

[54] **SYSTEM FOR FEEDING GRINDING MEDIA TO CONTINUOUS ATTRITION MILL**

[72] Inventor: **John David Nye**, Prescott, Ontario, Canada

[73] Assignee: **Ferrox Iron Ltd.**, Prescott, Ontario, Canada

[22] Filed: **Dec. 8, 1970**

[21] Appl. No.: **96,128**

[52] U.S. Cl. .... **241/79, 241/172**

[51] Int. Cl. .... **B02c 17/16**

[58] Field of Search .... **241/24, 30, 79, 170, 172, 173, 241/46.15, 68, 73, 137, 153, 171, 181**

[56] **References Cited**

**UNITED STATES PATENTS**

|           |        |                    |           |
|-----------|--------|--------------------|-----------|
| 2,595,117 | 4/1952 | Ahlmann .....      | 241/24 X  |
| 3,298,618 | 1/1967 | Talpey .....       | 241/172 X |
| 3,311,310 | 3/1967 | Engels et al. .... | 241/172 X |

3,486,705 12/1969 Szegvari.....241/172

*Primary Examiner*—Robert L. Spruill

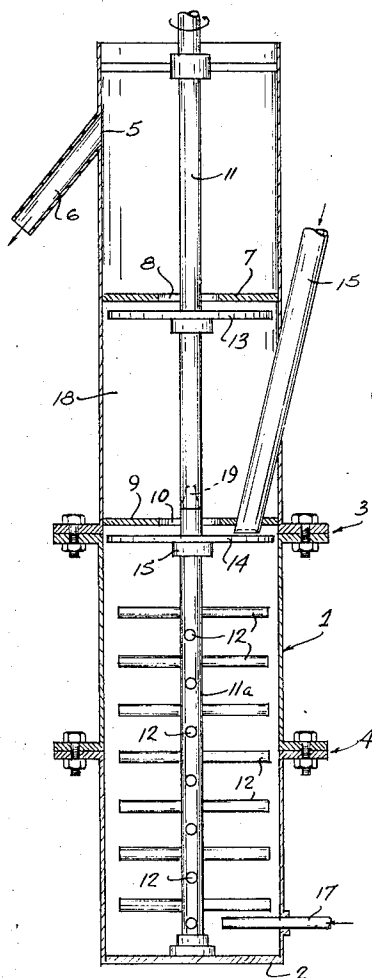
*Attorney*—Peter Kirby, Charles P. Curphey and Norris M. Eades

[57]

**ABSTRACT**

A system is described for feeding grinding balls to a continuous attrition mill of the type comprising a vertical cylindrical vessel having an inlet in the lower portion thereof, an annular suppression plate with an axial opening mounted in an upper region of the vessel, a horizontally rotatable disc mounted immediately below the suppression plate and a plurality of rotatable impellers within the vessel. The grinding ball feeding system of the invention comprises a pipe extending downwardly through a separate opening in the suppression plate and terminating a small distance above the rotatable disc. The pipe is arranged in relationship to the rotatable disc such that during operation the rotating disc draws the balls from the lower end of the pipe and delivers these to the outer walls of the vessel where they tend to sink down towards the bottom without interfering substantially with the operation of the mill.

**5 Claims, 4 Drawing Figures**



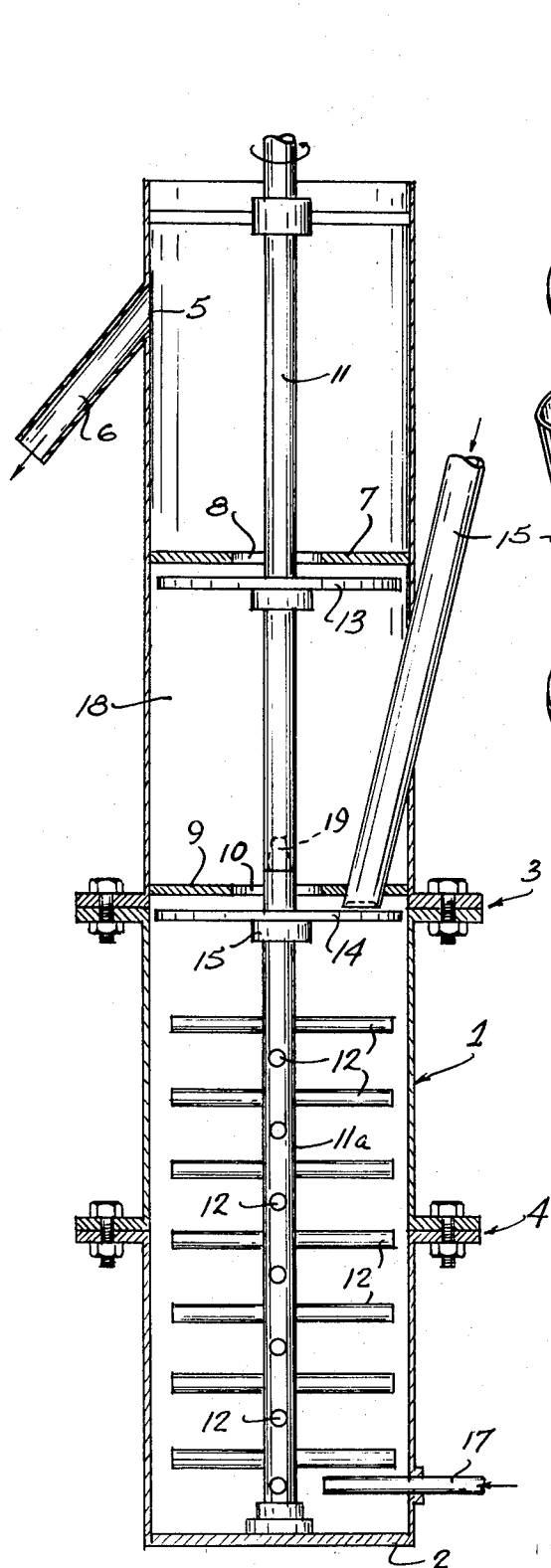


Fig. 1.

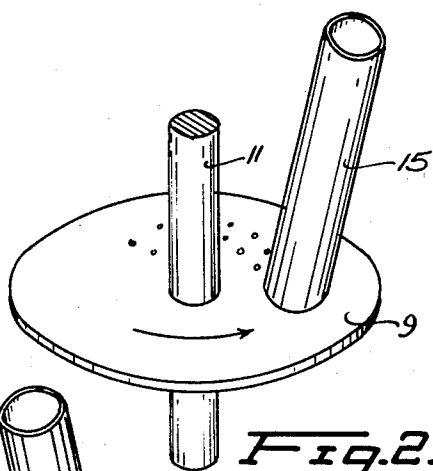


Fig. 2.

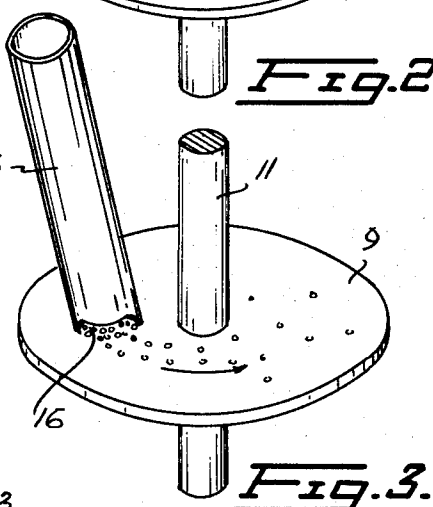


Fig. 3.

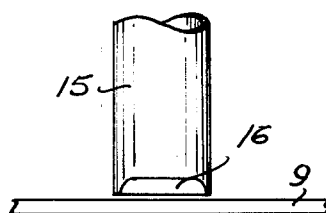


Fig. 4.

INVENTOR.  
JOHN D. NYE,  
BY  
*Berman, Davidson & Berman,*  
ATTORNEYS.

# SYSTEM FOR FEEDING GRINDING MEDIA TO CONTINUOUS ATTRITION MILL

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

This invention relates to a new and improved system for feeding grinding media to continuous attrition mills.

### 2. Description of Prior Art

Attrition mills are used for dispersing solid materials and reducing the particle size by agitating a dispersion of the solid material as a slurry with a particulate grinding medium. Such mills are well known and usually take the form of a vertical circular vessel having therein a rotating member for agitating the dispersion of solid material with the grinding medium. In operation, a dispersion of the solid materials to be ground is introduced continuously into the bottom of the mill in the form of a slurry while the rotatable member agitates the mixture with the grinding medium particles.

A particularly useful mill of the above type is described in Talpey, Canadian Pat. No. 771,141, issued Nov. 7, 1967. This mill has an annular suppression plate mounted in an upper region thereof and a rotatable shaft extends down through the opening in the suppression plate into the grinding zone. A plurality of impellers are mounted on the shaft in the grinding zone to agitate the dispersion and grinding medium and a horizontal disc is also mounted on the rotatable member immediately below the suppression plate. The annular suppression plate and rotating disc together form an internal classifier whereby only particles smaller than a certain size will pass through the suppression plate opening.

The grinding medium may be sand as described in the above Canadian patent or it may be in the form of balls of various materials, e.g. iron, aluminum oxide, glass, porcelain, etc. When a fine grinding material such as sand is used as described in the Canadian patent, it is possible to feed this into the mill along with the material to be ground. However, there are many instances where it is desirable to use balls, and particularly iron balls, as the grinding medium and it is not always possible to feed these into the mill with the material to be ground. It is highly desirable to be able to feed the material to be ground into the mill in the form of a very thick slurry and the problems of pumping such a thick slurry are sufficient in themselves without the further complication of also having iron balls in this slurry. These iron balls will usually be of a diameter of about one-sixteenth to about one-half inch so that the difficulty of incorporating these in the feed slurry will be readily apparent.

Various attempts have been made to feed the grinding balls into the mill through a separate inlet. One method that was tried was to feed the balls in through the axial suppression plate opening. However, the upward movement of material through this opening tended to entrain balls with it so that a substantial number of balls were carried up with the finely divided product. Also, the feeding of the grinding balls through the suppression plate opening tended to interfere with the classifying operation. Another attempt that was made was to feed the balls directly into the grinding zone by providing a stand pipe which opened directly into the grinding zone through an opening in the wall of the mill. This was also unsuccessful because the pressure as well as the very violent action within the grinding zone forced the contents of the mixing zone up the stand pipe, carrying the fresh grinding balls with it.

It is, therefore, the purpose of the present invention to provide an improved system for feeding the grinding balls into an attrition mill.

## SUMMARY OF THE INVENTION

According to the present invention fresh grinding balls are fed into the mill by means of a novel stand pipe arrangement which extends downwardly through a separate hole in the suppression plate and terminates a small distance above the rotatable disc. The size of the opening in the suppression plate

as well as spacing of the disc from the lower end of the feed pipe and the lower surface of the suppression plate are arranged such that during operation particles below a predetermined size pass upwardly through the suppression plate axial opening and out of the vessel as product while fresh grinding balls enter the vessel through the space between the rotatable disc and the feed pipe.

The lower end of the feed pipe is preferably arranged in such a manner that a gap is provided between the rotatable disc and the trailing edge of the feed pipe with respect to the direction of rotation of the disc, which gap is just sufficient to allow fresh grinding balls to enter the vessel. A deflector is provided on the leading edge of the pipe in very close proximity with the rotatable disc so as to push fresh grinding balls and other large particles off the disc before it passes beneath the grinding medium feed pipe. This deflector can be in the form of an extended portion of the pipe itself.

It has very surprisingly been found that this feed pipe arrangement completely overcomes the problem of slurry backing up the feed pipe so that the feed pipe can be left with an open top. Actually, it has been found that the rotating disc below the end of the feed pipe creates a suction effect whereby the liquid level in the feed pipe remains below the liquid level in the vessel. Grinding balls can simply be dumped into the top of the feed pipe and they will be smoothly fed into the attrition mill by the action of the rotating disc.

By feeding the grinding balls in on the rotating disc, the added advantage is obtained that these balls are thrown to the outside wall of the mill where they can sink down towards the bottom of the grinding zone without interfering with the grinding action.

Since the rotating disc which receives the grinding medium balls is also functioning as an internal classifier in conjunction with the corresponding suppression plate, it will be appreciated that the presence of these large fresh balls may interfere slightly with a complete classification. However, any difficulties in this respect can be totally avoided by providing a second suppression plate and rotating disc combination at a higher level in the mill, which prevents any small number of fresh grinding balls which may be carried upwardly through the first suppression plate from being carried out of the mill with the finely divided product.

In order to more clearly describe this invention, reference is made to the accompanying drawings which illustrate a preferred embodiment.

In the drawings:

FIG. 1 is a vertical section through a continuous attrition mill;

FIG. 2 is an isometric view showing details of the rotating disc and grinding ball feed pipe;

FIG. 3 is a further isometric view looking in the opposite direction to FIG. 2; and

FIG. 4 is a partial side elevation showing details of the rotating disc and feed pipe.

Referring to the drawings, the apparatus for pulverizing solid materials comprises a cylindrical vessel 1 having a bottom 2. For ease of dismantling, the vessel 1 is in three parts joined together by means of pipe flanges 3 and 4. In the upper region of the vessel 1 is an overflow weir 5 to which is connected an outlet conduit 6. Below the weir 5 is an annular suppression plate 7 which is fixed on the inner wall of the vessel. This suppression plate has an axial opening 8. At a spaced location below suppression plate 7 is another suppression plate 9 mounted on the inner wall of vessel 1 and this again has an axial opening 10. This suppression plate is just above the flange 3.

Extending downwardly through the openings 8 and 10 passes a motor driven shaft 11 to which is connected an impeller shaft 11a. The impeller shaft has attached thereto a series of spaced paddles on impellers 12. Also mounted on shaft 11a directly below suppression plate 7 is a flat, horizontal circular disc 13 while another flat horizontal circular disc 14 is mounted on shaft 11 directly below suppression plate 9 by means of a set screw collar 15.

Extending at an angle downwardly through the wall of vessel 1 is a stand pipe 15 for feeding grinding balls to the vessel. The lower end of this stand pipe terminates adjacent the top face of rotary plate 14 and this pipe has a small cut-out 16 at the trailing edge in the direction of rotation of disc 14. With this cut-out, balls which are travelling down pipe 15 are carried away by the rotation of disc 14 through the opening 16 but are knocked off the disc 14 by the opposite side of pipe 15 as they rotate around.

Adjacent the bottom of vessel 1 is a slurry inlet line 17. The vessel 1 can be surrounded by a water jacket for cooling purposes if necessary.

In operation, the pulverizing of solid material is accomplished by pumping the slurry into the bottom of vessel 1 through inlet line 17. The proper amount of iron balls is added to the system at start-up and the shaft 11 set in rotation. As pulverization takes place by the action of the impellers on the iron balls and solid particles, the dispersion is forced upwardly by the pump and first passes through opening 10. The larger iron balls tend to remain towards the bottom of the vessel because of gravity but particularly as these balls become smaller they tend to be carried up and the rotating disc 14 serves the dual function of centrifugally separating the large particles including both iron balls and large particles of material being pulverized from the finer particles which pass through the opening and up into the region 18. The large particles thrown off to the side by the disc 14 of course fall down the walls of vessel 1 and back into the pulverizing zone.

The dispersion which has passed through outlet 10 continues to move upwardly where it comes in contact with the second rotating disc 13 and suppression plate 7 at which location a second classification takes place. At this region any larger particles which have managed to pass through opening 10 are thrown to the side by disc 13 and the dispersion containing only fine particles passes through outlet 8 and over weir 5 down outlet pipe 6.

The suppression plates and outer walls are preferably made of steel although they may be surfaced with rubber or other materials. The impellers may be of any desired shape such as flat or curved circular discs, propellers, paddles, or other stirring means. The number of impellers and their relative spacing is not critical provided the stirring is capable of imparting motion to the balls and dispersion throughout the milling vessel. It is, however, preferable that the vessel be tall relatively to its diameter and that a number of impellers are provided along the height of the pulverizing zone. The reason for this is that the impellers are subjected to considerable wear by the action of the balls and material being pulverized and it has been found that the operation can be commenced with the balls in the lower part of vessel 1 so that the impellers at the lower end of shaft 11 are worn out first. As these lower impellers wear out, the high impellers can be made to take over by increasing the amount of balls in the system and thus raising the elevation of the balls. This has, of course, the effect of greatly increasing the duration of the run of the vessel without the necessity of shutting it down.

When the impellers become badly worn the vessel 1 can simply be dismantled at flange 3 and the entire lower impeller section disconnected from drive shaft 11 by means of the tapered screw connection 19. This entire lower section with the plate 14 attached is then removed, the plate taken off, placed on a fresh impeller section and the entire mechanism reassembled.

The most critical dimensions of the system are the diameters of the openings 8 and 10 as well as the spacing between the rotating plates 13 and 14 and the corresponding suppression plates 7 and 9. These can be varied depending on the material being processed, the product desired, etc., and the precise conditions can be easily determined by simple experiments.

With a fixed set of dimensions as discussed above, the parti-

cle size of the pulverized product can be varied by varying the throughput of slurry of particulate solids with the mill working at constant speed. Also, with a fixed throughput of particulate solids slurry, the grinding medium requirements can be determined by the electric power load on the drive motor. Thus, the grinding medium can be added during the operation in amounts sufficient to maintain a constant load on the drive motor.

In the embodiment shown in the drawings the vessel 1 is a 20-inch outside diameter standard steel pipe with half-inch walls. The impellers used are in the form of steel bars 16 inches long and 1 1/4 inches in diameter. Flange 4 is positioned 30 inches from the bottom 2 while flange 3 is positioned 30 inches above flange 4. The plates 13 and 14 are one half-inch thick steel and are dimensioned such as to provide a one half-inch peripheral clearance between their edge and the inside wall of vessel 1. The suppression plates 7 and 9 both have a 2-inch diameter axial opening and each rotating plate is positioned 1 inch below its corresponding suppression plate. The stand pipe 15 is a 3-inch diameter steel pipe and this extends 60 inches above flange 3.

The device is driven by a 75 h.p. motor at a speed of about 300 - 350 r.p.m. The starting material being fed to the device is less than -60 mesh while the iron balls being fed in are about one eight-inch diameter. With this system about 500 to 1,000 pounds per hour of barium ferrite can be processed. At this rate of operation it is necessary to provide cooling in order to maintain the temperature of this system below the boiling point.

#### I Claim As My Invention:

1. In an apparatus for grinding particulate solids by the grinding action of grinding particles which are substantially larger than the solids being ground, comprising a vertical cylindrical vessel having an inlet in the lower portion thereof, an annular suppression plate mounted in an upper region of said vessel, the opening in said suppression plate being generally centered therein, a rotatable member extending through said opening and into said vessel generally along the cylindrical axis of the vessel, a horizontal disc mounted on said rotatable member immediately below the suppression plate and a plurality of impellers within said vessel attached to said rotatable member below said disc, the improvement which comprises providing a grinding medium feed pipe extending downwardly through a separate opening in said suppression plate and terminating a small distance above said rotatable disc, the opening in said suppression plate being of such diameter and the disc being so spaced from the lower surface of said suppression plate and the lower end of said grinding medium feed pipe that during operation particles below a predetermined size pass upwardly through the suppression plate opening out of the vessel as product while fresh grinding medium particles enter the vessel between the rotatable disc and feed pipe.

2. An apparatus according to claim 1 wherein a gap is provided between the rotatable disc and the trailing edge of the grinding medium feed pipe with respect to the direction of rotation of the disc, which gap is sufficient to allow grinding medium particles to enter the vessel and a deflector is provided on the leading edge of the pipe in close proximity with the rotatable disc to push fresh grinding medium particles and other large particles off the disc before it passes beneath the grinding medium feed pipe.

3. An apparatus according to claim 2 wherein the grinding medium feed pipe has an open top.

4. An apparatus according to claim 1 wherein a second suppression plate and associated rotatable disc are mounted in said vessel above and spaced from the suppression plate containing the grinding medium feed pipe.

5. An apparatus according to claim 1 wherein said impellers are radially extending steel rods.

\* \* \* \* \*