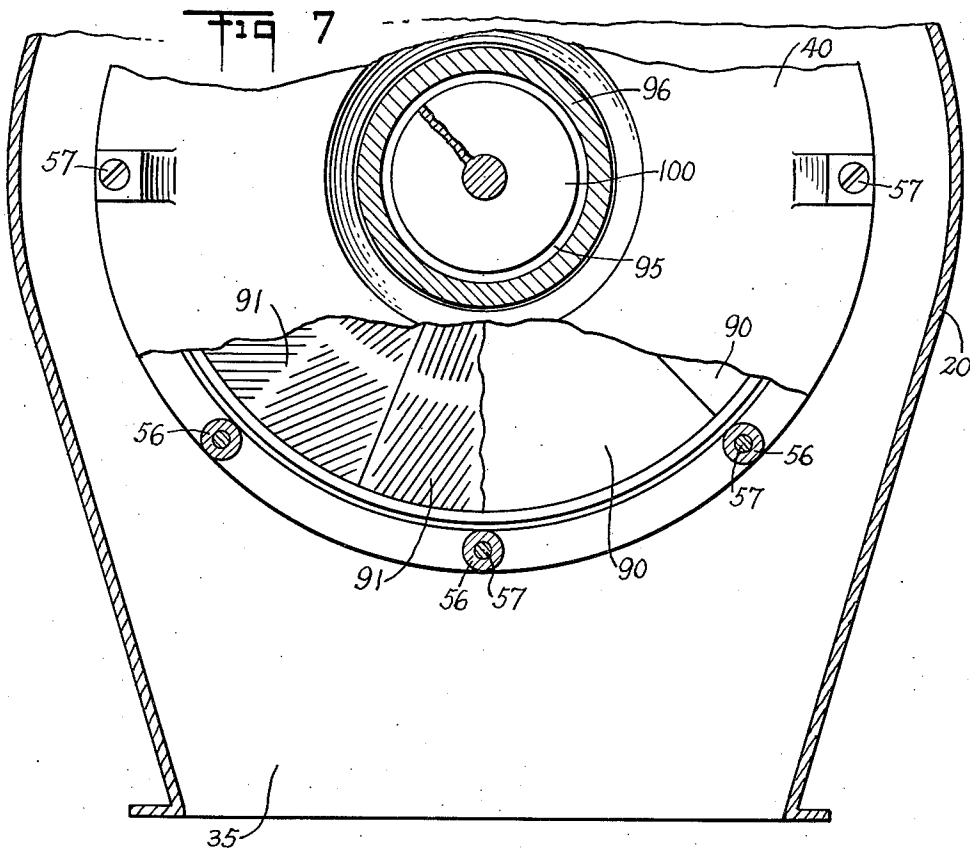
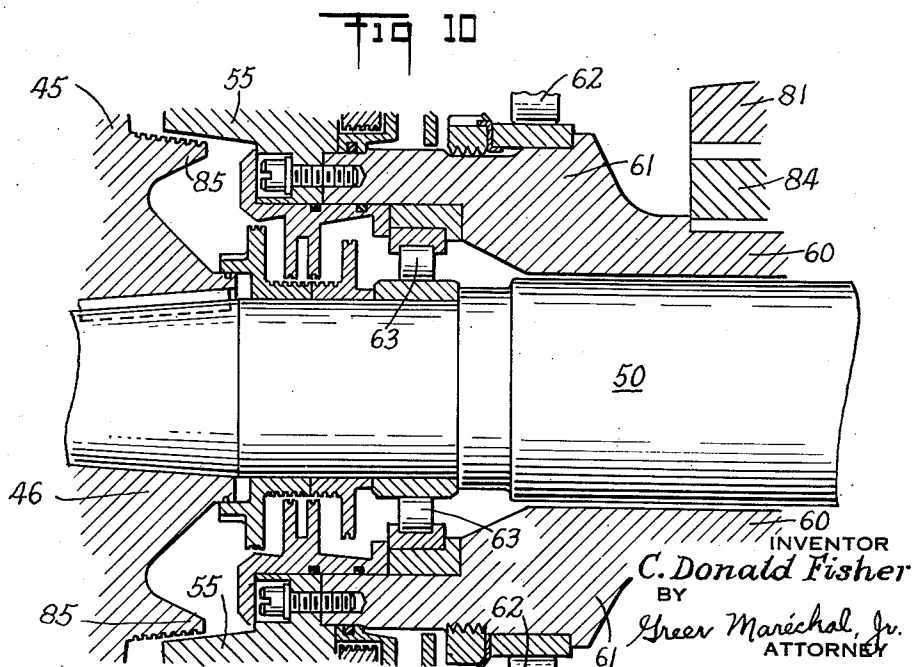
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ATTRITION MILL APPARATUS

Filed Feb. 19, 1960

5 Sheets-Sheet 4



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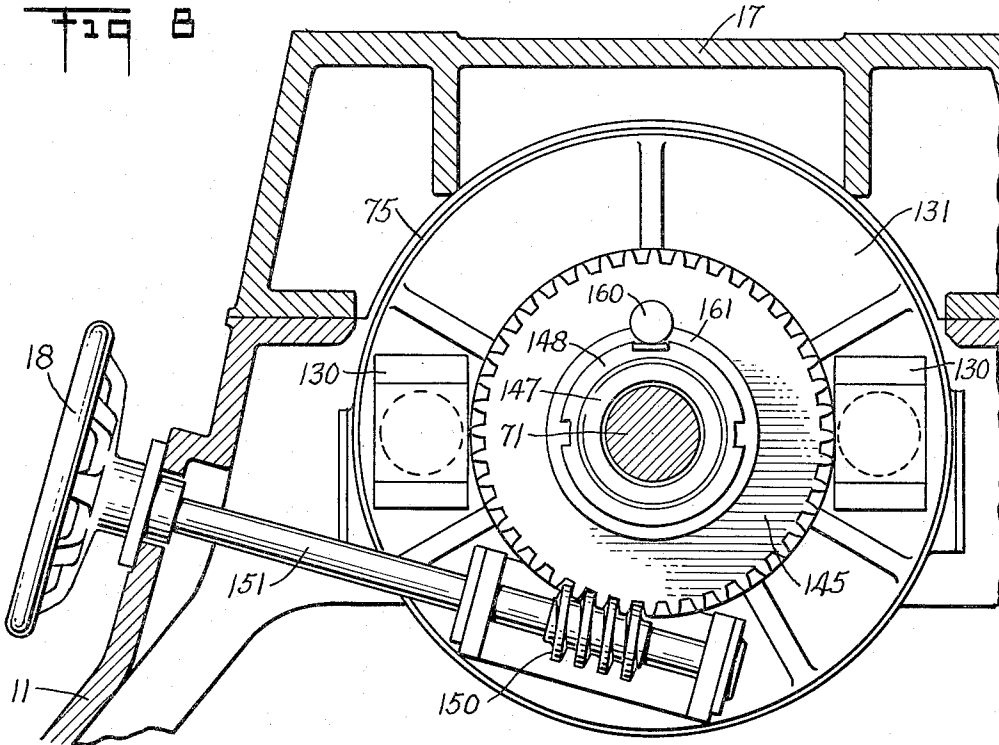
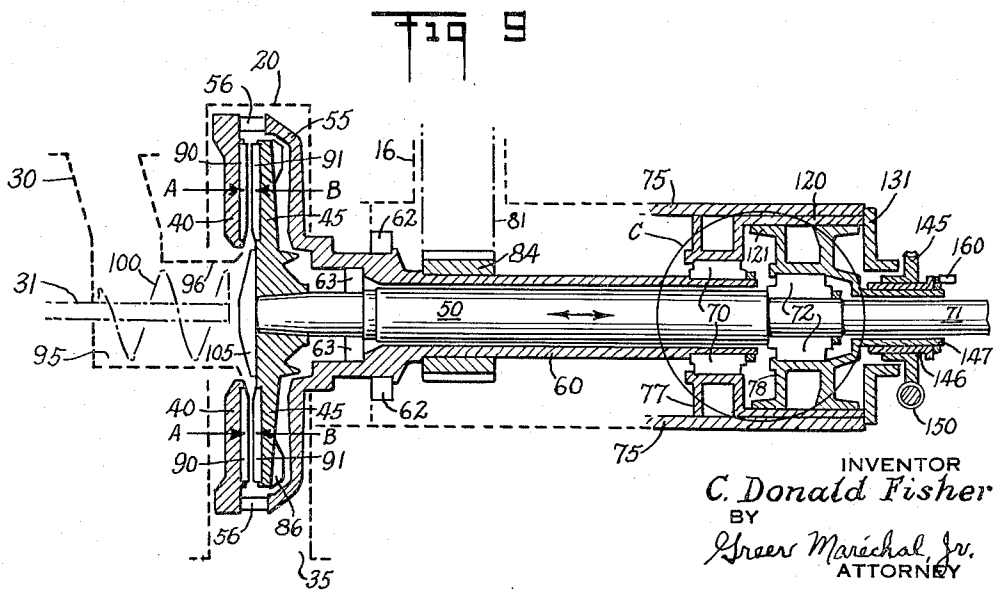
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ATTRITION MILL APPARATUS

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3,038,673

ATTRITION MILL APPARATUS

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Filed Feb. 19, 1960, Ser. No. 9,758

12 Claims. (Cl. 241-245)

This invention relates to attrition mill apparatus and, more particularly, to a rotating disc attrition mill for refining paper pulp and like usage and in which the attrition or refining or grinding action, as may be desired, is obtained by passing the material to be treated between the opposed faces of two cooperating rotating discs having grinding or refining or attrition action plates or surfaces thereon.

In so-called "double disc" or "double runner" mills of this type (which designations generally indicate that both the opposed discs are rotating as distinguished from so-called "single disc" mills having a single rotating disc cooperating with a stationary surface) especially in the field of "refining" wood pulp and similar substances in the form of a water slurry thereof for the manufacture of paper and the like, the material to be treated, usually in the form of the water slurry, is introduced through one of the discs, into the attrition spacing therebetween, generally adjacent the center or "eye" of the disc, with the material moving radially outward between the two discs under the action of centrifugal force to be discharged adjacent the periphery of the discs.

Also, as will be understood, the amount or severity of attrition action obtained (whether it be an actual grinding or size reduction action or merely a rubbing or crushing action) for any given concentration of slurry and design of attrition surfaces will be dependent upon and controlled by the spacing between the opposed attrition surfaces of the rotating discs. It may be desired for the two rotating discs to be driven at different speeds and/or in different directions of rotation, so that separate motors and/or other drive means are provided for each of the two rotating discs.

As a result of the foregoing, particularly considering such attrition mills having separately mounted and driven rotating discs of a diameter of several feet or more, some difficulty may be experienced in maintaining the desired slight spacing between the discs within close tolerance limits against deflection under substantial operating pressures applied over so large a disc surface, and particularly when it is understood that inadvertent variations of spacing of but a few thousandths of an inch may result in undesired variation or non-uniform treating results on the material being treated. Also, extremely minute misalignment variations adjacent the center of the discs are greatly magnified at the operating peripheries of discs several feet or more in diameter, whether such deflections or misalignments come from mechanical forces or from diverse heat expansion movements of the shafts or other mountings for the discs arising from increased friction or other temperature change in operation.

Similarly, some further difficulty may be experienced from the fact that, in such double disc attrition mills, the work being performed on the material being treated, since an attrition action between the discs is desired, results in substantial axial thrust forces tending to separate the discs against the opposed axial thrust of whatever mechanism is utilized for adjusting and maintaining the desired spacing between the opposed faces of the discs. Hence a non-uniform or inaccurate spacing may result from any or all of the separate factors of mechanical deflection in the discs themselves, the mechanical misalignment of the separate mountings of the rotating discs, or non-uniform axial heat expansion movement of either the discs or

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the mountings therefor as the temperature thereof rises during operation.

An additional complication may be interjected with such a structure because of the desire to introduce the material to be treated adjacent the center or eye of one of the rotating discs. Thus, if such disc has an open center with spokes radially supporting the disc on a shaft, it may be found that, if such spokes are sufficiently or heavy to prevent the aforementioned mechanical deflection of the open-centered disc, they will also be large enough to create substantial non-uniformity in the flowing of slurry through the spoked open portion of the rotating disc, whereas reducing the size of the spokes (or even attempting to streamline them) may prevent adequate sturdiness of the open-centered disc against deflections thereof. If it is attempted to avoid some of the foregoing difficulties by the utilization of other expedients, such as, for example, feeding the material through a hollow shaft on one of the discs, further difficulties may be experienced with regard to shutdown time in the event of clogging through the feedline, non-uniform thermal expansion movements, etc.

According to this invention, however, attrition mill apparatus of the character described is provided for obviating or minimizing the foregoing difficulties and having two rotating attrition discs mounted, respectively, one on a hollow shaft or quill and the other on a shaft coaxially extending therethrough for driving the discs, with one of the discs being carried by a peripheral spider to leave an opening adjacent the center or eye thereof substantially free or unobstructed by spokes, and with the thrust bearings for both the quill and the shaft being located in close proximity to each other for foreshortening the path of counterposed axial thrust; and, as a further feature of this invention, the material to be treated is fed into the central opening between the discs by a screw feeder apparatus, preferably mounted on a hinged cover to be readily removed or swung out of the way for access to both rotating discs.

One object of this invention is to provide apparatus of the character described having two opposed and mating attrition discs, each separately driven for rotation, and positive feed means for feeding material to be treated between said discs through a central opening in one of the discs, such open disc being mounted in the device at the periphery thereof to leave the central opening substantially free of spokes or other elements transverse to the line of flow of the material.

Another object of this invention is to provide apparatus of the character described in which two separately driven rotating attrition discs are mounted in opposed and mating relation on coaxial and interfitting shafts both at the same side of the discs and with one of the discs carried by means radially outward of the other disc to leave the side of the discs opposite to that from which the shafts extend substantially free of mounting or driving structure.

A further object of this invention is to provide, in apparatus of the character described, means for mounting two rotating and opposed and mating attrition discs for the treatment of material passed therebetween on coaxial shafts arranged so that thrust forces between the discs and axially of the shafts are carried by closely spaced thrust bearings to minimize the length of the line of thrust and to concentrate the thrust primarily in the cooperating and interconnected mountings for the thrust bearings to minimize the amount of axial thrust which must be carried by the base and other frame or supporting elements in the apparatus.

Still another object of this invention is to provide, in apparatus of the character described, means for mounting two rotating opposed and mating attrition discs on coax-

ial shafts to minimize mechanical deflection in the discs and maintain substantially continuous alignment of the shafts under various conditions of operation and not withstanding axial adjustment and movement of one shaft with respect to the other, and including at one end of the shafts bearing means for mutually maintaining the concentricity thereof and at the other end of the shafts means for maintaining the concentricity of separate thrust bearings for each of the shafts notwithstanding variations in axial thrust and axial adjusting movement thereof with respect to each other.

A still further object of this invention is to provide, in apparatus of the character described, means for separately mounting two opposed and mating rotating attrition discs on coaxial shafts to be separately driven in such manner that axial and radial alignment is maintained and thermal expansion movement compensated for notwithstanding substantial increases in the temperature of the apparatus in use from the attrition action of the discs and/or from increase in temperature of the separate driving means therefor.

Still another object of this invention is to provide, in apparatus of the character described, means for separately mounting and driving two rotating attrition discs on coaxial shafts on one side thereof and an inlet or feeder for material to be treated at the other side thereof so that access to the discs is obtained by opening the outer casing of the machine and without the necessity of pulling or disassembling either shaft or any of the bearings therefor or drive means therefor.

Other objects and advantages of this invention will be apparent from the following description, the accompanying drawings, and the appended claims.

In the drawings:

FIGS. 1 and 2 are elevation views of apparatus embodying and for practicing this invention from, respectively, the side and inlet or feeding end thereof;

FIG. 3 is a vertical axial section through the machine and taken on the line 3—3 of FIG. 2;

FIG. 4 is a fragmentary view on a larger scale of part of the view axial adjustment and control mechanism of the apparatus shown in FIG. 3;

FIG. 5 is a partial horizontal axial section on a larger scale illustrating a portion of the thrust bearing mountings and axial adjustment and control elements and taken along the lines 5—5 of FIG. 3;

FIG. 6 is a detail on a larger scale and partially broken away of an axially adjustable motor coupling and taken on the lines 6—6 of FIG. 3;

FIG. 7 is a vertical transverse section partly broken away showing the rotating discs and taken along the lines 7—7 of FIG. 3;

FIG. 8 is a vertical transverse section illustrating a portion of the axial adjustment means and taken along the line 8—8 of FIG. 1;

FIG. 9 is a diagrammatic showing indicating schematically the thrust paths, etc., as in the apparatus illustrated in FIG. 3; and

FIG. 10 is a fragmentary view on a larger scale of the concentric bearings of FIG. 3.

Referring to the drawings, in which like characters of reference designate like parts throughout the several views thereof, apparatus embodying and for practicing this invention is generally illustrated in elevation in FIGS. 1 and 2 as having a base 10 for supporting the apparatus and, particularly, the main housing and support frame indicated at 11. Base 10 also forms an aligned support for drive motor 12 for driving one rotating disc as will be later described, through a coupling 13 and another drive motor 14 is provided for driving the other disc through coupling 15 and gear train or other power transmission means in housing 16, with motor 14 being mounted on support 17 as indicated. A handwheel 18 is shown as part of the means for controlling and adjusting axial spacing between

the rotating discs, and a control panel for the operation of the machine is indicated generally at 19.

A generally cylindrical housing for the rotating discs themselves is indicated at 20 and as having a generally circular end closing plate 25. An inlet chute 30 is mounted at the center of plate 25, and contains feeding mechanism such as a screw feeder mounted on shaft 31 and separately driven by drive means in housing 32 for receiving material to be treated from inlet 30 and for feeding the material into the "eye" or central area of the discs within housing 20. A discharge opening 35 is indicated in the lower portion of housing 20 for the discharge of material after treatment by the discs within housing 20, although, as will be understood, the angular positioning of discharge 35 may assume any one of a variety of positions. Preferably housing 20 overhangs the end of base 10 so that discharge 35 is freely beyond the area of the base.

As noted, inlet 30 and its appertaining feeding apparatus 31, 32, etc., are all mounted directly upon and supported by end plate 25, which is in turn mounted on housing 20 and preferably bolted thereto. If desired, two pairs of pin hinges 38 and 39, one pair at either side of the apparatus are provided so that plate 25 may be swung open to either side for access to housing 20. As will be understood from the foregoing, then, by unbolting end plate 25, it, and all the various apparatus directly mounted thereon, can be swung out, on either pair of hinges 38 or 39, from either side to give unrestricted access to the interior of housing 20 and to the discs therein. It should also be noted that such access is frequently desired for inspection or cleaning of the discs and/or for changing the attrition plates thereon, and is accomplished according to this arrangement of apparatus without the necessity of uncoupling or disassembling any of the main drive means or bearings and even without the necessity of opening or having access to the main frame in housing 11 or the various main drives or interfering with whatever piping or conduit connections there may be associated with discharge 35.

Referring now, to FIG. 3, quill 60 includes an end portion 61 of enlarged diameter to be supported for rotation as by anti-friction bearings 62 outside thereof. The adjacent end of shaft 50 is supported for rotation within enlarged end portion 61 of quill 60 as by anti-friction bearings 63. The opposite end of quill 60 is supported by thrust bearings 70, and the opposite end of shaft 50, preferably having a reduced diameter portion 71, is supported by thrust bearings 72. It should be noted that the main frame or housing section 11 of the machine includes a generally cylindrical wall portion 75 extending therealong, the interior of which can be finished or bored to accurate cylindrical dimensions. It is within this support that bearing blocks 76 for anti-friction bearing 62, as well as bearing blocks 77 and 78 for thrust bearings 70 and 72 all fit. In this manner, with bearing blocks 76 and 77 fitting in a cylindrical support for quill 60 and with bearing 63 fitting within a cylindrical bore in quill 60 and bearing block 78 fitting with bearing block 77, the mounting of all the bearings, with their cylindrical bearing blocks, into cylindrical bores provides a readily achieved close tolerance means for maintaining the coaxial alignment of quill 60, shaft 50, spider 55, and both rotating discs 40 and 45, and virtually independently of misaligning deflections which might otherwise occur if the shafts were independently supported at such spaced points from a floor or base.

As previously noted, shaft 50, carrying disc 45, is driven for rotation by motor 12 through coupling 13, described below, and quill 60, carrying spider 55 and disc 40 is independently driven for rotation by motor 14 through coupling 15 and a power transmission which may satisfactorily comprise a gear train in housing 16 including gears 80 and 81 mounted on shafts 82 and 83, the latter of which is driven through coupling 15. Meshing with

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gear 81 is another gear 84 directly keyed to quill 60 for the driving thereof. It should also be noted that a labyrinth seal is preferably provided in front of anti-friction bearing 62 and between the rotating spider 55 and the stationary walls and a similar labyrinth seal is provided in front of bearing 63 between the bore of quill 60 and shaft 50, as noted in FIG. 10. Additional packing may also be provided on a rim or flange 85 on the back face of disc 45 cooperating with an offset portion as indicated on spider 55. Also it is preferred to provide a plurality of built-up segments 86 on the back face of disc 45 adjacent the outer periphery thereof as an aid to reducing deflection of attrition plate 91, noted below, by providing a mass of metal subject to centrifugal force roughly opposite and compensatory to the mass of plate 91. Referring particularly to FIGS. 3 and 7, segmented and/or annular attrition or grinding or refining plates 90 and 91, having on their exposed faces serrations or grooves or other surface design to accomplish the particular attrition or refining function as is well understood in this art, are bolted to the respective inner faces of discs 40 and 45, respectively, to provide the annular attrition surface to accomplish the desired treatment of the material as it is forced therebetween.

As previously noted material inlet 30 and feeding mechanism for feeding material into the apparatus are all mounted on end plate 25. As indicated in FIG. 3, inlet chute 30 leads to a generally cylindrical horizontal housing or passage 95 leading through end plate 25 and defined by cylindrical wall 96 which extends into and through a central opening in disc 40. Feeding means, such as a conventional screw feeder 100, mounted on shaft 31, which is supported by bearing blocks 101 and 102 in feeding housing 32, is provided to receive material to be treated from inlet chute 30 and conduct it horizontally directly and positively into the central opening or "eye" of disc 40. Screw 100 is separately driven, as by motor 103 acting through V-belt drive 104, to feed the material to be treated into the apparatus at the desired rate. Preferably a finger nut having a plurality of vanes 105 is affixed to the end of shaft 50 against the hub 46 of disc 45 to begin to give the material being fed by screw 100 a circular direction for radially outward flow thereof, under the action of centrifugal force, between discs 40 and 45 and the treating plates 90 and 91 mounted thereon. As will be understood, the rotation of discs 40 and 45 provide centrifugal force for pumping the material to be treated radially outwardly to pass between attrition or refining plates 90 and 91 for action on the material therebetween, to be discharged outwardly from both discs into housing 20 and further agitated by passing through the several spaced projections 56 by which disc 40 is mounted on spider 55 for ultimate existing from the apparatus through discharge 35.

As noted above, the severity or extent of attrition or refining action provided between the cooperating grinding or attrition services of plates 90 and 91 is, for any given plate design or any given concentration of slurry of material being fed therethrough, a function of the maintained spacing between the coating surfaces of plates 90 and 91. According to this invention, such spacing is adjusted and controlled and maintained by the axial positioning of shaft 50 with respect to axially fixed quill 60 and, consequently, of the positioning of disc 45 with respect to the cooperating and opposed inner face of disc 40. The provision of such axial control and adjustment of spacing according to this invention is illustrated in somewhat more detail by particular reference to FIGS. 5, 6, and 8 as showing more detailed views on a somewhat larger scale than in FIG. 3.

Thus, thrust bearing 70 for quill 60 and the appertaining bearing block 77 are axially permanently fixed within the supporting frame 75, and the axial positioning of quill 60 with respect to bearing 70 is similarly fixed as by ring 115 threaded on the end of quill 60 to form an axial abutment for the portion 116 of the bearing race of bear-

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ing 70 which rotates with quill 60. Extending from the block 77 is a cylindrical sleeve 120 within the main cylindrical frame 75, and axially slideably mounted within sleeve 120 are runners 121 which carry bearing block 78 for thrust bearing 72, it being understood that, although the radial or concentric alignment of thrust bearing 72 is thus maintained by mounting bearing block 78 on runners 121 within cylindrical sleeve 120 mounted within cylindrical frame 75, bearing block 78 is free to slide axially within sleeve 120. The axial positioning of the rotating portion 125 of the race for thrust bearing 72 with respect to shaft 50 is maintained by positioning race 125 on the reduced diameter portion 71 of shaft 50 between a shoulder 126 and a threaded ring 127 on the shaft so that axial movement of bearing block 78 will provide corresponding axial movement of shaft 50 and, of course, the disc 45 carried thereby.

Such axial movement in one direction (i.e., to the left in FIGS. 3 or 5) provided by fluid pressure cylinders 130 mounted on end closure plate 131 for the main frame 75. Cylinders 130, in known manner, have operating therein pistons 132 which, upon introduction of, for example, fluid pressure therebehind, act through piston rods 133 to urge runners 121 and, consequently, bearing block 78 to the left in the drawing, thus moving shaft 50 to the left and moving rotating disc 45 closer to rotating disc 40. As a means of adjusting or limiting the extent of movement of shaft 50 to the left under the action of fluid pressure cylinders 130, end plate 131 is provided with a flange 140 within which is mounted for rotation worm gear 145 which is threadably connected with sleeve 146 mounted around and for axial sliding movement with respect to an inner sleeve 147 surrounding reduced diameter portion 71 of shaft 50 and connected directly to bearing block 78 of thrust bearing 72. Inner sleeve 147 extends axially beyond sleeve 146 and carries at the right end thereof a threaded ring 148 arranged to abut against one end of sleeve 146 as thrust bearing 72 and shaft 50 move axially with respect to the axially fixed end plate 131 and worm gear 145.

A worm 150 is mounted on shaft 151 and the rotation thereof is controlled by handwheel 18 in such manner, as will be understood, that rotation of handwheel 18 positions sleeve 146 in a specific axial positioning (through rotation of worm gear 145 and the threaded connection therewith of sleeve 146). Under such circumstances, and for any given axial positioning of sleeve 146, the extent of movement of shaft 50 to the left in the drawing under the action of fluid pressure cylinders 130 is limited by the abutment of ring 148 against the right-hand end of sleeve 146, thus providing the desired adjustment and maintain control of the spacing between the treating surfaces of plates 90 and 91 mounted on rotating discs 40 and 45.

That is, as will be understood, with apparatus according to this invention in operation, the attrition action desired on the material being treated results in a moment of thrust tending to urge the working surfaces of plates 90 and 91 apart as material is forced therethrough. Such thrust against doing work on the material being treated is resisted by air cylinders 130 urging the plates 90 and 91 toward each other (by urging shaft 50 and disc 45 to the left in the drawings). Accordingly, the principal limiting adjustment here desired is provided by the positioning of sleeve 146 with respect to stop ring 148 to define positively the minimal spacing desired between the working surfaces of plates 90 and 91, it being desired not to limit positively the maximum spacing between these plates other than resiliently through the cylinders 130 so that a constant pressure can be maintained on the material being passed between the plates for the desired attrition action and also so that, should foreign matter be interjected between the plates along with the material to be treated, the pressure in cylinders 130 may be momentarily exceeded so that disc 45 and shaft 50 may be forced to the right of the drawings against the pressure in cylinders 130

to allow the passage of some hard object without ruinous damage to the attrition surfaces of plates 90 and 91.

It may be desired, however, for the operator of the apparatus to be aware of any such occurrence should the pressure between surfaces of plates 90 and 91 exceeding the pressure in cylinders 130 and/or, should there be a possible failure of pressure in cylinders 130. To this end there is preferably provided, as indicated in FIG. 4, a limit switch 160 mounted on stop ring 148 and positioned to coact with an abutment 161 on sliding ring 146 so that, should the pressure in cylinders 130 fail or should some circumstances occur in the material being fed between plates 90 and 91 so that the plates are separated with disc 45 being urged to the right in the drawings, the consequent separation of limit switch 160 from abutment 161 on axially set sleeve 146 will activate a light or sound signal to alert the operator of the apparatus that the desired minimal spacing or operating pressure as between attrition plates 90 and 91 is no longer being maintained.

To accommodate the desired axial movement of shaft 50 and still maintain positive driving contact for rotation as between shaft 50 and motor 12, satisfactory results are achieved by utilizing a coupling 13, as illustrated in FIG. 6, which will compensate for axial movement of the driven shaft. Thus, a coupling is provided for coupling the motor shaft 155 of motor 12 with the reduced end portion 71 of shaft 50 for driving engagement notwithstanding axial displacement of shaft 50 with respect to motor 12. A coupling element 156 is provided keyed to drive shaft 155 of motor 12, and an elongated coupling element 157 is provided keyed to the end of the reduced diameter portion 71 of shaft 50. An outer sleeve 160 is also provided for a sliding axial fit over motor sleeve 156, with internal keys or splines 161 for interfitting relation with keys or splines on a radially outwardly projecting flange 162 on sleeve 156, outer sleeve 160 may be free to slide axially of sleeve 156 but, because of the inter-relationship of the splines or gear teeth, will transmit a positive rotary driving action. A corresponding although somewhat elongated outer sleeve 170 is provided for the driven end of the coupling, also having internal splines 171 for interfitting and cooperating relation with similar splines on a radially outstanding flange 172 on sleeve 157 for imparting positive driving action to sleeve 157 notwithstanding the particular axial positioning thereof with respect to splines 171. The two outer sleeves 160 and 170 also incorporate cooperating and mating flanges 173 and 174, such that, with outer sleeves 160 and 170 in position and axially slid together, they may be positively joined by flanges 173 and 174 as by bolts 175 to be locked in coupling unison for rotational driving, thereby insuring a positive rotational drive from motor 12 through drive shaft 155 thereof, thence through element 156 keyed thereto and splines 161 and outer sleeve 160, through the bolted connection of flanges 173 and 174 to drive outer sleeve 170, which, in turn, drives the end 71 of shaft 50 by virtue of splines 171 acting through sleeve 157 keyed to the shaft, which positive rotational drive obtains notwithstanding the axial positioning of sleeve 157 and shaft 50 axially within sleeve 170 so long as the splines 171 positively engage the splines or cogs 172 on sleeve 157.

Although the lubrication of the various bearings involved in apparatus embodying this invention will be apparent, in view of the foregoing disclosure, to men skilled in this art, nevertheless, it might be well to note a preferred lubrication pattern as embodied in the particular apparatus illustrated. It is preferred to provide a circulating lubrication oil system, not only for forward bearings 62 and 63, but also thrust bearings 70 and 72. In this regard, a circulating oil system inlet may be preferably provided at 180 with a channel leading to manifold reservoir 181 communicating with the outer surface of quill 60. Similarly, a series of radial perforations through quill 60 as indicated at 182 are preferably provided communicating between the oil reservoir 181

and the outer surface of shaft 50 for providing, according to the foregoing disclosure, a film of oil axially along the inner surface of quill 60 in rotating association with the outer surface of shaft 50. It is also preferred, in this connection, that the clearance between the outer surface of shaft 50 and the inner surface of quill 60 be progressively somewhat diminished toward the right of, for example, FIG. 3 so that lubricating oil entering the space between shaft 50 and quill 60 through perforations 182 will be encouraged to flow toward the left of FIG. 3 for continuously maintained lubrication of bearing 62, although, as will be understood, such diminishing clearance is of such a low order of magnitude as not to be capable of illustration on the scale of drawings herein.

With reference to the foregoing and, particularly, to the schematic or skeletal diagram of FIG. 9 indicates that, in apparatus embodying and for practicing this invention, the accommodation of the inevitable axial thrust forces is greatly simplified in an economical and convenient manner. That is, as will be understood with apparatus of the type and size to which this invention relates, very substantial axial thrust forces are encountered between the large surfaces of the coacting attrition plates (which may be several feet in diameter), particularly, among other reasons, because one of the important controls on the work being performed by such an attrition mill is achieved by maintaining close tolerance spacing between the attrition plates of tiny fractions of an inch and forcing the material to be treated therebetween. Thus the attrition action results, not merely from the rotation of the plates, but also from forcing material through the close spacing therebetween.

As suggested in FIG. 9, there is a pronounced and substantial thrust moment of force tending to separate the attrition plates (as indicated in FIG. 9 diagram by the arrows A and B). Not only are such axial forces increased with increasing radius of the attrition plates, but such axial forces must be accommodated somehow within the apparatus and the bearing and other means incorporated therein for rotational supporting and axially positioning shaft and coaxial drive sleeve 60. As indicated in the diagram, such axial thrust forces are accommodated in apparatus according to this invention all by the thrust bearing arrangements 70 and 72, etc., for supporting the right-hand ends of shaft 50 and sleeve 60 respectively. More importantly, however, substantially the entire opposed axial thrust forces engendered between the attrition plates, as indicated by arrows A and B are accommodated within only that portion of the apparatus enclosed within the circle C of FIG. 9, with such opposed thrust forces having, essentially, a thrust path of no greater length than extends between the coacting bearing 70 and 72 within the small circle C.

Thus, according to this invention, the main frame and/or mounting of the machine may be designed virtually without regard to having to support or resist such forces (as compared with the situation where, either because of having oppositely extending drive shafts for each attrition disc or otherwise, the path of thrust forces must extend through and be carried by the base or main supporting member), and, similarly, firmly induce dimensional variations in the frame (whether induced by friction heat between the attrition plates or from the drive motors or otherwise) have little or no effect upon the spacing of the attrition discs or the axial adjustment of one or another of the discs or the shafts. That is, with both discs driven from coaxial shafts and with the concentric overall bearings thereof maintained by a single bore or cylindrical shell, the possibilities of misalignments due to either mechanical defections or thermally induced variations is minimized. Also, with substantially the entire axial thrust forces and the opposed paths thereof being concentrated within a small area (as represented by the circle C in FIG. 9) of the apparatus quite removed from the attrition plates themselves and either drive motor and mounted to be virtually independent of

the base structure, the maximum control of the setting between the attrition plates is achieved with a minimum of maintenance and a minimum of work or effort or heavy framework to maintain the close tolerance space desired for achieving the treatment of material between the attrition plates.

Similarly, the coaxial arrangement of drive sleeve or quill 60 around shaft 50 aids in compensating for and/or controlling heat expansion movements which might otherwise disrupt the desired setting between the plates. For example, thermally induced axial expansion of shaft 50 tends to enlarge the space between plates 90 and 91, but similarly induced axial expansion of quill 60 tends to decrease the spacing. Thus, with both shaft and quill being subjected to essentially the same frictional or other temperature conditions and changes, axial expansion of one counteracts or compensates for the expansion of the other to maintain the desired adjustment of the attrition discs and plates.

While the methods and forms of apparatus herein described constitute a preferred embodiment of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. In disc-type attrition mill apparatus having a pair of rotating and cooperating attrition plates between which material to be treated is passed, the combination which comprises a shaft carrying at one end thereof a rotor for supporting one of said plates, drive means for rotating said shaft and said rotor and said plate thereon, a drive sleeve coaxially mounted around said shaft for coaxial rotation independently of said shaft, a spider at the end of said sleeve adjacent said rotor for rotation with said sleeve and having a diameter in excess of said rotor for carrying another of said plates disposed for attrition cooperation with said plate on said rotor, second drive means for rotatably driving said sleeve and said spider independently of said shaft and said rotor, first bearing means for independently supporting said shaft and said sleeve at the ends thereof adjacent said rotor and said spider, second bearing means for rotatably supporting the other end of said sleeve and axially spaced from said first bearing means, and third bearing means for supporting the other end of said shaft and axially spaced from both said aforementioned bearing means, said third bearing means including means effecting axial moving and adjustment of said shaft for varying and controlling the axial spacing between the attrition surfaces of said plates on said rotor and said spider.

2. In disc-type attrition mill apparatus having a pair of rotating and cooperating attrition plates between which material to be treated is passed, the combination which comprises a shaft carrying at one end thereof a rotor for supporting one of said plates, drive means for rotating said shaft and said rotor and said plate thereon, a drive sleeve coaxially mounted around said shaft for coaxial rotation independently of said shaft, a spider at the end of said sleeve adjacent said rotor for rotation with said sleeve and having a diameter in excess of said rotor for carrying another of said plates disposed for attrition cooperation with said plate on said rotor, said rotor being disposed axially between said spider and said plate carried by said spider second drive means for rotatably driving said sleeve and said spider independently of said shaft and said rotor, first bearing means for independently supporting said shaft and said sleeve at the ends thereof adjacent said rotor and said spider, second bearing means for rotatably supporting the other end of said sleeve and axially spaced from said first bearing means, and third bearing means for supporting the other end of said shaft and axially spaced from both said aforementioned bearing means, said third bearing means including means effecting axial moving and adjustment of

said shaft for varying and controlling the axial spacing between the attrition surfaces of said plates on said rotor and said spider, and coupling means between said shaft and said drive means therefore for maintaining said rotational driving of said shaft notwithstanding said axial movement and adjustment thereof.

3. In disc-type attrition mill apparatus having a pair of rotating and cooperating attrition plates between which material to be treated is passed, the combination which comprises a shaft carrying at one end thereof a rotor for supporting one of said plates, drive means for rotating said shaft and said rotor and said plate thereon, a drive sleeve coaxially mounted around said shaft for coaxial rotation independently of said shaft, a spider at the end of said sleeve adjacent said rotor for rotation with said sleeve and having a diameter in excess of said rotor for carrying another of said plates disposed for attrition cooperation with said plate on said rotor, second drive means for rotatably driving said sleeve and said spider independently of said shaft and said rotor, first bearing means for independently supporting said shaft and said sleeve at the ends thereof adjacent said rotor and said spider, second bearing means for rotatably supporting the other end of said sleeve and axially spaced from said first bearing means, third bearing means for supporting the other end of said shaft and axially spaced from both said aforementioned bearing means, said third bearing means including means effecting axial moving and positioning of said shaft for varying and controlling the axial spacing between the attrition surfaces of said plates on said rotor and said spider, and adjusting means operable from outside said device for adjusting and varying said axial positioning of said third bearing means and said shaft and said rotor with respect to said sleeve and said spider.

4. In disc-type attrition mill apparatus having a pair of rotating and cooperating grinding plates between which material to be treated is passed, said material being introduced between said plates adjacent the axis thereof for radial passage of said material outwardly between said plates, the combination which comprises a shaft carrying at one end thereof a rotor for supporting one of said plates, drive means for rotating said shaft and said rotor and said plate thereon, a drive sleeve coaxially mounted around said shaft for coaxial rotation independently of said shaft, a spider at the end of said sleeve adjacent said rotor and disposed on said sleeve for rotation therewith independently of the rotation of said rotor on said shaft and having a diameter in excess of said rotor and said plate thereon, means affixed to said spider radially beyond said rotor for carrying another of said plates disposed for attrition cooperation with said plate on said rotor, said plate on said rotor being disposed axially between said spider and said plate carried thereby second drive means for rotatably driving said sleeve and said spider, first bearing means for independently and coaxially supporting said shaft and said sleeve at the ends thereof adjacent said rotor and said spider, second bearing means for rotatably supporting the opposite end of said sleeve and axially aligned with and spaced from said first bearing means, and third bearing means for supporting the opposite end of said shaft and being adjacent said second bearing means, said third bearing means including means for axially moving and adjusting said shaft with respect to said sleeve for varying and controlling the axial spacing between the attrition surfaces of said plates on said rotor and said spider.

5. In disc-type attrition mill apparatus having a pair of rotating and cooperating attrition plates between which material to be treated is passed, the combination which comprises a shaft carrying at one end thereof a rotor for supporting one of said plates, drive means for rotating said shaft and said rotor and said plate thereon, a drive sleeve coaxially mounted around said shaft for coaxial rotation independently of said shaft, a spider at the end of said sleeve adjacent said rotor for rotation with said sleeve and

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having a diameter in excess of said rotor for carrying another of said plates disposed for attrition cooperation with said plate on said rotor, said rotor being disposed axially between said spider and said plate carried by said spider second drive means for rotatably driving said sleeve and said spider independently of said shaft and said rotor, first bearing means for independently supporting said shaft and said sleeve at the ends thereof adjacent said rotor and said spider, second bearing means for rotatably supporting the other end of said sleeve and axially spaced from said first bearing means, third bearing means for supporting the other end of said shaft and axially spaced from both said aforementioned bearing means, said third bearing means including means effecting axial moving and adjustment of said shaft for varying and controlling the axial spacing between the attrition surfaces of said plates on said rotor and said spider, and positive feeding means including a screw conveyor for receiving material to be treated and feeding said material in between said grinding plates adjacent the axis thereof.

6. In disc-type attrition mill apparatus having a pair of rotating and cooperating attrition plates between which material to be treated is passed, the combination which comprises a shaft carrying at one end thereof a rotor for supporting one of said plates, drive means for rotating said shaft and said rotor and said plate thereon, a drive sleeve coaxially mounted around said shaft for coaxial rotation independently of said shaft, a spider at the end of said sleeve adjacent said rotor for rotation with said sleeve and having a diameter in excess of said rotor for carrying another of said plates disposed for attrition cooperation with said plate on said rotor, said rotor being disposed axially between said spider and said plate carried by said spider second drive means for rotatably driving said sleeve and said spider independently of said shaft and said rotor, first bearing means for independently supporting said shaft and said sleeve at the ends thereof adjacent said rotor and said spider, second bearing means for rotatably supporting the other end of said sleeve and axially spaced from said first bearing means, and third bearing means for supporting the other end of said shaft and axially spaced from both said aforementioned bearing means, said third bearing means including means effecting axial moving and adjustment of said shaft for varying and controlling the axial spacing between the attrition surfaces of said plates on said rotor and said spider, said plate on said spider having a substantially continuous and unobstructed central opening therein communicating with the space between said plates, and positive feeding means for receiving material to be treated and feeding said material in between said grinding plates through said central opening.

7. In disc-type attrition mill apparatus having a pair of rotating and cooperating attrition plates between which material to be treated is passed, the combination which comprises a shaft carrying at one end thereof a rotor for supporting one of said plates, drive means for rotating said shaft and said rotor and said plate thereon, a drive sleeve coaxially mounted around said shaft for coaxial rotation independently of said shaft, a spider at the end of said sleeve adjacent said rotor for rotation with said sleeve and having a diameter in excess of said rotor for carrying another of said plates disposed for attrition cooperation with said plate on said rotor, said rotor being disposed axially between said spider and said plate carried by said spider second drive means for rotatably driving said sleeve and said spider independently of said shaft and said rotor, first bearing means for independently supporting said shaft and said sleeve at the ends thereof adjacent said rotor and said spider, second bearing means for rotatably supporting the other end of said sleeve and axially spaced from said first bearing means, third bearing means for supporting the other end of said shaft and axially spaced from both said aforementioned bearing means, said third bearing means including means effecting axial moving and adjustment of

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said shaft for varying and controlling the axial spacing between the attrition surfaces of said plates on said rotor and said spider, said plate on said spider having a substantially continuous and unobstructed central opening therein communicating with the space between said plates, and positive feeding means for receiving material to be treated and feeding said material in between said grinding plates through said central opening, said feeding means being mounted in said apparatus on the side of said plates opposite to the side from which extend said coaxial shaft and sleeve.

8. In a double disc horizontal attrition mill having two cooperating and opposed attrition discs independently and separately rotated by a drive shaft and a drive sleeve coaxially disposed around said drive shaft, the combination which comprises anti-friction bearing means spaced along said sleeve for rotational mounting thereof in said mill independently of rotation of said coaxial shaft and in axially fixed position, second anti-friction bearing means at the end of said shaft adjacent said discs for mounting said shaft for rotation coaxially within and independently of said sleeve, said second bearing means permitting limited axial displacement of said shaft with respect to said coaxial sleeve, third bearing means for the other end of said shaft axially spaced from said sleeve and both said aforementioned bearing means, said third bearing means including means for axial movement of said shaft with respect to said sleeve, and means for adjusting and maintaining said axial positioning of said shaft effecting control of the axial spacing between said discs.

9. In a double disc horizontal attrition mill refiner having two cooperating and opposed refining discs independently and separately rotated by a drive shaft and a drive sleeve coaxially disposed around said drive shaft, the combination which comprises first bearing means spaced along said sleeve for rotational mounting thereof in said refiner independently of rotation of said coaxial shaft and in axially fixed position, second bearing means at the end of said shaft adjacent said discs for mounting said shaft for rotation coaxially within said sleeve and permitting limited axial displacement of said shaft with respect to said coaxial sleeve, third bearing means for supporting the other end of said shaft axially spaced from said sleeve and said aforementioned bearing means and mounted in said refiner for limited axial movement, means for urging said shaft axially with respect to said sleeve in a direction which diminishes the axial spacing between said discs, and adjustable stop means for limiting the amount of axial displacement of said shaft under the action of said urging means.

10. In a double disc horizontal attrition mill refiner having two cooperating and opposed refining discs independently and separately rotated by a drive shaft and a drive sleeve coaxially disposed around said drive shaft, the combination which comprises first bearing means for said sleeve for rotational mounting thereof in said refiner independently of rotation of said coaxial shaft, second bearing means at the end of said shaft adjacent said discs for mounting said shaft for rotation coaxially within and independently of said sleeve and permitting limited axial displacement of said shaft with respect to said coaxial sleeve, third bearing means for the other end of said shaft and mounted in said refiner for limited axial movement, means for urging said shaft axially with respect to said sleeve in a direction which diminishes the axial spacing between said discs, adjustable stop means for limiting the amount of said axial displacement of said shaft by said urging means, and signalling means for indicating when said shaft is not being urged axially to the limit permitted by said adjustable stop means.

11. In a double disc horizontal attrition mill refiner having two cooperating and opposed refining discs independently and separately rotated by a drive shaft and a drive sleeve coaxially disposed around said drive shaft, the combination which comprises first bearing means

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spaced along said sleeve for rotational mounting thereof in said refiner independently of rotation of said coaxial shaft and in axially fixed position, second bearing means at the end of said shaft adjacent said discs for mounting said shaft for rotation coaxially within said sleeve, said second bearing means permitting axial displacement of said shaft with respect to said coaxial sleeve, third bearing means for the other end of said shaft and mounted in said refiner for limited axial movement, said third bearing means including means for supporting said end of said shaft for rotation independently of said sleeve and for axial movement of said shaft with respect to said sleeve upon axial movement of said third bearing means, means including a fluid cylinder-piston arrangement for urging said third bearing means axially with respect to said sleeve in a direction which diminishes the axial spacing between said discs, and adjustable stop means cooperating with said third bearing means and said cylinder-piston means for limiting the amount of axial displacement of said shaft in said direction.

12. In a double disc horizontal attrition mill having two cooperating and opposed attrition discs independently and separately rotated by a drive shaft and a drive sleeve coaxially disposed around said drive shaft and all mounted in a main frame for said mill, the combination which comprises bearing means spaced along said sleeve for rotational mounting thereof in said main frame independently of rotation of said coaxial shaft and in axially fixed position, second bearing means at the end of said shaft

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adjacent said discs for mounting said shaft for rotation coaxially within and independently of said sleeve, said second bearing means permitting limited axial displacement of said shaft with respect to said coaxial sleeve, third bearing means for the other end of said shaft axially spaced from said sleeve and both said aforementioned bearing means, said third bearing means including anti-friction rotational and axial thrust bearing components for said shaft, a bearing block for carrying said third bearing means, means for mounting said bearing block in said frame for limited axial sliding movement of said block and said bearing means carried thereby with respect to said sleeve and said frame for axial movement of said shaft to vary the spacing between said attrition discs whereby substantially the entire thrust forces engendered between said attrition discs are carried only by said bearing block and portions of said frame adjacent thereto, and operating means accessible from the outside of said mill for adjusting and maintaining the axial positioning of said bearing block and of said shaft effecting control of the axial spacing between said discs.

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