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(71) Applicant: **Toyota Jidosha Kabushiki Kaisha**
Toyota-shi, Aichi 471-8571 (JP)

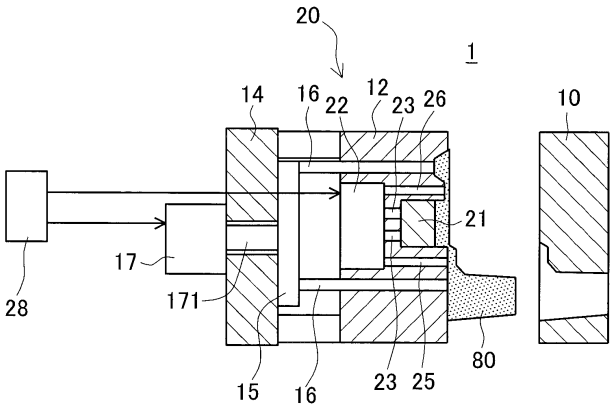
(72) Inventors:
- **SUGIURA Naoaki**
  Toyota-shi
  Aichi 471-8571 (JP)
- **IKUTA Hiroyuki**
  Toyota-shi
  Aichi 471-8571 (JP)

(74) Representative: **Albutt, Anthony John**
D Young & Co LLP
120 Holborn
London EC1N 2DY (GB)

(54) DIE CAST CASTING APPARATUS AND METHOD FOR RELEASING CASTING FROM MOLD

(57) Provided is a die cast casting apparatus (1) comprising: a fixed mold (10) and a movable mold (20) for forming a casting (80), wherein an insert core (21) is disposed in a slidable manner in a movable main mold (12) of the movable mold to form a convex-shaped portion (81) of the casting. The movable mold (20) comprises: casting extrusion mediums (16, 17) for releasing the casting from the movable main mold, insert core transportation mediums (22, 23) for moving the insert core towards the direction in which the casting is released from the mold, and convex-shaped portion release mediums (22, 25, 26) for releasing the convex-shaped portion from the insert core. In a first mold release step, a control medium (28) controls the operations of the casting extrusion mediums, the insert core transportation mediums, and the convex-shaped portion release mediums so that the casting is released from the movable main mold by the casting extrusion mediums (16, 17) and the insert core is moved along the casting by the insert core transportation mediums (22, 23). In a second mold release step, the convex-shaped portion is released from the insert core by the convex-shaped portion release mediums (22, 25, 26).

FIG. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a die casting apparatus and a method for releasing a casting from a die or mold to produce a casting including a plurality of protruding portions such as a cooling fin.

BACKGROUND ART

[0002] A die casting apparatus includes a fixed or stationary die and a movable die arranged so that a cavity is defined by the movable die and the fixed die in a closed state. The fixed die and the movable die are each provided with ejector pins for releasing a casting from the dies after casting. In casting, so-called vacuum casting is performed in which a predetermine amount of molten metal is supplied to the cavity under vacuum, the molten metal being injected under high pressure. After the molten metal in the cavity is solidified and a casting is formed, die-opening by retreating the movable die and die-releasing, or demolding, by ejecting the casting out of the movable die by use of ejector pins and the like are performed. FIG 11 is a cross sectional view of a die casting apparatus showing conceptually a state of such a demolding operation.

[0003] A casting shown herein is a cooling fin illustrated in FIG 12. A casting 80 integrally includes a plurality of fin portions 81 formed of standing thin plates arranged in parallel and a flat plate portion 82 vertical to the fin portions 81. FIG 11 shows how to produce this casting 80, which is seen in a side direction (X direction) in which the fin portions 81 are arranged side by side. A die casting apparatus 100 is configured so that a movable die 102 is separated from a fixed die 101 and then a hydraulic cylinder 103 is actuated to extend ejector pins 105 to forcibly release the casting 80 from the movable die 102.

RELATED ART DOCUMENTS

PATENT DOCUMENTS

[0004] Patent Document 1: JP8(1996)-A-300132

SUMMARY OF INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0005] The casting 80 including a protruding portion such as the fin portions 81 has a large contact area with the dies and thus exhibits large resistance when the casting 80 is being released from the dies after casting. In the conventional die casting apparatus 100, therefore, some problems may be caused, for example, the ejector pins 105 are broken or bent. In this respect, Patent Document 1 discloses a die casting apparatus in which an insert core is set in a movable die for forming a fin. This apparatus includes a fluid supply means for supplying a liquid such as water and machine oil under high pressure. Accordingly, the core is moved back after solidification of molten metal, thereby generating a clearance with respect to a cooling fin which is a product. The liquid is then supplied thereto to apply pressure. This reduces an ejection load of the ejector pins performed at the same time. However, the die casting apparatus in Patent Document 1 has to include the fluid supply means and others, resulting in a complicated structure, and needing time to deal with the liquid.

[0006] On the other hand, in the case of the die casting apparatus 100, when the ejector pins 105 push an area near the fin portions 81, stress is apt to concentrate on a corner 85 at a boundary between the fin portions 81 and the flat plate portion 82, causing breakage of that boundary portion. In this case, the casting 80 is a defective product, leading to a decreased yield, and also the fin portions 81 could not be released from the die and thus are broken and left in the mold. To prevent breakage of the casting 80, it is therefore conceivable to directly push the fin portions 81 for demolding. However, the apparatus provided with a plurality of pins for pushing the thin fin portions 81 results in a complicated structure and an increased cost. If a tip portion of each fin pushed by the ejector pin is buckled and deformed, such a deformed fin deteriorates the capacity of the cooling fin constituting a heat exchanger. Thus, the fin tip portions have to be subjected to finish machining to maintain the cooling capacity. This requires troubles and causes loss in manufacturing time.

[0007] The present invention has been made to solve the above problems and has a purpose to provide a die casting apparatus and a method for releasing a casting from a die to enable easy demolding of the casting.

MEANS OF SOLVING THE PROBLEMS

[0008] To achieve the above purpose, one aspect of the invention provides a die casting apparatus including a fixed die and a movable die to form a cavity for molding a casting, in which an insert core is slidably provided in a movable main die of the movable die to form a protruding portion of the casting, wherein the movable die includes: product ejecting means to release the casting from the movable main die; core moving means to move the core in a demolding direction of the casting; and protruding-portion demolding means to release the protruding portion from the core, wherein control means to control operations of the product ejecting means, the core moving means, and the protruding-portion demolding means is configured to execute a first demolding step in which the product ejecting means releases the casting from the movable main die and the core moving means moves the core in association with the casting, and a second demolding step in which the protruding-portion demolding means releases the protruding portion from the core.

[0009] In the above die casting apparatus, preferably, the protruding-portion demolding means is ejecting means configured to push the casting near the protruding portion in the demolding direction, and perform the second demolding step by pushing the casting by the ejecting means.

[0010] In the above die casting apparatus, preferably, when the core is configured to form the protruding portion consisting of a plurality of straight extending standing plates arranged side by side, the ejecting means is placed on both sides of the core corresponding to both sides of the standing plates in a straight extending direction, and the control means performs the second demolding step by alternately pushing each side of the ejecting means with respect to the core.

[0011] In the above die casting apparatus, preferably, the core moving means and the ejecting means are integrally formed by a hydraulic unit configured to separately independently extend and contract operation rods connected to the core and ejector pins to be pressed against a portion of the casting near the protruding portion.

[0012] In the above die casting apparatus, preferably, the core moving means and the protruding-portion demolding means are integrally formed by a hydraulic unit configured to separately independently extend and contract operation rods connected to the core and plate-shaped ejector blocks to be pressed against the casting near the protruding portion.

[0013] In the above die casting apparatus, preferably, the product ejecting means includes a plurality of ejector pins or ejector blocks fixed to an ejector plate to be moved by a hydraulic cylinder, and the control means is hydraulic control means to drive and control the hydraulic unit and the hydraulic cylinder.

[0014] In the above die casting apparatus, preferably, the core is formed of a plurality of separate blocks, and the protruding-portion demolding means includes core moving means to move each of the separate blocks of the core in a demolding direction of the casting and ejecting means to push the casting near the protruding portion in the demolding direction, and in the second demolding step, the separate blocks are stepwise moved relatively in an opposite direction to the demolding direction by the core moving means with respect to the protruding portion of the casting pushed or supported by the ejecting means.

[0015] In the above die casting apparatus, preferably, when the core is configured to form the protruding portion consisting of a plurality of straight extending standing plates arranged side by side, the separate blocks are separated in a straight extending direction of the standing plates.

[0016] In the above die casting apparatus, preferably, the core moving means and the ejecting means are integrally formed by a hydraulic unit configured to separately independently extend and contract operation rods connected to the separate blocks of the core and ejector pins to be pressed against the casing near the protruding portion.

[0017] In the above die casting apparatus, preferably, the core moving means and the ejecting means are integrally formed by a hydraulic unit configured to separately independently extend and contract operation rods connected to the separate blocks of the core and plate-shaped ejector blocks to be pressed against the casing near the protruding portion.

[0018] In the above die casting apparatus, preferably, wherein the product ejecting means includes a plurality of ejector pins or ejector blocks fixed to an ejector plate to be moved by a hydraulic cylinder, and the control means is hydraulic control means to drive and control the hydraulic unit and the hydraulic cylinder.

[0019] In the above die casting apparatus, preferably, the protruding-portion demolding means is grasping means configured to grasp and move the casting, and performing the second demolding step by moving the casting in a predetermined direction by the grasping means.

[0020] In the above die casting apparatus, preferably, when the core is configured to form the protruding portions consisting of a plurality of straight extending standing plates arranged side by side, and the grasping means performs the second demolding step by pulling pull the casting in the straight extending direction of the standing plates and moving the casting.

[0021] Another aspect of the invention provides a method for releasing a casting from a die, using a die casting apparatus to form the casting including a protruding portion, the method including separating a movable die from a fixed die for die opening and then demolding the casting from the movable die, wherein the method includes: a first demolding step including moving an insert core configured to form the protruding portion in association with the casting to release a portion of the casting other than the protruding portion from a movable main die of the movable die; and a second demolding step including releasing the protruding portion from the core.

[0022] In the above method for releasing a casting from a mold, preferably, when the core is configured to form the protruding portion consisting of a plurality of straight extending standing plates arranged side by side, the second demolding step uses ejecting means placed on both sides of the core corresponding to both side positions of the standing plates in a straight extending direction and includes alternately operating each side of the ejecting means to push the casting in the demolding direction.

[0023] In the above method for releasing a casting from a mold, preferably, the second demolding step uses the core formed of a plurality of separate blocks and includes stepwise moving the separate blocks to release the protruding portion by each separate block.

[0024] In the above method for releasing a casting from a mold, preferably, the second demolding step uses grasping means to grasp and move the casting and includes making the grasping means to move the casting

in a predetermined direction.

[0025] In the above method for releasing a casting from a mold, preferably, when the core is configured to form the protruding portion consisting of a plurality of straight extending standing plates arranged side by side, the second demolding step includes making the grasping means to pull the casting in a straight extending direction of the protruding portion.

EFFECTS OF THE INVENTION

[0026] According to the invention, in a first demolding step, an insert core is moved together with a casting and thus a protruding portion exhibiting large resistance during demolding is not released from the die. In a second demolding step, only the protruding portion is released from the die. The resistance in each step is thus reduced, thereby allowing entirely easy demolding of the casting. In each step, the resistance to the product ejecting means and the protruding-portion demolding means for releasing the casting from the die is reduced. Thus, their breakage can be prevented. Furthermore, the resistance generated in demolding the protruding portion in the second demolding step is reduced, so that stress applied at a boundary portion between the protruding portion and a peripheral portion thereof in the casting can be reduced. This can avoid breakage of the casting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

FIG 1 is a cross sectional view conceptually showing a die casting apparatus in a first embodiment, corresponding to a die open state after casting;
FIG 2 is a cross sectional view conceptually showing the die casting apparatus in the first embodiment, corresponding to a first demolding step;
FIG 3 is a cross sectional view conceptually showing the die casting apparatus in the first embodiment, corresponding to a second demolding step;
FIG 4 is a cross sectional view conceptually showing the die casting apparatus in the first embodiment, corresponding to another second demolding step;
FIG 5 is a cross sectional view conceptually showing the die casting apparatus in the first embodiment, corresponding to another second demolding step;
FIG 6 is a cross sectional view conceptually showing a die casting apparatus in a second embodiment, corresponding to a die open state after casting;
FIG 7 is a cross sectional view conceptually showing the die casting apparatus in the second embodiment, corresponding to a first demolding step;
FIG 8 is a cross sectional view conceptually showing the die casting apparatus in the second embodiment, corresponding to a second demolding step;
FIG 9 is a cross sectional view conceptually showing the die casting apparatus in the second embodiment, corresponding to the second demolding step;
FIG 10 is a cross sectional view conceptually showing a die casting apparatus in a third embodiment, corresponding to a second demolding step;
FIG 11 is a cross sectional view conceptually showing a conventional die casting apparatus, corresponding to a step for releasing a casting from a movable die;
FIG 12 is a perspective view showing a cooling fin which is one example of a casting;
FIG 13 is a perspective view showing locations of ejector pins for ejecting a casting; and
FIG 14 is a perspective view showing locations of ejector blocks for ejecting a casting.

REFERENCE SIGNS LIST

[0028]

1	Die casting apparatus
10	Fixed die
20	Movable die
12	Movable main die
15	Ejector plate
16	Ejector pin
17	Hydraulic cylinder
21	Core
22	Hydraulic unit
23	Operation rod
25, 26	Ejector pin
28	Hydraulic control unit
80	Casting
81	Fin portion

MODE FOR CARRYING OUT THE INVENTION

[0029] A detailed description of a preferred embodiment of a die casting apparatus and a method for releasing a casting from a die or mold embodying the present invention will now be given referring to the accompanying drawings. FIG 1 is a cross sectional view conceptually showing a die casting apparatus in a first embodiment, corresponding to a die open state after casting. This die casting apparatus 1 is configured to produce a casting 80 shown in FIG 12 as in a conventional example, that is, a cooling fin.

[0030] The die casting apparatus 1 includes a fixed die 10 and a movable die 20. The movable die 20 is moved by an actuator not shown for die opening or die clamping with respect to the fixed die 10. The movable die 20 includes a movable main die 12 coupled to a base 14. An ejector plate 15 is placed between the movable main die 12 and the base 14. To the ejector plate 15, a plurality of ejector pins 16 are fixed to extend through the movable main die 12. A hydraulic cylinder 17 is fixed to the base 14. An ejector rod 171 of the cylinder 17 extends through the base 14 and is connected to the ejector plate 15. In the movable die 20, accordingly, the hydraulic cylinder

17 makes the ejector pins 16 stick out to release the casting 80 from the die 20.

[0031] In the movable main die 12, an insert core 21 is slidably set. This core 21 is a block having a reversed shape of the fin portions 81 (see FIG 12) of the casting 80. The movable die 20 is provided with a hydraulic unit 22. This hydraulic unit 22 includes operation rods 23 connected to the core 21 and ejector pins 25 and 26 to release, or demold, the casting 80 so that the rods and pins are independently extended or contracted. Accordingly, the hydraulic unit 22 makes the core 21 slidable with respect to the movable main die 12.

[0032] Meanwhile, the die casting apparatus 1 uses the ejector pins 25 and 26 in addition to the ejector pins 16 to release the casting 80 from the movable main die 12. The ejector pins 25 and 26 are placed on both sides of the fin portions 81 in a longitudinal direction (a Y direction in FIG 12) as shown in FIG 13. For instance, five ejector pins 25 are provided on one side and five ejector pins 26 are similarly provided on the opposite side of the fin portions 81. The ejector pins 16 are arranged in predetermined several positions more apart from the fin portions 81 than the ejector pins 25 and 26.

[0033] When the casting 80 is to be released from the movable main die 12, the ejector pins 16 to be extended or contracted by the hydraulic cylinder 17 and the operation rods 23 and the ejector pins 25 and 26 to extended or contracted by the hydraulic unit 22 are separately independently controlled for extension or contraction. The die casting apparatus 1 is provided with a hydraulic control unit 28 to control the hydraulic cylinder 17 and the hydraulic unit 22.

[0034] Next, the method for releasing the casting 80 using the die casting apparatus 1 will be explained below. FIGs. 2 and 3 stepwise show a demolding step to be carried out by the die casting apparatus 1, corresponding to a step following the state shown in FIG 1. In the die casting apparatus 1, molten metal is injected in a cavity formed by the fixed die 10 and the movable die 20 clamped with each other, and the molten metal is solidified, thereby casting the casting 80. In the subsequent demolding steps, die-opening is first performed by separating the movable die 20 from the fixed die 10 as shown in FIG 1. At that time, the casting 80 is pushed toward the movable die 20 by ejector pins provided in the fixed die 10, even though not illustrated. Accordingly, as shown in FIG 1, the casting 80 is separated from the fixed die 10 and remains fitted to the side of the movable die 20.

[0035] In the present embodiment, when the casting 80 is to be released from the movable main die 12, demolding, or die-releasing, is implemented in two separate steps, i.e., a first demolding step and a second demolding step. In the first demolding step shown in FIG 2, firstly, the hydraulic cylinder 17 is actuated to extend, thereby making the ejector pins 16 eject and release the casting 80 from the movable main die 12. At that time, the hydraulic unit 22 makes the operation rods 23 extend or stretch by the same stroke as the hydraulic cylinder 17, thereby moving the core 21 together with the casting 80 pushed by the ejector pins 16. In this first demolding step, therefore, the casting 80 is demolded from the movable main die 12 but the fin portions 81 still remain fitted in the core 21.

[0036] In the second demolding step shown in FIG 3, therefore, the hydraulic unit 22 is then actuated to extend the ejector pins 25 and 26 to press against the casting 80. At that time, since the stroke of each operation rod 23 is not changed and thus the core 21 is left unmoved. Therefore, the casting 80 is ejected by the ejector pins 25 and 26 in the demolding direction, so that the fin portions 81 are separated from the core 21. The entire demolding is completed. In this demolding step, a robot arm not shown follows the casting 80. Accordingly, the released casting 80 is grasped by the robot arm so as not to drop down after demolding, and conveyed to a next step.

[0037] In the first demolding step shown in FIG 2, accordingly, the core 21 is moved in the demolding direction and the fin portions 81 having large resistance to releasing are not demolded, so that the resistance to the ejector pins 16 can be reduced. In the second demolding step, similarly, only the fin portions 81 are demolded, so that the resistance to the ejector pins 25 and 26 can be reduced. Since the resistance in each step is small, it is possible to prevent the ejector pins 16 and ejector pins 25 and 26 from breaking or bending. Furthermore, the reduced resistance to the ejector pins 25 and 26 enables reduction in the stress applied on the corner 85 at a boundary between the fin portions 81 and the flat plate portion 82 on which stress is likely to concentrate. This can prevent breakage of the casting 80 during die-releasing, or demolding.

[0038] In the second demolding step shown in FIG 3, meanwhile, the ejector pins 25 and 26 are synchronously extended, or stretched. Alternatively, the pins may be independently extended and contracted. FIGs. 4 and 5 are diagrams showing another second demolding step to be performed instead of the method shown in FIG 3. In this second demolding step, as shown in FIG 4, firstly, the hydraulic cylinder 17 is actuated to move back the ejector pins 16 through the ejector plate 15 into the movable main die 12. The ejector pins 16 thus separate from the casting 80. Then, the hydraulic unit 22 is operated to extend and contract the ejector pins 25 and 26 separately while maintaining the stroke of the operation rods 23.

[0039] To be concrete, as shown in FIG 4, only the ejector pins 25 located on one side of the fin portions 81 are stretched as shown in FIG 4 to press against the casting 80. Successively, as shown in FIG 5, the ejector pins 25 are contracted to separate from the casting 80 and the ejector pins 26 are stretched to press against the casting 80. In this manner, the fin portions 81 are released from the core 21 by alternately displacing the ends of the fin in the longitudinal direction. According to this demolding method, when the ejector pins 25 or ejector pins 26 push out the casting 80, each pin applies a force

in a direction at an angle to the demolding direction, thereby increasing a force in a shear direction between the core 21 and the fin portions 81, thus facilitating demolding. Furthermore, a force further acts in an oblique direction, increasing the clearance between the core 21 and the fin portions 81. This can reduce friction force between them.

[0040] Accordingly, the resistance to the ejector pins 25 and 26 is reduced, which can prevent the ejector pins 16 and the ejector pins 25 and 26 from breaking or bending. It is further possible to reduce the stress applied on the corner 85 of the casting 80 at which the stress is likely to concentrate and prevent breakage during demolding. The die casting apparatus 1 in the present embodiment can achieve the above effects by a hydraulic mechanism conventionally used, not by a special structure, and can achieve it without increasing costs. The apparatus itself is also easy to handle. In the die casting apparatus 1, furthermore, the ejector pins 16, 25, and 26 do not directly push the fin portions 81. This enables manufacture of thin fins and does not deform such fins during demolding.

[0041] In the case shown in FIG 5, the ejector pins 25 are contracted. Alternatively, the ejector pins 25 may be left extended when the ejector pins 26 are extended. The ejector pins 25 and 26 may be extended alternately and repeatedly, e.g., in steps of 0.1-mm stroke, and subsequently extended synchronously as in the method shown in FIG 3.

(Second Embodiment)

[0042] A second embodiment of a die casting apparatus according to the invention will be explained below. FIG 6 is a cross sectional view conceptually showing the die casting apparatus of the second embodiment, corresponding to a die open state after casting. This die casting apparatus 2 is also configured to produce a cooling fin, i.e., the casting 80 shown in FIG 12. Since this die casting apparatus 2 is identical in structure to the die casting apparatus 1 of the first embodiment, similar or identical parts are explained with the same reference signs as those in the first embodiment.

[0043] The die casting apparatus 2 includes the fixed die 10 and a movable die 30. The movable die 30 includes the movable main die 12 coupled to the base 14 and ejector pins 16 to be extended or contracted by the hydraulic cylinder 17. In the present embodiment, a split core 31 is provided in the movable main die 12 and is moved by a hydraulic unit 32. The core 31 consists of a first block 301 and a second block 302 which are connected respectively to operation rods 33 and 34 to move independently. The first block 301 and the second block 302 are two blocks separated in a longitudinal direction of the fin. Alternatively, they may be blocks separated in a direction perpendicular to the fin or more than two separate blocks.

[0044] The hydraulic unit 32 is also provided with ejector pins 35. The ejector pins 35 correspond to the ejector pins 25 and 26 shown in FIG 13 and are placed, several pins each, on both sides of the fin portions 81 in the longitudinal direction. The ejector pins 16 are placed at predetermined several positions more apart from the fin portions 81 than the ejector pins 35. The hydraulic cylinder 17 and the hydraulic unit 32 are connected to the hydraulic control unit 28 to control extension and contraction of the ejector pins 16 and 35 and the operation rods 33 and 34.

[0045] The demolding method using the above die casting apparatus 2 will be explained below. FIGs. 7 to 9 stepwise show a demolding step to be carried out by the die casting apparatus 2, corresponding to a step following the state shown in FIG 6. In the die casting apparatus 2, molten metal is injected in a cavity formed by the fixed die 10 and the movable die 30, and the molten metal is solidified, thereby casting the casting 80. In the subsequent demolding steps, die-opening is performed by separating the movable die 30 from the fixed die 10 as shown in FIG 6. At that time, the casting 80 is separated from the fixed die 10 and remains fitted to the side of the movable die 30 as shown in FIG 6.

[0046] Demolding of the casting 80 from the movable die 30 is first performed in the first demolding step as shown in FIG 7. In the first demolding step, the hydraulic cylinder 17 is actuated to extend, thereby making the ejector pins 16 eject and release the casting 80 from the movable main die 12. At that time, the hydraulic unit 32 makes the operation rods 33 and 34 extend or stretch by the same stroke as the hydraulic cylinder 17, thereby moving the core 31 together with the casting 80 pushed by the ejector pins 16. Therefore, the fin portions 81 of the casting 80 still remain fitted in the core 31. Then, the second demolding step is performed to release the fin portions 81.

[0047] In the second demolding step, as shown in FIG 8, the ejector pins 35 are extended or stretched to push and move the casting 80. At that time, the stroke of the operation rod 33 is not changed and only the other operation rod 34 is extended or stretched to move the second block 302 in association with movement of the casting 80 by the ejector pins 35. Accordingly, the fin portions 81 are first released from the first block 301 of the core 31. Thereafter, as shown in FIG 9, the ejector pins 35 are further extended to move the casting 80 while the stroke of the operation rod 34 is kept. Thus, the fin portions 81 of the casting 80 are separated from the second block 302 of the core 31. The entire demolding is completed. The released casting 80 is grasped by a robot arm not shown so as not to drop down and is conveyed to a next step.

[0048] The second demolding step mentioned above shows the method for extending the ejector pins 35 while the first block 301 and the second block 302 are stopped. Conversely to the above method, it may be arranged so that the ejector pins 35 are stopped in an extended state and the operation rods 33 and 34 are stepwise contracted separately to demold the fin portions 81. Accordingly, the

ejector pins 35 in this method function to push out the casting 80, thereby releasing the casting 80 from the movable main die 12 in the first demolding step, and function to support the casting 80 without changing the stroke in the second demolding step.

[0049] In the die casting apparatus 2 of the present embodiment, the core 31 is moved in the demolding direction so that the fin portions 81 are not demolded in the first demolding step, and then only the fin portions 81 are demolded in the second demolding step. This can reduce the resistance to die releasing in each step. Since the resistance to the ejector pins 16 and 35 during demolding is reduced, it is possible to prevent the ejector pins 16 and 35 from breaking or bending. In the second demolding step, especially, demolding is performed stepwise by the split core 31, so that resistance during demolding in each block is made small. Accordingly, this reduces the stress applied on the corner 85 present at a boundary between the fin portions 81 and the flat plate portion 82 on which stress is likely to concentrate. This can prevent breakage of the casting 80 during demolding. In the die casting apparatus 2, furthermore, the ejector pins do not directly push the fin portions 81. This enables manufacture of thin fins and does not deform the fins during demolding.

(Third Embodiment)

[0050] A third embodiment of a die casting apparatus of the invention will be explained below. FIG 10 is a cross sectional view conceptually showing the die casting apparatus of the third embodiment, corresponding to a step to release a casting from a movable die. This die casting apparatus 3 is also configured to manufacture a cooling fin, that is, the casting 80 shown in FIG. 12. This die casting apparatus 3 is also identical in structure to the die casting apparatus 1 of the first embodiment and thus similar or identical parts are explained with the same reference signs as those in the first embodiment.

[0051] The die casting apparatus 3 includes a movable die 40 and a fixed die not shown. The movable die 40 includes the movable main die 12 fixed to the base 14 and ejector pins 16 to be extended or contracted by the hydraulic cylinder 17. The movable main die 12 is provided with the slidable core 21 connected to the operation rods 23 of the hydraulic unit 22. Meanwhile, the die casting apparatus 3 is configured to stepwise perform demolding using the ejector pins 16 and demolding using a robot arm for grasping the casting 80. FIG 10 illustrates a hand portion of a robot arm 50 used to grasp the casting 80 to prevent the casting 80 from dropping down and convey the casting 80 to a next step.

[0052] In the die casting apparatus 3, the casting 80 is die-released, or demolded, in the following manner. The movable die 40 is separated from the fixed die for die opening, and then the first demolding step of the casting 80 is performed in the movable die 40. FIG 10 shows a stage shifting from the finished first demolding step to the next second demolding step. In the first demolding step, the hydraulic cylinder 17 is actuated to extend, thereby moving the ejector plate 15 to stick out the ejector pins 16, thereby ejecting the casting 80 out of the movable main die 12 as shown in FIG 10. At that time, the hydraulic unit 22 causes the operation rods 23 to extend or stretch by the same stroke as the hydraulic cylinder 17, thereby moving the core 21 together with the casting 80 pushed by the ejector pins 16 in the demolding direction.

[0053] Accordingly, the fin portions 81 of the casting 80 still remain fitted in the core 21 and then the fin portions 81 are demolded in the following second demolding step. In the second demolding step, the fin portions 81 are pulled out by the robot arm 50. The robot arm 50 moves the casting 80 in the fin longitudinal direction. Thus, the fin portions 81 of the casting 80 are separated from the core 21. The entire demolding is completed.

[0054] As above, the die casting apparatus 3 of the present embodiment is also operated to move the core 21 out of the die and the fin portions 81 are not demolded in the first demolding step and then only the fin portions 81 are demolded in the second demolding step. This can reduce the demolding resistance in each step. The resistance to the ejector pins 16 during demolding is reduced, so that the ejector pins 16 are prevented from breaking or bending. In particular, since the casting 80 is moved in the fin longitudinal direction in the second demolding step, this can reduce the stress applied on the corner 85 at a boundary between the fin portions 81 and the flat plate portion 82 on which the stress is likely to concentrate, thereby preventing breakage of the casting 80 in during demolding. Furthermore, the ejector pins do not directly push the fin portions 81. This enables manufacture of thin fins and does not deform the fins.

[0055] The above explanations are given to the die casting apparatus and the method for releasing the casting from the die according to the invention. However, the present invention is not limited to the above embodiments and may be embodied in other specific forms without departing from the essential characteristics thereof. For instance, in the first and second embodiments, the fin portions 81 are demolded by use of the ejector pins 25 and 26 and the ejector pins 35 as shown in FIG 4. Instead of the ejector pins 25 and 26 and the ejector pins 35, it may be configured so that plate-shaped ejector blocks 45 shown in FIG 14 are moved in and out by a hydraulic unit. The casting to be produced by the die casting apparatus is not limited to the cooling fin. The cooling fin is also not limited to a straight fin depending to the embodiments. For example, a meandering or zigzag fin or pin fin may be adopted.

[0056] In the second demolding step executed by the die casting apparatus 1 of the first embodiment, the stroke of each ejector pin 25 and 26 may be controlled by detecting resistance by a load cell. In the third embodiment, there is not provided pins to push the casting 80 in the second demolding step. Alternatively, the third

embodiment may include the ejector pins 25 and 26 as in the first embodiment so that the fin portions 81 are displaced and then pulled by the robot arm 51. Furthermore, a means for imparting vibrations to an insert core and a casting may be added.

Claims

1. A die casting apparatus including a fixed die and a movable die to form a cavity for molding a casting, in which an insert core is slidably provided in a movable main die of the movable die to form a protruding portion of the casting,
wherein the movable die includes: product ejecting means to release the casting from the movable main die; core moving means to move the core in a demolding direction of the casting; and protruding-portion demolding means to release the protruding portion from the core,
wherein control means to control operations of the product ejecting means, the core moving means, and the protruding-portion demolding means is configured to execute a first demolding step in which the product ejecting means releases the casting from the movable main die and the core moving means moves the core in association with the casting, and a second demolding step in which the protruding-portion demolding means releases the protruding portion from the core.

2. The die casting apparatus according to claim 1, wherein the protruding-portion demolding means is ejecting means configured to push the casting near the protruding portion in the demolding direction, and perform the second demolding step by pushing the casting by the ejecting means.

3. The die casting apparatus according to claim 2, wherein when the core is configured to form the protruding portion consisting of a plurality of straight extending standing plates arranged side by side,
the ejecting means is placed on both sides of the core corresponding to both sides of the standing plates in a straight extending direction, and
the control means performs the second demolding step by alternately pushing each side of the ejecting means with respect to the core.

4. The die casting apparatus according to claim 2 or 3, wherein the core moving means and the ejecting means are integrally formed by a hydraulic unit configured to separately independently extend and contract operation rods connected to the core and ejector pins to be pressed against a portion of the casting near the protruding portion.

5. The die casting apparatus according to claim 1, wherein the core moving means and the protruding-portion demolding means are integrally formed by a hydraulic unit configured to separately independently extend and contract operation rods connected to the core and plate-shaped ejector blocks to be pressed against the casting near the protruding portion.

6. The die casting apparatus according to claim 4 or 5, wherein the product ejecting means includes a plurality of ejector pins or ejector blocks fixed to an ejector plate to be moved by a hydraulic cylinder, and the control means is hydraulic control means to drive and control the hydraulic unit and the hydraulic cylinder.

7. The die casting apparatus according to claim 1, wherein the core is formed of a plurality of separate blocks, and the protruding-portion demolding means includes core moving means to move each of the separate blocks of the core in a demolding direction of the casting and ejecting means to push the casting near the protruding portion in the demolding direction, and
in the second demolding step, the separate blocks are stepwise moved relatively in an opposite direction to the demolding direction by the core moving means with respect to the protruding portion of the casting pushed or supported by the ejecting means.

8. The die casting apparatus according to claim 7, wherein when the core is configured to form the protruding portion consisting of a plurality of straight extending standing plates arranged side by side, the separate blocks are separated in a straight extending direction of the standing plates.

9. The die casting apparatus according to claim 7, wherein the core moving means and the ejecting means are integrally formed by a hydraulic unit configured to separately independently extend and contract operation rods connected to the separate blocks of the core and ejector pins to be pressed against the casing near the protruding portion.

10. The die casting apparatus according to claim 7, wherein the core moving means and the ejecting means are integrally formed by a hydraulic unit configured to separately independently extend and contract operation rods connected to the separate blocks of the core and plate-shaped ejector blocks to be pressed against the casing near the protruding portion.

11. The die casting apparatus according to claim 9 or 10, wherein the product ejecting means includes a plurality of ejector pins or ejector blocks fixed to an ejector plate to be moved by a hydraulic cylinder,

and the control means is hydraulic control means to drive and control the hydraulic unit and the hydraulic cylinder.

12. The die casting apparatus according to claim 1, wherein the protruding-portion demolding means is grasping means configured to grasp and move the casting, and performing the second demolding step by moving the casting in a predetermined direction. by the grasping means.

13. The die casting apparatus according to claim 12, wherein when the core is configured to form the protruding portions consisting of a plurality of straight extending standing plates arranged side by side, and the grasping means performs the second demolding step by pulling pull the casting in the straight extending direction of the standing plates and moving the casting.

14. A method for releasing a casting from a die, using a die casting apparatus to form the casting including a protruding portion, the method including separating a movable die from a fixed die for die opening and then demolding the casting from the movable die, wherein the method includes: a first demolding step including moving an insert core configured to form the protruding portion in association with the casting to release a portion of the casting other than the protruding portion from a movable main die of the movable die; and a second demolding step including releasing the protruding portion from the core.

15. The method for releasing a casting from a die according to claim 14, wherein when the core is configured to form the protruding portion consisting of a plurality of straight extending standing plates arranged side by side,
the second demolding step uses ejecting means placed on both sides of the core corresponding to both side positions of the standing plates in a straight extending direction and includes alternately operating each side of the ejecting means to push the casting in the demolding direction.

16. The method for releasing a casting from a die according to claim 14, wherein the second demolding step uses the core formed of a plurality of separate blocks and includes stepwise moving the separate blocks to release the protruding portion by each separate block.

17. The method for releasing a casting from a die according to claim 14, wherein the second demolding step uses grasping means to grasp and move the casting and includes making the grasping means to move the casting in a predetermined direction.

18. The method for releasing a casting from a die according to claim 17, wherein when the core is configured to form the protruding portion consisting of a plurality of straight extending standing plates arranged side by side,
the second demolding step includes making the grasping means to pull the casting in a straight extending direction of the protruding portion.

FIG. 1

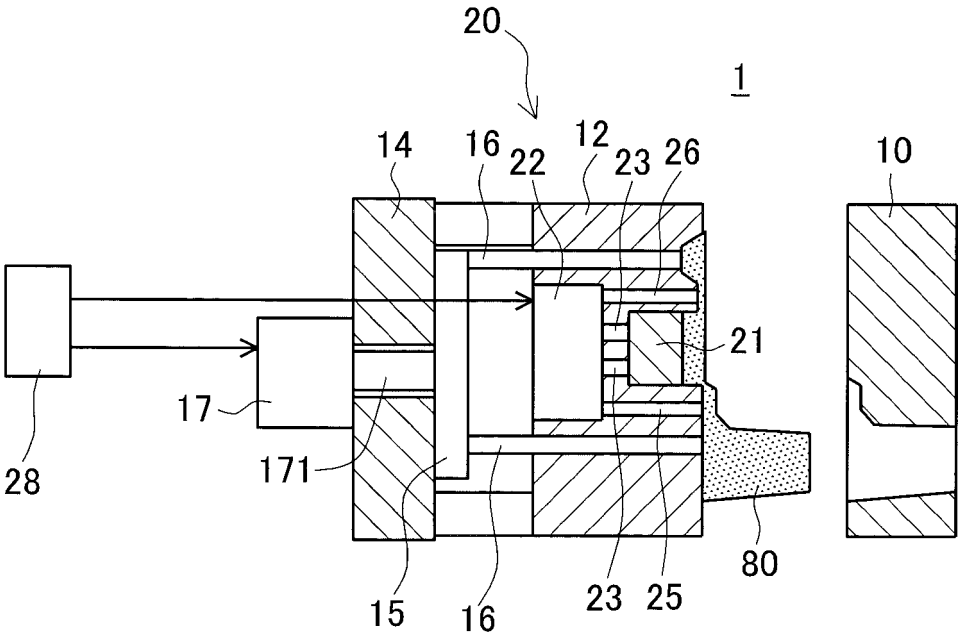
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FIG. 2

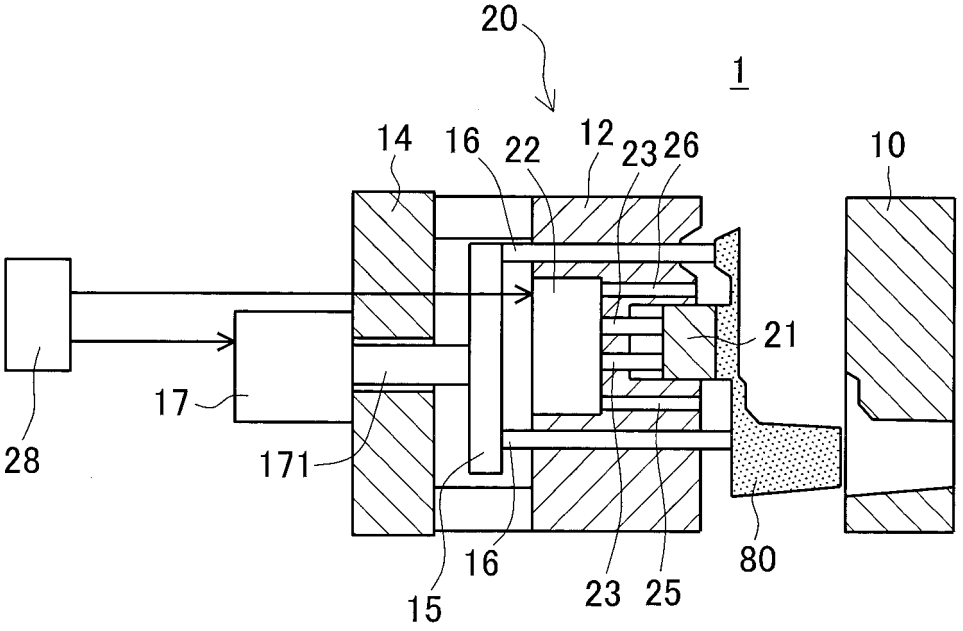
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FIG. 3

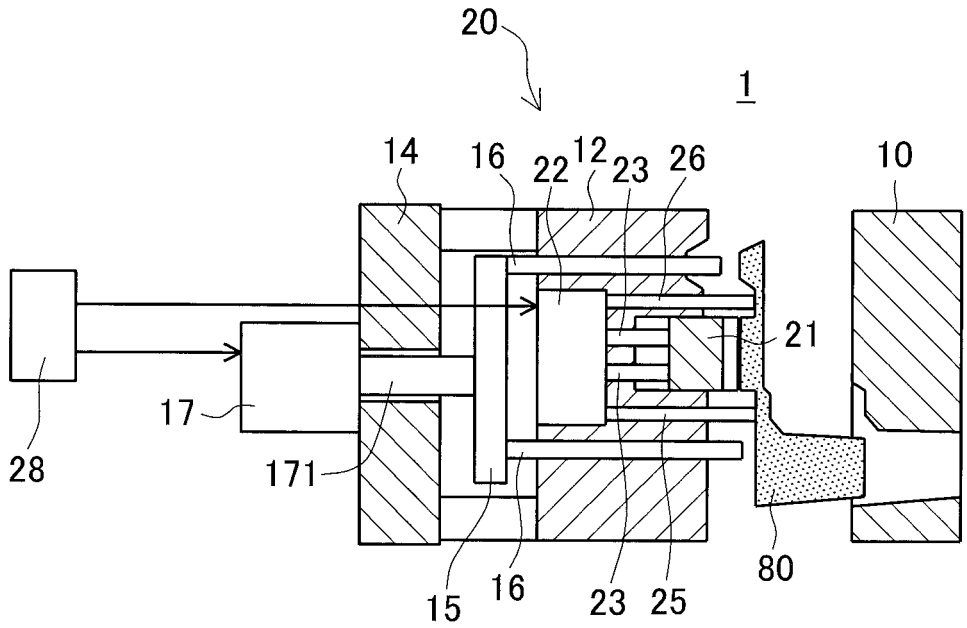

FIG. 4

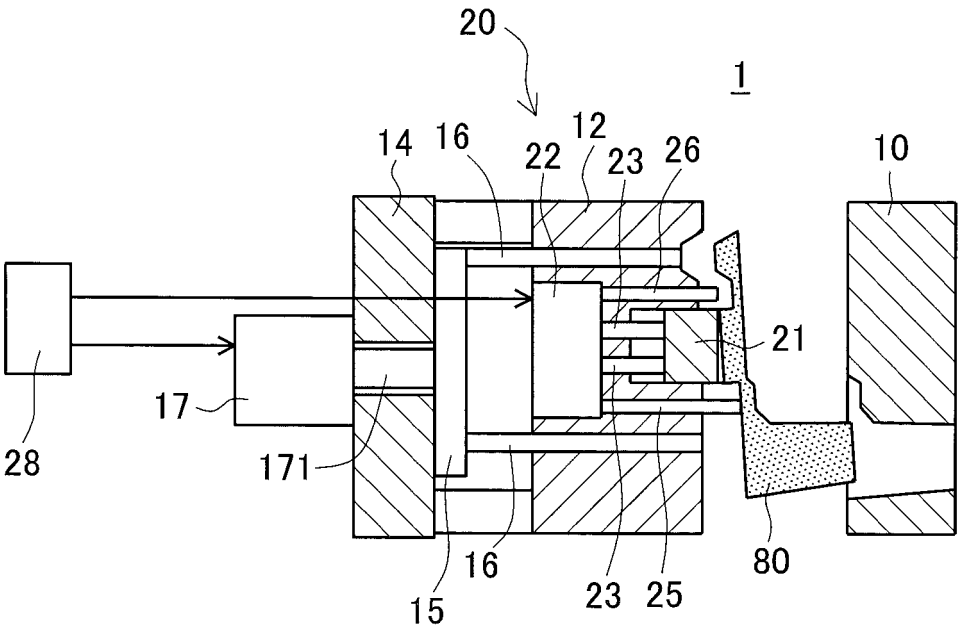
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FIG. 5

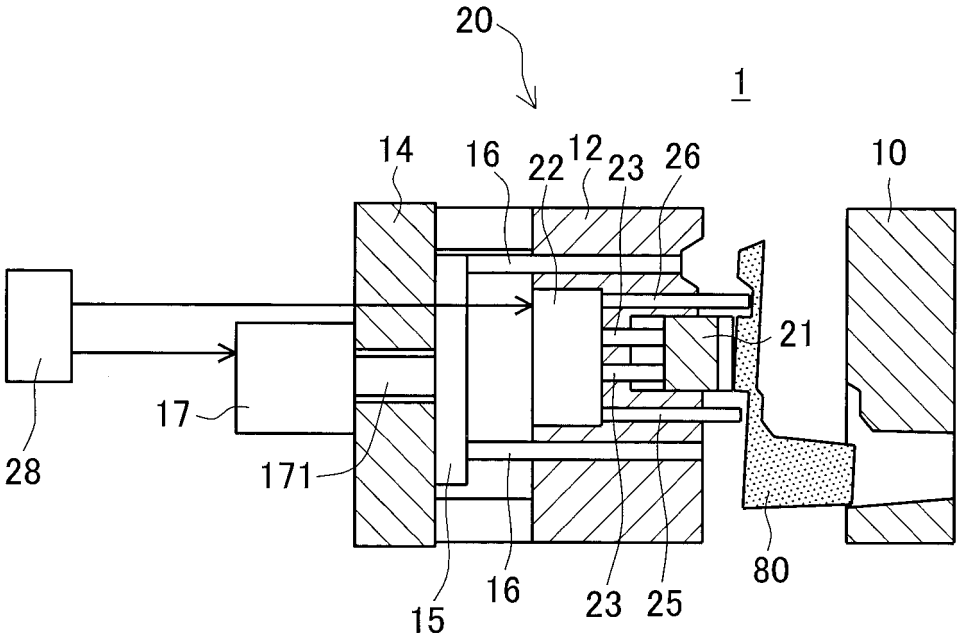
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FIG. 6

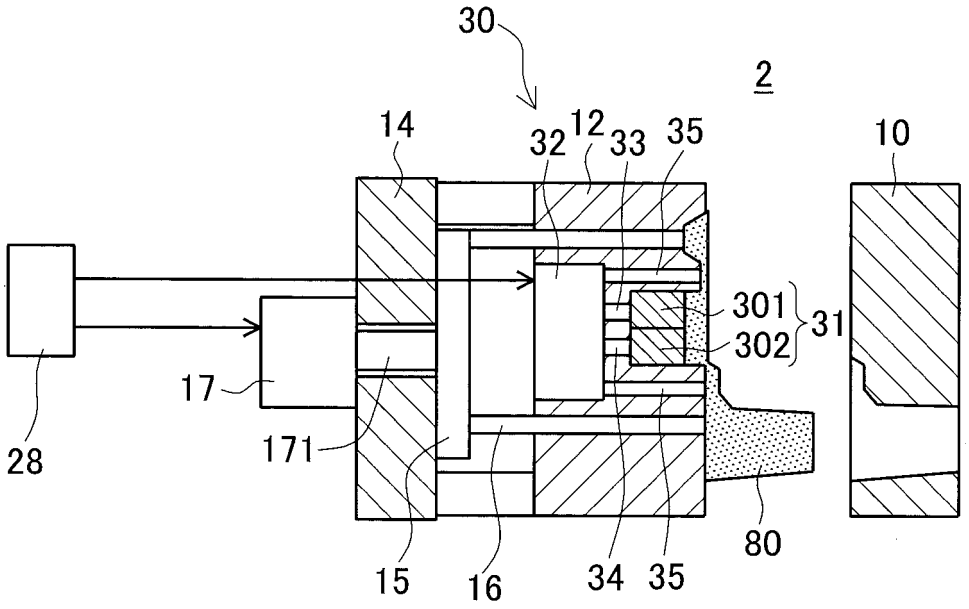
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FIG. 7

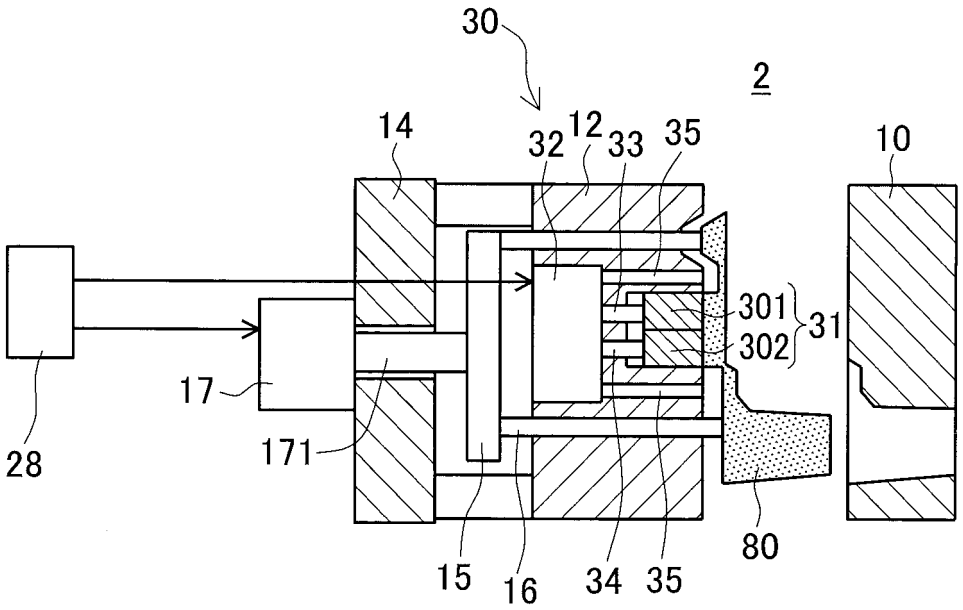
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FIG. 8

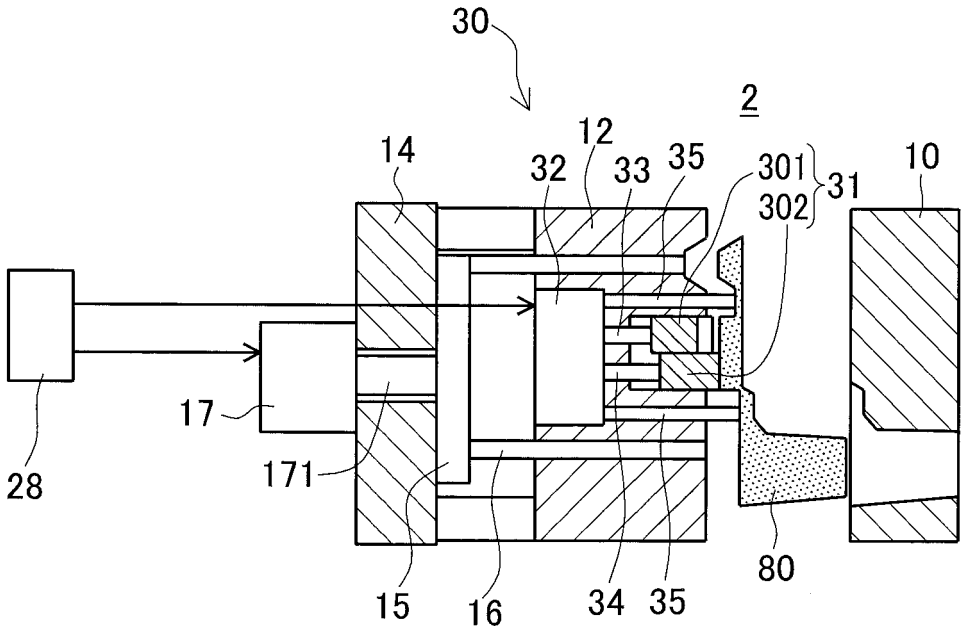
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FIG. 9

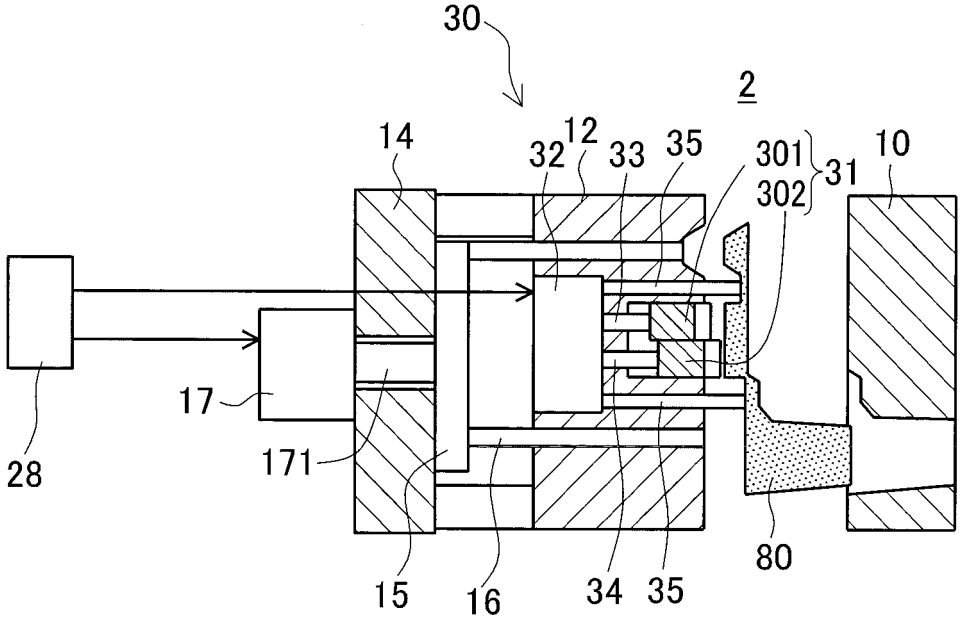
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FIG. 10

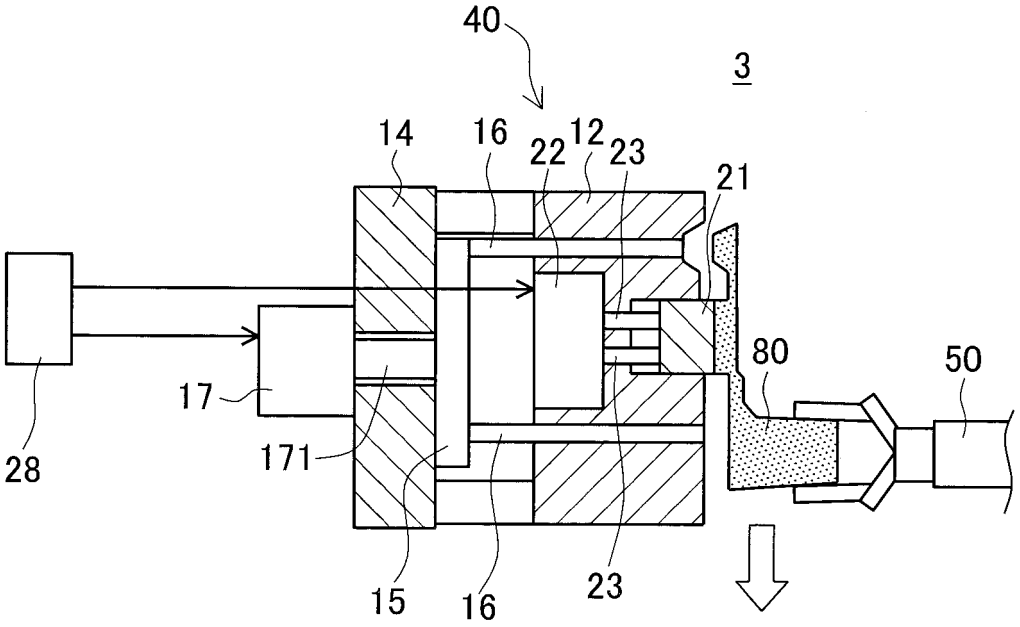


FIG. 11

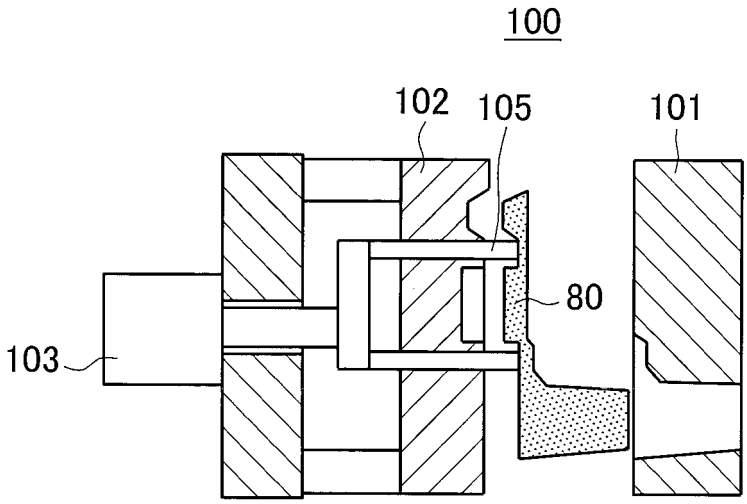


FIG. 12

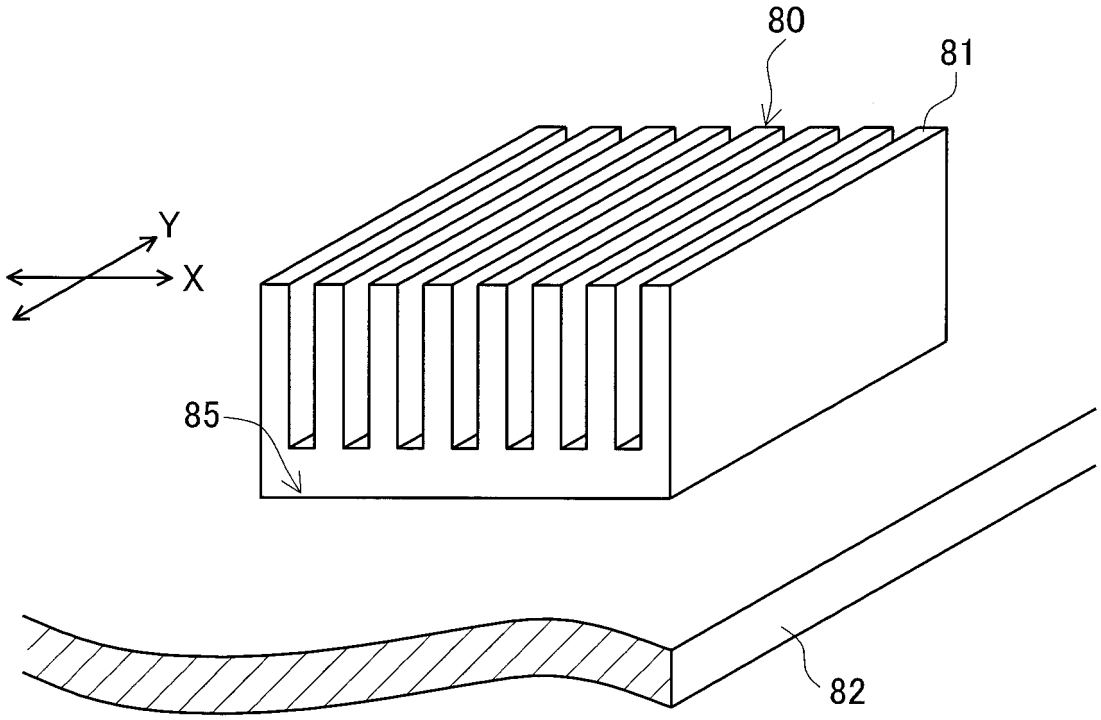


FIG. 13

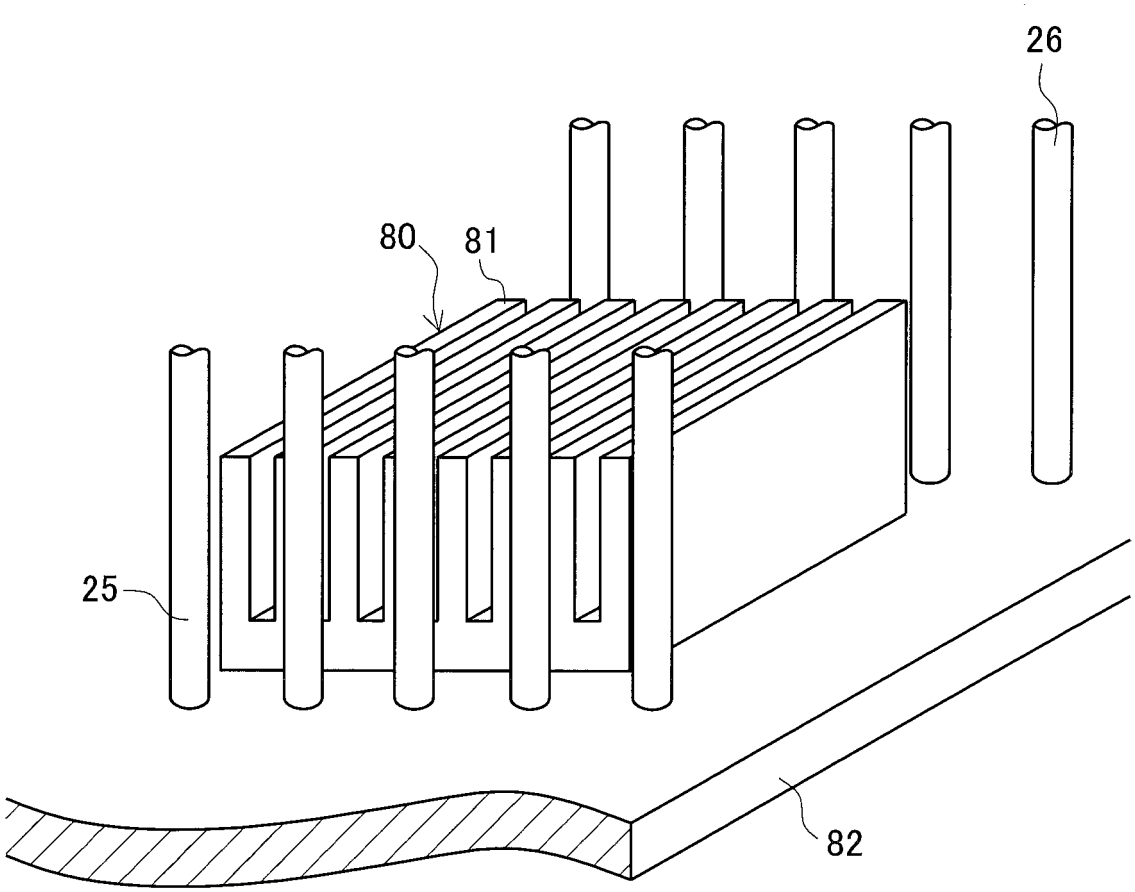
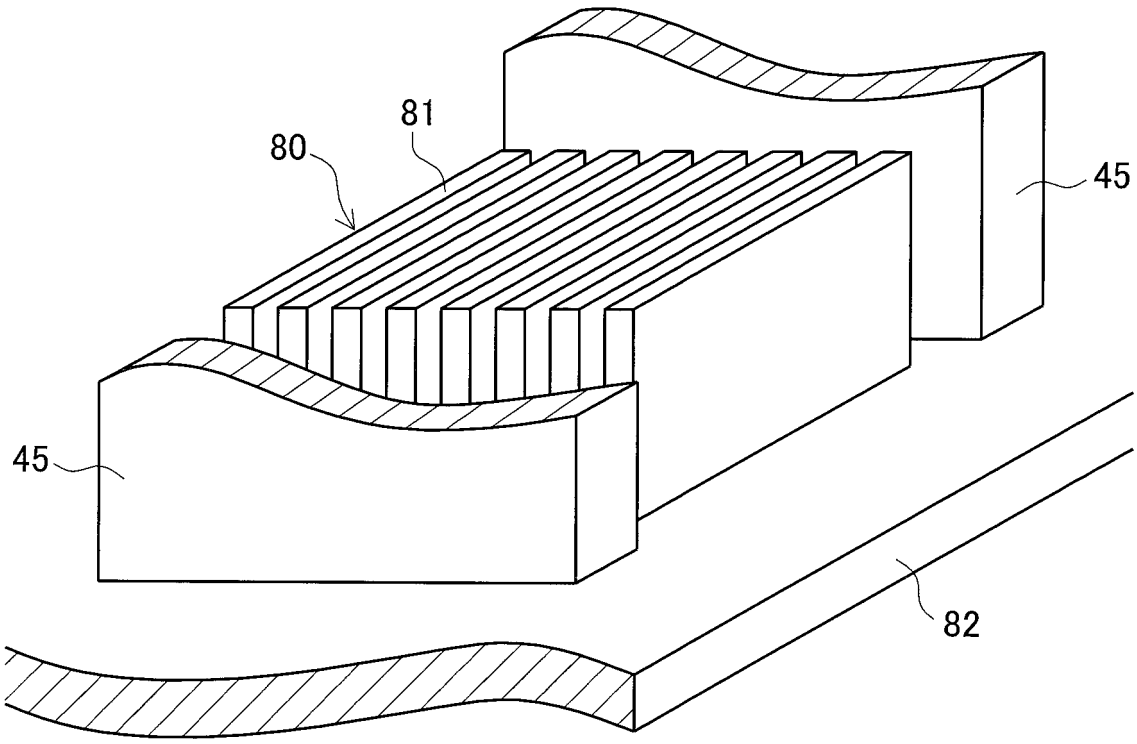


FIG. 14



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/055125

A. CLASSIFICATION OF SUBJECT MATTER
B22D17/22(2006.01)i, *B22C9/06*(2006.01)i, *B22D17/00*(2006.01)i

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)
B22D17/22, B22C9/06, B22D17/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011
Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 09-300058 A (Kabushiki Kaisha Aresuti), 25 November 1997 (25.11.1997), fig. 1 to 4 and those explanations (Family: none)	1,2,4-6,14 12,13,17,18 3,7-11,15,16
Y	JP 08-300425 A (Fanuc Ltd.), 19 November 1996 (19.11.1996), paragraph [0020] (Family: none)	12,13,17,18

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"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
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 April, 2011 (04.04.11)	12 April, 2011 (12.04.11)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/055125

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 090456/1985(Laid-open No. 205652/1986) (Toyota Motor Corp.), 25 December 1986 (25.12.1986), entire text (Family: none)	1-18
A	JP 04-176621 A (Nissan Motor Co., Ltd.), 24 June 1992 (24.06.1992), entire text (Family: none)	1-18
A	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 071953/1991(Laid-open No. 026332/1993) (Toyota Boshoku Corp.), 06 April 1993 (06.04.1993), entire text (Family: none)	1-18

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Patent documents cited in the description

- JP 81996A300132 B **[0004]**