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(54) Crushing member of gyrating-type crushers

Brechwerkzeug für Kreiselbrecher

Elément broyeur d'un broyeur giratoire

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EP-A- 0 271 336
EP-A- 0 306 023
GB-A- 1 043 945

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Description

This invention relates to a crushing member (toothed plate) according to the pre-characterizing part of each of claims 1,2 and 3. A crushing member of this type is known from EP-A-0 306 023. According to this document, the crushing member is used to crush minerals. The crushing member is made for use in gyrating-type crushers, such as cone crushers, gyratory crushers or others, which include mantles and concaves.

A known crushing member of a gyrating-type crusher comprises toothed plate bodies of a mantle and of a concave respectively having continuously undulating convexities and concavities circumferentially formed in the crushing surfaces of the toothed plate bodies of the mantle and the concave, whereby an object to be crushed fed into the crushing chamber of the crusher is crushed in a state where the object is hindered from slipping, for the improvement of the crushing efficiency (See Japanese Patent Publication (KOKOKU) No. 50580/1991).

In the crushing member of the gyrating crusher of this type, a part of the object-to-be-crushed loaded in the crushing chamber is trapped in the concavities of the crushing surface of the mantle, held by three points of these concavities, the peripheral surface of the concave, and the convexities of the crushing surface of the mantle, and crushed by bending shearing force in such restricted state from slipping upward and circumferentially. But abrasion of the toothed plate takes place with long time operation, and as the abrasion progresses, the above-mentioned crushing efficiency decreases.

The conventional crushing member of the above-described structure is effective only when the object-to-be-crushed is crushed in a state where the object is hindered from slipping, but sometimes sufficient crushing cannot be obtained unless the directions of the convexities and the concavities are suitable. The crushing effect also decreases with increased abrasion of the toothed plate.

GB-A- 1,043,945 discloses a machine for treating and refining pulp, i.e. soft materials. The machine includes a mantle and a concave. In contrast to crushers, the material to be treated in the pulp treating machine is fed to the large diameter end of the mantle and the concave.

The object of this invention is to provide a gyrating-type crusher having optimum direction lines of groove forming members disposed on the crushing surface of the toothed plate bodies, and combinations of the direction lines, whereby the crushing achievement in terms of required crushing power, particle sizes of crushed products, crushing efficiency, bites, etc. is optimized, and the drop of the crushing achievement accompanying the abrasion of the toothed plate can be effectively prevented.

To achieve the above-described object, this invention relates to a crushing member having the features of claim 1, claim 2 and claim 3. It is used in gyrating-type crushers, including a mantle and a concave, the toothed plate comprising a plurality of groove forming members in the shape of a strip circumferentially spaced from each other by a set pitch on crushing surfaces of the mantle and the concave, the groove forming members of the mantle defining a direction line, i.e. a line normal to the groove forming members, forming a direction angle of 45° - 75° with respect to a vertical direction line of the mantle, and the groove forming members defining a direction line normal to a vertical direction line of the concave. The groove forming members of the mantle define a direction line normal to a vertical direction line of the mantle, and the groove forming members of the concave define a direction line forming a direction angle of 45° - 74° with respect to the vertical direction line of the concave. The groove forming members of each of the mantle and the concave define a direction line forming a direction angle of 65° - 90° with respect to the vertical direction line, and the direction lines are intersected by each other at a relative angle of 15° - 45° on the crushing surfaces.

The reasons why the direction angles of the direction lines of the groove forming members are restricted will be explained.

In the first invention, the direction angle of the direction line of the mantle is 45° - 75°, and that of the concave is normal (90°). With the direction angles set outside these ranges, the crushing achievement cannot be optimized:

Higher loads are produced in the crushing operation;
Distributions of particle sizes of the crushed products have wide widths and lack sensitivity, and fine powders are generated;
the crushing efficiency which is defined by a ratio between a normalized particle size crushing amount and a work done; and
bites in the crushing chamber lower nip angles.

In the second invention, the direction angle of the direction line of the mantle is normal, and that of the concave is 45° - 74°: Outside these ranges, the crushing achievement cannot be optimized. These ranges are set in accordance with the first invention, and in comparison with the first invention, the crushing achievement tends to lower but with the above-described disadvantages improved.

In the third invention, the direction angles of the directions lines of the mantle and the concave are 65° - 90°, and their relative angle on the crushing surfaces is 15° - 45°. Outside this range, optimum crushing achievement is not available. In comparison with the first or the second invention, the third invention is easily adaptable to requirements for

desired crushing ability and crushing achievement.

In such arrangement, while an object to be crushed is compression-crushed in the crushing chamber extended from the upper part of a gyrating-type crusher to the lower part thereof, the object to be crushed is subjected to bending forces and shearing forces in addition to compressive forces, and a required crushing load can be low. An object to be crushed can be prevented from overcrowding in the crushing chamber during a crushing operation to eventually produce too fine a powder. Thus, optimum crushing achievement in terms of crushed product particle sizes, crushing efficiency, nips, etc. can be obtained, and even in a case that the toothed plate is increasingly abraded, the crushing surfaces can sustain their wavy configurations with the result that drop of the crushing achievement can be effectively prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an explanatory view of direction lines of the groove forming members of the toothed plate body of the mantle of the crushing member for use in gyrating-type crushers according to one embodiment of this invention.

FIG. 2 is an explanatory view of direction lines of the concave.

FIG. 3 is an explanatory view of direction lines of the mantle and the concave.

FIG. 4 is a partial development of the direction lines of the mantle and the concave of FIG. 3, which explains the direction lines.

FIG. 5 is a general structural view of the crushing member according to this invention.

FIG. 6 is a graph of relationships between the crushing achievement of the crushing member according to this invention, and the direction angles of the mantle.

FIG. 7 is a sectional view of a major part of the teeth plate of FIG. 5 along the line A-A.

FIG. 8 is an explanatory of a used state of the mantle of FIG. 7.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of this invention will be explained with reference to the drawings attached hereto.

FIG. 1 is a view explaining direction lines of a grooved member of a mantle of the toothed plate according to one embodiment of this invention for use in a gyrating-type crusher. FIG. 2 is a view explaining direction lines of a concave of the crushing member. FIG. 3 is a view explaining the direction lines of the mantle and the concave. FIG. 4 is a partially expanded view of the direction lines of FIG. 3. FIG. 5 is general structural view of the crushing member. FIG. 6 is a graph of the relationships between the crushing achievement of the toothed plate according to this invention, and direction angles of the mantle. FIG. 7 is a sectional view of the toothed plate of FIG. 5 along the line A-A. FIG. 7 is an explanatory view of the toothed plate of FIG. 7 in its used state.

In FIG. 1, on the crushing surface of the toothed plate body 14 of the mantle 12 there are disposed a plurality of groove forming members 16 in the shape of a strip spaced circumferentially from each other. The line Z_1-Z_1 represents the vertical direction line of the mantle 12 and indicates the direction of up-to-down movement of an object-to-be-crushed along the line Z_1-Z_1. Reference numeral 17 represents a direction line, and the groove forming members 16 are normal to the vertical direction line Z_1-Z_1 at a direction angle θ_1. The direction line 17 is normal to the groove forming members 16. In this embodiment, the direction angle θ_1 is roughly divided in three. That is, the direction angle θ_1 indicates a 45° - 75° direction angle. A direction angle θ_1' indicates a 90° normal direction angle. A direction angle θ_1" indicates a 65° - 90° direction angle.

In FIG. 2, on a toothed plate body 20 of a concave 18 there are disposed a plurality of groove forming members 22 spaced circumferentially from each other. The groove forming members 22 may be equidistantly or unequidistantly spaced from each other.

The line Z_2-Z_2 indicates a vertical direction line of the concave 18 and indicates a direction of up-to-down movement of the object-to-be-crushed. Groove forming members 22 are directed at an orientation angle θ_2 with respect to the vertical line Z_2-Z_2. The direction line 23 is normal to the groove forming members 22. The direction angle θ_2 is roughly divided in three. That is, the direction angle θ_2 indicates a 90° normal direction angle. The direction angle θ_2' indicates a 45° - 75° direction angle. The direction angle θ_2" indicates a 65° - 90° direction angle.

As shown in FIG. 3, in a gyrating-type crusher 10 the mantle 12 is mounted inside the concave 18 with the tooth plate body 14 of the mantle 12 opposed to the toothed plate body of the concave 18 , and a crushing chamber 24 is defined between the toothed plate bodies 14 and 20. The line M-M indicates the vertical center line of the gyrating-type crusher 10 and is substantially in agreement with the vertical direction line Z_2-Z_2 of the concave 18. The vertical direction line Z_1-Z_1 of the mantle 12 is slightly inclined to the vertical center line M-M, and the intersection point between the two lines is represented by (O). The vertical direction line Z_1-Z_1 of the mantle 12 depicts an eccentric circle around the vertical center line M-M with the intersection point (O) as the vertex. The direction line 17 of the mantle 12 and the direction line 23 of the concave 18 intersect each other at a relative angle θ_r of 15° - 45° on their respective crushing surfaces.

As shown in FIG. 4, the vertical direction line Z_1-Z_1 of the mantle and that Z_2-Z_2 of the concave are in agreement with each other, and the direction line 17 of the mantle 12 and the that 23 of the concave 18 intersect each other at the relative angle θ_r on their respective crushing surfaces. The relative angle θ_r is a total of the direction angle θ_1 and the direction angle θ_2 of the concave.

This arrangement allows loads from a number of points or in a number of directions, including the internal structure, to act on the respective contact points of the surface of the object to be crushed in the crushing chamber 24. The crushing action can be enhanced.

In the gyrating-type crusher 10 of FIG. 5, the direction line 17 is defined with respect to the direction angle θ_1, 45° - 75° of the groove forming members of the mantle 12, and the direction line 23 forms the direction angle θ, which is normal (90°) to the groove forming members 22 of the concave 18.

FIG. 6 shows the result of a crushing experiment using the crushing member for use in gyratory-type crushers according to this embodiment. In this experiment, with the direction angle θ_2 of the concave, which is normal (90°), the direction angle θ_1 of the mantle was changed to give the influence of a crushing load, crushing efficiency, a particle size distribution, a nip angle, etc. on the crushing achievement. The result of this experiment shows that the optimum crushing achievement is obtained in a range where the groove forming members of the mantle has a direction angle of 45° - 75°, and the concave has a normal (90°) direction angle.

With reference to FIG. 7, the mantle 12 of the gyrating-type crusher 10 will be explained.

The mantle 12 has a toothed plate body 14 of a highly abrasion resistant material, e.g, high manganese cast steel containing manganese by 13 weight% or more. The toothed plate body 14 has a plurality of deep grooves 30 formed in the troughs of the undulated outer peripheral surface of the toothed plate body 14, and groove forming members 16 embedded in the deep grooves 30 by casting. Each groove forming memeber 16 has a side surface 28, and the side surfaces 28 may be formed of a low abrasion resistant material, e.g., rolled steel for the general purpose.

The crests of the undulated outer peripheral surface of the toothed plate body 14 are formed in edges 26 of curvy section with a required curvature. The edges 26 may have a curved section of an increased curvature to provide crushing surfaces in non-undulated flat outer surfaces.

FIG. 8 shows a state in which accompanying a long period of operation time of the gyrating-type crusher, the crushing surfaces are abraded. The edges 26 of the toothed plate body 14 have little abrasion, but the side surfaces 28 of the groove forming members 16 are abraded from the surfaces depicted by the two-dot chain lines to the side surfaces 28a depicted by the solid lines to eventually generate abraded steps E. According to experiments, the structure of this embodiment hinders the above-described abraded steps E from increasing with long time operation of the gyrating-type crusher, so that the abraded steps of a constant size are continuously maintained between the edges 26 and the side surfaces 28a of the groove forming members 16 down to an abrasion limit for the edges 26. Accordingly decreases of the crushing achievement can be prevented, and even if the abrasion of the toothed plate body 14 continues, the gyrating-type crusher can be operated always with the same crushing achievement.

Next, the operational achievement of the gyrating-type crushers including the crushing member according to this invention is shown in Table 1. As shown in Table 1, it is found that in comparison with the conventional art, this invention exhibits improved crushing achievement in terms of crushing capacity and crushing power consumption. In the above-described gyrating-type crusher, a direction angle θ of the mantle was 70°, and the direction angle θ of the concave was 90°.

TABLE 1

	This Invention	Prior Art
Type	1200	1200
Crushing Capacity ton/hour (set: 13 mm)	140	104
Particle Size of Crushed Product (%) (Setunder)	80 - 90	50 - 60
Actual Crushed Product Ratio (%)	56 - 60	52 - 55
Fine Powder Ratio % (at -20 mm, 60%)	8	10
Maximum Loaded Mass Size (mm) (along side length)	360	220
Crushing Ratio	6 - 10	4 - 6
Crusher Height (mm)	2,545	3,091
Crushing Power Consumption (KW)	45 - 90	120

As described above, according to this invention, directions of direction lines of the groove forming members disposed on the crushing surfaces of the toothed body members, and combinations of the direction lines allow bending forces and shearing forces in addition to compression forces to exert onto an object to be crushed while the object to be crushed is being compressed and crushed in the crushing chamber extended from the upper part of the gyratory-type crusher to the lower part thereof, whereby the crushing achievement in terms of the required crushing power, particle size of a crushed product, crushing efficiency, bite, etc. can be optimized, and even in a case that the toothed plate is increasingly abraded, the drop of the crushing achievement can be effectively prevented. Thus this invention can produce significant advantageous effects.

Claims

1. A crushing member of gyrating-type crushers (10), said crushing member including a mantle (12) and a concave (18) wherein the mantle (12), in use, gyrates inside the concave (18), said crushing member further comprising a plurality of groove forming members (16, 22) in the shape of a strip circumferentially spaced from each other by a set pitch on crushing surfaces of the mantle (12) and the concave (18), the groove forming members (16) of the mantle (12) defining a direction line (17) i.e. a line normal to the groove forming members, characterized in that the direction line is forming a direction angle of 45° - 75° with respect to a vertical direction line (Z_1, Z_1) of the mantle (12), and the groove forming members (22) of the concave defining a direction line (23) normal to a vertical direction line (Z_2, Z_2) of the concave (18).

2. A crushing member of gyrating-type crushers (10), said crushing member including a mantle (12) and a concave (18) wherein the mantle (12), in use, gyrates inside the concave (18), said crushing member further comprising a plurality of groove forming members (16, 22) in the shape of a strip circumferentially spaced from each other by a set pitch on crushing surfaces of the mantle (12) and the concave (18), the groove forming members (16) of the mantle (12) defining a direction line (17) i.e. a line normal to the groove forming members, characterized in that the direction line is normal to a vertical direction line (Z_1, Z_1) of the mantle (12), and the groove forming members (22) of the concave (18) defining a direction line (23) forming a direction angle of 45° - 74° with respect to the vertical direction line (Z_2, Z_2) of the concave (18).

3. A crushing member of gyrating-type crushers (10), said crushing member including a mantle (12) and a concave (18) wherein the mantle (12), in use, gyrates inside the concave (18), said crushing member further comprising a plurality of groove forming members (16, 22) in the shape of a strip circumferentially spaced from each other by a set pitch on crushing surfaces of the mantle (12) and the concave (18), the groove forming members (16, 22) of each of the mantle (12) and the concave (18) defining a direction line (17, 23) i.e. a line normal to the groove forming members, characterized in that the direction lines forming a direction angle of 65° - 90° with respect to the vertical direction line (Z_1, Z_2), and the direction lines (17, 23) being intersected by each other at a relative angle of 15° - 45° on said crushing surfaces.

4. The crushing member of gyrating-type crushers according to any one of claims 1, 2 and 3, wherein the groove forming members (16, 22) are formed of a low abrasion resistant material and are embedded by casting in the crushing member bodies (14, 20) of a highly abrasion resistant material.

5. The crushing member of gyrating-type crushers according to any one -of claims 1 to 4, wherein the groove forming members (16, 22) are circumferentially spaced equidistantly from each other on the mantle and concave.

6. The crushing member of gyrating-type crushers according to any one of claims 1 to 4, wherein the groove forming members (16, 22) are circumferentially spaced unequidistantly from each other on the mantle and the concave.

7. The crushing member of gyrating-type crushers according to any one of claims 1 to 6, wherein the crushing surfaces of said toothed plate bodies (14, 20) are undulated, and the groove forming members (16, 22) are embedded in portions of the crushing surfaces.

Patentansprüche

1. Eine Brechanordnung in Kreiselbrechern (10), wobei die Brechanordnung einen Mantel (12) und ein Konkavteil (18) aufweist, bei Anwendung der Mantel (12) sich innerhalb des Konkavteils (18) dreht, die Brechanordnung ferner eine Mehrzahl von streifenförmigen, rillenbildenden Elementen (16 bzw. 22) aufweist, welche umfangsmäßig um eine gegebene Teilung an der Brechfläche des Mantels (12) bzw. des Konkavteils (18) voneinander beabstandet sind, und die rillenbildenden Elemente (16) des Mantels (12) eine Richtungslinie (17) definieren, d.h. eine Linie

rechtwinklig zu den rillenbildenden Elementen,
dadurch gekennzeichnet,
daß die Richtungslinie einen Richtungswinkel von 45° bis 75° in Bezug auf eine vertikale Richtungslinie (Z_1, Z_1) des Mantels (12) bildet und die rillenbildenden Elemente (22) des Konkavteils eine Richtungslinie (23) rechtwinklig zu einer vertikalen Richtungslinie (Z_2, Z_2) des Konkavteils (18) definieren.

2. Eine Brechanordnung in Kreiselbrechern (10), wobei die Brechanordnung einen Mantel (12) und ein Konkavteil (18) aufweist, bei Anwendung der Mantel (12) sich innerhalb des Konkavteils (18) dreht, die Brechanordnung ferner eine Mehrzahl von streifenförmigen, rillenbildenden Elementen (16 bzw. 22) aufweist, welche umfangsmäßig um eine gegebene Teilung an der Brechfläche des Mantels (12) bzw. des Konkavteils (18) voneinander beabstandet sind, und die rillenbildenden Elemente (16) des Mantels (12) eine Richtungslinie (17) definieren, d.h. eine Linie rechtwinklig zu den rillenbildenden Elementen,
dadurch gekennzeichnet,
daß die Richtungslinie rechtwinklig zu einer vertikalen Richtungslinie (Z_1, Z_1) des Mantels (12) ist und die rillenbildenden Elemente (22) des Konkavteils (18) eine Richtungslinie (23) definieren, welche einen Richtungswinkel von 45° bis 74° in Bezug auf die vertikale Richtungslinie (Z_2, Z_2) des Konkavteils (18) bildet.

3. Eine Brechanordnung in Kreiselbrechern (10), wobei die Brechanordnung einen Mantel (12) und ein Konkavteil (18) aufweist, bei Anwendung der Mantel (12) sich innerhalb des Konkavteils (18) dreht, die Brechanordnung ferner eine Mehrzahl von streifenförmigen, rillenbildenden Elementen (16 bzw. 22) aufweist, welche umfangsmäßig um eine gegebene Teilung an der Brechfläche des Mantels (12) bzw. des Konkavteils (18) voneinander beabstandet sind, und die rillenbildenden Elemente (16 bzw. 22) des Mantels (12) bzw. des Konkavteils (18) eine Richtungslinie (17 bzw. 23) definieren, d.h., eine Linie rechtwinklig zu den rillenbildenden Elementen,
dadurch gekennzeichnet,
daß die Richtungslinien einen Richtungswinkel von 65° bis 90° in Bezug auf die vertikale Richtungslinie (Z_1, Z_2) bilden und die Richtungslinien (17 bzw. 23) unter einem relativen Winkel von 15° bis 45° an den Brechflächen miteinander gekreuzt sind.

4. Die Brechanordnung in Kreiselbrechern gemäß einem der Ansprüche 1, 2 und 3, bei welcher die rillenbildenden Elemente (16 bzw. 22) aus einem niedrigverschleißfesten Material gebildet und durch Giessen in dem entsprechenden, aus einem hochverschleißfesten Material bestehenden Körper (14 bzw. 20) der Brechanordnung eingebettet sind.

5. Die Brechanordnung in Kreiselbrechern gemäß einem der Ansprüche 1 bis 4, bei welcher die rillenbildenden Elemente (16 bzw. 22) umfangsmäßig um einen gleichen Abstand voneinander an dem Mantel bzw. dem Konkavteil beabstandet sind.

6. Die Brechanordnung in Kreiselbrechern gemäß einem der Ansprüche 1 bis 4, bei welcher die rillenbildenden Elemente (16 bzw. 22) umfangsmäßig um einen ungleichen Abstand voneinander an dem Mantel bzw. dem Konkavteil beabstandet sind.

7. Die Brechanordnung in Kreiselbrechern nach einem der Ansprüche 1 bis 6, bei welcher die Brechflächen der gezahnten Plattenkörper (14, 20) wellenförmig sind und die rillenbildenden Elemente (16, 22) in Bereiche der Brechflächen eingebettet sind.

Revendications

1. Un élément broyeur de broyeurs giratoires (10), ledit élément broyeur comprenant une couronne (12) et une partie concave (18), dans lequel la couronne (12), en service, tourne à l'intérieur de la partie concave (18), ledit élément broyeur comprenant en outre un ensemble d'éléments formant des cannelures (16, 22) sous la forme de bandes écartées de manière circonférentielle l'une de l'autre d'un pas réglé sur les surfaces de broyage de la couronne (12) et de la partie concave (18), les éléments formant des cannelures (16) de la couronne (12) définissant une ligne de direction (17), c'est-à-dire une ligne normale aux éléments formant des cannelures, caractérisé en ce que la ligne de direction forme un angle de direction de 45° à 75° par rapport à une ligne de direction verticale (Z_1, Z_1) de la couronne (12), et les éléments formant des cannelures (22) de la partie concave définissant une ligne de direction (23) normale à une ligne de direction verticale (Z_2, Z_2) de la partie concave (18).

2. Un élément broyeur de broyeurs giratoires (10), ledit élément broyeur comprenant une couronne (12) et une partie concave (18), dans lequel la couronne (12), en service, tourne à l'intérieur de la partie concave (18), ledit élément

broyeur comprenant en outre un ensemble d'éléments formant des cannelures (16, 22) sous la forme de bandes écartées de manière circonférentielle l'une de l'autre d'un pas réglé sur les surfaces de broyage de la couronne (12) et de la partie concave (18), les éléments formant des cannelures (16) de la couronne (12) définissant une ligne de direction (17), c'est-à-dire une ligne normale aux éléments formant des cannelures, caractérisé en ce que la ligne de direction est normale à une ligne de direction verticale (Z_1, Z_1) de la couronne (12) et les éléments formant des cannelures (22) de la partie concave (18) définissant une ligne de direction (23) formant un angle de direction de 45° à 74° par rapport à la ligne de direction verticale (Z_2, Z_2) de la partie concave (18).

3. Un élément broyeur de broyeurs giratoires (10), ledit élément broyeur comprenant une couronne (12) et une partie concave (18), dans lequel la couronne (12), en service, tourne à l'intérieur de la partie concave (18), ledit élément broyeur comprenant en outre un ensemble d'éléments formant des cannelures (16, 22) sous la forme de bandes écartées de manière circonférentielle l'une de l'autre d'un pas réglé sur les surfaces de broyage de la couronne (12) et de la partie concave (18), les éléments formant des cannelures (16, 22) à la fois de la couronne (12) et de la partie concave (18) définissant une ligne de direction (17, 23), c'est-à-dire une ligne normale aux éléments formant des cannelures, caractérisé en ce que les lignes de direction forment un angle de direction de 65° à 90° par rapport à la ligne de direction verticale (Z_1, Z_2), et les lignes de direction (17, 23) se coupant l'une l'autre selon un angle relatif de 15° à 45° sur lesdites surfaces de broyage.

4. L'élément broyeur de broyeurs giratoires selon une quelconque des revendications 1, 2 et 3, dans lequel les éléments formant des cannelures (16, 22) sont formés d'une matière à faible résistance à l'abrasion et sont noyés par moulage dans les corps d'éléments broyeurs (14, 20) d'une matière fortement résistante à l'abrasion.

5. L'élément broyeur de broyeurs giratoires selon une quelconque des revendications 1 à 4, dans lequel les éléments formant des cannelures (16, 22) sont circonférentiellement écartés de manière équidistante l'un de l'autre sur la couronne et la partie concave.

6. L'élément broyeur de broyeurs giratoires selon une quelconque des revendications 1 à 4, dans lequel les éléments formant des cannelures (16, 22) sont circonférentiellement écartés de manière non-équidistante l'un de l'autre sur la couronne et la partie concave.

7. L'élément broyeur de broyeurs giratoires selon une quelconque des revendications 1 à 6, dans lequel les surfaces de broyage desdits corps plats dentés (14, 20) sont ondulées, et les éléments formant des cannelures (16, 22) sont noyés dans des parties des surfaces de broyage.

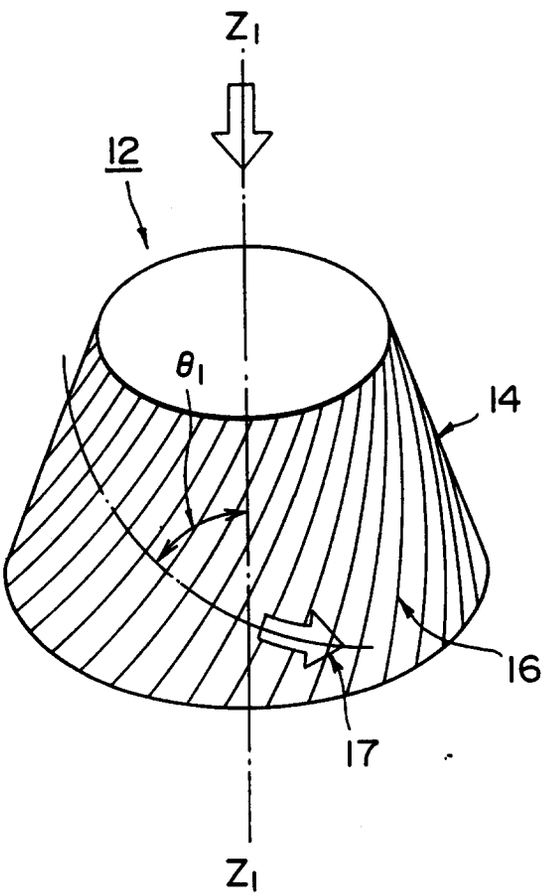


FIG. 1

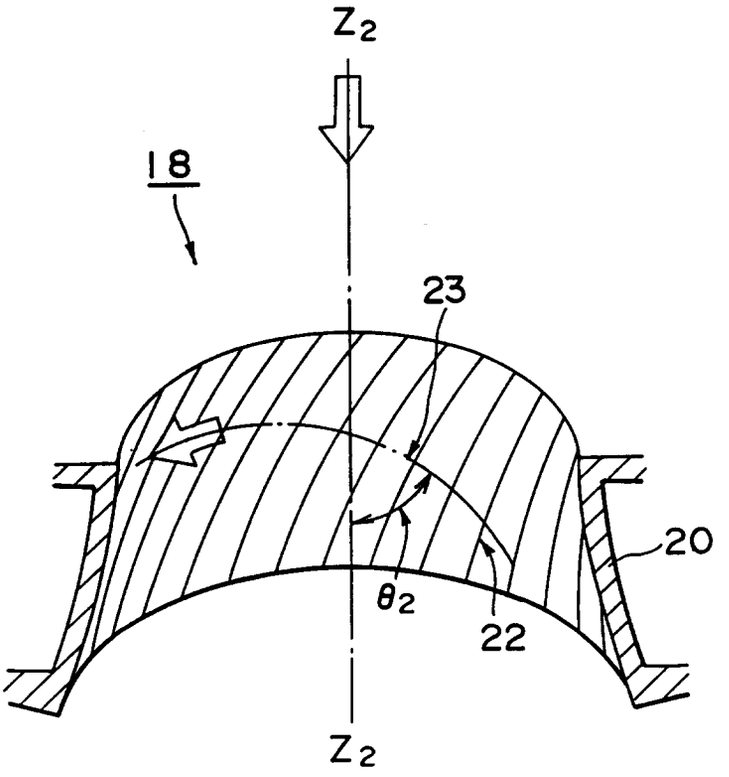


FIG. 2

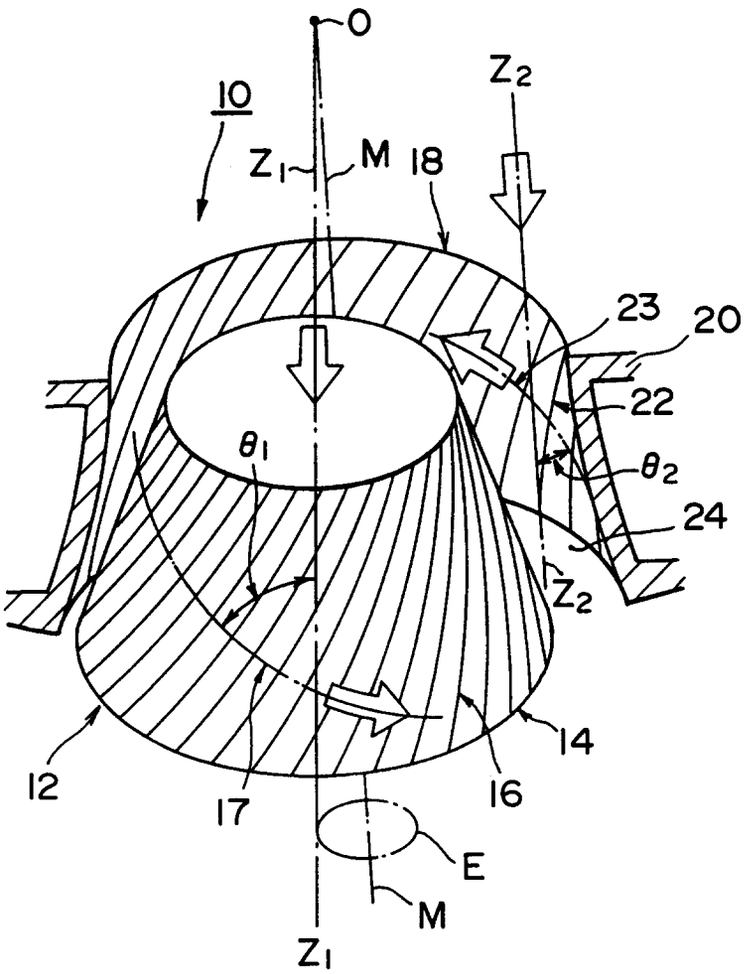


FIG. 3

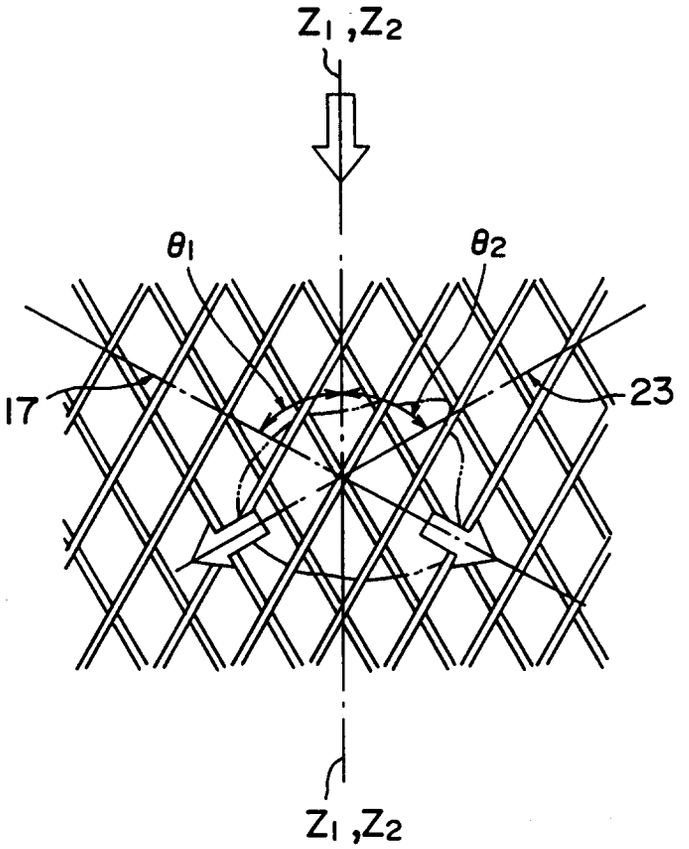


FIG. 4

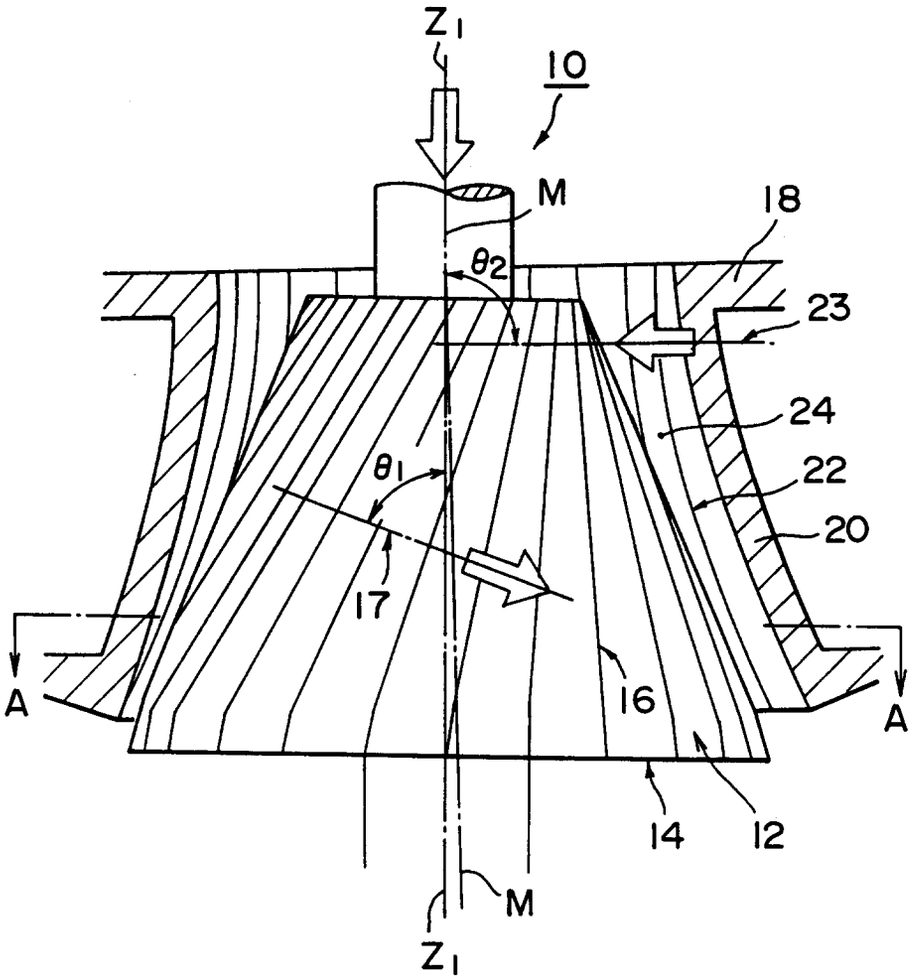


FIG. 5

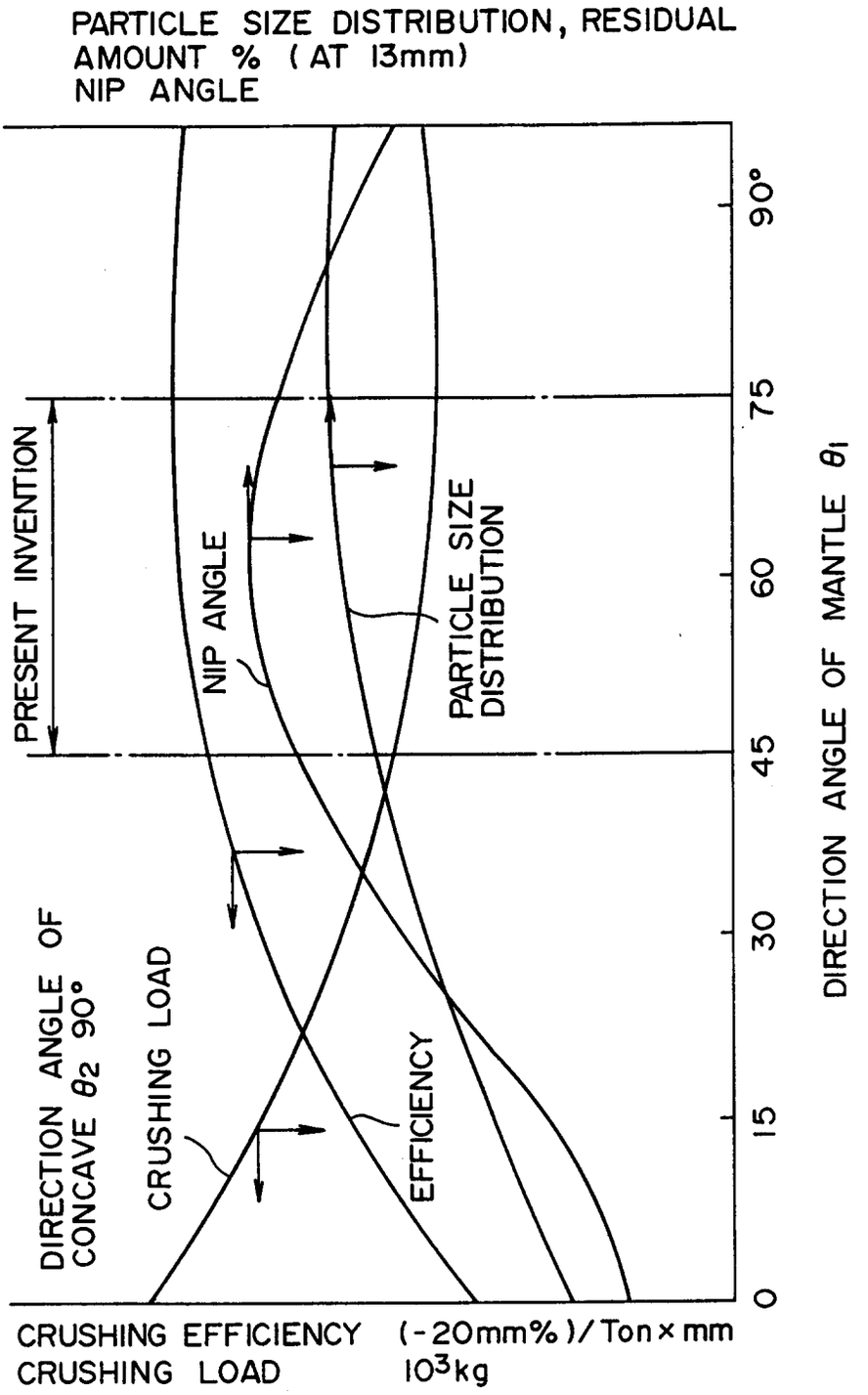

PARTICLE SIZE DISTRIBUTION, RESIDUAL AMOUNT % (AT 13mm)
NIP ANGLE
PRESENT INVENTION
NIP ANGLE
PARTICLE SIZE DISTRIBUTION
DIRECTION ANGLE OF CONCAVE θ2 90°
CRUSHING LOAD
EFFICIENCY
0
15
30
45
60
75
90°
DIRECTION ANGLE OF MANTLE θ1
CRUSHING EFFICIENCY (-20mm%)/Ton×mm
CRUSHING LOAD 10³kg

FIG. 6

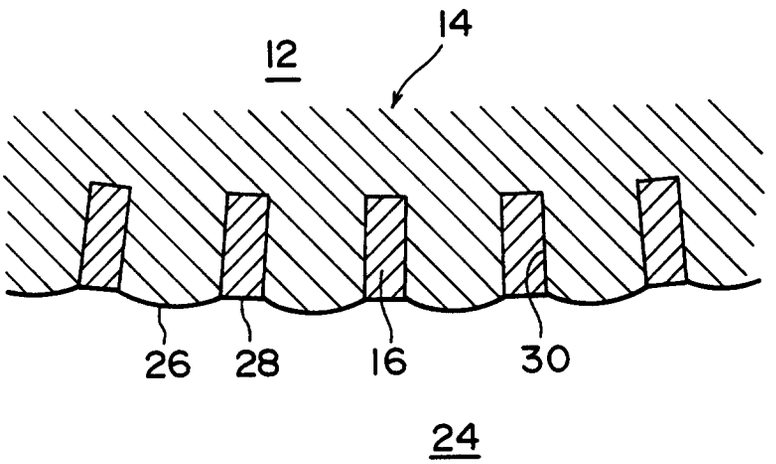


FIG. 7

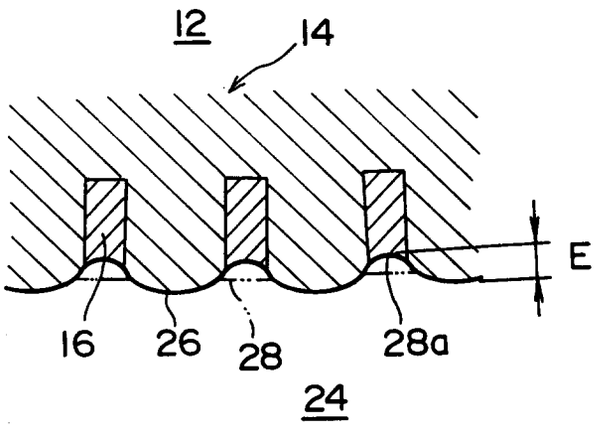


FIG. 8