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- (71) Applicants: **BOSCH CAR MULTIMEDIA PORTUGAL S.A.** [PT/PT]; R. Max Grundig, 35, 4705-820 Braga (PT). **UNIVERSIDADE DO MINHO** [PT/PT]; Largo do Paço, 4704-553 Braga (PT).
- (72) Inventors: **BRITO, António M.**; Departamento De Engenharia De Polímeros, Univ. Do Minho (campus De, Azúrem, Alameda Da Universidade), 4804-533 Guimarães (PT). **CORREIA, Pedro**; Universidade Do Minho (Campus De Gualtar), 4710-057 Braga (PT). **CAPELA PEREIRA LEITE FREITAS, Luís Miguel**; Universidade Do Minho (Campus De Gualtar), 4710-057 Braga (PT). **FERNANDES PIMENTEL, Anthony Michael**; Universidade

Do Minho (Campus De Gualtar), 4710-057 Braga (PT). **GOMES NOVERSA, João Tiago**; Universidade Do Minho (Campus De Gualtar), 4710-057 Braga (PT). **NUNES, João Pedro**; Universidade Do Minho (Campus De Gualtar), 4710-057 Braga (PT). **FREITAS ALVES, Tiago Samuel**; Bosch Car Multimedia Portugal S.A., R. Max Grundig, 35, 4705-820 Braga (PT). **FERNANDES, André**; Bosch Car Multimedia Portugal S.A., R. Max Grundig, 35, 4705-820 Braga (PT). **SILVA, Rui**; Bosch Car Multimedia Portugal S.A., R. Max Grundig, 35, 4705-820 Braga (PT). **SOUSA, Carlos Reinaldo**; Bosch Car Multimedia Portugal S.A., R. Max Grundig, 35, 4705-820 Braga (PT).

(74) Agent: **SILVESTRE ALMEIDA FERREIRA, Luis Humberto**; Patentree, Rua de Salazares 842 - Edf. NET, 4149-002 Porto (PT).

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(54) Title: ASSEMBLY WORKSTATION AND INSTALLATION METHOD THEREOF

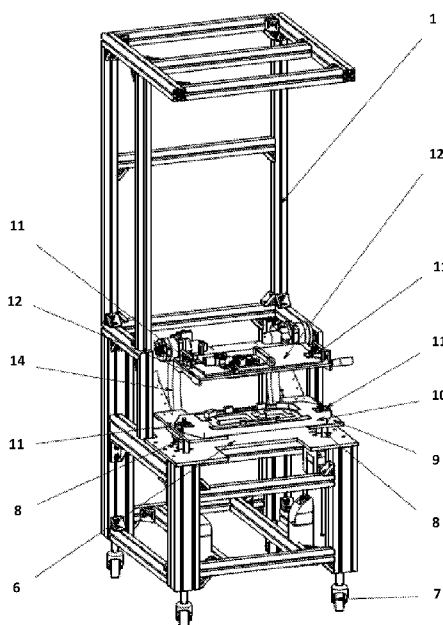


Fig. 1

(57) Abstract: Assembly workstation for assembling products by a person, comprising a lower workbench base nest and an upper workbench mask nest, wherein the base nest and mask nest define an assembly jig for said products; a support frame; a vertically displaceable platform for receiving said base nest; and an actuator attached to the support frame and attached to the platform for creating vertical displacement of said platform; wherein said lower workbench base nest is arranged onto said platform and said upper workbench mask nest is pivotally coupled to said support frame for rotating about a transversal horizontal axis. The assembly workstation of the present disclosure is a universal, ergonomic assembly workstation using modular additive manufacturing tools.



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## DESCRIPTION

### ASSEMBLY WORKSTATION AND INSTALLATION METHOD THEREOF

#### Technical field

[0001] The present disclosure relates to an assembly workstation for assembling products, and an installation method thereof, for simplifying changes of assembly tools with a wide variety of geometries and dimensions, in particular for assembling parts, by using modular additive manufactured tools.

#### Background

[0002] In highly competitive markets, such as the automotive industry, the improvement of products quality, reduction of manufacturing costs and the fulfilment of all delivery deadlines are paramount concerns. Regarding the assembly processes, the achievement of these goals has been especially challenging.

[0003] Presently, assembly processes rely on dedicated jigs (a jig is a type of custom-made tool used to control the location and/or motion of parts or other tools) mounted on standard workbenches that are specifically designed for a specific assembly task of a specific product. This means that each new product requires a new jig and consequently a new engineering project. In certain cases, the technical solutions are so customized that a simple product change, during the development project phase, forces the production of a new jig. In addition to this lack of flexibility, the monitoring systems has contributed to an ever-increasing complexity of the assembly jigs and a higher project lead-time.

[0004] The assembly processes used on the industrial world widely uses workbenches with jigs incorporated into them to perform the various assembly tasks required.

[0005] In the current market the jigs to perform assembly processes, are based on two major groups depending on how they are manufactured: additive manufacturing or subtractive manufacturing, being the later the most widely used in the industry. Most assembly processes use jigs for the support of the different parts such as in patent

document CN203817741U which presents a workbench comprised of jigs for the fixation of parts to be assembled. These jigs are made by subtractive manufacturing and it is necessary to do a different jig for each product.

[0006] Document EP3235605 also discloses a method for configuring an assembly workstation, the assembly workstation having container receptacle devices configured to receive an associated material container, each container receptacle device having a first data carrier, the material containers having a second data carrier, the assembly workstation having a first position determination device configured to ascertain one of a position of a hand of a worker and a marking connectable to the hand, the first position determination device being connected to a control device.

[0007] The modular jigs are based on the use of a structure (the base) that can be adaptable to the product in question. These structures allow a wide number of arrangements for the positioning fixtures, which can be used for different parts, for example, US20010044997A1 and CN107775337A patents refers to a flexible assembly workstation with geometry fixtures that can be exchanged. Moreover, an identification process for the recognition of the different parts is used, such as in patent US2017300032A which has container receptacle devices configured to receive an associated material container and identify it. These types of modular jigs can also be made mobile. CN201366708Y demonstrates a workbench for assembly of an instrument valve which utilizes mounted wheels for mobility. This allows the easy transport and repositioning of the machine.

[0008] These facts are disclosed in order to illustrate the technical problem addressed by the present disclosure.

## **General Description**

[0009] The present disclosure relates to an assembly workstation for assembling products, and an installing method thereof, for simplifying changes of assembly tools with a wide variety of geometries and dimensions, in particular for assembling parts, by using modular additive manufactured tools. In order to change the current

assembly process concept, which is based in customized solutions, to a much more flexible one, which will be based in a standard solution, workbench and jig principles were combined into a universal assembly workstation.

[0010] In a such universal assembly workstation, where the workbench and jig are already combined, the customized tools (jigs) are reduced to the fixture geometries of each product which are replaceable and interchangeable. Hence, any product can be made in the universal workstation, by simply changing the assembly tools that only contain the product supports.

[0011] Additive manufacturing technologies can be utilized as an alternative to traditional tools. The process can be divided in two subgroups: completely made by additive manufacturing or partially (only the positioning fixtures). In the complete version, all the jig, the base and the positioning fixtures, are made by additive manufacturing. The other group is similar to the subtractive manufacturing, as the base is almost the same for different products and then the positioning fixtures are design for each product. The difference is that this positioning fixtures are made by additive manufacturing.

[0012] These assembly tools are produced by additive manufacturing (AM) technologies using the 3D CAD geometry. Since the monitoring system is integrated in the smart workbench, the assembly tools are potentially sensors free. The combined effect of the modular concept, based in the smart workbench standardization and the AM tools without sensors leads to a truly drastic simplification of the engineering project. The current assembly tools are too big, bulky and heavy, while with this disclosure the weight of the assembly tools is significantly reduced. Another main improvement of this disclosure is related with the adjustment system. The universal assembly workstation proposed here allows two levels of adjustment. The first one is related with the product adjustment and makes it possible to assemble products of different heights. The second level concerns the ergonomic adjustment and makes it possible to automatically adapt the machine to the worker height.

[0013] Therefore, the presented disclosure contributes to the development of an assembly tool with low weight and having the ability to accomplish all planed targets.

This includes the optimization of the processes allowing the quick and easy manufacturing of tools and component assembly. Furthermore, it allows to include new materials and technologies in the involved processes and enhance potentialities to develop and produce new tools more capable, smarter and with quicker development and production times. Overall, this disclosure results in a significant reduction of the project lead time representing a much more cost effective competitive product.

[0014] The disclosure is capable of performing several tasks related to the assembly process of parts. It can perform many different process, with different requirements and specifications, for different parts and industries. The main aspects that make this universality possible are described below.

[0015] The modularity of the disclosure, including the base and mask nest that make this adaptable for many processes and parts, will allow for the inclusion on product others than the ones being used. Other distinctive aspect that is included on this disclosure is the additive manufacturing of tools which allow for bigger flexibility and complexity of parts and processes. The height adjustment systems, for operator and product are also technologies that increase the product reach and capability to be proved on competitor products.

[0016] It is disclosed an assembly workstation for assembling products by a person, comprising:

- a lower workbench base nest and an upper workbench mask nest, wherein the base nest and mask nest define an assembly jig for said products;
  - a support frame;
  - a vertically displaceable platform for receiving said base nest; and
  - an actuator attached to the support frame and attached to the platform for creating vertical displacement of said platform;
- wherein said lower workbench base nest is arranged onto said platform and said upper workbench mask nest is pivotably coupled to said support frame for rotating about a transversal horizontal axis.

[0017] The workstation has a front towards the person using the workstation. The back of the workstation is opposite the front of the workstation. This defines a front-back direction. A transversal direction is a direction that is perpendicular to this front-back direction. The workstation has a lower workbench base nest for receiving the product to be assembled and an upper workbench mask nest for guiding the person using the workstation in using tools and parts to be assembled or to execute assembly processes and supporting parts. This defines a vertical direction between said lower workstation base nest and upper workstation mask nest.

[0018] In an embodiment, the lower workbench base nest and the upper workbench mask nest are obtained by additive manufacturing.

[0019] In an embodiment, the lower workbench base nest and the upper workbench mask nest are obtained by subtractive manufacturing.

[0020] In an embodiment, the actuator is manually, hydraulically, pneumatically or electrically actuatable.

[0021] In an embodiment, another vertically displaceable platform may be coupled to the upper workbench mask nest.

[0022] In an alternative embodiment, the vertically displaceable platform may be coupled to the workbench mask and not to the platform.

[0023] In an embodiment, the lower workbench nest rests onto said vertically displaceable platform.

[0024] In an embodiment, the vertically displaceable platform is placed at a height to accommodate the product height.

[0025] In an embodiment, the support frame is height-adjustable, in particular comprising actuator means for adjusting the height of the support frame, further in particular wherein the height-adjustable support frame is placed at a height to ergonomically accommodate the person height.

[0026] In an embodiment, the platform comprises locking means for holding the workbench nest.

[0027] In an embodiment, the platform comprises electrical, sensor, pneumatic or hydraulic couplings, or combinations thereof for coupling to corresponding couplings in the workbench nest.

[0028] In an embodiment, the assembly workstation of the present disclosure may comprise a rotary damper for smoothing the rotation of the upper workbench mask.

[0029] In an embodiment, the assembly workstation of the present disclosure may comprise an actuator for rotating the upper workbench mask.

[0030] In an embodiment, the assembly workstation of the present disclosure may use a manual operation for rotating the upper workbench mask.

[0031] In an embodiment, the assembly workstation of the present disclosure may use a movement other than, or coupled with, rotation to move the upper workbench mask nest.

[0032] In an embodiment, the assembly workstation of the present disclosure may not use an upper workbench mask nest, just using the base nest for an assembly.

[0033] In an embodiment, the assembly workstation of the present disclosure may have the upper workbench mask coupled on the support frame such that closure of the jig is achieved only by vertical displacement of the base nest.

[0034] In an embodiment, the assembly workstation of the present disclosure may comprise sensor or sensors for detecting if the mask and nest are closed for assembling said product.

[0035] In an embodiment, the assembly workstation of the present disclosure may comprise sensor or sensors for detecting parts, assembly steps or assembly operations.

[0036] In an embodiment, the assembly workstation of the present disclosure may comprise sensor or sensors embedded or placed on the base nest and/or mask nest.

[0037] In an embodiment, the assembly workstation of the present disclosure may comprise sensor or sensors embedded or placed on the base nest and/or mask nest.

[0038] In an embodiment, the assembly workstation of the present disclosure may comprise sensor or sensors placed on a location of the workstation.



[0039] In an embodiment, the assembly workstation of the present disclosure may use a robot, either in collaboration or not with an operator or with another robot.

[0040] It is also described a method for installing an assembly jig of an assembly workstation for assembling products by a person, said workstation comprising:

- a lower workbench nest and an upper workbench mask, wherein the nest and mask define an assembly jig for said products;

- a support frame;

- a vertically displaceable platform for receiving said nest; and

- an actuator attached to the support frame and attached to the platform for creating vertical displacement of said platform;

wherein said lower workbench nest is arranged onto said platform and said upper workbench mask is pivotably coupled to said support frame for rotating about a transversal horizontal axis;

said method comprising obtaining said lower workbench nest and upper workbench mask by additive manufacturing; and installing the obtained nest and mask onto said workstation.

## **Brief Description of the Drawings**

[0041] The following figures provide preferred embodiments for illustrating the description and should not be seen as limiting the scope of disclosure.

[0042] **Figure 1** is a schematic representation of the general view of assembly workstation.

[0043] **Figure 2** is a schematic representation of the main elements of the proposed main embodiment.

[0044] **Figure 3** is a schematic representation of the perspective view of structural element sub-group.

[0045] **Figure 4** is a schematic representation of the view of the structural element and the ergonomic adjustment system sub-group.

[0046] **Figure 5** is a schematic representation of the perspective view of the structural element, the ergonomic adjustment system and the product adjustment system sub-group.

[0047] **Figure 6** is a schematic representation of the view of the structural element, the ergonomic adjustment system and the upper system sub-group.

### **Detailed Description**

[0048] The main function of this workstation is to assemble parts, with a wide variety of geometries and dimensions. The smart ergonomic and product adjustments are also important features.

[0049] In an embodiment, the structure of the universal workstation **16** can be divided (**figure 2**) in two main elements: 1) the workbench **18** and 2) the assembly tools **17**.

[0050] In an embodiment, the workbench is the support for the assembly tools that incorporates the adjustments and the mechanical, electronic and pneumatic elements.

[0051] In an embodiment, there are two adjustments: product and ergonomic. The product adjustment allows the structure to adapt itself to different product heights and/or support/perform assembly processes. The ergonomic adjustment allows the work height to be changed according to the assembly and collaborators specific ergonomics.

[0052] In an embodiment, the ergonomic adjustment is manually, hydraulically, pneumatically or electrically actuatable.

[0053] In an embodiment, the ergonomic adjustment may not be used; In an embodiment, the assembly tools, which fix and position the products, are divided as mask nest and base nest. Both components are preferably fabricated in additive manufacturing allowing a wide range of shapes and geometries.

[0054] An embodiment of the workstation is presented in **figure 2**, wherein **16** represents an embodiment of the assembly workstation; **17** represents an embodiment of the assembly tools – mask and nest; and **18** represents an

embodiment of the support frame; and it is divided in four groups by its specific function in the system, as listed below:

Structural elements: elements that support the movable and functional systems. **(figure 3)**

Ergonomic adjustment system: the system that will move the smart workbench to adapt its work plane height. **(figure 4)**

Product adjustment system: movable base, where the bottom assembly tool (nest) is positioned. **(figure 5)**

Upper system: elements where the upper assembly tool (mask and mask nest) is positioned. **(figure 6)**

[0055] According to an embodiment, the structural elements, presented in figure 3, is composed by a frame structure **1**, and a base **6** coupled to the frame that will serve as support for the upper system and as the reference height for the product adjustment.

[0056] As for the ergonomic adjustment, according to an embodiment, it is an electrohydraulic synchronized system **7** mounted on the frame **1** that will actuate and move the entire workbench, as described in **figure 4**.

[0057] The product adjustment system consists, according to an embodiment, in the electric actuator **8** attached to a movable base **9** that will move accordingly to different product heights. The base nest (bottom assembly tool **10**) is positioned onto the base by the means of a locking element **11**. The entire system is presented in **figure 5**.

[0058] Finally, the mask nest (upper assembly tool **12**) is, according to an embodiment, located on the upper system (**figure 6**). A structural support **13** provides guidance and locks **11** the mask nest in the desired position, maintaining the quick-change concept. The correct relative position of the upper system in relation to the entire smart workbench is guaranteed by two structural C-profiles **14**. These parts ensure the rotational movement of the mask, together with bearings and pneumatic rotary cylinders **15**, making easier the opening movement and reduce the impact during the mask closing motion. Sensors and pneumatic cylinders are mounted, according to an embodiment, to guarantee that the mask closes and opens in the desire position.

[0059] This specific embodiment is improved to a manual screw driving assembly process. Different assembly processes (clinching, bonding, clipping, among others) and levels of automation applied (automatic screwing, robot, among others) are also included in the present disclosure.

[0060] In an embodiment, the different components of the workstation may be replaced by other components with different materials, shapes or sizes and it is not intended that the description above limits the disclosure itself.

[0061] The term "comprising" whenever used in this document is intended to indicate the presence of stated features, integers, steps, components, but not to preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

[0062] The disclosure should not be seen in any way restricted to the embodiments described and a person with ordinary skill in the art will foresee many possibilities to modifications thereof. The above described embodiments are combinable. The following claims further set out particular embodiments of the disclosure.

**C L A I M S**

1. Assembly workstation (16) for assembling products by a person, comprising:  
a lower workbench base nest (10) and an upper workbench mask nest (12),  
wherein the base nest (10) and mask nest (12) define an assembly jig (17) for  
said products;  
a support frame (1);  
a vertically displaceable platform (9) for receiving said base nest (10); and  
an actuator (8) attached to the support frame (1) and attached to the platform  
for creating vertical displacement of said platform (9);  
wherein said lower workbench base nest (10) is arranged onto said platform (9)  
and said upper workbench mask nest (12) is pivotably coupled to said support  
frame (1) for rotating about a transversal horizontal axis.
2. Assembly workstation (16) according to the previous claim wherein said lower  
workbench base nest (10) and/or said upper workbench mask nest (12) are  
obtained by additive manufacturing.
3. Assembly workstation (16) according to any of the previous claims wherein said  
actuator (8) is manually, hydraulically, pneumatically or electrically actuatable.
4. Assembly workstation according to any of the previous claims wherein said  
lower workbench base nest (10) rests onto said platform (9).
5. Assembly workstation (16) according to any of the previous claims wherein the  
vertically displaceable platform (9) is placed at a height to accommodate the  
product height.
6. Assembly workstation (16) according to any of the previous claims wherein the  
support frame (1) is height-adjustable.
7. Assembly workstation (16) according to the previous claim comprising a height-  
adjustment actuator (7) for adjusting the height of the support frame (1).

8. Assembly workstation (16) according to claim 6 or 7, wherein the height-adjustable support frame (1) is arranged to be placed at a height to ergonomically accommodate the person height.
9. Assembly workstation (16) according to any of the previous claims wherein said platform (9) comprises locking means for holding the lower workbench base nest (10).
10. Assembly workstation (16) according to any of the previous claims wherein said upper workbench mask nest (12) comprises locking means for releasably coupling to said support frame (1).
11. Assembly workstation (16) according to any of the previous claims wherein said platform (9) comprises electrical, sensor, pneumatic or hydraulic couplings (11) for coupling to corresponding couplings in the lower workbench base nest (10).
12. Assembly workstation (16) according to any of the previous claims comprising a rotary damper (15) for smoothing the rotation of the upper workbench mask (12).
13. Assembly workstation (16) according to any of the previous claims comprising an actuator (15) for rotating the upper workbench mask (12).
14. Use of the assembly workstation (16) according to any of the previous claims for assembling products by a person.
15. Method for installing an assembly jig (17) of an assembly workstation (16) for assembling products by a person, said workstation comprising:
  - a lower workbench base nest (10) and an upper workbench mask nest (12), wherein the base nest and mask nest define an assembly jig (17) for said products;
  - a support frame (1);
  - a vertically displaceable platform (9) for receiving said base nest (10); and
  - an actuator (8) attached to the support frame (1) and attached to the platform (9) for creating vertical displacement of said platform (9);

wherein said lower workbench base nest (10) is arranged onto said platform (9) and said upper workbench mask nest (12) is pivotably coupled to said support frame (1) for rotating about a transversal horizontal axis;  
said method comprising obtaining said lower workbench base nest (10) and said upper workbench mask nest (12) by additive manufacturing; and installing the obtained base nest (10) and mask nest (12) onto said workstation (16).

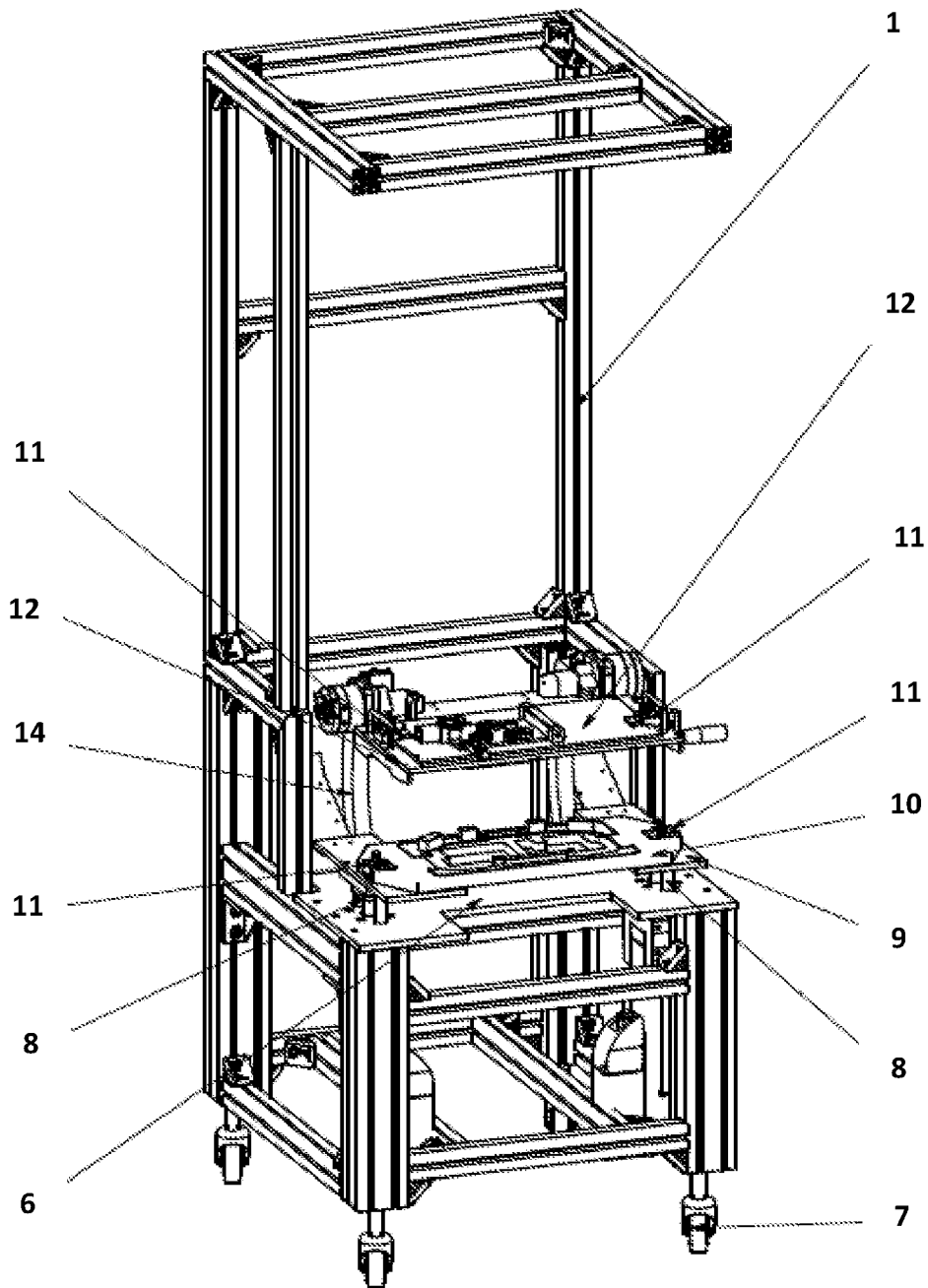


Fig. 1



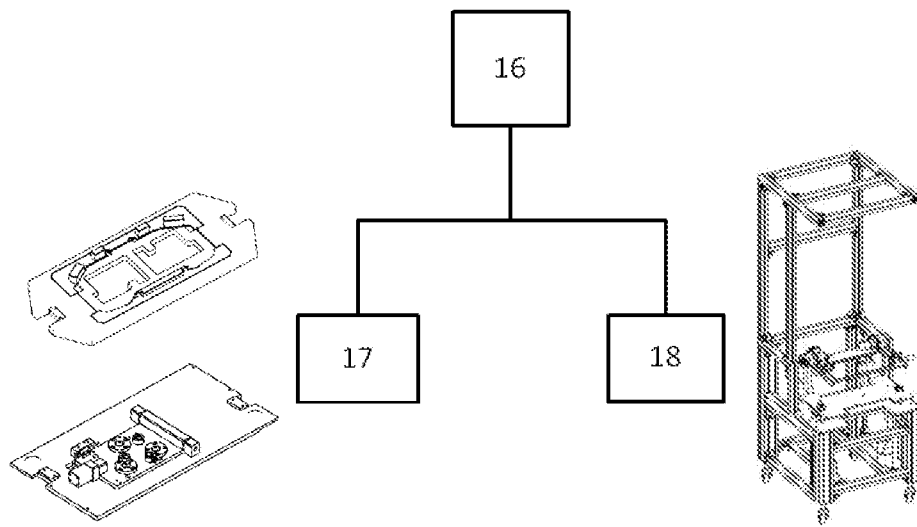


Fig. 2

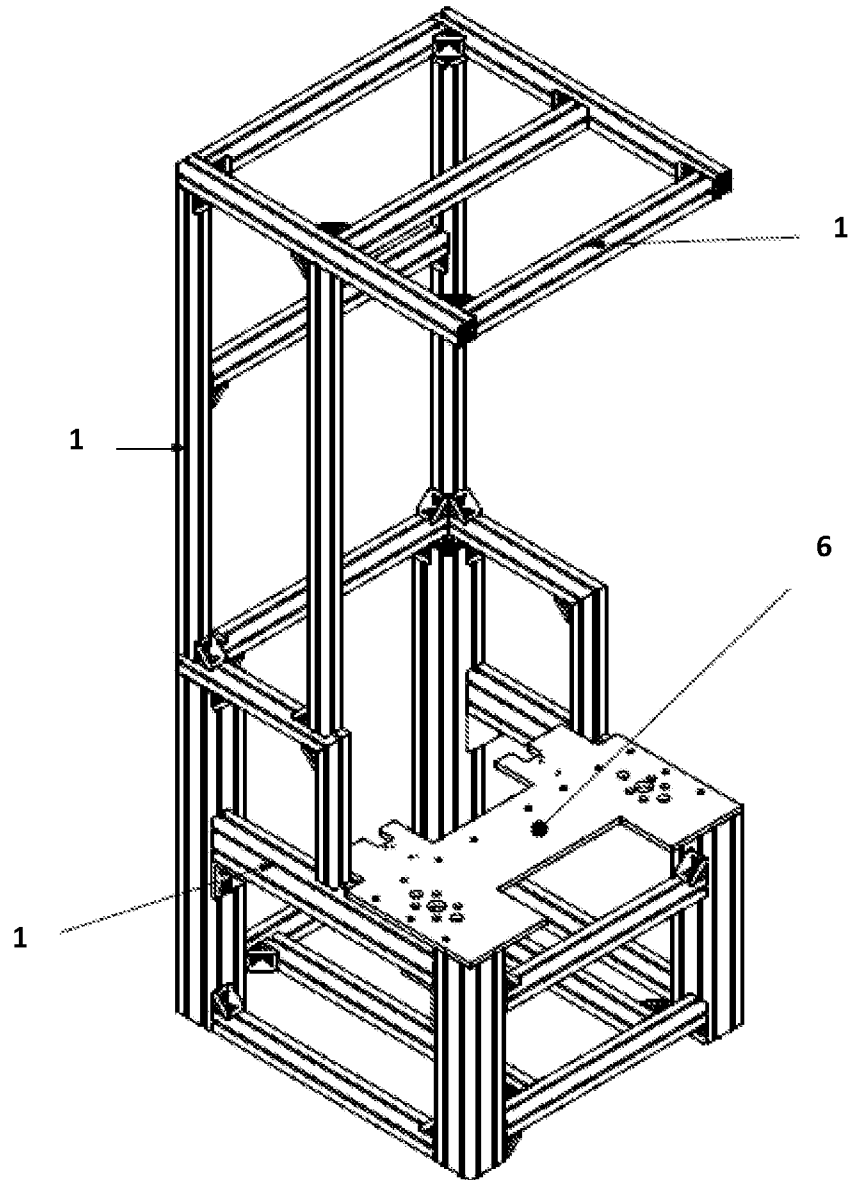


Fig. 3

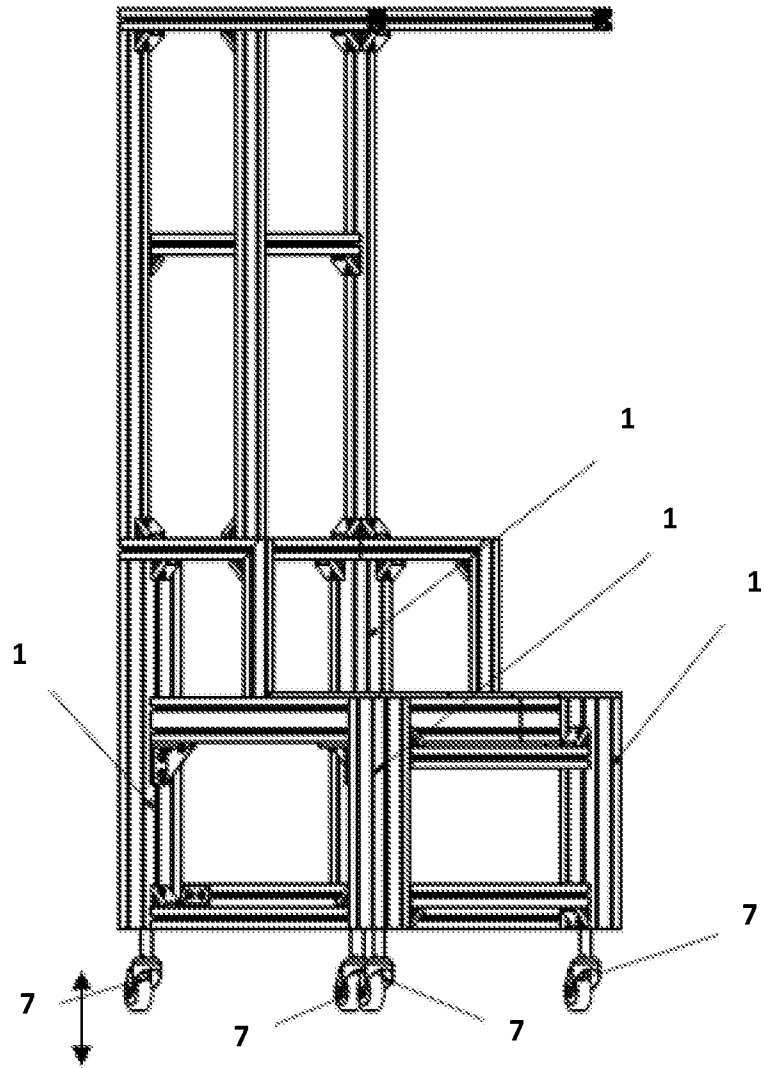


Fig. 4

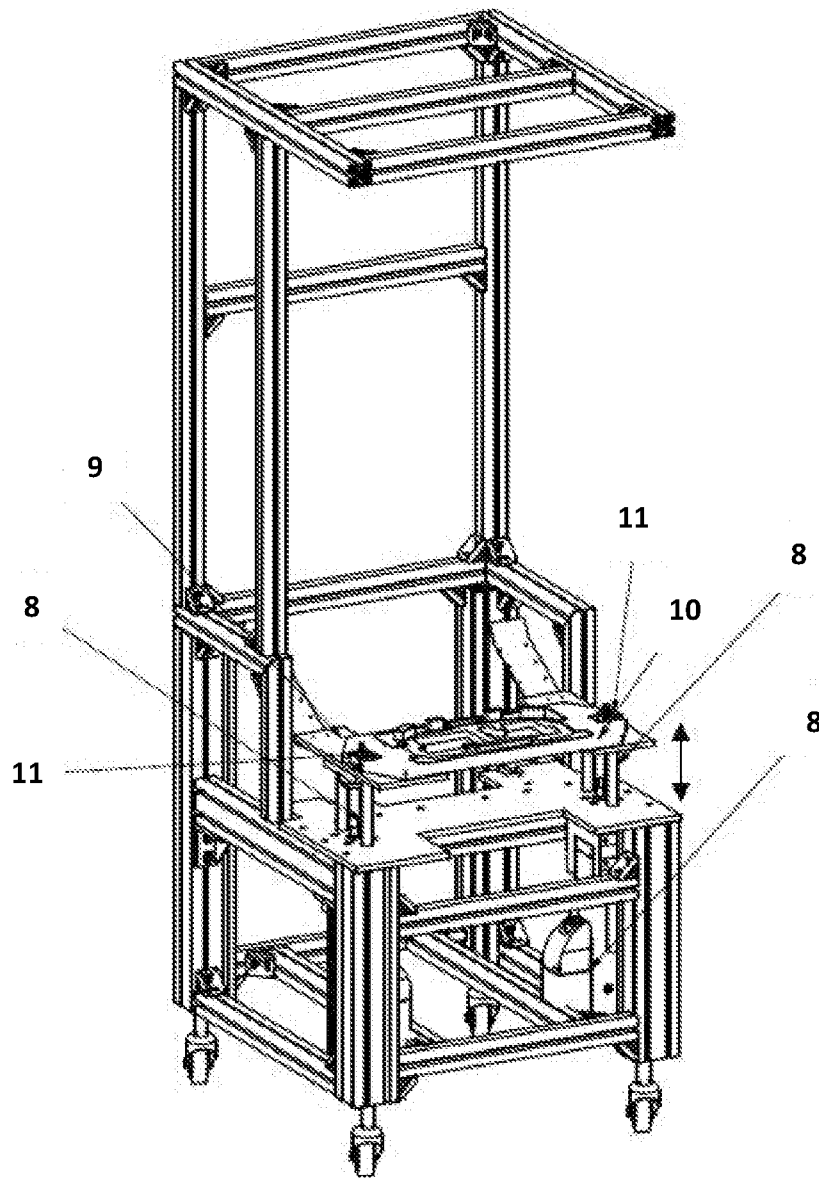


Fig. 5

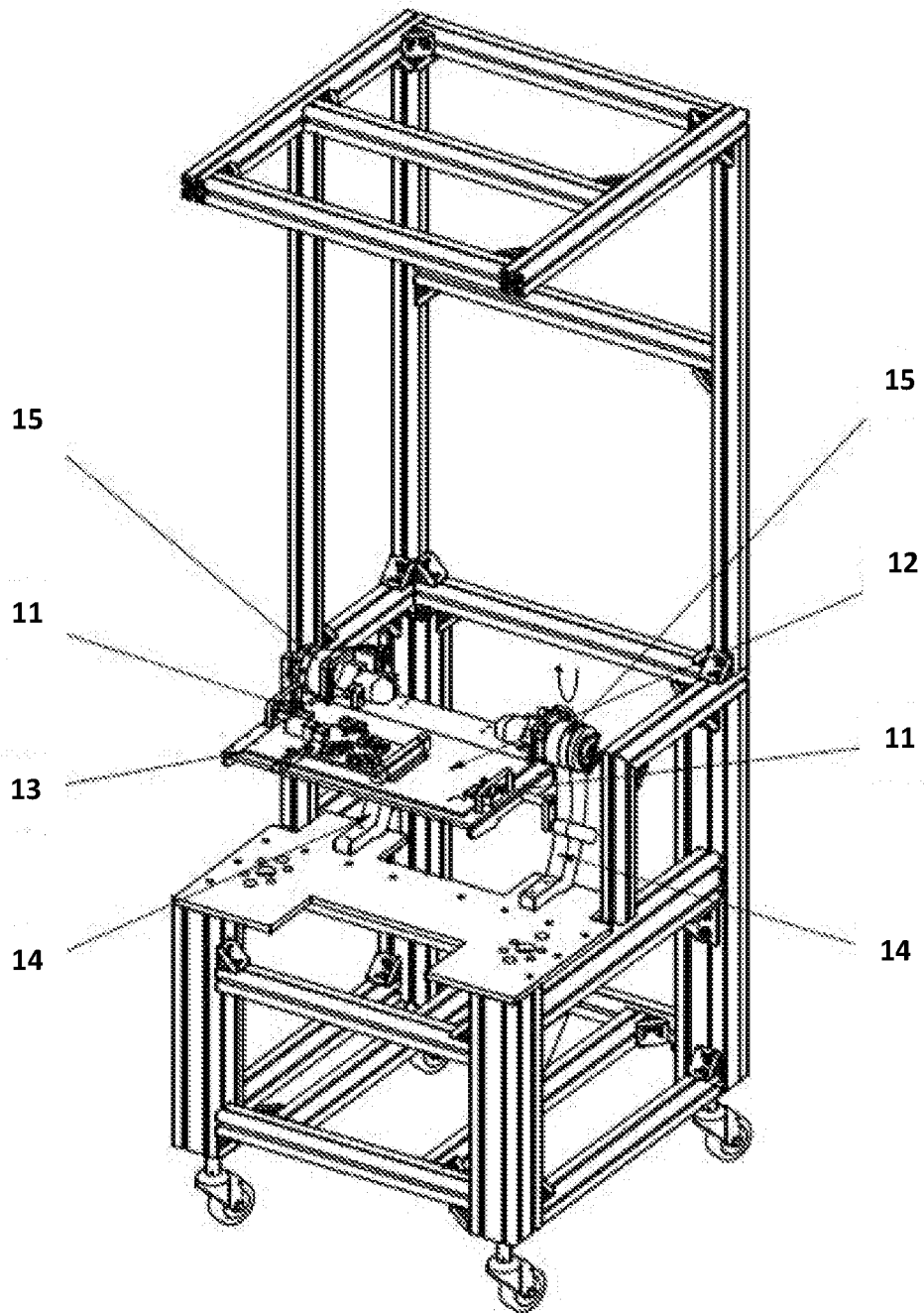


Fig. 6

**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/IB2018/055413

**A. CLASSIFICATION OF SUBJECT MATTER**  
 INV. B25H1/16 B25H1/18  
 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)  
 B25H

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, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 297 15 386 U1 (PROESL JOHANNA [DE]) 29 January 1998 (1998-01-29) page 4, lines 19-21; claim 1 page 6, lines 10-25; figures 1,2 -----	1-15
X	DE 10 2013 220107 A1 (HOCHSCHULE ESSELINGEN [DE]; SCHNAITHMANN MASCHB GMBH [DE]) 16 April 2015 (2015-04-16) paragraphs [0077], [0080], [0117]; figures -----	1-15
X	US 2007/029011 A1 (THATCHER JOHN T [US]) 8 February 2007 (2007-02-08) figures 1,2 -----	1-15
X	US 3 053 007 A (GOODWIN JOSEPH T) 11 September 1962 (1962-09-11) column 3, lines 31-65; figure 1 -----	1
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Further documents are listed in the continuation of Box C.  See patent family annex.

\* Special categories of cited documents :

<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"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</p> <p>"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</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p>
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Date of the actual completion of the international search  10 May 2019	Date of mailing of the international search report  24/05/2019
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Popma, Ronald
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## INTERNATIONAL SEARCH REPORT

International application No  
PCT/IB2018/055413

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2006/086565 A1 (HERNANDEZ MICHAEL [US] ET AL) 27 April 2006 (2006-04-27) figures -----	1-15
A	DE 20 2005 005365 U1 (BEHINDERTENWERKSTAETTEN OBERPF [DE]) 10 August 2006 (2006-08-10) paragraphs [0004], [0005], [0006], [0046], [0047]; figures 1-3 -----	1-15

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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