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(71) Applicant: **Okuya, Yasuaki**
Nishio-City,
Aichi-Pref. 444-0305 (JP)

(72) Inventor: **Okuya, Yasuaki**
Nishio-City,
Aichi-Pref. 444-0305 (JP)

(74) Representative: **Beresford, Keith Denis Lewis**
BERESFORD & Co.
16 High Holborn
London
WC1V 6BX (GB)

(54) **Cutter device mounted on casting breaking apparatus, and method of enhancing the hardness of cutter device**

(57) In a related art, fixed and movable cutter units (casting breaking apparatus) having open top and bottom are composed of fixed and movable cutter supporting parts, fixed and movable cutter plates (referred to as "fixed and movable cutter plates") provided in the fixed and movable cutter supporting parts, a number of ridged fixed and movable cutters provided in the fixed and movable cutter plates so as to project therefrom and having a mutually fitting relationship, and a cylinder capable of moving the movable cutter plates, and sliding surfaces of both sides of the movable cutter supporting part and/or movable cutter plate advances or retreats along the inner surfaces of side plates.

To explain the crushing and breaking operation (method) of this casting breaking apparatus, during advancement or retreat of the movable cutter plate, a casting waste is loaded through a loading opening formed between the movable cutter plate and the fixed cutter plate, the movable cutter plate is caused to advance or retreat via the cylinder, and the casting waste is broken using the fitting and/or pressing relationship between the movable cutter of the movable cutter plate and the fixed cutter of the fixed cutter plate. The sliding surfaces of the movable cutter plate advance or retreat so as to come into sliding contact with the side plates of the casting breaking apparatus. This advancement causes a casting waste loaded into the casting breaking apparatus to be broken, and the retreat causes the broken casting waste

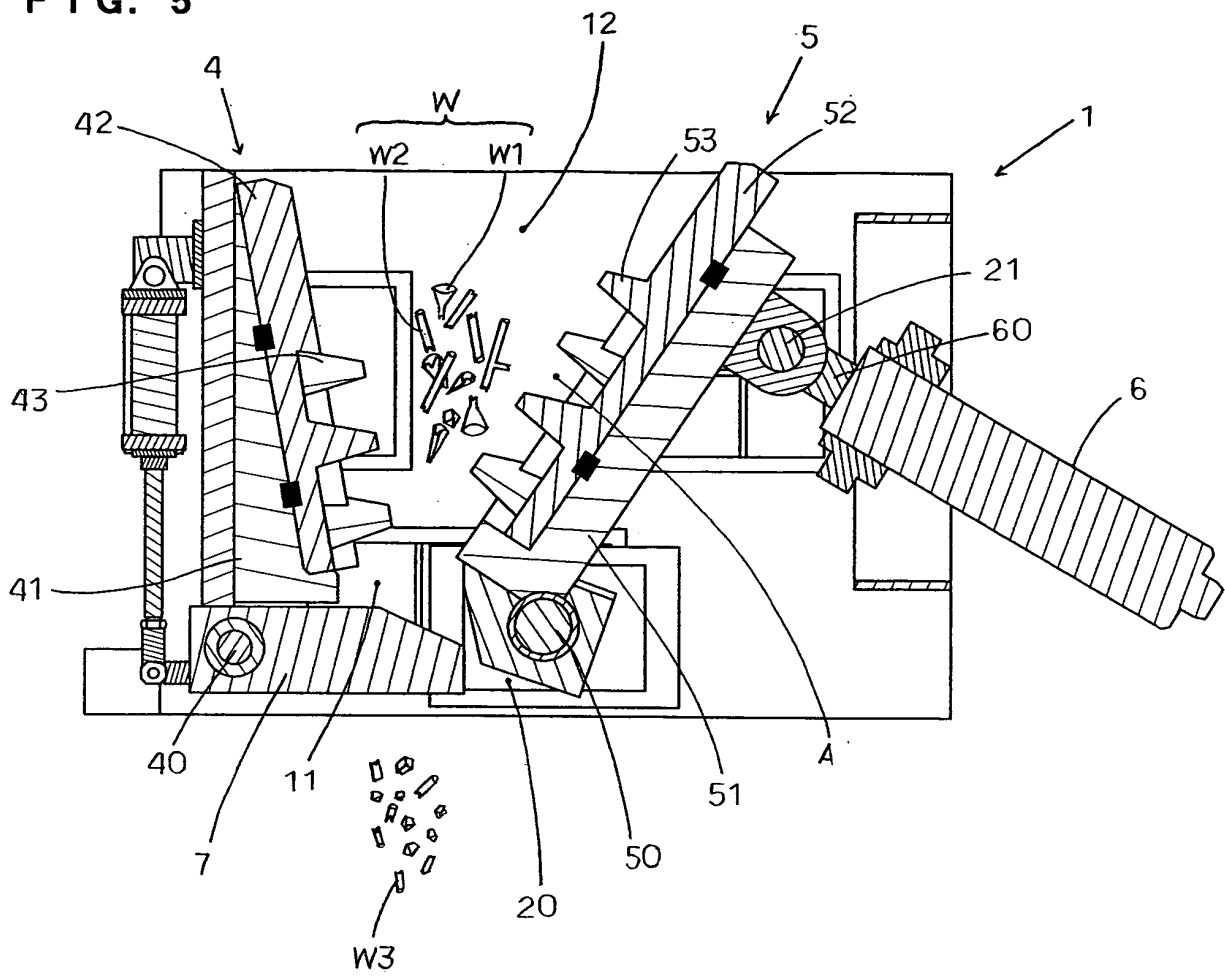
piece to be discharged by natural drop through a discharge port between the movable cutter plate and the fixed cutter plate.

In this type of casting breaking apparatus, the toughness and wear resistance of the fixed cutter plate and/or fixed cutters are required. Therefore, there are adverse effects that deposit welding and the operation of giving impact to the deposit welding are performed after casting of the fixed cutters, advanced skill and labor are required, operation becomes complicated, working hours are required, and the like.

In consideration of the above circumstances, in the invention, high-manganese steel is mixed in the fixed cutter plate and/or fixed cutters. This eliminates a structure of performing deposit welding and giving impact to the deposit welding, thereby ensuring toughness and wear resistance after casting of the fixed cutters. Thereby, for example, advanced skill and labor required for welding and/or deposit operation is eliminated, operation is simplified, and working hour is shortened. Also, the fixed cutters can be made into a structure which is not broken, loss of the fixed cutters can be avoided, and mixing of chips of high-manganese steel constituting the fixed cutters into a regenerated casting is eliminated (mixing of high-manganese steel by wear does not become a hindrance so much). Also, quality deterioration of a regenerated casting is avoided.

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FIG. 5



Description

Technical Field

[0001] The present invention provides a cutter device mounted on a casting breaking apparatus which crushes and breaks (referred to as "break") casting wastes, such as gates, runners, weirs and defective castings, and a method of enhancing the hardness of the cutter device.

Background Art

[0002] As for the cutter device mounted on a casting breaking apparatus, and the method of enhancing the hardness of the cutter device, inventions related to the present applicant's suggestion are disclosed in Japan, America, or Europe. As examples of the inventions, there exist, for example, "Apparatus for crushing and breaking weir, runner, defective castings, etc. for casting by hydraulic pressure" of Japanese Patent Application 6-106083, "Casting breaking method, and cutter structure" Japanese Unexamined Patent Application Publication No. 2002-224580, "Crushing-breaking apparatus" of US Patent No. 5,791,573, "An apparatus for crushing-breaking useless cast products using a fixed and a rocking cutter device and method for coating said breaking devices" of Europe Patent No. 0919283, "Casting breaking method" of International Application PCT/JP2006/301918, and "Cutter unit mounted on casting breaking apparatus" of International Application PCT/JP2006/324035.

[0003] The basic structure of these conventional techniques will be described in the following Outlines (1), (2), and (3). In Outline (1), to explain a cutter device of this casting breaking apparatus, the cutter device is composed of a fixed cutter unit and a movable cutter unit facing the fixed cutter unit. The cutter device also has a structure in which fixed and movable cutter plates including a number of alternately projecting fixed and movable cutters are attached to cutter supporting parts of the fixed and movable cutter units, and a structure in which crushing and breaking of a weir, runner, and defective products for casting (referred to as "casting waste") are performed between the fixed and movable cutters provided in the fixed and movable cutter plates.

The fixed cutter unit is provided in a frame so as to incline, in use, at an angle of about 15 degrees to the vertical. Also, the movable cutter unit has a structure in which it can move via a movable means (cylinder) and a shaft.

[0004] Also, since the fixed and movable cutters and/or the fixed and movable cutter plates (referred to as "fixed and movable cutters") perform crushing using their facing relationship, the fixed and movable cutters (they will be described in the fixed cutters) require toughness and wear resistance (enhancement in the hardness of the fixed cutters), respectively. In order to ensure the toughness and wear resistance, deposit welding is performed on a seat of fixed cutters that are cast products and/or

the surfaces of the cutters, and then impact is given to the deposit welding, thereby ensuring the toughness and wear resistance (refer to the aforementioned US Patent No. 5,791,573).

[0005] Problems that the welding and/or deposit operation requires advanced skill and labor, requires the accuracy of operation, and requires working hours, should be considered in the structure of performing deposit welding and giving impact to the deposit welding, thereby ensuring toughness and wear resistance.

[0006] Upon investigation of earlier literatures which can solve the problems, the following suggestions were made. To explain an example of the suggestions, a structure in which a tool holding part having coils for electromagnetic induction heating arranged apart is made of a heat-resistant high-manganese steel on the surface of which a sprayed layer of martensitic steel or ferrite steel is formed is disclosed in "Shrinkage fitting device of cutter tool by electromagnetic induction heating, and tool holding part for cutter tool holder" of Japanese Unexamined Patent Application Publication 2001-179544. However, since this invention utilizes a heat-resistant high-manganese steel as a member, it does not sufficiently utilize the characteristics of a raw material. Also, a structure in which austenitic stainless steel or austenitic manganese steel containing chromium or nickel is deposit-welded on the surface of a base material bend pipe to form a holding layer is disclosed in "Heat-resistant and wear-resistant bend pipe and manufacturing method thereof" of Japanese Unexamined Patent Application Publication 2002-139190. However, since this invention utilizes a heat-resistant high-manganese steel as a member, problems that the characteristics of a raw material is not utilized sufficiently, and the welding and/or deposit operation requires advanced skill and labor, requires the accuracy of operation, and requires working hours, should be considered.

Disclosure of the Invention

[0007] In view of the above problems, the invention suggests the following improvements and/or structures.

- (1) By eliminating a structure of performing deposit welding and giving impact to the deposit welding, thereby ensuring toughness and wear resistance after casting of fixed and movable cutters and/or fixed and movable cutter plates (referred to as "fixed and movable cutters"; they will be described in the fixed cutters), for example, advanced skill and labor required for welding and/or deposit operation are eliminated, operation is simplified, working hours are shortened, operator's physical burdens are relieved, workplace environments are improved, and the like.
- (2) The forms (mainly, the whole surface shape, the shape of all angles of the fixed cutters, and the shape of connecting parts between the fixed cutters and the fixed cutter plates) of the fixed cutters become a

structure which is not broken, loss of the fixed cutters is avoided, mixing of chips (broken pieces) of high-manganese steel constituting the fixed cutters in a regenerated casting is eliminated, and quality deterioration of the regenerated casting is avoided.

(3) By utilizing the features of (1), the cost of the casting breaking apparatus and/or the fixed cutters is reduced, rapid manufacture and/or delivery is achieved, CO₂ is reduced, and the global environment is maintained, pneumoconiosis by intake of welding gas, etc. is avoided, medical expenses are reduced, workplace environments are improved, and the like.

(4) By utilizing the features of (1), the factory management required for welding, and office work administration are relieved, and a factory space is utilized effectively.

(5) In the casting breaking apparatus and/or the fixed cutters, there are provided fixed cutters capable of coping with the size of the apparatus and cutters, for example, large-sized models having an apparatus that are 4250 mm (numeric values are approximate values) in total length, 1950 mm in total width, and 1900 mm in height, and a fixed cutter that is 1600 mm in the longitudinal width of a cutter bottom, 1500 mm in the lateral width of the cutter bottom, and 300 mm in projection height to small-sized models having an apparatus that are 2750 mm in total length, 1250 mm in total width, and 1300 mm in height, and a fixed cutter that is 1000 mm in the longitudinal width of a cutter bottom, 600 mm in the lateral width of the cutter bottom, and 190 mm in projection height.

Advantage of the Invention

[0008] The invention of Claim 1 is a cutter device mounted on a casting breaking apparatus, in which fixed and movable cutter units provided in a frame of the casting breaking apparatus are composed of fixed and movable cutter supporting parts, and fixed and movable cutter plates provided with fixed and movable cutters suspended by the fixed and movable cutter supporting parts, the fixed and movable cutter supporting parts are made of a casting, the fixed and movable cutters are made of a casting including high-manganese steel, and the fixed and movable cutters made of the casting including high-manganese steel are attached to the fixed and movable cutter supporting parts made of the casting.

[0009] Accordingly, Claim 1 can exhibit the features of the aforementioned (1) to (5).

Feature (1)

[0010] A build-up operation after casting required to ensure the toughness and wear resistance of the fixed cutters can be eliminated. Also, labor and advanced skill required for welding and/or build-up operation can be eliminated. Moreover, operation can be simplified, and

working hours can be shortened. Also, operator's physical burdens can be relieved, and workplace environments can be improved.

5 Feature (2)

[0011] Also, the fixed cutters can be made into a structure which is not broken, loss of the fixed cutters can be avoided, and mixing of chips of high-manganese steel constituting the fixed cutters into a regenerated casting can be eliminated. Also, quality deterioration of a regenerated casting can be avoided.

10 Feature (3)

[0012] By utilizing the features of (1), the cost of the casting breaking apparatus and/or the fixed cutters can be reduced, and rapid manufacture and/or delivery can be achieved. Also, CO₂ can be reduced, and the global environment can be maintained. Also, pneumoconiosis by intake of welding gas, etc. can be avoided, medical expenses can be reduced, and workplace environments can be improved.

15 Feature (4)

[0013] By utilizing the features of (1), the factory management required for welding, and office work administration can be relieved. Also, a factory space can be utilized effectively.

20 Feature (5)

[0014] In the casting breaking apparatus and/or the fixed cutters, there can be provided fixed cutters capable of coping with the size of the apparatus and cutters, for example, large-sized models having an apparatus that are 4250 mm (numeric values are approximate values) in total length, 1950 mm in total width, and 1900 mm in height, and a fixed cutter that is 1600 mm in the longitudinal width of a cutter bottom, 1500 mm in the lateral width of the cutter bottom, and 300 mm in projection height to small-sized models having an apparatus that are 2750 mm in total length, 1250 mm in total width, and 1300 mm in height, and a fixed cutter that is 1000 mm in the longitudinal width of a cutter bottom, 600 mm in the lateral width of the cutter bottom, and 190 mm in projection height.

[0015] The invention of Claim 2 is the cutter device mounted on a casting breaking apparatus according to Claim 1, in which the mixing ratio of the fixed and movable cutters made of the casting including high-manganese steel is set as follows.

[0016] C: 1.0 to 1.6 wt%, Si: 0.25 to 0.8 wt%, and Mn: 10 to 15 wt%.

[0017] Accordingly, in Claim 2, it is possible to minimize adverse effects resulting from high-manganese steel.

[0018] Next, the invention of Claim 3 is a method of enhancing the hardness of a cutter device mounted on a casting breaking apparatus, in which fixed and movable cutter units provided in a frame of the casting breaking apparatus are composed of fixed and movable cutter supporting parts, and fixed and movable cutter plates provided with fixed and movable cutters suspended by the fixed and movable cutter supporting parts, the fixed and movable cutter supporting parts are made of a casting, the fixed and movable cutters are made of a casting including high-manganese steel, the fixed and movable cutters made of the casting including high-manganese steel are attached to the fixed and movable cutter supporting parts made of the casting, a casting waste is crushed by the casting breaking apparatus in this attachment state, and the hardness of the fixed and movable cutters made of the casting including high-manganese steel is made high to a predetermined hardness.

[0019] Accordingly, in Claim 3, the hardness of the fixed and movable cutters made of a casting including high-manganese steel can be enhanced naturally during operation through crushing of a casting waste by the casting breaking apparatus. Also, uniform and predetermined hardness can be ensured without requiring labor and/or skill. Moreover, operation can be simplified, and cost can be reduced.

[0020] The invention of Claim 4 is a method of enhancing the hardness of the cutter device mounted on a casting breaking apparatus according to Claim 2, in which the mixing ratio of the fixed and movable cutters made of the casting including high-manganese steel is set as follows.

[0021] C: 1.0 to 1.6 wt%, Si: 0.25 to 0.8 wt%, and Mn: 10 to 15 wt%.

[0022] Accordingly, in Claim 4, it is possible to minimize adverse effects resulting from high-manganese steel.

Brief Description of the Drawings

[0023] First, description of drawings will be made.

[0024] FIG. 1 is a plan view showing a whole casting breaking apparatus;

FIG. 2 is a bottom view showing the whole casting breaking apparatus;

FIG. 3 is a left side view showing the whole casting breaking apparatus;

FIG. 4 is a right side view showing the whole casting breaking apparatus;

FIG. 5 is a schematic sectional view showing the whole casting breaking apparatus;

FIG. 6 is a front view showing a fixed cutter plate of the casting breaking apparatus;

FIG. 7 is a front view showing a movable cutter plate of the casting breaking apparatus; and

FIG. 8 is an enlarged front view of a fixed or movable cutter plate of the casting breaking apparatus.

Best Mode for Carrying out the Invention

[0025] The basic structure of a casting breaking apparatus (referred to as "breaking apparatus") of the invention is shown in FIG. 1. An example of the breaking apparatus will now be described. First, reference numeral 1 denotes a breaking apparatus of a casting waste. This breaking apparatus 1 includes, as its main components, a frame 2 composed of side plates 2a and 2b, and a span plate 2c and having open top and bottom, a fixed cutter unit 4 (one cutter unit) provided in the frame 2, a movable cutter unit 5 (the other cutter unit) which faces the fixed cutter unit 4, a cylinder 6 (a driving means; hereinafter referred to as "cylinder 6"), such as hydraulic pressure, which advances and retreats the movable cutter unit 5, and a damper 7.

[0026] First, the fixed cutter unit 4 is composed of a span shaft 40 provided between the side plates 2a and 2b of the frame 2, a fixed cutter supporting part 41 for attaching a cutter plate which is suspended by the span shaft 40, a fixed cutter plate 42 (there may also be a fixed cutter plate with upper and lower two-stage structure.) detachably provided in the fixed cutter supporting part 41, a plurality of truncated semi-conical fixed cutters 43 (received cutters or embossed cutters; there may also be fixed cutters with upper and lower two-stage structure.) for crushing and breaking which are alternately provided in the facing surface of the fixed cutter plate 42. In order to eliminate loss of high-manganese steel, all angles of the fixed cutters 43 are formed in the shape of a curved surface, and a connecting part 44 between the fixed cutter plate 42 and each of the fixed cutters 43 is formed in the shape of a curved surface. Loss (chipping and/or breaking) can be avoided by forming the angles and connecting parts in the shape of a curved surface as such. The fact that the loss of high-manganese steel has an adverse effect on a regenerated casting, and for example, causes quality deterioration can be mentioned as the above reason. It is also desirable to form the angles of the quadrilateral fixed cutter plate 42 in the shape of a curved surface if required. The reason is as mentioned above.

[0027] Also, the fixed cutter 43 contains C: 1.0 to 1.6 wt% of carbon, Si: 0.25 to 0.8 wt% of silicon, and Mn: 10 to 15 wt% of manganese as its chief constituent elements.

[0028] Next, the movable cutter unit 5 is composed of a span shaft 50 provided between the side plates 2a and 2b of the frame 2, a movable cutter supporting part 51 for attaching a cutter plate which is suspended by the span shaft 50, a movable cutter plate 52 (there may also be a movable cutter plate with upper and lower two-stage structure.) detachably provided in the movable cutter supporting part 51, a plurality of truncated semi-conical movable cutters 53 (received cutters or embossed cutters; there may also be movable cutters with upper and lower two-stage structure.) for crushing and breaking which are alternately provided in the facing surface of

the movable cutter plate 52. In order to eliminate loss of high-manganese steel, all angles of the movable cutters 53 are formed in the shape of a curved surface, and a connecting part 54 between the movable cutter plate 52 and each of the movable cutters 53 is formed in the shape of a curved surface. Loss (chipping and/or breaking) can be avoided by forming the angles and connecting parts in the shape of a curved surface as such. The fact that the loss of high-manganese steel has an adverse effect on a regenerated casting, and for example, causes quality deterioration can be mentioned as the above reason. It is also desirable to form the angles of the quadrilateral movable cutter plate 52 in the shape of a curved surface if required. The reason is as mentioned above.

[0029] Also, the movable cutter 53 contains C: 1.0 to 1.6 wt% of carbon, Si: 0.25 to 0.8 wt% of silicon, and Mn: 10 to 15 wt% of manganese as its chief constituent elements.

[0030] The top surfaces of the fixed cutters 43 and the movable cutters 53 form curved inclined planes 43a and curved inclined planes 53a, and the curved inclined planes 43a and curved inclined planes 53a have an inclination at which a casting waste can drop positively and naturally. The movable cutters 53 are arranged alternately, a space A into which the truncated semi-conical fixed cutters 43 of the aforementioned fixed cutter unit 4 can be fitted is formed between the movable cutters 53, and the fixed cutters 43 of the fixed cutter unit 4 described later is fitted into the space A. A broken casting drops into fitting gaps formed between the fixed cutters 43 of the fixed cutter unit 4 fitted into the space A, and the movable cutters 53 of the movable cutter unit 5. In addition, according to casting wastes, cast products, other castings (referred to as "raw material W"), etc., and the capacity, structure, etc. of the breaking apparatus 1, a basal ridge may be provided in a ridge shape below the movable cutters 53. Also, this basal ridge is effective for efficient breaking and/or cutting, crushing, etc., of a raw material W, prevention of pinching of a regenerated casting W3 (a raw material for regeneration or casting) between the movable cutters 53 and/or the fixed cutters 43, breaking and/or cutting (breaking force) of a conglomerate raw material W1, breaking of a long raw material W2, and the like. Moreover, the basal ridge has features of performing prevention of scattering of a regenerated casting W3, and pressing (pressing stress) of the regenerated casting W3 existing in the breaking apparatus 1 (downward) towards a discharge port 11 of the breaking apparatus 1. Moreover, the basal ridge is effective for reinforcement, etc. of the movable cutters 53.

[0031] Next, a method of embodying the invention and a method for enhancing hardness will be described. Referring to FIG. 1, first, a method of enhancing the hardness of the fixed cutters 43 of the fixed cutter unit 4 and the movable cutters 53 of the movable cutter unit 5 will be described. In a situation where the movable cutter unit 5 is at its retreat limit, a raw material W is charged from above a substantially V-shaped charging opening 12

formed by the movable cutter plate 52 and movable cutters 53 of the movable cutter unit 5, and the fixed cutter plate 42 and the fixed cutters 43 of the fixed cutter unit 4.

[0032] As for the charged raw material (casting waste) W, when the movable cutter unit 5 advances along a circular arc locus with a lower pivot point 20 as a fulcrum, almost the whole pressing force of the cylinder 6 acts on a fulcrum shaft 21 above the movable cutters 53, and the movable cutters 53 advance along a circular arc locus, a strong crushing force and/or breaking force (referred to as "breaking force") is generated according to the principle of a lever above the discharge port 11 in the vicinity of the lower pivot point 20, thereby positively and smoothly cutting the charged raw material W between the movable cutters and their facing fixed cutters 43. Like the above, breaking is performed using fitting and/or pressing relationship between the movable cutters 53 and/or movable cutter plate 52, and the fixed cutters 43 and/or fixed cutter plate 42 (between both the cutters).

[0033] Also, since this breaking is surely performed with low pressure by a configuration of being movable with the pivot point 20 as a fulcrum and of being movable along a circular arc locus via the upper fulcrum shaft 21 and the upper cylinder 6, this is helpful and useful in miniaturizing the whole breaking apparatus 1 and reducing running cost. Also, the pivot point 20 has features that smooth movement as an annular metal and a fulcrum bearing, which are not shown, and load resistance, are ensured. Also, a broken regenerated cast product (regenerated casting W3) naturally drops towards the discharge port 11 via the surfaces of both the cutters and/or gaps therebetween sequentially.

[0034] In addition, in the invention, the damper 7 catches a relatively slender raw material (long raw material W2) of the charged raw material W, which has dropped from between the fixed and movable cutters 43 and 53 (referred to as "between both the cutters"), whereby positive reception of the raw material W and/or long raw material W2 described below, and positive and efficient breaking thereof can be achieved. Also, when a predetermined load is applied to the damper 7, the damper is opened automatically.

[0035] Through repetition of the fitting and/or pressing relationship between the movable cutters 53 and the fixed cutters 43 described above, and/or impact against the movable cutters 53 and/or movable cutter plate 52 and the fixed cutters 43 and/or fixed cutter plate 42 by breaking, the hardnesses of the movable cutters 53 and/or the movable cutter plate 52 and the fixed cutters 43 and/or the fixed cutter plate 42 are enhanced. Such enhancement in hardness has the aforementioned features. That is, through crushing of a casting waste by the casting breaking apparatus 1, the hardness can be naturally enhanced during operation. Also, uniform and predetermined hardness can be ensured without requiring labor and/or skill. Moreover, operation can be simplified, and cost can be reduced. In addition, when the hardness of the movable cutters 53 and/or movable cutter plate

52, and the hardness of the fixed cutters 43 and/or fixed cutter plate 42 are fixed, the hardnesses are maintained.

[0036] As mentioned above, the movable cutter unit 5 at an advancement limit retreats through extension and retraction of the piston rod 60 of the cylinder 6, and stops by the operation reaching a retreat limit as it is.

[0037] However, generally, when a raw material W exists between the both the cutters, the movable cutter unit 5 advances, and repeats the same breaking operation as the aforementioned operation. That is, when a raw material W exists between both the cutters, advancement and retreat of the movable cutter unit 5 are repeated. Also, when any raw material W does not exist between both the cutters, a new raw material W is charged towards the charging opening 12 in a state of a retreat limit in principle similarly to the above.

[0038] As described above, the invention provides a cutter device mounted on a casting breaking apparatus which crushes and breaks (referred to as "break") casting wastes, such as gates, runners, weirs, and defective castings, and a method of enhancing the hardness of the cutter device. This makes it possible to eliminate a deposit operation after casting required to ensure the wear resistance of the fixed cutters and movable cutters. Also, labour and advanced skill required for welding and/or deposit operation can be eliminated. Moreover, operation can be simplified, and working hours can be shortened. Accordingly, there is a feature useful for the casting industry and the industrial field.

Claims

1. A cutter device (4, 5) mounted on a casting breaking apparatus (1),
fixed and movable cutter units (4, 5) provided in a frame (2) of the casting breaking apparatus being composed of fixed and movable cutter supporting parts (41: 51), and fixed and movable cutter plates (42, 52) provided with fixed and movable cutters (43, 53) suspended by the fixed and movable cutter supporting parts (41: 51),
the fixed and movable cutter supporting parts (41: 51) being made of a casting,
the fixed and movable cutter plates (42, 52) and/or the fixed and movable cutters (43, 53) being made of a casting including high-manganese steel, and
the fixed and movable cutter plates (42, 52) and/or fixed and movable cutters (43, 53) made of the casting including high-manganese steel being attached to the fixed and movable cutter supporting parts (41: 51) made of the casting.
2. The cutter device mounted on a casting breaking apparatus according to Claim 1,
wherein the mixing ratio of the fixed and movable cutter plates (42, 52) and/or fixed and movable cutters (43, 53) made of the casting including high-man-

ganese steel is set as follows:

C: 1.0 to 1.6 wt%, Si: 0.25 to 0.8 wt%, and Mn: 10 to 15 wt%.

3. A method of enhancing the hardness of a cutter device mounted on a casting breaking apparatus, fixed and movable cutter units provided in a frame of the casting breaking apparatus being composed of fixed and movable cutter supporting parts (41: 51), and fixed and movable cutter plates (42, 52) provided with fixed and movable cutters (43, 53) suspended by the fixed and movable cutter supporting parts (41: 51),
the fixed and movable cutter supporting parts (41: 51) being made of a casting,
the fixed and movable cutter plates (42, 52) and/or the fixed and movable cutters (43, 53) being made of a casting including high-manganese steel,
the fixed and movable cutter plates (42, 52) and/or fixed and movable cutters (43, 53) made of the casting including high-manganese steel being attached to the fixed and movable cutter supporting parts (41: 51) made of the casting, a casting waste being crushed by the casting breaking apparatus in this attachment state, and
the hardness of the fixed and movable cutter plates (42, 52) and/or fixed and movable cutters (43, 53) made of the casting including high-manganese steel being made high to a predetermined hardness.
4. A method of enhancing a cutter device mounted on a casting breaking apparatus according to Claim 2, wherein the mixing ratio of the fixed and movable cutter plates (42, 52) and/or fixed and movable cutters (43, 53) made of the casting including high-manganese steel is set as follows:

C: 1.0 to 1.6 wt%, Si: 0.25 to 0.8 wt%, and Mn: 10 to 15 wt%.
5. A cutter unit (4, 5) mountable in a frame (2) of a casting breaking apparatus (1), the cutter unit (4, 5) comprising:

a cutter supporting part (41: 51) made of a casting; and
a cutter plate (42, 52) provided with cutters (43, 53) and made of a casting including high-manganese steel; and
the cutter plate (42, 52) and/or cutters (43, 53) being attached to the cutter supporting part (41: 51).
6. A cutter unit (4, 5) according to Claim 5, wherein the mixing ratio of the cutter plate (42, 52) and/or cutters (43, 53) is set as follows:

C: 1.0 to 1.6 wt%, Si: 0.25 to 0.8 wt%, and Mn:
10 to 15 wt%.

7. A casting breaking apparatus (1), comprising fixed and movable cutter units (4, 5) provided in a frame (2), the movable cutter unit (5) being mounted for pivoting movement towards and away from the fixed cutter unit (4), and wherein at least one of the cutter units comprises:

a cutter supporting part (41: 51) made of a casting; and
a cutter plate (42, 52) provided with cutters (43, 53) and made of a casting including high-manganese steel; and
the cutter plate (42, 52) and/or cutters (43, 53) being attached to the cutter supporting part (41: 51).

8. A casting breaking apparatus according to Claim 5, wherein the mixing ratio of the cutter plate (42, 52) and/or cutters (43, 53) is set as follows:

C: 1.0 to 1.6 wt%, Si: 0.25 to 0.8 wt%, and Mn:
10 to 15 wt%.

9. A method of breaking casting waste, comprising placing the casting waste between the fixed and movable cutter units (4, 5) of a casting breaking apparatus (1) according to claim 7, and moving the movable cutter unit (5) toward the fixed cutter unit (4).

FIG. 1

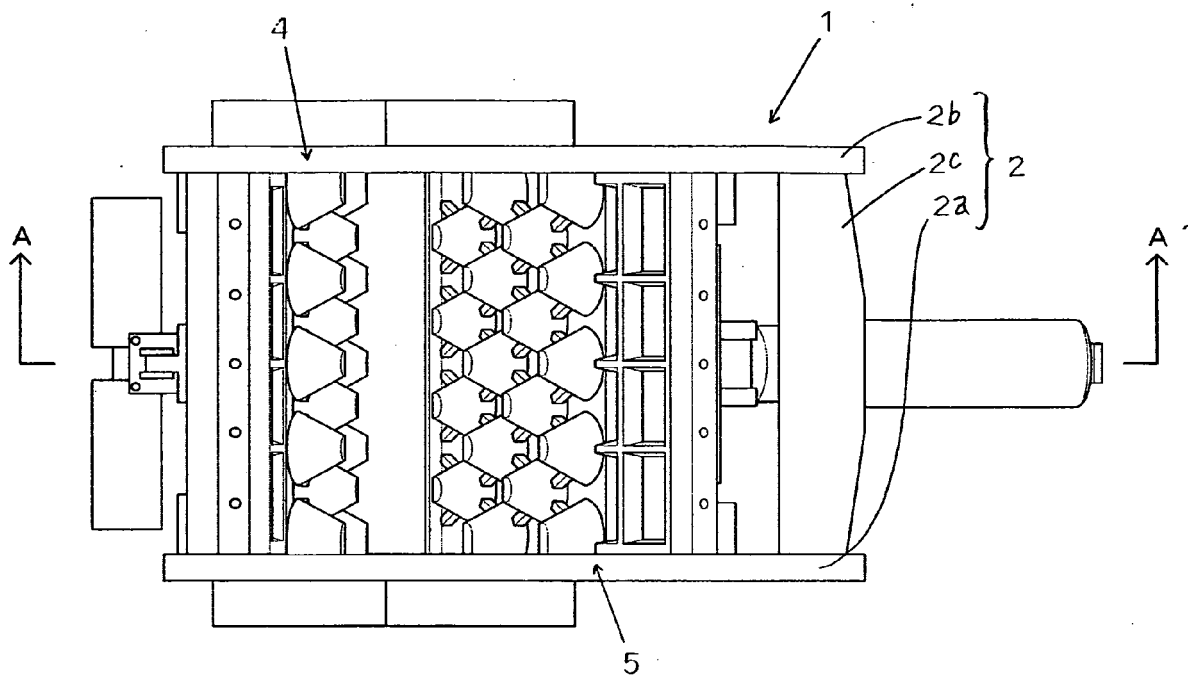


FIG. 2

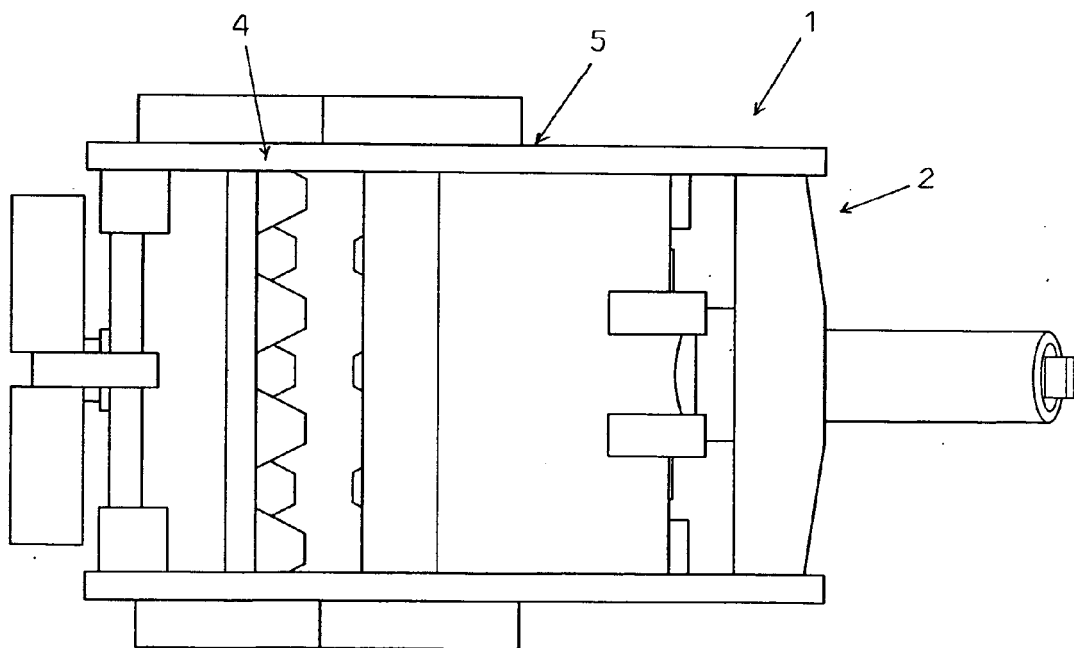


FIG. 3

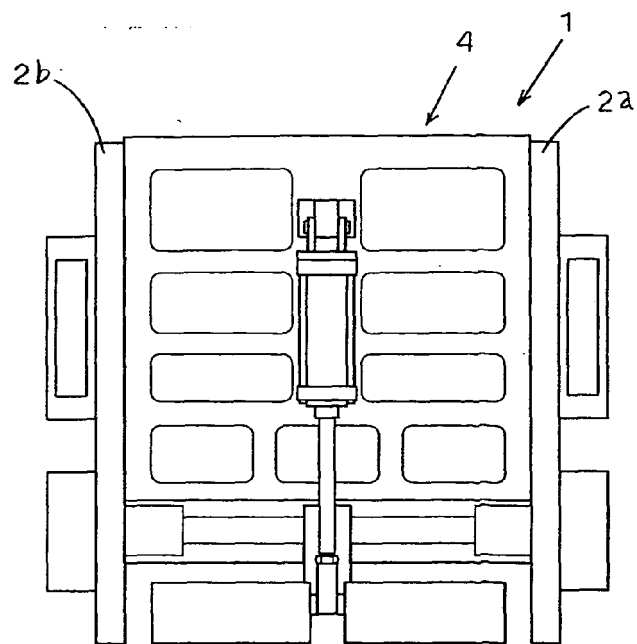


FIG. 4

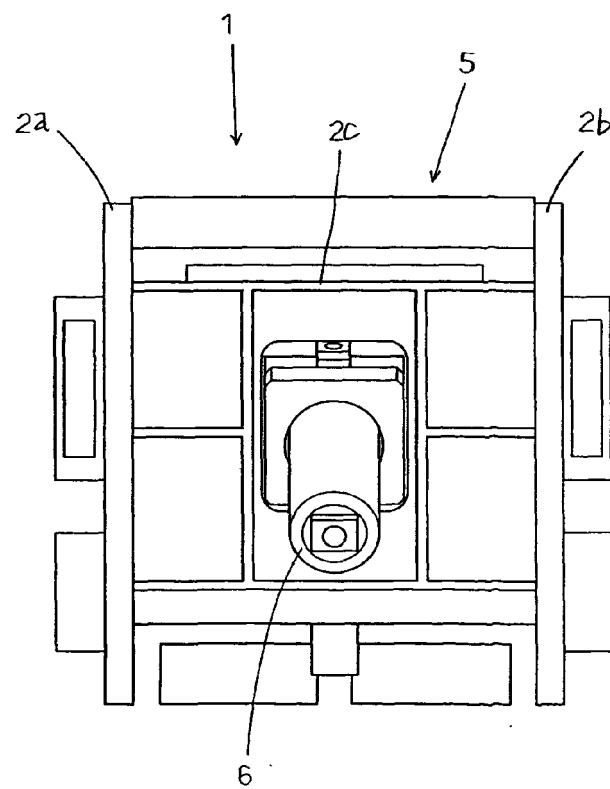


FIG. 5

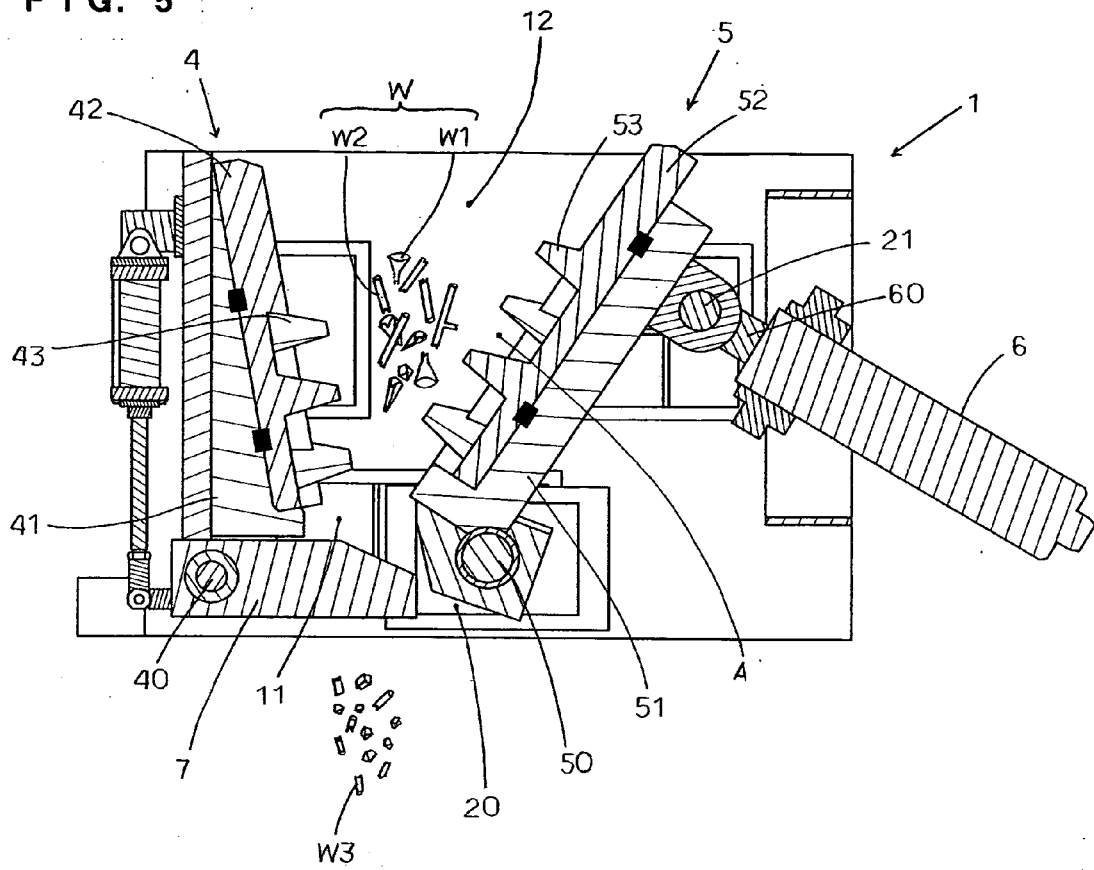


FIG. 8

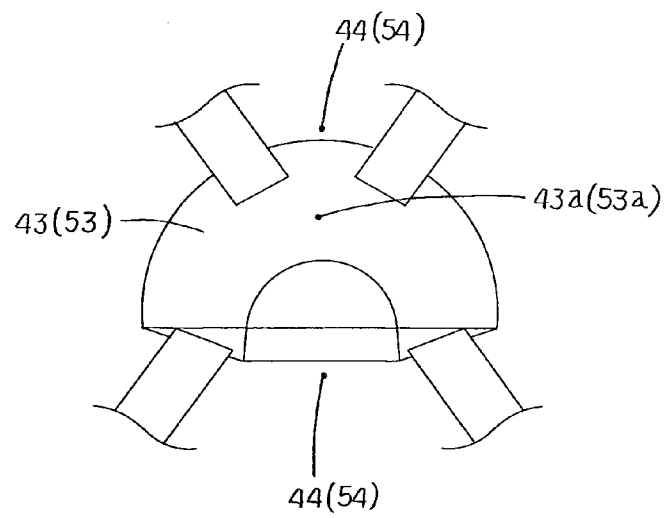


FIG. 6

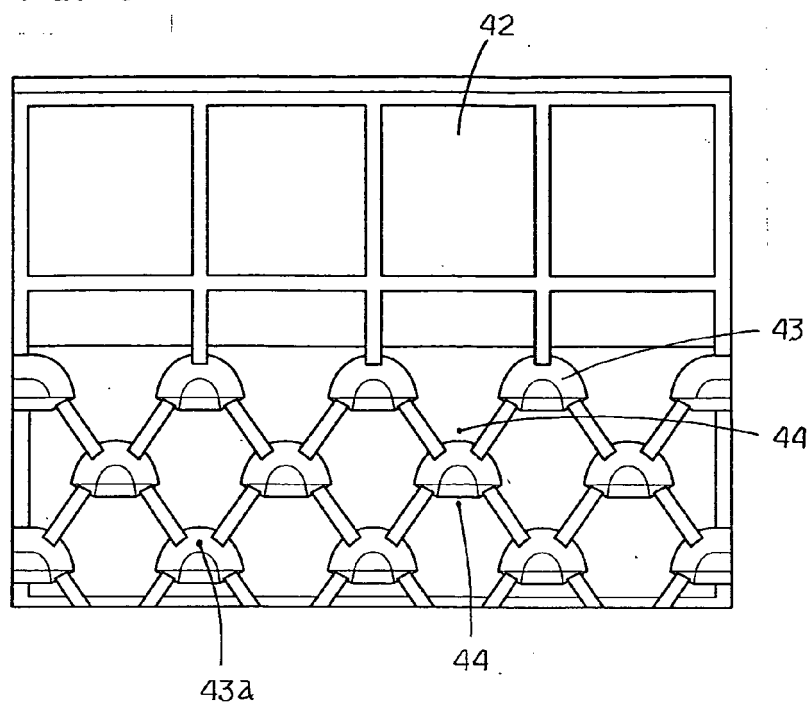
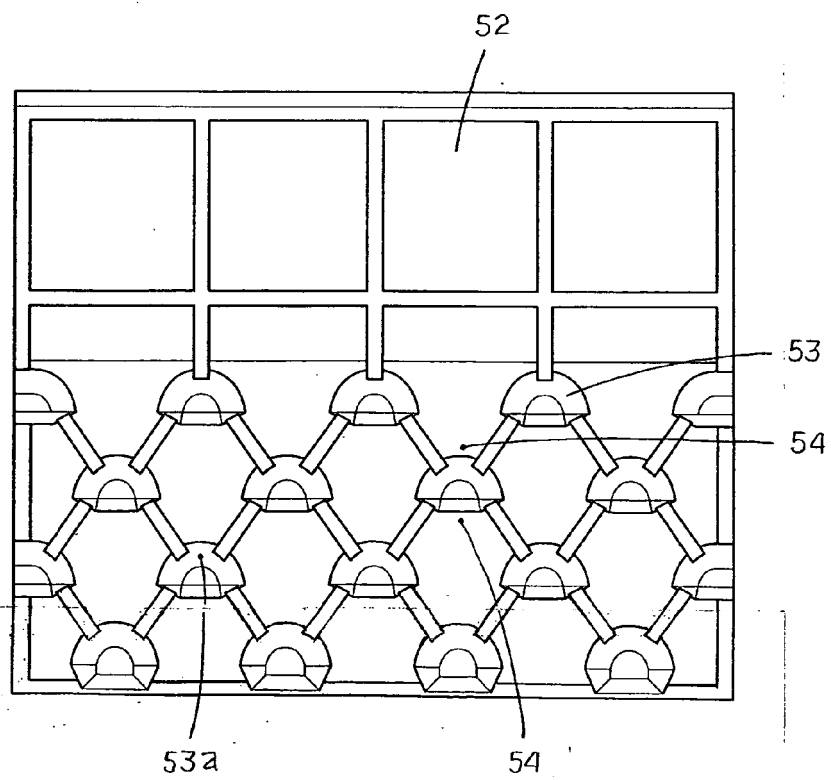


FIG. 7





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 25 1968

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
D,Y	EP 0 919 283 A (OKUYA YASUAKI [JP]) 2 June 1999 (1999-06-02) * the whole document *	1,2,5-9	INV. B02C1/10
Y	DE 197 21 637 A1 (KRONENBERGER ERNST JOSEF [DE]; MAERZHEUSER PETER DIPL ING [DE]) 26 November 1998 (1998-11-26) * the whole document *	1,2,5-9	
Y	US 3 804 345 A (DE DIEMAR R) 16 April 1974 (1974-04-16) * the whole document *	1,2,5-9	
A	US 5 601 782 A (KUNIOKA SABURO [JP] ET AL) 11 February 1997 (1997-02-11) * the whole document *	1	
Y		2,6,8	
			TECHNICAL FIELDS SEARCHED (IPC)
			B02C
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		29 October 2007	Kopacz, Ireneusz
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)



European Patent
Office

Application Number

EP 07 25 1968

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- ☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- ☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- ☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:
- 1, 2, 5-9
- ☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



European Patent
Office

**LACK OF UNITY OF INVENTION
SHEET B**

Application Number

EP 07 25 1968

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1,2,5-9

A casting breaking apparatus

2. claims: 3,4

A method of enhancing the hardness of cutter device

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 25 1968

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

29-10-2007

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REFERENCES CITED IN THE DESCRIPTION

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