United States Patent

Tobe

[15] 3,645,458

[45] Feb. 29, 1972

[54] VIBRATING GRINDING MILL

[72] Inventor: **Hideharu Tobe,** 903-17, 1-banchi, 4 chome, Shimomeguro, Meguroku, Tokyoto, Japan

[22] Filed: **Jan. 29, 1970**

[21] Appl. No.: **6,842**

[30] **Foreign Application Priority Data**

Feb. 7, 1969 Japan.....44/8705
Feb. 27, 1969 Japan.....44/16844

[52] **U.S. Cl.**.....**241/175,** 259/56
[51] **Int. Cl.**.....**B02c 17/14**
[58] **Field of Search**.....241/137, 153, 175, 184, 199, 241/284, 291; 51/164.5; 259/DIG. 42, 56, 75, 91

[56] **References Cited**

UNITED STATES PATENTS

3,346,200 10/1967 Lesin et al.....241/175 X
2,286,599 6/1942 Chott.....241/175

FOREIGN PATENTS OR APPLICATIONS

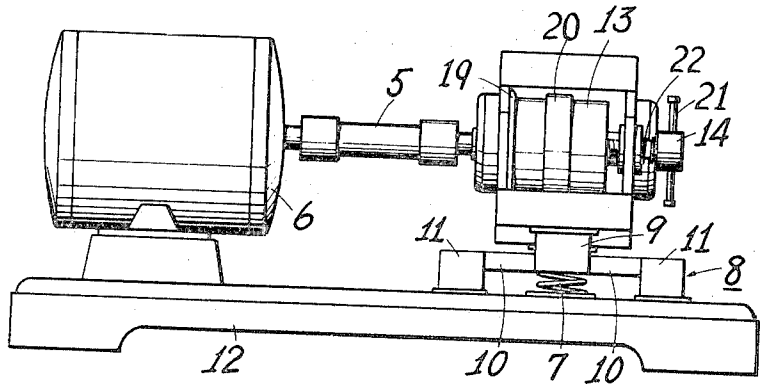
132,985 10/1919 Great Britain.....241/184

Primary Examiner—Robert L. Spruill
Attorney—Arnold Robinson

[57] **ABSTRACT**

A miniature grinding device for grinding small samples which comprises an electrically driven vibratory structure including an eccentrically weighted shaft, a frame supported on said shaft, one or more cylindrical grinding chambers secured to said frame and an axially aligned free-moving grooved rod or roller in each chamber, each said rod having a size slightly less than the inside volume of each chamber.

3 Claims, 8 Drawing Figures



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2 Sheets-Sheet 1

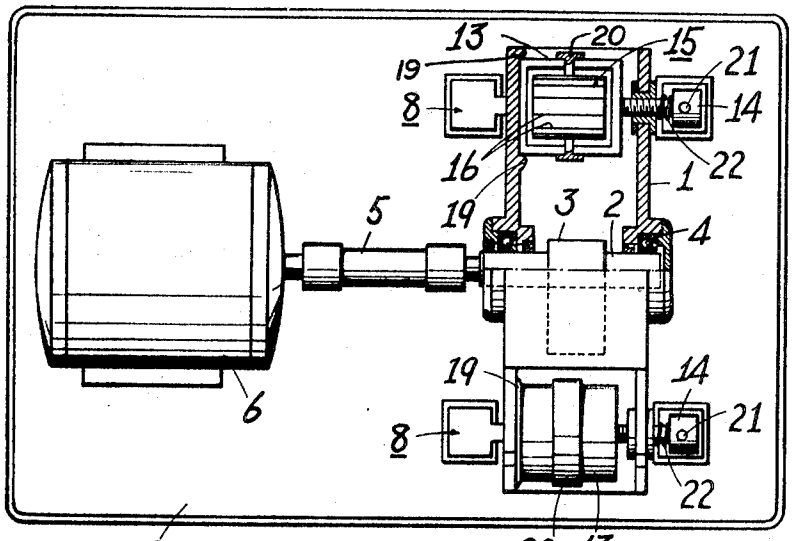


Fig. 1

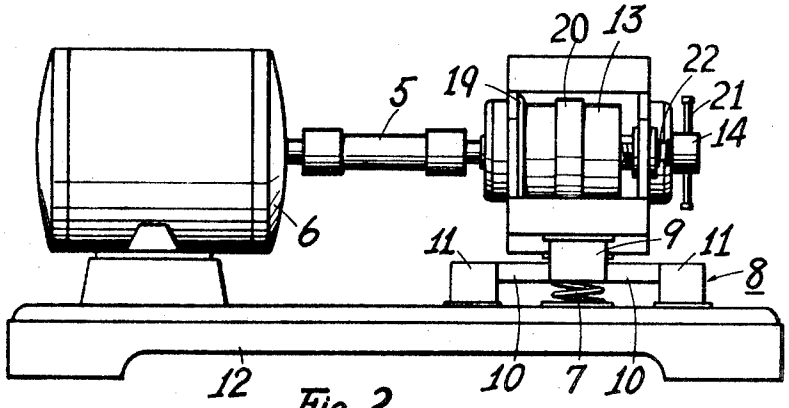


Fig. 2

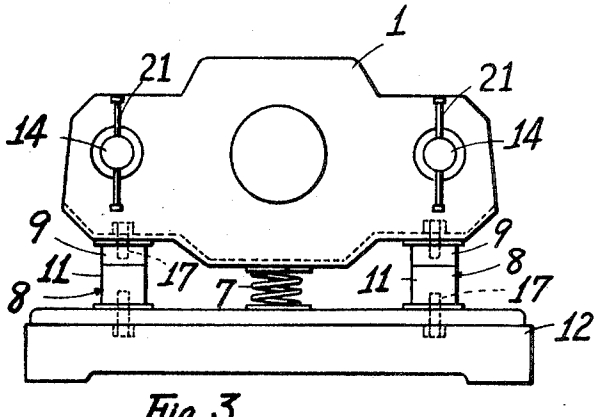


Fig. 3

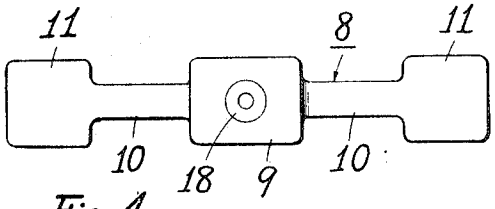


Fig. 4

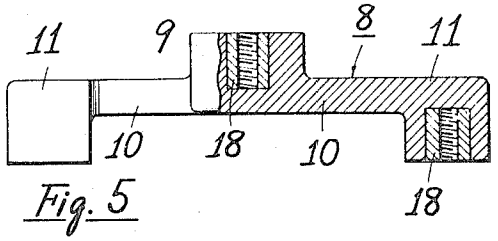


Fig. 5

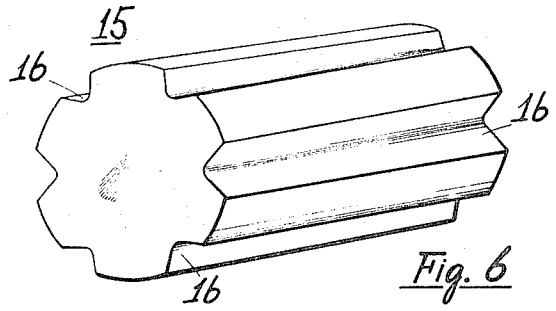


Fig. 6

Rod Shape	Rod Dia. (mm)	Grinding Condition	Amount of Material (g)	Grain Distribution (%) 250 or more (μ)	250 to 149 (μ)	149 to 105 (μ)	Total Value / 3 (times) 105 to 74 (μ)	74 to 62 (μ)	62 to 44 (μ)	44 or less (μ)
grooved	45	Rotation: 1430rpm Amplitude: 8.8mm Hours: 2 min.	12.3	0.8	18.6	12.0	15.7	10.2	17.2	25.5
grooved	40		16.5	0.1	4.3	14.7	35.5	21.2	9.5	14.7
grooved	35		17.8	0.1	17.9	18.9	34.9	11.0	8.6	8.6
non	45		15.8	17.3	27.6	11.9	11.1	6.4	10.8	14.9
non	40		15.9	4.3	21.9	11.5	20.5	17.0	12.6	12.5
non	35		16.9	3.0	22.6	12.5	20.2	16.9	12.4	12.4
grooved	45	Rotation: 1100rpm Amplitude: 14.8mm Hours: 2 min.	16.4	3.7	29.7	13.5	13.1	6.7	12.2	21.1
grooved	40		16.5	0.1	15.1	12.1	16.5	14.2	18.8	23.2
grooved	35		16.7	0	6.4	11.9	25.4	22.6	15.9	17.8
non	45		11.1	33.6	27.7	9.1	9.5	3.2	5.8	11.1
non	40		11.9	12.3	30.2	11.8	12.8	7.0	10.5	15.4
non	35		16.7	6.4	25.0	11.4	14.6	14.4	13.4	14.8
Grain Distribution of Material Supplied				78.2	11.2	3.4	3.6	0.9		2.7

Fig. 7

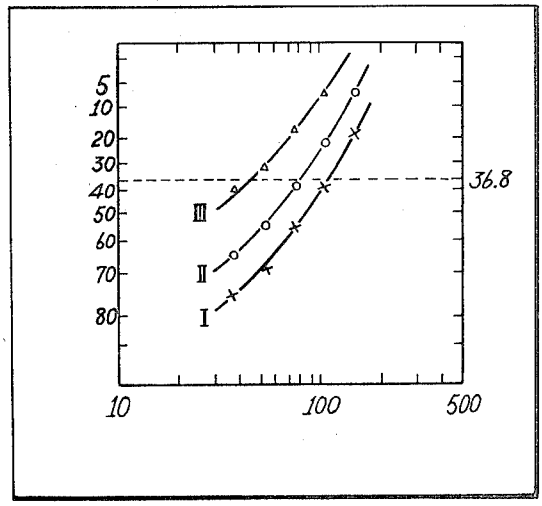


Fig. 8

VIBRATING GRINDING MILL

This invention relates to miniature apparatus for grinding relatively small amounts or samples of material into finely divided powder, and more particularly to such apparatus for use on a desk, in a chemical laboratory, a hospital, a school classroom, et cetera.

A desk grinding mill of compact size is widely used, but the mechanism is limited because of its small size, resulting in difficulties in producing finely divided powder.

The present invention has solved the problems and disadvantages of the known device, and has for its object to provide a grinding apparatus for producing the finest powder of a sample material effectively, regardless of its limited mechanism.

According to the present invention, there is provided a grinding apparatus for producing a finely divided powder from a sample material, comprising a vibratory structure arranged to oscillate over a uniform cycle, one or more cylindrical chambers in which the material is loaded for grinding, mounted in the vibratory structure, and a grooved grinding rod or roller axially located in each chamber and of a size slightly less than the internal volume of each said chamber.

The invention will now be more particularly described by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a plan view of an apparatus in accordance with the invention, parts being broken away to reveal the internal construction.

FIG. 2 is a front elevation of the apparatus illustrated in FIG. 1.

FIG. 3 is an end elevation of the apparatus illustrated in FIG. 2.

FIG. 4 is a plan view of a support for the apparatus constructed in one piece.

FIG. 5 is a front view of the support illustrated in FIG. 4, parts being broken away.

FIG. 6 is a schematic view of an example of a grooved grinding rod constructed in accordance with the invention.

FIG. 7 is a Table of data, showing the differences in achievement between the apparatus in accordance with the invention and prior art apparatus.

FIG. 8 is a Rosin-Rammler Grain Distribution Diagram.

A vibratory frame 1 is supported on a base 12 by means of a coiled spring 7 of relatively weak strength (FIG. 3). The entire weight of the frame 1 concentratedly rests upon the coiled spring 7, and the frame 1 is further provided with a pair of supports 8 of elastic material, such as rubber, which supports are placed transversely at each extreme side of the frame 1. Each support 8 advantageously comprises a central rigid portion 9, (FIGS. 4 and 5), a resilient beam 10 of square section horizontally extending in both directions from the central portion 9, and a pair of stands 11 accepting the resilient beam 10, the support per se being constructed in one piece. The rigid portion 9 is securely fixed on the undersurface of the frame 1, and the stands 11 are attached to the base 12, by means of fastening screws 17 through bushings 18.

Transversely of the vibratory frame 1, a shaft 2 is rotatably supported in bearings 4, which is driven by an electric motor 6 through a flexible coupling 5, and which is provided with an eccentric weight 3, causing centrifugal motion when the shaft 2 is driven.

A cylindrical chamber 13 in which the material to be ground is placed, is detachably mounted in the vibratory frame 1 in parallel with the shaft 2, the number of which chamber is determined as appropriate. In the example illustrated, two chambers are provided, each being placed in parallel with the rotatory shaft 2. Each chamber 13 is supported with its bottom end held insertedly in a ring-shaped projection 19 formed on the inside wall of the frame 1, and the other end held by a fixing screw 14 arranged progressively in relation to the chamber 13.

Preferably, the cylindrical chamber may be separable into two parts, coupled by means of a joint 20 of elastic material having a T-shaped cross section. The fixing screw 14 is prevented from undesired relaxation by means of a coiled spring 22, and a handle 21 is provided so as to secure and release the cylindrical chamber 13.

Located in each chamber 13 is a grooved rod or roller 15, the groove 16 being axially engraved on the surface of the rod, as illustrated in FIG. 6. The grooved rod 15 is located in the chamber 13 in coexistence with the material to be ground into powder. Modifications to the grooved rod specifically described and illustrated can be of course made without departing from the invention. For example, other forms of groove, such as a helix, could be engraved. In the example illustrated the rod 15 has six straight line grooves 16 which are parallel with each other. Regardless of the form of grooves, the rod or roller per se is required to be situated in parallel with the shaft 2.

The operation of the invention is as follows.

The motor 6 is energized to rotate the shaft 2, causing the frame 1 to fluctuate substantially at uniform cycle by dint of the centrifugal action brought about by the eccentric weight 3 on the shaft 2, whereby the material contained in the cylindrical chamber 13 is frictionally ground by impact of the grooved rod 15 against the inside wall of the chamber, the groove serving as pockets for the material.

The vibratory frame 1 concentratedly rests upon the coiled spring 7 with equilibrium, and is further provided with the supports 8 on each extreme side, particularly supported by the resilient beams 10 arranged in parallel with the rotary shaft 2, so that the resisting force of the supports 8 is substantially uniform at any selected time, in relation to the centrifuging force applied to the frame 1, thereby imparting to the frame 1 the stable vibrations of uniform cycle, and hence the material is effectively compressed and reduced to powder between the inside wall of the chamber 13 and the grooved rod 15.

The chamber 13 consisting of two separable parts will be of particular value in the case when the powder thus produced is removed from the chamber, thus eliminating the problem of product residues in the chamber 13.

The remarkable advantages of the invention are seen from the contrasted data shown in FIGS. 7 and 8. The data shown in FIG. 7 is derived from the experiment in which the grinding apparatus employs a rod having six straight line grooves as illustrated in FIG. 6, whereas the contrasted data is from the apparatus using a grooveless rod, i.e., a cylinder-shaped rod. It is evident that the apparatus according to the invention is predominant when the conditions are the same. In FIG. 8 the Rosin-Rammler Grain Distribution Diagram is shown, in which the material is quartz (SiO_2) of 10 g. respectively, the particulars of which are as follows:

Graph	Kind of Apparatus	Working Hours (min.)
I	motor-driven mortar	20
II	manual mortar	12
III	apparatus according to the invention	0.5

In the graph depicted, the Y-axis is "multiplied weight on a net," expressed in percentage, and the X-axis is "degree of grain" in terms of micron.

It follows from the graphs that the apparatus according to the invention can produce more finely divided powder in a shorter period of time than any other.

As has been described and illustrated, the apparatus according to the invention comprises a vibratory frame arranged to fluctuate over a uniform cycle, one or more cylindrical chambers in which the material is loaded for grinding, the chamber being mounted in the vibratory frame, and a grooved rod axially located in each chamber, and, as a result, it is adapted for accessible use, such as on a desk, in a chemical laboratory, a hospital, a school classroom, et cetera, particularly ensuring that it can grind a small amount of material into fine powder.

The advantages of the present invention, as well as certain changes and modifications of the disclosed embodiment thereof, will be readily apparent to those skilled in the art. It is the applicant's intention to cover all those changes and modifications which could be made to the embodiment of the invention herein chosen for the purposes of the disclosure without departing from the spirit and scope of the invention.

I claim:

1. A grinding apparatus for producing a finely divided powder of a sample material, comprising:

vibratable means operative to oscillate uniformly and including at least one cylindrical chamber for reception of the material to be ground, with a grooved rod axially disposed within said at least one cylindrical chamber;

a platform operative to support said vibratable means;

spring means disposed between said platform and said vibratable means so that the vibratable means normally rests on said spring means in a position of equilibrium;

a pair of support means spaced apart from one another,

each support means comprising a rigid portion, a resilient beam extending in both directions from said rigid portion, and a pair of rigid stands for supporting the ends of said resilient beam, each support means being disposed so that said resilient beams are parallel with a rotary shaft, between the undersurface of said vibratable means and said platform; and

said rotary shaft being a motor-driven shaft rotably supported transversely with respect to said vibratable means, with an unbalanced weight being disposed on said shaft.

2. A grinding apparatus according to claim 1 wherein said at least one cylindrical chamber is separable into two parts by a joint of elastic material having a T-shaped cross section.

3. A grinding apparatus according to claim 1 wherein said vibratable means comprises first and second cylindrical chambers, each chamber having a grooved rod axially disposed therein.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,645,458 Dated February 29, 1972

Inventor(s) Hideharu Tobe

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the Front Page below item "[72]" insert --[73]

Assignee: Kabushiki Kaisha Heikoo Seisakusho,
Tokyo, Japan --

Signed and sealed this 7th day of November 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

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