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## (54) CRUCIBLE SKIMMING, STIRRING AND SAMPLE TAKING STATION

(57) Crucible skimming, stirring and sample taking station, for removing the dross from molten aluminum in a crucible (3), which has a robot (1) with an articulated arm (2), position detecting means (4) connected to the robot (1) for detection of the position of the crucible (3) on the horizontal plane X, Y, a skimming tool (6) for removing the bath from the molten aluminum in the crucible (3), a collecting box (8) in which the robot (1) throws away the bath removed from the crucible (3), a reactive dosifying system (12) which adds reactive components into the molten aluminum of the crucible (3), a stirring tool (7), a sample taking tool (10) and a control desk (11) for the control of the station. The articulated arm (2) of the robot (1) is configured to take and move in the three dimensions X, Y, Z the tools (6,7,10).

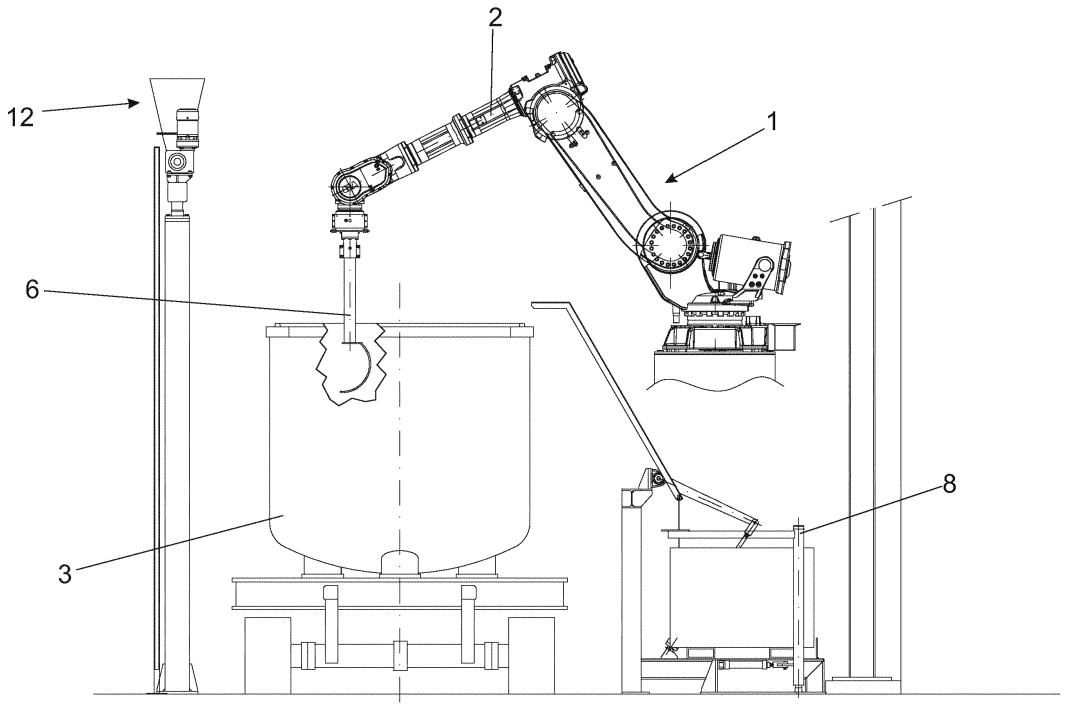


Fig. 3

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## Description

### Field of the invention

**[0001]** The present invention is encompassed within the technical field of the treatment for molten aluminum obtained from the potlines before being delivered to the casthouse furnace in order to assure the quality thereof, and more specifically within the aluminum skimming operation, for cleaning and removing the dross from the aluminum crucible ,treatment to reduce alkalis and sample taking.

**[0002]** The invention relates, in particular, to crucible skimming, stirring and sample taking station including a robot and artificial vision means for automatically removing the dross and "bath" from the surface of the molten aluminum of the crucible, treating the metal to eliminate alkalis by adding aluminium fluoride or other reagents, stirring to homogenize and taking a sample, if necessary.

### Background of the invention

**[0003]** Nowadays the ingot casting process for aluminum includes a step in which the molten aluminum obtained from the potlines is delivered to the casthouse furnaces by special trucks in crucibles or ladles. This molten aluminum will be poured from the furnaces into the ingot caster.

**[0004]** The bath floating on the aluminum in the crucibles is the electrolyte (cryolite) which is collected together with the molten aluminum, and floats over it.

**[0005]** In order to recover the bath floating on the aluminum in the crucibles, this aluminum in the crucible has to be skimmed.

**[0006]** Skimming the crucibles is necessary to be done if removal of alkalis is required, and taking a sample is done to verify the analysis of the metal to be poured.

**[0007]** In order to assure the quality of the the final product, in which alkalis are undesirable, addition of reagents as aluminium fluoride have to be made and stirring is necessary to achieve an adequate reaction time and effect.

**[0008]** Skimming operation is normally carried out in the casthouse prior to pour molten aluminum into the casting equipment. In order to minimize the accumulation of dross in the furnaces, skimming operation can also be carried out directly in the crucibles, before transferring the metal to the furnaces.

**[0009]** If crucible skimming is not done the bath will adhere to the bottom and walls of the furnace damaging the refractory or will be part of the furnace dross without value.

**[0010]** All current crucible skimming machines have a scissor type double paddle system that circles on the centre of the crucible and they only cover round-shaped crucibles and only one size of crucible, so current skimming presents the drawback that each kind and size of crucible requires a different skimming machine.

**[0011]** Additionally, due to the fact that the scissor type double paddles are fixed in the skimming machine, there is no possibility of changing tools, and additionally machines would be needed for additional operations over the molten aluminum, such as stirring.

**[0012]** After stirring is highly recommended to make an additional cleaning, so having it in the same machine avoids additional movements.

**[0013]** Nowadays sample taking is either done manually, which is hot and uncomfortable for the operator, or not done at all. Besides, no automatic sample taker exists.

**[0014]** Another drawback of the current molten aluminum skimming is that the crucible has to be positioned accurately by the operator in a prefixed position, with the difficulty and risk that this entails.

**[0015]** Nowadays stirring is done in already existing machines with a rotor placed on a fixed position. A better mixing is achieved by moving the rotor around the crucible and changing the vertical position of the stirring.

**[0016]** Therefore, it would be necessary a skimming system which removes the bath from molten aluminum in a crucible, efficiently overcoming the drawbacks of the prior art skimming machines.

### Description of the invention

**[0017]** The present invention provides an advantage with respect to the current skimming machines, providing a crucible skimming, stirring and sample taking station, for removing the dross from molten aluminum in a crucible, which can work with any shape of crucible and adapts automatically to the shape of any crucible.

**[0018]** This crucible skimming, stirring and sample taking station has a robot, which has in turn an articulated arm configured to take and move a skimming tool in the three dimensions X, Y, Z, for automatically removing the dross from the molten aluminum in the crucible.

**[0019]** The crucible skimming, stirring and sample taking station of the present invention has a reactive dosifying system which adds reactive components into the molten aluminum of the crucible, and a stirring tool, which is interchangeable with the skimming tool, so the articulated arm of the robot is configured to take and move the stirring tool in the three dimensions X, Y, Z, for automatically stirring the molten aluminum with the reactive components. This operation achieves the reduction of alkali elements dissolved in the molten aluminum inside the crucible.

**[0020]** Additionally, the station has a sample taking tool, which is also interchangeable with the skimming and stirring tools, so the articulated arm of the robot is configured to take and move the sample taking tool in the three dimensions X, Y, Z for automatically taking a sample of aluminium.

**[0021]** So, this sample taking tool take a small quantity of aluminum in a determined shape, which may be put in a spectrograph to determine the elements of the alu-

minum alloy. There is no currently an automatic system for taking a sample of aluminum.

**[0022]** The station comprises additionally position detecting means which are connected to the robot for detection of the position of the crucible on the horizontal plane X, Y. So, since the robot locates the position of the crucible, neither the crucible nor the skimming machine has to be positioned accurately by an operator, and less skill is needed by the operator. Besides, there is a high reduction of errors and processing time.

**[0023]** A collecting box is provided inside the station so that the robot throws away the dross removed from the crucible.

**[0024]** Finally, a control desk allows the user to monitor, control and operate all the skimming and additional operations, including displaying the position of the crucible on the horizontal plane X, Y, and sending this information to the robot.

**[0025]** According a particular embodiment of the invention, the crucible skimming, stirring and sample taking station comprises level measuring means for measuring the distance along the vertical axis Z to the dross surface, and for measuring the aluminum height in the crucible after the dross has been removed from said crucible.

**[0026]** Preferably, the level measuring means may consist of a laser device.

**[0027]** Regarding the tools, that is, skimming, stirring and sample taking tools, they are originally placed in at least a tools stand, which is located in a prefixed position, and detectors are provided at the positions of these tools in order to control taking and releasing of the tools by the robot.

**[0028]** So, the skimming, stirring and sample taking operations are automatically driven by the robot. The robot takes the selected tool that is moved in the three dimensions X, Y, Z in order to remove the dross from the surface of the molten aluminum in the crucible, or to stir the aluminium, or to take a sample of said aluminium. Once the operation is finished, the tool is placed back in its original position.

**[0029]** Regarding the sample taking tool, another detector is provided to control the use of said sample taking tool.

**[0030]** The level measuring means will send the information of the aluminum height for the sample taking operation.

**[0031]** So, according the object of the present invention, the crucible skimming, stirring and sample taking station is a robot system that makes in one station and in the same location a set of operations in the crucibles that holds molten aluminum, which has been collected from electrolysis. This set of operations are skimming, stirring for alkali removal and aluminum sample taking, and they are currently carried out at different locations and using different machines, so, the station object of the present invention provides a high reduction of space and processing time.

Brief description of the drawings

**[0032]** Next, in order to facilitate the comprehension of the invention, in an illustrative rather than limitative manner an embodiment of the invention with reference to a series of figures shall be made below.

Figure 1 shows a plan view of a particular embodiment of a crucible skimming, stirring and sample taking station object of the present invention.

Figure 2 shows an elevation view of a particular embodiment of a crucible skimming, stirring and sample taking station object of the present invention.

Figure 3 shows an elevation view of an embodiment of the crucible skimming, stirring and sample taking station in which the articulated arm of the robot holds a skimming tool.

Figure 4 shows a view similar to figure 3, in which the articulated arm of the robot holds a stirring tool.

**[0033]** These figures refer to the following set of elements:

1. robot
2. mobile arm of the robot
3. crucible
4. position detecting means
5. level measuring means
6. skimming tool
7. stirring tool
8. collecting box
9. tool stand
10. sample taking tool
11. control desk
12. dosifying system

Detailed description of the invention

**[0034]** The object of the present invention is a crucible skimming, stirring and sample taking station, for molten aluminum in a crucible 3.

**[0035]** As shown in the figures, the crucible skimming station has a robot 1, comprising in turn an articulated arm 2, which is configured to take and move a tool 6,7,10 in the three dimensions X, Y, Z, for automatically removing the dross from the molten aluminum in the crucible 3. The tool is selected among a skimming tool 6, a stirring tool 7, and a sample taking tool 10.

**[0036]** According a particular embodiment of the invention, the skimming tool 6 may consists of a paddle, although it might consists of any other tool suitable for taking and removing the bath from the molten aluminum in the crucible 3.

**[0037]** Additionally, the crucible skimming, stirring and sample taking station has a reactive dosifying system 12 which adds reactive components into the molten aluminum of the crucible 3, and a stirring tool 7 interchangeable with the skimming tool 6. The articulated arm 2 of the

robot 1 is configured to take this stirring tool 7 and move it in the three dimensions X, Y, Z, for automatically stirring the molten aluminum with the reactive components.

**[0038]** As shown in the figures, the station of the present invention has a sample taking tool 10 which is also interchangeable with the skimming tool 6 and stirring tool 7, so the articulated arm 2 of the robot 1 is configured to take and move the sample taking tool 10 in the three dimensions X, Y, Z for automatically taking a sample of aluminium.Position detecting means means 4 are connected to the robot 1 for detection of the position of the crucible 3 on the horizontal plane X, Y.

**[0039]** Preferably, the position detecting means 4 is complemented with at least a CCTV camera to monitor the skimming station and all the operations carried out in it.

**[0040]** A collecting box 8 is provided inside the station so that the robot throws away the dross removed from the crucible.

**[0041]** A control desk 11 is provided at the station, which allows the user to control and operate all the skimming, stirring and sample taking operations.

**[0042]** According a particular embodiment of the invention, the crucible skimming, stirring and sample taking station comprises level measuring means 5 for measuring the distance along the vertical axis Z to the dross surface, and for measuring the aluminum height in the crucible 3 after the dross has been removed from said crucible 3. Preferably, the level measuring means may consist of a laser device.

**[0043]** Regarding the tools 6,7, 10, they are originally placed in a tool stand 9, which is located in a prefixed position, and detectors are provided at the positions intended for these tools 6,7, 10 in order to control taking and releasing of said tools 6,7,10 by the robot 1. Figure 1 shows schematically the tool stand 9.

**[0044]** With accord to preferred embodiments of the invention, the station has safety means, as drippings splash guard, which has two positions, home and operation, and is actuated by means of a pneumatic cylinder activated by a correspondent pneumatic solenoid valve, with controls on the control desk 11.

**[0045]** Additionally, the station is closed by a fence all around. The truck entry and exit is covered by two safety light curtains linked with the main safety circuit and with controls on the control desk 11. There may be also traffic lights, and a door to give access to a forklift with a safety switch linked with the main safe circuit.

**[0046]** Therefore, and according to the invention, and the different elements thereof, the operation according a particular embodiment of the crucible skimming, stirring and sample taking station is the following:

**[0047]** Initially, the station is in initial conditions, that means: robot 1 at home position, dross splash guard released, collecting box 8 placed, tool stand 9 with tools 6,7,10 placed, fence door closed, and traffic light green.

**[0048]** With traffic light green, operators will place the truck with the crucible 3. Then, the traffic light flashes intermittently amber, until reflexive cells detect the crucible 3 in a right position. Then the traffic light will flash continuously amber indicating that crucible 3 is positioned.

**[0049]** As safety light curtains will have detected truck and operators, the following operation to do is to reset the emergency alarm.

**[0050]** Traffic light will turn to red indicating that the access to the robot 1 influence area is denied.

**[0051]** An operator pulses the start cycle function on the control desk 11 and the splash guard will be placed, and the bath skimming tool 6 or the stirring tool 7 will be selected.

**[0052]** Position detecting means 4 will detect the position of the crucible 3 on the horizontal plane X, Y, as well as level measuring means 5 will detect the aluminum height inside the crucible 3, including the dross.

**[0053]** The operator will check at the control desk 11 that the starting point is adequate and will press acceptance button.

**[0054]** Data will be transferred from the control desk 11 to the robot 1 and by pressing "start of cycle" pushbutton, the robot 1 will start the skimming or stirring operation.

**[0055]** When the cycle finishes, the CNC robot 1 will move back to home position. Start cycle & robot at home indication lamps will flash.

**[0056]** The cycle can be repeated the times required if operator considers, checking the CCTV at the control desk 11.

**[0057]** Once there is no dross inside the crucible 3, the operator will place the sample taking tool 10, by pressing its correspondent pushbutton, then will select "take sample" function, and will press the "start cycle" pushbutton.

**[0058]** The robot 1 releases the skimming tool 6 or the stirring tool 7 in the original place thereof, changing to the sample taking tool 10, then takes aluminum from the crucible 3 dropping it into a box for the sample taking. After that, the robot 1 will release the sample taking tool 10 in its correspondent stand and will go back to home position, being ready for a new cycle.

**[0059]** Traffic light will turn to green, allowing the driver to leave the truck from the station.

**[0060]** Once the invention has been clearly described, it is hereby noted that the particular embodiments described above can be the subject of detail modifications as long as they do not alter the fundamental principle and the essence of the invention.

## Claims

1. Crucible skimming, stirring and sample taking station, for removing the dross from molten aluminum in a crucible (3), **characterized in that**

   - it comprises

- a robot (1) comprising in turn an articulated arm (2)
- position detecting means (4) connected to the robot (1) for detection of the position of the crucible (3) on the horizontal plane X, Y,
- a skimming tool (6) for removing the bath from the molten aluminum in the crucible (3),
- a collecting box (8) in which the robot (1) throws away the bath removed from the crucible (3),
- a reactive dosifying system (12) which adds reactive components into the molten aluminum of the crucible (3),
- a stirring tool (7),
- a sample taking tool (10)
- and a control desk (11) for the control of the station,

- and **in that** the articulated arm (2) of the robot (1) is configured to take and move in the three dimensions X, Y, Z the skimming tool (6), the stirring tool (7), and the sample taking tool (10).

**2.** Crucible skimming, stirring and sample taking station, according to claim 1, **characterized in that** it comprises at least a CCTV camera for monitoring said station.

**3.** Crucible skimming, stirring and sample taking station, according to any of claims 1-2, **characterized in that** it comprises level measuring means (5) configured for measuring the distance along the vertical axis Z to the dross surface, and for measuring the aluminum height in the crucible (3) after the dross has been removed from said crucible (3).

**4.** Crucible skimming, stirring and sample taking station, according to claim 3, **characterized in that** the level measuring means (5) comprise a laser device.

**5.** Crucible skimming, stirrking and sample taking station, according to any of claims 1-4, **characterized in that** the skimming tool (6) is a paddle.

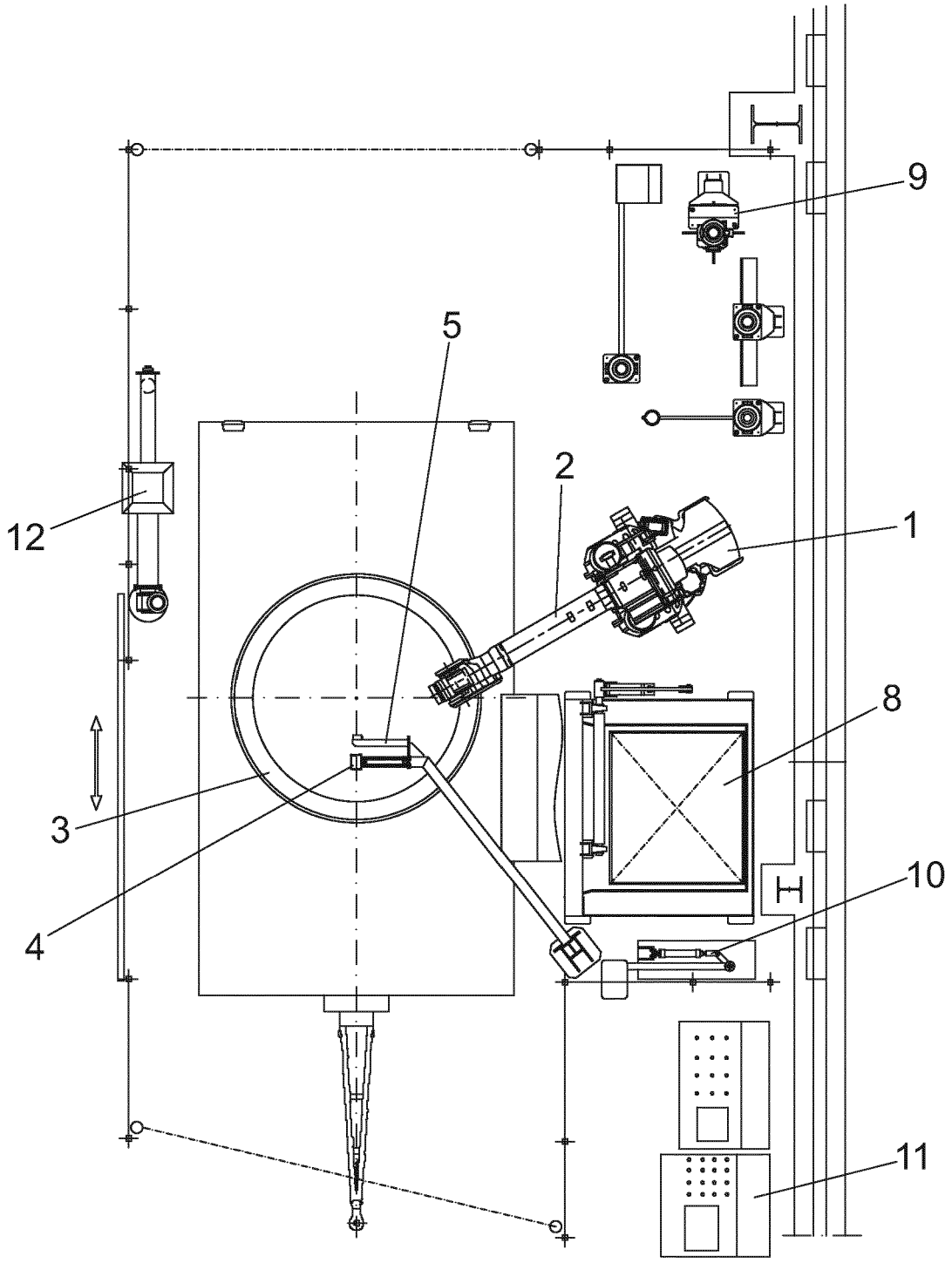


Fig. 1

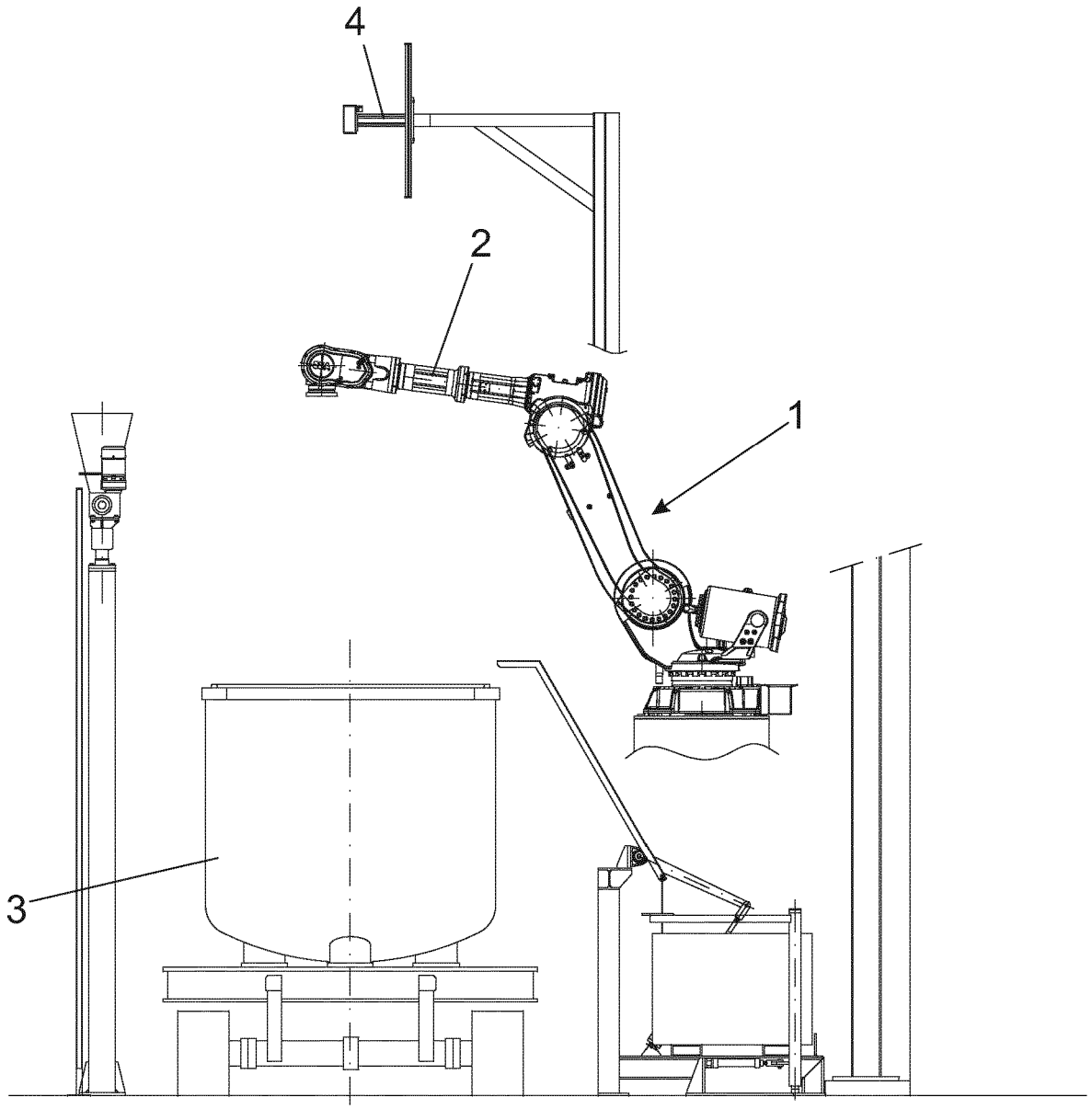


Fig. 2

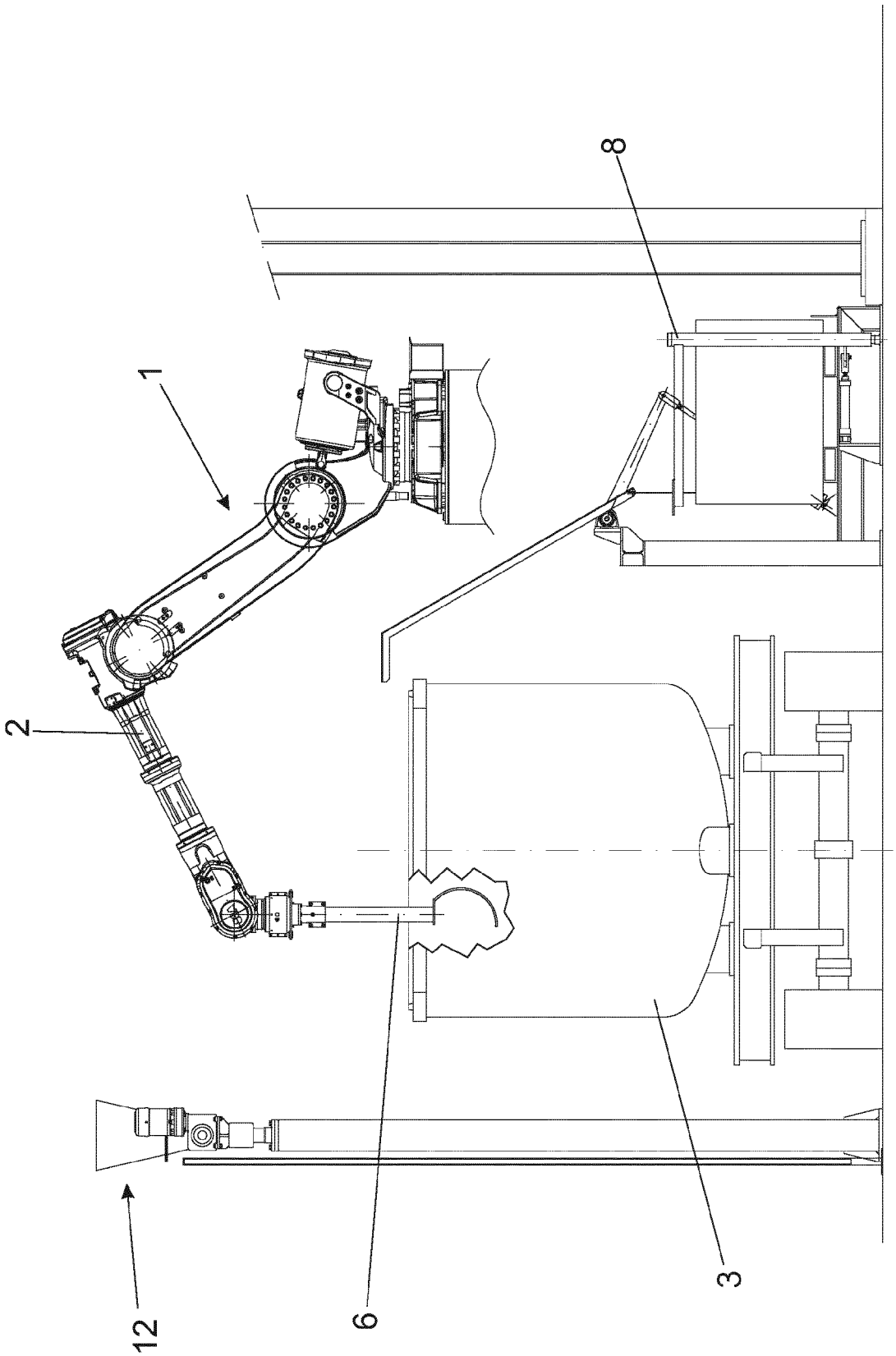


Fig. 3

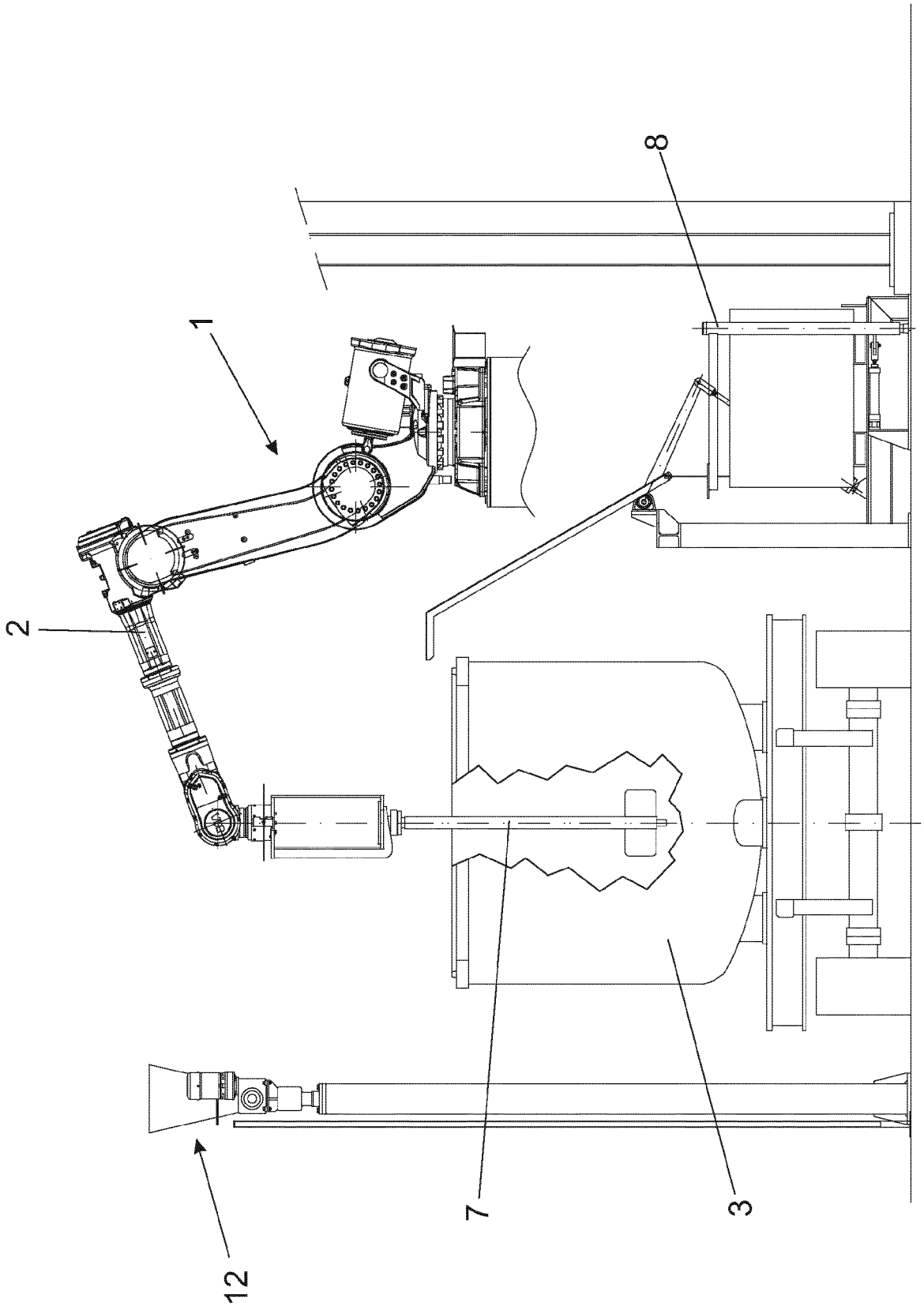


Fig. 4

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# EUROPEAN SEARCH REPORT

Application Number
EP 15 38 2539

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The present search report has been drawn up for all claims

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| Munich | 21 April 2016 | Zimmermann, Frank |

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# EUROPEAN SEARCH REPORT

Application Number
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