March 21, 1967 H. DECKER ETAL 3,310,245

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

Filed July 7, 1964 2 Sheets-Sheet 1

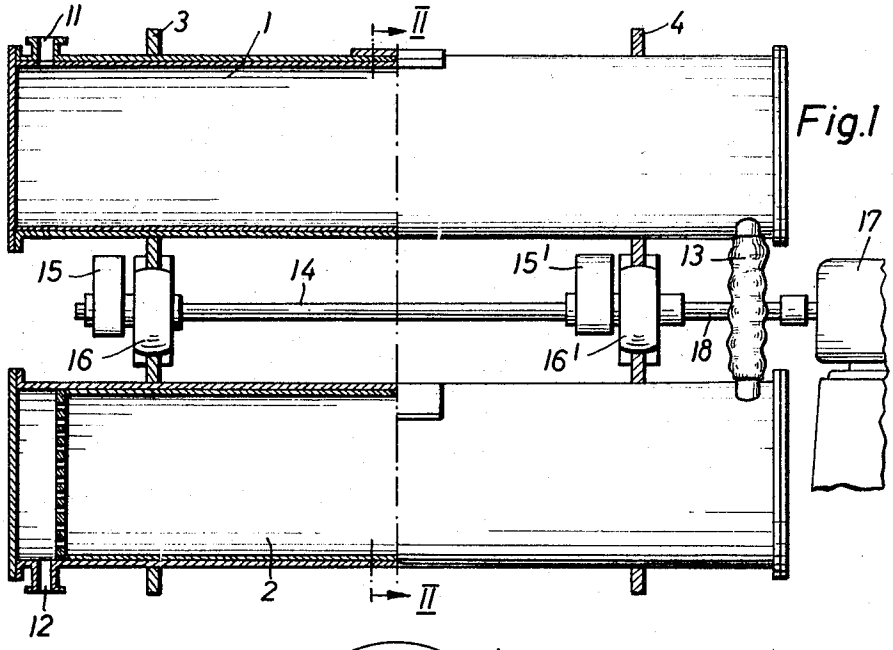


Fig.1

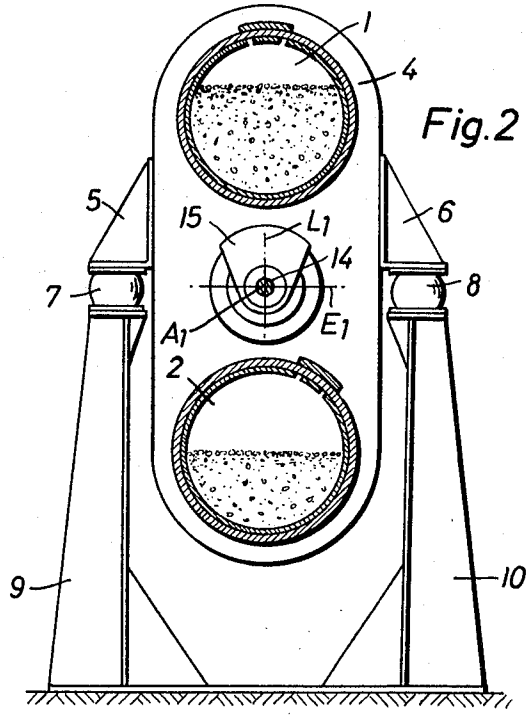


Fig.2

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

Filed July 7, 1964 2 Sheets-Sheet 2

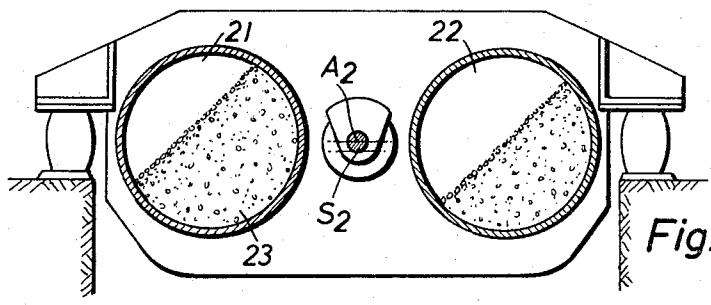


Fig.3

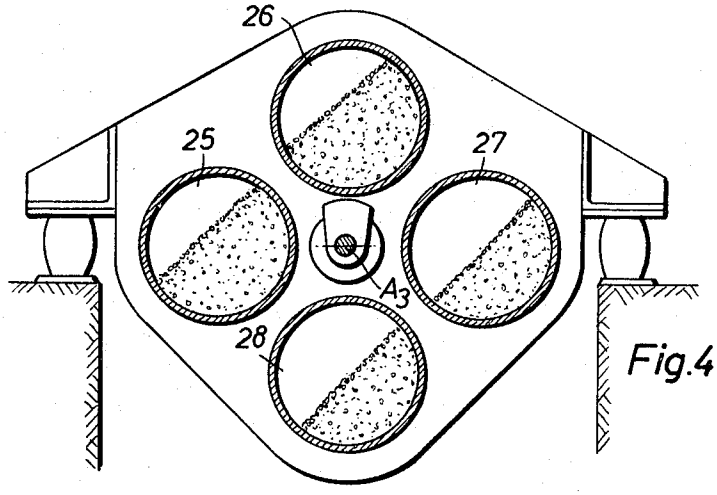


Fig.4

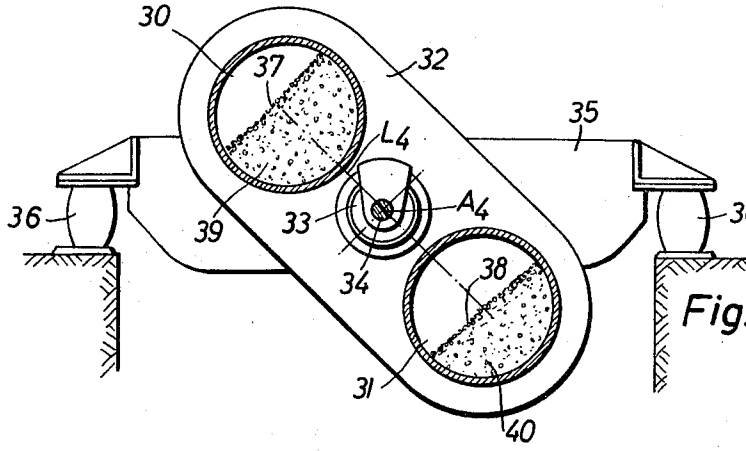


Fig.5

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3,310,245

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

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7 Claims. (Cl. 241—153)

Our invention relates to grinding mills of the swinging type with two or more horizontal drums for receiving the material to be ground between balls, rods, or other hard grinder bodies as they are being agitated by swinging motion of the drums. In a more particular aspect, our invention relates to a grinder of the type mentioned in which the gravity axis of the swinging assembly is approximately coincident with the driving axis so that the swinging motion is substantially circular, such mills being described in U.S. Patent 3,082,965.

In known grinders of the swinging type with two or more drums, the unbalancing effect of the grinder bodies contained in the drums causes the gravity axis to considerably depart from the geometrical center axis, usually the driving axis, of the mill. As a result, the swinging motion of such machines is not circular but elliptical. According to the above-mentioned patent, additional weights are mounted on the swinging system in such positions that the gravity axis of the swinging assembly is largely identical with the driving axis thus securing a substantially circular swinging motion.

It is an object of the present invention to provide a greatly simplified way of having the gravity axis in such mills substantially coincident with the driving axis. Another object is to afford obtaining this improvement also in already existing mills of the swinging type without requiring excessive changes in construction.

For achieving these objects, our invention utilizes the concept of the above-mentioned patent, namely to shift the gravity axis by means of counterpoises, but it is based upon the recognition that such a shift is more readily obtainable by providing the grinder drums with respective contents of grinder bodies having respectively different weights.

According to a feature of our invention, therefore, the drums on one side of the drive-shaft axis are given a content of grinder bodies whose weight is larger than that of the corresponding content in the drums on the diametrically opposite side, the difference in weight being such that the swinging assembly has a gravity axis in a plane which passes substantially through the drive-shaft axis and is perpendicular to the geometric connecting line between the mutually opposite drums.

According to more specific features of our invention, those grinder drums that are located above the drive axis and/or the drums located at the left of the drive axis with reference to clockwise swinging motion, or that are located at the right with reference to counterclockwise swinging motion, are provided with a heavier filling of grinder bodies than the drums on the opposite side of the drive axis. The difference in weight is in accordance with the above-mentioned requirement that the gravity line of the system extend substantially in a plane which passes through the drive axis and is perpendicular to the geometric connecting line between mutually opposite grinder drums.

The required difference in weight or mass can be secured simply by increasing the number of grinder bodies in the proper drums. In principle, however, the grinder bodies used in the more highly weighted drums may also have higher weight individually. The latter expedient, however, is inconvenient in most cases because generally the weight of the grinder bodies is preferably adapted to the constitution of the material to be ground and to the desired product resulting from the grinding operation.

During operation of a swinging-type mill, the grinder bodies in the interior of the drums form a sloping surface level. Consequently, the gravity line of such a system, if no compensation is provided for, is sloped below the geometric center line which coincides with the driving axis. If only two grinder drums are provided and are arranged vertically above and below the driving axis or horizontally on both sides of the axis, then a corresponding selection as to difference in weight of the respective contents of grinder bodies in the drums permits displacing the gravity axis in only one direction, so that some residual departure in the gravity axis from the driving axis will be encountered. However, it has been found in practice that the approximation of the gravity axis to the drive axis obtainable in this manner is very often sufficient for considerably improving the operation of the mill.

If the mill has more than two grinder drums distributed about the drive axis, a virtually complete coincidence of gravity line and drive axis is obtainable. For example, if four grinder drums are located horizontally beside and vertically above and below the drive axis, and the drum located above the drive axis, and one of the two drums located at the right or left, depending upon the direction of swinging motion, are provided with a heavier filling of grinder bodies, the gravity axis can be made completely coincident with the drive axis.

However, the same effect can be obtained with a swinging-type mill having only two grinder drums, namely by arranging the two drums in a mutual position in which their connecting line with the horizontal defines an angle, in such a manner that the connecting line is approximately perpendicular to the slope of the mass of grinder bodies obtaining in the drums during operation of the mill. If in such a mill, the mass of the filling in the upper drum is increased relative to the content of the lower drum, the gravity line can be accurately displaced onto the drive axis. To permit an accurate adjustability, the grinder drums are preferably mounted in a frame which is pivotally displaceable and arrestable with respect to the drive axis. This permits accurately selecting and fixing the direction of gravity line displacement.

Embodiments of grinding mills according to the invention are 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 mounted vertically above one another.

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

FIG. 3 shows schematically a vertical section through a mill equipped with two grinding drums horizontally beside each other.

FIG. 4 is a schematic cross-sectional view of a grinding mill with four drums; and

FIG. 5 is a schematic, vertical section of still another embodiment of a two-drum grinding mill.

The grinding mill according to FIGS. 1 and 2 comprises two cylindrical grinder drums **1** and **2** mounted vertically above one another 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 supported on rigid standards **9** and **10** secured to the foundation of the plant. The rigid assembly com-

prising 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 inlet 11 is located on top of the upper drum 1 at one end thereof for supplying the material to be ground. The lower drum 2 has an outlet 12 for discharging the ground material. A corrugated hose 13 passes 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 shaft axis A_1 of the drive coincides with the geometric center line relative to which the two drums 1 and 2 are symmetrical. The drive shaft 14 runs in roller or ball bearings 16 and 16' secured to the respective bridge members 3 and 4. The shaft 14 is driven from a stationarily mounted motor 17 through a universal linkage.

As shown in FIG. 2, the grinder drums are partially filled with grinding bodies. If the masses of the respective drum contents were equal in the two drums, the gravity axis of the system would be displaced downwardly and would not coincide with the drive or swing axis A_1. The system, therefore, would not perform a circular swinging motion about the axis A_1 but an elliptical motion which interferes with the desired uniformity of the grinding performance. However, as shown in FIG. 2, the upper drum 1 is provided with a larger amount of grinder bodies than the lower drum 2. By virtue of the larger mass thus incorporated in the portion of the swinging system above the drive axis, the gravity center is shifted upwardly. By suitably dimensioning the difference in weight, the gravity axis can be made substantially coincident with the drive axis A_1.

During operation, the filling of grinder bodies in each drum assumes a sloping level toward one side depending upon the swinging direction of the system. This displaces the gravity axis of the system toward the same side, although the gravity axis remains substantially at the height of the plane schematically indicated at E_1 in FIG. 2, which is perpendicular to the connecting line L_1 between the axes of the two grinder drums 1, 2 and which passes through the drive axis A_1. Consequently, while the gravity axis and the drive axis substantially coincide in the condition of rest, some amount of spacing between the two axes occurs during operation. It has been found that this spacing, as a rule, is so slight as to be negligible or not appreciable in practice.

During operation, the material to be ground, for example quartz, is continuously supplied through inlet 11 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 to the outlet 12.

Instead of providing the grinder drum 1 with a larger amount of grinder bodies, the bodies in this drum may also have larger weight individually than those in drum 2. Generally, however, an increase in the number of grinder bodies is preferable because it is advisable to adapt the weight of these bodies to the properties of the material being ground and to the desired result of the grinding operation.

The embodiments of mills according to the invention shown in FIGS. 3 to 5 are illustrated in operating condition. FIG. 3 shows a mill with two drums symmetrically located on opposite sides of the drive or swing axis A_2. In operation, the system swings counterclockwise. The contents 23, 24 of grinder bodies in each drum thus forms a sloping level extending from the upper right downwardly to the left. This has the result of displacing the gravity axis to the right. Such displacement is compensated by providing the left drum according to FIG. 3 with a larger quantity of grinding bodies than the right drum 22. In this embodiment, too, the drive axis A_2 coincides with the geometrical center line, and some spacing occurs between the gravity axis S_2 and the drive axis A_2 because, under operating conditions, the gravity axis is slightly below the drive axis.

Complete coincidence between the drive axis and center axis, however, is readily obtainable in swing-type mills according to the invention that are equipped with more than two grinder drums. This is exemplified by the embodiment shown in FIG. 4 in which two drums 25, 27 are horizontally arranged on diametrically opposite sides of the drive or swing axis A_3, and the two drums 26, 28 are located above and below respectively the same axis. The mill also swings counterclockwise. The left drum 25 and the upper drum 26 contain larger amounts of grinder bodies than the other drums, so that the horizontal and the vertical displacement of the gravity axis are compensated. As a result, the gravity axis remains coincident with the drive axis during operation of the mill.

The embodiment according to FIG. 5 exemplifies a case in which full coincidence of gravity axis and drive axis during operation of the mill is obtained, although the mill has only two grinder drums. To achieve this, the mill is especially designed. That is, the two grinder drums 30 and 31 are mounted in bridge members 32 which, in turn, are rotationally adjustable about the drive or swing axis A_4. The bridge members 32 are seated on a tubular structure 33 traversed by the drive shaft 34, and can be secured in a fixed selected position on the tubular structure. The tubular structure is rigidly secured to transverse carriers 35 which are supported on the machine foundation by spring members 36. The bridge members 32 are turned to such a position that the geometric connecting line L_4 between the two metal drums 30 and 31 is substantially perpendicular to the sloping levels 37 and 38 formed by the masses of grinder bodies 39 and 40 in the respective drums 30 and 31. By suitably selecting the amount of grinder bodies in the upper drum 30, as explained in the foregoing, and also adjusting the angular position of the bridge members 32, the gravity axis can be displaced to remain coincident with the drive axis A_4 during operation of the mill.

We claim:

1. A grinding mill of the swinging type comprising a plurality of horizontal grinder drums, a resiliently supported assembly comprising said drums and capable of substantially circular swinging motion about a swing axis in planes transverse to said drums, said drums being located on opposite sides of said swing axis, the drums on one side of said axis having a content of grinder bodies whose weight is larger than that of the content of the oppositely located drums, and said assembly having due to the difference in weight a gravity axis in a plane which passes substantially through said swing axis and is perpendicular to the geometric connecting line between said opposite drums.

2. A grinding mill of the swinging type, comprising two horizontal grinder drums, a resiliently supported assembly comprising said drums, and capable of substantially circular swinging motion about a swing axis in planes transverse to said drums, said drums being located above and below respectively of said swing axis with the drum axes parallel to said swing axis, said drum above said swing axis having a content of grinder bodies whose weight is larger than that of the content of the lower drum, and said assembly having due to the difference in weight a gravity axis in a plane which passes substantially through said swing axis and is perpendicular to the geometric connecting line between the respective drum axes.

3. A grinding mill of the swinging type comprising a plurality of horizontal grinder drums, a resiliently supported assembly comprising said drums and capable of substantially circular swinging motion about a swing axis in planes transverse to said drums, one of said drums located at the left of said swing axis—when viewing said assembly from the side showing counterclockwise swinging motion—having a content of grinder bodies whose

weight is larger than that of the content of another of said drums at the right of said swing axis, and said assembly having due to the difference in weight a gravity axis in a plane which passes substantially through said swing axis and is perpendicular to the geometric connecting line between one and said other drum axes.

4. A grinding mill of the swinging type comprising a plurality of horizontal grinder drums, a resiliently supported assembly comprising said drums and capable of substantially circular swinging motion in planes transverse to said drums, an oscillator drive having a horizontal drive shaft journalled on said assembly for imparting said motion thereto, said respective drums being located above and below and on both sides of said shaft in diametrically opposite pairs, the respective drums located above said shaft and located at the left of said shaft—when viewed from the side showing counterclockwise swinging motion—having a content of grinder bodies whose weight is larger than that of the content of the other drums.

5. A grinding mill of the swinging type, comprising four horizontal grinder drums, a resiliently supported assembly comprising said drums and capable of substantially circular swinging motion in planes transverse to said drums, an oscillator drive having a horizontal drive shaft journalled on said assembly for imparting said motion thereto, said four drums being located vertically above and below said shaft and laterally at the right and left thereof respectively in two diametrically opposite pairs, the upper drum and the one lateral drum which

is at the left of said shaft—when viewing the assembly from the side at which the swinging motion is counterclockwise—each having a content of grinder bodies whose weight is larger than that of the content of the other drums, and said assembly having due to said difference in weight a gravity axis substantially coincident with the drive shaft axis during operation of the mill.

6. A grinding mill according to claim 1, having a total of two grinder drums whose diametrical connecting line forms an acute angle with the horizontal and is perpendicular to the slope of said drum contents during operation of the mill.

7. In a grinding mill according to claim 6, said resiliently supported assembly comprising a frame structure to which said drums are secured, said frame structure being angularly adjustable about said swing axis.

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