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(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.**

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(73) Proprietor: **KOTOBUKI ENGINEERING & MANUFACTURING CO LTD**  
**8-1, Shinjuku 1-chome**  
**Shinjuku-ku**  
**Tokio (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-81675 München (DE)**

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## Description

The present invention relates to apparatus and method of breaking pieces of solid mineral material comprising the features of the preamble of claims 1 and 2, respectively.

5 In a conventional apparatus and method of breaking pieces of solid mineral material into fragments, as is described in EP-A-0 093 013, 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  
10 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 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  
15 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.

20 With the above in mind the object of the present invention is to provide a solid mineral material breaking apparatus and a 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 and sorting fragments of solid mineral material according to size.

According to the present invention there is provided a centrifugal breaking apparatus comprising the  
25 features of claim 1.

According to the present invention there is also provided a method of breaking pieces of solid mineral material and sorting fragments according to size comprising the features of claim 2. 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  
30 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 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  
35 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, there is provided a fragment-sorting method in combination with such a breaking method as described above in which fragment-sorting method an outlet is provided in the  
40 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  
45 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  
50 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  
55 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 6a and 6b coupled together. The breaking chamber 2 is built in the upper frame section 6b. 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 6a 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 6b 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 6a. The support box 4 is connected to a vibrator 5, which comprises a motor and an associated eccentric cam to vibrate the "dead bed" vertically. The support box 4 is also connected to the upper and lower frame sections 6b and 6a 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 different 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 (2), an accelerating hollow rotor (1) and a hopper arranged to supply pieces of solid mineral material into and along the longitudinal axis of said rotor (1), thereby permitting said rotor (1) when rotating at an increased speed to throw said pieces of solid mineral material from radial outlets incorporated in said rotor (1) in tangential directions to cause said pieces of solid mineral material to strike against a "dead bed" (3) of fragments of solid mineral material which encircles said rotor (1) and cause said pieces of solid mineral material to reduce to fragments, characterized in that a support box (4) and vibrator (5) are operatively associated with the "dead bed" (3) in the breaking

chamber (2) surrounding the rotor (1), the breaking chamber (2) of an upper frame section (6b) of chamber (2) is open at its bottom floor to allow fragments of said mineral material to accumulate on the upper surface of the support box (4) so as to form the "dead bed" (3), the support box (4) being isolated from the upper frame section (6b) and a lower frame section (6a) by flexible plates (7) so that said fragments of mineral material are subjected to vibration when said support box (4) is vibrated and so that fragments of said mineral material are separated under the influence of vibration, and said centrifugal breaking apparatus further comprises a separator plate (8) vertically provided along the course on which said fragments of solid mineral material fall from said "dead bed" (3), whereby said falling fragments of solid mineral material are sorted according to size.

2. A method of breaking pieces of solid mineral material and sorting fragments according to size using the centrifugal breaking apparatus according to claim 1, characterized in that the "dead bed" (3) of fragments of solid mineral material is subjected to vibration when the support box (4) is vibrated, and fragments of relatively small size are moved to the lower layer of the "dead bed" (3) to permit these fragments of relatively small size to fall outside of the separator plate (8), and fragments of relatively large size are moved to the upper layer of the "dead bed" (3) to permit these fragments of relatively large size to fall inside of the separator plate (8), so that said pieces of solid mineral material can be separated according to their particle diameter.

## Patentansprüche

1. Zentrifugalbrechvorrichtung mit einem in einer Brechkammer (2) angeordneten hohlen Beschleunigungs-Rotor (1) und einem Fülltrichter zum Einbringen von Stücken von Mineralfeststoff in den Rotor (1) und längs dessen Längsachse, um dabei den Rotor (1), wenn er mit erhöhter (hoher) Drehzahl rotiert, die Mineralfeststoffstücke über im Rotor (1) vorgesehene radiale Auslässe in tangentialen Richtungen herausschleudern und die Mineralfeststoffstücke auf ein den Rotor (1) umgebendes "Totbett" (3) aus Fragmenten bzw. Bruchstücken des Mineralfeststoffs auftreffen zu lassen und dadurch die Mineralfeststoffstücke zu Fragmenten zu zerkleinern, dadurch gekennzeichnet, daß ein Lagerkasten (4) und ein Rüttler (5) dem "Totbett" (3) in der den Rotor (1) umgebenden Brechkammer (2) betrieblich oder wirkungsmäßig zugeordnet sind, die Brechkammer (2) einer oberen Rahmensektion (6b) der Kammer (2) bodenseitig offen ist, so daß Fragmente des Mineral(fest)stoffs sich unter Bildung des "Totbetts" (3) an der Oberseite des Lagerkastens (4) ansammeln können, der Lagerkasten (4) durch flexible Platten (7) gegenüber der oberen Rahmensektion (6b) und einer unteren Rahmensektion (6a) isoliert ist, so daß die Fragmente des Mineral(fest)stoffs mit Schwingung beaufschlagt werden, wenn der Lagerkasten (4) in Schwingung versetzt wird, und die Fragmente des Mineral(fest)stoffs unter dem Einfluß der Schwingung getrennt werden, und die Zentrifugalbrechvorrichtung ferner eine lotrecht längs der Strecke, auf welcher die Fragmente des Mineralfeststoffs aus dem "Totbett" (3) herabfallen, angeordnete Scheiderplatte (8) umfaßt, wodurch die herabfallenden Fragmente des Mineralfeststoffs nach Größe sortiert werden.
2. Verfahren zum Zerkleinern bzw. Aufbrechen von Mineralfeststoffstücken und zum Sortieren von Fragmenten bzw. Bruchstücken nach Größe mittels der Zentrifugalbrechvorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß das "Totbett" (3) der Fragmente des Mineralfeststoffs bei der Schwingung des Lagerkastens (4) mit Schwingung beaufschlagt wird und (dabei) Fragmente einer vergleichsweise kleinen Größe zur unteren Schicht des "Totbetts" (3) verlagert werden, so daß diese vergleichsweise kleinen Fragmente zur Außenseite der Scheiderplatte (8) herabfallen können, während Fragmente einer vergleichsweise großen Größe zur oberen Schicht des "Totbetts" (3) verlagert werden, so daß diese vergleichsweise großen Fragmente zur Innenseite der Scheiderplatte (8) herabfallen können und damit die Mineralfeststoffstücke nach ihrem Teilchendurchmesser getrennt (bzw. klassiert) werden können.

## Revendications

1. Machine centrifuge de fragmentation, comprenant à l'intérieur d'une chambre de fragmentation (2) un rotor creux d'accélération (1) et une trémie disposée pour déverser des morceaux de matière minérale solide dans et le long de l'axe longitudinal dudit rotor (1) de manière à permettre audit rotor (1), lorsqu'il est entraîné en rotation à une vitesse élevée, de projeter lesdits morceaux de matière minérale solide dans des directions tangentielles par des sorties radiales que comporte ledit rotor (1) pour faire

en sorte que lesdits morceaux de matière minérale solide heurtent un "lit mort" (3) de fragments de matière minérale solide qui entoure ledit rotor (1) et pour faire en sorte que lesdits morceaux de matière minérale solide soient réduits en fragments, caractérisée en ce que

5 une boîte de support (4) et un vibreur (5) sont reliés fonctionnellement audit "lit mort" (3) situé dans la chambre de fragmentation (2) et entourant le rotor (1), la chambre de fragmentation (2) d'une partie supérieure de châssis (6b) de la chambre (2) étant ouverte dans le plancher de fond pour permettre aux fragments de ladite matière minérale de s'accumuler sur la surface supérieure de la boîte de support (4) de façon à former le "lit mort" (3), la boîte de support (4) étant isolée de la partie supérieure de châssis (6b) et d'une partie inférieure de châssis (6a) par des plaques souples (7) de  
10 façon que lesdits fragments de matière minérale soient soumis à vibration lorsque ladite boîte de support (4) est amenée à vibrer et de façon que les fragments de ladite matière minérale soient séparés sous l'effet de la vibration et en ce que ladite machine centrifuge de fragmentation comprend par ailleurs une plaque de séparation (8) montée verticalement le long de la course sur laquelle lesdits fragments de matière minérale solide tombent dudit "lit mort" (3), de façon que lesdits fragments  
15 tombants de matière minérale solide soient triés selon leur dimension.

2. Procédé de fragmentation de morceaux de matière minérale solide et de triage des fragments selon leur dimension à l'aide de la machine centrifuge de fragmentation selon la revendication 1, caractérisé en ce que le "lit mort" (3) de fragments de matière minérale solide est soumis à vibration lorsque la  
20 boîte de support (4) est amenée à vibrer et les fragments de dimension relativement petite sont déplacés vers la couche inférieure du "lit mort" (3) pour permettre à ces fragments de dimension relativement petite de tomber à l'extérieur de la plaque de séparation (8) et les fragments de dimension relative grande sont déplacés vers la couche supérieure du "lit mort" (3) pour permettre à ces fragments de dimension relativement grande de tomber à l'intérieur de la plaque de séparation (8), de  
25 sorte que lesdits morceaux de matière minérale solide peuvent être séparés selon le diamètre de leurs particules.

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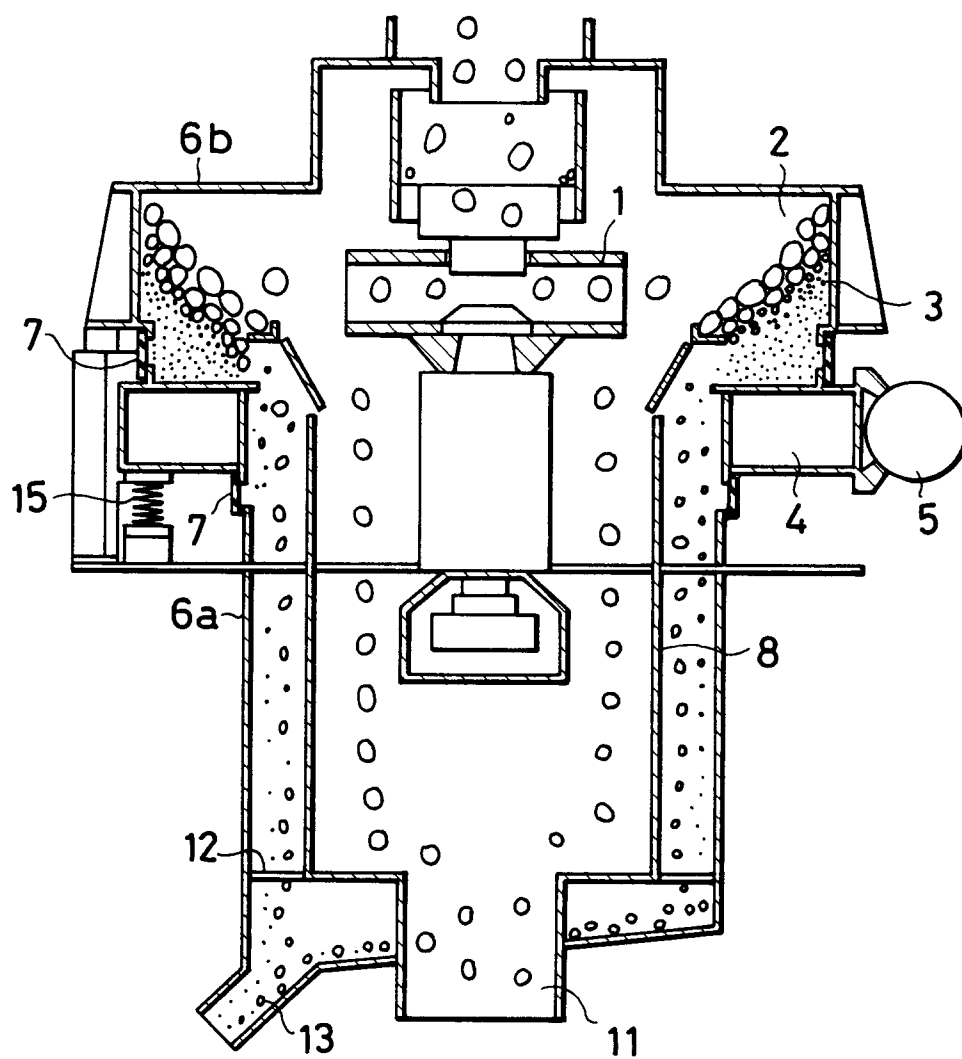
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FIG. 1



**F I G . 2**

