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(54) Crushing member of gyratory crusher.

(57) A crushing member of a gyratory crusher for crushing materials successively from an upstream side towards a downstream side of a material flow direction. The crushing member comprises a mantle (1) having a frustoconical outer structure and composed of a teeth plate member (2) formed of a material having high anti-wearing property and a plurality of grooves (3,6,7) formed to an outer peripheral surface of the teeth plate member (2). The grooves (3,6,7) are arranged in a plurality of circumferential stages of the outer peripheral surface of the teeth plate member (2) so as to extend parallelly along a generating line of the mantle (1) and disposed with spaces from each other in the respective stages. Each of the grooves (3,6,7) formed to a peripheral surface portion on the downstream side of the material flow direction has a pitch and a width narrower stepwise than those of the grooves (3,6,7) formed to a peripheral surface portion of the upstream side of the material flow direction. The grooves of the downstream side are substituted with a plurality of groove forming members casted into the downstream side portion of the members disposed with spaces from each other. The groove forming members each has a pitch and a width relatively narrower than those of the grooves and is formed of a material having a low anti-wearing property.

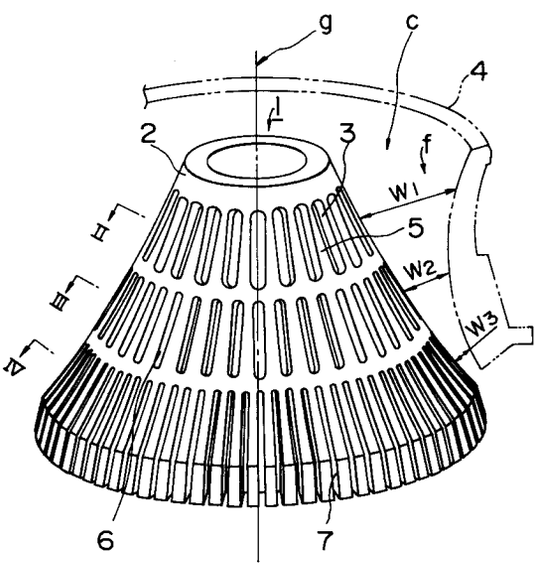

FIG. 1

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BACKGROUND OF THE INVENTION

The present invention relates to a crushing member (mantle and concave), of a grooved teeth plate structure, of a gyration type crusher such as cone crusher or gyratory crusher.

In the prior art, a crushing member of a gyratory crusher is composed of a grooved crushing plate member provided with, such as shown in Fig. 12 showing a mantle (movable member) 13 of a cone crusher, for example, a plurality of grooves 14 formed on an outer peripheral surface of the mantle 13 of frustoconical structure and extending in the same directions as that of a generating line g of the mantle 13. A crushing chamber 12 having a wedge-shaped section c is formed between the outer peripheral surface of the mantle 13 and a concave (fixed member of inverted frustoconical structure) 11 arranged around it.

In a gyratory crusher of the structure described above, as shown in Fig. 12, materials S to be treated and having sizes of D_1, D_2, D_3, D_4 ... corresponding to crushing gaps W_1, W_2, W_3, W_4, ... which are formed between the outer peripheral surface of the mantle 13 and the concave 11 and which are gradually made narrow from the upper portion towards the lower portion of the crushing chamber 12 as viewed in Fig. 12 along the material flow direction f, are sheared and crushed under compression caused by a gyration of the mantle 13.

In such a gyratory crusher, as shown in Fig. 13, it is basically necessary for the size D of the material S to be treated and a pitch P of teeth 16 of a grooved crushing member 15 to have a suitable relationship therebetween. Thus, it is desired that the ratio D/P is of about 2 to 5.

As shown in Fig. 14, in a case where the groove pitch P_1 of the teeth 16 of the grooved crushing member 15 is small with respect to the size D_1 of the material S, good crushing effect is not expected and the strength of the teeth 16 is itself insufficient, thereby resulting in causes of deformation, wearing and the like of the crushing member.

On the contrary, as shown in Fig. 15, in a case where the groove pitch P_2 of the teeth 16 is large with respect to the size D_2 of the material S, the crushing effect is degraded and crushed materials will enter into the grooves 17 and clog the same, thereby disturbing the smooth passing of the crushed products and hence adversely lowering the workability of the crusher.

However, the crushing member, particularly the mantle, of the conventional gyratory crusher of the structure described above has a frustoconical structure. Accordingly, it is impossible in its principle or basic shape in relation to a casting mold (such as relating a draft angle, strength of molding sand, baking and the like) to form the mantle so as to have an upper portion thereof with wide teeth having rough pitches and a lower portion thereof with fine teeth having fine pitches in accordance with the basic condition or requirement described hereinabove. Such formation of the mantle has a tendency that opposes this requirement. That is, the upper portion of the mantle has a fine pitch and the lower portion has a rough pitch, thus achieving no good crushing effect.

Furthermore, in the conventional crushing member of the gyratory crusher, the grooved teeth plate provides the following problems for the reason that it is considerably difficult to cast fine and deep grooves to the intermediate and lower surface portions of the outer peripheral surface of the crushing member.

(1). As shown in Figs. 16 and 17, a material 18 to be crushed enters into or bites the groove 17 of the crushing member 15 and the downward flow of the material to be treated is thereby hindered, resulting in the lowering of the throughput capacity.

(2). The groove 17 has a wide groove width, so that the width of each tooth 16 is relatively reduced, thus reducing the crushing surface area of the crushing member, which may result in the lowering of the material crushing ability. In the case of presence of proceeding wear, the lifetime of the crushing member is reduced.

(3). In the case of the material having a small feed size, as shown in Fig. 18, corner portions 16a of the teeth 16 are worn to become round surfaces, and when the roundness progresses, there may be the adverse case of it being impossible to crush the materials.

(4). In the case of hard rocks or the like having a high hardness to be treated, there may be caused a case where the teeth portion 16 falls down or is broken.

(5). In a case where a mud or water component is included in the material to be treated, the mud component may enter into or clog the grooves 17, which will cause wear and result in the lowering of the material throughput capacity.

In order to obviate the defects of such prior art, there has been also provided a crushing member in which two kinds of members having different anti-wear properties are provided on the surface of the teeth plate member alternately so as to extend in the same direction of the generating line and in which grooves are formed by the wearing of one of these members having relatively low anti-wear property when the material to be treated is crushed. Such prior art is disclosed in, for example, the Japanese Patent Publication No. 2-39939 (39939/1990) which corresponds to U.S. Patent No.

4,848,683. According to this prior art, when it is intended to make suitable the feed size of the material at the lower portion of the mantle, the pitch of the teeth at the upper portion thereof have to have extremely a small pitch with respect to the material to be treated.

Consequently, in any of the prior art, there has not yet been provided an improved technique for adequately satisfying the basic conditions or principle for the ideal crushing function.

SUMMARY OF THE INVENTION

An object of the present invention is to substantially eliminate the defects or drawbacks encountered in the prior art described above and to provide a crushing member of a gyratory crusher capable of satisfying the basic conditions required for a grooved teeth plate of the crushing member in correspondence with the feed size of the material to be treated at the downstream flow direction of the material.

This and other objects can be achieved according to the present invention by providing, in one aspect, a crushing member of a gyratory crusher for crushing materials successively from an upstream side towards a downstream side of a material flow direction, the crushing member comprising a mantle having a frustoconical outer structure and composed of a teeth plate member formed of a material having high anti-wearing property and a plurality of grooves formed to an outer peripheral surface of the teeth plate member. The grooves are arranged in a plurality of circumferential stages of the outer peripheral surface of the teeth plate member so as to extend in the direction of a generating line of the mantle and disposed with spaces from each other in the respective stages. The grooves are formed to a peripheral surface portion on the downstream side of the material flow direction each having a pitch and a width narrower stepwise than those of the grooves formed to a peripheral surface portion of the upstream side of the material flow direction.

The grooves formed to the downstream side of the material flow direction are increased in number in comparison with the grooves formed to the upstream side thereof.

In another aspect, there is provided a crushing member of a gyratory crusher for crushing materials successively from an upstream side towards a downstream side of a material flow direction, the crushing member comprising a mantle having a frustoconical outer structure and composed of a teeth plate member formed of a material having high anti-wearing property. A plurality of grooves are formed to an outer peripheral surface of the teeth plate member, the grooves are arranged to the upstream side portion of an outer peripheral surface of the teeth plate member so as to extend in the direction of a generating line of the mantle and disposed with spaces from each other. The grooves have a relatively wide pitch and width, and a plurality of groove forming members are disposed to the downstream side portion of the outer peripheral surface of the teeth plate member so as to extend in the same direction of the generating line of the mantle and disposed with spaces from each other. The groove forming members have a relatively narrow pitch and width and are formed of a material having a low anti-wearing property.

The groove forming members are casted into the outer peripheral surface of the teeth plate member. The groove forming members are arranged in a plurality of circumferential stages of the outer peripheral surface of the teeth plate member at the downstream side portion of the grooved upstream side portion thereof in a manner that the groove forming members arranged in a downstream side stage each has a pitch and a width narrower stepwise than those of each of the grooves formed to an upstream side stage of the peripheral surface portion of the teeth plate member.

According to the aspects of the present invention described above, the grooves or groove forming members, which are formed as grooves by the wearing thereof at a time of the material crushing operation, are formed or disposed in a plurality of circumferential stages to the outer peripheral surface of the teeth plate member of the frustoconical mantle. The pitches and the widths of these grooves and groove forming members are designed so as to have narrow pitches and widths at the downstream side stage of the material flow direction with respect to the upstream side portion, and they are also increased in their number . Accordingly, the crushing member can crush the materials in accordance with the sizes of the materials along the flow direction thereof, thus improving the crushing ability of the gyratory crusher.

In another aspect, there is provided a

crushing member of a gyratory crusher for crushing materials successively from an upstream side towards a downstream side of a material flow direction, comprising:

a concave having an inverted frustoconical inner structure and composed of a teeth plate member formed of a material having high anti-wearing property; and

a plurality of grooves formed to an inner peripheral surface of the teeth plate member,

said grooves being arranged in a plurality of circumferential stages along the material flow direction of the inner peripheral surface of the teeth plate member so as to extend in the direction of a

generating line of the concave and disposed with spaces from each other in the respective circumferential stages, the grooves formed to a peripheral surface portion on the downstream side of the material flow direction each having a pitch and a width narrower stepwise than those of the grooves formed to a peripheral surface portion of the upstream side of the material flow direction.

In another aspect, there is provided a

crushing member of a gyratory crusher for crushing materials successively from an upstream side towards a downstream side of a material flow direction, comprising:

a concave having an inverted frustoconical inner structure and composed of a teeth plate member formed of a material having high anti-wearing property;

a plurality of grooves formed to an inner peripheral surface of the teeth plate member, said grooves being arranged to the upstream side portion of an inner peripheral surface of the teeth plate member so as to extend in the direction of a generating line of the concave and disposed with spaces from each other, said grooves each having a relatively wide pitch and width; and

a plurality of groove forming members disposed to the downstream side portion of the inner peripheral surface of the teeth plate member so as to extend in the

direction of a generating line of the concave and disposed with spaces from each other, said groove forming members each having a relatively narrow pitch and width with respect to the grooves formed to the upstream side of the concave and being formed of a material having a low anti-wearing property.

In another aspect, there is provided a

gyratory crusher for crushing materials successively from an upstream side towards a downstream side of a material flow direction, comprising:

a mantle having a frustoconical outer structure and composed of a teeth plate member formed of a material having high anti-wearing property;

a concave co-axially arranged around the mantle and having an inverted frustoconical inner structure and composed of a teeth plate member formed of a material having high anti-wearing property; and

a plurality of grooves formed to a peripheral surface of each teeth plate member,

said grooves being arranged in a plurality of circumferential stages along the material flow direction of the peripheral surface of each teeth plate member so as to extend in the direction of a generating line of the mantle and the concave and disposed with spaces from each other in the respective circumferential stages, the grooves formed to a peripheral surface portion on the downstream side of the material flow direction each having a pitch and a width narrower stepwise than those of the grooves formed to a peripheral surface portion of the upstream side of the material flow direction.

In another aspect, there is provided a

gyratory crusher for crushing materials successively from an upstream side towards a downstream side of a material flow direction, comprising:

a mantle having a frustoconical outer structure and composed of a teeth plate member formed of a material having high anti-wearing property;

a concave co-axially arranged around the mantle and having an inverted frustoconical inner structure and composed of a teeth member formed of a material having high anti-wearing property;

a plurality of grooves formed to a peripheral surface of each teeth plate member, said grooves being arranged to the upstream side portion of an outer peripheral surface of the teeth plate member so as to extend in the direction of a generating line of the mantle and the concave and disposed with spaces from each other, said grooves each having a relatively wide pitch and width; and

a plurality of groove forming members disposed to the downstream side portion of the outer peripheral surface of the teeth plate member so as to extend in the

direction of a generating line of the mantle and the concave and disposed with spaces from each other, said groove forming members each having a relatively narrow pitch and width with respect to the grooves formed to the upstream side of the mantle and being formed of a material having a low anti-wearing property.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a mantle as a crushing member of a gyratory crusher according to a first embodiment of the present invention;

Figs. 2, 3 and 4 are partial sectional views taken along the lines II-II, III-III and IV-IV of Fig. 1;

Figs. 5, 6 and 7 are views corresponding to Figs. 2, 3 and 4, respectively, for describing the operation of grooved teeth portions of the crushing member;

Fig. 8 is a perspective view of a mantle as a crushing member of a gyratory crusher according to a second embodiment of the present invention;

Figs. 9, 10 and 11 are partial sectional views taken along the lines IX-IX, X-X and XI-XI of Fig. 8;

Fig. 12 is a front view of a mantle of a conventional gyratory crusher;

Fig. 13 is a partial sectional view of a grooved teeth portion of the mantle for describing a basic

condition for the operation of the grooved teeth plate member;

Fig. 14 is a view for describing a case wherein the basic condition for the ideal crushing function is not satisfied because of the teeth portion having a small pitch;

Fig. 15 is a view for describing a case wherein the basic condition is not satisfied because of the teeth portion having a wide pitch;

Fig. 16 is a partial sectional view of the conventional mantle of bad condition in function;

Fig. 17 is an illustration in part of a conventional gyratory crusher; and

Fig. 18 is a partial sectional view of a grooved teeth portion of the conventional mantle in a case where materials each having a feed size smaller with respect to grooves of the grooved teeth plate are fed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first embodiment of a mantle as a crushing member of a gyratory crusher according to the present invention will be first described hereunder with reference to Fig. 1.

Referring to Fig. 1, a mantle 1 is composed of a teeth plate member 2 of frustoconical structure made of a high manganese cast steel including manganese of 13 wt% or more. The outer peripheral surface of the frustoconical mantle 1 is divided into three circumferential stage portions, i.e. upper, intermediate and lower staged surface portions, of the teeth plate member 2 along the material flow direction f.

As shown in Figs. 1 and 2, a plurality of grooves 3 and teeth 5 are formed to the upper surface portion of the teeth plate member 2 so as to extend parallel in the same direction of a generating line g of the mantle 1 and disposed with spaces with each other along the peripheral surface of the mantle 1 with relatively large pitches P_1 (See Fig. 5). Each of the grooves 3 has a relatively wide width and deep depth corresponding to the wearing limit of the teeth plate member 2. The pitch P_1 is determined so as to satisfy the basic condition for the ideal crushing function in relation to a size D_1 of a material S to be treated corresponding to a gap W_1 (See Fig. 1) between the upper surface portion of the teeth plate member 2 and a concave 4 arranged around it as shown in Fig. 5. The space between the outer peripheral surface of the teeth plate member 2 and the conecave 4 is called a crushing chamber C. Each tooth 5 formed between the adjacent grooves 3, 3 has a thickness t_1, as shown in Fig. 5, capable of withstanding the strength of the material S.

As shown in Figs. 1 and 3, a plurality of grooves 6 are formed to the intermediate surface portion of the teeth plate member 2 so as to extend parallel in the same direction of the generating line g of the mantle and disposed with spaces with each other along the peripheral surface of the mantle 1 with pitches P_2 each narrower than that of P_1. Each of the grooves 6 has a width smaller than that of the groove 3 and a depth equal to that of the groove 3. The pitch P_2 is determined so as to satisfy the basic condition in relation to a size D_2 of the material S to be treated corresponding to a gap W_2 (See Fig. 1) in the crushing chamber C between the intermediate surface portion of the teeth plate member 2 and the concave 4.

Furthermore, as shown in Figs. 1 and 4, a plurality of grooves 7 are formed to the lower portion of the teeth plate member 2 so as to extend parallelly in the same direction of the generating line g of the mantle 1 and disposed with spaces with each other along the peripheral surface of the mantle 1 with pitches P_3 each narrower than that of P_2. Each of the grooves 7 has a width smaller than that of the groove 6 and a depth equal to that of the groove 6. The pitch P_3 is determined so as to satisfy the basic condition in relation to a size D_3 of the material S to be treated corresponding to a gap W_3 (See Fig. 1) in the crushing chamber C between the lower surface portion of the teeth plate member 2 and the concave 4.

In the gyratory crusher provided with the mantle 1 of the structures described above, the pitches and the widths of the grooves 3, 6, 7 formed to the outer peripheral surface of the mantle 1 are made smaller or narrower from the upper portion towards the lower portion in three circumferential stages along the material flow direction f, and the grooves 3, 6, 7 are also increased in number in the respective stages.

Accordingly, the materials S each having the size D_1 fed from the upper side of a crushing chamber C formed between the mantle 1 and the concave 4 are first crushed in an ideal state at the upper portion of the crushing chamber C into materials each having a size D_2. These materials S are then fallen down into an intermediate portion of the crushing chamber C and subjected to the crushing operation by the intermediate teeth portion having grooves 6 of the structures described above into materials each having a size D_3. The materials S thereafter fall down into the lower crushing chamber C and are subjected to the same crushing operation into materials each having a desired size, and the materials thus crushed in three stages are finally discharged out of the gyratory crusher.

Fig. 8 shows a second embodiment according to the present invention, which includes a mantle 8 as a crushing member having a teeth plate mem-

ber 2 having substantially the same grooved structure in the upper portion thereof as that of the first embodiment shown in Fig. 1. Namely, the outer peripheral surface of the teeth plate member 2 is divided into three, i.e. upper, intermediate and lower, circumferential stage portions along the material flow direction f thereof. The grooves 3 are formed to the upper portion of the peripheral surface of the teeth plate member 2 as shown in Figs. 8 and 9.

However, as shown in Figs. 8 and 10, to the intermediate portion of the teeth plate member 2 are disposed groove forming members 9 formed of a mild steel such as SS41 (JIS) and each having substantially a rectangular shape and having a thickness smaller than the width of the groove 3. The groove forming members 9 are disposed parallelly along the outer peripheral surface of the teeth plate member 2 so as to extend in the direction of the generating line g of the teeth plate member 2 with spaces and with pitches each being smaller than that of the groove 3. The groove forming members 9 are cast into the peripheral surface of the teeth plate member 2 so that the side portions thereof are exposed outward from the peripheral surface of the teeth plate member 2.

Furthermore, as shown in Figs. 8 and 11, to the lower peripheral portion of the teeth plate member 2 are disposed groove forming members 10 formed of the same material as that of the groove forming members 9, and each having substantially a rectangular shape and having a thickness smaller than that of the groove forming member 9. The groove forming members 10 are also disposed parallelly along the outer peripheral surface of the teeth plate member 2 so as to extend in the direction of the generating line of the teeth plate member 2 with spaces and with pitches each being smaller than that of the groove forming member 9. The groove forming members 10 are casted into the peripheral surface of the teeth plate member 2 so that the side portions thereof are exposed outwardly from the peripheral surface of the teeth plate member 2.

According to the gyratory crusher provided with the mantle 8 of the structure described above as shown in Fig. 8, grooves are formed at portions corresponding to the groove forming members 9 and 10 by the wearing at the time of the crushing of the materials to be treated. Accordingly, substantially the same effects as that of the first embodiment can be achieved. In addition, according to this embodiment, grooves obtained have narrower widths and deeper depths than those formed by casting.

It is, of course, to be noted that in the foregoing embodiments, the outer peripheral surface of the mantle is divided into three circumferential stages along the material flow direction. But the present invention is not limited to this structure and the peripheral surface may be divided into two or more than three stages.

Furthermore, the grooved structures of the present embodiments may also be applied to the concave 4 of the gyratory crusher, which has an inverted frustoconical inner surface structure.

Claims

1. A crushing member of a gyratory crusher for crushing materials successively from an upstream side towards a downstream side of a material flow direction, comprising:

a mantle having a frustoconical outer structure and composed of a teeth plate member formed of a material having high antiwearing property; and

a plurality of grooves formed to an outer peripheral surface of the teeth plate member,

said grooves being arranged in a plurality of circumferential stages along the material flow direction of the outer peripheral surface of the teeth plate member so as to extend in the direction of a generating line of the mantle and disposed with spaces from each other in the respective circumferential stages, the grooves formed to a peripheral surface portion on the downstream side of the material flow direction each having a pitch and a width narrower stepwise than those of the grooves formed to a peripheral surface portion of the upstream side of the material flow direction.

2. The crushing member according to claim 1, wherein said grooves formed to the downstream side of the material flow direction are increased in number in comparison with the grooves formed to the upstream side thereof.

3. A crushing member of a gyratory crusher for crushing materials successively from an upstream side towards a downstream side of a material flow direction, comprising:

a mantle having a frustoconical outer structure and composed of a teeth plate member formed of a material having high antiwearing property;

a plurality of grooves formed to an outer peripheral surface of the teeth plate member, said grooves being arranged to the upstream side portion of an outer peripheral surface of the teeth plate member so as to extend in the same directions as that of a generating line of the mantle and disposed with spaces from each other, said grooves each having a relatively wide pitch and width; and

a plurality of groove forming members dis-

posed to the downstream side portion of the outer peripheral surface of the teeth plate member so as to extend in the

direction of a generating line of the mantle and disposed with spaces from each other, said groove forming members each having a relatively narrow pitch and width with respect to the grooves formed to the upstream side of the mantle and being formed of a material having a low anti-wearing property.

4. The crushing member according to claim 3, wherein said groove forming members are casted into the outer peripheral surface of the teeth plate member.

5. The crushing member according to claim 3 or 4, wherein said groove forming members are arranged in a plurality of circumferential stages of the outer peripheral surface of the teeth plate member at the downstream side portion of the grooved upstream side portion in a manner that the groove forming members arranged in a downstream side circumferential stage each has a pitch and a width narrower stepwise than those of the grooves formed to an upstream side stage of the peripheral surface portion of the teeth plate member.

6. A crushing member of a gyratory crusher for crushing materials successively from an upstream side towards a downstream side of a material flow direction, comprising:

a concave having an inverted frustoconical inner structure and composed of a teeth plate member formed of a material having high anti-wearing property; and

a plurality of grooves formed to an inner peripheral surface of the teeth plate member,

said grooves being arranged in a plurality of circumferential stages along the material flow direction of the inner peripheral surface of the teeth plate member so as to extend in the direction of a generating line of the concave and disposed with spaces from each other in the respective circumferential stages, the grooves formed to a peripheral surface portion on the downstream side of the material flow direction each having a pitch and a width narrower stepwise than those of the grooves formed to a peripheral surface portion of the upstream side of the material flow direction.

7. The crushing member according to claim 6, wherein said grooves formed to the downstream side of the material flow direction are increased in number in comparison with the grooves formed to the upstream side thereof.

8. A crushing member of a gyratory crusher for crushing materials successively from an upstream side towards a downstream side of a material flow direction, comprising:

a concave having an inverted frustoconical inner structure and composed of a teeth plate member formed of a material having high anti-wearing property;

a plurality of grooves formed to an inner peripheral surface of the teeth plate member, said grooves being arranged to the upstream side portion of an inner peripheral surface of the teeth plate member so as to extend in the direction of a generating line of the concave and disposed with spaces from each other, said grooves each having a relatively wide pitch and width; and

a plurality of groove forming members disposed to the downstream side portion of the inner peripheral surface of the teeth plate member so as to extend in the

direction of a generating line of the concave and disposed with spaces from each other, said groove forming members each having a relatively narrow pitch and width with respect to the grooves formed to the upstream side of the concave and being formed of a material having a low anti-wearing property.

9. The crushing member according to claim 8, wherein said groove forming members are casted into the inner peripheral surface of the teeth plate member.

10. The crushing member according to claim 8 or 9, wherein said groove forming members are arranged in a plurality of circumferential stages of the inner peripheral surface of the teeth plate member at the downstream side portion of the grooved upstream side portion in a manner that the groove forming members arranged in a downstream side circumferential stage each has a pitch and a width narrower stepwise than those of the grooves formed to an upstream side stage of the peripheral surface portion of the teeth plate member.

11. A gyratory crusher for crushing materials successively from an upstream side towards a downstream side of a material flow direction, comprising:

a mantle having a frustoconical outer structure and composed of a teeth plate member formed of a material having high anti-wearing property;

a concave co-axially arranged around the mantle and having an inverted frustoconical inner structure and composed of a teeth plate

member formed of a material having high anti-wearing property; and

a plurality of grooves formed to a peripheral surface of each teeth plate member,

said grooves being arranged in a plurality of circumferential stages along the material flow direction of the peripheral surface of each teeth plate member so as to extend in the direction of a generating line of the mantle and the concave and disposed with spaces from each other in the respective circumferential stages, the grooves formed to a peripheral surface portion on the downstream side of the material flow direction each having a pitch and a width narrower stepwise than those of the grooves formed to a peripheral surface portion of the upstream side of the material flow direction.

12. The gyratory crusher according to claim 11, wherein said grooves formed to the downstream side of the material flow direction are increased in number in comparison with the grooves formed to the upstream side thereof.

13. A gyratory crusher for crushing materials successively from an upstream side towards a downstream side of a material flow direction, comprising:

a mantle having a frustoconical outer structure and composed of a teeth plate member formed of a material having high anti-wearing property;

a concave co-axially arranged around the mantle and having an inverted frustoconical inner structure and composed of a teeth member formed of a material having high anti-wearing property;

a plurality of grooves formed to a peripheral surface of each teeth plate member, said grooves being arranged to the upstream side portion of an outer peripheral surface of the teeth plate member so as to extend in the direction of a generating line of the mantle and the concave and disposed with spaces from each other, said grooves each having a relatively wide pitch and width; and

a plurality of groove forming members disposed to the downstream side portion of the outer peripheral surface of the teeth plate member so as to extend in the

direction of a generating line of the mantle and the concave and disposed with spaces from each other, said groove forming members each having a relatively narrow pitch and width with respect to the grooves formed to the upstream side of the mantle and being formed of a material having a low anti-wearing property.

14. The gyratory crusher according to claim 13, wherein said groove forming members are casted into the peripheral surface of each teeth plate member.

15. The gyratory crusher according to claim 13 or 14, wherein said groove forming members are arranged in a plurality of circumferential stages of the peripheral surface of each teeth plate member at the downstream side portion of the grooved upstream side portion in a manner that the groove forming members arranged in a downstream side circumferential stage each has a pitch and a width narrower stepwise than those of the grooves formed to an upstream side stage of the peripheral surface portion of the teeth plate member.

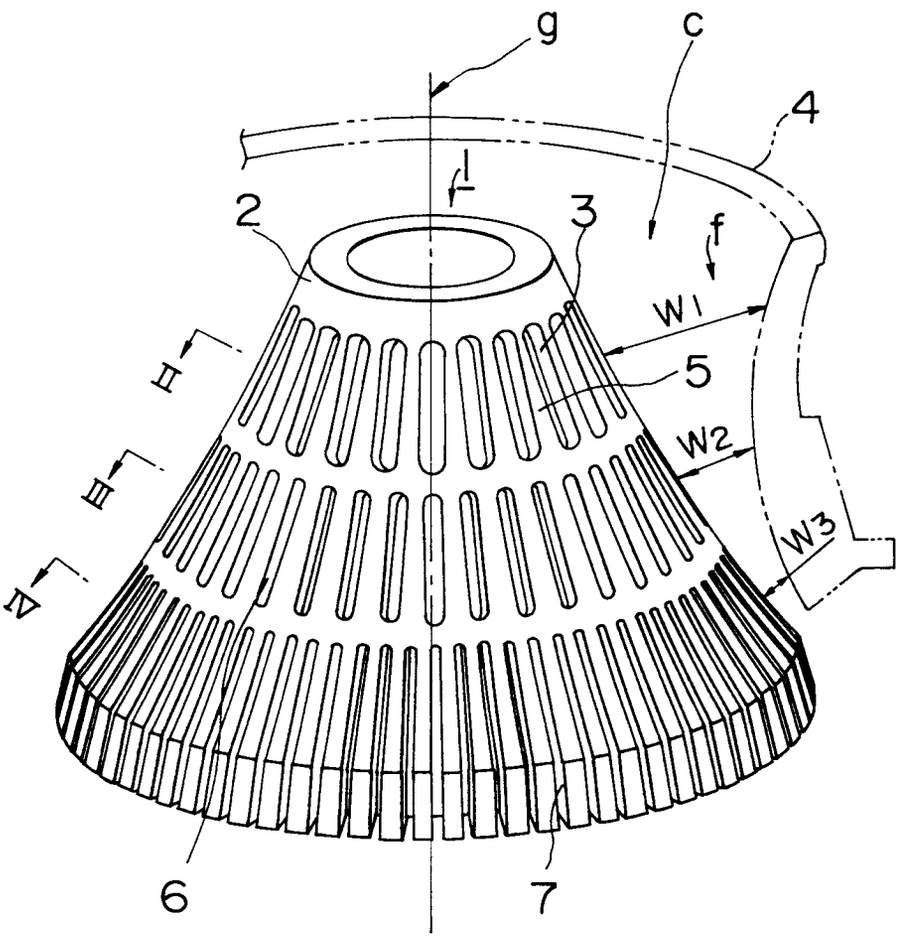

FIG. 1

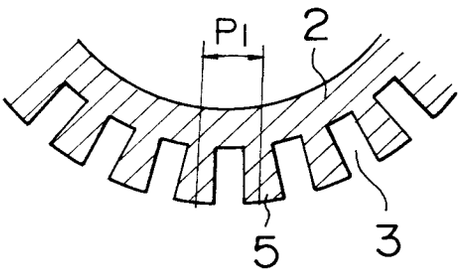

FIG. 2

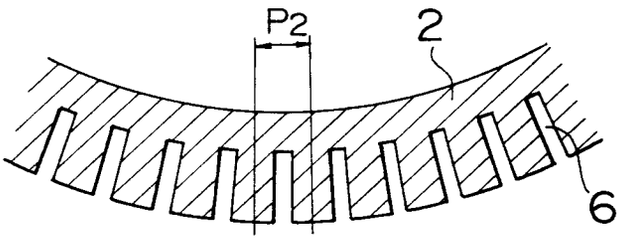

FIG. 3

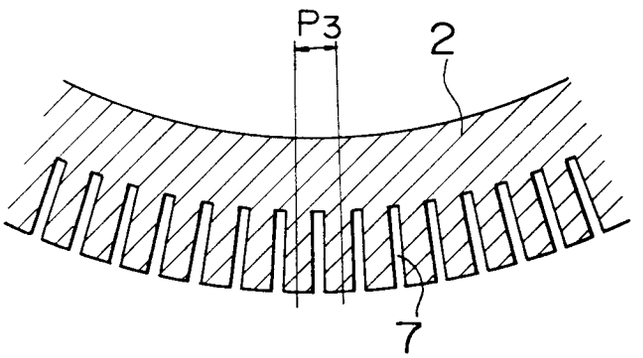

FIG. 4

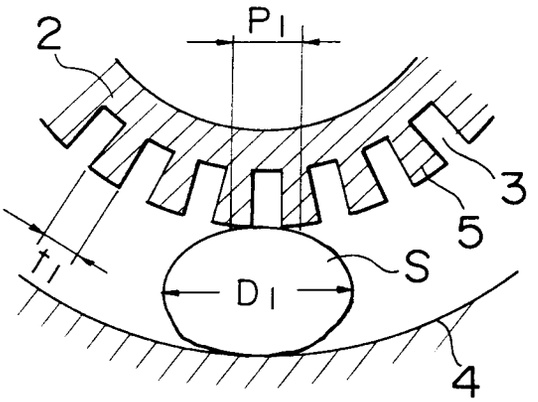

FIG. 5

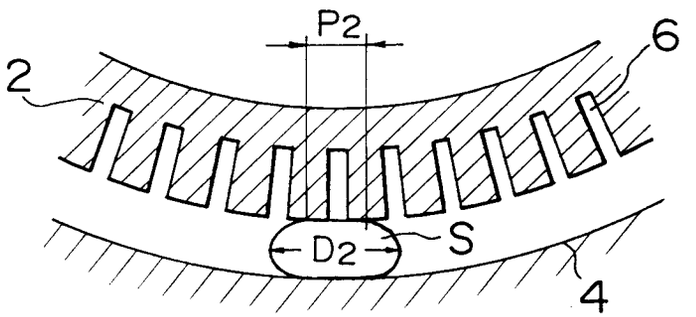

FIG. 6

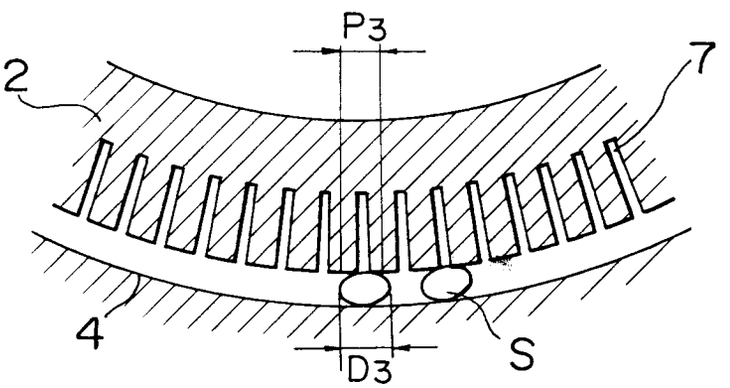

FIG. 7

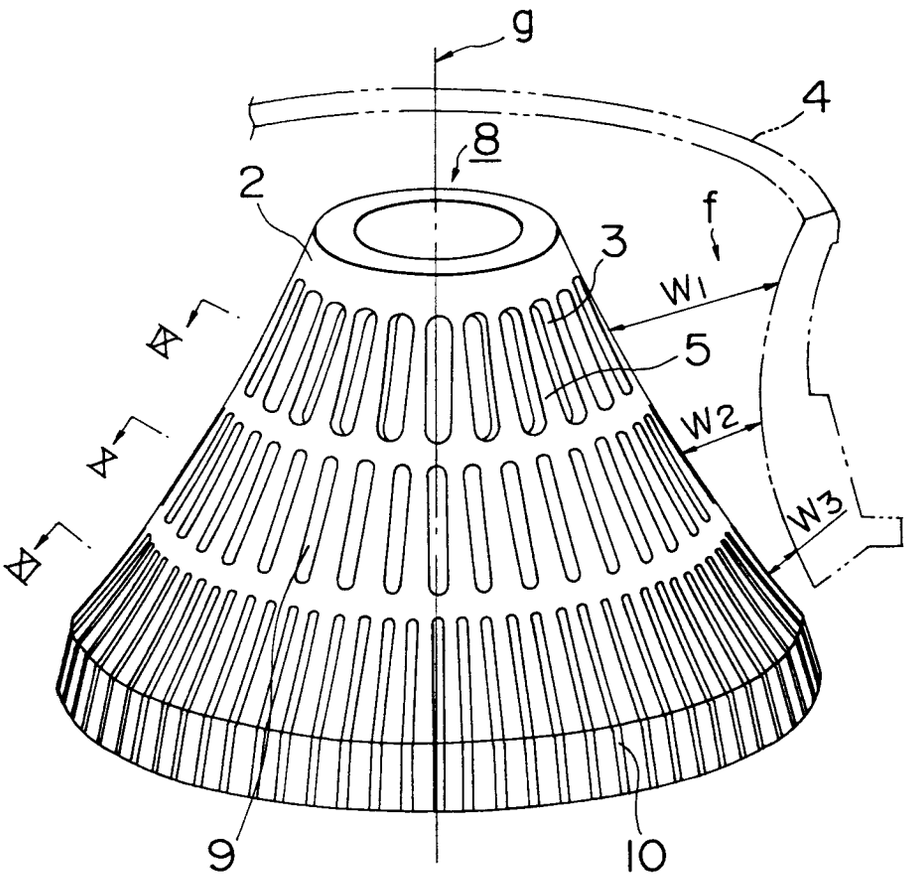

FIG. 8

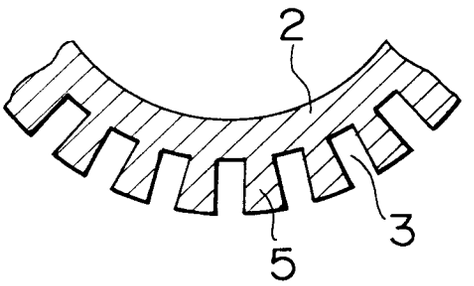

FIG. 9

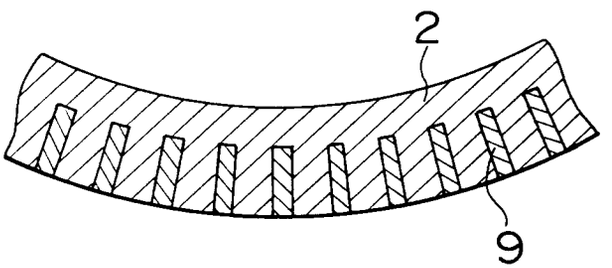

FIG. 10

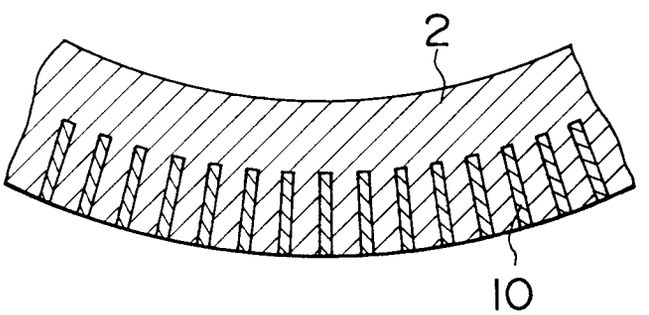

FIG. 11

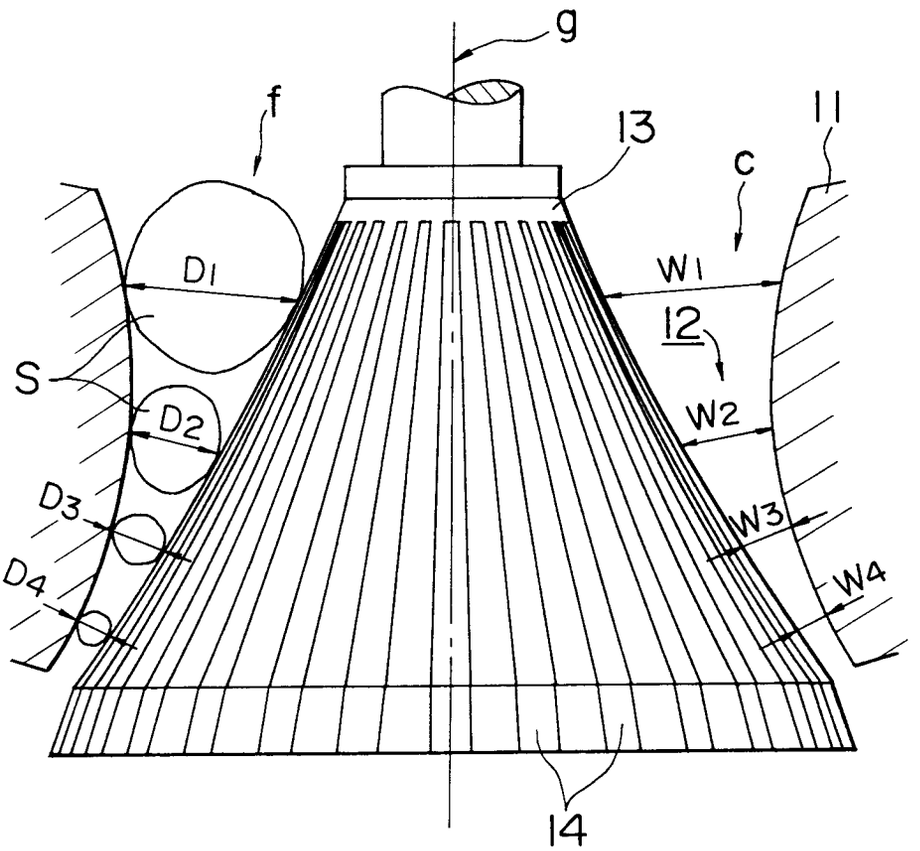

FIG.12
PRIOR ART

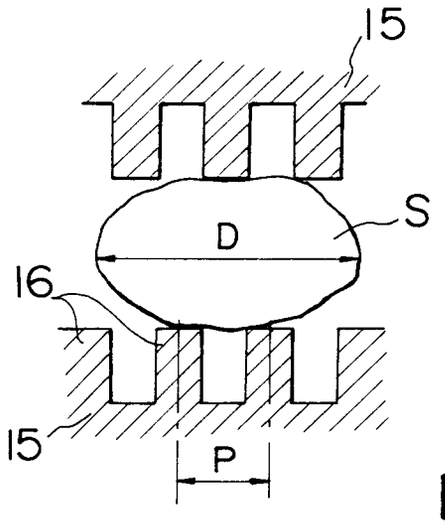

FIG.13
PRIOR ART

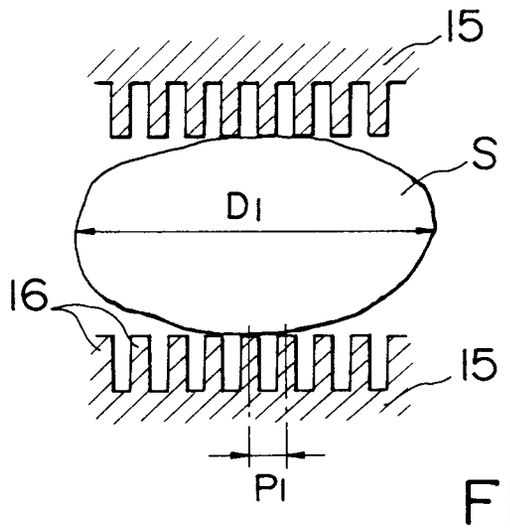

FIG.14
PRIOR ART

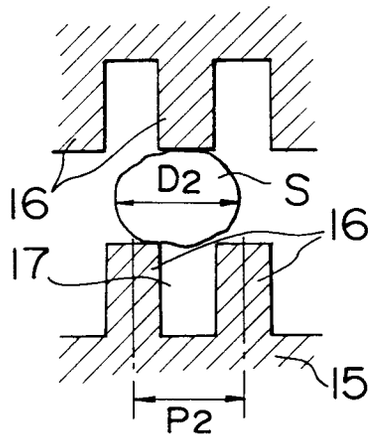

FIG.15
PRIOR ART

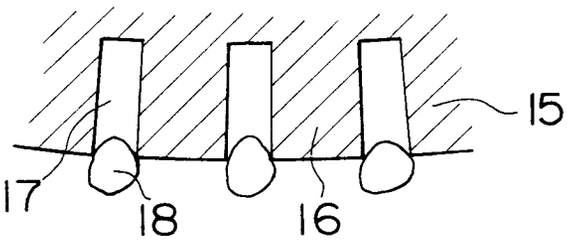

FIG.16
PRIOR ART

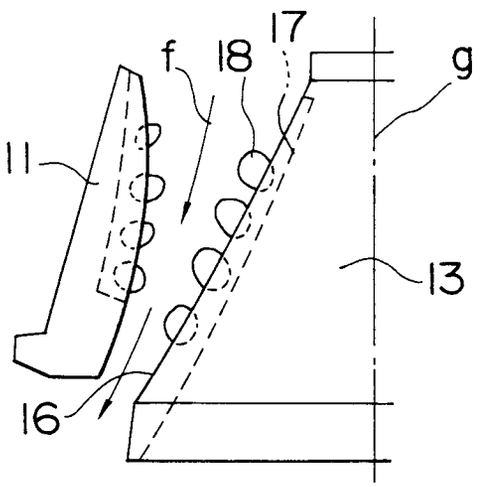

FIG.17
PRIOR ART

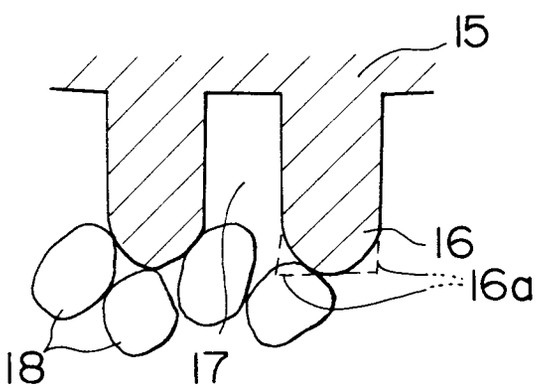

FIG.18
PRIOR ART

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 10 5382

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	AU-B-578 377 (KAWASAKI JUKOGYO KABUSHIKI KAISHA) * claims 1-6 *	1,6,11	B02C2/00
A	SOVIET INVENTIONS ILLUSTRATED Section PQ, Week D37, 21 October 1981 Derwent Publications Ltd., London, GB; Class P41, AN J6300 D & SU-A-791 421 (CONS MATLS HYDROMEC) 30 December 1980 * abstract *	1,6,11	
A	WORLD PATENTS INDEX LATEST Section PQ, Week 9003, Derwent Publications Ltd., London, GB; Class P41, AN 90-020629 & SU-A-1 470 320 (MOSCOW MEAT DAIRY INST.) 7 April 1989 * abstract *	1-3,5-8, 10-13,15	
A	EP-A-0 306 023 (KAWASAKI JUKOGYO KABUSHIKI KAISHA) * abstract; figure 1 *	1,6,11	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A,D	US-A-4 848 683 (H. KAWATSU) * the whole document *	1,3,4,6, 8,9,11, 13,14	B02C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 JUNE 1992	VERDONCK J.C.M.J.

CATEGORY OF CITED DOCUMENTS

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