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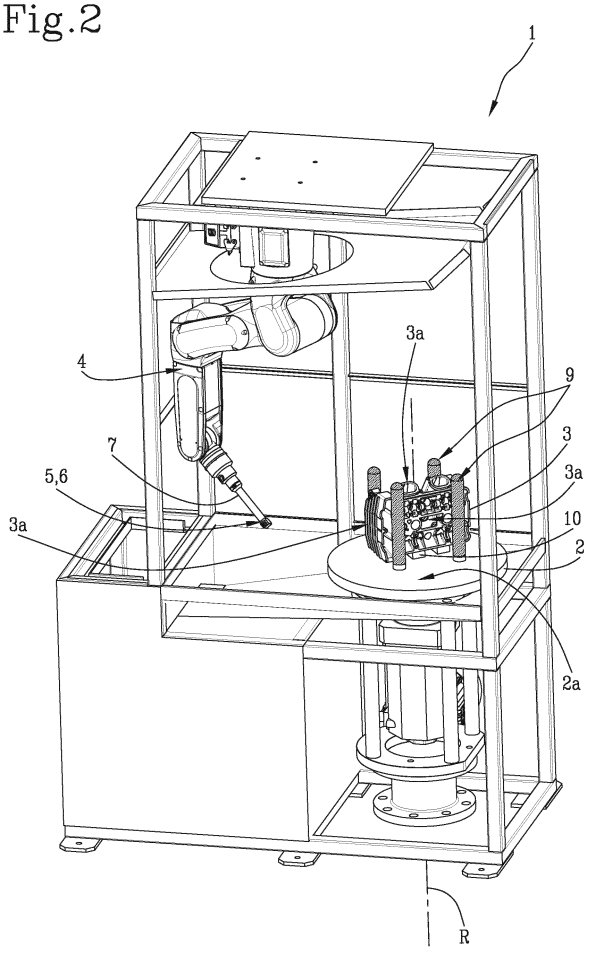
(54) **MACHINE AND METHOD FOR WASHING MECHANICAL COMPONENTS**

(57) Described is a machine for washing mechanical components, comprising at least one industrial robot (4) and at least one workpiece holder table (2) on the surface (2a) of which to position the one or more components (3) to be processed using the robot (4);
the machine (1) comprises a control unit (8) configured to move the one or more movement axes (A) of the robot (4) in a controlled manner; the robot (4) is configured to dispense at least the washing fluid onto the surfaces (3a) of the component (3); more specifically, the workpiece holder table (2) rotates around its vertical axis of rotation (R) and is configured to continuously rotate at such a speed as to centrifuge the washing fluid away from the component (3) positioned on the workpiece holder table (2).

Fig.2



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Description

[0001] The present invention relates to a machine for washing mechanical components.

[0002] In the process for production of mechanical components, with reference in particular, by way of example, to the automobile sector, there are currently increasingly strict requirements which these components must comply with in the quality and supply specifications and in the respective technical specifications.

[0003] Consequently, following the machining processes, the need is felt to carry out a thorough cleaning of the components to remove any metal swarf, liquids for lubrication-cooling of the tools and any residue of contaminating substances (grit, dirt in general, etc.).

[0004] In this regard, there are prior art booths for washing mechanical components which comprise a workpiece holder table on which to position the mechanical component to be cleaned and involve the use of an industrial robot to perform the washing, configured to move relative to the component and to the table.

[0005] After completing the washing of the component, some prior art machines comprise dryers which introduce air, if necessary hot, in the washing booth to dry the component positioned on the workpiece holder table.

[0006] In order to carry out the drying of the component, use may be made of a vacuum, which results in a significant increase in the constructional complexity of the machine and, with it, the relative production and maintenance cost.

[0007] It has been however been found that the known drying means have several drawbacks, as they do not suitably eliminate the washing residues from the component and involve a considerable waste of time at the end of which it is not possible to carry out any activities or tests on the mechanical component, since its parts, mostly inside parts, are not at an ambient temperature, resulting a further stoppage time of the mechanical component.

[0008] In this context, one aspect of this invention is to provide a machine for washing mechanical components comprising at least one industrial robot and at least one workpiece holder table on the surface of which to position the one or more components to be processed using the robot. The machine comprises a control unit configured to move in a controlled manner the one or more axes for moving the robot, configured for dispensing on the surfaces of the component at least one washing fluid. The workpiece holder table rotates around its vertical axis of rotation and is configured to continuously rotate at such a speed as to centrifuge the washing fluid away from the component positioned on the workpiece holder table.

[0009] Advantageously, the centrifugal action determined by the workpiece holder table results in a greater and accurate removal of the washing residue from the mechanical component and in a period of time less than that of the prior art. Further, following this centrifugal action, the mechanical component has in all its parts, even the inside one, a temperature approximately equal to the ambient temperature, allowing the continuation of the activities and/or tests on the component, thus reducing, or eliminating, the waiting times of the component compared with the prior art.

[0010] Further features and advantages of this invention are more apparent in the description below, with reference to a non-limiting embodiment of a machine for washing mechanical components as illustrated in the accompanying drawings, in which:

- Figure 1 is a schematic perspective view of a first embodiment of a machine for washing mechanical components according to this invention;
- Figure 2 is in a further schematic perspective view of the machine of Figure 1;
- Figure 3 is a schematic perspective view of a second embodiment of a machine for washing mechanical components according to this invention.

[0011] With reference to the accompanying drawings, the numeral 1 denotes a machine for washing mechanical components.

[0012] The machine 1 comprises at least one workpiece holder table 2 on which to position one or more components 3 to be processed. More specifically, the components 3 are positioned on the surface 2a of the table 2.

[0013] The surface 2a of the table 2 defines a horizontal work table.

[0014] It should be noted that the term "processing" the component 3 used in this description means the washing and drying of the component 3 positioned on the workpiece holder table 2.

[0015] The machine 1 comprises at least one industrial robot 4 configured to process at least one mechanical component 3.

[0016] The industrial robot 4 comprises at least two movement or operating axes A.

[0017] Preferably, the industrial robot 4 is an anthropomorphic robot. Alternatively, the robot could be of "SCARA" Cartesian type, fixed in place or mobile.

[0018] In the embodiment illustrated, the robot 4 has five axes A of operating movement.

[0019] The robot 4 is movable by one or more axes A of movement relative to the workpiece holder table 2 to reach the surfaces 3a of the component 3 to be processed.

[0020] The machine 1 comprises a control unit 8 configured to move the one or more movement or operating axes A of the robot 4 in a controlled manner. The robot 4 comprises at least one mouth 5 for dispensing the washing fluid and at least one mouth 6 for blowing pressurised air.

[0021] The term washing fluid means preferably a mixture of water and detergent. The washing fluid is dispensed under pressure from the dispensing mouth 5 of the robot 4.

[0022] The dispensing pressure of the washing fluid is

preferably between 20 bar and 200 bar.

[0023] The washing fluid is preferably dispensed at ambient temperature.

[0024] Preferably, the air dispensed by the robot is at ambient temperature. Preferably, the air dispensed by the robot is at a pressure generally between 2 bar and 8 bar.

[0025] The robot 4 is configured to dispense the washing fluid and/or the pressurised air onto the surfaces 3a of the component 3.

[0026] Preferably, the mouth 5 for dispensing the washing fluid and the mouth 6 for blowing air are positioned at the same head 7 of the robot 4.

[0027] More specifically, the blowing of pressurised air allows the removal from the surfaces 3a of the component 3 of any undesired reside, such as, for example, machining waste or residue of the fluid for washing the component.

[0028] The workpiece holder table 2 rotates about a relative vertical axis of rotation R.

[0029] The workpiece holder table 2 rotates about the vertical axis of rotation R for varying the relative orientation relative to the position of the robot 4, passing from one relative position to the other.

[0030] The control unit 8 of the machine 1 is configured to synchronise the movements of the one or more axes A for moving the robot 4 and the rotation around the axis R of the workpiece holder table 2 to pass from one relative position to the other during the processing operations of the component 3.

[0031] The control unit 8 of the machine 1 is configured for synchronising the movements axes A for movement of the robot 4 and the rotation about the axis R of the workpiece holder table 2 during the dispensing of the washing fluid from the dispensing mouth 5 and during the dispensing for the pressurised air from the blowing mouth 6.

[0032] The control unit 8 of the machine 1 is configured for synchronising the dispensing of the washing fluid from the dispensing mouth 5 of the robot 4 and the dispensing of the pressurised air from the blowing mouth 6.

[0033] The control unit 8 of the machine 1 is configured to synchronise rotation of the table 2, at the speed such as to centrifuge the washing fluid, with the movements of the axes A for moving the robot 4, during the dispensing of the pressurised air from the blowing mouth 6.

[0034] In this way, it is possible to dry all parts of the component 3, allowing access even in the remote areas in which the washing fluid accumulates.

[0035] As the robot 4 has a fixed connection relative to the workpiece holder table 2 , the component 3 positioned on the table 2 may have one or more surfaces 3a to be processed which are not accessible to the field of operation of the robot 4.

[0036] Advantageously, the synchronisation of the movement of the robot 4, in particular of the axes A for moving the robot 4, and the rotation about the axis R of the workpiece holder table 2 allows the component 3 to be positioned on the table 2 in such a way as to make accessible to the robot 4 all the surfaces 3a of the component, such as, for example, the surfaces 3a initially not accessible.

[0037] In other words, the axis of rotation R of the table 2 implements the possibility of moving the robot 4 with respect to its operating or movement axes A.

[0038] Advantageously, the synchronising of the rotation of the table 2 and the movement of the robot 4 reduces the operating spaces of the robot 4 around the component 3.

[0039] According to this invention, the workpiece holder table 2 rotates continuously about its own axis of rotation R for centrifuging the washing fluid away from the component 3 positioned on the surface 2a of the workpiece holder table 2.

[0040] During the continuous rotation of the table 2 around the axis of rotation R for centrifuging the washing fluid away from the component 3, the control unit 8 is configured to stop the movement of the axes A for moving the robot 4 according to a non-operating configuration.

[0041] In the non-operating configuration of the robot 4 it does not interfere with the continuous rotation of the workpiece holder table 2 about the axis of rotation R.

[0042] According to a preferred embodiment, for centrifuging the washing fluid away from the component 3 positioned on the table 2, the table 2 rotates about its axis of rotation R at a speed at least equal to 750 revolutions per minute.

[0043] During the centrifuging operation of the table 2, the components 3 must be securely positioned on the surface 2a of the workpiece holder table 2 to prevent possible movements of the component 3 towards the outside.

[0044] In this regard, the machine 1 comprises means 9 of retaining the components 3 on the workpiece holder table 2 configured to keep the components 3 in the respective location during rotation of the workpiece holder table 2 about its own axis of rotation R, especially during the continuous rotation for centrifuging the washing fluid away from the component 3.

[0045] The retaining means 9 are positioned on the surface 2a of the workpiece holder table 2.

[0046] More specifically, the components 3 are arranged on the surface 2a of the table 2 in the vicinity of the axis of rotation R, minimising in this way the imbalance of the table 2 and, with it, the harmful vibrations due to unbalanced masses, reducing the moment of inertia during the centrifuging action.

[0047] According to a variant embodiment, the retaining means 9 are positioned on the surface 2a of the workpiece holder table 2 in such a way as to at least partly surround the respective component 3 relative to its perimeter surface 3a.

[0048] According to a further variant embodiment, the installation and retaining means 9 are configured to be connected to respective parts 3b of the component 3.

[0049] More specifically, the installation means 9 are

configured to be inserted at least partly into respective holes 3b of the component 3, in particular in through holes 3b.

[0050] The installation means 9 are preferably in the form of tubular elements 9.

[0051] The tubular elements 9 have a plastic material on the surface intended to come into contact with the component 3, such as, for example Teflon, nylon or PVC.

[0052] With reference to the variant embodiment wherein the installation and retaining means 9 are configured to be inserted at least partly inside respective holes 3b of the component 3 they are made of at least two elements, a tubular element 9a for insertion into the hole 3b and a clamping element 9b of the tubular element.

[0053] The clamping element 9b is preferably made of plastic material, such as, for example, Teflon, nylon or PVC.

[0054] To avoid the direct contact between the component 3 and the surface 2a of the table 2, there are means 10 for supporting respective parts of the component 3 positioned on the surface 2a of the workpiece holder table 2. These supporting means 10 are preferably made of plastic material, such as, for example Teflon, nylon or PVC.

[0055] The machine 1 according to this invention comprises a system 11 for heating the washing fluid used by the robot 4.

[0056] The heating system 11 is controlled by a respective control unit 12 through which it is possible to set the temperature of the washing fluid.

[0057] Preferably, the temperature of the washing fluid varies in a range of from 20°C to 90°C, included.

[0058] The temperature of the washing fluid makes it possible to prevent that during the centrifugal action of the table 2 on the component 3, the action of heat removal referable to the movement of the air produces a lowering of the temperature of the component 3 in such a way that it is below the ambient temperature.

[0059] In a variant embodiment illustrated in Figure 3, the machine 1 comprises two workpiece holder tables 2 and a single robot 4 configured to operate alternatively on the first and on the second workpiece holder table 2.

[0060] In this embodiment, the control unit 8 of the machine 1 is configured to activate the movement of the axes A of the robot 4 alternatively relative to the first or to the second workpiece holder table 2.

[0061] With reference to the first or the second workpiece holder table 2, the control unit 8 of the machine 1 is configured for synchronising the movement of the axes A for moving the robot 4 with the rotation about the axis R of the first or the second workpiece holder table 2.

[0062] Preferably, the workpiece holder tables 2 are arranged side by side.

[0063] The machine 1 comprises a panel 13 interposed between the two workpiece holder tables 2.

[0064] In order to screen one table 2 relative to the other from the washing fluid or from the pressurised air dispensed by the robot 4, the machine 1 comprises screening means 14 preferably integral with the movement of the robot 4 in such a way as to be facing the workpiece holder table 2 free from the action of the robot 4.

[0065] The screening means 14 are in the form of walls, preferably circular. The screening means 14 have a window 14a for access of the robot 4 towards the component 3 to be processed located on the first or second workpiece holder table 2.

[0066] Advantageously, whilst the robot 4 is engaged in the processing of a component 3 positioned on one respective workpiece holder table 2, on the other workpiece holder table 2 it is possible, for example, to centrifuge the washing fluid away from the component 3 or perform the operations for loading and unloading the components 3, thereby reducing any down times.

[0067] Advantageously, the two workpiece holder tables 2 allow processing of respective components 3, such as, for example, semi-guards or semi-bases, which are intended to be assembled together.

[0068] This invention also relates to a method for washing mechanical components 3.

[0069] The method comprises the step of positioning one or more mechanical components 3 on the surface 2a of a workpiece holder table 2.

[0070] More specifically, the one or more mechanical components 3 are located on the surfaces 2a of a workpiece holder table 2 near the axis of rotation R of the table 2.

[0071] The method comprises a step of keeping the one or more components 3 on the surface 2a of the workpiece holder table 2 in a respective location, relative to the axis of rotation R of the table 2, by the retaining means 9. The method comprises dispensing a washing fluid onto the surface 3a of the component 3 positioned on the table 2 by using an industrial robot 4, preferably an anthropomorphic robot 4.

[0072] The method comprises blowing pressurised air onto the surface 3a of the component 3 positioned on the table 2 by using an industrial robot 4, preferably an anthropomorphic robot 4.

[0073] During the step of dispensing the washing fluid and/or blowing pressurised air on the surface 3a of the component 3, the movement of the robot 4, in particular the movement of one or more axes A of movement, and the rotation of the workpiece holder table 2 about its own axis of rotation R, are controlled in a synchronised fashion by a control unit 8.

[0074] During the step of the robot 4 dispensing the washing fluid and/or blowing pressurised air onto the surface 3a of the component 3 positioned on the workpiece holder table 2, the movements of the one or more movement axes A of the robot 4 are synchronised with the rotation around the axis R of the workpiece holder table 2, which is configured to pass from one relative position to the other, in particular with respect to the position of the robot 4.

[0075] The method according to this invention com-

prises a step of centrifuging the washing fluid away from the component 3 by continuously rotating the workpiece holder table 2 around its own vertical axis of rotation R, after the step of dispensing the washing fluid on the surfaces 3a of the component 3 using the robot 4.

[0076] During the step of centrifuging the washing fluid away from the component 3 using the continuous rotation of the workpiece holder table 2 around its axis R, the one or more axes A for moving the robot 4 are positioned according to a non-operating configuration of non-interference with the rotation of the workpiece holder table 2 around the axis of rotation R.

[0077] The step of blowing pressurised air on the surface 3a of the component 3 positioned on the table 2 may be performed simultaneously and/or after the step of centrifuging the washing fluid away from the component 3. During the step of the robot 4 dispensing the washing fluid and/or blowing pressurised air onto the surface 3a of the component 3 positioned on the workpiece holder table 2, the movements of the movement axes A of the robot 4 are synchronised with the rotation around the axis R of the workpiece holder table 2, which is configured to pass from one relative position to the other.

[0078] The step of dispensing the washing fluid being synchronised with the step of blowing pressurised air on the surface 3a of the component 3 positioned on the workpiece holder table 2.

[0079] The method may comprise repeating the step of centrifuging the washing fluid away from the component 3 several times during the same processing cycle of the component 3.

[0080] The step of centrifuging the washing fluid away from the component 3 by rotating the workpiece holder table 2 continuously about its own axis R is synchronised with the step of dispensing pressurised air.

[0081] More specifically, the method comprises alternating the step of dispensing the washing fluid with the step of blowing pressurised air and the step of centrifuging the washing fluid away from the component 3.

[0082] The method comprises optionally the heating of the washing fluid before it is dispensed from the robot 4 on the surfaces 3a of the component 3, in such a way that, at the end of processing, the component 3 has a temperature suitable for any seal tests, hot or cold assembly, specific testing, etc.

Claims

1. A machine for washing mechanical components, comprising at least one industrial robot (4), comprising at least two movement or operating axes (A), and at least one workpiece holder table (2) on the surface (2a) of which to position the one or more components (3) to be processed by the action of the robot (4);
the machine (1) comprises a control unit (8) configured to move the movement or operating axes (A) of the robot (4) in a controlled manner; the robot (4) comprises at least one mouth (5) for dispensing the washing fluid and at least one mouth (6) for blowing pressurised air on the surfaces (3a) of the component (3);
the workpiece holder table (2) being rotated around its vertical axis of rotation (R) and being configured to continuously rotate at such a speed as to centrifuge the washing fluid away from the component (3) positioned on the workpiece holder table (2);
the machine being **characterised in that** the control unit (8) of the machine (1) is configured for synchronising the movements axes (A) for movement of the robot (4) and the rotation about the axis (R) of the workpiece holder table (2) to pass from one relative position to the other during the dispensing of the washing fluid from the dispensing mouth (5) and during the dispensing for the pressurised air from the blowing mouth (6);
the control unit (8) of the machine (1) being configured for synchronising the dispensing of the washing fluid from the dispensing mouth (5) of the robot (4) and the dispensing of the pressurised air from the blowing mouth (6);
the control unit (8) of the machine (1) being configured to synchronise rotation of the table (2), at the speed such as to centrifuge the washing fluid, with the movements of the axes (A) for moving the robot (4), during the dispensing of the pressurised air from the blowing mouth (6).

2. The machine according to claim 1, **characterised in that** it comprises means (9) for retaining the components (3) on the surface (2a) of the workpiece holder table (2), and configured to keep the components (3) in their respective position, relative to the axis of rotation (R) of the workpiece holder table (2), during the centrifugal action of the workpiece holder table (3).

3. The machine according to claim 1 or 2, **characterised in that** the retaining means (9) are positioned on the surface (2a) of the workpiece holder table (2) in such a way as to at least partly surround the respective component (3) relative to its perimeter surface (3a).

4. The machine according to claim 2 or 3, **characterised in that** the retaining means (9) are configured to be connected to respective parts (3b) of the component (3), in particular to be at least partly inserted into respective holes (3b) of the component (3), more specifically into through holes (3b).

5. The machine according to any one of the preceding claims, **characterised in that** it comprises means (10) for supporting respective parts of the component (3) configured to prevent contact of these parts with the surface (2a) of the workpiece holder table (2).

6. The machine according to any one of the preceding claims, **characterised in that**, during the continuous rotation of the table (2) around the axis of rotation (R) for centrifuging the washing fluid away from the component (3), the control unit (8) of the robot (4) is configured to stop the movement of the axes (A) for moving the robot (4) according to a non-operating configuration of non-interference with the rotation of the workpiece holder table (2).

7. The machine according to any one of the preceding claims, **characterised in that** it comprises two or more workpiece holder tables (2) and a single industrial robot (4) configured to alternatively operate at least on the first and on the second workpiece holder table (2); the control unit (8) of the machine (1) is configured to activate the movement of the axes (A) for moving the robot (4) alternatively relative to the first or to the second workpiece holder table (2).

8. The machine according to any one of the preceding claims, **characterised in that** it comprises a system (11) for heating the washing fluid dispensed by the robot (4) onto the surfaces (3a) of the component (3).

9. A method for washing mechanical components, comprising the steps of
positioning one or more mechanical components (3) on the surface (2a) of a workpiece holder table (2) which rotates around its own vertical axis of rotation (R);
dispensing a washing fluid and blowing pressurised air onto the surface (3a) of the component (4) positioned on the workpiece holder table (2) by using an industrial robot (4) comprising at least two movement or operating axes (A) of the robot (3) controlled by a control unit (8); centrifuging the washing fluid away from the component (3) by continuously rotating the workpiece holder table (2) around its own vertical axis of rotation (R) after the step of dispensing the washing fluid using the robot (4);
the method being **characterised in that** it comprises a step of:

synchronising the movement of the movement axes (A) of the robot (4) and the rotation about the axis (R) of the workpiece holder table (2) to pass from one relative position to the other during the step of dispensing the washing fluid and blowing pressurised air by the robot (4) onto the surface (3a) of the component (3) positioned on the workpiece holder table (2);
the step of dispensing the washing fluid being synchronised with the step of blowing pressurised air on the surface (3a) of the component (3) positioned on the workpiece holder table (2);
the step of centrifuging the washing fluid away from the component (3) by rotating the workpiece holder table (2) continuously about its own axis (R) is synchronised with the step of dispensing pressurised air.

10. The method according to claim 9, **characterised in that** it comprises a step of keeping the one or more components (3) on the surface (2a) of the workpiece holder table (2) in the respective position, relative to the vertical axis of rotation (R) of the table (2).

11. The method according to claim 9 or 10, **characterised in that** the step of blowing pressurised air on the surface (3a) of the component (3) positioned on the table (2) may be performed simultaneously and/or after the step of centrifuging the washing fluid away from the component (3).

12. The machine according to any of claims 9 to 11, **characterised in that** it comprises a step of heating the washing fluid before it is dispensed by the robot (4) onto the surfaces (3a) of the component (3).

13. The method according to any one of claims 9 to 12, **characterised in that**, during the step of centrifuging the washing fluid away from the component (3) using the continuous rotation of the workpiece holder table (2) around its axis (R), the axes (A) for moving the robot (4) are positioned according to a non-operating configuration of non-interference with the rotation of the workpiece holder table (2) around the axis of rotation (R).

Fig.1

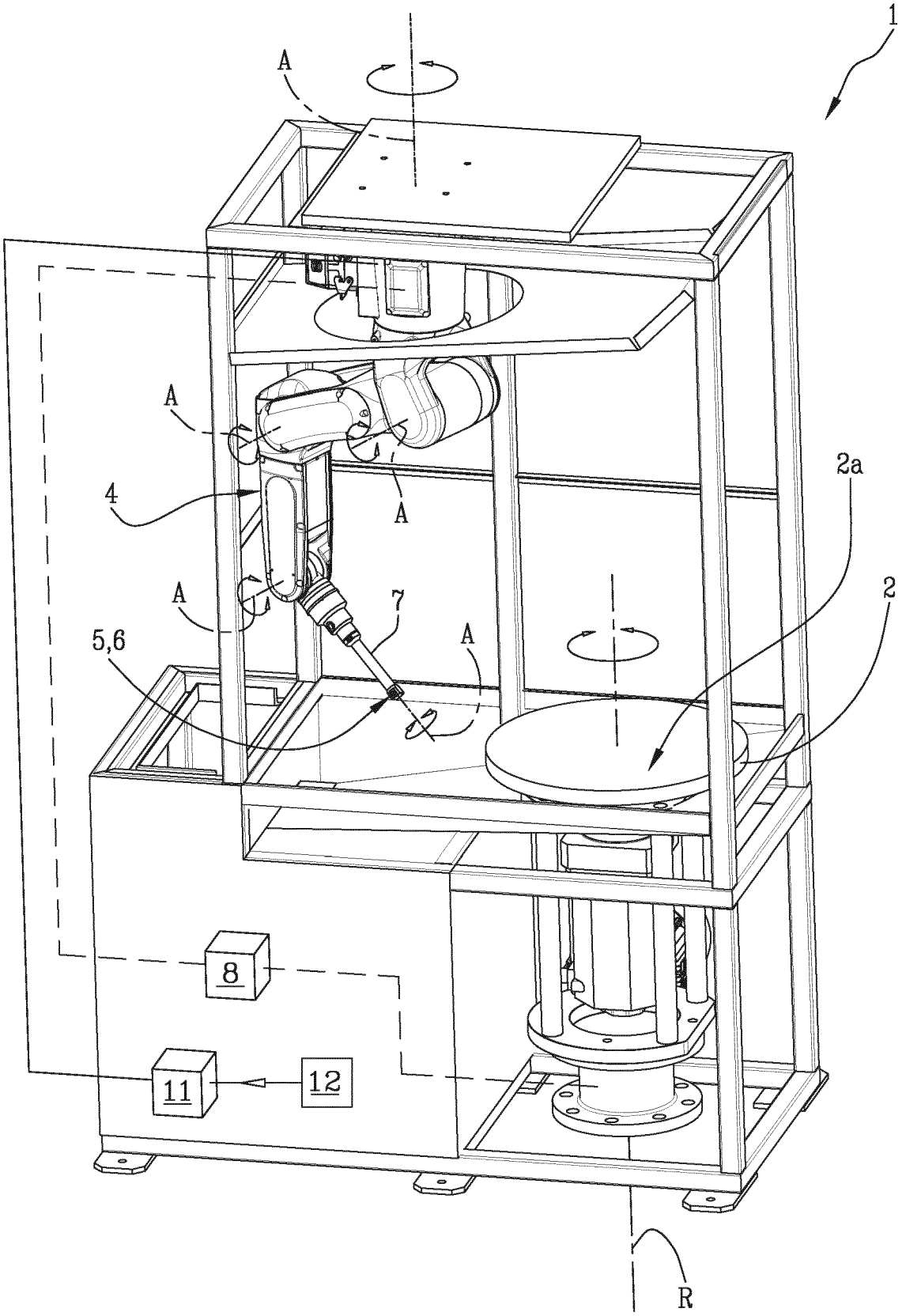


Fig.2

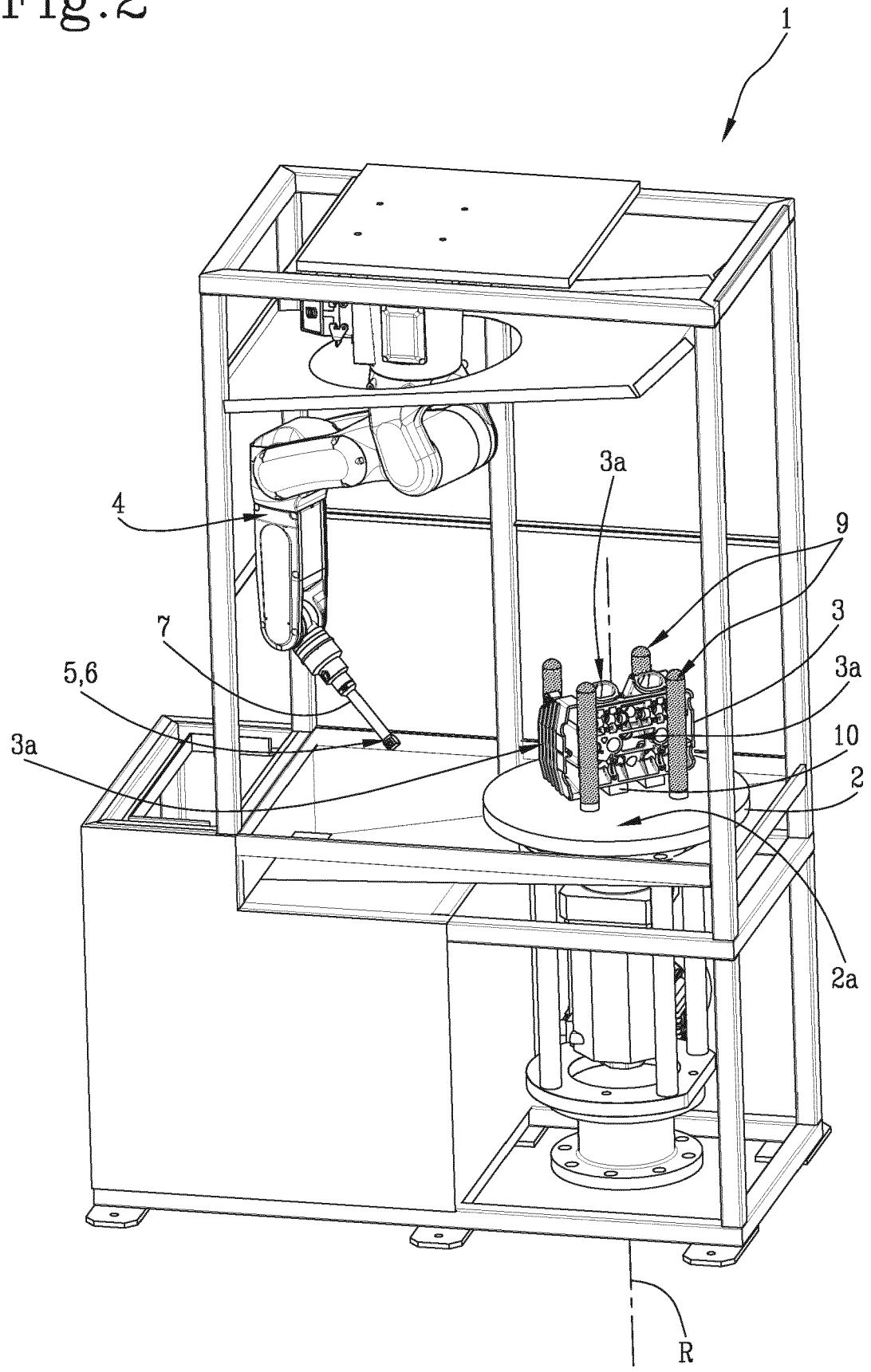
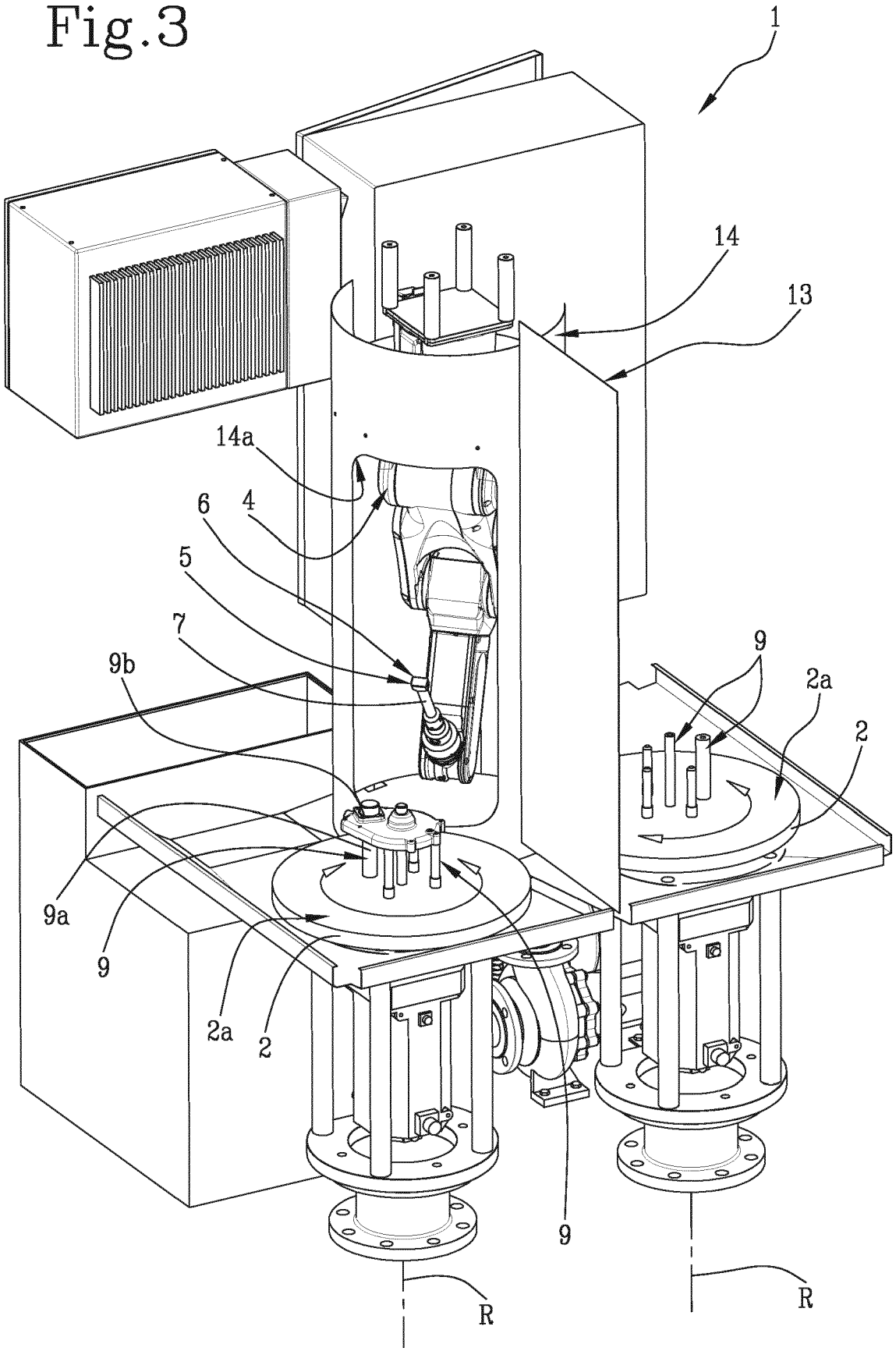


Fig.3



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EUROPEAN SEARCH REPORT

Application Number
EP 17 17 7231

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
			B08B B25J B05B F26B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27 October 2017	Psoch, Christian

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 17 7231

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82