



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.06.2007 Bulletin 2007/25

(51) Int Cl.:
B22D 18/04 (2006.01) B22D 33/02 (2006.01)

(21) Application number: **06125985.9**

(22) Date of filing: **13.12.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

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(30) Priority: **13.12.2005 IT PD20050362**

(54) **Low-pressure die-casting apparatus**

(57) A low-pressure die-casting apparatus, of the type comprising:

- at least one furnace (11, 111) adapted to produce the molten mass to be cast into the die (12),
- at least one station (18, 118) for unloading the cast part and/or loading at least one core to be inserted in the die (12),
- at least one die supporting fixture (14, 114), which is associated with means for translational motion on a guide (13, 113) proximate to which the at least one furnace (11, 111) and a station (18, 118) for unloading the part and/or loading at least one core are arranged,
- means (31) for preparing for the step for filling the die (12),

and comprising rotation means (30) for the die supporting fixture (14, 114) which are suitable to arrange the fixture (14, 114) so that the die (12) is located on one chosen side of the guide (13, 113) for interaction with preset apparatus components.

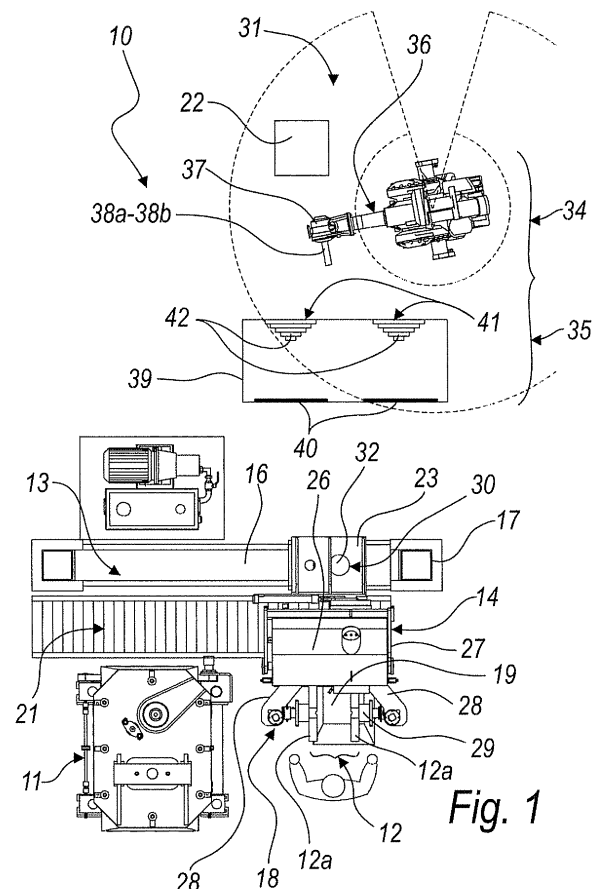


Fig. 1

Description

[0001] The present invention relates to a low-pressure die-casting apparatus.

[0002] The invention is useful particularly but not exclusively in the production by low-pressure die-casting of faucets and unions for water and the like and in any case in all foundry processes which use metallic permanent dies.

[0003] As is known, low-pressure die-casting apparatuses are usually constituted by a furnace which is adapted to produce the molten metallic mass into which a pipe is dipped in order to dispense, by feeding pressure into the furnace, said molten mass into the die.

[0004] According to a typical method, the molten mass is fed into the die by rising from below, so as to prevent the formation of air bubbles inside.

[0005] A die supporting fixture is provided at the furnace and allows to perform the appropriate movements of said die in order to arrange it at the furnace, at the position for unloading the cast part or for loading the core, if provided, into the die or to arrange it proximate to all the components of the apparatus which are adapted to work on the die, such as for example the fixtures for preparing for the die filling step, which typically provide an apparatus for distributing release agent within the die (suitable to allow the separation of the cast part from said die once it has been formed) or a fixture for cleaning the inside of the die.

[0006] In order to reduce the time between the various operating steps, in one type of these apparatuses the die supporting fixture is arranged so that it can slide in a motorized manner on a horizontal guide which is raised from the ground and along one side of which there are the furnace, the station for unloading the cast part (or for loading the core) and the other components of the apparatus which interact with the die.

[0007] A typical work sequence entails positioning the die supporting fixture at the core loading station (the die is open, with its two halves arranged so as to face each other), the closure of the die and movement of the die supporting fixture toward the furnace, where low-pressure filling occurs.

[0008] The fixture is then moved to the unloading station, which typically coincides with the core loading station, where the die is opened and the cast part is extracted by an automated extractor, which before depositing the cast part onto a conveyor belt shows it to an operator who is present and examines it in order to determine whether there are any defects.

[0009] The die supporting fixture is then moved until the die is at the fixtures for cleaning and distributing release agent; once the operations linked to said fixtures have ended, the die is returned to the core loading station, ready for a new cycle of operations.

[0010] In some embodiments of the apparatus there are two furnaces arranged at the ends of the guide and there are two die supporting fixtures, each with one die,

so as to allow continuous production and unloading of cast parts (when one part is being cast, the other part is being unloaded).

[0011] Although these apparatus configurations have now been commercially available for several years and are appreciated due to the characteristic of speed of operation, they are not free from improvements and enhancements, aimed at ensuring a further increase in the speed of the various operations (to the benefit of overall productivity) and ensure optimum control of all the steps by the operator, such as for example cast part quality control, control of optimum mating between the die and the furnace, the control of any leaks of gas from the furnace and the correct rise rate of the molten metallic mass within the die.

[0012] The aim of the present invention is to provide a low-pressure die-casting apparatus which allows to have optimum operator control of the operations for filling the die and for unloading the cast part.

[0013] Within this aim, an object of the present invention is to provide a low-pressure die-casting apparatus which allows to increase as a whole the production rate of the cast parts.

[0014] Another object of the present invention is to provide a low-pressure die-casting apparatus which allows considerable flexibility in organizing the layout of the various components.

[0015] Another object of the present invention is to provide a low-pressure die-casting apparatus which allows to increase the quality of the cast part.

[0016] This aim and these and other objects, which will become better apparent hereinafter, are achieved by a low-pressure die-casting apparatus, of the type which comprises:

- at least one furnace suitable to produce the molten mass to be cast into the die,
- at least one station for unloading the cast part and/or loading at least one core to be inserted in said die,
- at least one die supporting fixture, which is associated with means for translational motion on a guide proximate to which said at least one furnace and said at least one station for unloading the part and/or loading at least one core are arranged,
- means for preparing for the step for filling said die,

characterized in that it comprises rotation means for said die supporting fixture which are suitable to arrange said fixture so that said die is located on one chosen side of said guide for interaction with preset apparatus components.

[0017] Further characteristics and advantages of the invention will become better apparent from the following detailed description of a preferred but not exclusive embodiment thereof, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a schematic plan view of an apparatus

according to the invention;

Figure 2 is a schematic front view of an apparatus according to the invention, shown in the same operating step shown in Figure 1;

Figure 3 is a schematic front view of an apparatus according to the invention, shown in a different operating step with respect to the one shown in Figure 2;

Figure 4 is a schematic side view of an apparatus according to the invention, shown in the same step of operation shown in Figures 1 and 2;

Figure 5 is a schematic plan view of an apparatus according to the invention, shown in a different step of operation with respect to the ones shown in the preceding figures;

Figure 6 is a schematic plan view of an apparatus according to the invention in a different embodiment with respect to the one shown in the preceding figures.

[0018] In the exemplary embodiments that follow, individual characteristics, given in relation to specific examples, may actually be interchanged with other different characteristics that exist in other exemplary embodiments.

[0019] Moreover, it is noted that anything found to be already known during the patenting process is understood not to be claimed and to be the subject of a disclaimer.

[0020] With reference to the figures, a low-pressure die-casting apparatus according to the invention is generally designated by the reference numeral 10.

[0021] The apparatus 10 comprises a furnace 11, which is adapted to produce the molten mass to be cast in a die (designated hereinafter by the reference numeral 12), which is arranged laterally and proximate to a guide 13 on which a die supporting fixture 14 is arranged slidably; said fixture is associated with means for translational motion along the guide 13, which are not shown in the figures, such as for example an electric motor drive associated with a device of the rack-and-pinion type.

[0022] The guide 13 is constituted for example by a sliding beam 16, which is raised at a certain height from the ground and is supported by pillars 17.

[0023] Along the guide 13, on the same side as the furnace 11, there is a station 18 for loading the core to be inserted in the die 12 before the step for filling the die and unloading the cast part once it has cooled.

[0024] The station 18 is monitored by an operator, who checks all the steps of the production of the article.

[0025] In particular, on the station 18 there is a tray 19 which is adapted to collect the cast part once it has been extracted from the die.

[0026] Means 20 for tilting the tray 19 from a horizontal position to a position which is inclined toward a conveyor belt 21, suitable to transfer the produced cast part toward a temporary storage unit (not shown in the figures), are associated with the station 18.

[0027] The tilting means 20 are shown schematically, merely by way of example, by means of a hydraulic cylinder which acts below the tray 19 and is pivoted to a supporting structure.

[0028] The conveyor belt 21 runs adjacent to the guide 13 and parallel thereto.

[0029] The die supporting fixture 14 comprises a slider 23, which is associated with said translational motion means and is arranged on the guide 13, and a turret 24, which supports a press 25 to which the two half-dies 12a that constitute the die 12 are rigidly coupled.

[0030] In particular, the press 25 is constituted by a frame 26 which is pivoted to a fork-like body 27, which in turn is pivoted about a horizontal axis to the turret 24, as clearly shown in Figures 1 and 4; the two mutually opposite arms 28 of the press are arranged on the frame 26 and support the two half-dies 12a; hydraulic actuators (not designated by reference numerals in the figures for the sake of simplicity), adapted to move the two mutually opposite arms 28 in order to open and close the die 12, are associated with said arms.

[0031] A motor drive is associated with each hinge axis and is suitable to actuate rotation.

[0032] The ends of the mutually opposite arms 28 are constituted by flanges 29 for connection to the half-dies 12a, each of which comprises a motorized coupling which is suitable to turn the half-dies 12a about three perpendicular axes.

[0033] Advantageously, the apparatus 10 comprises rotation means 30 for the die supporting fixture 14, which are suitable to arrange the fixture 14 so that the die 12 is located on a chosen side of the guide 13 for interaction with preset apparatus components which, in this embodiment, are constituted by means 31 for preparing for the step for filling the die 12, which is described hereinafter.

[0034] In particular, in this embodiment the rotation means 30 for the die supporting fixture 14 comprise a center bearing 32 which has a vertical axis and is associated with a rotation actuator (not shown in the figures) interposed between the slider 23 and the turret 24.

[0035] The center bearing 32 allows the fixture to rotate through at least 180°, thus moving the die 12 from one side to the other of the guide 13.

[0036] The means 31 for preparing for the step for filling the die 12 are provided on the side of the guide 13 that lies opposite the side where the furnace 11 and the station 18 are provided; said means, in this embodiment, are constituted by a fixture 34 for cleaning by means of high-pressure liquid the interior of the die 12 and by a fixture 35 for distributing release agent inside the die 12.

[0037] Cleaning of the impressions of the die is necessary in order to remove impurities remaining after the unloading of the cast part, in order to ensure subsequent optimum casting of a new part, while the distribution of release agent is necessary in order to allow the cast part to separate from the impressions of the die once said die is opened.

[0038] The release agent is, for example, based on

liquid graphite and is sprayed onto the impressions of the die.

[0039] In particular, in this embodiment the cleaning fixture 34 and the release agent distribution fixture 35 comprise a common containment housing 39 for the half-dies 12a during the operations for cleaning and distributing release agent, which allows to avoid the diffusion of cleaning liquid (water) and of release agent into the environment.

[0040] The containment housing 39 has doors 40 which are automated for opening and closure and are adapted to allow the access of the half-dies 12a.

[0041] High-pressure water ejectors are moved within the containment housing 39 and clean the half-dies and the release agent ejectors.

[0042] Advantageously, in this embodiment, the cleaning fixture 34 and the release agent distribution fixture 35 comprise a common robot 36, for example of the anthropomorphic type, which allows to move said ejectors.

[0043] In particular, the robot 36 has on its wrist 37, depending on the operation to be performed, a high-pressure water ejector 38a, which is functionally connected, by means of a tube, to a high-pressure supply apparatus, or a release agent ejector 38b, which is also functionally connected, by means of a corresponding tube, to its own supply system; the figures show only the anthropomorphic robot 36 supporting an ejector (which can be equally a high-pressure water ejector 38a or a release agent ejector 38b), but not the corresponding supply systems.

[0044] The figures show in broken lines the range of motion of the robot 36.

[0045] The ejectors, when not in use, are arranged in a storage unit, designated schematically by the reference numeral 22, which is arranged proximate to said robot.

[0046] The ejectors 38 of the cleaning and release agent distribution fixtures can be inserted in appropriately provided openings 41 formed in the housing 39 in order to allow the operations for cleaning and distributing release agent within the housing.

[0047] In particular, concertina protections 42 are associated with the openings 41, one for each half-die 12a, and allow broad maneuverability of the wrist 37 of the robot 36 which moves the ejector 38 into the housing 39 without compromising the issue of containment of the fluids ejected internally.

[0048] It is evident that in different embodiments there can be a single larger opening.

[0049] In other embodiments (not shown in the figures), the ejectors for high-pressure water and for distributing release agent are always present within the protective housing and are associated with movement mechanisms which also lie inside the housing 39 and have respective actuation portions which protrude from the openings 41 (associated with the "concertina" protections 42 so as to keep said housing "sealed"), which are suitable to be moved by the robot 36.

[0050] The operation of the apparatus is as follows.

[0051] At the beginning of the cycle, the die supporting

fixture 14 is arranged at the station 18 where the operator is present, so that the die 12 is arranged above the tray 19; the die is open, with its impressions clean and treated with the release agent.

5 [0052] During this step, the core is inserted in one of the impressions of the die and the die is then closed.

[0053] Figures 1, 2 and 4 illustrate the moment when the die is open on the station 18, with the half-dies arranged vertically so that they face each other; the step for core insertion entails a rotation of the fork 27 so as to move the half-dies 12a to a horizontal arrangement so as to be able to rest the core; the die is then closed and the fork 27 is turned back through 90°, returning the die to the vertical position.

10 [0054] The die supporting fixture 14 is moved to the furnace 11, and is arranged so that its supply port lies above the tube for feeding the molten metallic mass that arrives from the furnace 11 (Figure 3).

[0055] The furnace, according to known methods, shifts upward, arranging its supply tube at the supply port of the die 12.

[0056] Therefore, by increasing the pressure inside the furnace the molten mass rises up to the die and fills it.

[0057] Once the cast part is sufficiently solid, the die supporting fixture 14 is moved toward the station 18, the die is opened (an arrangement which is similar to the one shown Figures 1, 2 and 4) and the half-dies are turned toward the operator; the cast part remains inside one of the two impressions and the operator can view the surface conditions of half of the article.

25 [0058] At this point, the half-dies 12a are turned downward and the article is arranged on the tray 19 by gravity; the operator can thus view the other half of the article.

[0059] The tray 19 is then tilted toward the conveyor belt 21 and the cast part slides toward said belt, which conveys the part to an accumulation unit (see Figure 4, in which the tilted tray is shown schematically in broken lines).

30 [0060] At this point, the die supporting fixture 14 is turned through 180° and the die, which is open with its half-dies turned outward, is inserted within the containment housing 39 (Figure 5).

[0061] The anthropomorphic robot 36 takes the high-pressure water ejector and accesses the housing 39 by means of the openings 41 with the concertina protections 42 and cleans the impressions.

[0062] The robot 36 then replaces the high-pressure water ejector with the release agent ejector, distributing graphite on the impressions.

35 [0063] Once the step for distributing release agent has ended, the die supporting fixture 14 is turned until it is returned to the station 18, where the cycle just described begins again.

[0064] It is evident that an apparatus of this type can also be used with a plurality of furnaces.

40 [0065] For example, Figure 6 shows an apparatus, designated by the reference numeral 100, in which there are two furnaces 111 arranged on a same side of the

guide 113 and at its ends.

[0066] There are also two die supporting fixtures 114, a single station 118 and a single anthropomorphic robot 136 with a single containment housing 139.

[0067] According to this apparatus layout, when a die is in the step for forming the article, therefore at the furnace 111, the other die, by means of the respective die supporting fixture, performs the operations for unloading, cleaning, distributing release agent and inserting the core.

[0068] The apparatus in practice is completely automated, since each movement of a component is matched by a motor drive which is controlled by way of known types of programmable electronic means.

[0069] In practice it has been found that the invention thus described achieves the intended aim and objects.

[0070] In particular, the present invention provides a low-pressure die-casting apparatus which allows optimum control of all the steps on the part of the operator.

[0071] By clearing the region occupied by the operator of the fixtures for cleaning and for distributing release agent, the operator in fact easily has greater visual control of all the steps, such as for example the control of the optimum coupling between the die and the furnace, the control of any leaks of gas from the furnace and the correct rise rates of the molten metallic mass in the die.

[0072] This has been achieved by way of the possibility to rotate the die supporting fixture and thus arrange the fixtures on the opposite side with respect to the operator.

[0073] Further, the provision of more space for the cleaning and release agent distribution fixtures has allowed to provide an anthropomorphic robot which allows to achieve much higher levels of quality of cleaning and release agent distribution with respect to known methods; the robot in fact allows to direct the ejectors both for water at high pressure and for the graphite according to the correct orientation of the various parts of the impressions, allowing to follow substantially its behavior.

[0074] Moreover, another advantage is achieved by adopting the tilting tray instead of the manipulation unit which is currently in use and picks up the molten part, shows it to the operator and deposits it onto the conveyor belt.

[0075] By adopting the tilting tray, the operation has in fact been speeded up, since the step for picking up the part and for moving it towards the operator is no longer necessary; the operator in fact performs a first visual check on half of the part while it is still within the impression and a second visual check when it is on the tray.

[0076] Further, it is evident that the possibility to rotate the die supporting fixture in combination with its ability to move along the guide 13 allows to provide apparatus layout configurations which are extremely flexible with respect to the particular requirements of the manufacturer, since in practice the components of the apparatus might be distributed around the guide 14 depending on the layout requirements and on the most convenient operating sequences.

[0077] It is possible to use a plurality of work lines arranged side-by-side and mutually inclined according to requirements.

[0078] The invention thus conceived is susceptible of numerous modifications and variations, all of which are of within the scope of the appended claims; all the details may further be replaced with other technically equivalent elements.

[0079] In practice, the materials employed, so long as they are compatible with the specific use, as well as the dimensions, may be any according to requirements and to the state of the art.

[0080] The disclosures in Italian Patent Application No. PD2005A000362, from which this application claims priority, are incorporated herein by reference.

[0081] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A low-pressure die-casting apparatus, of the type which comprises:

- at least one furnace (11, 111) adapted to produce the molten mass to be cast into the die (12),
- at least one station (18, 118) for unloading the cast part and/or loading at least one core to be inserted in said die (12),
- at least one die supporting fixture (14, 114), which is associated with means for translational motion on a guide (13, 113) proximate to which said at least one furnace (11, 111) and said at least one station (18, 118) for unloading the part and/or loading at least one core are arranged,
- means (31) for preparing for the step for filling said die (12),

characterized in that it comprises rotation means (30) for said die supporting fixture (14, 114) which are suitable to arrange said fixture (14, 114) so that said die (12) is located on one chosen side of said guide (13, 113) for interaction with preset apparatus components.

2. The low-pressure die-casting apparatus according to claim 1, **characterized in that** said die supporting fixture (14, 114) comprises a slider (23), which is associated with said translational motion means and is arranged on said guide (13, 113), and a turret (24) which supports a press (25) to which the two half-dies (12a) that constitute the die (12) are rigidly coupled, said rotation means (30) for said die supporting

fixture (14, 114) comprising a center bearing (32) which has a vertical axis and is associated with a rotation actuator and is interposed between said slider (23) and said turret (24).

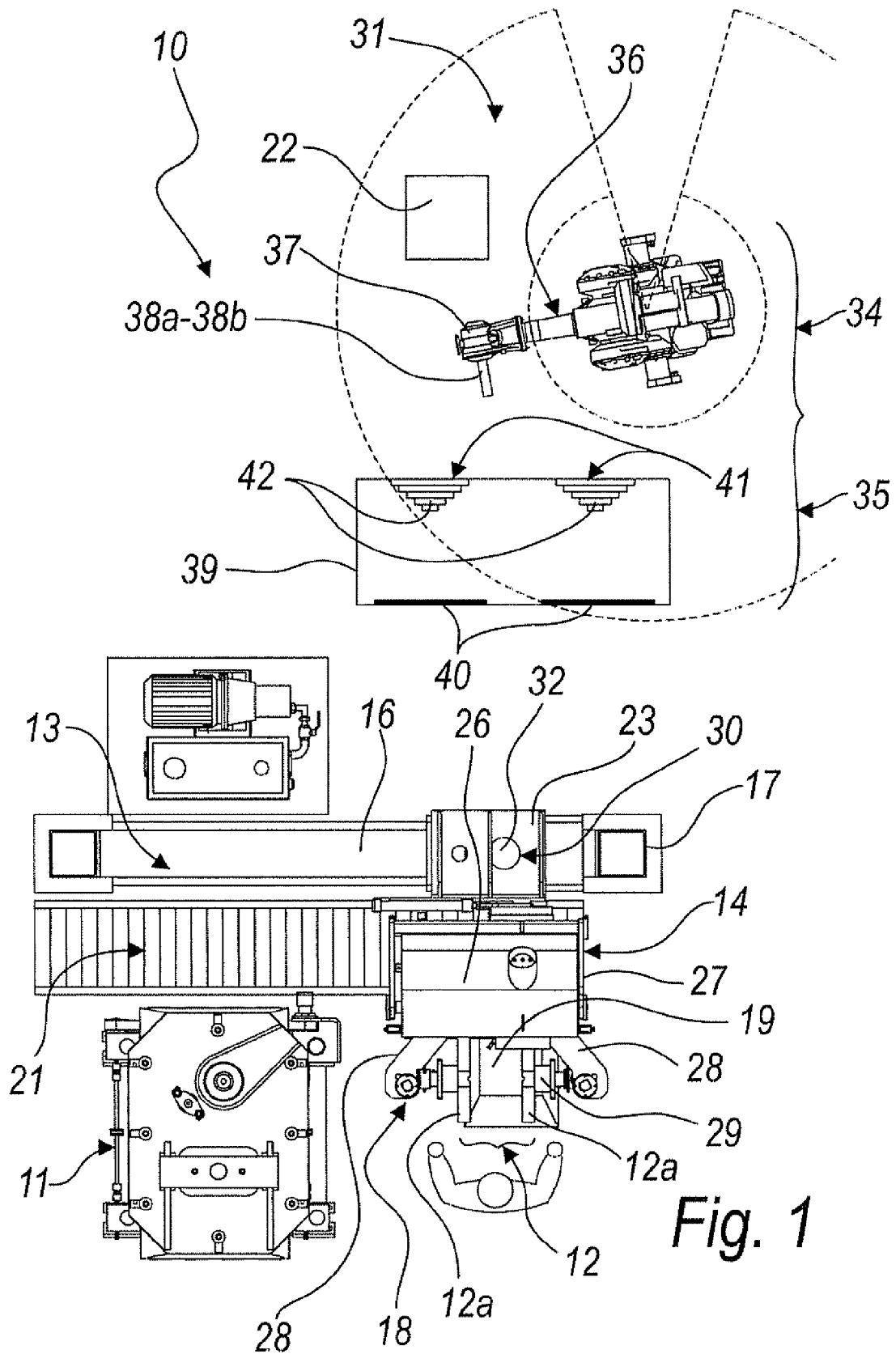
3. The low-pressure die-casting apparatus according to claim 2, **characterized in that** said press (25) is constituted by a frame (26) pivoted to a fork-like body (27), which in turn is pivoted about a horizontal axis to said turret (24), two mutually opposite arms (28) of said press being arranged on said frame (26) and supporting the two half-dies (12a), actuators being associated with said arms and being adapted to move said two mutually opposite arms (28) in order to open and close said die (12), a motor drive being associated with each hinge axis and being suitable to produce rotation, the ends of said mutually opposite arms (28) being constituted by flanges (29) for connection to the half-dies (12a), each of which comprises a motorized joint which is suitable to turn said half-dies (12a) about three perpendicular axes.
4. The low-pressure die-casting apparatus according to one of the preceding claims, **characterized in that** said means (31) for preparing for the step for filling said die (12) are arranged on the side of said guide (13, 113) which lies opposite said furnace (11, 111) and said station (18, 118) for unloading the part and/or loading at least one core and comprise a fixture (34) for cleaning by means of a high-pressure liquid for the interior of the die and a fixture for distributing release agent (35) into the die.
5. The low-pressure casting apparatus according to claim 4, **characterized in that** said cleaning apparatus (34) and said release agent distribution fixture (35) comprise a containment housing (39) which has at least one door (40), which is automated for opening and closure and allows access of the half-dies (12a), at least one ejector (38a) for high-pressure water and at least one release agent ejector (38b) being moved within said containment housing (39), said water ejector (38a) being functionally connected, by means of a tube, to a high-pressure supply apparatus, said release agent ejector (38b) being functionally connected, by means of a corresponding tube, to its own supply apparatus, said ejectors (38) being moved by a robot (36, 136) which lies outside said containment housing (39), said containment housing (39) having at least one suitable opening (41) which is formed in said housing (39) in order to allow the operations for moving said ejectors (39) on the part of said robot (36), said housing (39) being arranged on the side of said guide (13, 113) which lies opposite said furnace (11, 111).
6. The low-pressure die-casting apparatus according to claim 5, **characterized in that** a concertina pro-

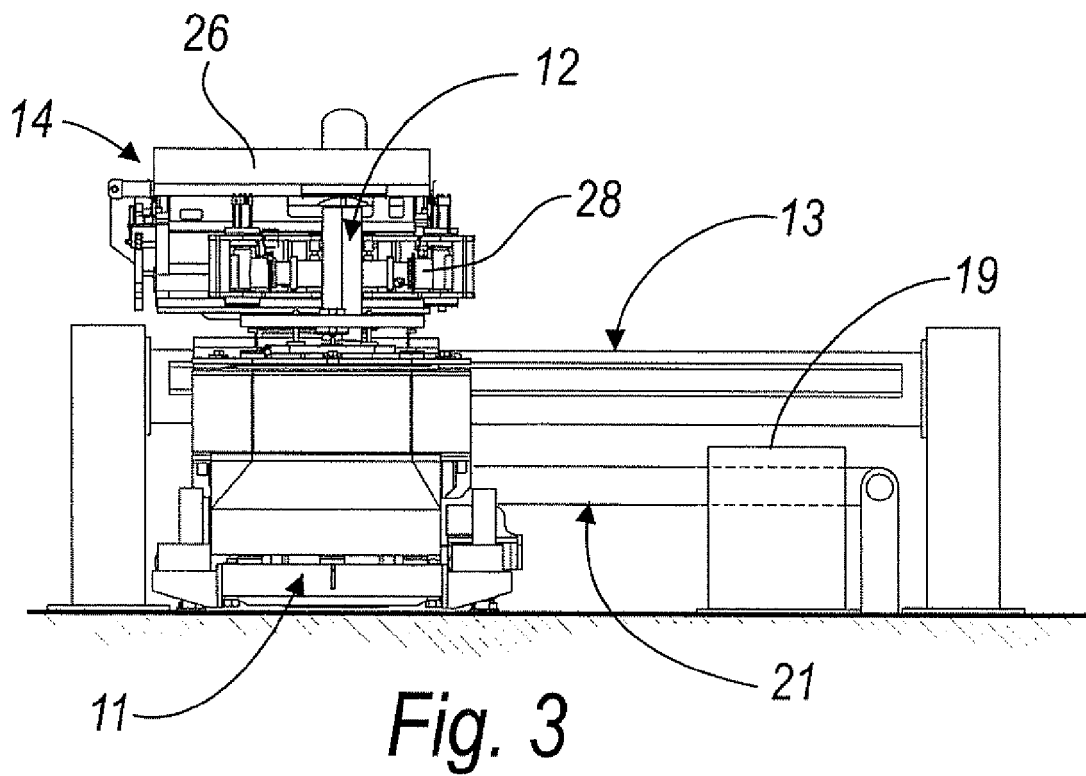
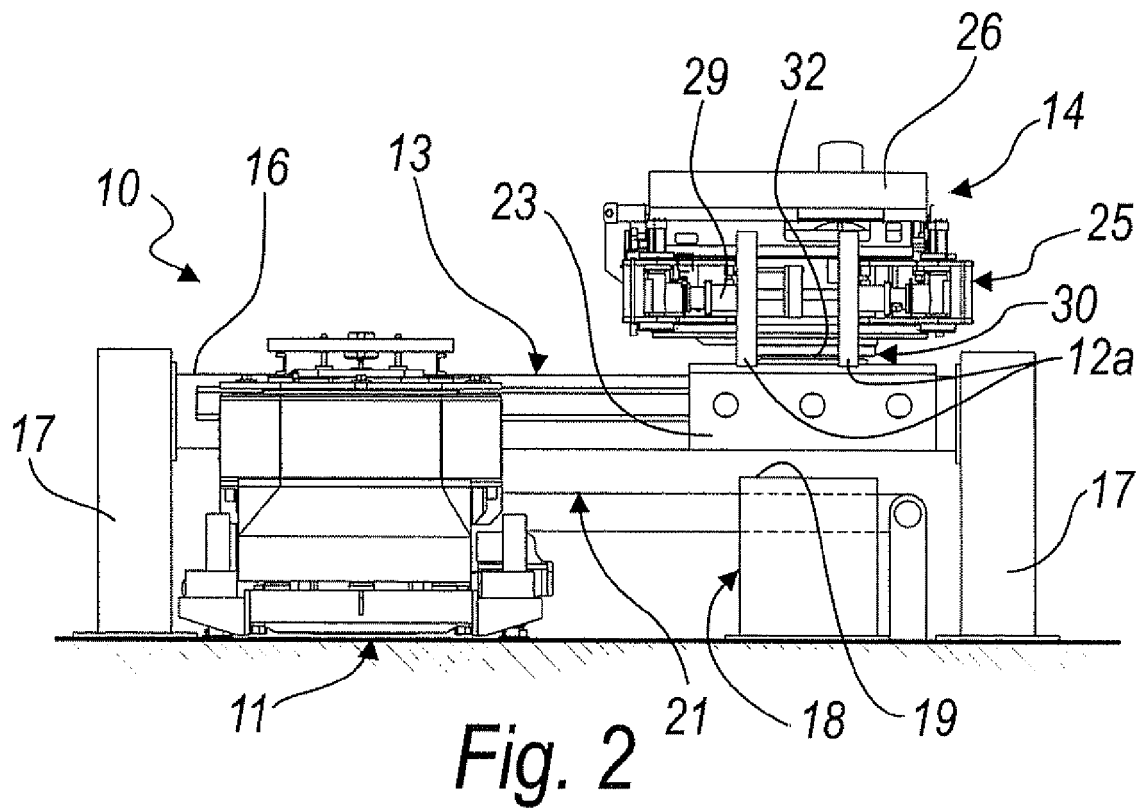
tection (42) is associated with said at least one preset opening (41) formed in said housing (39) and is suitable to allow ample maneuverability of said robot (36) while maintaining an optimum seal of said housing (39).

7. The low-pressure die-casting apparatus according to claim 5 or 6, **characterized in that** said robot (36) has on its wrist (37), depending on the operation, at least one high-pressure water ejector (38a) or at least one release agent ejector (38b).
8. The low-pressure die-casting apparatus according to one of the preceding claims, **characterized in that** in said station (18) there is a tray for depositing the cast part extracted from said die (12), said station (18) containing means (20) for tilting said tray (19) from a horizontal position to an inclined position which descends toward a conveyor belt (21) which is suitable to move the cast part.
9. The low-pressure die-casting apparatus according to claim 8, **characterized in that** said conveyor belt (21) runs adjacent to said guide (13) and parallel thereto.
10. A low-pressure die-casting apparatus, of the type which comprises:
 - at least one furnace (11, 111), which is adapted to produce the molten mass to be cast into the die (12)
 - at least one station (18, 118) for unloading the cast part and/or loading at least one core to be inserted in said die (12),
 - at least one die supporting fixture (14, 114), which is associated with means for translational motion on a guide (13, 113), proximate to which said at least one furnace (11, 111) and said at least one station (18, 118) for unloading the part and/or loading at least one core are arranged,
 - means (31) for preparing for the step for filling said die (12),**characterized in that** said means (31) for preparing for the step for filling said die (12) comprise a fixture (34) for cleaning by means of high-pressure liquid for the interior of the die and a fixture (35) for distributing release agent within the die, said cleaning fixture (34) and said release agent distribution fixture (35) comprising a containment housing (39) which has at least one door (40), which is automated for opening and closure and is suitable to allow the access of the half-dies (12a), at least one high-pressure water ejector (38a) and at least one release agent ejector (38b) being moved within said containment housing (39), said high-pressure water ejector (38a) being functionally connected by means of a tube to

a high-pressure supply apparatus, said release agent ejector (38b) being functionally connected, by means of a corresponding tube, to its own supply apparatus, said ejectors (38) being moved by a robot (36, 136) which lies outside said containment housing (39), said containment housing (39) having at least one appropriately provided opening (41) which is formed in said housing (39) to allow the operations for moving said ejectors (39) on the part of said robot (36), said housing (39) being arranged on the side of said guide (13, 113) which lies opposite said furnace (11, 111).

11. The low-pressure die-casting apparatus according to claim 10, **characterized in that** a concertina protection (42) is associated with said at least one suitable opening (41) formed in said housing (39) and is suitable to allow ample maneuverability of said robot (36) while maintaining an optimum seal of said housing (39).
12. The low-pressure die-casting apparatus according to claim 10 or 11, **characterized in that** said robot (36) supports on its wrist (37), depending on the operation, at least one ejector (38a) for high-pressure water or at least one release agent ejector (38b).
13. The low-pressure die-casting apparatus according to one of the preceding claims, **characterized in that** said robot is anthropomorphic.
14. A low-pressure die-casting apparatus, of the type comprising:
 - at least one furnace (11, 111), which is adapted to produce the molten mass to be cast into the die (12),
 - at least one station (18, 118) for unloading the cast part and/or loading at least one core to be inserted in said die (12),
 - at least one die supporting fixture (14, 114), which is associated with means for translational motion on a guide (13, 113) proximate to which said at least one furnace (11, 111) and said at least one station (18, 118) for unloading the part and/or loading at least one core are arranged,
 - means (31) for preparing for the step for filling said die (12),**characterized in that** in said station (18) there is a tray for depositing the cast part extracted from said die (12), in said station (18) there being means (20) for tilting said tray (19) from a horizontal position to an inclined position which descends toward a conveyor belt (21) which is adapted to move the cast part.





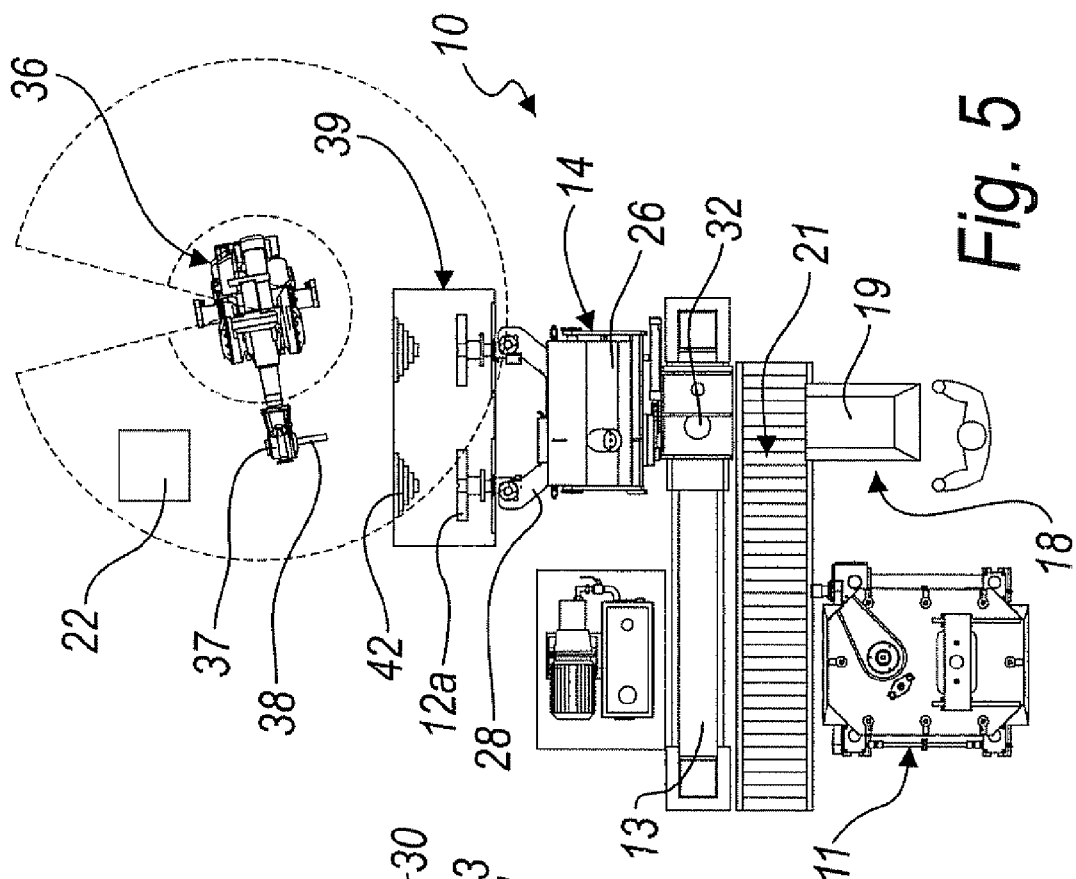


Fig. 5

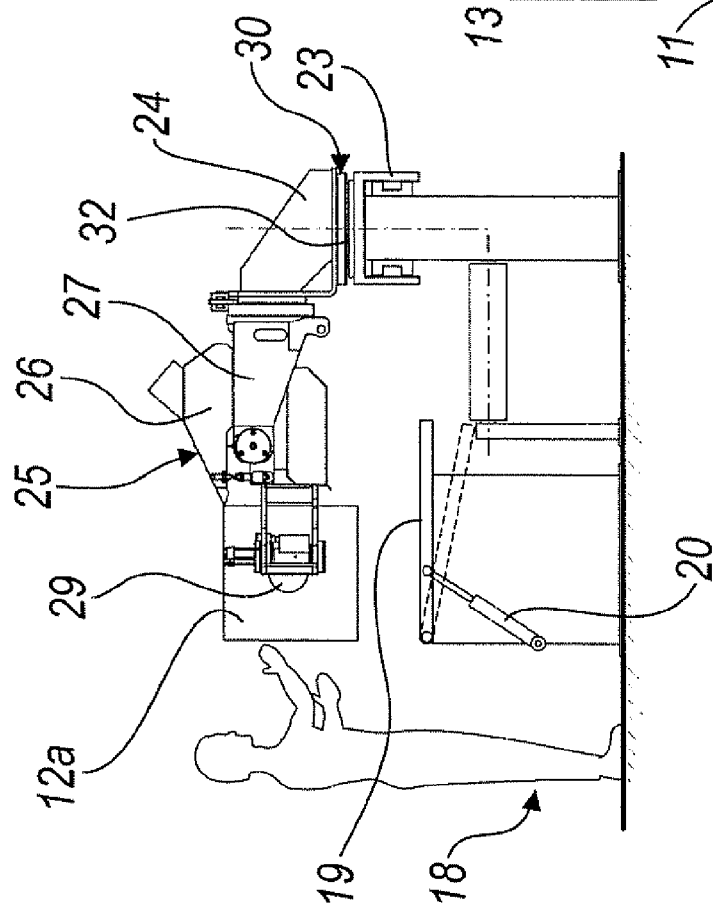


Fig. 4

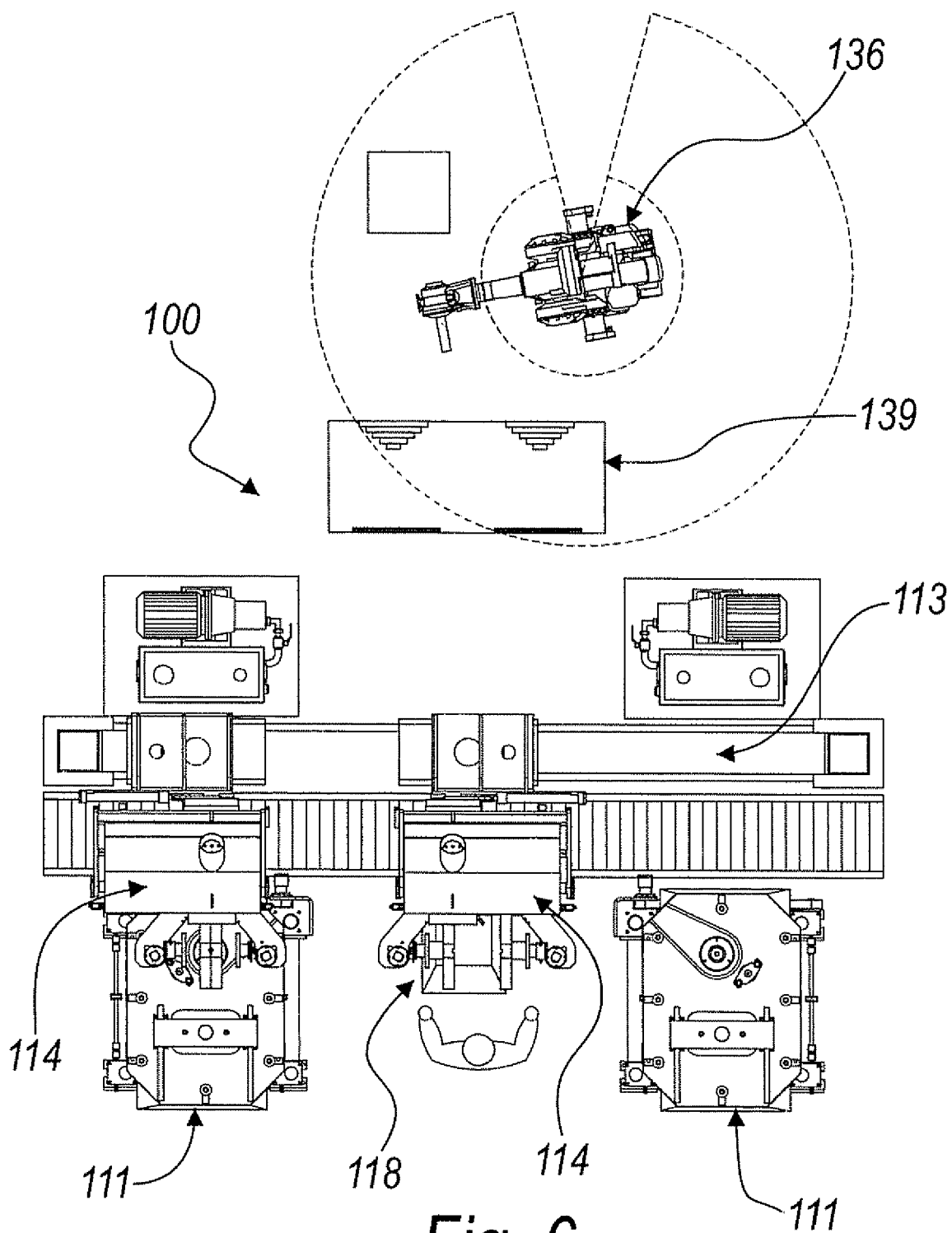


Fig. 6

REFERENCES CITED IN THE DESCRIPTION

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