This invention relates to roll and bar grinding mills for dispersing discrete particles in liquids. Mills of this general character are exemplified by U.S. Patent No. 2,163,765 and U.S. Re-Issue Patent No. 20,939 of Asbjorn Sornshagen. Mills of this kind are commonly used for dispersing discrete particles in liquids. The grinding of pigments into vehicles in the paint and ink industries and the refining of chocolate are examples of their uses.

In mills of the character described, the material, generally in the form of a paste, is ground between the circumferential surface of a rotating roll and a relatively stationary grinding bar arranged parallel to the axis of the latter. It is the practice to hold the bar, usually by hydraulic pressure, in proper spaced relation to the surface of the roll, so that the paste, in passing through the space between these parts, will be sheared or ground to the degree desired. The surface of the bar contiguous to the roll is concentric with and maintained at all times parallel to the circumferential of the roll and the grinding is accomplished within the working width of the gap between the bar and the roll surface.

Since these surfaces have always been parallel and are rigidly maintained at all times in such relation, it has heretofore been necessary to associate with the bar some means to insure the entry of the paste into the grinding zone. To this end, it has been customary to provide the forward face of the bar with a vane arranged in angular relation to the surface of the roll and forming therewith an entrant angle or a tapering throat leading to the "nib" of the roll. The purpose of this entrant angle is to wedge the paste into the grinding zone. This structure and procedure present numerous difficulties. For example, if the paste is too heavy for the hydraulic pressure upon the bar, it lifts the bar too much and the gap then becomes too great to produce effective dispersing. If the paste is fluid or slippery, the vane will not feed a continuous film to the nip of the roll and the latter acts like a scraper with the result that the output is severely restricted.

In the past, the difficulty of the conflicting forces, set up by the wedging action of the vane and the scraping tendency of the grinding surfaces, have been combated by various complicated and time consuming expedients or procedures. For example, various vane bars having different vane angles, which may range from 2° to 30°, have been provided, it being the practice to select and use a vane bar according to the requirements of the particular paste. Bars with adapters, such as described in U.S. Patent No. 2,163,765 have also been used extensively and, in some instances, relief holes through one of the grinding surfaces have been utilized to permit re-circulation of the paste during the grinding operation.

There is an ideal relation between the angle of the vane, the hardness of the pigment, the hydraulic pressure under which the bar is held to its work and the thickness of the resulting ground film, but this ideal relationship under prior practice has been practically impossible to obtain because it is necessary to individually normally adjust each factor to the particular requirements of the paste to be ground.

There has long been the need for some simple practical solution of this troublesome problem which is overcome by apparatus of the present invention. In the use of said apparatus, a wide variety of pastes may be ground, without appreciable adjustment of the apparatus.

The apparatus of this invention comprises a grinding bar having a grinding surface complementary to the surface of the roll in that it is curved on the same radius, but said bar is fluted for pivotal movement on an axis parallel to the axis of the roll and located in a plane radially of the roll and passing through the grinding surface of the bar nearer to the trailing edge of said grinding surface than to the leading edge thereof. This arrangement permits the bar to freely tilt on its own axis so that the leading edge of its grinding surface is spaced further from the circumference of the roll than its trailing edge, i.e., the clearance at the leading edge is greater than at the trailing edge. How much wider the gap is at the leading edge than at the trailing edge depends upon the consistency of the paste and the speed of the roll and the only variable that has to be controlled in order to obtain the desired dispersion is the pressure under which the bar is held in spaced relation to the roll. The higher the pressure, the thinner the film which is formed. Thus it is possible to control the film thickness between the roll and the grinding surface by pressure as the only variable requiring adjustment. This greatly simplifies operation as the adjustment of all except the pressure is automatically afforded.

Features of the invention, other than those adverted to, will be apparent from the hereinafter detailed description and appended claims when read in conjunction with the accompanying drawing.

The accompanying drawing illustrates one
practical embodiment of the invention, but the construction therein shown is to be understood as illustrative, only, but not as defining the limits of the invention.

Figure 1 is a more or less schematic view showing apparatus embodying the present invention.

Figure 2 is a detail section showing on enlarged scale the manner in which the grinding bar assembly is constituted according to the apparatus of this invention.

Apparatus for carrying out this invention may manifestly partake of widely different forms. However, for the purpose of illustration, it will be assumed that the grinding bar assembly is supported on a guide or bridge 1 of the general character disclosed in U. S. Re-Issue Patent No. 20,956 and mounted on an appropriate frame, as indicated in said patent, in juxtaposition with the grinding roll 2. In contradistinction to the particular structure of holder in said patent, however, the grinding bar assembly of this invention is shown as comprising a holder 3 to the lower end of which is attached a shoe support 4 which is in turn fulcrumed to a shoe 5 constituting the actual grinding bar. The support 4 may be conveniently attached to the holder 3 by screws 6 and both the holder and supports are mounted for movement radially of the roll 2 within the guide or bridge 1, being urged in the direction of the roll surface by an appropriate force indicated at F which, in practice, may be the hydraulic pistons of the United States Re-Issue Patent No. 20,956.

The shoe or grinding bar 5 is in the form of a strip, substantially equal in length to the length of the roll 2, and fulcrumed upon the support 4 by any appropriate hinge. As shown in the drawings, the fulcrum is of the knife edge variety, the edge being formed on a rib 7 which extends longitudinally of the shoe support 4 to engage a V-shaped channel 8 formed in the upper surface of the shoe constituting the grinding bar. Other forms of fulcrum may be used, as cylindrical socket joints or a piano type hinge or the like. The primary requirement is that the shoe be fulcrumed to its support in such manner as to permit of lifting of the shoe 5 while prohibiting passage of the paste between the shoe support and the shoe. The grinding surface of the shoe 5 constituting the grinding bar is designated G and it extends in the direction of rotation of the roll from a point 9, indicating its leading edge, to a point 10, indicating its trailing edge. Between these edges the surface G is formed, ground or lapped to substantially the same radius as the circumference of the roll 2, so as to be complementary thereto. The points 9 and 10 designate lines parallel to one another and to the axis of the roll and extending longitudinally of the grinding shoe 5.

It will be noted particularly from Figure 3 that a portion of the width of the bar extends forward of the leading edge 9 of the grinding surface, but in practice this is not necessary except to furnish extra stock for wear and to impart to the shoe more backbone or strength than would be provided if the shoe were of a width only equal to the width of the actual grinding surface.

By mounting the shoe upon a fulcrum as indicated, it is thereby adapted for tilting movement on the axis A of such fulcrum. The position of this axis is important. It must be so located with respect to the grinding surface G that, when the surface is in facial contact with the circumference of the roll, the axis A will lie in a plane P radially of the roll and passing through the grinding surface G of the shoe nearer to the trailing edge 10 of said grinding surface than to the leading edge 9 thereof. The axis A lying in the plane P will be particularly located at the intersection of such plane with another plane perpendicular to the first and parallel to the roll axis. In Figure 2 of the drawing, the point 11 indicates a longitudinal line medially of the width of the grinding surface, i.e., parallel to and equidistant from the lines indicated by the points 9 and 10. When the axis A is so positioned, a plane radially of the roll and passing through said axis will at all times be rearwardly of the point 11 no matter how much the leading edge of the grinding surface is tilted upward.

We have found that when these conditions prevail, the feed of paste by the moving roll to the grinding shoe will cause the leading edge of the grinding surface G of the shoe to lift as shown in Figures 1 and 2, so that the grinding surface G is no longer parallel to or coaxial with the surface of the roll. On the contrary, the clearance at the leading edge is wider than at the trailing edge. Experience has shown that by merely adjusting the pressure applied to the holder 3, it is possible to grind pastes of widely different characteristics, the pressure being the only variable which it is necessary to adjust. The tilt of the shoe and consequent thickness of resulting film 89 will be automatically accomplished and will automatically compensate for varying characteristics of the paste, to produce an efficient grind and the desired dispersion. The higher the pressure, the thinner the film which is formed.

In the operation of the bar mill, the force F constantly tends to hold the grinding surface G of the grinding bar against the grinding roll 2. The material that is being ground does of course tend to raise the grinding bar 5 against the action of the force F. Hence the clearance between the grinding bar and the roll surface can be altered in the sense that if the force F is decreased the grinding bar can rise under the action of the ground material whereas if such force is increased then the clearance decreases until an equilibrium state is reached.

With this invention, therefore, it is no longer necessary to provide vanes on the grinding bar assembly. Nor is it necessary to change the grinding bars when pastes of different characteristics are encountered. Nor are any escape holes required as herefore necessary in so many cases. The paste material M to be ground is simply placed in the hopper 12 and the pressure F adjusted to produce the desired thickness of film at m and consequent efficient and satisfactory dispersing of the pigment in the vehicle. The film may be removed from the roll 2 by the usual doctor blade 13, as shown in Figure 1.

With the structure described there will of course be the inevitable wear, but this constitutes no serious problem for the wear on the surface G of the shoe will progress in such manner that the line 10 will follow the upwardly and rearwardly inclined face 14 of the shoe. This inclination, while not absolutely necessary, is desirable, for it will permit the use of the shoe until it is worn quite thin without the possibility that the axis A will in time fall outside of the space between the lines 9 and 10. As long as the axis A is between these two lines and on the
trailing side of a radial plane including the axis of the roll and the medial point of the grinding surface, the apparatus will continue to properly function in an automatic manner. It may be true that the portion of the width of the shoe which is forwardly of the line 9 may have some wending effect, but this is secondary and unessential. The real active wending and grinding operation takes place within the grinding zone of which the surface G constitutes one wall and, in contradistinction to prior practice, that wall in this invention is not parallel to the surface of the roll or coaxial therewith while carrying out its grinding function.

In practically carrying out the invention, it is preferred that at least a part of the grinding surface of the shoe have a radius complementary to the surface of the roll. However, this is not essential and, if desired, the grinding surface of the shoe may be made flat, without departing from this invention.

It will of course be understood that appropriate seals are provided at the opposite ends of the grinding bar, but these seals constitute no part of the present invention.

The apparatus of this invention may, in practice, be used in conjunction with a grinding roll which is mounted for rotation without axial movement or with a roll which is axially reciprocated as it is rotated.

In the accompanying claims, reference is made to apparatus for the grinding of pastes without intending to limit the invention to any particular type or form of paste provided that it is one that may be operated upon in the manner stated.

The foregoing detailed description sets forth the invention in its preferred practical forms, but the invention therein set forth is to be understood as fully commensurate with the appended claims.

Having thus fully described the invention, what we claim as new and desire to secure as Letters Patent is:

1. In a bar mill having a grinding roll and a bridge supported in juxtaposition to the roll, a grinding bar assembly on the bridge urged toward the roll and including a shoe arranged parallel to the axis of the roll and having a grinding surface opposing the circumference of the roll, and complementary means on said bar assembly and shoe defining a floating pivot therebetween permitting movement of said shoe relative to said bar assembly on a pivot axis which is at the intersection of a plane radial of the roll and another plane which is both perpendicular to the first plane and parallel to the roll axis, said radial plane passing through said grinding surface at a location nearer the trailing edge of the grinding surface of said shoe than the leading edge thereof.

2. A bar mill according to claim 1, wherein the grinding bar assembly comprises a holder slidably mounted in the bridge for movement toward and away from the roll, and a shoe support on the side of said holder facing the roll and upon which said shoe has its floating pivot.

3. A bar mill according to claim 1, wherein the grinding bar assembly comprises a holder supported on the bridge for bodily movement toward and away from the roll and upon which said shoe is pivoted.

4. A bar mill according to claim 1, wherein the grinding bar assembly has a shoe support facing said shoe, and said complementary means comprises a rib formed on said shoe support and extended parallel to said pivot axis, and a channel in said shoe on the side facing said shoe support and into which said rib extends.

5. A bar mill according to claim 4, wherein said rib is of V-shaped cross-section, said channel being of a greater width at its open end than the width of said V-shaped rib at its base end to floatingly receive said rib.

6. A bar mill comprising a roll mounted to rotate, a bar arranged parallel to the axis of the roll and having a grinding surface opposing the circumference of the roll, a pivotal support for said bar disposed with the pivotal axis in a plane radial of the roll and passing through said grinding surface of the bar nearer to the trailing edge of said surface than to the leading edge thereof, said pivotal axis lying in said plane at the intersection of the latter with another plane which lies perpendicular to the first-mentioned plane and parallel to the axis of rotation of the roll, and means acting through said pivotal support for effectively pressing said bar onto the roll whilst allowing the bar to move about said pivotal axis.

7. A bar mill as claimed in claim 6, wherein the bar is movable relatively to the roll to vary the spacing therebetween.

8. A bar mill according to claim 6, including a holder for the grinding bar supported for bodily movement toward and away from the roll and having a face opposing a face of said grinding bar the latter face being remote from the grinding surface of said grinding bar, a rib upon one of said faces and a groove upon the other of said faces for the reception of said rib thereby to pivotally connect said faces.

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