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(71) Applicant: **KOTOBUKI ENGINEERING & MANUFACTURING CO LTD**
6-2, Ohtemachi-2-Chome
Chiyoda-ku Tokyo100(JP)

(72) Inventor: **Kawaguchi, Mitsuru**
Kotobuki Eng. & Mfg. Co. Ltd. 1-2-2 Hiroshiratake
Kure-shi Hiroshima-ken 737-01(JP)

(74) Representative: **Henkel, Feiler, Hänzel & Partner**
Möhlstrasse 37
D-8000 München 80(DE)

(54) Apparatus and method of breaking pieces of solid mineral material in fragments, and method of sorting fragments of solid mineral material according to size.

(57) A centrifugal breaking apparatus is constructed so that for having an effect on the breaking function, the pieces of solid mineral material are thrown from the axle of the rotor, when rotating at an increased speed, in tangential directions, through the radial outlets of the rotor by centrifugal force to strike against the "dead bed" of fragments of solid mineral material which encircles the rotor, then fragments are reduced by vibrating the "dead bed".

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Apparatus and Method of Breaking Pieces of Solid Mineral Material in Fragments and Method of Sorting Fragments of Solid Mineral Material According to Size.

Background of the Invention

Field of the Invention

The present invention relates to apparatus and method of breaking pieces of solid mineral material by feeding pieces of solid mineral material along the axle of a rotor and rotating said rotor at an increased speed to throw said pieces of solid mineral material from the radial outlets of said rotor in tangential directions to cause said pieces of solid mineral material to strike against the "dead bed" of fragments of solid mineral material which encircles said rotor and cause said pieces of solid mineral material to reduce to fragments, and method of sorting resulting fragments of solid mineral material according to size.

Description of the Prior Art

In a conventional method of breaking pieces of solid mineral material into fragments, fragments of solid mineral material is heaped up to encircle a rotor and the rotor is made to rotate to throw pieces of solid mineral material to the heap or "dead bed" of fragments. Then, these pieces of solid mineral material strike the "dead bed" to reduce to fragments, which are allowed to fall from the space between the rotor and the breaking chamber. After leaving the lower part of the breaking apparatus the fragments of solid mineral material are sorted according to size.

The breaking force available in such a breaking apparatus will depend on the force with which pieces of solid mineral material can strike against the "dead bed", and as a matter of course, the breaking g effect increases with the striking force. The "dead bed", however, will be covered thick with fragments of relatively small size because collision takes place on the surface of the "dead bed". Therefore pieces of solid mineral material when thrown at the "dead bed" are likely to land soft on the "dead bed", thereby causing thrown pieces of solid mineral material to lose their kinetic energy, which otherwise, would be used to break pieces of solid mineral material into fragments.

Also, disadvantageously fragments of different sizes are mixed, and therefore, subsequent screening is necessitated

Summary of the Invention

With the above in mind one object of the present invention is to provide solid mineral material breaking apparatus and method which can make full use of the kinetic energy of thrown pieces of mineral material in breaking themselves in fragments, thereby substantially increasing the breaking efficiency. Another object of the present invention is to provide a method of sorting fragments of solid mineral material according to size.

According to a first aspect of the present invention there is provided a centrifugal breaking apparatus including. in a breaking chamber, a rotor and a hopper arranged to supply pieces of solid mineral material along the axle of said rotor, thereby permitting said rotor when rotating at an increased speed, to throw said pieces of solid mineral material from the radial outlets of said rotor in tangential directions to cause said pieces of solid mineral material to strike against the "dead bed" of fragments of solid mineral material which encircles said rotor, and cause said pieces of solid mineral material to reduce to fragments, characterized in that said breaking chamber is open at its bottom floor and that said centrifugal breaking apparatus comprises a vibrator, said breaking chamber having a support box fixed to its undersurface, said support box being connected to said vibrator. According to a second aspect of the present invention there is provided such a centrifugal breaking apparatus which has a frame structure isolated from the breaking chamber, but still supporting the breaking chamber so as to permit the vibration of the breaking chamber as separate from the frame structure. According to a third aspect of the present invention there is provided such a centrifugal breaking apparatus which has upper and lower frame sections and that the upper frame section has a breaking chamber formed therein.

According to a fourth aspect of the present invention there is provided such a centrifugal breaking apparatus which has a vibrating frame structure and a vibrator, said vibrator along with a rotor drive motor being connected to the frame structure.

According to a fifth aspect of the present invention there is provided a method of breaking pieces of solid mineral material by feeding pieces of solid mineral material along the axle of a rotor and rotating said rotor at an increased speed to throw said pieces of solid mineral material from the radial outlets of said rotor in tangential directions to cause said pieces of solid mineral material to strike against the "dead bed" of fragments of solid mineral material which encircles said rotor and cause

said pieces of solid mineral material to reduce to fragments, characterized in that said "dead bed" of fragments of solid mineral material is subjected to vibration. In the breaking apparatus and method just described, the "dead bed" is subjected to vibration to cause fragments of relatively large size to come up on the surface of the "dead bed", and therefore, pieces of solid mineral material when thrown to the "dead bed", will strike against relatively large fragments on the surface of the "dead bed" so that the kinetic energy of the flying pieces of solid mineral material may be fully used in breaking themselves into fragments. Thus. the breaking efficiency will be substantially increased.

According to a sixth aspect of the present invention there is provided a fragment-sorting method in combination with such a breaking method just described in which fragment-sorting method a separator plate is provided on the course on which fragments of solid mineral material fall from the "dead bed", and when the "dead bed" is subjected to vibration, fragments of relatively large size will come up on the surface of the "dead bed" to permit these fragments of relatively large size to fall inside and fragments of relatively small size to fall outside of the separator plate. Finally, according to a seventh aspect of the present invention there is provided a fragment-sorting method in combination with such a breaking method as described above in which fragment-sortering method an outlet is provided in the vicinity of the "dead bed", and when the "dead bed" is subjected to vibration, fragments of relatively large size will come up on the surface of the "dead bed" to leave fragments of relatively small size inside and fall from the outlet. In the fragment-sorting method just described, fragments of relatively large size which come up on the surface of the "dead bed" as a result of vibration, will be automatically selected and removed as separate from fragments of relatively small size, which are left inside the "dead bed" as a result of the vibration.

Other objects and advantages of the present invention will be understood from the following description of a breaking apparatus according to one embodiment of the present invention, which is shown in the accompanying drawings:

Fig. 1 is a longitudinal section of a breaking apparatus according to one embodiment of the present invention; and

Fig. 2 is a graphic representation showing the distribution of fragment sizes in a conventional breaking method and a breaking method using vibration of the "dead bed" according to the present invention.

Fig. 1 shows a centrifugal breaking apparatus according to one embodiment of the present invention as including a rotor 1 in a breaking chamber 2. The rotor 1 is designed to be driven at an increased speed by an associated motor (not shown). A hopper is arranged above the rotor 1 to supply pieces of solid mineral material along the axle of the rotor, thereby permitting the rotor 1 when rotating at an increased speed to throw pieces of solid mineral material from its radial outlets in tangential directions to cause pieces of solid mineral material to strike against the "dead bed" 3 of fragments of solid mineral material which encircles the rotor 1. Then, the pieces of solid mineral material reduce to fragments.

As shown, the centrifugal breaking apparatus has lower and upper frame sections 5a and 8b coupled together. The breaking chamber 2 is built in the upper frame section 5b. The hopper (not shown) is connected to the top of the upper frame section 6b to supply pieces of solid mineral material along the axle of the rotor 1 as described above. The lower frame section 8a has an outlet 11 at the center of the bottom of the lower frame section, an annular opening 12 encircling the outlet 11 and a chute 13 to collect fragments of solid mineral material falling from the annular opening 12.

As shown, the breaking chamber 2 of the upper frame section 5b is open at its bottom floor, and the opening of the bottom floor is encircled by a cylindrical wall. The breaking chamber 2 has an annular support box 4 connected to its undersurface. The annular support box 4 is resiliently supported by springs 15 as indicated at the lower frame section 6a, thus preventing transmission of vibration to the lower frame section 5a. The support box 4 is connected to a vibrator 5, which comprises a motor and an associated eccentric can to vibrate the "dead bed" vertically. The support box 4 is also connected to the upper and lower frame sections 6b and 8a by flexible material such as rubber plates 7, thereby permitting the vertical vibration of the annular box 4.

The lower frame section 6a has a cylindrical separator 8 arranged coaxial with the lower frame section. When the support box 4 vibrates, fragments of relatively large size come up on the surface of the "dead bed" to fall inside the cylindrical separator 8 whereas fragments of relatively small size fall between the cylindrical separator 8 and the lower frame section 6. Then, the fragments of relatively large size are ejected from the exit 11 of the breaking system whereas the fragments of relatively small size are ejected from the chute 13.

Fig. 2 shows the relationship between the fragment size and the weight of fragments of diffferent sizes. Curve 1 shows the result of a conventional centrifugal breaking system using no vibration whereas curves 2 shows the results of a centrifugal breaking system using vibration according to the

present invention. Taff having been supplied to the rotor, particulars of the experiments are as follows:

Feeding rate of pieces of solid mineral material 40t/h

Circumferential speed of the rotor 55m/sec

Amplitude of the vibration of the support box 2. 5mm

Frequency of vibration 58Hz

As seen from Fig. 2, the rate of fragments of relatively small size is large in a centrifugal breaking apparatus using vibration according to the present invention. compared with a conventional centrifugal breaking apparatus using no vibration. This shows that pieces of solid mineral material reduce to fragments at an increased efficiency in the centrifugal breaking apparatus using vibration according to the present invention.

This particular embodiment uses a cylindrical separator to separate fragments of solid mineral material according to size. In place of the cylindrical separator, however, an outlet may be provided to the support box or the side wall of the breaking chamber to allow fragments of relatively small size to leave the "dead bed" while fragments of relatively large size slide and roll on the slant of the "dead bed" to fall in the center hollow space of the centrifugal breaking apparatus. If occasions demand, a net may be applied to the outlet of the breaking apparatus, thereby screening fragments of solid mineral material.

This particular embodiment uses a support box as vibrating means. Alternatively the breaking chamber, the upper frame section having a braking chamber, or the framework itself may be designed to vibrate. When the framework is designed to vibrate as a whole, a motor for driving the rotor is fixed to the framework so as to vibrate together while rotating the rotor.

Claims

1. A centrifugal breaking apparatus including, in a breaking chamber, a rotor and a hopper arranged to supply pieces of solid mineral material along the axle of said rotor, thereby permitting said rotor when rotating at an increased speed to throw said pieces of solid mineral material from the radial outlets of said rotor in tangential directions to cause said pieces of solid mineral material to strike against the "dead bed" of fragments of solid mineral material which encircles said rotor and cause said pieces of solid mineral material to reduce to fragments, characterized in that said breaking chamber is open at its bottom floor and that said centrifugal breaking apparatus comprises a vibrator, said breaking chamber having a support box fixed to its undersurface, said support box being connected to said vibrator.

2. A centrifugal breaking apparatus including, in a breaking chamber, a rotor and a hopper arranged to supply pieces of solid mineral material along the axle of said rotor, thereby permitting said rotor when rotating at an increased speed to throw said pieces of solid mineral material from the radial outlets of said rotor in tangential directions to cause said pieces of solid mineral material to strike against the "dead bed" of fragments of solid mineral material which encircles said rotor and cause said pieces of solid mineral material to reduce to fragments, characterized in that said centrifugal breaking apparatus has a frame structure isolated from said breaking chamber, but still supporting said. breaking chamber so as to permit the vibration of said breaking chamber as separate from said frame structure.

3. A centrifugal breaking apparatus including, in a breaking chamber, a rotor and a hopper arranged to supply pieces of solid mineral material along the axle of said rotor, thereby permitting said rotor when rotating at an increased speed to throw said pieces of solid mineral material from the radial outlets of said rotor in tangential directions to cause said pieces of solid mineral material to strike against the "dead bed" of fragments of solid mineral material which encircles said rotor and cause said pieces of solid mineral material to reduce to fragments, characterized in that said centrifugal breaking apparatus has upper and lower frame sections and that the upper frame section has said breaking chamber formed therein.

4. A centrifugal breaking apparatus including, in a breaking chamber, a rotor and a hopper arranged to supply pieces of solid mineral material along the axle of said rotor, thereby permitting said rotor when rotating at an increased speed to throw said pieces of solid mineral material from the radial outlets of said rotor in tangential directions to cause said pieces of solid mineral material to strike against the "dead bed" of fragments of solid mineral material which encircles said rotor and cause said pieces of solid mineral material to reduce to fragments, characterized in that said centrifugal breaking apparatus has a vibrating frame structure and a vibrator, said vibrator along with a rotor drive motor being connected to said frame structure.

5. A method of breaking pieces of solid mineral material by feeding pieces of solid mineral material along the axle of a rotor and rotating said rotor at an increased speed to throw said pieces of solid mineral material from the radial outlets of said rotor in tangential directions to cause said pieces of solid mineral material to strike against the "dead bed" of fragments of solid mineral material which encircles said rotor and cause said pieces of solid mineral material to reduce to fragments, character-

ized in that said "dead bed" of fragments of solid mineral material is subjected to vibration.

6. In combination with a method of breaking pieces of solid mineral material by feeding pieces of solid mineral material along the axle of a rotor and rotating said rotor at an increased speed to throw said pieces of solid mineral material from the radial outlets of said rotor in tangential directions to cause said pieces of solid mineral material to strike against the "dead bed" of fragments of solid mineral material which encircles said rotor and cause said pieces of solid mineral material to reduce to fragments, a method of sorting fragments according to size characterized in that a separator plate is provided on the course on which fragments of solid mineral material fall from said "dead bed", and that said "dead bed" is subjected to vibration, thereby causing fragments of relatively large size to come up on the surface of said "dead bed" to permit these fragments of relatively large size to fall inside and permit fragments of relatively small size to fall outside of said separator plate.

7. In combination with a method of breaking pieces of solid mineral material by feeding pieces of solid mineral material along the axle of a rotor and rotating said rotor at an increased speed to throw said pieces of solid mineral material from the radial outlets of said rotor in tangential directions to cause said pieces of solid mineral material to strike against the "dead bed" of fragments of solid mineral material which encircles said rotor and cause said pieces of solid mineral material to reduce to fragments, a method of sorting fragments according to size characterized in that an outlet is provided in the vicinity of said "dead bed", and that said "dead bed" is subjected to vibration, thereby causing fragments of relatively large size to come up on the surface of said "dead bed" to leave fragments of relatively small size inside and fall from said outlet.

FIG. 1

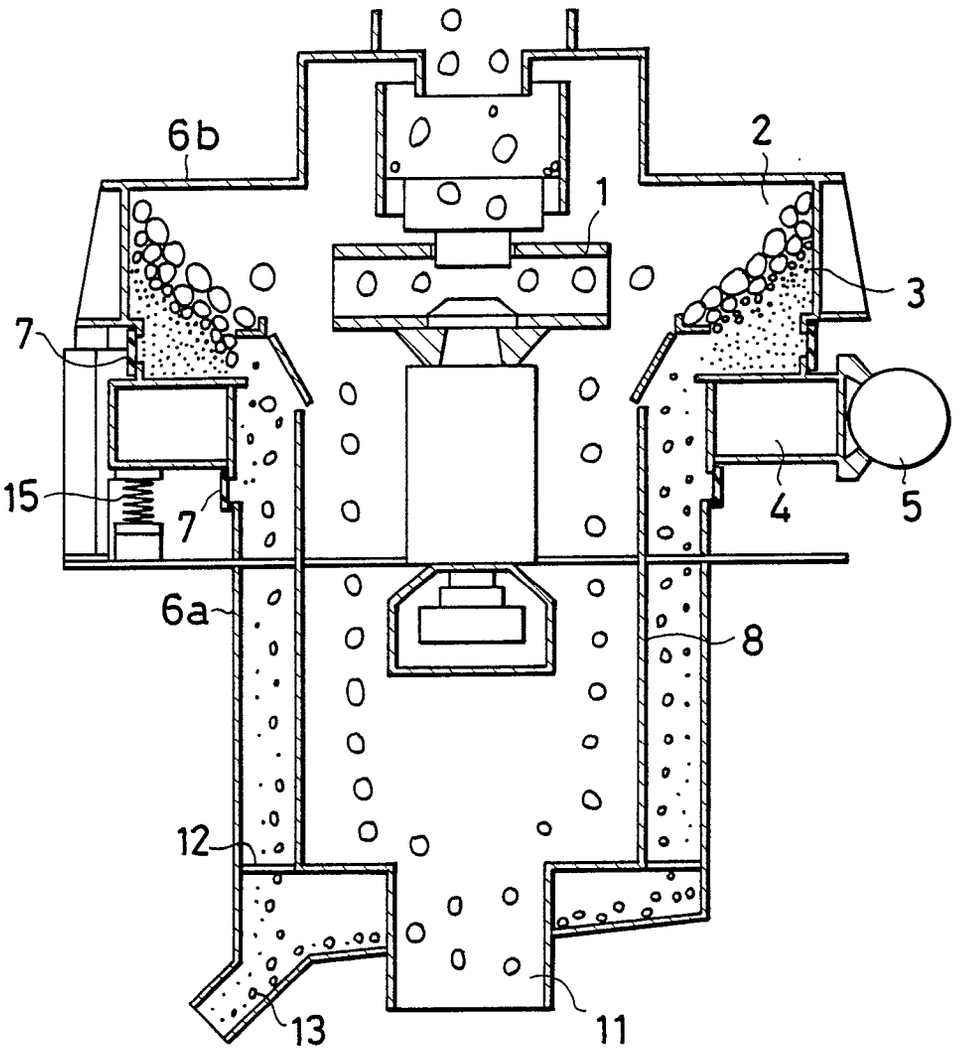

FIG. 2