

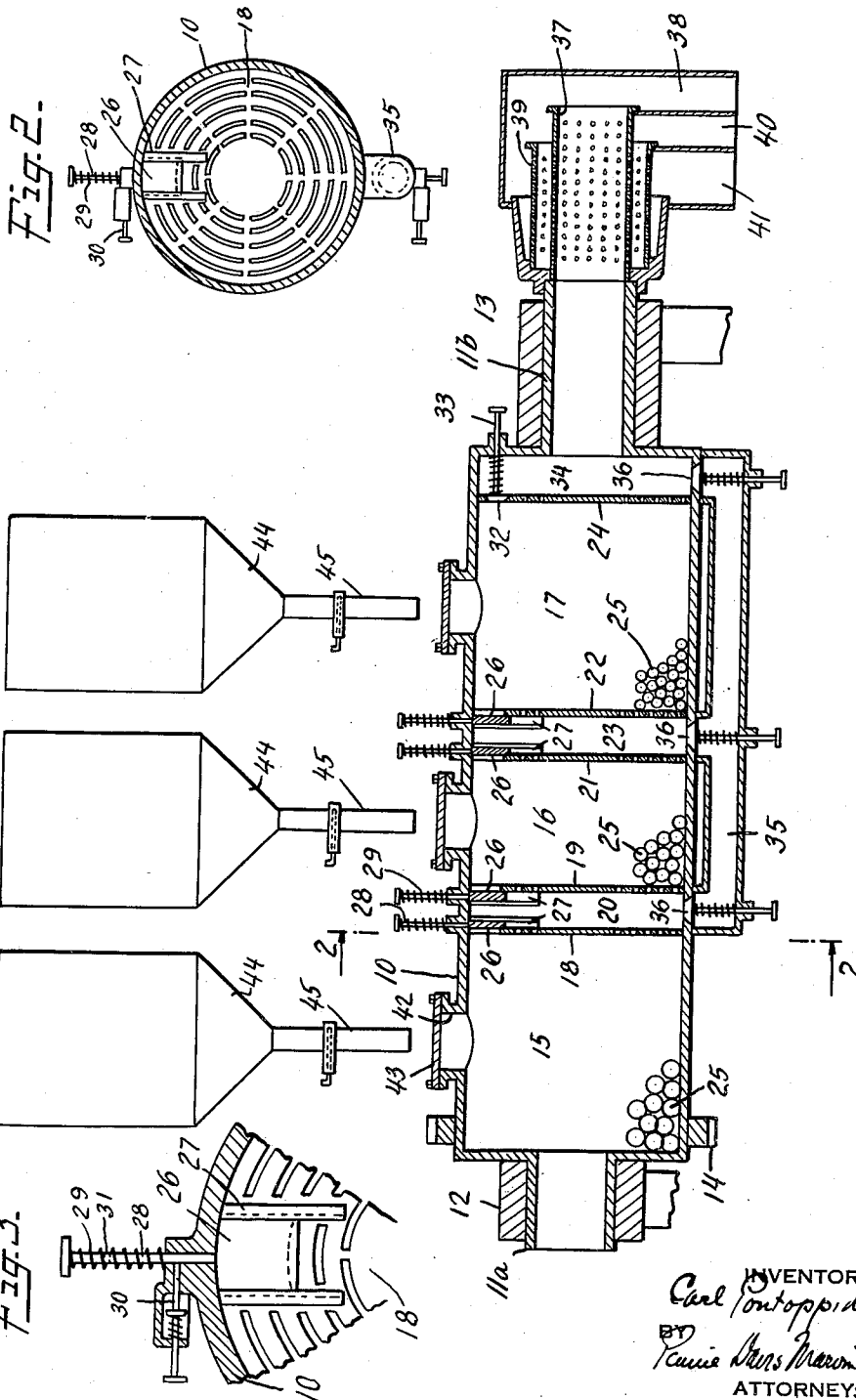
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MILL

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This invention relates to grinding mills having a plurality of grinding chambers each containing a charge of grinding bodies and is concerned more particularly with a new mill of the type referred to which is so constructed that changes in the fineness of the output may be made without difficulty and with little delay in the operation of the mill.

In multi-chamber grinding mills, the chambers are separated by partitions having perforations through which the material being ground passes from one chamber to the next, the partitions serving to retain the grinding bodies in the chambers in which they operate. Ordinarily, the first chamber, into which the material is fed, contains a charge of heavy steel balls or other grinding bodies of substantial size and the material, ground therein to granulated condition, passes to the second chamber in which the grinding bodies are of smaller size. The succeeding chamber or chambers contain grinding bodies of successively smaller size and the material in finely ground condition is discharged from the last chamber in the series. In some instances, the mills have a pair of chambers and in others there may be four, five, or more chambers in alignment.

For a given output from the mill, the proper size of the grinding chambers and the proper charge of grinding bodies in the chambers depend on the following factors: the hardness of the material to be ground, the size of the material as fed to the mill, and the desired fineness of the finished product. For a given hardness and size of material, therefore, the proper chamber sizes and grinding body charges vary with the desired fineness of the finished product and it will be understood that for a definite fineness of finished material, the material undergoing grinding in each chamber must also have a definite average fineness.

With mills of this type, it is frequently desirable to grind materials of the same kind to different finenesses at different times. Thus, in a mill employed in the cement industry, it sometimes happens that some cement is to be ground very fine in order that it will harden rapidly, while in other grinding operations, the final product need not be ground to so fine a degree. When the grinding in an ordinary mill is to be changed, it is customary to remove a portion of the charge of the grinding bodies from the first and second chambers and the practice heretofore has been to dump the charges upon the floor beneath the mill, sort out the bodies and return

to the mill as much of the charges as is required for the particular grinding operation. The removal of the charges in this way is always troublesome, and this is particularly true when the mill is externally water-cooled and the cooling water may be discharged upon the floor.

The mill of the present invention is constructed so that variations in the grinding operation may be accomplished without the difficulties above pointed out and the mill is accordingly provided with means by which all or part of the charge in one or more of the grinding chambers may be discharged at the end of the mill. For this purpose, one or more longitudinal discharge passages may be provided, these passages being connected through valve-controlled openings with the chambers so that by opening the appropriate valve or valves and rotating the mill, the charge will leave the selected chamber and be led away through the passage. The passage or passages employed may be straight and extend lengthwise of the mill or they may run helically around the mill so as to facilitate discharge as the mill rotates, but in all instances, the passages run in a general longitudinal direction. If desired, only one such passage may be provided, this passage leading from the last chamber in the series to the end of the mill, but ordinarily it will be preferable to provide a passage leading from at least one of the chambers ahead of the last chamber.

The discharge passage or passages preferably lead to the usual outlet of the mill, and a further feature of the invention involves the provision of a screening device at the outlet, which rotates with the mill and to which the charges removed from the chambers are delivered. This device may be constructed to separate the grinding bodies, small pieces of broken grinding bodies, and material that is being subjected to grinding, and after such separation, the grinding bodies may be returned to the chambers in the desired quantities without difficulty.

For a better understanding of the invention, reference may be had to the accompanying drawing in which is illustrated, in somewhat conventional and diagrammatic form, a grinding mill constructed in accordance with the principles of the invention. In the drawing,

Fig. 1 is a longitudinal section through the mill;

Fig. 2 is a sectional view on the line 2 . . . 2 of Fig. 1, and

Fig. 3 is an enlarged sectional view illustrating a detail of the construction.

Referring to the drawing, the mill proper is shown as comprising a cylindrical housing 10 provided with inlet trunnions 11a and 11b, respectively, mounted in bearings 12, 13 and the housing is rotated by means of a girth gear 14. The mill illustrated includes three grinding chambers 15, 16, and 17 and the chambers 15, 16 are separated by a pair of spaced partitions 18, 19 forming an intermediate compartment 20. Similarly, the chambers 16 and 17 are separated by spaced partitions 21, 22 leaving an intervening compartment 23, and the chamber 17 is separated from the outlet trunnion 11b by a partition 24 spaced from the inner end of the outlet. Each of the chambers 15, 16, and 17 carries a charge of grinding bodies 25, which are of successively smaller size in the successive chambers along the mill.

The partitions 18, 19, 21, 22 are provided with openings normally closed by valves 26, each valve being in the form of a plate, slidably mounted in suitable guides 27 on the partition, and provided with a stem 28 encircled by a spring 29 which normally holds the valve in closed position. Each valve may be moved inward to clear its opening by pressure on the stem and may be held in open position by a spring pressed plunger 30, the end of which is received in the opening 31 in the stem. The partition 24 is similarly provided with an opening normally closed by a valve 32 having a spring pressed stem 33, and the valve 32 may be similarly held in open position.

Leading from each of the compartments 20, 23 and from the compartment 34 between partition 24 and the outlet trunnion 11b is an opening in the wall of the mill, these openings leading to a conduit 35 extending lengthwise of the mill and being normally closed by spring-pressed valves 36, which may be secured in open position. The conduit 35 may be straight and extend axially of the mill or it may be of helical form, as desired.

At the end of the outlet trunnion 11b, may be mounted a screening device which comprises an inner cylindrical screen 37, which is of such coarse mesh that the material being ground and small pieces of broken grinding bodies will pass through it. The screen 37 discharges at its end into a passage 38 and it is enclosed by another cylindrical screen 39, which is of sufficiently fine mesh so as to permit the passage therethrough of ground material only. The open end of screen 39 leads to a passage 40, and material which passes through the screen 39 enters a passage 41.

Each of the chambers 16, 17, 18 is provided with a manhole 42 normally closed by a cover 43 and above the mill are hoppers 44 provided with discharge spouts 45 in registry with the manholes of the respective compartments.

In the normal operation of the mill, the openings through the screens and the openings leading to and from the passage 35 are closed. Each compartment contains a charge of grinding bodies of the desired size and number and as the mill rotates, material is fed through the inlet trunnion into the first chamber and then passes into the successive chambers as the size of the particles is reduced. The material is finally discharged through the outlet trunnion in a condition of fineness which depends on the factors previously referred to.

Whenever a change in the fineness of the output is required, necessitating changes in the charges of grinding bodies, all or part of the charge in any chamber may be quickly removed through the passage provided by conduit 35.

Thus, for example, if the charge of grinding bodies in the first chamber is to be altered, the valve on partition 18 is opened as are also the valves 36 leading from compartment 20 into passage 35 and from the passage into compartment 34. When the mill is thereafter rotated, the contents of chamber 15 enter the passage 35 and pass through compartment 34 and the outlet trunnion 11b to the screening device, where the ground material, the grinding bodies, and the broken pieces of the latter are separated from one another and discharged through the passages 38, 40, and 41. The ground material entering the passage 41 is ordinarily returned to the mill for further grinding, while the broken pieces of grinding bodies discharged through the passage 40 are discarded. The grinding bodies which have thus been separated out, are then delivered to the charging hopper above chamber 15, for example, by an elevator not shown, and a charge of such bodies in the required amount is introduced into chamber 15 from the hopper through the manhole. Ordinarily, the valves are so operated that one chamber only is discharged at a time so that the grinding bodies from the various chambers will not be mixed together, but, if desired, all of the valves controlling the openings through the partitions 18, 19, 21, 22 and 24 may be opened so that the charges in the first and second chambers are discharged through the third chamber.

In the construction illustrated, there are two partitions separating each chamber from the next and each partition is provided with its own valve. If desired, adjacent chambers may be separated by a single partition only, but in that case, there are no compartments free of grinding bodies between adjacent chambers. Accordingly, the faces of valves 36 will be exposed to the grinding action and these valves must be constructed so as to be capable of withstanding the exposure to such grinding.

In all embodiments of the invention, changes in the charges of grinding bodies in the chambers may be made rapidly and without difficulty, and there is no discharge of material upon the floor beneath the mill. In some instances, it may be desirable to take the charges out of the chambers to remove small pieces of broken grinding bodies, the presence of which in the chambers is disadvantageous. Also, it may be desired to remove the charges from all the chambers in order to check the charges and make up for any deficiency. The new mill facilitates the performance of all these operations and makes it possible to carry on the grinding efficiently and with little loss in output.

I claim:

1. In a mill, the combination of a rotatable housing having an inlet and an outlet and subdivided into at least three grinding chambers by pairs of spaced perforated partitions having openings of substantial size therethrough, valves for controlling said openings, charges of grinding bodies in the chambers, each pair of partitions defining a compartment between them which is free of grinding bodies during the normal operation of the mill, a perforated partition adjacent to the outlet defining one end of the third chamber and spaced from the outlet to provide an outlet compartment, said partition having an opening of substantial size therethrough, a conduit mounted on the outside of the housing and extending lengthwise thereof, said conduit being in communication with the compartments through

openings in the housing wall, and valves for controlling said openings.

2. In a mill, the combination of a rotatable housing having an inlet and an outlet and subdivided into at least three grinding chambers by pairs of spaced perforated partitions having openings of substantial size therethrough, valves for controlling said openings, charges of grinding bodies in the chambers, each pair of partitions defining a compartment between them which is free of grinding bodies during the normal operation of the mill, a perforated partition adjacent

to the outlet defining one end of the third chamber and spaced from the outlet to provide an outlet compartment, said partition having an opening of substantial size therethrough, a conduit mounted on the outside of the housing and extending lengthwise thereof, said conduit being in communication with the compartments through openings in the housing wall, valves for controlling said openings, and a screening device mounted in alignment with the outlet and rotating with the housing.

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