



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
15.05.2002 Bulletin 2002/20

(51) Int Cl.7: **B22D 29/00, B22D 29/04,
B22C 5/00**

(21) Application number: **01901530.4**

(86) International application number:
PCT/JP01/00444

(22) Date of filing: **24.01.2001**

(87) International publication number:
WO 01/54845 (02.08.2001 Gazette 2001/31)

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR**

(30) Priority: **28.01.2000 JP 2000019753
28.01.2000 JP 2000019772
28.03.2000 JP 2000087847
06.04.2000 JP 2000104378
14.04.2000 JP 2000114247**

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(54) **METHOD AND DEVICE FOR COLLAPSING AND SEPARATING MOLD MATERIAL AND MOLD GREEN SAND FROM GREEN SAND MOLD**

(57) A method and apparatus for collecting molding greensand for greensand molds into which molten metal has been cast, wherein the molding greensand that has not been affected by heat and the molding greensand that is attached to the molding material that has been affected by the heat of molten metal can be separately collected by collapsing the greensand molds into which molten metal has been cast.

The method and apparatus for collecting molding greensand, comprising airtightly surrounding greensand molds into which molten metal has been cast and which is carried in at a place where the molds are collapsed, depressurizing/collapsing the airtightly surrounded greensand molds so as to separate molding material to which the molding greensand that has been affected by heat is attached from the molding sand that has not been affected by heat, vibrating the molding material at a place different from the place where the mold is collapsed so as to separate the molding greensand that has been affected by heat from the molding mate-

rial, and separately collecting the molding greensand that has been affected by heat and that that has not.

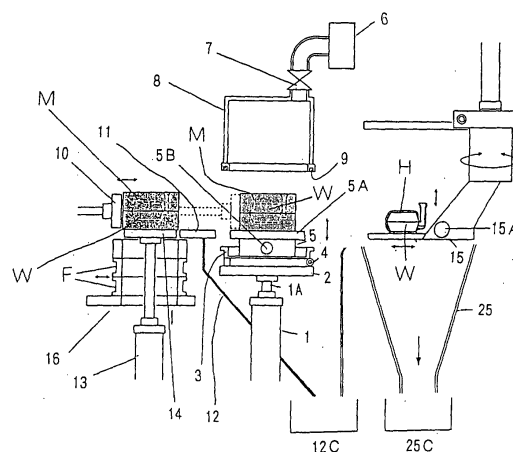


Fig. 2

Description

Technical Field

[0001] This invention relates to a method and apparatus for readily collapsing greensand molds to separate the molding material and molding greensand, particularly to a method and apparatus for separating and recovering greensand from greensand molds according to the thermal history of the greensand.

Background of the Invention

[0002] As shown in Fig. 1, the conventional circulative processes of collecting molding greensand consist of molding molds, inserting a core in the molds, casting molten metal into the molds with the core, breaking or collapsing the molds after the molding material has solidified, taking out the molding material, and collecting/reusing the molding greensand. In the conventional processes greensand molds are collapsed by means of the impact of their falling, vibrations of a rotary drum or mechanical external force, and all the separated molding greensand being sent to a single machine to be processed there. For example, in the device disclosed in Japanese Patent No. 2575713, the separated greensand is merely processed such that its portions that have not been affected by heat are taken out separately from those that have been affected by heat so as to be processed separately. Thus, hitherto no process has been disclosed at all wherein the portions of the main greensand molds are systematically collapsed, separated, and collected independently of those portions that have been affected by heat.

Disclosure of Invention

[0003] Since there has been no conventional method for accurately and readily separating molding greensand, and since greater external force is needed to collapse high-strength greensand molds, especially recently-made high-hardness ones, damaging the molding material is inevitable when the conventional collapsing method is used. Further, it has been difficult to separate and collect molding greensand with a known history by separating the part of it that has been affected by heat from the part that has not, so as to keep the amount needed of the molding greensand to a minimum. If otherwise, extra greensand will be taken out to the next process.

[0004] Thus, one object of this invention is to provide a method for 'readily and accurately collapsing molding greensand that has not been affected by heat, without any molding material being damaged.

[0005] Another object of this invention is to keep the amount of molding greensand that would have been taken out or wasted at a minimum by systematically and in a circulative manner processing the molding sand such

that that has not been affected by heat is separately collected from that which has been attached to the molding material and affected by heat.

[0006] According to one aspect of this invention, provided is a method for collapsing greensand molds to achieve the above-mentioned purposes. The method comprises the steps of airtightly surrounding greensand molds, into which molten metal has been cast, and depressurizing the airtightly surrounded greensand molds so that the portions of the greensand molds which have not been thermally affected by the molten metal are collapsed.

[0007] According to another aspect of this invention, provided is a method for collapsing greensand molds, comprising the steps of airtightly surrounding greensand molds into which molten metal has been cast, separating the greensand molds from molding material by depressurizing the airtightly surrounded greensand molds so that the greensand molds are collapsed, and taking out the molding material after the airtightly surrounded greensand molds have been released.

[0008] According to a further aspect of this invention, provided is a method for separating molding material, comprising the steps of airtightly surrounding greensand molds into which molten metal has been cast, pressurizing the airtightly surrounded greensand molds to raise the boiling point of the water, separating the greensand molds from the molding material by depressurizing the airtightly surrounded greensand molds so that the greensand mold is collapsed, and taking out the molding material after the airtightly surrounded greensand molds have been released.

[0009] According to a still further aspect of this invention, provided is a method for separating/taking out molding material, comprising sending in greensand molds into which molten metal has been cast, one-by-one at a position for collapsing them, airtightly surrounding the greensand molds into which molten metal has been cast, depressurizing the airtightly surrounded greensand molds so as to collapse them by boiling the high-temperature water, and vibrating the collapsed greensand molds and molding material so as to separate the greensand molds from the molding material and so as to take out the separated molding material.

[0010] According to a further aspect of this invention, provided is an apparatus for taking out molding material, comprising means disposed in a position where molds are collapsed, for collapsing/separating molding greensand which is collapsed by means of weak vibrations, the means having a mount 5 for the mold, which is fixed to the means and movable up-and-down, and a vibrator 5A, a plate 2 on which an inclinable tray 3 is mounted, and a sealable box 8, which communicates with a vacuum source 6 via an opening-and-closing valve 7, and which is movable up and down; and means for separating the molding greensand from the molding material by means of strong vibrations, the means having a takeout fork 15 with a generator 15A, the takeout fork being dis-

posed in one side of the collapsing/separating position such that the fork can be moved up and down, and vibrated.

[0011] According to another aspect of this invention, provided is a method for collecting molding greensand, comprising the steps of airtightly surrounding greensand molds into which molten metal has been cast and which is carried in at a place where the molds are collapsed, depressurizing/collapsing the airtightly surrounded greensand molds so as to separate molding material to which the molding greensand that has been affected by heat is attached, from the molding sand that has not been affected by heat, vibrating the molding material at a place different from the place where the mold is collapsed so as to separate the molding greensand that has been affected by heat from the molding material, and separately collecting the molding greensand that has been affected by heat and that that has not.

[0012] According to still another aspect of this invention, provided is an apparatus for collecting molding greensand, comprising first means, disposed in a first collapsing-and-separating station, for collapsing/separating molding greensand which is collapsed by means of weak vibrations, the means having a mount 5 for the mold, which is fixed to the means and movable up and down, and which has a vibrator 5A, a plate 2 on which an inclinable tray 3 is mounted, a sealable box 8, which is movably disposed up and down above the mount 5, and which communicates with a vacuum source 6 via an opening-and-closing valve 7, and a first collecting shoot 12 for collecting the molding greensand that has not been affected by heat; and second means, disposed in a second collapsing-and-separating station, for separating the molding greensand from the molding material by means of strong vibrations, the means having a takeout fork 15 with a generator 15A and a second shoot 13 for collecting the molding greensand that has been affected by heat.

Brief Descriptions of Drawings

[0013] Fig. 1 is a block diagram to show some of the conventional processes for collecting molding greensand.

[0014] Fig. 2 is a vertical section to show a schematic of the first embodiment of this invention.

[0015] Fig. 3 is a partial-section front view to show the second embodiment of this invention.

[0016] Fig. 4 is a schematic to explain the operations as shown in one main part of Fig. 3.

[0017] Fig. 5 is a schematic to explain the operations as shown in another main part shown in Fig. 3.

[0018] Fig. 6 is a partial-section front view to show the third embodiment of this invention.

[0019] Figs. 7a and 7b are schematics to explain the operations of the main parts of Fig. 6.

Preferred Embodiments of Invention

[0020] In general, a so-called condensed-water layer of weak strength is formed around the peripheries of the molding material for main molds. Because of the heat of molding material, the temperature of the condensed-water layer is higher than that in other portions, and lots of water gathers there. This invention is based on the fact that since high-temperature water is boiled due to the decrease in the boiling point of water when greensand molds are airtightly surrounded and rapidly depressurized by means of absorption just after the molds have been cast, the molding material and the molding greensand are readily collapsed and separated at the condensed-water layer, which serves as a boundary. The passage "just after the molds have been cast" means the point of time where the molten metal is solidified, and where the water in the condensed-water layer has been heated by the heated molding material so that the water is able to boil. The degree of depressurization carried out under a sealed condition is such that water is boiled by reducing the boiling point of all the water in the main molds, thereby providing a negative degree of pressure that can readily collapse the above-mentioned condensed-water layer.

[0021] When the airtightly surrounded greensand molds are pressurized, the boiling point of the water rises above 100 °C, and the thus-formed high-temperature water causes a water-condensed layer of weak strength to form. When the airtightly surrounded greensand molds into which molten metal has been cast is then rapidly depressurized, the boiling point of the water falls, and the high-temperature water boils so that the greensand molds are readily collapsed. The airtightly surrounded greensand molds are preferably depressurized to a pressure less than, rather than to, the atmospheric pressure. In this invention, "greensand molds into which molten metal has been cast" mean molds with no flasks, i.e., wherein the flasks are removed just after the molds have been molded with flasks, or molds without any flasks just after the molds have been molded.

[0022] We now explain a first embodiment of this invention by referring to Fig. 2. In the center lower part of Fig. 2, namely, in a first collapsing/separating station wherein the novel collapsing/separating of this invention is carried out, a lift cylinder 1 is disposed. The lift cylinder 1 has a piston rod 1A, on the top part of which a mounting plate 2 is fixed. In an upper portion of the mounting plate 2 an inclinable tray 3 is pivoted on a coupling pin 4. A T-shaped mold-mounting table 5 is fixed on the center part of the tray 3. A plurality of grooves are formed in the upper surface of the mold-mounting table 5 by distancing a number of I-shaped steel plates parallel to the front-and-rear directions, as seen from the front of the drawing. The table 5 is equipped with a vibrator 5B. It generates vibrations accompanied by up-and-down, left-and-right, aslant, and rotary movements, a first shoot or hopper 12 for guiding greensand that falls after

it has been collapsed and separated, and a first transport conveyor 12 C.

[0023] An apparatus for depressurizing greensand molds is disposed above the mold-mounting table 5. The depressurizing apparatus comprises an inverse-U-shaped sealable or airtight box 8 communicating with a vacuum source 6 via an opening- and-closing valve and a seal 9 disposed around the peripheries of the sealing box 8.

[0024] On one side of the first collapsing/separating station a station for transporting greensand molds to the first collapsing/separating station is provided. The transport station comprises means 16 for removing flasks, a plate 10 for pushing greensand molds out, and a plate 11 for passing or guiding greensand molds. Greensand molds M, which have molding flasks F, and into which molten metal has been cast, are placed on a flask-removing plate 14, which is fixed to the top part of a rod of a lift cylinder 13. The greensand molds are then pushed up through the flask-removing means 16 so that the flasks are removed from the greensand molds. The flaskless greensand molds M are pushed out by the mold-push-out plate 10 fixed to a reciprocating cylinder (not shown) onto the mold-mounting table 5 via a mold-passing plate 11.

[0025] On another side of the first collapsing/separating station, a second separating/collecting station for separating and collecting molding greensands is provided. The second separating/collecting station comprises a fork member 15A, movable up and down, for taking out the greensand molds; a vibrator 15A for generating vibrations accompanied by up-and-down, left-and-right, aslant, and rotary movements; a second shoot or hopper 25 for separating and collecting the molding greensand that is attached to the peripheries of the molding material W, and that has been affected by heat; and a second transport conveyor 25C.

[0026] Below we detail the operations of the first embodiment, shown in Fig. 2. In the transport station, the greensand molds M from which flasks have been removed are pushed up to the mold-passing plate 10, the level of which is the same as that of the mold-mounting table 5, and the raised-state greensand molds M are then transported by the mold-pushing plate 10 onto the mold-mounting table 5 via the passing plate 11.

[0027] In the first collapsing/separating station, after the mold-pushing plate 10 has been retracted, the greensand molds M that are transported onto the mold-mounting table 5 are raised by the lifting cylinder until the upper surface of the tray 3 abuts the inverse-U-shaped sealing box 8, and then they are accommodated within an airtight chamber defined by the upper surface of the tray and the sealing box 8. In the thus-accommodated state the opening-and-closing valve 7 is opened to have the airtight chamber communicate with the vacuum source 6 so that the airtight chamber is rapidly depressurized. Thereby, much of the high-temperature water that exists in a condensed-water layer near the

molding material W boils, and the greensand molds M are collapsed through the difference in pressure between the outside of the molds and the inside of the depressurized chamber. After the molds have been collapsed, and after the opening-and-closing valve 7 has been closed, and an air-supply valve (not shown) has been opened to reduce the pressure in the airtight chamber to the atmospheric pressure, the mold-mounting table 5, together with the collapsed greensand molds M and molding material W, is moved down to the place shown in Fig. 1 through the downward movement of the lift cylinder 1. At the same time as the table 5 starts to fall, the vibrator 5B is operated to give weak vibrations to the collapsed greensand molds M and molding material W via the mold-mounting table 5, so that the molding greensand that has not been affected by heat is separated from the molding material W. The words "weak vibrations" mean vibrations sufficient to separate the molding greensand from the molding material. The vibrations are distinguishable, for example, by the amount of their acceleration or amplitudes. In place of the collapse, after the molding material has been taken out, the tray 3 can be rotated pivotally counterclockwise on the coupling pin 4, and the molding greensand on both the tray 3 and mold-molding table 5 can be collected via the sand shoot or hopper 12 in the transport conveyor 12 C. Thus, the molding material W can be taken in order one-by-one to be sent to the next process, without the material W being contacted by any other member.

[0028] In the second separating/collecting station, the take-out fork 15 is inserted in the grooves or the concave spaces, and it is raised and moved back a little so as to scoop up the molding material W to move it to the other, second, place of separating/collecting. At the same time that the movement starts, the vibrator 15A is operated to give strong vibrations to the molding material W via the take out fork 15 so that the molding greensand that has been affected by heat is separated from the molding material W, and so that the separated molding greensand is collected in the second conveyor 25 C through the shoot or hopper 25 to be sent to the next process. The words "strong vibrations" mean vibrations sufficient to separate the molding greensand H attached to the molding material W that has been collapsed. The vibrations are distinguishable, for example, by the size of the acceleration or amplitudes.

[0029] Although in the embodiment of this invention the separation of collapsed molding material W is carried out in different places, both separations may be performed in the same mold-mounting table 5. In that case, after the molding greensand has been separated through weak vibrations, the molding greensand H attached to the molding material W may be separated through strong vibrations. Or, both the collapsed molding greensand and molding greensand H attached to the molding material W may be simultaneously separated through strong vibrations.

[0030] The process of separating molding greensand

from the molding material W is carried out by vibrating the molding material on the mold-mounting table 5 after the pressure in the sealing chamber has been returned to the atmospheric pressure. However, the process may also be performed in a state wherein the sealing chamber is being depressurized.

[0031] When it is difficult to dispose the vibrator 5B in the mold-mounting table 5, only the vibrator 15A that is disposed in the take-out fork member 15 may be used to separate the molding greensand in both the first and second stations.

[0032] The greensand molds M with no flask, into which molten metal has been cast, may be molds into which molten metal is cast after the flasks have been removed or molds from which the flasks are removed after molten metal has been cast therein.

[0033] The mold-pushing plate 10 used to transport the greensand molds M to the place of the collapsing may be replaced with the one similar to the take-out fork 15 used for taking out the molding material W.

[0034] Since the core-print portion of a core may fall, the core-print portion is preferably collected by a screen disposed in a process, after the second transport conveyor 25 C.

[0035] Below we explain a second embodiment of this invention by referring to Fig. 3, wherein like reference numbers are used for like members. In the second embodiment, means comprising projection members 22, 24 for making scratches in the surfaces of the greensand molds M, acting to begin the collapsing, are additionally provided. Means 20 for supporting the greensand molds is also provided to replace the mold-mounting table 5 of the first embodiment. On the constitutions and operations other than for those stated above, see the first embodiment of this invention.

[0036] We now detail the newly-provided scratching means and the box-shaped tray 20, which replaces the mold-mounting table 5. As shown in Figs. 3-5, the scratching means are additionally disposed above flask-removing means 16. The scratching means comprise numbers of vertical projections 22 and numbers of lateral projections 24. The vertical and lateral projections 22 and 24 are passed through frame bodies 21 and 23 to make vertical and lateral scratches on the surfaces of upper and lower greensand molds, respectively.

[0037] The box-shaped tray 20 is inclinably pivoted on the coupling pin 4 in the upper portion of the mounting plate 20 to replace the T-shaped mounting table 5 of the first embodiment. In the box-shaped tray 20, a plurality of band-like plates 17, which extend laterally and that are moved up and down by the lift cylinder 1 and a plurality of rod-shaped members 19 are provided.

[0038] We now explain the operations of the scratching means and box-shaped tray. The greensand molds M are pulled out by the cylinder 13 from the upper and lower flasks F through the flask-removing means 16 and the frame body 21 of the scratching means, and the surfaces of the upper and lower greensand molds M are

vertically scratched there by the vertical projections 22. Next, the greensand molds M are pushed up toward the box-shaped tray 20 through the inside of the frame body 23 of the scratching means, and the surfaces of the upper and lower greensand molds M are laterally scratched there by the lateral projections 24. The vertically and laterally scratched greensand molds M, are supported on the plurality of band-like plates 17 and in the box-shaped tray 20 by being passed through the frame bodies 21 and 23 of the scratching means. The greensand molds M are placed on the tip part of rods 19 after the plurality of band-like plates 17 have been moved down by the cylinder 1. The greensand molds M are then moved up by the lift cylinder for the next collapsing/separating process until the tray 20 abuts the inverse-U-shaped sealing box 8.

[0039] Now we detail the third embodiment of this invention. In it, means for depressurizing and means for pressurizing the inverse-U-shaped sealable box 8 are additionally used. On the constitutions and operations other than for the means stated above, see the first embodiment of this invention.

[0040] We now explain the pressurizing and depressurizing means of the third embodiment by referring to Figs. 6 and 7. The pressurizing means 30, comprising an opening-and-closing valve 31, a conduit 32, and a source 33 of compressed air, is communicatively connected to the sealable box 8. As shown in Fig. 7a, after the greensand molds M mounted on the mold-mounting table 5 have been accommodated in the airtight chamber defined by the tray and the sealing box 8 and when the source 33 of compressed air communicates with the airtight chamber by opening the opening-and-closing valve 31, then the parts of the condensed-water layer 34 whose strength is weaker than that of the other parts are pressurized so that the boiling point of the water of that layer is raised, and so that high-temperature water of more than 100 °C is generated throughout the condensed-water layer and greensand molds M. Next, when the opening-and-closing valve 31 is closed so that the supply of the compressed air to the airtight chamber is stopped, and at the same time the opening-and-closing valve 7 is opened so the airtight chamber is rapidly depressurized, the boiling point of the water of the entire condensed-water layer and the greensand molds M is lowered to less than 100 °C, to be boiled. Thereby, the greensand molds M are collapsed and at the same time they are separated, as shown in Fig. 7b. After that the pressure in the airtight chamber may be returned to the atmospheric pressure by closing the opening-and-closing valve 7 and by opening a return valve to the atmosphere (not shown) disposed in the sealing box 8.

[0041] Although in the third embodiment the airtight chamber defined by the tray and the sealing box 8 is depressurized to a pressure less than the atmospheric pressure after it has been pressurized, the pressure in the airtight chamber may also be returned to the atmospheric pressure by opening the return valve after it has

been pressurized.

Effects of Invention

[0042] As is clear from the above explanations, according to the method and apparatus for collecting molding material and greensand through the collapsing of the greensand molds, molding material and greensand can easily be controlled by separately collecting both the molding greensand that has been affected and not affected by molten metal, and by accurately understanding their respective manufacturing histories, so that the invention has various effects in keeping the quality of molding greensand similar to that of burnt away bentonite and in saving additives and the like.

Claims

1. A method of collapsing greensand molds, comprising the steps of
 airtightly surrounding greensand molds into which molten metal has been cast and depressurizing the airtightly surrounded greensand molds so that the portions of the greensand molds which have not been thermally affected by the molten metal are caused to collapse. 20
2. The method of claim 1, wherein the step of collapsing further comprises the step of
 pressurizing the airtightly surrounded greensand molds before depressurizing the greensand molds. 25
3. The method of claim 1, further comprising the step of scratching the surface of the greensand molds before airtightly surrounding the greensand molds into which molten metal has been cast. 30
4. An apparatus for collapsing greensand molds, comprising means for airtightly surrounding greensand molds into which molten metal has been cast and means for depressurizing the airtightly surrounded greensand molds. 35
5. A method of separating molding material from greensand molds, comprising the steps of airtightly surrounding greensand molds into which molten metal has been cast and separating the greensand molds from the molding material by depressurizing the airtightly surrounded greensand molds to collapse the greensand molds and taking out the molding material after releasing the airtightly surrounded greensand molds. 40
6. The method of claim 5, further comprising the step of scratching the surface of the greensand molds 45

before airtightly surrounding the greensand molds into which molten metal has been cast.

7. The method of claim 5, wherein the step of collapsing further comprises the step of pressurizing the airtightly surrounded greensand molds before depressurizing the greensand molds. 5
8. The method of claim 7, wherein in the step of depressurizing the airtightly surrounded greensand molds the airtightly surrounded greensand molds are depressurized to atmospheric pressure or less. 10
9. The method of claim 5, wherein the greensand molds into which molten metal has been cast are flask-less greensand molds. 15
10. The method of claim 9, wherein the flask-less greensand molds are obtained by removing flasks from the greensand molds carrying flasks when they have been cast.
11. The method of claim 9, wherein the flask-less greensand molds are in the flask-less state when they have been cast.
12. The method of any one of claims 9-11, wherein the flask-less greensand molds are molds divided in half.
13. An apparatus for separating molding material from greensand molds, comprising
 means for airtightly surrounding greensand molds into which molten metal has been cast,
 absorbing means for depressurizing the airtightly surrounded greensand molds, and
 means for separating and taking out the molding material from the collapsed greensand molds after the depressurized state has been released.
14. The apparatus of claim 13, further comprising means for scratching the surface of the greensand molds into which molten metal has been cast.
15. The apparatus of claim 13, further comprising means for pressurizing the airtightly surrounded greensand molds. 45
16. A method for separating/taking out molding material, comprising the steps of
 transporting one-by-one greensand molds into which molten metal has been cast at a collapsing position,
 airtightly surrounding the transported greensand molds into which molten metal has been cast,
 depressurizing the airtightly surrounded greensand molds so as to collapse the greensand molds by boiling any high-temperature water, and 50

vibrating the collapsed greensand molds and molding material so as to separate the greensand molds from the molding material and then taking out the separated molding material.

17. The method of claim 16, wherein the steps of vibrating the greensand molds and molding material comprises the steps of separating the collapsed molding greensand from the molding material by giving weak vibrations in the place where the greensand molds are airtightly surrounded, and then separating the molding greensand from the molding material by giving strong vibrations in a place different from that where the greensand molds are airtightly surrounded.

18. The method of any one of claims 16 and 17, wherein the greensand molds into which molten metal has been cast are flask-less molds.

19. The method of claim 18, wherein the flask-less greensand molds are pulled out from the molding flasks after molten metal has been cast.

20. The method of claim 18, wherein the flask-less greensand molds are pulled out from the molding flasks before molten metal has been cast.

21. An apparatus for taking out molding material, comprising

means disposed in a position where molds are collapsed for collapsing/separating molding greensand which is collapsed by means of weak vibrations, the means having a table 5 for the molds that is fixed to the means and movable up-and-down and a vibrator 5A, a plate 2 on which an inclinable tray 3 is mounted, and a sealable box 8, which communicates with a vacuum source 6 via an opening-and-closing valve 7, and which is movable up and down, and

means for separating the molding greensand from the molding material by means of strong vibrations, the means having a take-out fork 15 with a generator 15A, the take-out fork being disposed in one side of the collapsing means such that the fork can be moved up and down and vibrated.

22. The apparatus of claim 21, further comprising mold-transport means having a mold-push-out plate 10 for transporting the greensand molds onto the mold-mounting table 5 and mold-passing plate 11, the mold-transport means being provided in another side of the collapsing/separating means.

23. The apparatus of claim 22, the mold-transport means further comprising a flask-removing plate 14 for removing flasks from the greensand molds, the flask-removing plate 14 being provided in the out-

side of the mold-passing plate 11.

24. A method for collecting molding greensand, comprising the steps of airtightly surrounding greensand molds into which molten metal has been cast and which is carried in at a place where the molds are collapsed,

depressurizing/collapsing the airtightly surrounded greensand molds so as to separate the molding material to which the molding greensand that has been affected by heat is attached from the molding sand that has not been affected by heat,

vibrating the molding material at a place different from the place where the mold is collapsed so as to separate the molding greensand that has been affected by heat from the molding material, and

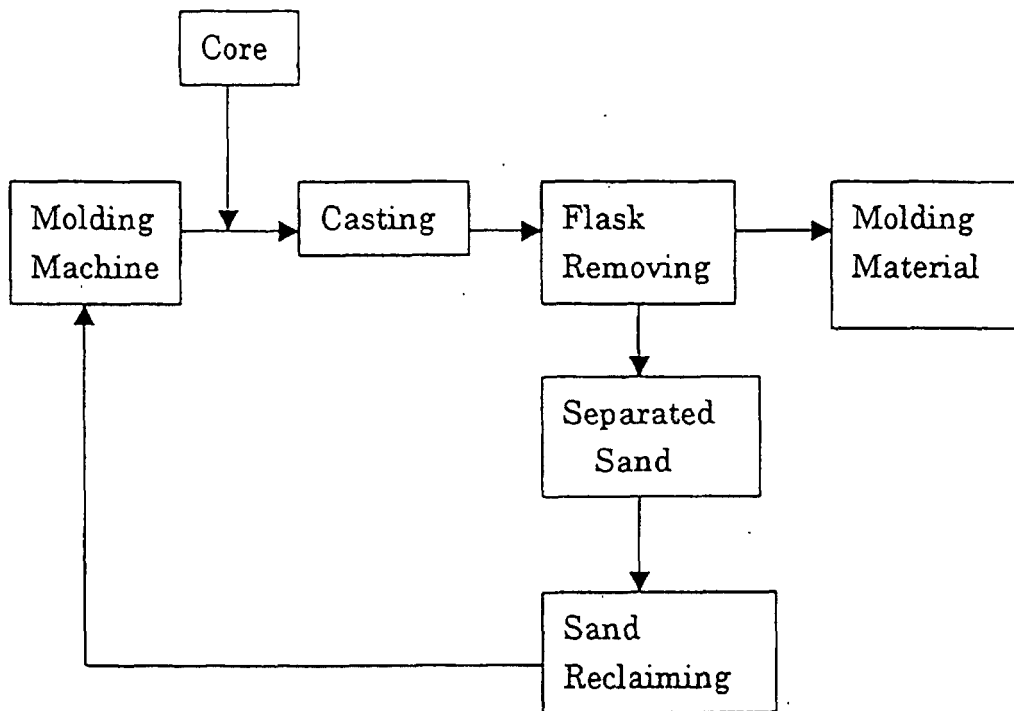
separately collecting the molding greensand that has been affected by heat and that that has not.

25. The method of claim of 24, wherein the greensand molds into which molten metal has been cast are in a flask-less state.

26. An apparatus for collecting molding greensand, comprising first means, disposed in a first collapsing/separating station, for collapsing/separating molding greensand which is collapsed by means of weak vibrations, the means having a mold-mounting table 5 for the mold, which is fixed to the means and movable up and down, and which has a vibrator 5A, a plate 2 on which an inclinable tray 3 is mounted, a sealable box 8, which is disposed so as to be moveable up and down above the table 5, and which communicates with a vacuum source 6 via an opening-and-closing valve 7, and a first collecting shoot 12 for collecting the molding greensand that has not been affected by heat, and

second means, disposed in a second collapsing-and-separating station, for separating the molding greensand from the molding material by means of strong vibrations, the means having a takeout fork 15 with a generator 15A and a second shoot 13 for collecting the molding greensand that has been affected by heat.

Fig. 1



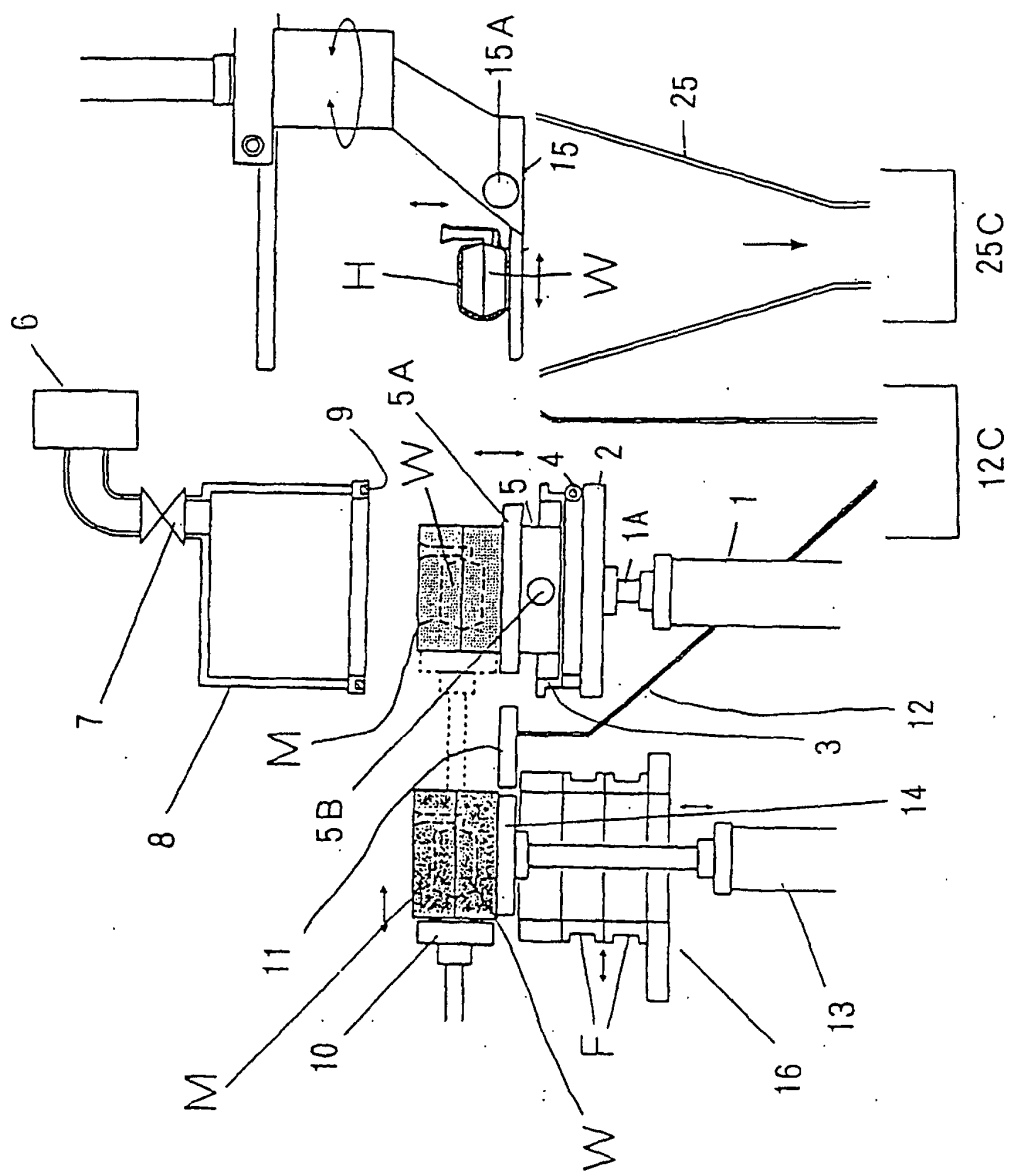


Fig. 2

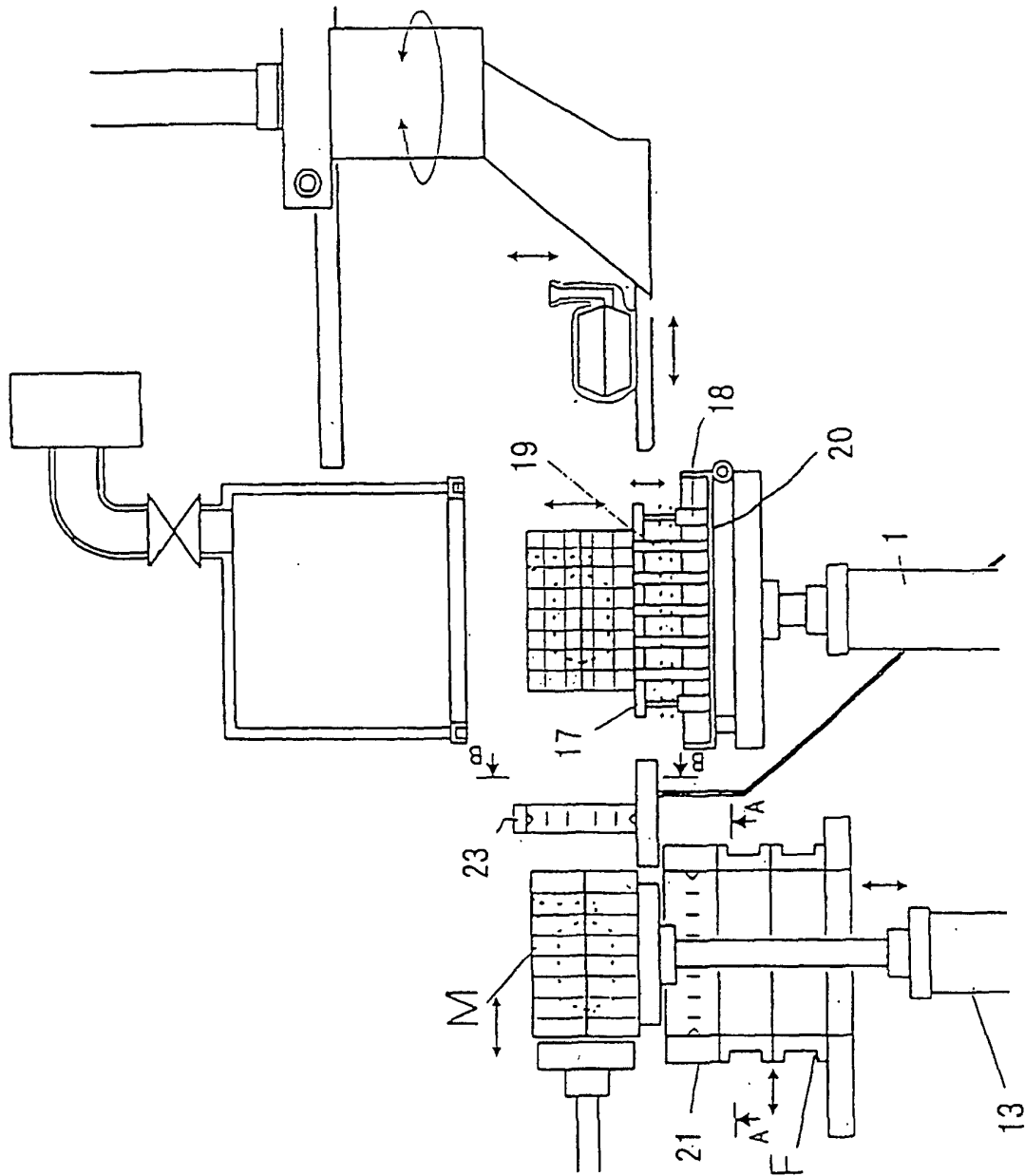


Fig. 3

Fig. 4

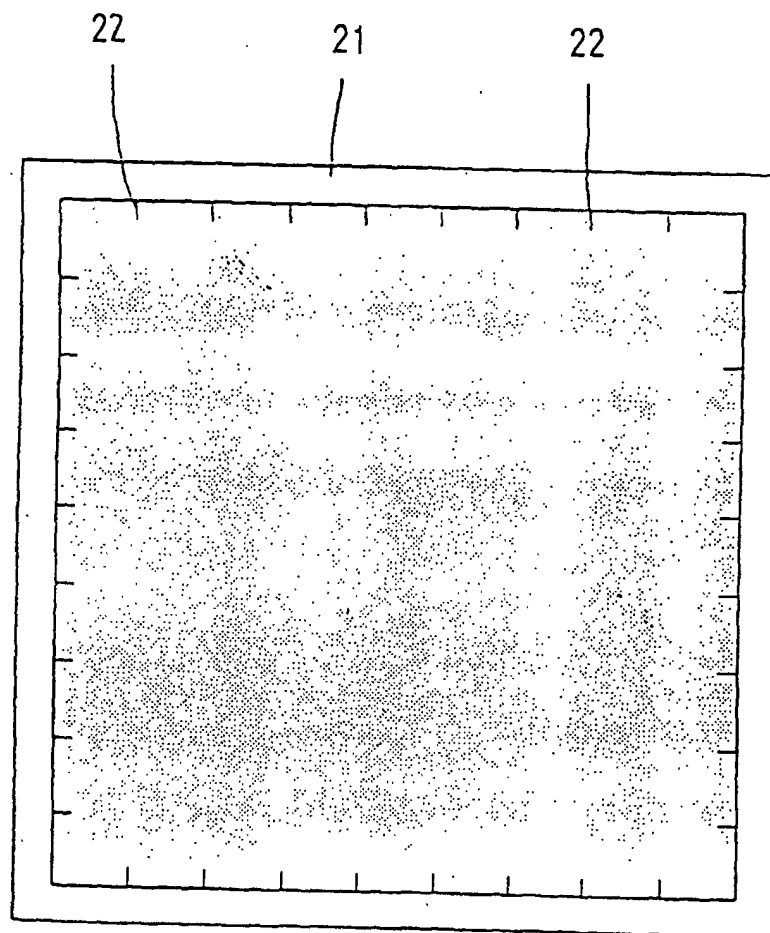


Fig. 5

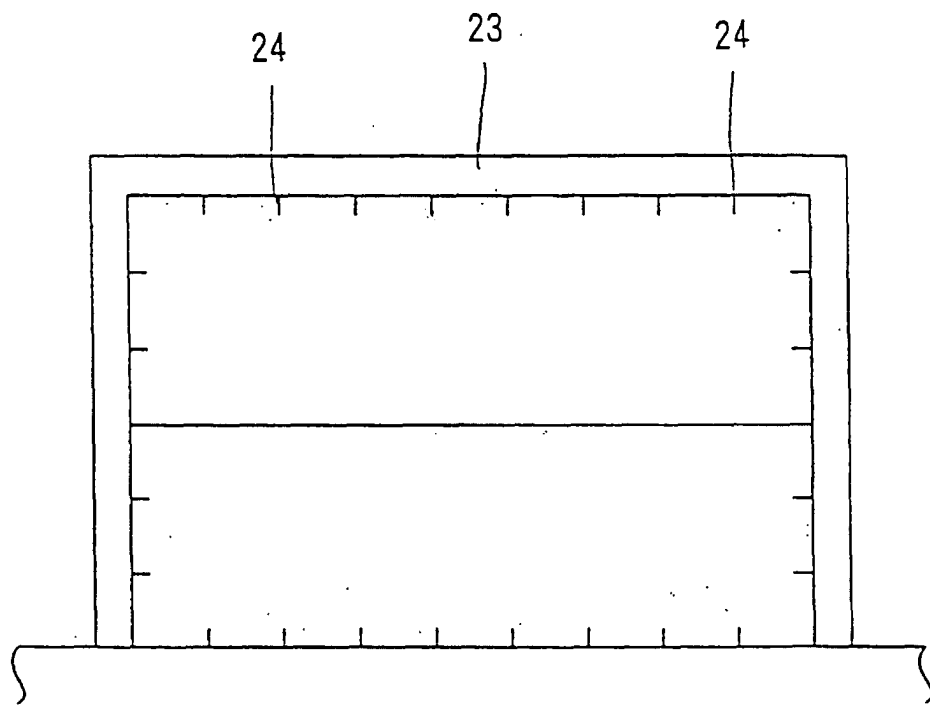


Fig. 6

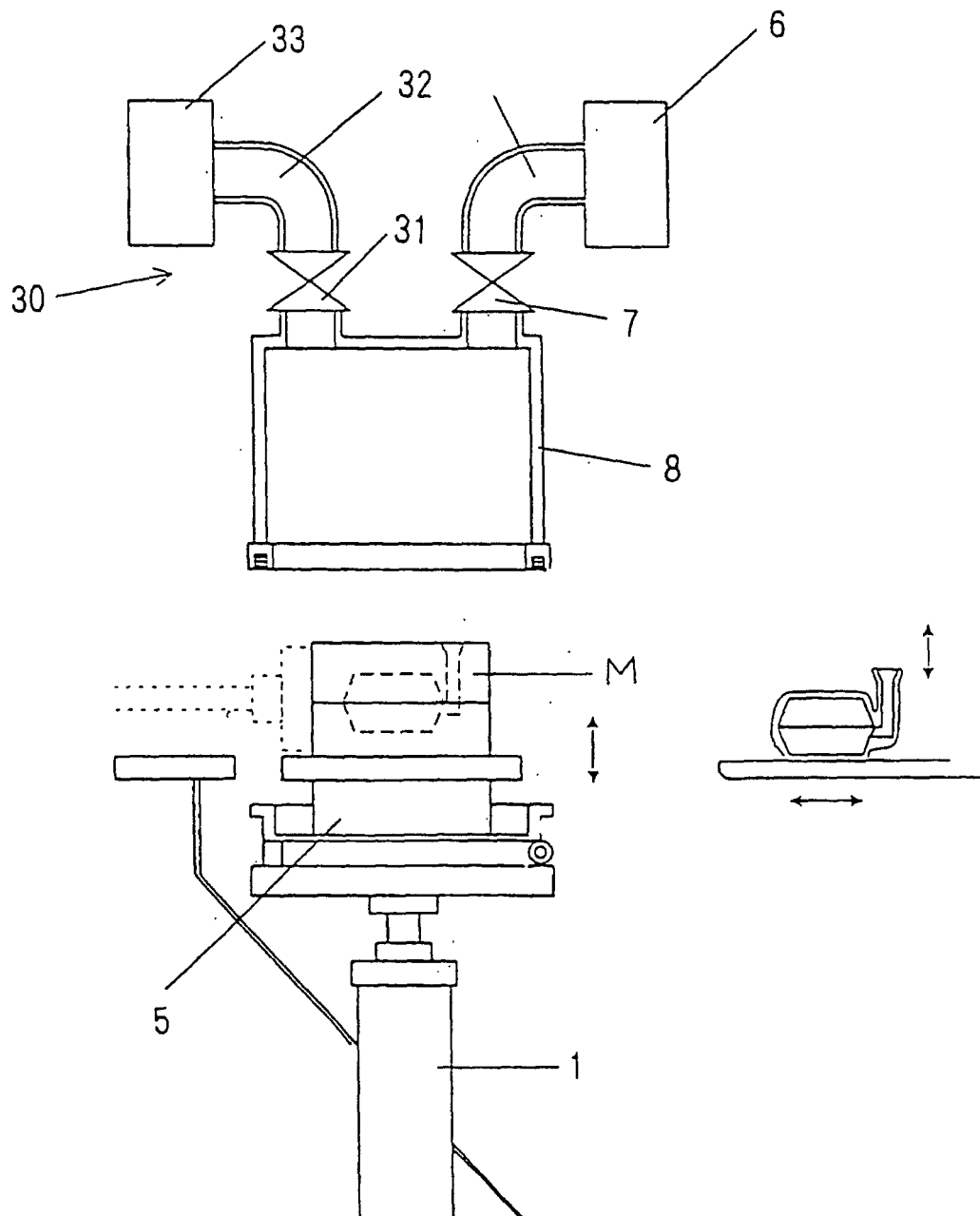
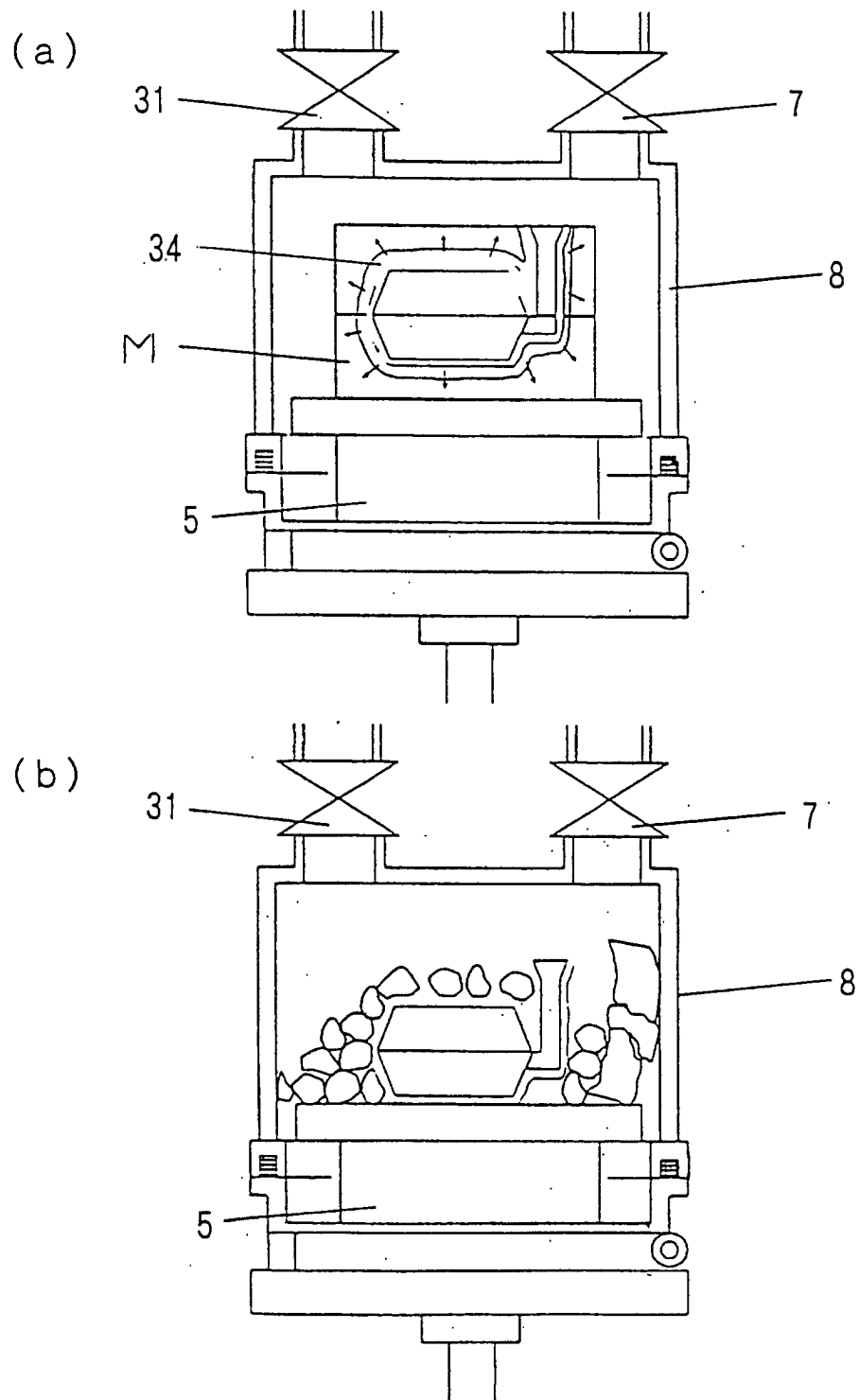


Fig. 7.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP01/00444

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁷ B22D29/00 B22D29/04 B22C5/00				
According to International Patent Classification (IPC) or to both national classification and IPC				
B. FIELDS SEARCHED				
Minimum documentation searched (classification system followed by classification symbols) Int.Cl. ⁷ B22D29/00 B22D29/04 B22C5/00				
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2001 Kokai Jitsuyo Shinan Koho 1971-2001 Jitsuyo Shinan Toroku Koho 1996-2001				
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DIALOG (WPI/L)				
C. DOCUMENTS CONSIDERED TO BE RELEVANT				
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.		
X A	US, 4620586, A (Albert Musschoot), 04 November, 1986 (04.11.86), Claims; Column 3, line 24 to Column 5, line 61; Figs. 1 to 5 & JP, 53-93118, A & BE, 863143, A & DE, 2802419, A	1, 4, 5, 13, 16, 24 2, 3, 6-12, 14, 15 , 17-23, 25, 26		
A	JP, 53-125935, A (Asahi Malleable Iron Co., Ltd.), 02 November, 1978 (02.11.78), Claims; drawing (Family: none)	1-26		
A	JP, 6-262339, A (Nissan Motor Co., Ltd.), 20 September, 1994 (20.09.94), Claims; drawing (Family: none)	1-26		
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.				
<table border="0"> <tr> <td style="vertical-align: top;"> * Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed </td> <td style="vertical-align: top;"> "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family </td> </tr> </table>			* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
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Date of the actual completion of the international search 27 March, 2001 (27.03.01)		Date of mailing of the international search report 03 April, 2001 (03.04.01)		
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer		
Facsimile No.		Telephone No.		

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