Nov. 1, 1949. J. E. KENNEDY 2,486,477

TUBE MILL

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Fig. 1.

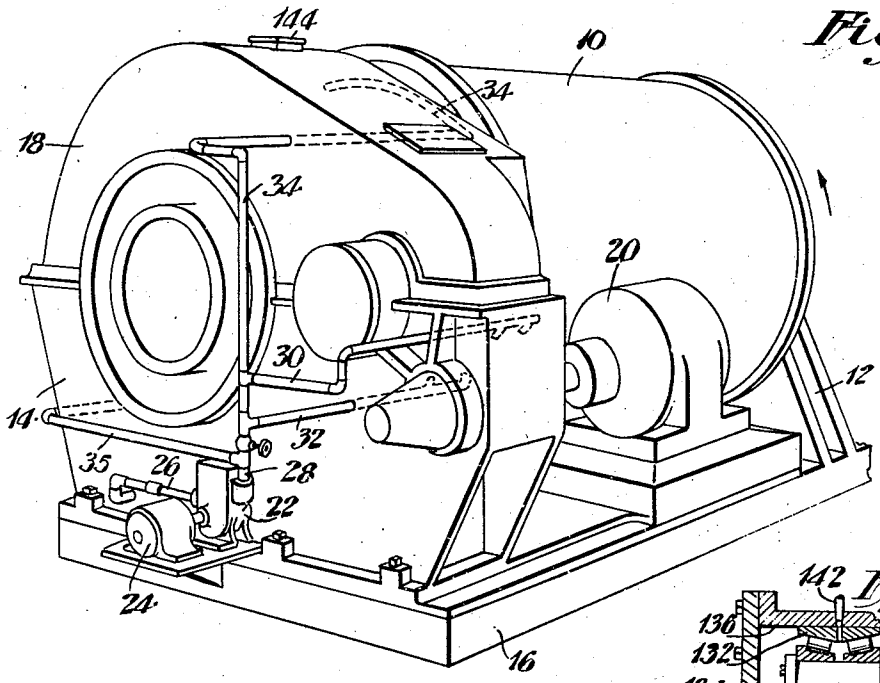


Fig. 5.

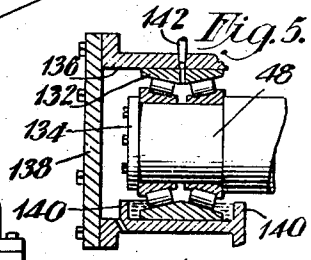


Fig. 2.

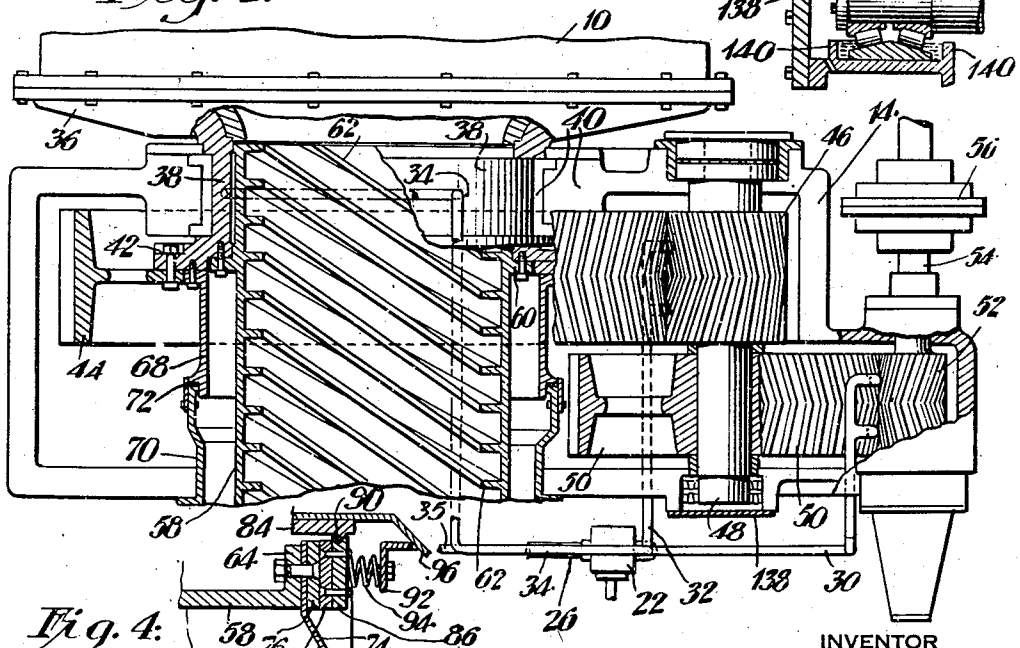
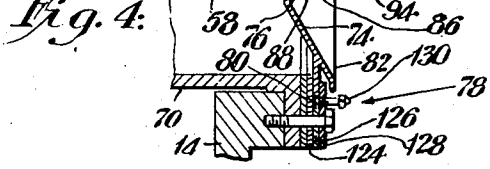


Fig. 4.



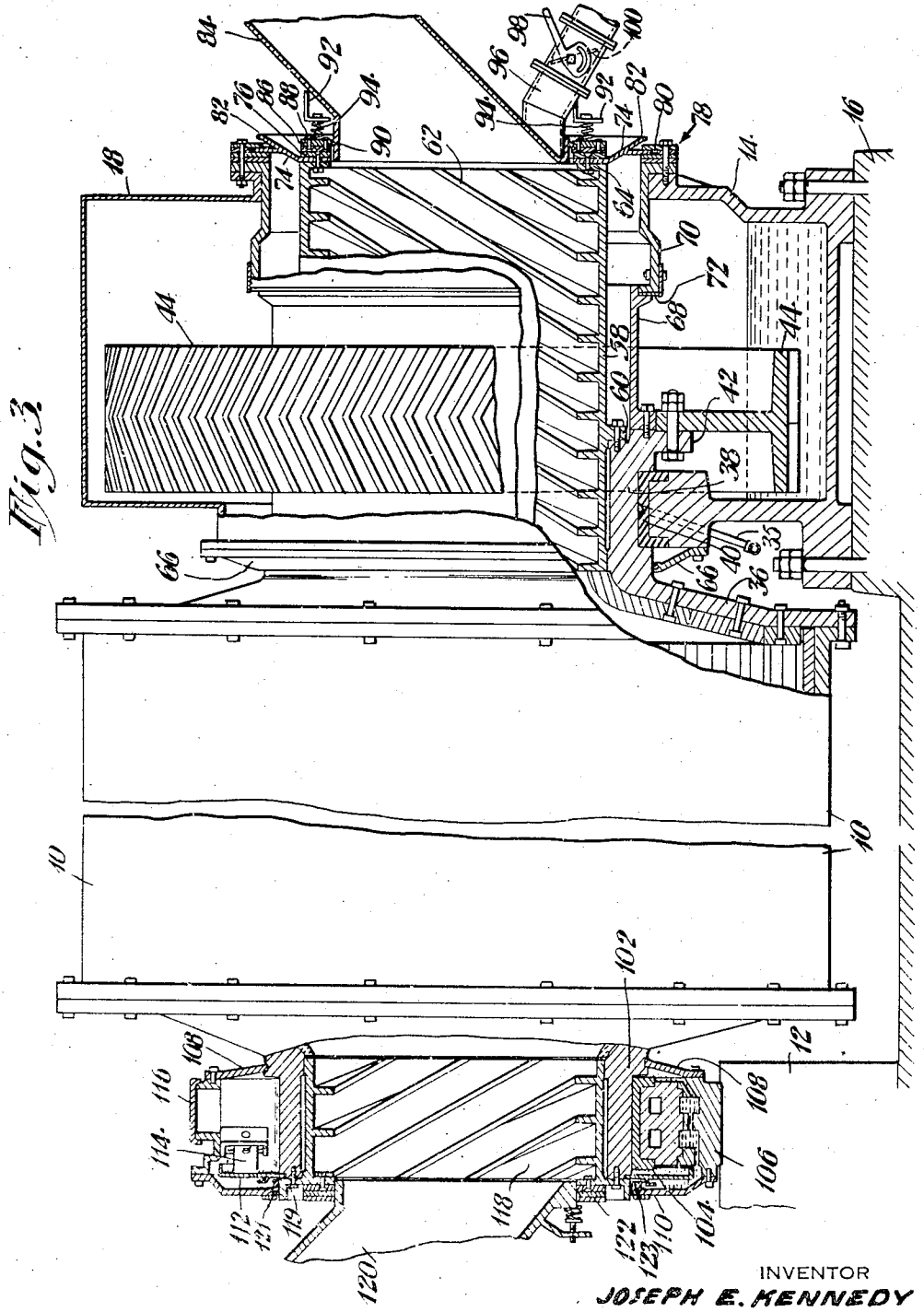
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TUBE MILL

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Fig. 3



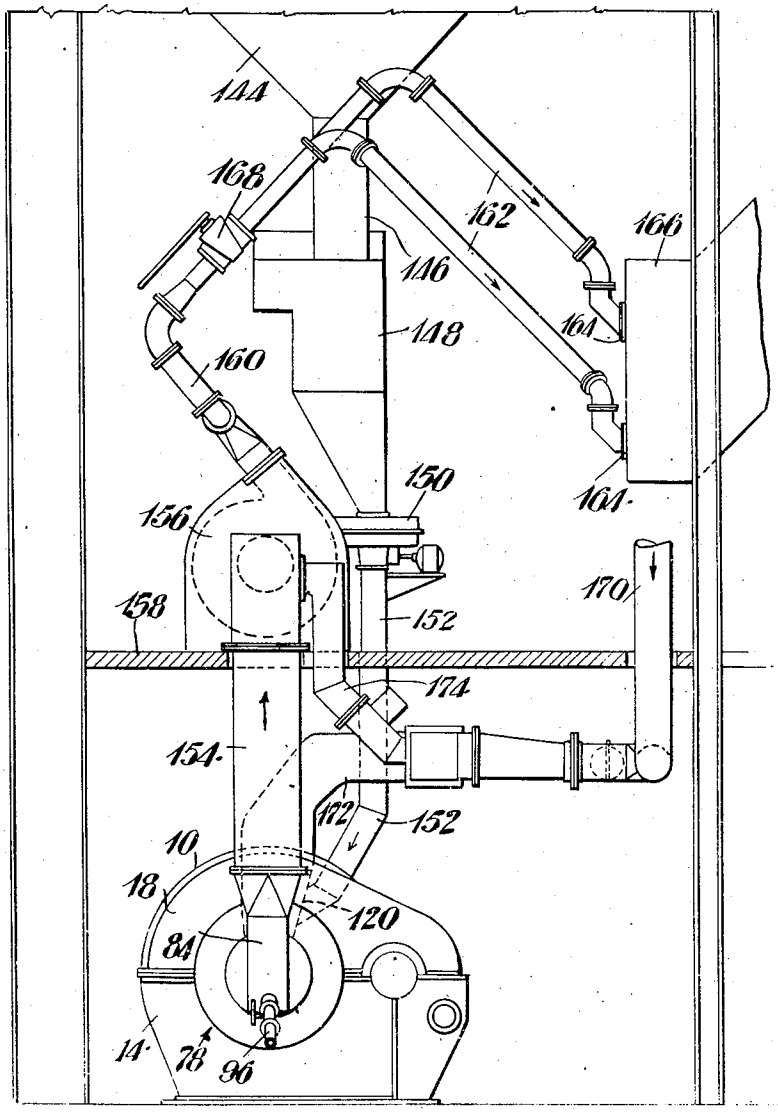
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TUBE MILL

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Fig. 6.



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UNITED STATES PATENT OFFICE

2,486,477

TUBE MILL

Joseph Elliott Kennedy, New York, N. Y.

Application June 20, 1945, Serial No. 600,561

5 Claims. (Cl. 241—54)

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This invention relates to improvement in tube mills such as those of the rotary drum type in which tubes, rods, balls, etc., are used as grinding elements to pulverize coal and other materials.

More particularly, the present invention relates to tube mills of the very large or heavy type in which the drum has a diameter of the order of ten feet, and in which a heavy double reducing gear system is employed for rotating the drum. Large tube mills of this type are presently employed in grinding units for producing pulverized or powdered coal which is burned in large steam generator units and other industrial equipment. In these installations the coal is fed into the mill through a hollow trunnion which serves as one of the end bearings for the mill. The coal is pulverized in the rotary drum by means of rods, balls or other grinding elements, and during this operation the mill is swept by an air stream which picks up the dust or pulverized material and carries it through a hollow trunnion at the opposite end of the drum which also serves as a bearing for the rotation of the mill. The air stream containing the pulverized coal for example, is sent to a separator or directly to burners. In mills of this type, one of the trunnions serves as an anchor for a gear wheel of the gear system for driving the drum, and the rotary trunnion is sealed with respect to a gear casing mounted around the gears to exclude the dust produced in the grinding operations. The gears are commonly lubricated by having them dip into bodies of lubricating oil in the casing.

A number of problems has arisen in connection with the operation of these heavy tube mills, one of which relates to the starting of the mill. Anyone familiar with this art will understand that a large rotary drum of the type referred to, having a heavy lining of wear-resisting material and also containing a substantial weight of loose grinding elements, will be extremely difficult to start. An electric motor of high horse-power is capable of starting the rotation of the drum because of the great leverage provided by the reducing gear system. However, the gears have been severely damaged in certain instances because of the lack of lubricant at the points of contact when the rotation of the drum is started. The gears of such a mill are very expensive and difficult to make and in most cases a shut-down

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for replacement or repair becomes very serious.

The provision of clutches and gear shifts for avoiding the troubles involved in starting the rotation of the drum has not been successful, apparently because of the very heavy starting loads involved.

Another problem encountered in the operation of such mills where the dust or pulverized material is swept from the mill by a stream of air, is the difficulty in keeping the gear case free of the dust produced in the grinding operations. Many attempts have been made to provide seals around the critical stationary and rotary parts of the gear case but such seals for the most part have been ineffective for keeping the dust out of the gear case. Other problems are involved in obtaining uniformly fine pulverized coal.

The primary object of the present invention is therefore to provide an improved tube mill in which the difficulties involved in the starting operation are avoided by a relatively simple arrangement.

Another object of the invention is to provide an improved means for sealing the gear case from the entrance of dust produced in the grinding operations.

Another feature of the present invention is the provision of a gear casing combined with a hollow trunnion for the charge of material into, or discharge of material from, the drum, in which a laminated sealing means is provided between the outer portion of the gear casing and a hollow rotatable trunnion member, said seal including an annular plate extending from the rotary trunnion member and bearing against a plate on the casing surrounding the trunnion member, a spacer plate surrounding said rotary plate and a cover plate overlying said spacer and the rotary plate, and means for supplying a lubricating grease into the laminated seal assembly.

The improved tube mill of the present invention includes other features of importance which will be described in detail in connection with the accompanying drawings forming a part of this application.

In the drawings:

Fig. 1 is a perspective view of the mill of the present invention showing the relationship of some of the parts, with other parts removed.

Fig 2 is a broken horizontal sectional view of

a portion of one end of the mill showing the relationship of the various gears for driving the mill and the lines for lubricating the gears in accordance with the present invention.

Fig 3 is a broken side elevational view partly in section, showing the detailed construction of both ends of the mill and the details of the improved means for sealing the gear case with respect to the rotary trunnion.

Fig. 4 is an enlarged sectional view showing the details of construction of the improved laminated sealing means for dustproofing the gear case.

Fig. 5 is a detailed broken vertical sectional view of a preferred form of bearing construction.

Fig. 6 is a broken elevational end view showing a partial assembly including the mill, a coarse coal separator, an exhaust fan, and other elements.

Referring to the drawings which are partly diagrammatic, the improved mill of the present invention is shown in general outline in Fig. 1, while the apparatus assembly is shown in Fig. 6 of the drawings. The mill comprises a large rotary drum 10 mounted for rotation at one end on a support 12 and at the other end on a support 14, including a heavy casting forming the lower portion of the gear casing. The support 14, as well as certain other elements of the apparatus, is mounted upon a heavy reinforced foundation 16. The apparatus, for pulverizing or grinding coal and all kinds of materials, of the type shown, is of very large diameter. For example, the drum 10 may have a diameter between ten and eleven feet and would include a heavy lining of wear-resisting material of the type commonly used in such equipment. In Fig. 1 the gear casing in addition to comprising a part of the support 14 also includes a cover section 18 sealed thereto in a dustproof manner. The gears for driving the drum 10 preferably comprise a double reduction gear set, shown more in detail in Figs. 2 and 3, and which are preferably driven by an electric motor 20 of suitable high horsepower, although other power means may be used.

An important feature of the apparatus of the present invention comprises means for suitably lubricating the driving gears and main trunnion bearing mounted in the gear casing. This means includes a cylinder pump 22 driven by an electric motor 24 through suitable driving means. The pump draws lubricating oil from an oil reservoir in the lower portion of the gear casing 14, through a line 26, and forces the oil through a valved discharge line 28 to the various critical points to be lubricated. Lubricant is forced through branch lines 30, 32, 34, 35 and others, if desired, the lines 30 and 32 terminating in nozzles which discharge at the points at which gears inter-mesh, while the lines 34 and 35 supply lubricant respectively to the upper and lower portions of the trunnion bearing.

An important feature of the invention resides in the arrangement for lubricating the critical points of the driving mechanism prior to the actual starting of the apparatus. For example, when it is desired to start up the apparatus, the motor 24 is started and runs for a minute or more to build up sufficient pressure in the lines 30, 32, 34 and 35, to thoroughly lubricate the gear elements and bearing surfaces which come in contact first. After the lapse of the desired time for accomplishing this object, the motor 20 is started, and since the gears and trunnion bearing have been previously lubricated, damage of the gears by the heavy starting load will be prevented. The motors 24 and 20 are started by separate switches and by hand, if desired, but the entire apparatus may be conveniently started by a starting switch which initiates the operation of the motor 24 and a time delay relay which will throw a switch to start the motor 20 after the lapse of a predetermined time, or after the build-up of a predetermined pressure in the lubricating oil line 28. Instruments for accomplishing these results are well known, and the circuit therefore is not illustrated in the drawings.

Fig. 2 of the drawings shows more in detail the means for the distribution of the lubricating oil to the various gears, as well as showing the relationship of the gears with respect to the drum 10 and its mounting. As shown in this figure of the drawings, the driving end of the drum 10, which may be either the feed or the discharge end, includes a heavy metal head 36 having an integral projecting hollow axial trunnion 38 having an exterior bearing surface mounted in a semicylindrical bearing 40 comprising a part of the support 14. The projecting end of the trunnion 38 includes a heavy integral annular flange 42 to which is secured a large diameter herringbone gear 44 by which the drum 10 is driven. The gear 44 meshes with a herringbone pinion gear 46 keyed to a shaft 48, to which is also keyed a relatively large herringbone gear 50 which meshes with and is driven by a small herringbone pinion gear 52. The gear 52 may be cut integral with or keyed to the shaft 54 which is coupled to the drive shaft of the motor 20 by means of a coupling member 56. The shafts 48 and 54 are mounted in the support casing 14 and completely encased, to prevent the infiltration of dust.

The direction of rotation of the drum 10 is indicated by the arrow to the right in Fig. 1. From this the direction of rotation of the gears 44, 46, 50 and 52 will be apparent. Fig. 2 shows the arrangement for distributing or spraying the lubricant oil onto the various gears and trunnion bearings. The pipe 30 terminates above the juncture of the gears 50 and 52 to supply lubricant directly through two spray heads at the point where the converging gear teeth meet during the rotation of the gears. On the other hand, the oil line 32 terminates in a pair of spray nozzles directly below the juncture of the gears 44 and 46. The oil line 34 extends above the gears 44 and 50, around the gear 44 and terminates in a spray nozzle directly over the bearing surface of trunnion 38 at a point above the left-hand end of the bearing 40. The line 35 extends around the base 14 and terminates in a slot from three to six inches long in the bearing 40 under the bearing 38 (Fig. 3). The valve in line 28 is preferably used to build up a pressure of 300 lbs. per square inch in the line 35 to lift the trunnion 38 in the bearing 40. The supply of lubricant to this point prior to the starting of the gears frees the trunnion bearing 38 and insures lubrication of the bearing 40, along with oil from the line 34.

In many cases the bearings corresponding to the bearing 40 become hot because of the heavy load, and they must be thoroughly lubricated and usually provided with channels for the circulation of cooling water. When the mill is stopped after considerable operation, and the bearings are hot, the lubricating oil has a tendency to run out or to be forced out because of its thinness at the high bearing temperatures. Accordingly, it is important that the lubricant be

supplied to the bearings prior to the starting of the gears. The importance of supplying lubricating oil to the lines 30 and 32 at the gear junctures, has been pointed out above. The bearings for shafts 48 and 54 may be oiled from lines 30 and 32 or by oil carried up by the gears.

The driving gear mechanism described above may be mounted either at the feed or at the discharge end of the mill. However, in Fig. 3, the gear arrangement is shown, for purposes of illustration, as mounted at the discharge end in connection with special means for protecting the gear system from the very fine dust which is present in material handling plants. The hollow trunnion 38, as shown in Figs. 2 and 3, is lined with a cylindrical sleeve member 58 having an external annular flange 60 by which it is secured to a shoulder on the projecting end of the trunnion 38. The member 58 extends beyond the side of the gear casing and is provided with internal helical fins 62 arranged to convey coarse material back into the drum 10. Mills of this type can be discharged by overflow or by mechanical lifting means, but when air-swept, they are usually operated in connection with an air stream which flows into the mill through the inlet end and which picks up the pulverized material produced by the mill and carries it to the outlet end to storage or points of use. This stream of air has a tendency to carry relatively large particles of the material being reduced, and these particles are caught by the fins 62 and moved back into the drum 10 due to the rotation of the member 58 along with the drum.

Fig. 3 shows the cylindrical sleeve member 58 in greater detail and the fact that at each end it is provided with inwardly extending flanges, the inner flange of which engages the wear-resisting lining of the head 36. The outer flange 64 serves as a mounting for the sealing means for connecting the mill to the outlet or discharge duct or chute which conveys the air stream or pulverized material. The joint between the trunnion 38 and the gear casing is provided with a sealing member adjacent the head 36 comprising an annular metal sealing plate 66 bolted to the base 14 and to the casing 18 and extending at an angle out to the trunnion where it terminates in a packing seal at the inner edge of the annular plate 66. The gear casing also includes a projecting rotary sleeve 68 which is bolted to the flange 42 and which is substantially spaced from and surrounds the member 58. Sleeve 68 extends substantially beyond the gear wheel 44 where it is engaged by a stationary flanged sleeve member 70 of S-shape in cross-section. This member is bolted to the outside of the base 14 and a flange on the upper portion of the casing 18. A packing ring 72 is held between the inner end of the member 70 and a flange bead near the outer end of the annular sleeve 68. The end of the sleeve 68 projects into the stationary member 70 and rotates therein.

While the rotary sleeve member 68, together with the member 70, provides a seal for the gear casing, considerable trouble has developed because of the fact that pulverized material and dust has a tendency to get back in between the member 58 and the sealing members 68 and 70, and work into the gears. According to the present invention, an auxiliary seal has been provided between the outer ends of the members 58 and 70 in order to more completely eliminate the presence of dust around the member 58. Accordingly, an annular flange plate 74 is bolted

to the outer flange 64 on the member 58 and sealed thereto with a suitable gasket. The flange plate 74 is faced with a rub plate 76 and the two are bolted to the flange 64 by means of countersunk bolts as shown. The outer edge or rim of the plate 74 slides in an annular laminated sealing joint 78 bolted to the gear casing and base 14 along with the outwardly extending annular flange of the member 70. The laminated seal includes a pair of relatively thin plates held against the member 70, a spacer plate of approximately the thickness of the movable flange plate 74 and a cover plate which overlaps the rim of plate 74 and the spacer plate. The spacer plate is of somewhat larger diameter than the circumference of the plate 74 so that an annular space 80 is provided for a grease-like lubricant to complete the seal. An annular deflecting flange 82 extends over the laminated seal so as to deflect any dust or fine pulverized material which may pass around the rub plate 76.

As shown in Fig. 3, the discharge end of the mill includes an upwardly extending chute 84 which projects inside of the annular plate 76. This projecting section of the chute includes a horizontal cylindrical portion surrounded by a rub plate assembly comprising an annular plate 86 to which is bolted a heavy rub plate or packing ring 88, by means of countersunk bolts, as shown. A narrow packing ring 90 is also provided between the plate 86 and the horizontal cylindrical portion of the chute 84. The chute mounting includes bracket members 92 supporting a spring and pin assembly 94 for urging the plate 86 and the packing ring 88 against the rub plate 76.

As the drum 10 rotates, the rub plate 76 also rotates and rubs against the annular ring 88 which is urged in close engagement therewith by means of the spring units 94. These spring units are distributed around the periphery of the discharge passage so as to provide the best possible seal under the circumstances.

During the operation of the apparatus, the drum may become overcharged with the material to be pulverized and it may fill substantially into the outlet trunnion section. The apparatus therefore includes a blow-down pipe 96 of substantial size for discharging the excess material. The pipe 96 is normally closed but an operator may blow out the excess material by throwing the valve lever 98 which operates a valve member 100.

The feed end of the mill of the present invention is shown in some detail in Fig. 3 of the drawings, and comprises a hollow trunnion 102 resting in a semiannular bearing 104 carried by a support 106. The trunnion 102 is sealed with respect to the support and the upper part of a casing surrounding the bearing, by means of an annular sealing plate or ring 108. The outer end of the trunnion is sealed with respect to the support and upper portion of the casing by means of an annular sealing plate 110, which, together with the support 106, forms a well for lubricating oil. Lubricant is carried to the top of the trunnion by an attached annular flanged plate 112 which rotates with the trunnion and carries lubricant, which is removed by a spring-pressed scraper 114. Access to the upper portion of the casing is obtained by removing cover 116. The trunnion 102 is provided with a sleeve-like lining 118 having internal helical fins for advancing material into the drum 10. An L-shaped flange 119 on the end of the sleeve 118 is bolted to the

end of the trunnion 102 to hold plate 112 in place and to provide a bearing for plate 110 which terminates in a hooked flange serrated seal and a felt ring 121 held in place by a plate as shown. A slot 123 drains oil from the serrations into the reservoir, although most of the oil on the outside of plate 112 is caught by the L-flange thereon. The material to be pulverized is supplied to the member 118 by means of a feed chute 120 which is sealed with respect to the trunnion and the member 118 by means of a spring-pressed rub seal assembly 122 of similar construction to that at the opposite end of the mill.

Fig. 4 of the drawings shows in enlarged detail the construction of the laminated seal arrangement described above in connection with Fig. 3 of the drawings. In this view it will be noted that the rotating plate 74 extends over a plate 124 held against the member 70, and that the annular space 80 is formed by a spacer plate 126 outside the plate 124, and a cover plate 128 which overlies the spacer 126, the space 80 and a portion of the rotary plate 74. Grease is supplied to the space 80 by any suitable type of grease gun through a grease connection 130. Sufficient grease is preferably introduced until it is forced between the plates 124, 128 and the rotating plate 74. The laminated seal assembly 78 may be tightened by drawing up the bolts which extend through the outer flange of the member 70.

The improved tube mill of the present invention may include other features and certain auxiliary equipment for aiding in its operation. For example, the mill may be provided with an electric-eye level control mechanism adapted to indicate the level of the charge in the mill and to control a motor used for feeding coal or other material to the mill. Such a device insures full capacity of the mill and guards against filling the mill so full that an improper operation is obtained such that the blowout 96 must be used. The mill furthermore may be operated with the air stream induced through the outlet chute 84 or by the forced introduction of an air stream through the feed chute 120. The lubrication of the trunnion bearings may be modified from the system shown, by providing channels in the bearing 104 like that in bearing 40, into which oil may be forced from a high pressure line connected to the line 35. The gears and bearings of the mill may be lubricated in the manner described above, entirely lubricated from the pump 22, or partly by the pump 22 and partly by lubricating oil carried up by the gears or bearings. Means may be provided in the gear casing 18 for taking lubricating oil from a high point on the gear 44 and conducting it to the various bearings such as for shafts 48 and 54.

Fig. 5 of the drawings illustrates a preferred arrangement for lubricating the bearings of the shafts 48 and 54, the showing being particularly directed to the lubrication of one end of the shaft 48. As shown, the shaft 48 is provided with a roller bearing unit 132, the inner race of which is held to the end of the shaft by means of a plate 134. The unit 132 is in a casing 136 which may be in or comprise a part of the casing of elements 14 and 18. The bearing 48 is enclosed by a cover plate 138. The casing 136 includes flanges 140 for retaining lubricating oil around the lower rollers of the bearing unit. These elements 140 provide a small reservoir of oil which will be present when the apparatus is started and insure proper lubrication at the beginning of the operation. Lubricant may be supplied to the bearing through a pipe 142 which may be connected to one of the lines 30 or 32, or to a drainage system for oil elevated by the gear 44. Excess oil may overflow either of the flanges 140 and drain back into the reservoir in the gear casing.

A preferred grinding apparatus assembly for the production of finely pulverized coal and other materials is shown in Fig. 6 of the drawings in which the improved tube mill of the present invention is shown with certain details removed such as the pumping system for lubricating the bearings. These and other details are not illustrated in Fig. 6 in order to simplify the showing. The particular arrangement of Fig. 6 is made in connection with a steam generator unit mounted in a building structure which supports various elements of the apparatus. The coal to be pulverized, or other materials, are taken from a main bin 144 and conducted through a chute 146 into a small bin 148 in which a rather definite level is maintained for the feed of coal into a feed regulator 150, the latter being of a known rotary disk type or other suitable feeder which discharges the coal into a chute 152, the lower end of which terminates in the feed chute 120 at the front end of the mill 10.

In the particular arrangement shown in Fig. 6 the air stream passed through the mill is induced through the feed chute 120 and the air stream containing the pulverized coal flows through the upwardly inclined discharge chute 84 at the discharge end of the mill 10 but which is connected to an upwardly extending duct 154 of considerably larger diameter than that of the chute 84 and which is provided as a separator for coal particles which have not been pulverized to the desired extent. These particles fall back through the chute 84 and are conveyed back into the rotary drum by means of the spiral fins 62. The upper end of the separator duct 154 is connected into the center of a centrifugal suction fan 156 which is mounted on a floor 158. The fan is operated at a suitable high speed by means of a motor directly in back of the fan and not shown in the drawing, to induce the air stream through the mill 10 and deliver a mixture of pulverized coal and air through one or more ducts 160 and branching ducts 162 to pulverized coal burners 164 of a steam generator furnace 166, or the coal may be delivered to a suitable storage bin. Supply of pulverized coal-air mixture to the ducts 162 is regulated by valves 168.

Steam generator units, particularly those used for the production of electricity and other types of power usually include means for heating the air used in the furnace. In the burning of pulverized coal the use of hot air is particularly important. According to a preferred form of the invention hot or preheated air, taken either from the steam generator unit or from any source, is supplied to the system shown in Fig. 6 through a hot air duct 170. This hot air is conducted through a main supply duct 172 to the feed chute 120 with which the duct is directly connected, the fan 156 serving to induce the hot air through the ducts 170, 172 and the mill 10. The use of hot air in the grinding operation is particularly important if the coal contains appreciable moisture, since the hot air serves to dry out the coal and facilitates the grinding and pulverizing operation in the mill. The temperature of the air is sufficiently above 212° F. so that any moisture removed from the coal will remain in superheated condition and not interfere with the

proper burning of the pulverized coal in the burners 164.

One of the difficulties encountered in the burning of pulverized coal is the matter of obtaining and maintaining proper firing conditions for the coal. It has been found that the firing is greatly improved if the coal is uniformly fine or contains little, if any, particles of any appreciable size. The combination arrangement shown in Figs. 3 and 6 involving the use of an induced air stream through the separator 154 and the helical return fins 62 has been found to greatly improve the fineness of the pulverized coal delivered to the burners 164 and the uniformness of such coal. The helical fins 62 naturally trap considerable of the larger coal particles which settle out in the air stream passing through the trunnion of the mill. These particles are fed back into the mill. Other particles which would not be readily burned, or only superficially burned, in the furnace 166, are separated in the enlarged separator duct 154 and fall back through the chute 84 and are returned to the mill 10 for further drying and grinding. The apparatus, including the fan 156, is preferably correlated so that the separator 154 delivers substantially only a uniformly fine coal for the burners 164.

The separation of the coarser coal particles in the separator 154 is effected by the substantially rapid change of velocity when the air stream flows through the relatively narrow chute 84 into the large diameter duct 154. The separated coal particles tend to move to the side walls of the duct 154 and slide down the slope of the chute 84 into the pockets formed by the helical fins 62.

The ratio of air to pulverized coal delivered through the ducts 162 may be varied by the general control of the amount of air passed through the mill 10. However, additional hot air may be supplied with the air-coal mixture through a valved bypass duct 174 between the duct 172 and the upper portion of the separator 154. This arrangement permits the maintenance of the correct air velocity in the separator 154 to insure the proper separation of the relatively large particles of coal. The velocity through the separator 154 may be maintained substantially constant while the actual volume of air-coal mixture delivered by the fan 156 is controlled by the speed of the fan and the amount of hot air conducted through the bypass duct 174. The use of the separator 154 produces a much finer coal than would otherwise be possible, resulting in improved firing and efficiency in the furnace 166 and a greater tonnage of coal pulverized in the apparatus.

The improved mill of the present invention may include other modifications in the structure and arrangement of the various parts, as will be understood by those skilled in the art from the foregoing description. The mill may include an oil sealed breather for the gear casing as at 144, Fig. 1, so that expansion and contraction of the air in the gear casing may be taken care of without admission of dust. It is to be understood that the mill is of general application and that it may be used either for wet or dry grinding by means of balls, rods, or other loose grinding elements. Furthermore, the mill may be used for grinding various kinds of material, such as cement, slurries, ores, chemicals, paints and other materials.

The subject matter relating to the lubrication of the tube mill as disclosed in this application and originally claimed herein is now disclosed and claimed in my divisional application Serial No. 45,073, filed August 19, 1948.

What I claim as new is:

1. In a grinding mill for pulverizing coal and other materials including a rotary drum having hollow axial end trunnions projecting therefrom and mounted in bearing supports, a gear system connected to one of said trunnions for rotating said drum and a gear casing surrounding said gear system and the trunnion bearing thereat, a hollow rotary trunnion sleeve member having one end sealed with respect to the trunnion to which said gear system is connected, the other end of said sleeve member extending through the side of the gear casing, an annular radial flange plate sealed to the extending end of said sleeve member and rotatable therewith, an annular rub plate sealed with respect to said casing and engaging the inner surface of the flange plate, a space plate attached to said rub plate and spaced from the rim of said flange plate, and an annular cover plate attached to said rub and spacer plates in a sealed manner and overlying the rim of said flange plate.

2. In a grinding mill as defined by claim 1 in which a hollow projecting sleeve surrounds a portion of said rotary trunnion sleeve member in spaced relation and is attached to said trunnion for rotation therewith, and a stationary hollow sleeve surrounding said rotary trunnion sleeve member having one end attached to said casing and the other end engaging said spaced rotary sleeve in sealing relationship.

3. In a grinding mill for pulverizing coal and other materials including a rotary drum having hollow axial end trunnions projecting therefrom and mounted in bearing supports, means for supplying the material to be pulverized into one of the trunnions, the pulverized material being discharged through the opposite trunnion, a hollow rotary trunnion sleeve member mounted in the discharge trunnion and extending substantially therebeyond, a drive gear mounted on the discharge trunnion, a casing extending over the discharge trunnion, drive gear and bearing thereat and around said sleeve member, an annular outwardly-extending flange plate attached to the end of and rotatable with the sleeve member, an annular rub plate attached to the casing parallel to and engaging the inner surface of the flange plate, a spacer plate attached to the rub plate and spaced from the rim of the flange plate, and an annular cover plate attached to the rub and spacer plates in a sealed manner and overlying the rim of the flange plate.

4. In a tube mill for pulverizing coal and other materials including a horizontal rotary drum having hollow axial end trunnions projecting therefrom and mounted in bearing supports, a gear system connected to one of said trunnions for rotating said drum and a gear casing surrounding said gear system and the trunnion bearing thereat, a hollow rotary trunnion sleeve member having one end extending within and sealed with respect to the trunnion to which said gear system is connected, the other end of said sleeve member extending substantially beyond the trunnion and through the side of the gear casing, an annular radially outwardly-extending flange plate attached to the extending end of said sleeve member and rotatable therewith, an annular rub plate attached to said casing and having an annular face engaging the inner face of the flange plate, a space plate attached to said rub plate and spaced from the rim of said flange plate, an an-

nular cover plate attached to said rub and spacer plates in a sealed manner for overlying the peripherial outer surface of said flange plate, a hollow projecting sleeve surrounding a portion of said rotary trunnion sleeve member in spaced relation thereto and attached to said trunnion for rotation therewith, and a stationary hollow sleeve surrounding the outer portion of said rotary trunnion sleeve member and having its outer end attached to the rub plate and to the casing, the other end of the stationary hollow sleeve engaging said spaced rotary sleeve in sealing relationship.

5. In a grinding mill for pulverizing coal and other materials including a rotary drum having hollow axial end trunnions projecting therefrom and mounted in bearing supports, means for supplying the material to be pulverized into one of the trunnions, the pulverized material being discharged in an air stream through the opposite trunnion, a hollow rotary trunnion sleeve member mounted in and secured to the discharge trunnion and extending substantially therebeyond, a drive gear mounted on the discharge trunnion, a casing extending over the discharge trunnion, drive gear and bearing thereat and around the extending end of the sleeve member, an annular outwardly-extending flange attached to the end of and rotatable with the sleeve member, a dust seal between said flange plate and said casing, an annular rub plate mounted over said flange plate and attached to the end of the sleeve member, an upwardly-inclined discharge chute of smaller diameter than and mounted in fixed position at the outlet end of the trunnion sleeve member, an annular peripheral rub plate on the chute engaging the rub plate attached to the sleeve member, a continuously upright separator duct for separating coarse particles from the air

stream the lower end of which is connected to the upper part of the chute, said separator duct being of substantially larger cross-sectional area than said chute whereby coarse particles carried in the air stream through the chute into the upright duct settle out and pass directly downwardly through the chute into the trunnion sleeve member, a plurality of internal helical fins in said sleeve member arranged to feed coarse material back into the mill, and a fan connected to the upper portion of the upright separator duct for inducing air through the mill, the discharge trunnion sleeve member, the chute and the upright separator duct.

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