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H. DECKER ETAL
GRINDING MILL OF THE SWINGING TYPE WITH
A PLURALITY OF GRINDER DRUMS

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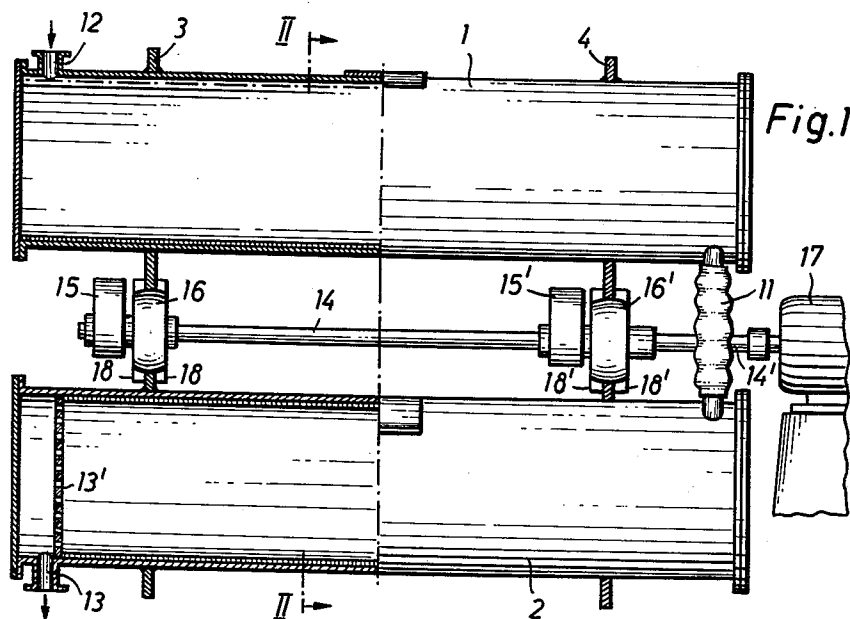


Fig. 1

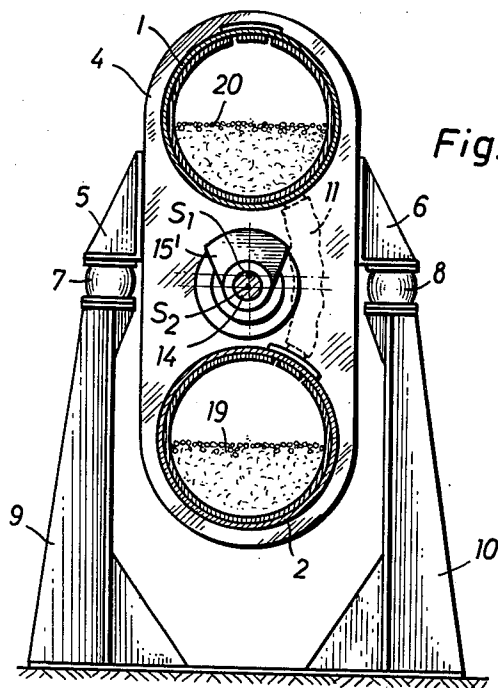
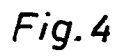
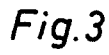


Fig. 2

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GRINDING MILL OF THE SWINGING TYPE WITH A PLURALITY OF GRINDER DRUMS

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Our invention relates to grinders of the swinging type with two or more horizontal drums for receiving the material to be ground between balls, rods or other hard bodies during swinging motion of the drums.

There are known mills of this type in which the elastically supported, swinging system is connected with a drive designed as a rotary unbalance mechanism whose drive shaft is coupled with the swing system substantially on the gravity axis of the system relative to standard conditions of the latter when idle. The axis of the drive shaft, however, does not correspond to the actual gravity-center line during operation of the mill because the weight of the drum loads, comprising the grinding bodies and the material to be ground, displace the gravity axis from the geometric center axis in the downward direction; and since during operation the drum loads assume an inclined position in the drums, the actual gravity axis is additionally displaced in a lateral direction. As a result, the machine does not swing in accurately circular motion but on an elliptical path.

It has been found that in elliptically swinging mills the grinding bodies have a rubbing action against each other in some regions of the mill drums. Such rubbing is undesirable because it causes increased wear and inferior grinding work on many substances to be processed.

It is therefore an object of our invention to secure a milling operation with an optimum of beating reduction and a minimum of frictional reduction of the material as obtainable by a circular swinging motion.

Another, more specific object of the invention is to improve the known swinging-type grinding mills toward causing the grinder drums to swing on circular paths or to have their motion substantially approach an accurate circle, with the aid of a machine design of utmost simplicity.

To this end, and in accordance with a feature of our invention, a swinging-type mill with a plurality of substantially horizontal grinder drums has its drive shaft so arranged that the shaft axis is substantially coincident with the operational gravity axis of the swinging drum assembly in loaded and swinging condition, thus producing an approximately circular swinging motion during active grinding performance. Such coincidence of driving axis and operational gravity axis of the mill is obtained by coupling the drive shaft with the drum assembly in radially and downwardly spaced relation to the geometric center axis and/or by mounting additional weights on the swinging system at a proper location.

The swinging system is preferably supported on spring members which are arranged laterally at the height of the driving shaft and in symmetrical relation thereto.

The above-mentioned and further objects and features of our invention, said features being set forth with particularity in the claims annexed hereto, will be described in, and will be apparent from, the following in conjunction with the embodiments of grinding mills according to the invention illustrated by way of example on the accompanying drawings in which:

FIG. 1 is a lateral view, partly in section, of a mill with two horizontal grinder tubes or drums.

FIG. 2 is a section along the line II-II in FIG. 1.

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FIG. 3 shows one phase of the operation of the grinding mill according to the invention by a partly sectional view corresponding to that of FIG. 2; and

FIG. 4 is a similar view of still another embodiment.

The grinding mill according to FIGS. 1 and 2 comprises two cylindrical grinder drums 1 and 2 mounted one above the other symmetrically to a vertical center line S1 and rigidly held in two bridge members 3 and 4 which are horizontally spaced from each other. Each bridge member has two lateral supports 5 and 6 seated on respective spring members 7 and 8 preferably designed as rubber springs. The springs 7 and 8 are in turn supported on rigid standards 9 and 10 secured to the foundation of the plant. In this manner the rigid assembly that comprises the two grinder drums is capable of swinging motion in transversal planes parallel to the plane of illustration with respect to FIG. 2.

A feeder nipple 12 is located on top of the upper drum 1 at one end thereof for supplying the material to be ground. The lower drum 2 is provided with an outlet nipple 13 for discharging the ground material. A hose 11, preferably designed of the corrugated type, serves for passing the material from the upper to the lower drum. Located between the two drums is an unbalance drive which comprises a horizontal shaft 14 and unbalance weights 15 and 15'. The drive shaft 14 runs in roller or ball bearings accommodated in housings 16 and 16' which are secured to the respective bridge members 3 and 4 by ring structures 18 and 18'. The shaft 14 of the unbalance drive is driven from a stationarily mounted motor 17 through a universal linkage or Cardanic shaft 14'.

During operation, the material to be ground, for example quartz, is continuously supplied through nipple 12 into the upper drum 1. The material then passes longitudinally through the drum 1 and thereafter through the drum 2 while being subjected to the beating action of the grinding bodies. In this manner the material is pre-ground in the upper drum and finished in the lower drum from which it passes through a screen 13' to the outlet nipple 13.

FIG. 2 shows the loads 19 and 20 in respective drums 1 and 2 at rest. These loads comprise the grinding bodies such as balls, and the material to be ground. When at rest, the level of the load is substantially horizontal as illustrated. Under the weight of the drum loading, the gravity axis of the loaded system, in comparison with the unloaded system, becomes displaced from the geometric center line S1 to the location denoted by S2 in FIG. 2. In the machine according to the invention, the drive shaft 14 of the unbalance drive is so journaled in the grinder-drum assembly that it coincides with the displaced gravity axis S2 of the loaded system but not with the geometric or gravity axis S2 of the unloaded system. As a result, the oscillating motion of the grinder drums closely approaches a circular path.

FIG. 3 shows the loads 21 and 22 in grinder drums 1 and 2 in positions which they may occupy during grinding operation. Due to the fact that the surface of the load in each drum is not horizontal but assumes an inclined position whose direction of inclination depends upon the sense of rotation of the drive, the actual gravity axis of the loaded and operating system becomes displaced from the geometric center line S1 to the downward and lateral location indicated at S3. In the machine according to the invention therefore, it is preferable to journal the unbalance drive shaft 14 relative to the bridge members 3 and 4 of the swinging system so that the axis of shaft 14 is coincident with the operational gravity axis S3 of the loaded and swinging system. As a result an accurately circular swinging motion of the grinder drums is obtained.

FIG. 4 also shows the unilateral inclined position of the grinder-drum loads during operation. By means of correspondingly dimensioned additional weights 23 and 24 fastened to the grinder drums 1 and 2 respectively, the gravity axes of the drums 1 and 2 are made coincident with the respective drum axes during grinding operation. As a result, the gravity axis of the swinging system as a whole, which without the additional weights would be located at S3, becomes displaced from S3 to the geometric center line S1 and thus remains coincident with the axis of the unbalance drive shaft 14.

In lieu of the two additional weights 23 and 24, a single additional weight 25 of corresponding dimension can be fastened between bridge members 3 and 4 so that in this case, too, the gravity axis of the loaded and swinging system coincides with the geometric center line S1 to secure an accurately circular swinging path of the grinder drums. Such a single weight is shown in FIG. 4 at 25. It will be understood that weights may also be attached at all three locations 23, 24, 25.

As is apparent from FIGS. 2 to 4, the rubber springs 7 and 8 are mounted laterally of the two drums at the height of the unbalance shaft 14 and in symmetrical relation to the shaft. This provides for a very stable mounting of the swinging system and also contributes to securing great accuracy of the swinging motion performed by the two grinder drums.

As a result, the present invention affords in a particularly simple and reliable manner a virtually circular swinging motion of the grinder drums, thus considerably reducing the wear of the grinding bodies and greatly improving the beating reduction of the material to be ground.

We claim:

1. A grinding mill of the swinging type having a plurality of horizontal grinder drums, each containing when active a load of grinder bodies and material to be ground, an inherently rigid and resiliently supported assembly comprising said drums and capable of swinging motion in planes transverse to said drums, and a rotary oscillator drive having a drive shaft journaled on said assembly for imparting said motion thereto, said assembly having in loaded and operating drum condition a gravity axis substantially coincident with said drive axis and having a substantially circular swinging motion.

2. A grinding mill of the swinging type having a plurality of horizontal grinder drums, each containing when active a load of grinder bodies and material to be ground, an inherently rigid and resiliently supported assembly comprising said drums and capable of swinging motion in planes transverse to said drums, and a rotary oscillator drive having a drive shaft journaled on said assembly for imparting said motion thereto, said assembly having a geometric center axis radially spaced from the rotational drive axis and having in loaded condition of said drums a gravity axis substantially coinci-

dent with said drive axis to perform a substantially circular swinging motion.

3. A grinding mill of the swinging type having a plurality of horizontal grinder drums, each containing when active a load of grinder bodies and material to be ground, an inherently rigid and resiliently supported assembly comprising said drums and capable of swinging motion in planes transverse to said drums, and a rotary oscillator drive having a drive shaft journaled on said assembly for imparting said motion thereto, said assembly having additional weight means whose gravity center is eccentric to the drive axis, said weight means being rated and oriented to place the gravity axis of said assembly substantially in coincidence with said drive axis when said drums are loaded, and said assembly having, due to said weight means, a substantially circular path of swinging motion.

4. A grinding mill of the swinging type having a plurality of horizontal grinder drums, each containing when active a load of grinder bodies and material to be ground, an inherently rigid and resiliently supported assembly comprising said drums and capable of swinging motion in planes transverse to said drums, a rotary unbalance drive having a drive shaft journaled on said assembly at a location downwardly and laterally spaced from the geometric center axis of said assembly and substantially coincident with the gravity axis of said assembly when said drums are loaded and in swinging motion.

5. A grinding mill of the swinging type having a plurality of horizontal grinder drums, each containing when active a load of grinder bodies and material to be ground, an inherently rigid and resiliently supported assembly comprising said drums and capable of swinging motion in planes transverse to said drums, a rotary unbalance drive having a drive shaft revolvably mounted on said assembly and substantially coincident with the horizontal geometric center axis of said assembly, said assembly having weight means whose gravity center is eccentric to said geometric center axis, said weight means being rated and oriented to place the gravity axis of said assembly substantially in coincidence with said center axis in the position occupied during milling operation by the load in said drums.

6. A grinding mill according to claim 1, comprising two spring means on which said assembly is resiliently supported, said spring means being mounted on transverse sides respectively of said shaft at the height of said shaft and symmetrically thereto.

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