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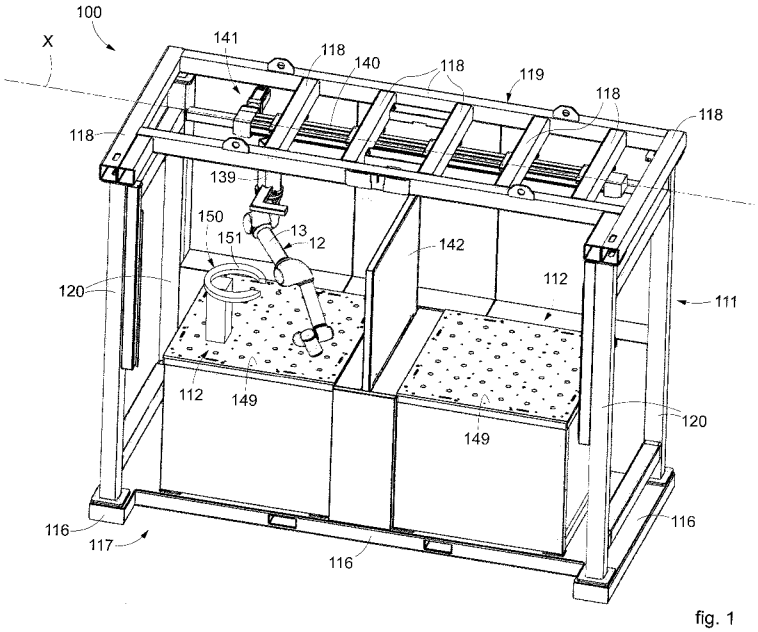

fig. 1

(57) Abstract: Work cell (100) comprising at least one automatic operating device (12) and feed means (18) configured to feed at least one tool (11, 40), characterized in that it comprises a fixed support (150) and at least one tool holder device (10) configured to be attached, directly or indirectly and alternatively, to said fixed support (150) or to said automatic operating device (12) and which comprises both a holding member (20) configured to hold a tool (11, 40), and also connection means (35) configured to connect a tool (11) to said feed means (18).

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"CELL AND WORK METHOD"

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FIELD OF THE INVENTION

The present invention concerns a work cell having an automatic operating device and a tool for performing works such as, for example, but not limited to generality, welding, cleaning, sanding, grinding, assembling objects or other.

BACKGROUND OF THE INVENTION

Work cells are known comprising a work plane on which the objects to be worked are attached and a robotic anthropomorphic arm that moves a tool to perform some works on said objects.

The tool is moved by the robotic anthropomorphic arm with respect to the object disposed on the work plane to perform work.

This known solution is appreciated and widely used to perform works on objects having determined shapes and sizes due to which they can be easily held on the work plane by clamps or other similar members.

However, this known solution is hardly applicable for some objects with shapes and sizes due to which it is difficult to dispose and attach them on the work plane.

For example, it is difficult to effectively hold objects with oblong shape and small size due to which surface finishing operations, such as grinding or sanding thereof, are usually performed manually by a specialized operator.

Moreover, in these cases, the reciprocal movement between the tool, the robotic anthropomorphic arm and the clamp on which the object required by these works is attached might lead to collisions between the latter.

There is therefore a need to perfect a work cell that can overcome at least one of the disadvantages of the prior art.

To do this, it is necessary to solve the technical problem of allowing a reciprocal movement between the object to be worked and the tool, which also allows working objects with shapes and sizes due to which it is complicated to hold them on the work plane by means of clamps or similar members.

In particular, one purpose of the present invention is to embody a work cell that allows to automatically perform a wide range of works on objects of any shape and size.

Another purpose of the present invention is to embody a work cell that also

allows to automate the works that are normally performed manually by a specialized operator.

Another purpose of the present invention is to embody a work cell that is simple, economical and easy to use.

The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

SUMMARY OF THE INVENTION

The present invention is set forth and characterized in the independent claims. The dependent claims describe other characteristics of the present invention or variants to the main inventive idea.

In accordance with the above purposes and to resolve the above technical problem in a new and original way, also achieving considerable advantages compared to the state of the prior art, a work cell comprising at least one automatic operating device and feed means configured to feed at least one tool.

The work cell further comprises a fixed support and also at least one tool holder device configured to be attached, directly or indirectly and alternatively, to said fixed support or to said automatic operating device and which comprises both a holding member configured to hold a tool and connection means configured to connect a tool to said feed means.

In accordance with another aspect of the present invention, the work cell further comprises a work plane and said automatic operating device is disposed above said work plane and said fixed support is attached to said work plane.

In accordance with another aspect of the present invention, said feed means comprise both first output connectors associated with said automatic operating device and second output connectors associated with said fixed support. Furthermore, said connection means are configured to be connected alternatively to said first output connectors or to said second output connectors.

In accordance with another aspect of the present invention, said automatic operating device comprises a robotic anthropomorphic arm and the work cell further comprises a connection device having a first part attached to said robotic anthropomorphic arm and configured to be selectively and reversibly connected with a second part attached to said tool holder device.

In accordance with another aspect of the present invention, said mounting portion is configured to temporarily fasten said second part of said connection device.

In accordance with another aspect of the present invention, said second part comprises both first fastening elements configured to selectively fasten corresponding fastening elements of said first part and second fastening elements configured to selectively fasten said fastening portion.

In accordance with another aspect of the present invention, the work cell comprises both one or more work tools configured to perform mechanical work on an object, and one or more gripping tools configured to grip an object.

In accordance with another aspect of the present invention, said holding member has a holding seating configured to at least partially envelop a tool.

In accordance with another aspect of the present invention, said holding seating has a shape which reverse matches an external portion of a tool and said holding member comprises two or more half shells which define said holding seating between them and each of which comprises fastening means configured to be fastened to each other.

In accordance with a further aspect of the present invention, a work method to perform work on an object by means of a work tool in a work cell provides to:

- dispose said object in said work cell;
- temporarily attach said work tool on said fixed support connecting said work tool to said feed means;
- temporarily attach said gripping tool to said automatic operating device connecting said gripping tool to said feed means;
- grip said object by means of said gripping tool;
- move said object with respect to said work tool by means of said automatic operating device to perform work on said object.

In accordance with another aspect of the present invention, the method also provides to:

- disconnect said gripping tool from said automatic operating device;
- temporarily attach said work tool to said automatic operating device;
- dispose a second object in said work cell;
- move said work tool by means of said automatic operating device to perform

work on said second object.

DESCRIPTION OF THE DRAWINGS

These and other aspects, characteristics and advantages of the present invention will become apparent from the following description of some embodiments, given as a non-restrictive example with reference to the attached drawings wherein:

- fig. 1 is an axonometric view of a work cell according to an embodiment of the present invention;
- fig. 2 is a front and schematic view of a work cell according to an embodiment of the present invention;
- fig. 3 is an axonometric view of a tool holder device of the work cell of fig. 2;
- fig. 4 is an exploded axonometric view of the device of fig. 3;
- fig. 5 is a simplified electrical diagram of a work cell according to an embodiment of the present invention.

We must clarify that in the present description the phraseology and terminology used, as well as the figures in the attached drawings also as described, have the sole function of better illustrating and explaining the present invention, their function being to provide a non-limiting example of the invention itself, since the scope of protection is defined by the claims.

To facilitate comprehension, the same reference numbers have been used, where possible, to identify identical common elements in the drawings. It is understood that elements and characteristics of one embodiment can be conveniently combined or incorporated into other embodiments without further clarifications.

DESCRIPTION OF SOME EMBODIMENTS OF THE PRESENT INVENTION

With reference to figure 1, the work cell 100 of the present invention comprises a frame 111 inside which a work plane 112 is disposed on which the objects O to be worked are positioned.

Such a frame 111 comprises first structural elements 116 of elongated shape, intersected and reciprocally integral to form a base 117 and second structural elements 118 of elongated shape, intersected and reciprocally integral to form a ceiling 119. The ceiling 119 and the base 117 are joined by means of further vertical structural elements 120 with elongated shape disposed at the vertices of the base 117 and of the ceiling 119.

The structural elements 116, 118 and 120 can be reciprocally integral with

coupling by interlocking, screws, bolts or other so that such a frame 111 assumes a substantially box-like shape.

Preferably, but not necessarily, the work plane 112 comprises a pair of work benches 149, disposed side by side or at a certain distance from each other, within the work cell 100.

Optionally, the work cell 100 also comprises a bulkhead 142 positioned between the work benches 149 and configured to assume at least one raised position, in which it physically divides the work benches 149, for example to perform differentiated operations in each of them, and a lowered position, in which, in fact, there is no solution of continuity between the work benches 149. Preferably, but not necessarily, when the bulkhead 142 is in the lowered position it is recessedly housed below the two work benches 149.

In the work cell 100 there is also disposed an automatic operating device 12 configured to move a tool 11, 40 (fig. 2 or fig. 3) in order to perform mechanical works on the objects O disposed on the work plane 112, or to manipulate the latter.

In the example provided herein, the automatic operating device 12 comprises a robotic anthropomorphic arm 13 (fig. 1 or 2) of collaborative type, i.e. a so-called co-robot of a per se known type, placed above the work plane 112 and commanded by a control unit 200 (fig. 5).

Specifically, the frame 111 comprises a guide 140 (fig. 2) placed at a certain height above the work plane 112, for example attached to the ceiling 119, and the automatic operating device 12 comprises a support 139 sliding along said guide 140.

The support 139 is associated with at least one actuating device 141 (fig. 1 and 2), commanded by the control unit 200 (fig. 5), configured to move the support 139 along the guide 140, and therefore also the automatic operating device 12 along the work plane 112.

The support 139 is associated with a slide and is moved along the guide 140 in any manner known per se, for example by means of a screw and nut screw mechanism, in which the nut screw is obtained in the slide, or other and the screw is rotated by the actuating device 141.

The tools 11, 40 included in the work cell 100 can be both work tools 11 (fig. 2, 3 and 4), suitable for performing mechanical works on the objects O disposed on

the work plane 112, and gripping tools 40 (fig. 2) configured to grip the objects O present on the work plane 12.

By way of example only, the work tool 11 may be a sander, a drill, a grinder, a welder, and others. Furthermore, the gripping tool 40 can be a pneumatic gripper suitable for stably and securely gripping even small and oblong shaped objects.

Optionally, the work cell 100 may also comprise more than one work tool 11 and/or more than one gripping tool 40.

In order to be able to deposit the tools 11, 40 not involved in a work, a tool magazine 155 (fig. 2) can also be disposed in the work cell 10 consisting of any space or place defined in the work cell 100 or of any case, receptacle, container, and the like, included in the work cell 100 that are configured and suitable for the deposit, storage, arrangement, and recovery of at least one tool 11, 40 by the automatic operating device 12 or by an operator.

The person skilled in the art will understand that the tool magazine 155 can also be external to the work cell 100 without this affecting the scope of protection of the invention. The position of the tool, or tools, 11, 40 deposited and stored in the tool magazine 155 is known to the control unit 200 and may be recorded in a memory unit 201 configured to communicate with the control unit 200.

The work cell 100 further comprises feed means 18 (fig. 2, 3 and 4), commanded by the control unit 200 and configured to provide one or more tools 11, 40 involved in a work, with the utilities they need for correct operation.

By way of example, said utilities may be electricity, compressed air, water, oil or any other pressurized and non-pressurized fluid, sand, melting material for welding and others. By way of not limiting example only, the feed means 18 may comprise electrical cables or conduits for transporting the above-listed utilities and a plurality of output connectors 19, 129.

The work cell 100 also comprises a fixed support 150 (figs. 1 and 2), attached to the work plane 112, on which a work tool 11 can be temporarily attached, as will be described below.

Each tool 11, 40 is associated with a respective tool holder device 10 (Figs. 3 and 4) which comprises a holding member 20 configured to hold the tool 11, 40.

In the example provided herein, the holding member comprises two half shells 21, 22 configured to be fastened to each other and define a holding seating 23 for

the tool 11, 40 between them. In particular, the inner surface of each half shell 21, 22 delimits a portion of the holding seating 23.

The holding seating 23 is configured to envelop an external portion of the tool 11, 40 and has a shape that reverse matches the shape of the portion of the respective tool 11, 40 to be enveloped.

The holding seating 23 envelops the handle of the tool 11 and also comprises an opening 24 from which the operating portion of the tool 11 emerges, which, in this case, is a grinder.

Instead, in the non-limiting example in figure 2 both a work tool 11 and a gripping tool 40 are present, each of which is associated with a respective tool holder device 10. In this example, the work tool 11 is a disc sanding machine while the gripping tool 40 is a pneumatic gripper.

Preferably, the half shells 21, 22 are made, in plastic or metal and by 3D printing so as to be able to define a holding seating 23 also having a complex shape and suitable for following and adhering without plays to the surface of the external portion of the tool 11, 40 to be held.

By doing so, the holding seating 23 can perfectly envelop part of the tool 11, 40 which can be stably and securely attached to the automatic operating device 12.

Each half shell 21, 22 comprises fastening means 25 configured to be stably and reversibly fastened with the other half shell 21, 22.

In the example provided herein, the fastening means 25 (fig. 3 and 4) of each half shell 21, 22 comprise three fastening portions 26 extending from the respective half shell 21, 22 in conjugate positions so as to overlap two by two. Each fastening portion 26 comprises a through hole 27 and the fastening means 25 also comprise fastening elements (not depicted), such as screws, bolts, or other, configured to be inserted into the through holes 27 of two fastening portions 26 which are overlapped to stably fix the two half shells 21, 22 together.

It is clear that in other embodiments the fastening means 25 can be of any other suitable type, such as, for example, interlocking, magnetic, mechanical and others.

The holding member 20 further comprises an attaching portion 30, configured to be alternatively attached to both the automatic operating device 12 and to the fixed support 150.

In the example provided herein, the attaching portion 30 is substantially

discoidal in shape and develops as a single body from one of the two half shells 21, 22.

It should be noted that the attaching portion 30 can be attached directly or indirectly, by means of interposed devices, to the automatic operating device 12 or to the fixed support 150.

In fact, optionally, in order to indirectly attach the attaching portion 30 to the automatic operating device 12 or to the fixed support 150, the work cell 100 also comprises a connection device 14 having a first part 15 and a second part 16 configured to be selectively and reversibly connected to each other. In particular, the first and second parts 15, 16 comprise respective first fastening elements 44 configured to be selectively fastened with each other.

Said first part 15 is attached to one end of the robotic anthropomorphic arm 13 while said second part 16 comprises a plurality of attaching elements 17 such as, for example, holes, slots etc., configured to cooperate with the attaching portion 30.

For example, the second part 16 is discoidal in shape and the attaching elements 17 comprise a plurality of holes obtained on an outer surface thereof.

In this case, also the attaching portion 30 comprises a substantially planar surface on which a plurality of holes 32 disposed in a position conjugated with that of the attaching elements 17 of the second part 16 are made.

The tool holder device 10 further comprises attaching elements (not depicted) such as screws, bolts or others, each of which is configured to be inserted into a hole 32 of the attaching portion 30 so as to cooperate with the fastening elements 17 of the second part 16 of the connection device 14 and connect the latter with the attaching portion 30 of the holding member 20.

The second part 16 of the connection device 14 also comprises second fastening elements 144 configured to cooperate with a mounting portion 151 of the fixed support 150.

In the example provided herein, the mounting portion 151 is shaped to cooperate with the second fastening elements 144 and hold the second part 16 of the connection device 14 and, consequently, also the tool holder device 10 with the respective tool 11, 40.

Since the second part 16 of the connection device 14 has first and second

fastening elements 44, 144 distinct from each other, it allows to bring a tool 11, 40 attached to the robotic anthropomorphic arm 13, towards the fixed support 150, as long as the second fastening elements 144 are fastened to the mounting portion 151.

This advantageously allows a tool 11, 40 to be carried and attached automatically by means of the robotic anthropomorphic arm 12 on the fixed support 150 without requiring the intervention by an operator.

In other embodiments not shown, the mounting portion 151 may be shaped to cooperate directly with the attaching portion 30 of the tool holder device 10.

The tool holder device 10 also comprises connection means 35 configured to automatically connect, on the one hand, to the output connectors 19, 129 of the feed means 18 and, on the other hand, with the tool 11, 40.

Preferably, the feed means 18 comprise first output connectors 19 associated with the automatic operating device 12 and second output connectors 129 associated with the fixed support 150.

The connection means 35 may comprise electrical cables, and/or one or more conduits to allow the passage of a fluid such as, for example, water or pressurized air, depending on the specific tool 11, 40 involved.

The holding member 20 also comprises a containing body 36 configured to contain therein at least part of the connection means 35.

Preferably the containing body 36 is rigid and develops as a single body from one of the two half shells 21, 22.

By way of example only, the containing body 36 may be tubular in shape and the connection means 35 may be disposed therein.

In further embodiments not depicted in the drawings, the containing body 36 may essentially comprise a cavity, even passing-through, for example of tubular shape, obtained inside one of the two half shells 21, 22.

The containing member 36 advantageously makes it possible to attach the connection means 35 to the holding member 20 so as to prevent them from being an obstacle and obstruct the movement of the tool 11, 40 and of the robotic anthropomorphic arm 13.

The connection means 35 also comprise first connection members 37 which protrude from the containing body 36 in the vicinity of the output connectors 19,

129 of the feed means 18 and which are configured to connect therewith.

Furthermore, the connection means 35 also comprise second connection members 39 which protrude from the containing body 36 and which are configured to connect with the tool 11, 40.

This makes it possible to avoid the presence of electrical cables or mobile conduits hanging precariously from the tool 11, 40, the automatic operating device 12 and/or the frame of the work cell 100, which could hinder the movement of the tool 11, 40 and the correct performance of the works by the latter.

The work cell 100 of the present invention also allows to work objects O with shapes and sizes that are normally difficult to attach on the work plane 12. In fact, in these cases it is sufficient to dispose a work tool 11 on the fixed support 150 and to hold the object O by means of a gripping tool 40 attached to the automatic operating device 12. In this case the gripping tool 40 moves the object O with respect to the work tool 11 which is attached to the fixed support 150.

The movement of the object O by means of the automatic operating device 12 allows to widen the range of reciprocal movements executable between the object O and the work tool 11. Therefore, the work cell 100 of the present invention also allows to automate the works that are normally performed manually by a specialized operator.

It is clarified that the work cell 100 of the present invention can also be used as a traditional work cell in which the object to be worked is disposed on the work plane 112 and the work tool 11 is moved by the automatic operating device 12.

The operation of the work cell 10 described so far, which corresponds to the method according to the present invention comprises the following steps.

It is clarified that below reference will be made to the performance of work on an object O having a shape and sizes due to which holding it on the work plane 112 by means of clamps or similar members is complicated. However, it is clarified that the work cell 100 of the present invention is suitable and also configured to perform work on an object O disposed on the work plane 112, without further clarifications.

It is also clear that said tools 11, 40 are always held by a respective tool holder device 10, as described above, and possibly associated with the second part 16 of the connection device 14.

A computer program comprising a list of operations executable by the work cell 100 is stored in the memory unit 201. Each work to be performed on a specific object O corresponds to a respective computer program.

The computer program stored in the memory unit 201 is executed by the control unit 200 which, on the basis thereof, commands the operation of the automatic operating device 12, of the feed means 18, and of the actuating device 141 (Fig. 5).

At the beginning of the method of the present invention, the object O is disposed on the work plane 112 at a set starting position stored in the computer program.

In the computer program it is defined which is the work tool 11 with which to perform work so that the control unit 200 moves the robotic anthropomorphic arm 13 to pick said work tool 11 from the tool magazine 155.

Subsequently, the control unit 200 moves the robotic anthropomorphic arm 13 to bring the work tool 11 towards the fixed support 150 until the second fastening means 144 are fastened to the mounting portion 151. When the second fastening means 144 are fastened to the mounting portion 151 the control unit 200 commands the release of the first fastening means 44.

It should be noted that in other embodiments, the work tool 11 can be disposed on the fixed support 150 manually.

In the computer program it is also defined which one is the gripping tool 40 with which to grip the object O, whereby the control unit 200 moves the robotic anthropomorphic arm 13 to pick said gripping tool 40 from the tool magazine 155.

Then, the control unit 200 commands the robotic anthropomorphic arm 13 to bring said gripping tool 40 towards the object O disposed in the set starting position on the work plane 112.

Subsequently, the control unit 200 commands the feed means 18 to actuate the gripping tool 40 which grips the object O. Further, the control unit 200 commands the feed means 18 to actuate the work tool 11.

Then, the control unit 200 commands the robotic anthropomorphic arm 13 to move the object O with respect to the work tool 11 disposed on the fixed support 150 and perform work.

Once the work is finished, the control unit 200 commands the robotic anthropomorphic arm 13 to bring the object O to a set final position described in

the computer program.

Furthermore, optionally, the control unit 200 commands the robotic anthropomorphic arm 13 to return the gripping tool 40 to the tool magazine 155.

Finally, the control unit 200 moves the robotic anthropomorphic arm 13 towards the work tool 11 disposed on the fixed support 150 until it is fastened to the latter by means of the first fastening elements 44.

Alternatively, the work tool 11 is returned to a set position in the tool magazine 155 manually by an operator and the control unit 200 moves the robotic anthropomorphic arm 13 towards the work tool 11 disposed in the tool magazine 155 until it is fastened to the latter by means of the first fastening elements 44.

Optionally, at this point an operator can attach on the work plane 112 a new object having shape and sizes whereby it is easily attachable to the work plane 112, and which is to be worked by means of the work tool 11 which is now attached to the robotic anthropomorphic arm 13, or by means of another work tool 11.

At this point, the control unit 20 can execute a new computer program containing the instructions for working the new object disposed on the work plane 112.

It is therefore evident that the work cell 100 of the present invention allows a wide range of working operations to be carried out automatically on objects of any shape and sizes, both in the case where the latter can be easily attached on the work plane 112, and in the case where the latter are difficult to attach on the work plane 112.

It is clear that modifications and/or additions of parts may be made to the work cell 100 and to the method as described heretofore, without departing from the field and scope of the present invention, as defined by the claims.

It is also clear that, although the present invention has been described with reference to some specific examples, a person of skill in the art shall certainly be able to achieve other equivalent forms of a work cell and method having the characteristics as set forth in the claims and hence all coming within the field of protection defined thereby.

In the following claims, the sole purpose of the references in brackets is to facilitate their reading and they must not be considered as restrictive factors with regard to the field of protection defined by the claims.

CLAIMS

1. Work cell (100) comprising at least one automatic operating device (12) and feed means (18) configured to feed at least one tool (11, 40), **characterized in that** it comprises a fixed support (150) and at least one tool holder device (10) configured to be attached, directly or indirectly and alternatively, to said fixed support (150) or to said automatic operating device (12) and which comprises both a holding member (20) configured to hold a tool (11, 40), and also connection means (35) configured to connect a tool (11, 40) to said feed means (18).

2. Work cell (100) as in claim 1 and also comprising a work plane (112), **characterized in that** said at least one automatic operating device (12) is disposed above said work plane (112) **and in that** said fixed support (150) is attached to said work plane (112).

3. Work cell (100) as in claim 1 or 2, **characterized in that** said feed means (18) comprise both first output connectors (19) associated with said automatic operating device (12) and also second output connectors (129) associated with said fixed support (150), **and in that** said connection means (35) are configured to be connected alternatively to said first or said second output connectors (19, 129).

4. Work cell (100) as in any claim from 1 to 3, wherein said automatic operating device (12) comprises a robotic anthropomorphic arm (13), **characterized in that** it comprises a connection device (14) having a first part (15) attached to said robotic anthropomorphic arm (13) and configured to be selectively and reversibly connected with a second part (16) attached to said tool holder device (10).

5. Work cell (100) as in claim 4, **characterized in that** said mounting portion (151) is configured to temporarily fasten said second part (16) of said connection device (14).

6. Work cell (100) as in claim 5, **characterized in that** said second part (16) comprises both first fastening elements (44) configured to selectively fasten to corresponding fastening elements of said first part (15), and also second fastening elements (144) configured to selectively fasten to said mounting portion (151).

7. Work cell (100) as in any claim hereinbefore, **characterized in that** it comprises both one or more work tools (11), each of which is associated with a respective tool holder device (10) and which are configured to perform mechanical work on an object, and also one or more gripping tools (40), each of which is associated

with a respective tool holder device (10) and which are configured to grip an object.

8. Work cell (100) as in any claim hereinbefore, **characterized in that** said holding member (20) has a holding seating (23) configured to at least partly envelop a tool (11, 40).

9. Work cell (100) as in claim 8, **characterized in that** said holding seating (23) has a shape which reverse matches an external portion of a tool (11, 40) **and in that** said holding member (20) comprises two or more half shells (21, 22) which define said holding seating (23) between them and each of which comprises fastening means (25) configured to be fastened to each other.

10. Work method to perform work on an object (O) by means of a work tool (11) in a work cell (100) as in any claim hereinbefore and comprising a gripping tool (40), **characterized in that** it provides to:

- dispose said object (O) in said work cell (100);
- temporarily attach said work tool (11) on said fixed support (150) connecting it to said feed means (18);
- temporarily attach said gripping tool (40) to said automatic operating device (12) connecting it to said feed means (18);
- grip said object (O) by means of said gripping tool (40);
- move said object (O) with respect to said work tool (11) by means of said automatic operating device (12) to perform work on said object (O).

11. Method as in claim 10, **characterized in that** it also provides to:

- disconnect said gripping tool (40) from said automatic operating device (12);
- temporarily attach said work tool (11) to said automatic operating device (12);
- dispose a second object in said work cell (100);
- move said work tool (11) by means of said automatic operating device (12) to perform work on said second object.

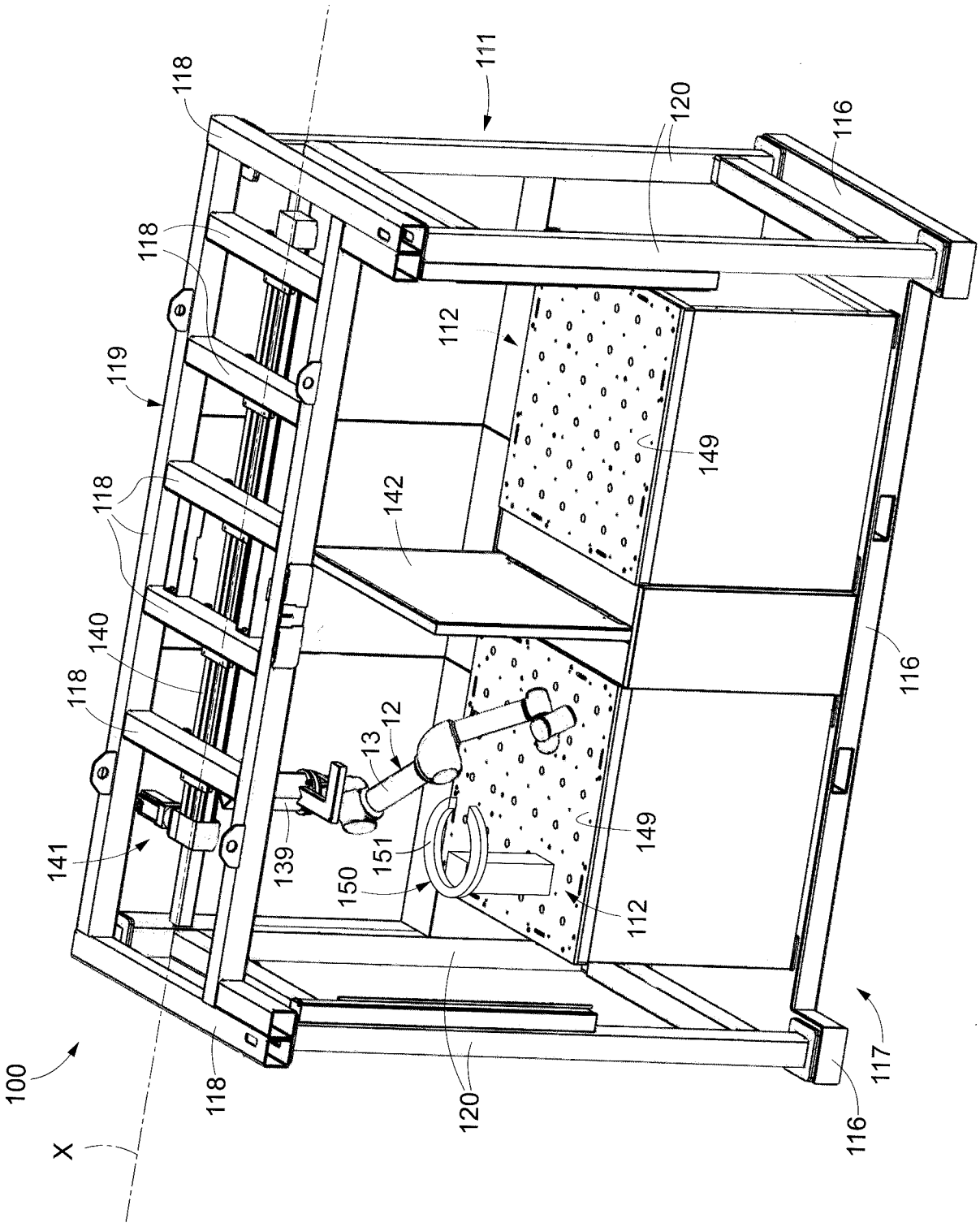
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fig. 1

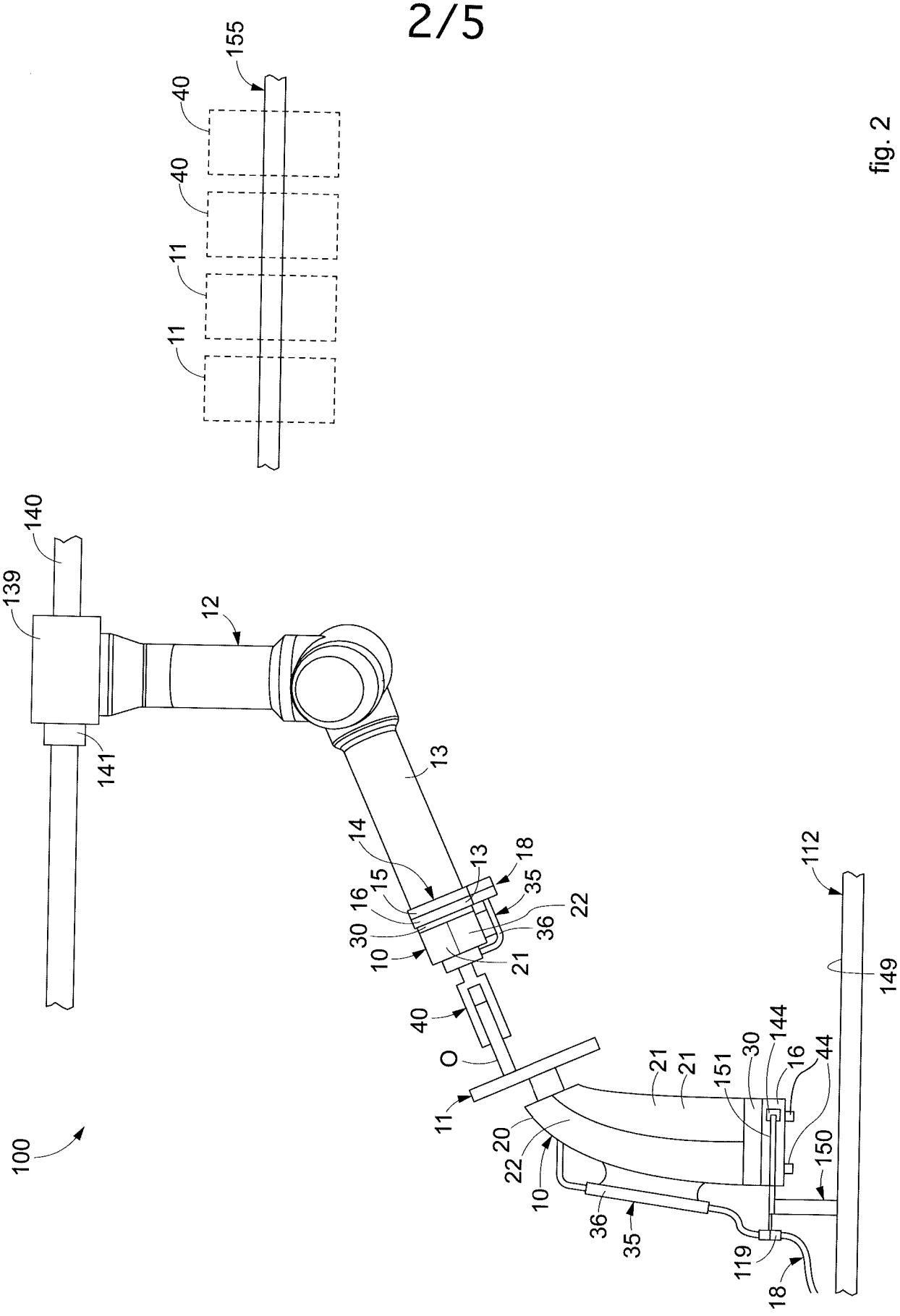
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fig. 2

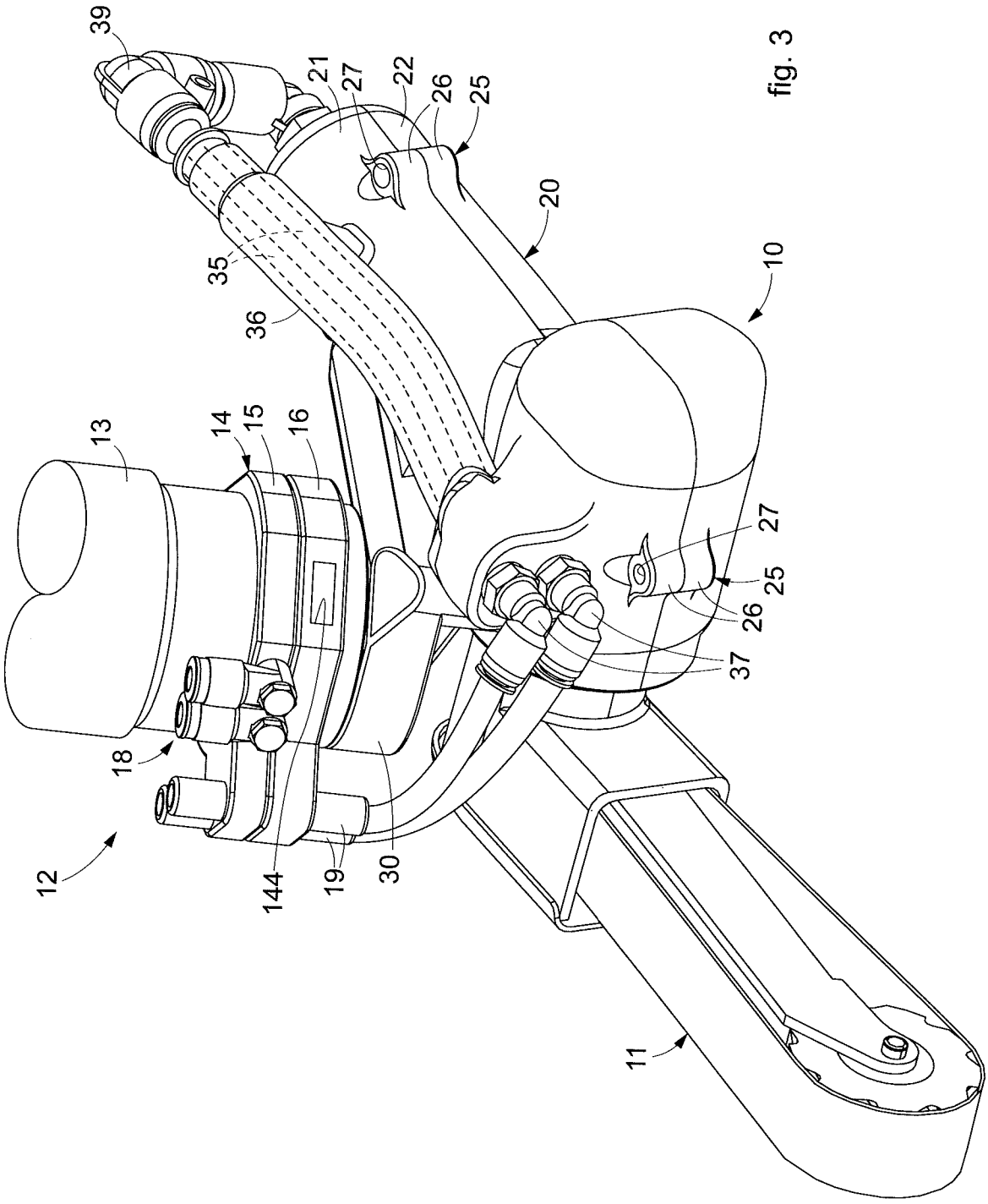

fig. 3

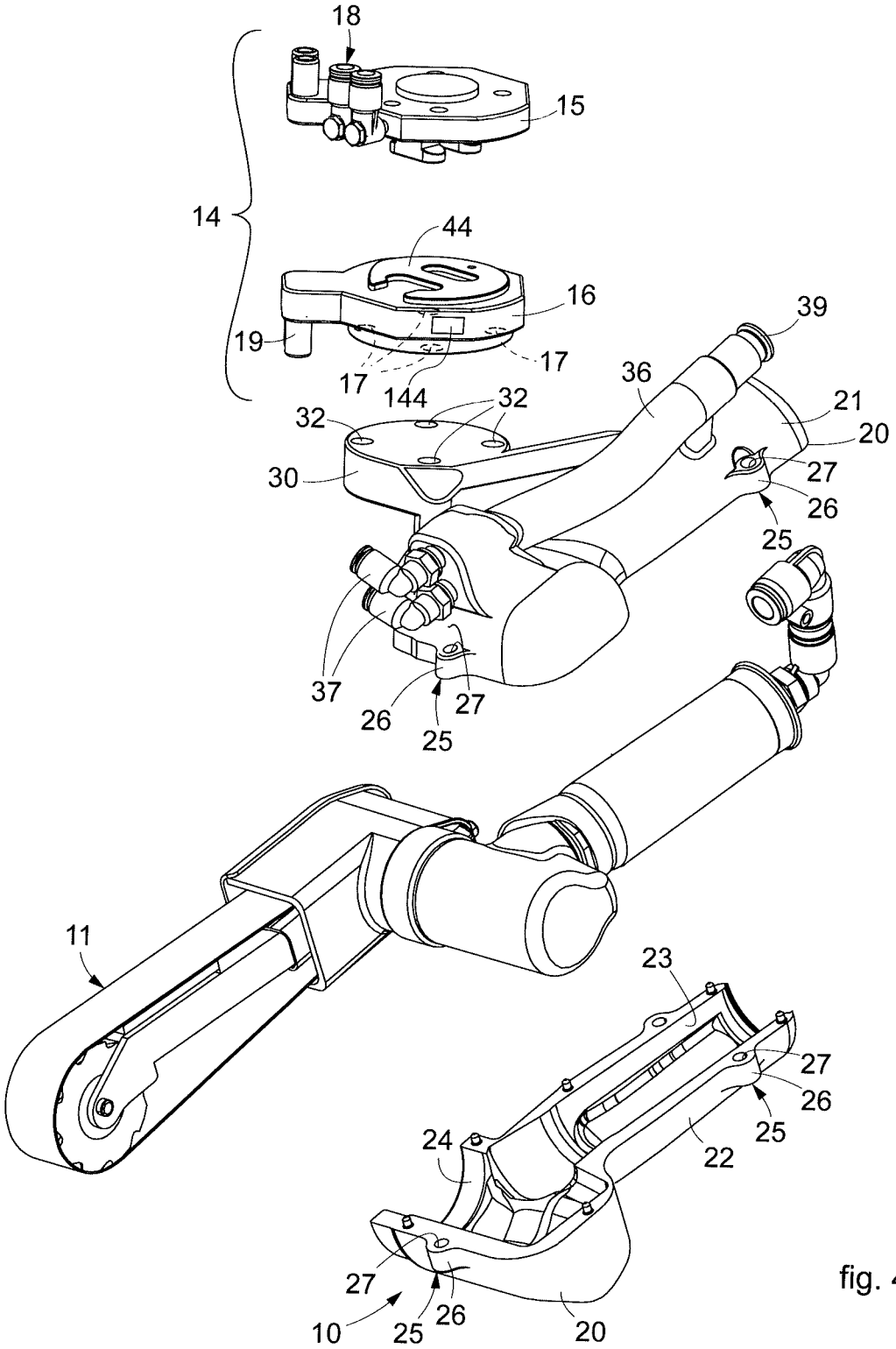
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fig. 4

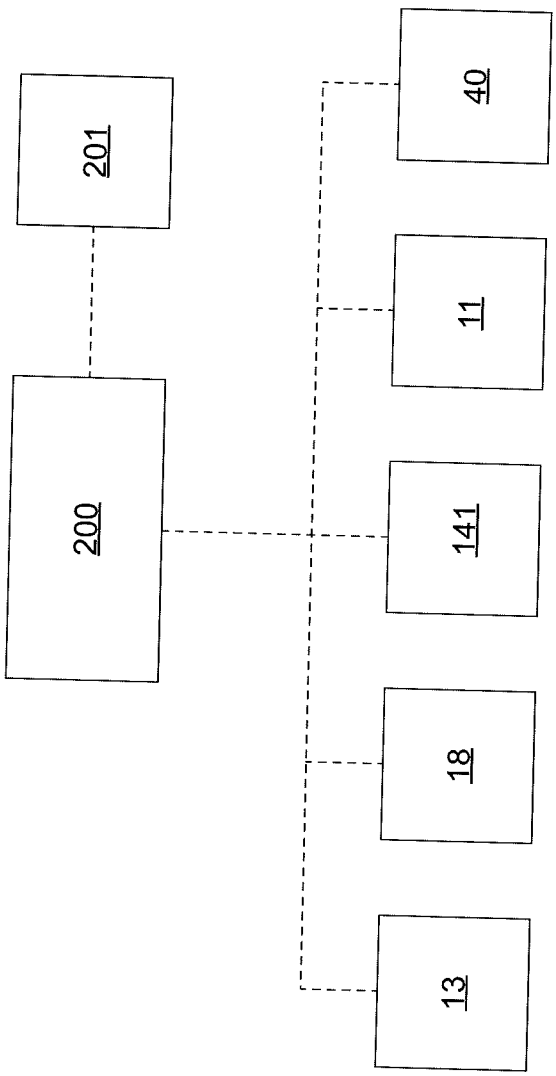

fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2023/050035

A. CLASSIFICATION OF SUBJECT MATTER
INV. B24B27/02 B24B41/00 B24B41/06 B23Q7/04 B24B27/00
ADD.

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)
B24B B25J B23Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 4 604 787 A (SIEVERS JR RALPH H [US]) 12 August 1986 (1986-08-12) column 2, line 21 - column 3, line 10 column 4, line 29 - column 6, line 31; figures	1,2,4-7 8-11

X Y	US 2019/111575 A1 (ASANO HIDETADA [JP] ET AL) 18 April 2019 (2019-04-18) paragraph [0082] - paragraph [0089] paragraph [0166] - paragraph [0189] paragraphs [0217], [0231] - [0265] figures	1-7 8-11

Y	DE 10 2017 120923 A1 (AIRBUS OPERATIONS GMBH [DE]) 14 March 2019 (2019-03-14) paragraph [0081] - paragraph [0082]; figures	8,9

	-/--	

[x] Further documents are listed in the continuation of Box C.

[x] See patent family annex.

* Special categories of cited documents :

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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

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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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
16 May 2023	24/05/2023

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Oliveira, Casimiro

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	EP 0 671 246 A2 (SIEMENS AG [DE]) 13 September 1995 (1995-09-13) the whole document	11

INTERNATIONAL SEARCH REPORT

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