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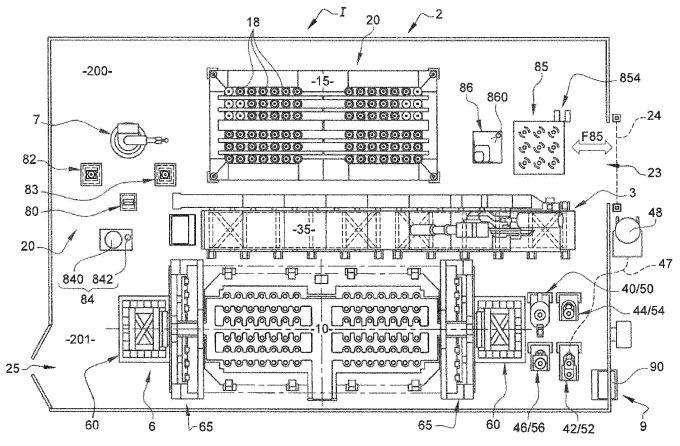
(54) INSTALLATION FOR THE MAINTENANCE, IN PARTICULAR THE CLEANING, OF A CASTING TABLE ASSEMBLY AND AUTOMATED MAINTENANCE METHOD USING SUCH INSTALLATION

(57) This installation (I) comprises a main robot (3), said main robot comprising a body as well as coupling means (34) mobile with respect to said body, a starting head grab device (40), a brushing device (42), for brushing upper part of casting table, a screw device (44), for screwing/unscrewing each mould of the casting table with respect to upper table; and a mould grab device (46), each device being provided with complementary coupling means (402, 422, 442, 462) adapted to cooperate with main robot so as to permit a removable attachment between each main operative device and said main robot.

Moreover, the installation is provided with control means (9) comprising a human machine interface (90), control lines (95-98) adapted, upon receipt of inputs actuated by an operator, to transmit control orders to at least said main robot (3), said displacement means (37) and Prior art maintenance is essentially based on manual operations. The installation and method according to the invention enable the user to facilitate the maintenance of casting tables, moulds and mould components such as starting heads.

Fig. 5



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Description

Technical field of the invention

[0001] The invention relates to casthouse technology, and more precisely to mold tables used for vertical semi-continuous casting of billets. Such mould tables are most often used in aluminium industry; they are also used for casting billets in copper, magnesium and other non-ferrous metals. Similar mould tables and moulds can be used for horizontal casting processes, and for casting ferrous metals. The invention pertains to an installation for the cleaning of mould tables, in which numerous individual steps for handling, disassembling, cleaning, and reassembling of mould tables and components thereof can be simplified and automatized using robots, appropriate exchangeable devices and sensors.

Prior art

[0002] Liquid metal obtained from electrometallurgical or other chemical reduction processes, if not directly used for the manufacturing of castings, needs to be cast into shapes such as rolling ingots and extrusion billets in order to render the metal usable for further processing. Such rolling ingots and extrusion ingots are long parts of constant cross section. They can be obtained by vertical semi-continuous casting, or by horizontal casting.

[0003] Vertical semi-continous casting utilizes a vertically oriented mould situated above a casting pit that extends beneath the floor level of the casthouse. Usually, a plurality of such moulds are provided in a horizontal mould table. The lower component of the vertical casting mould is a starting block (also called « starting head » or « stool cap »). When the casting process begins, the starting blocks are in their highest upward position and in the moulds. During casting molten metal is poured onto the upper part of the mould table, where it is carried through a system of branched casting launders to spouts into the mould bores or cavities. The starting block, sitting on the top of a stool, is lowered at a predetermined rate (usually by hydraulic means), and solidified metal emerges from the bottom of the moulds; in this way long ingots are formed which can have a length of more than ten meters, said length being limited by the depth of the casting pit. Their cross section is determined by the mould geometry and is selected in order to suit their intended use. As the external, soldifying surface of the emerging metal strand is cooled (usually by water), this process is therefore called chill casting.

[0004] Such mould tables and moulds are known as such and are commercially available from several manufacturers. They are used for casting ferrous and non-ferrous metals and alloys, such as aluminium, brass, lead, copper, magnesium, steel. The present invention is directed to a system intended to be used in aluminium industry but is not limited to such use.

[0005] As an example, WO 2009/025874 (assigned to Wagstaff) discloses a mould and bottom block system for vertical semi-continous chill casting of aluminium. The geometry of a mould table system is described in detail in US 7,296,613 and EP 2 051 825 (both assigned to Wagstaff). US 4,598,763 (Wagstaff) describes the structure of an annular billet casting mould and its starting block.

[0006] It is well known that the state of the mould and its components may directly affect the quality of the cast metal ingot. Mould tables, moulds and stool caps require regular cleaning, inspection and maintenance. More precisely, molten metal, such as aluminium, can be very sticky when it is running through the casting launders, and every more when it gets solidified. Some of these surfaces (such as casting launders) are made from ceramic materials, other are metallic materials. To avoid accumulation of layers of solified metal, specific active substances are applied onto all the surfaces in contact with liquid metal. As a consequence, any surface that is in contact with liquid metal needs to be cleaned and inspected once the casting process is finished, and may need to be coated, repaired or replaced if needed.

[0007] According to the state of the art most of these operations are carried out manually once the mould table has been removed from the casting pit. These operations include a significant number of individual operations of inspection of surfaces and mechanical parts, cleaning of surfaces, unfastening and fastening of fixing elements, removal and repositioning of moulds, and so on.

[0008] Prior art maintenance of casting tables leads to several disadvantages. Indeed, said maintenance is essentially based on manually operated tasks, which constitute very tedious works. For instance, workers may be exposed to dangerous products, while being subjected to physical injuries, in particular due to the weight of transported mechanical elements. As an example, the upper part of the mold table, including the system of branched casting launders, needs to be cleaned by a brush; this is a tedious task in which the workers are exposed to the produced dust. It should also be noted that a purely manual maintenance may induce some severe lacks, in the quality of the maintenance itself.

[0009] Moreover, removal of the moulds and theoir components is also a dangerous task, according to prior art proceedings, as they may fall down during handling, or they may lead to finger jamming during fitting in or during manual removal. Such manual removal may also imply unconfortable positions and/or repeated manual lifting of heavy workpieces. Screwing and unscrewing of moulds and starting heads, even if carried out with automatic screwdrivers, may further imply repeated movements.

[0010] As a consequence, there is a need to provide a device for cleaning and preparation of mould tables and their components, which makes it possible to remedy to the above drawbacks.

Objects of the invention

[0011] In this respect a first object of the invention is an installation for the maintenance, in particular the cleaning, of a casting table assembly, said casting table assembly comprising

an upper part, also called upper table (10), said upper table comprising a rectangular frame (100), a plurality of openings (110) provided in the frame, a plurality of moulds (12), each facing a respective opening, and removable attachment means (13), in particular bolts, making it possible to attach said moulds with respect to said frame,

a lower part, also called lower table (15), said lower table (15) comprising a body (150), a plurality of so-called starting heads (18), each being intended to be inserted into a respective mould, and locking means (19) making it possible to lock said starting heads with respect to said body,

said installation further comprising

a peripheral fence (2) defining a working area,

a main robot (3), said main robot comprising a body as well as coupling means (34) mobile with respect to said body,

displacement means (37) adapted to displace said main robot, so that it is mobile along at least one direction of said working area,

a set of so-called main operative devices (40 - 46), comprising at least

a starting head grab device (40), provided with means (405, 406) for grabing each starting head,

a brushing device (42), provided with means for brushing at least surface of upper table opposite to said moulds,

a screw device (44), provided with means (45) for screwing/unscrewing each mould with respect to upper table; and

a mould grab device (46), provided with means (464, 466) for grabing each mould,

bearing in mind that said screw device and said mould grab device may form a single combined screw and mould grab device,

each main operative device being provided with complementary coupling means (402, 422, 442, 462) adapted to cooperate with said coupling means of main robot so as to permit a removable attachment between each main operative device and said main robot,

a reception zone (200) for said lower part of said casting table assembly,

a tilting device (6), adapted to move into rotation upper part of said casting table assembly,

control means (9) comprising:
a human machine interface (90),

control lines (95-98) adapted, upon receipt of inputs actuated by an operator, to transmit control orders to at least said main robot (3), said displacement means (37) and each of said operative devices (40 - 46).

[0012] According to one aspect of the invention brushing device (42) comprises a brushing assembly (43) provided with a shaft (431) and at least one brush, adapted to be removably attached on said shaft, advantageously at least two brushes (48, 49) comprising a metallic brush, for example a steel brush, and a plastic brush.

[0013] According to another aspect of the invention screw device (44) is provided with a sensor (455) configured to detect that a predetermined so-called maximum torque has been applied to removable attachment means (13), said sensor being also configured to send an alarm to said control means if said predetermined maximum torque has not been detected.

[0014] According to still another aspect of the invention tilting device comprises two fixed bases as well as two mobile flanges, each base and each flange being equipped with complementary drive means, each flange comprises clamping means, so as to firmly maintain body of upper table with respect to said flange, said tilting device comprising also safety bridges (68) each adapted to cooperate with a respective flange.

[0015] According to still another aspect of the invention starting head grab device (40) comprises a body (400), claws mobile with respect to said body between a grab configuration and a release configuration, as well as at least one finger mobile with respect to said body between an inactive configuration and an active configuration for unlocking said locking means.

[0016] According to still another aspect of the invention said installation comprises a so-called auxiliary robot (7), said auxiliary robot (7) comprising a body as well as a cleaning device adapted to clean starting head.

[0017] According to an advantageous feature said installation may comprise at least one cleaning station (82, 83), comprising holding means for holding said starting head, said installation comprising also a so-called auxiliary cleaning robot (7) provided with cleaning means for

cleaning said starting head.

[0018] According to a further advantageous feature said robot may comprise at least one intermediate arm, mobile with respect to body, said arm supporting said coupling means.

[0019] According to still another aspect of the invention mould grab device (46) comprises jaws (464, 466) mobile between a grab configuration and a release configuration of said mould.

[0020] According to an advantageous feature starting head grab comprises a mobile scrapping member, mobile with respect to said body.

[0021] According to still another aspect of the invention said brush is located in a so-called suction volume, brushing device being provided with fittings adapted to cooperate with a suction system.

[0022] According to an advantageous feature of the invention at least one and in particular several stands are provided, each for a respective main device, each stand comprising detector adapted to detect the presence of one given device on its stand.

[0023] According to another aspect of the invention said installation comprises a so-called scrapping station, comprising a fixed scrapping member.

[0024] According to another aspect of the invention peripheral fence defines a substantially closed working area, said fence defining at least one aperture for entrance and exit in particular of a trolley intended to support moulds.

[0025] A second object of the invention is an automated maintenance method of a casting table assembly, said casting table assembly comprising

an upper part, also called upper table (10), said upper table comprising a rectangular frame (100), a plurality of openings (110) provided in the frame, a plurality of moulds (12), each facing a respective opening, and removable attachment means (13) making it possible to attach said moulds with respect to said frame,

a lower part, also called lower table (15), said lower table (15) comprising a body (150), a plurality of so-called starting heads (18), each being intended to be inserted into a respective mould, and locking means (19) making it possible to lock said starting heads with respect to said body,

said method comprising, under control of control means (9),

placing said lower table on said reception zone,

engaging said upper table on said tilting device,

removing at least one, in particular a majority of starting heads, via starting head grab device (40), cleaning said starting heads and placing back said cleaned starting heads in their initial location,

brushing at least surface of upper table opposite to said moulds via said brushing device (42),

removing at least one, in particular a majority of moulds, via said screw device (44) and said mould grab device (46), and driving said moulds to a repair area.

[0026] According to an advantageous feature of this maintenance method:

some first parts of upper table, in particular cover (114) and protrusions (115) protruding out of said cover, are cleaned with the metallic brush; and

some second parts of upper table, in particular roads (111), corners (112) and holes (113) are cleaned with the metallic brush the plastic brush.

[0027] According to a further advantageous aspect of the invention metallic brush is given a first so called cleaning height (H1) to clean first protrusions (115), and a second so called cleaning height (H2) to clean then cover (114).

[0028] According to still another aspect of the invention the instantaneous wear of metallic brush is determined and a warning message is sent, if the instantaneous magnitude of said wear is superior to a predefined value.

[0029] According to an advantageous feature, said method comprises determining the instantaneous wear of metallic brush comprises moving said brush towards a so-called reference surface, calculating the motion distance and comparing it to a threshold distance.

[0030] According to another aspect of the invention, removing each mould comprises unscrewing said bolts, and unscrewing each bolt first comprises

- engaging said screwing/unscrewing means with said bolts,
- rotating said screwing/unscrewing means in the direction of screwing said bolts and
- if said maximum torque is detected, rotating said screwing/unscrewing means in the direction of unscrewing said bolts.

[0031] According to an advantageous feature of the invention, if said maximum torque is not detected, moving said screwing/unscrewing means laterally with respect to said bolts.

[0032] According to still another advantageous feature of the invention, cleaning said starting head comprises

- moving said starting head, with main robot, towards cleaning station,

- leaving alone said starting head on cleaning station; and

- cleaning starting head on said cleaning station, with auxiliary cleaning robot (7). According to another feature of the invention, engaging said upper table on said tilting device comprises

- moving upper table horizontally towards said first flange until it abuts against clamping means of said first flange,

- moving said second flange until clamping means of said second flange cooperate with said upper table; and

positioning each safety bridge close to each flange.

Brief description of figures

[0033]

Figure 1 is a perspective view, showing an upper table and a lower table, which are part of a casting table assembly which is intended to be cleaned according to the invention.

Figure 2 is a perspective view, showing under another angle the upper table of figure 1.

Figure 3 is a schematic perspective view, illustrating the fixation of a mould on said upper table.

Figure 4 is a schematic front view, illustrating the locking of a starting head on said lower table.

Figures 5 and 6 are respectively a top view and a perspective view, showing an installation for the maintenance of said casting table assembly.

Figure 7 is a perspective view, illustrating a main robot which is part of said installation.

Figures 8 and 9 are perspective views, illustrating under different angles a starting head grab which is part of said installation.

Figures 10 and 11 are perspective views, illustrating under different angles a brushing device which is part of said installation.

Figure 12 is a perspective view, illustrating a screw device which is part of said installation.

Figures 13 and 14 are perspective views, illustrating under different angles a mould grab which is part of said installation.

Figure 15 is a perspective view, illustrating a stand adapted for supporting starting head grab of figures 8 and 9.

Figure 16 is a perspective view, illustrating a stand adapted for supporting brushing device according to figures 10 and 11.

Figure 17 is a perspective view, illustrating a fixed frame which belongs to a tilting device, part of said installation.

Figures 18 and 19 are perspective views, illustrating under different angles a mobile flange which belongs to a tilting device part of said installation.

Figure 19a is a perspective view, illustrating the mounting step on above table on the tilting device of figures 17 to 19.

Figure 20 is a perspective view, illustrating at greater scale the final fixing of said upper table on the tilting device of figures 17 to 19.

Figure 21 is a perspective view, illustrating an auxiliary so-called cleaning robot which is part of said installation.

Figure 22 is a perspective view, illustrating a cleaning post, adapted to receive said starting head.

Figure 23 is a perspective view, illustrating a scrapping post, which cooperates with a starting head held by said starting head grab.

Figure 24 is a perspective view, illustrating a trolley for the reception and transportation of moulds.

Figure 25 is a schematic view, illustrating the control means which are part of the installation according to the invention.

Figure 26 is a front view, illustrating extraction of a starting head from lower table, due to starting head grab of figures 8 and 9.

Figure 27 is a perspective view illustrating a cleaning operation of a starting head carried by auxiliary robot of figure 21.

Figure 28 is a schematic view, illustrating the brushing of upper table, due to brushing device of figures 10 and 11.

Figure 28a is a top view, showing at a far greater scale a part of the upper table illustrated in particular on figure 1.

Figure 28b is a schematic view, illustrating the co-operation between two different types of brushes and the brushing device of figure 28.

Figure 28c is a schematic view, illustrating the different cleaning heights given to the metallic brush of figure 28b.

Figure 28d is a schematic view, illustrating the calculation of the wear of the brush of figures 28b and 28c.

Figure 29 is a schematic view, illustrating the unscrewing operation of a mould from the upper table, due to screw device of figure 12.

Figures 29a to 29d are schematic views, illustrating different steps of the unscrewing operation of figure 29.

Figure 30 is a schematic view, illustrating the transportation of the mould of figure 29 from this upper table to a transportation trolley.

Figure 31 is a schematic view, illustrating the forth motion of trolley of figure 30 towards a mould repair area.

Figure 32 is a schematic view, illustrating the back motion of trolley of figure 30 from said repair area.

Figure 33 is a schematic view, illustrating the screwing of a repaired mould on the upper table.

[0034] The following reference numerals are used throughout the present description.

1 casting table assembly - 10 upper table - 100 frame of 10 - 11 trough -110 openings in 11 - 111 roads of 11 - 112 corners of 11 - 113 holes in 11 - 114 cover of 11 - 115 bolts on 114 - 12 moulds - 12a to 12i removed moulds - 12'a to 12'i repaired moulds - 13 screws - 15 lower table - 150 body of 15 - 16 rams - 17 platen - 18 starting head - 19 pin

I installation according to the invention

2 fence - 20 working area - 200 and 201 working zones of 200- 21 posts - 22 grid members - 220 and 221 pivoting members - 210 and 211 posts of 220 and 221 - 23 aperture - 24 barrier - 25 opening

3 main robot - 30 base plate of 3 - 31 body of 30 -32 proximal arm - 33 distal arm - 34 coupling - A31 to A34 rotation axes of 31 to 34 - 35 track - X35 axis of 35 - 36 frame - 37 displacement means

40 starting head grab - 400 body of 40 - 401 centring disc - 402 coupling - 403 404 actuators - 405 406 claws - 408 finger - 41 scrapper assembly - 410 actuator - 411 scrapping rubber

42 brushing device - 420 body of 42 - 422 coupling - 424 bracket - 425 plate - 426 linear bearing - 43 brush assembly - 431 shaft - 433 curtain - 434 top of 433 - 435 suction volume - 436 connectors

44 screw device - 440 body of 44 - 442 coupling - 444 bracket - 45 screwing assembly - 451 screwing tip - 452 socket - d452 distance between 452 and 13 - F452 and f452 opposite rotation directions of 452 - G452 and H452 translation directions of 452 - 455 sensor

46 mould grab - 460 body of 46 - 462 coupling - 463 support - 464 466 jaws - 467 fittings

47 suction pipes - 470 suction system - 475 vacuum system

48 metallic brush - H1 and H2 cleaning heights - 480 free extremity of 48 - Sref reference surface - F48 motion direction of 48 - Dinst instantaneous distance between Sref and 480

49 plastic brush

50 to 56 stands for 40 to 46 - 501 to 561 base chassis - 51 to 57 pedestal - 511 to 571 notch - 512 to 572 support strips - 513, 514 to 573, 574 centring pins

6 tilting device - 60 fixed frames - 61 base plate - 62 support structure - 63 drive - 64 motor - 65 flange - 66 bottom - 661 clamps - 662 studs - 663 pads - 67 rim - 671 drive - 68 safety bridge - 681 projection

7 auxiliary robot - 70 base plate - 71 body - 72 proximal arm - 73 distal arm - 74 cleaning device - A71 to A74 rotation axes of 71 to 74

80 scrapping station - 802 base structure - 804 scrapping member - 806 notch 82, 83 cleaning stations - 820 post - 822 gripper - 823 top support

84 grease station - 840 tank - 842 distributor

85 trolley - 850 base structure - 852 top carpet - 854 identification camera - 86 auxiliary device - 860 further camera

9 control means - 90 computer - 91 to 94 information lines - 940 reading camera - 95 to 98 control lines - 99 detection system

Detailed description of the invention

[0035] The present invention deals with the maintenance and, in particular, with the cleaning of a casting table assembly. This assembly is shown on figures 1 and 2, where it is referenced **1** as a whole. This assembly, which is known as such and is not part of the invention, will be now briefly described.

[0036] Said casting table assembly **1** comprises first an upper part, also called upper table **10.** This upper table is also called fixed, since it does not move in use with respect to the casting pit. Said upper table **10** mainly comprises a rectangular frame **100,** as well as a trough **11** provided on the upper part of this frame. Said trough defines a plurality of openings **110,** whereas a corresponding number of moulds **12** are provided on the lower part of the frame (see in particular figure 2). Each mould **12** is attached on the lower face **101** of frame **100** by way of appropriate attachment means: removable means are preferred, in particular screws which are schematically illustrated and referenced **13** on figure 3. Typically four screws are provided, for the attachment of each mould on the frame.

[0037] Said casting table assembly **1** also comprises a lower part, also called lower table **15.** This upper table is also called mobile, since it moves in use with respect to the casting pit, typically along a vertical axis. Said lower table **15** mainly comprises a rectangular body **150,** the dimensions of which are similar to those of frame **100.** Said body **150** is provided with a plurality of rams **16,** each supporting a respective platen **17.** Moreover, lower table comprises a plurality of so-called starting heads **18,** which are inserted within the moulds of the fixed table at the beginning of the casting. Then, once the aluminium in the moulds starts to solidify, the mobile table starts going down gradually by creating the billet.

[0038] Each starting head **18** is attached on a respective platen **17,** by way of locking means. In a typical way, as shown on figure 4, a pin **19** held by said starting head cooperates with a housing of said platen. In a way known as such, in use, each starting head **18** is inserted within a respective mould of the fixed table at the beginning of the casting. Then, once the aluminum in the moulds starts to solidify, the mobile table starts going down gradually by creating a billet.

[0039] Figures 5 and 6 show a general view of an installation according to the invention, referenced I as a whole. it essentially comprises a peripheral fence **2,** a first or main robot **3,** a set **40** to **46** of main devices adapted to cooperate with robot **3,** a set **50** to **56** of stands for main devices, a tilting device **6,** a second or auxiliary robot **7,** a set of accessory stations, as well as control means **9.**

[0040] Peripheral fence **2,** which is rectangular shaped, defines an inside working area **20.** This fence comprises a plurality of horizontal posts **21,** which support grid members **22.** One permanent aperture **23** is provided in the grid members so as to permit entrance of a transportation trolley, amongst others. The motions across said aperture are monitored by an optical barrier **24,** of any appropriate type. Moreover, two adjacent grid members **220** and **221** are pivotally mounted on their posts **210** and **211,** so as to define a provisional opening **25.**

[0041] As can be seen at a greater scale on figure 7, main robot **3** comprises a base plate **30,** which is attached to a track **35.** The latter defines a main axis *X35,* so as to delimit two working zones **200** and **201** of working area **20,** respectively on the top and on the bottom of figure 5. Track **35** rests on a frame **36,** so as to be located above the ground. Motion of base plate **30** with respect to tracks **35,** along axis *X35,* is ensured by appropriate displacement means, which are schematically illustrated on figure 7. The latter, which are not part of the invention, will not be described in further details.

[0042] Said base plate **30** supports a body **31** which is adapted to rotate around the substantially vertical axis *A31,* with respect to said base plate. A proximal arm **32** is mounted on said body **31,** while being adapted to rotate with respect to the latter, around an axis A32. Moreover, a distal arm **33** is mounted on said arm **32,** while being adapted to rotate with respect to the latter, around an axis A33. Said arm **33** is provided with an appropriate coupling **34,** which makes it possible to handle each device of the set **4.** Moreover, said coupling **34** is adapted to rotate with respect to arm around axis A34, to enable the tilting of main device fixed on said coupling.

[0043] Set of main devices comprise a so-called starting head grab **40,** a brushing device **42,** a screw device **44** and a so-called mould grab **46.** Each of these devices is adapted to rest, in use, on respective stands **50, 52, 54** and **56.**

[0044] With reference to figures 8 and 9, starting head grab device **40** comprises first a body **400,** which supports a centring disc **401** upon which rests a so-called complementary coupling **402.** The latter is adapted to cooperate with above-mentioned coupling **34,** provided on main robot 3. The locking and unlocking of these quick type couplings **34** and **402** can be achieved by any appropriate means, such as non-represented pneumatic means.

[0045] On opposite sides of body **400,** grab device **40** is equipped with actuators **403, 404,** in particular of the pneumatic type, adapted to displace claws **405, 406** the one with respect to each other. As will be further described, these claws are intended to grasp a starting head **18** out of body **150** of lower table **15.** One **405** of above claws supports a finger **408,** which is adapted to unlock connecting means **19.** Moreover, a scrapper assembly **41** is fixed on body **400** by any appropriate means, in particular screwing. Said assembly **41** comprises an actuator **410,** for example of pneumatic type, which is adapted to move a so-called scrapping rubber **411.**

[0046] As shown on figures 10 and 11 brushing device **42** comprises first a body **420,** which supports a complementary coupling **422,** analogous to the above described

one **402.** These couplings **402** and **442** are of any appropriate type, known as such. The body is attached, via a bracket **424,** to a support plate **425** which support a brush assembly **43.** The plate **425** is mobile with respect to bracket **424,** thanks to any appropriate means such as a linear bearing **426.**

[0047] Brush assembly comprises a shaft **431** which is driven in rotation by any appropriate means. This shaft supports, at its lower end, a metallic brush **48.** In an advantageous way, the fixation between shaft and brush is of the removable type, so that several kinds of brushes may be adapted for a better operation. Said shaft is adapted to cooperate with two kinds of brushes, in particular said metallic brush and a brush **49** made of plastic material. The natures of these respective metallic and plastic brushes are known as such. The brush assembly **43** is surrounded by a peripheral protection curtain **433,** for example made of rubber.

[0048] This curtain, which is provided with a top **434** attached to plate **425** but which is opened at its bottom, defines a cylindrical so-called suction volume **435.** So as to carry out suction operation, said top **434** is equipped with connectors **436,** adapted to cooperate with suction pipes **47** that are illustrated in dotted lines on figure **5.** Said pipes can be plugged on a suction system **470,** located outside fence **2.**

[0049] With reference to figure 12 screw device **44** comprises first a body **440,** which supports a complementary coupling **442,** analogous to the above described one **402.** The body is attached to a bracket **444,** which supports a screwing assembly **45** which is adapted to cooperate with the fixation screws of the moulds. This screwing assembly comprises in particular a screwing tip **451** configured to screw or unscrew said fixation screws. There is also provided a socket **452,** of any known type.

[0050] As shown on figures 13 and 14 mould grab device **46** comprises first a body **460,** which supports a complementary coupling **462,** analogous to the above described one **402.** Body **460** is attached to a support **463,** which holds two jaws **464** and **466.** The latter are mobile as the one with respect to the other, along axis *X462,* between a first position wherein they are adapted to grab one mould, and a release position of this mould. Motion is ensured in a pneumatic way, due to fittings **47** capable of cooperating with a not represented pipe.

[0051] In the illustrated embodiment, screw device **44** is separated from mould grab device **46.** According to a not shown variant, these devices may be gathered to form a so-called single combined device, ensuring both screwing/unscrewing function as well as mould grab function. In this respect this combined device comprises a single body, supporting both screwing assembly as well as grab jaws.

[0052] Figures 15 and 16 illustrate stands **50** to **56** adapted to cooperate with above described devices **40** to **46.** Stands **52** to **56** of figure 16 are analogous, whereas stand **50** of figure 16 is slightly different while having globally the same structure. Indeed, each of these stands comprises first a base chassis **50**1 to **561** of any appropriate type, upon which rests a pedestal **51** to **57.** The latter, which is provided with a central notch **511** to **571,** defines two opposite support strips **512** to **572** each equipped with centring pins **513, 514** to **573, 574.** The latter cooperate in use with guides, such as the ones **413** to **473** provided on the lower face of body **400** to **460.**

[0053] Moreover, each strip **512** to **572** is also equipped with support fingers **515, 516** to **575, 576,** which cooperate in use of with washers such as the one **414** provided on the lower face of body **400** to **460.** Strips are also equipped with a presence sensor **517** to **577,** which makes it possible to confirm device **40** to **46** is actually on its stand **50** to **56.** When device **40** to **46** rests on its stand, the notch **511** to **571** allows a free passage under pedestal **51** to **57,** for some structural members of said device, such as claws **405, 406** of grab **40.** The shape and size of some mechanical components may vary from one stand to another, bearing in mind that the functions of these components are substantially the same for each stand.

[0054] Tilting device **6** comprises two external fixed frames **60** shown on figure 17, cooperating with respective internal mobile flanges **65** illustrated on figures 18 and 19. Frame **60** is first provided with a base plate **61,** as well as a tubular support structure **62.** The latter holds a slewing drive **63,** driven itself by a motor **64** of any appropriate type. Flange **65** comprises first a bottom **66** which is provided (see figure 19a) with fixation clamps **661,** centring studs **662** as well as resting pads **663.**

[0055] On a first side of bottom **16** there is provision of a rim **67,** which is equipped with a complementary drive **671,** adapted to cooperate with drive **63** so as to ensure the motion of the whole flange. On the other side bottom **66** is adapted to cooperate with a safety bridge **68,** which is provided with a median U shaped projection **681.** The implementation of this tilting device will be described hereafter.

[0056] As shown on figure 21 auxiliary robot **7,** also called cleaning robot, comprises a base plate **70** which rests in a fixed manner on working zone **200.** Said base plate **70** supports a body **71** which is adapted to rotate around the substantially vertical axis *A71*, with respect to said base plate. A proximal arm **72** is mounted on said body **71,** while being adapted to rotate with respect to the latter, around an axis *A72*. Moreover, a distal arm **73** is mounted on said arm **72,** while being adapted to rotate with respect to the latter, around an axis *A73*. Said distal arm **73** is provided with a cleaning device **74,** adapted to rotate with respect to arm **73** around axis *A74*.

[0057] Accessory stations first comprise one scrapping station **80,** shown on figure 23, which is equipped with a base structure **802,** supporting a so-called fixed scrapping member **804** typically made of rubber. This member **804** is provided with a central notch **806,** adapted to cooperate with the bottom of the starting head during operation, so as to precisely position this starting head.

[0058] Moreover, there are two identical cleaning stations **82** and **83,** shown on figure 22. With reference to figure 22 each station, such as the one **82,** comprises a post **820** which supports a pneumatic gripper **822.** The latter makes it possible to firmly hold the starting head during the process, by way of a top support **823.** Moreover, this station **82** is equipped with a not shown sensor, for detecting the starting when arriving on said station.

[0059] Furthermore, a grease station **84** is provided, which is schematically represented on figure 5. This station comprises a tank **840,** a not shown pump as well as a grease distributor **842.**

[0060] A so-called mould trolley **85,** shown on figure 2 as well on figure 31 at a greater scale, is provided close to the main aperture. This trolley comprises a mobile base structure **850,** as well as a top carpet **852** for the reception of some moulds. This trolley is associated with an identification camera **854,** of the artificial intelligence type, the function of which will be further detailed.

[0061] In addition, close to trolley **85,** an auxiliary device **86** makes it possible to check the correct centring of the moulds. In this respect it comprises a further camera **860,** of the optical character recognition, the function of which will also be further detailed.

[0062] Control means **9,** shown on figure 25, comprise first a human machine interface, in the form of a computer **90** intended to receive inputs from an operator. Said computer is associated with Programmable Logic Controller (or PLC), with a motor control center (or MCC) as well as with artificial vision device.

[0063] Control means also comprise a plurality of so-called information lines, which connect the above-mentioned computer **90** with structural members of the installation. A first information line **91** connects computer with detectors, provided on the table assembly. Two further information lines **92** and **93** connect computer with detectors, provided on each cleaning station **82** and **83.** Another information line **94** connects computer with a reading device adapted to read an identification code. Said reading device may be a camera **940** of any appropriate type, not shown in detail on the figures.

[0064] Control means comprise in addition a plurality of so-called control lines, which connect computer **90** with some others structural members of the installation. A first control line **95** connects computer with motor means, adapted to drive the main robot **3.** Another control line **96** connects computer with specific motor means, adapted to drive the auxiliary robot **7.** Still another control line **97** connects computer with specific motor means, adapted to drive tilting device **6.** A further control line **98** connects computer with vacuum system **475.** The above control lines **95** to **98** are configured to control respectively robots **3** and **7,** tilting device **6** and vacuum system **475,** upon inputs from an operator on computer **90.**

[0065] An implementation of the above installation, according to the invention, will now be described.

[0066] The casting table assembly **1** is first collected from a not illustrated cast house shop floor and is inspected visually for possible damage. This step is carried out by an operator. In a second step, the casting table assembly is fixed in a not shown lifting hook; this is typically a manual operation.

[0067] The type and size of the casting table assembly **1** are then selected. This can be carried out by an operator on the computer or can be carried out automatically by above mentioned camera **940** reading the unique identification code of the casting table assembly, or by the detectors provided on the table assembly. Information line **91** transmits appropriate information from the detector or camera to the computer. This step is not illustrated on the figures.

[0068] The bottom part **15** of the casting table assembly **1** is then placed on first working zone **200,** whereas the upper part **10** is mounted on the tilting device located on other working zone **201.** To this end these two parts are first separated the one from the other using an overhead crane, which is typically done by an operator and is not shown on the figures. The mounting of upper part on device **6** is carried out using an overhead crane, which is typically done by an operator. Said upper part is also properly secured to tilting device **6** which is supervised by an operator. If the tilting station is busy, then the upper part **10** is stored elsewhere (typically on the floor).

[0069] With reference to figures 19a and 20, let us detail and now the mounting of upper part **11** on tilting device **6.** Upper table **11** is moved horizontally towards first flange **65a** according to arrow *F11,* using a not shown crane, until its front face abuts both clamps **661** and studs **662,** while resting upon pads **663.** Then not shown other flange **65b** is moved also horizontally according to arrow *F65b* until its clamps studs and pads cooperate with opposite front face of table 11. Finally, each bridge **68** is lowered according to arrow *F68*, also using said crane, so as to firmly lock table with respect to both flanges.

[0070] In final use, as can be seen on figure 20, opposite ends **101** of rectangular frame **100** extend through the passage **69** defined by bottom **66** and bridge **68.** In particular the tips **112** of table **11** extend through projection **681.**

[0071] A first specific aspect of the implementation is the maintenance of starting heads **18.** To this end, starting heads that need to be cleaned are first selected. As will be explained, the invention allows flexibility by giving the option of selecting if all the starting heads are to be cleaned or just a selection made by the operator. The layout of the starting heads is shown on the computer and the operator can select the starting heads to be cleaned. If required, the cleaning of all the heads can be selected as well.

[0072] When the desired starting heads are validated, a corresponding order is transferred to robot **7** via control line **96,** so as to start cleaning process of said starting heads. The robot first moves towards stand **50,** upon which rests starting head grab **40.** Coupling of robot **3** engages with complementary coupling of grab **40** so that robot **3** and grab **40** are adapted to mutually cooperate.

Said robot, now provided with grab **40,** moves to the position of the starting head that has to be removed. As shown on figure 26, which does not illustrate the robot itself, once above the head the robots goes down with the grab according to arrow *F40.*

[0073] The finger **408** is moved along arrow *F408,* so as to push up the releasing pin **19** of the starting head. Then the actuator **403** moves the respective claw along arrow *F405,* so as to put off-center the starting head from its support platen **17.** In an advantageous way a not shown mechanical stopper is adapted to limit the stroke of this actuator so that the starting head puts off-center just the required distance from the lower table. This allows the robot to lift the starting head without obstruction when required.

[0074] Then the other actuator **404** grabs the starting head **18,** using the other claw **406.** Then robot **3** takes out this starting head of the lower table 15 and moves upwards so that mobile grease scrapper **411** extends downwards from the grab along arrow *F411.* This scrapper cleans the facing surfaces of the platen **17,** typically with two passes.

[0075] Main robot **3,** provided with the starting head **18,** moves towards scrapping station **80.** First of all, the bottom of the starting head is cleaned from grease on the fixed scrapping member **804.** Once done, the grease scrapper **411** of the grab **40** is cleaned as well on this fixed scrapping member **804.**

[0076] Once this grease scrapping operation has been carried out, robot 3 provided with starting head **18** moves towards the cleaning stations **82** and **83.** Information concerning the availability of each station is given to the operator, via lines **92** and **93.** This operator controls then robot **3** via line **95,** so that said robot approaches one available cleaning station. By releasing the actuators, robot **3** leaves alone the head **18** on the cleaning station, such as the one **82.** At the same moment, the pneumatic gripper **822** of the cleaning post is actuated along arrow *F822,* so that the starting head is firmly held on top support **823** as shown on figure **27.** The robot **3** provided with the starting head grab **40** can now head to another task.

[0077] Now the cleaning robot **7** starts to clean the top of the starting head **18** with its metallic brush **74,** as shown on figure **27.** Said cleaning step is operated circularly from the outer circle up to the center, by making concentric circles. The brushing finishes when it cleans even the external diameter part of the starting head.

[0078] Once cleaned by brush **74,** the starting head **18** is picked up by the main robot **3** from the cleaning post **82.** Robot **3** and grab **40,** the latter holding head **18,** move to the greasing station **84,** where grease is applied to the bottom of the starting head, by turning the starting head upside down. The main robot **3** then takes the starting head **18** and returns it back to the position it was taken before on the lower table **15,** making the same backwards process.

[0079] Another specific aspect of the implementation is the maintenance of upper table **10** as well as of moulds **12** held by this table. In this respect upper table is tilted with tilting device **6** for example by 75°, to allow access to its bottom side. Said table **10** is then properly identified in the computer system using its identification code, which is typicaly marked on a label affixed to the table; this identification can be done for example by reading the idenfication code on said label using reading camera **940,** and then transmitted to computer **90.** This identification can also be carried out manually entering the identification code into the computer system using the Human-Machine-Interface (HMI).

[0080] The top side of the upper table is then cleaned. To this end, said top side is first visually inspected by the operator, start up dam holders are removed, and any solidified aluminium that may stick on the table is removed; any damaged refractories are replaced.

[0081] In a further step the cleaning operation to be carried out by the robot is determined and defined; this is typically done by the operator and entered into the computer system using the HMI. Certain parameters necessary for the cleaning operation are determined and entered or validated; this is typically done by the operator and entered into the computer system using the HMI.

[0082] More precisely, the type and size of the table has to be selected on the HMI. Appropriate detectors may be provided on the tables to ensure the selected table is the right one. Moreover, the system is configured such that the layout of the brushing areas can be selected on the HMI. This allows flexibility, as it may not be sensible to clean areas that do not require cleaning.

[0083] In still a further step, the vacuum system 475 is actuated by control line 98 and the main robot 3 is actuated by control line 95. Under these circumstances robot 3 heads to stand 52, so as to engage and to pick up brush device **42.** The pre-programmed cleaning cycle is then carried out, as illustrated on figure 28, and may include spraying small quantities of water on the top plates to minimize formation of dust. Grinding on the top plates is performed by the robot using steel brush attachments.

[0084] According to an advantageous feature of the invention, brushing step is operated according to several manners, throughout the upper side of upper table **10.** In a way known as such, with reference to figure 28a, said upper side may be divided into different zones.

[0085] Trough **11** forms branches, which define so called roads **111,** corners **112** and holes **113.** Roads **111** are the main parts, from where the metal is distributed into every opening **110.** Corners **112** are formed by the areas connecting the roads with the holes surrounding the openings **111:** they typically have the shape of a truncated cone, with their smaller face at the bottom, close to the hole. Finally, the holes **113** are provided at the periphery of each opening **110:** they connect the table **10** with the starting heads and the billet ingot.

[0086] Apart from said trough **11,** said upper side delimits a so-called cover **114.** In a way known as such, this cover is provided with some protrusions, due in particular

to the presence of bolts **115** (schematically representated on figure 28a but also illustrated on figure 1).

[0087] According to an advantageous embodiment of the invention, covers **114** are brushed with metallic brush whereas both roads, corners and holes are treated with plastic brush. Due to the importance of the nature of the brushes, the installation is provided with a detection system **99** which is adapted to determine which brush is actually mounted on brushing shaft **431.** In this respect figure 28b schematically illustrates brushing shaft **431,** metallic brush **48,** plastic brush **49** and detection system **99.** In case the appropriate brush is not engaged on shaft, detection system is adapted to give appropriate information to control means **9,** which in turn warns the operator to change the brush.

[0088] The brushing of the covers **114** starts by cleaning first the protrusions **115:** to this end, a first so-called cleaning height *H1* is given to the brush by the control means. Said height corresponds to the distance between the free extremity **480** of brush **48** and the facing wall of the shaft **431.** Once protrusions are cleaned, a second cleaning height H2 so as to clean the rest of cover **114.** Providing these two different heights *H1* and *H2,* which are schematically represented on figure 28c, is advantageous: indeed, if the same cleaning height is set for the whole cover, it will result in collisions with the protrusions. These collisions are likely to create vibrations and improper movements, causing the decrease of the performance. In addition, the brushing motor may be advantageously provided with a not shown sensor: in case the latter detects an increase in the torque value, the motor stops and an alarm is raised.

[0089] According to a particularly advantageous feature of the invention, wear of brushes are periodically identified. Indeed, said wear is of high importance for the proper processing of the method according to the invention. Figure 28d illustrates the so-called instantaneous working distance, namely the distance along vertical axis between the free extremity **480** of brush **48** and a reference horizontal surface Sref, which typically corresponds to the table platten. This distance is measured by moving brush **48** along arrow *F48*, and it contacts with reference surface Sref. If instantaneous distance Dinst is superior to a threshold value Dthr, it means that brush has undergone a significant wear and therefore needs to be changed. Indeed, this worn brush is not adapted any more to carry out an efficient brushing operation.

[0090] Said wear calculation is advantageously processed at the beginning of the cycle and thereafter periodically, for example every two areas brushed.

[0091] When the cleaning cycle as pre-programmed is completed, the robot will return to its home position to facilitate inspection of the part. The surface of the top side of upper table, which has been submitted to cleaning process, is thereafter inspected, by a camera and/or by an operator. If it decided that, if said surface has not been properly cleaned, further cleaning is programmed, using appropriate parameters; these parameters may be entered by the operator using the HMI. When the last cleaning cycle is finished, the main robot **3** will move to its home position.

[0092] Then the moulds **12** which require removing are identified and designated; this can be done by the operator who inspects the moulds and enters instructions to the robot **3** into the HMI, via control line **95.** The table **10** is turned of 180° according to arrow *f10* on figure 29, so that the moulds are now located above the table for easy access of the robot. The robot **3** heads to stand **54,** so as to engage with and grasp screw device **44.** Robot provided with screw device moves then towards the table in order to unscrew the bolts **13** from each designated mould on the casting table, in particular the one **12a** on figure 29.

[0093] In a more detailed way, with reference to figure 29a, robot **3** heads to the first mould to be removed, directly above the first bolt to be unscrewed. When distance *d452* between socket **452** and said first bolt reaches a given value, for example 50 mm, socket is driven to rotate in a direction *F452* to tighten the bolt, typically clockwise. Socket is then approached until it engages with the bolt **13** (figure 29b) and, since this bolt is already tightened, a predetermined so-called maximum value of torque is applied. According to an advantageous feature of the invention, screw device **44** is provided with a schematically illustrated sensor **455,** which is adapted to detect the occurrence of said maximum torque. Once sensor **455** has sent an information in connection with this occurrence, socket is driven to rotate in an opposite direction f452 to unscrew the bolt, typically counter-clockwise (figure 29c). This rotation is carried out during a predetermined duration, for example 13 seconds. It is preferred that the unscrewed bolt stays always in the mould, no matter the time it is unscrewed.

[0094] If sensor **455** does not send an information concerning the occurrence of maximum torque, it means that socket does not engage the bolt. In this case socket is first displaced laterally with respect to said mould (see figure 29d), along the two double arrows *G452* and *H452.* if still no detection is received after this first cycle, socket is moved away from the bolt, is displaced laterally with respect to said mould and is once again moved toward the mould, until maximum torque is detected. After this second cycle, if no signal of maximum torque is received, control means **9** acknowledge that operation has not been successfully carried out, thus raising an appropriate alarm.

[0095] In a further step the robot **3** disengages with screw device **44,** so as to place it back on its stand **54** (not shown operation). Said robot heads then to stand **56,** so as to engage with mould grab **46.** Robot provided with grab **46** moves then to the table, so to remove the designated moulds, which have been previously unscrewed. Robot heads then to trolley **85,** so as to transport the designated moulds on top of this trolley.

[0096] The different moulds are then placed in a given order on the transportation trolley **85,** as shown on figure

30. When the last designated mould has been removed, the robot will move to its home position. The removed moulds **12a** to **12i** on figure 31 are then moved through aperture **23,** along arrow *F85*. These moulds are driven to a mould repair area **1000,** of any appropriate type, for maintenance. After this step, the repaired moulds **12'a** to **12'i** are posed back on trolley **85,** and then reintroduced into working area, along arrow *F'85* as seen on figure 32.

[0097] Thereafter camera **860** checks the identification digit of each repaired mould **12'a** to **12'i,** as shown on figure 32. Finally, as shown on figure 33, the robot grasps each repaired mould and screws them back in their initial location on the table. In a more detailed way, the same way as explained with reference to figure 29a, robot **3** heads to the first mould to be attached, directly above the first bolt to be screwed. When distance *d452* between socket **452** and said first bolt reaches a given value, socket is driven to rotate until it engages with the bolt **13** (like in figure 29b). When sensor **455** detects that maximum torque is applied, the screwing operation is considered fulfilled and robot processes next bolt.

[0098] If sensor **455** does not send an information concerning the occurrence of maximum torque, it means that socket does not engage the first bolt to be screwed. In this case, socket is first displaced laterally with respect to said mould (like in figure 29d). If still no detection is received after this first cycle, socket is moved away from the bolt, is displaced laterally with respect to said mould and is once again moved toward the mould, until maximum torque is detected. After this second cycle, if no signal of maximum torque is received, control means **9** acknowledge that operation has not been successfully carried out, thus raising an appropriate alarm.

[0099] The invention brings about several advantages with respect to the prior art cleaning and maintenance of casting table assembly. As explained above, prior art processes are essentially based on manual operations. The installation and method according to the invention enable the user to facilitate the maintenance of casting tables, moulds and mould components such as starting heads.

[0100] As mentionned several times throughout this description, it is highly desirable to individually indentify certain components, i.e. to allocate a unique identification code to all parts of certain types of components. This applies in particular to the table 10 and to the moulds 12. Said identification code can be of any suitable type, such as a bar code, a QR code, an alphanumerical code, and it can be of any suitable kind, such as an engraved code (for example by laser engraving), or an affixed label printed on a suitably heat-resistant material. It can be read by any suitable reading device, such as a camera liked to a suitably configured computing device executing a suitably configured identification software. It is highly adavantageous to be able to keep track of each component bearing a unique identification code, both for the sake of localisation of the component within the workshop and for the sake of tracking it history of use. Concerning the history of use, the unique identification of a component such as a mold may allow to relate its state and maintenance history to the slow emergence of deviations in product quality (such as surface quality) of the cast ingots or billets.

Claims

1. An installation (I) for the maintenance, in particular the cleaning, of a casting table assembly, said casting table assembly comprising

   an upper part, also called upper table (10), said upper table comprising a rectangular frame (100), a plurality of openings (110) provided in the frame, a plurality of moulds (12), each facing a respective opening, and removable attachment means (13), in particular bolts, making it possible to attach said moulds with respect to said frame,
   a lower part, also called lower table (15), said lower table (15) comprising a body (150), a plurality of so-called starting heads (18), each being intended to be inserted into a respective mould, and locking means (19) making it possible to lock said starting heads with respect to said body,
   said installation (I) comprising

      a peripheral fence (2) defining a working area,
      a main robot (3), said main robot comprising a body as well as coupling means (34) mobile with respect to said body,
      displacement means (37) adapted to displace said main robot, so that it is mobile along at least one direction of said working area,
      a set of so-called main operative devices (40 - 46), comprising at least

         a starting head grab device (40), provided with means (405, 406) for grabing each starting head,
         a brushing device (42), provided with means for brushing at least surface of upper table opposite to said moulds,
         a screw device (44), provided with means (45) for screwing/unscrewing each mould with respect to upper table; and
         a mould grab device (46), provided with means (464, 466) for grabing each mould,
         bearing in mind that said screw device and said mould grab device may form

a single combined screw and mould grab device,
each main operative device being provided with complementary coupling means (402, 422, 442, 462) adapted to cooperate with said coupling means of main robot so as to permit a removable attachment between each main operative device and said main robot,

a reception zone (200) for said lower part of said casting table assembly,
a tilting device (6), adapted to move into rotation upper part of said casting table assembly, control means (9) comprising:
a human machine interface (90),
control lines (95-98) adapted, upon receipt of inputs actuated by an operator, to transmit control orders to at least said main robot (3), said displacement means (37) and each of said operative devices (40 - 46).

2. An installation according to any of proceeding claim, wherein brushing device (42) comprises a brushing assembly (43) provided with a shaft (431) and at least one brush, adapted to be removably attached on said shaft, advantageously at least two brushes (48, 49) comprising a metallic brush, for example a steel brush, and a plastic brush.

3. An installation according to any of proceeding claim, wherein screw device (44) is provided with a sensor (455) configured to detect that a predetermined so-called maximum torque has been applied to removable attachment means (13), said sensor being also configured to send an alarm to said control means if said predetermined maximum torque has not been detected.

4. An installation according to any of proceeding claim, wherein tilting device comprises two fixed bases as well as two mobile flanges, each base and each flange being equipped with complementary drive means, each flange comprises clamping means, so as to firmly maintain body of upper table with respect to said flange, said tilting device comprising also safety bridges (68) each adapted to cooperate with a respective flange.

5. An installation according to any of proceeding claim, wherein starting head grab device (40) comprises a body (400), claws mobile with respect to said body between a grab configuration and a release configuration, as well as at least one finger mobile with respect to said body between an inactive configuration and an active configuration for unlocking said locking means

6. An installation according to any of preceeding claim, wherein said installation comprises a so-called auxiliary robot (7), said auxiliary robot (7) comprising a body as well as a cleaning device adapted to clean starting head.

7. An installation according to any of proceeding claim, wherein said installation comprises at least one cleaning station (82, 83), comprising holding means for holding said starting head, said installation comprising also a so-called auxiliary cleaning robot (7) provided with cleaning means for cleaning said starting head.

8. An automated maintenance method of a casting table assembly, said casting table assembly comprising

an upper part, also called upper table (10), said upper table comprising a rectangular frame (100), a plurality of openings (110) provided in the frame, a plurality of moulds (12), each facing a respective opening, and removable attachment means (13) making it possible to attach said moulds with respect to said frame,
a lower part, also called lower table (15), said lower table (15) comprising a body (150), a plurality of so-called starting heads (18), each being intended to be inserted into a respective mould, and locking means (19) making it possible to lock said starting heads with respect to said body,
said method comprising, under control of control means (9),
placing said lower table on said reception zone,
engaging said upper table on said tilting device,
removing at least one, in particular a majority of starting heads, via starting head grab device (40), cleaning said starting heads and placing back said cleaned starting heads in their initial location,
brushing at least surface of upper table opposite to said moulds via said brushing device (42),
removing at least one, in particular a majority of moulds, via said screw device (44) and said mould grab device (46) and driving said moulds to a repair area.

9. A maintenance method according to proceeding claim, wherein

some first parts of upper table, in particular cover (114) and protrusions (115) protruding out of said cover, are cleaned with the metallic brush; and
some second parts of upper table, in particular roads (111), corners (112) and holes (113) are cleaned with the metallic brush the plastic brush.

10. A maintenance method according to proceeding claim, wherein metallic brush is given a first so-called cleaning height (H1) to clean first protrusions (115), and a second so called cleaning height (H2) to clean then cover (114).

11. A maintenance method according to proceeding claim, wherein the instantaneous wear of metallic brush is determined and a warning message is sent, if the instantaneous magnitude of said wear is superior to a predefined value.

12. A maintenance method according to preceeding claim, wherein determining the instantaneous wear of metallic brush comprises moving said brush towards a so-called reference surface, calculating the motion distance and comparing it to a threshold distance.

13. A maintenance method according to any of claims 8 to 12, wherein removing each mould comprises unscrewing said bolts, and wherein unscrewing each bolt first comprises

- engaging said screwing/unscrewing means with said bolts,
- rotating said screwing/unscrewing means in the direction of screwing said bolts and
- if said maximum torque is detected, rotating said screwing/unscrewing means in the direction of unscrewing said bolts.

14. A maintenance method according to any of claims 8 to 13, wherein cleaning said starting head comprises

- moving said starting head, with main robot, towards cleaning station,
- leaving alone said starting head on cleaning station; and
- cleaning starting head on said cleaning station, with auxiliary cleaning robot (7).

15. A maintenance method according to any of claims 8 to 14, wherein engaging said upper table on said tilting device comprises

- moving upper table horizontally towards said first flange until it abuts against clamping means of said first flange,
- moving said second flange until clamping means of said second flange cooperate with said upper table; and

positioning each safety bridge close to each flange.

Fig. 1

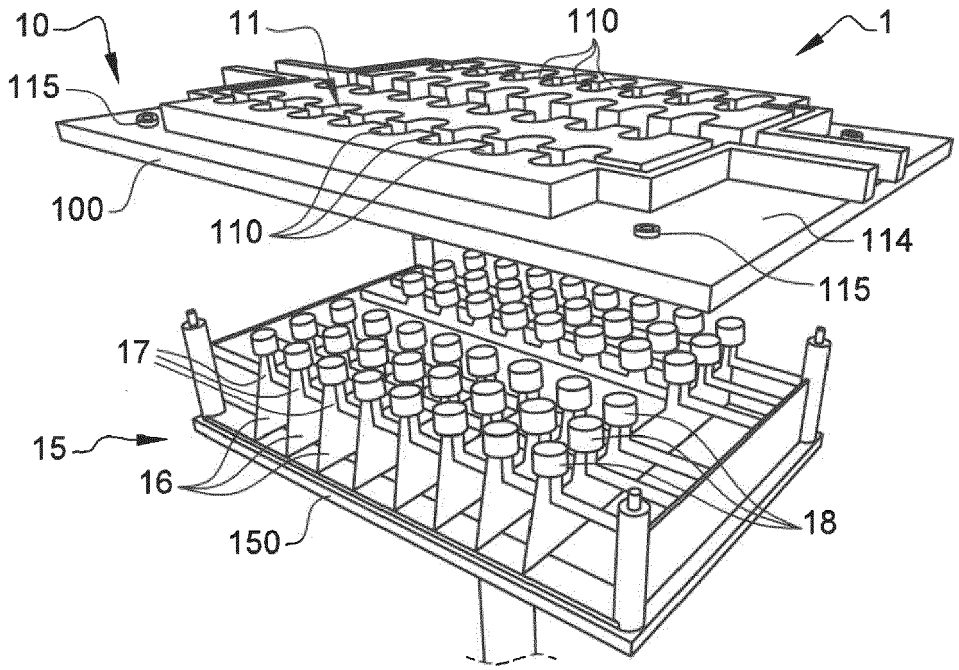

Fig. 2

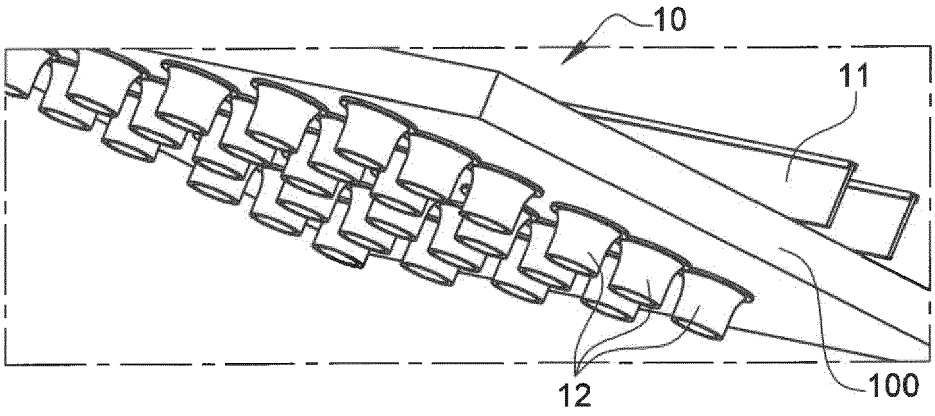

Fig. 3

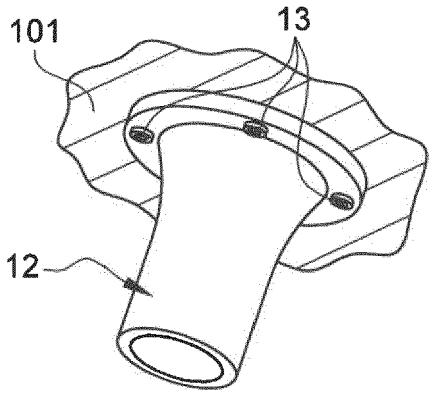

Fig. 4

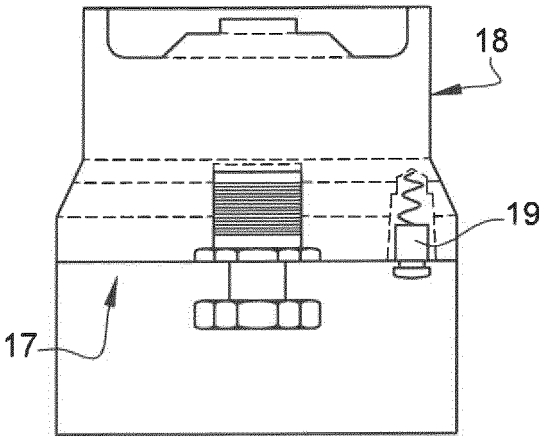

Fig. 5

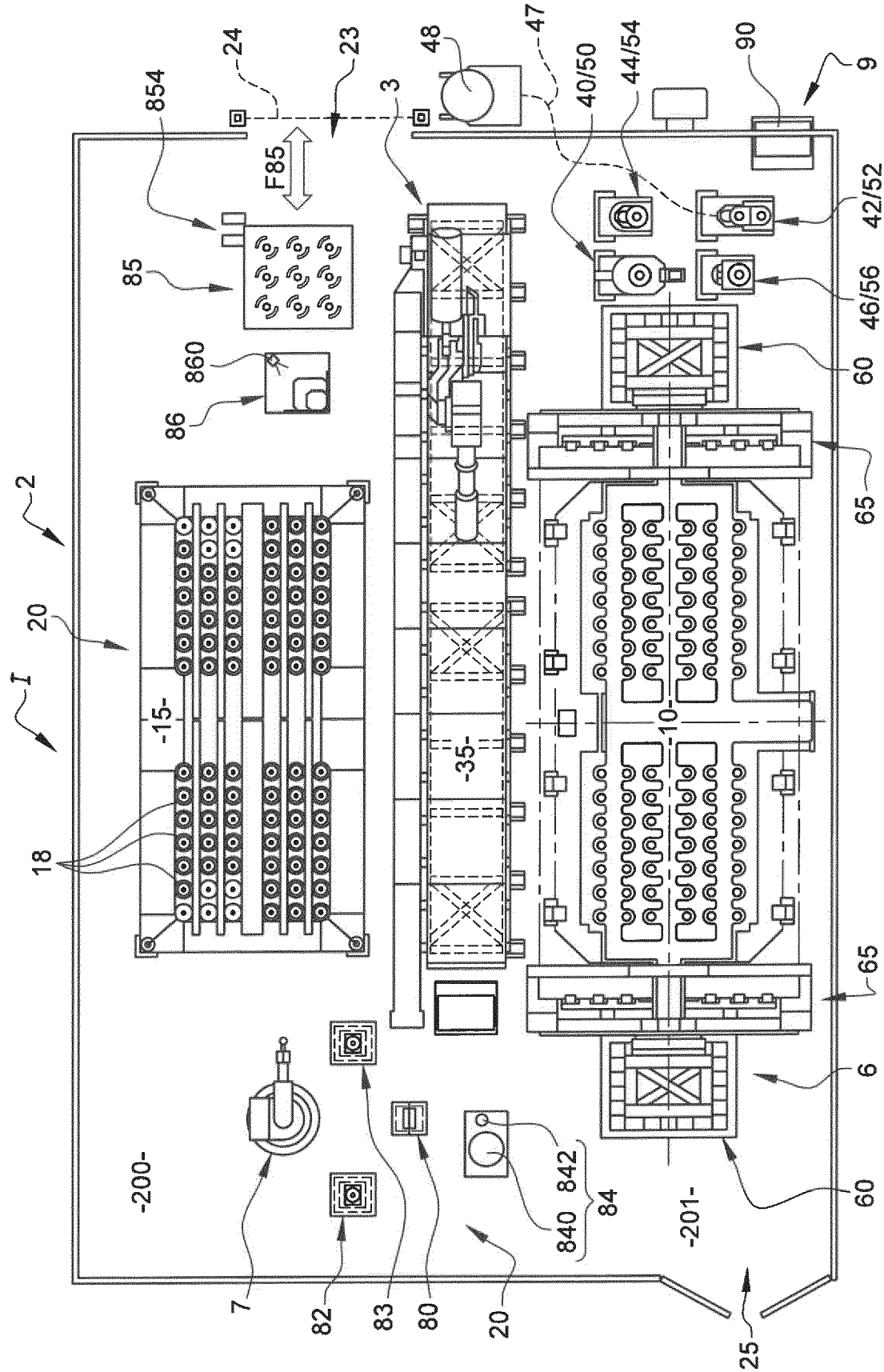
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Fig. 6

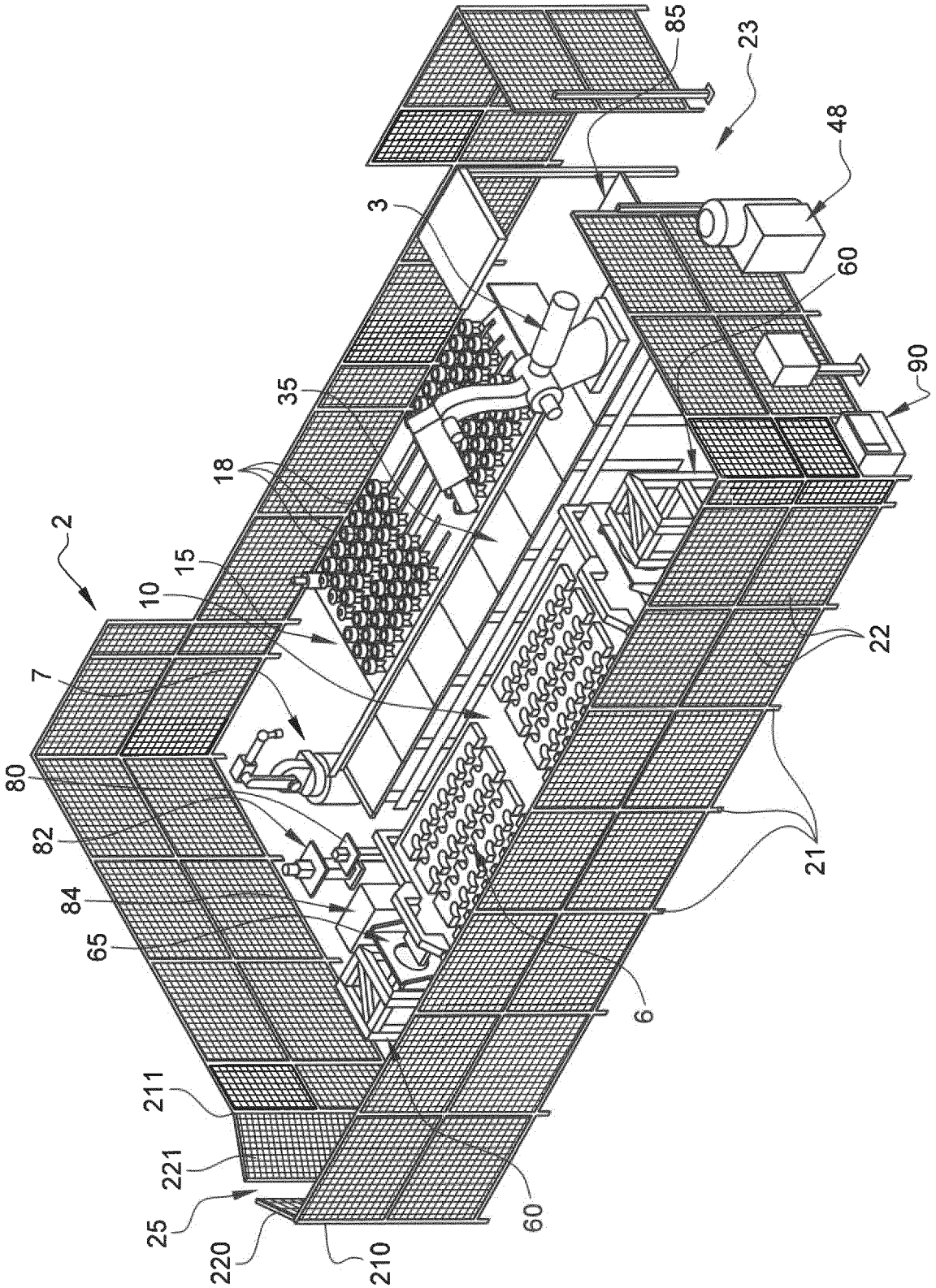
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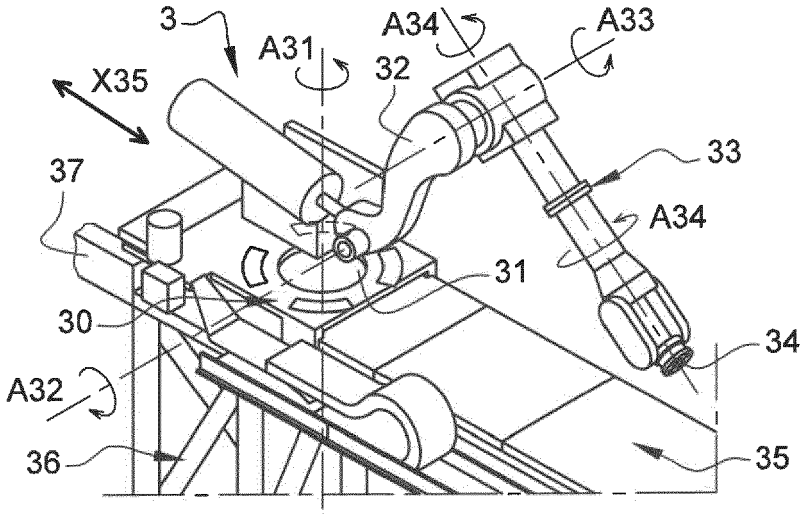
Fig. 7



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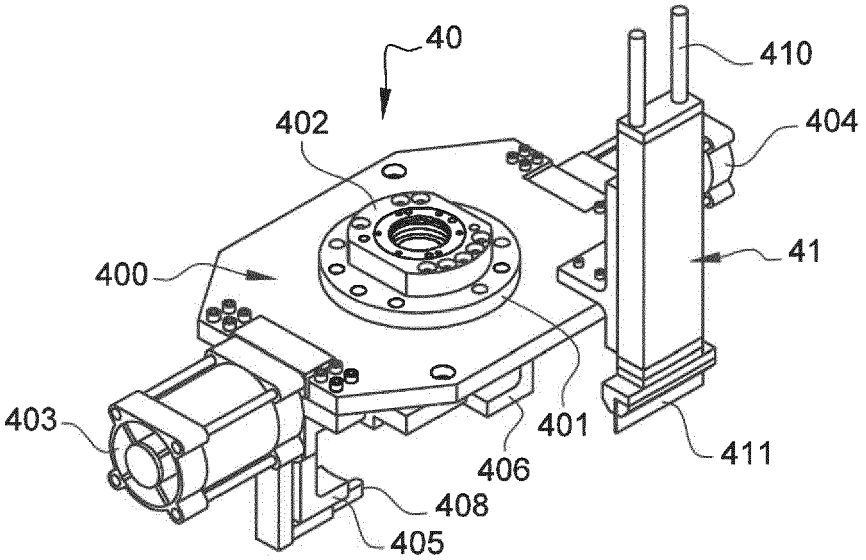

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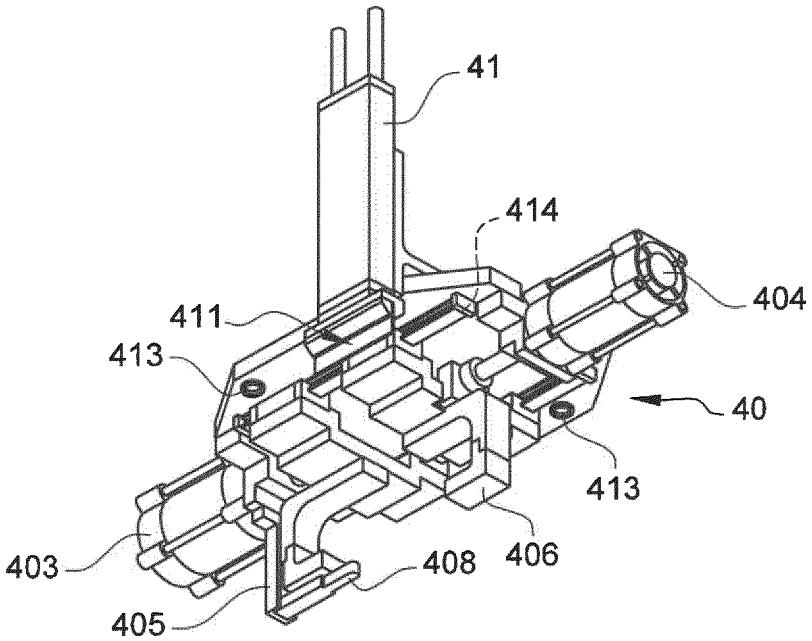

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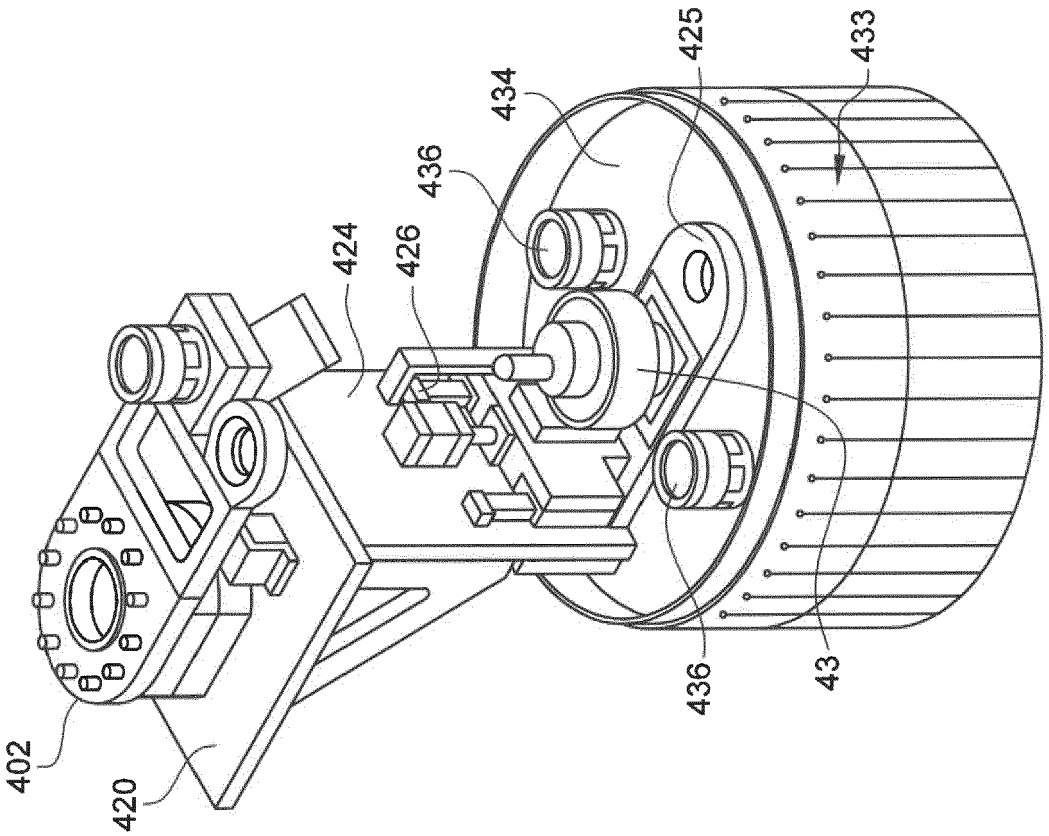
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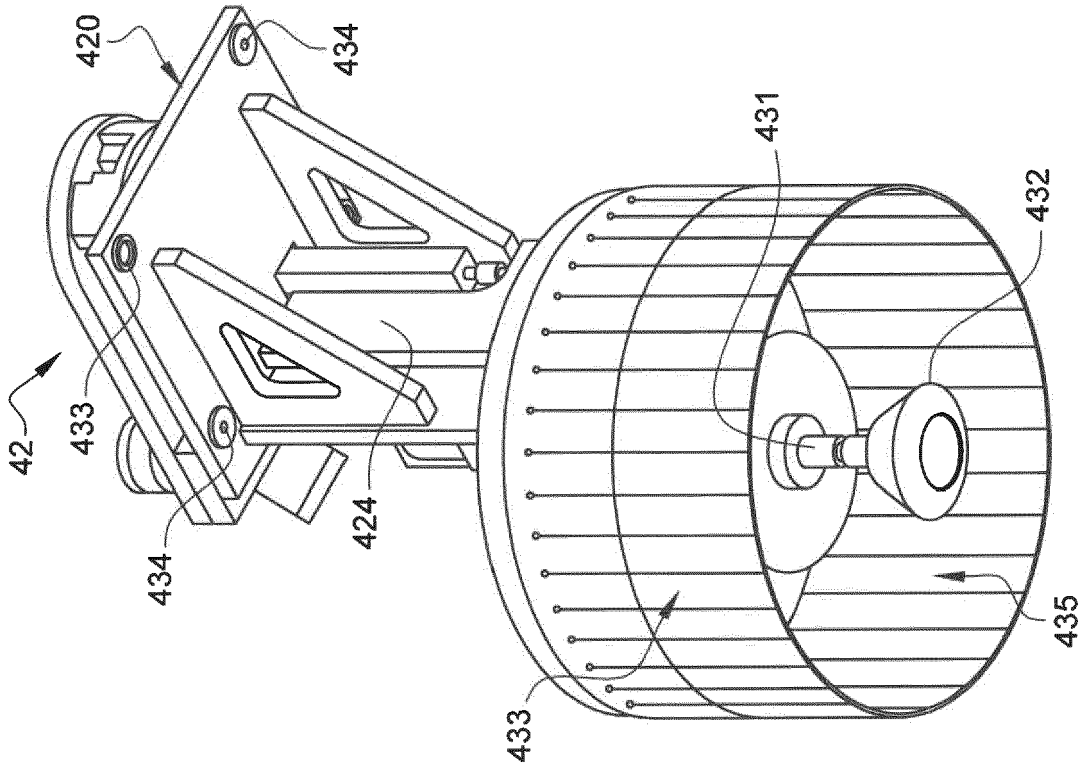
Fig. 10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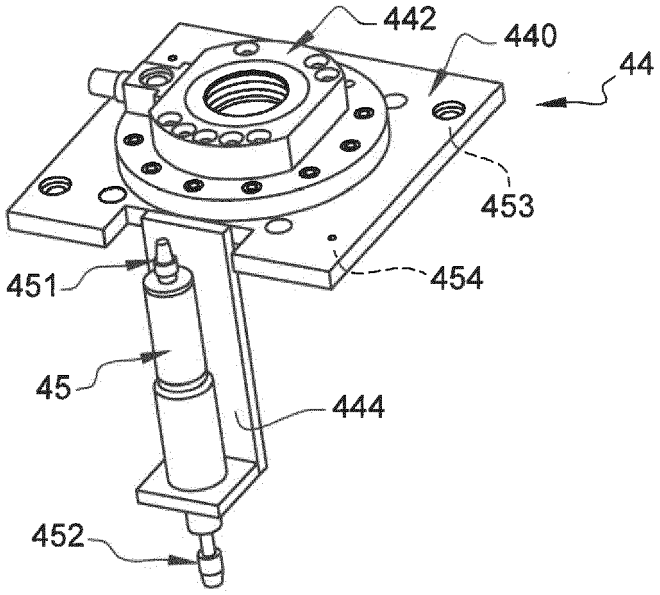

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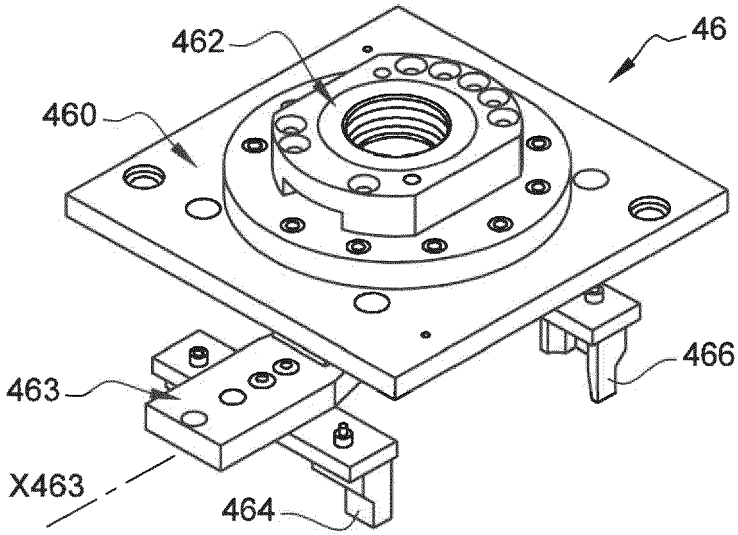

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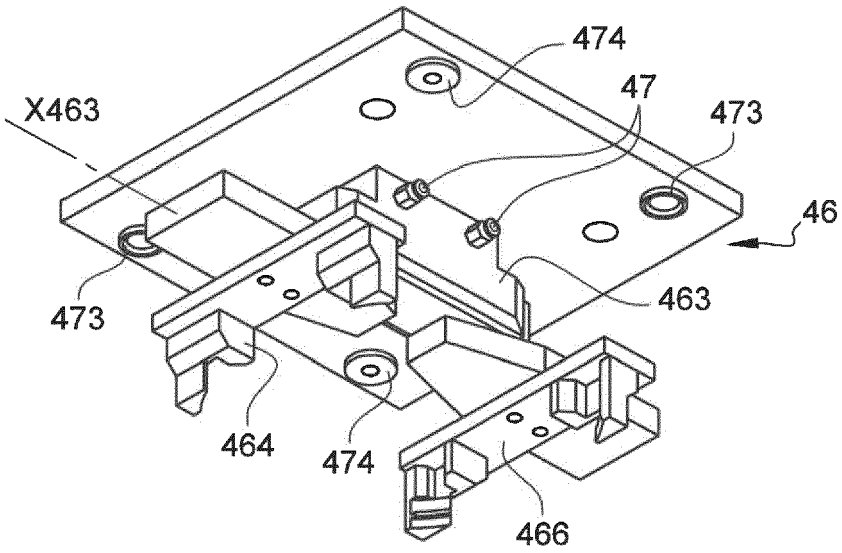

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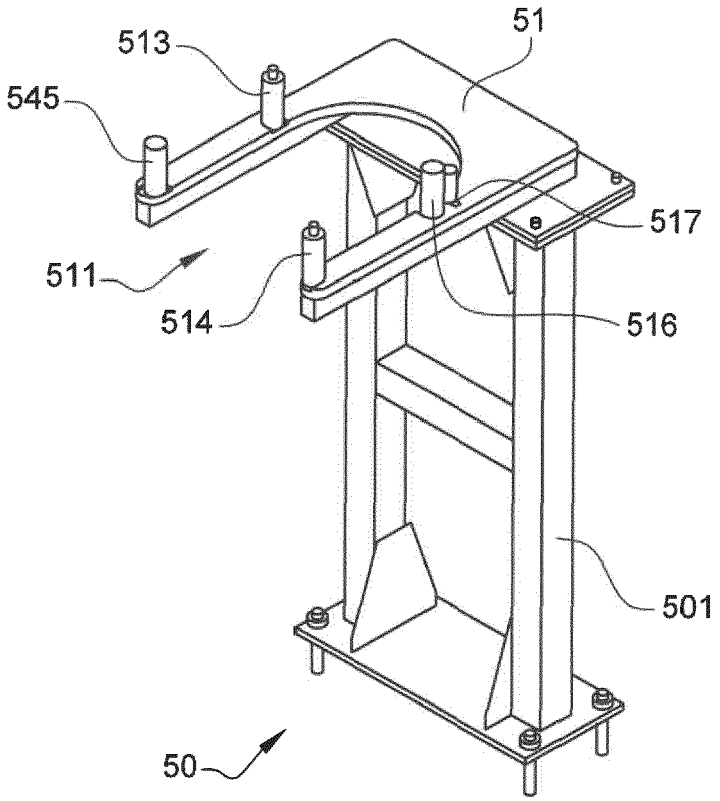
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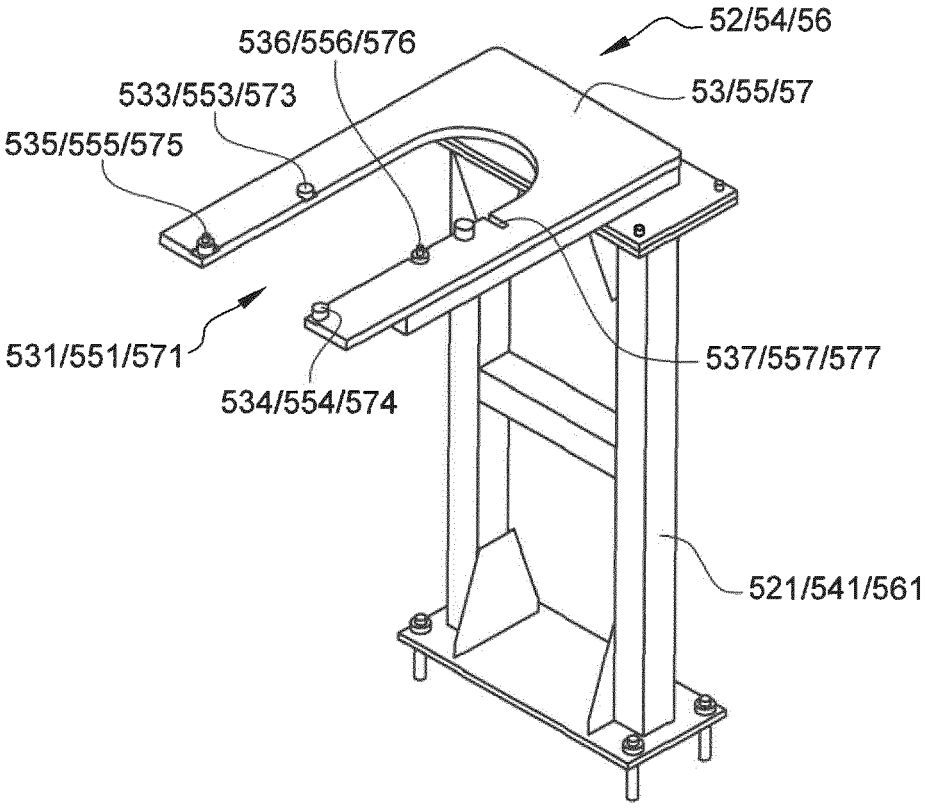
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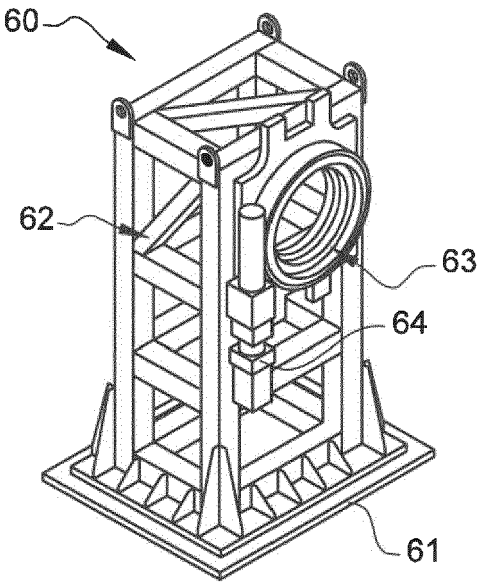
Fig. 17



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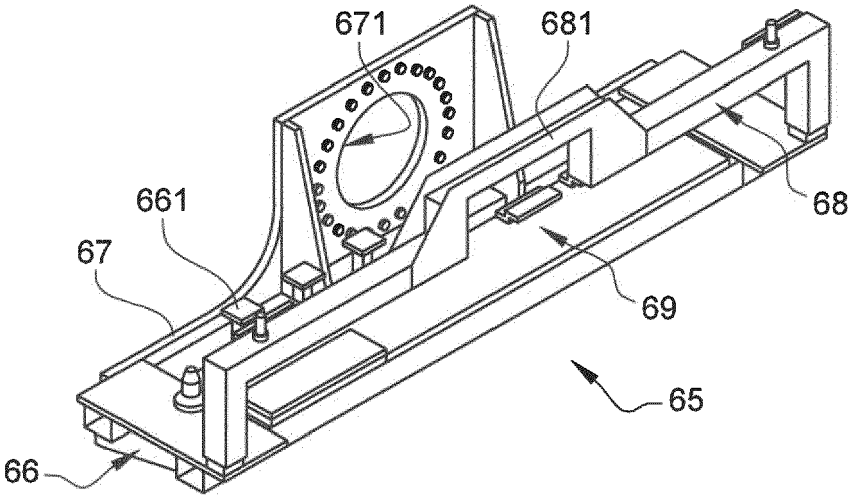

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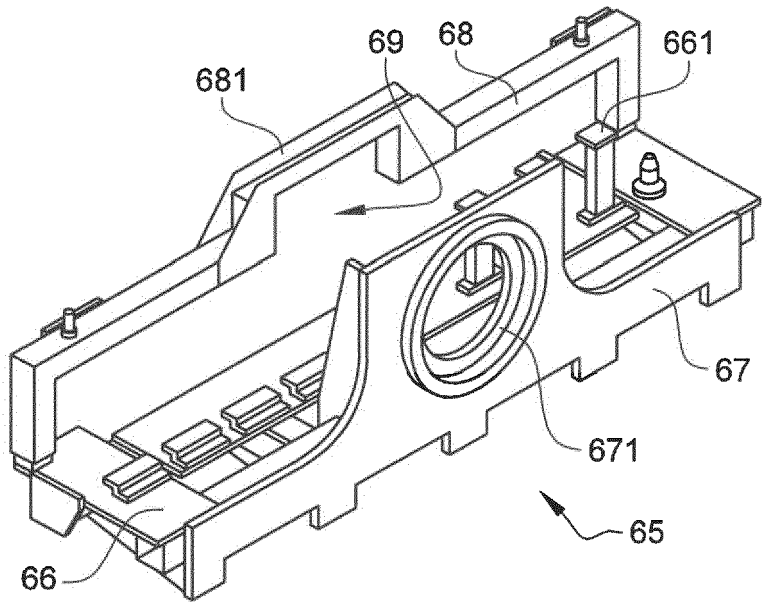

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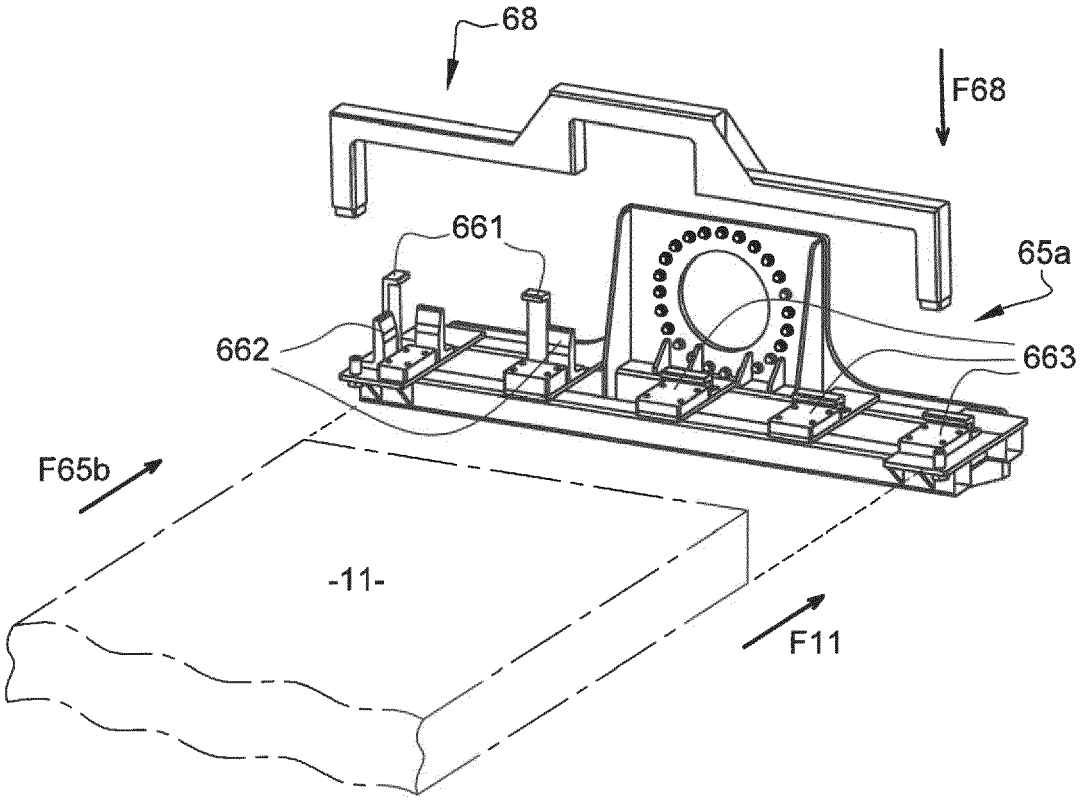

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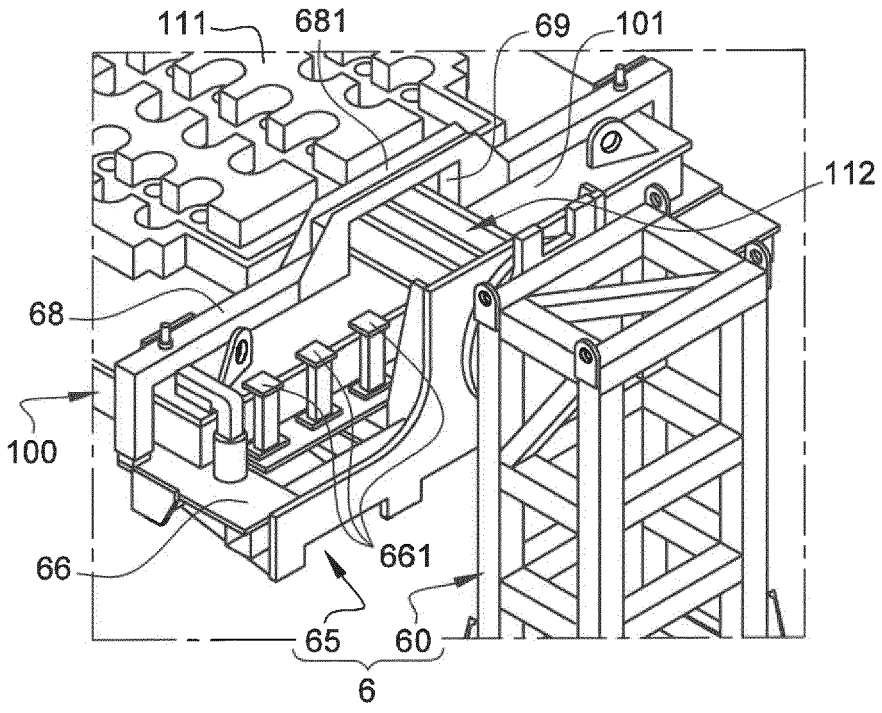

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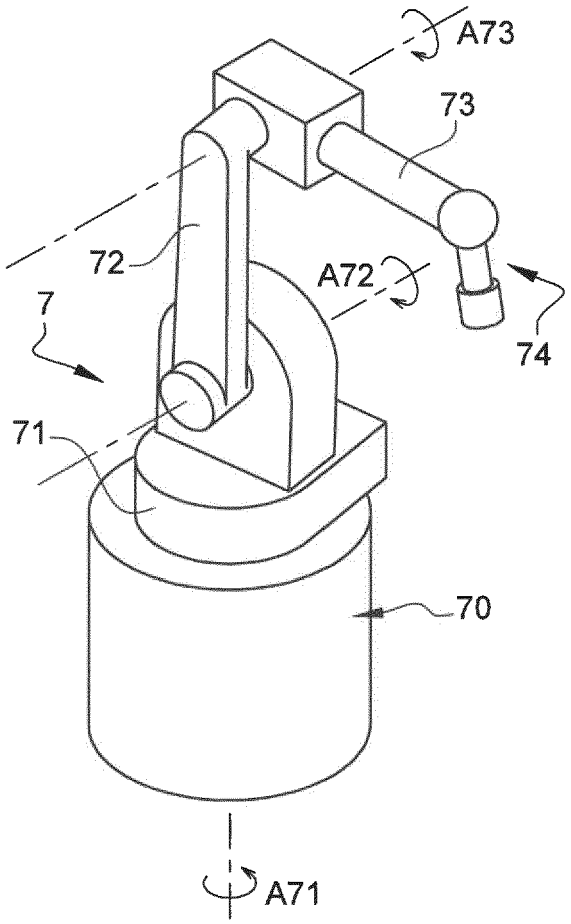

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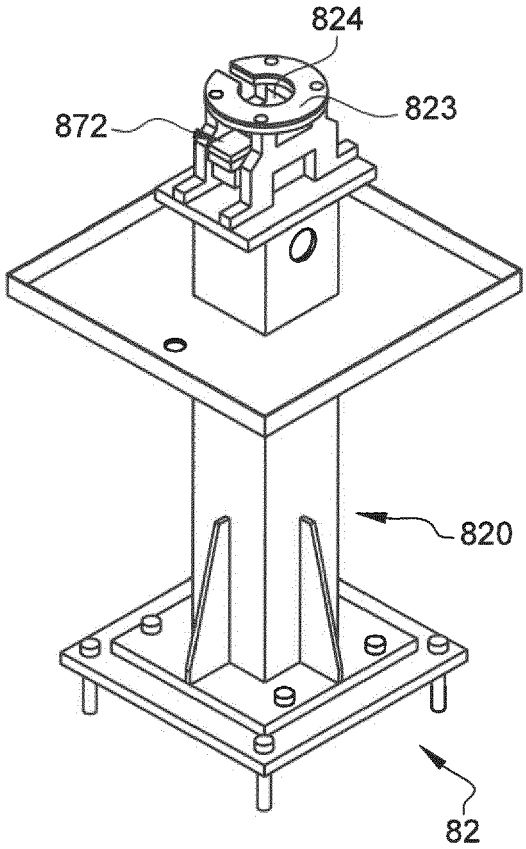

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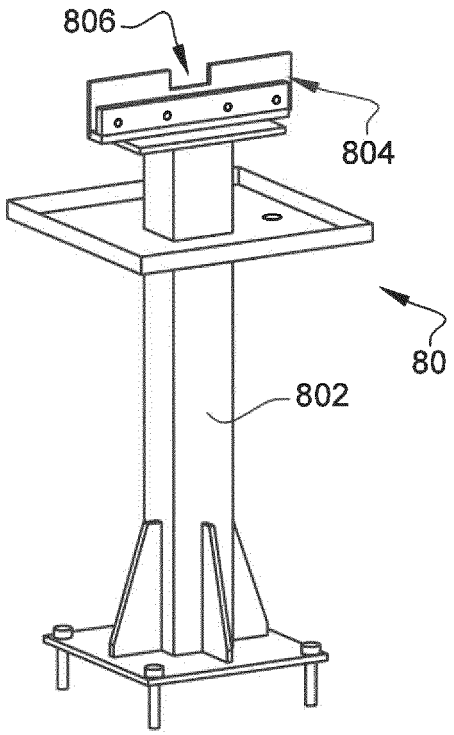

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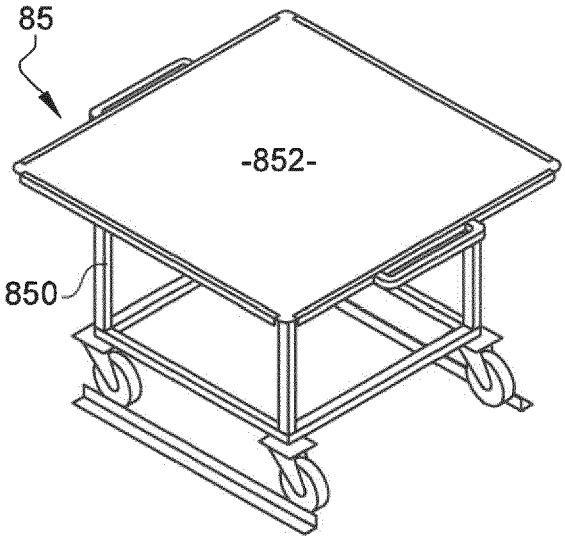

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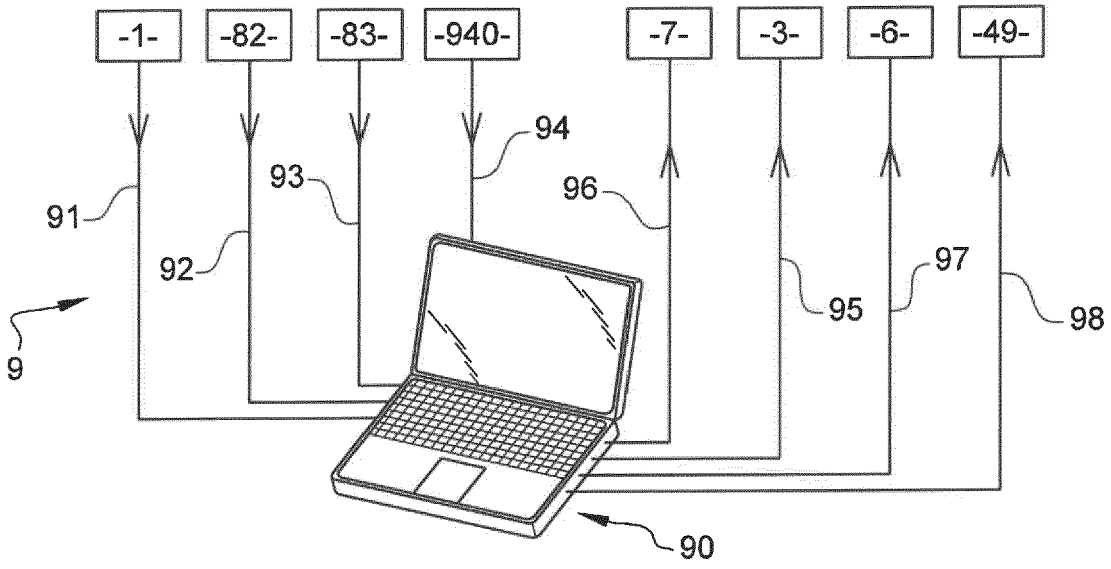

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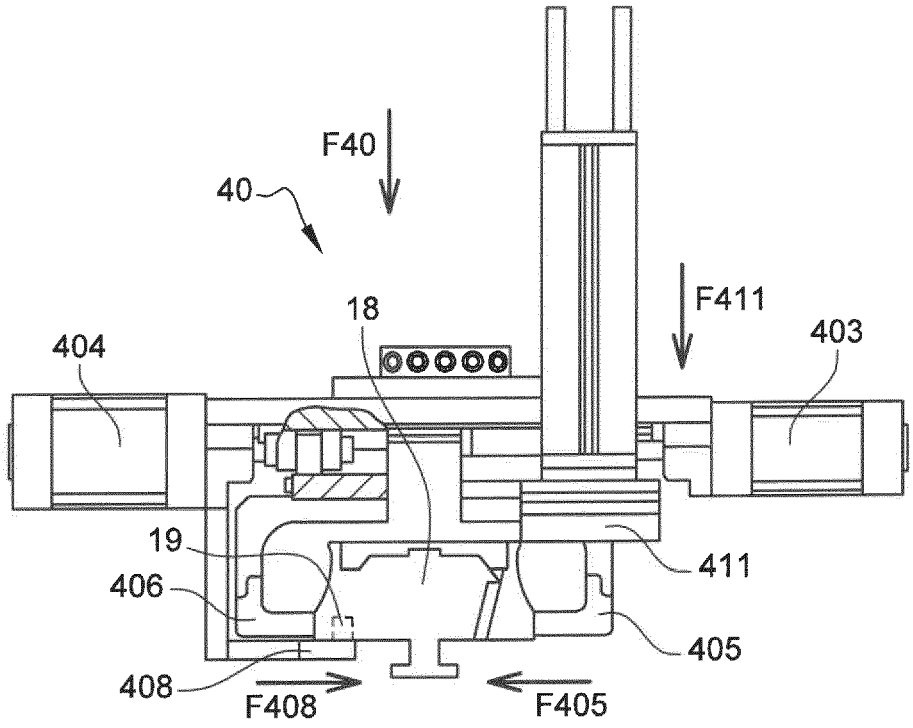
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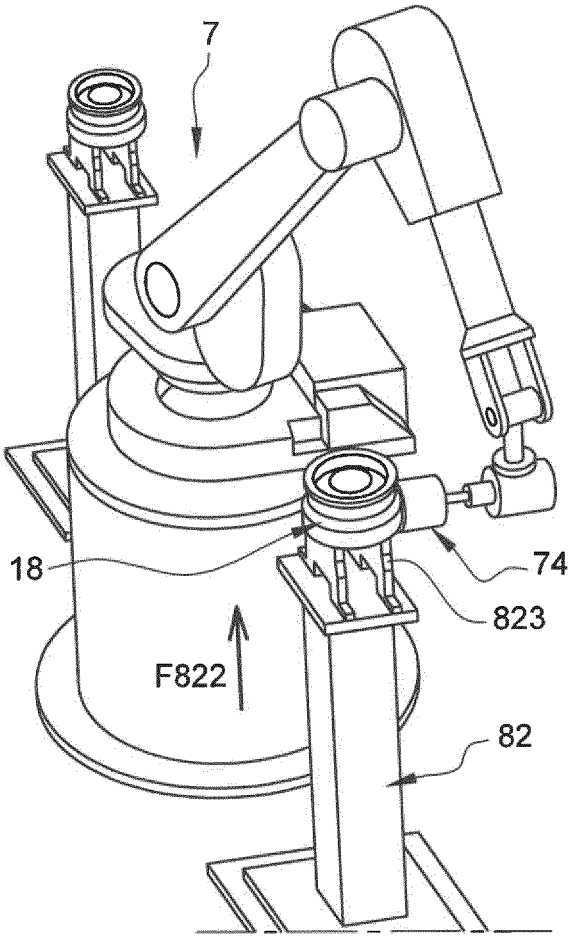
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Fig. 28

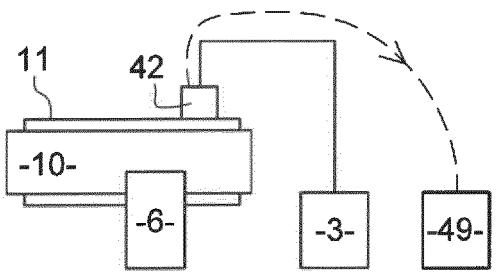


Fig. 28b

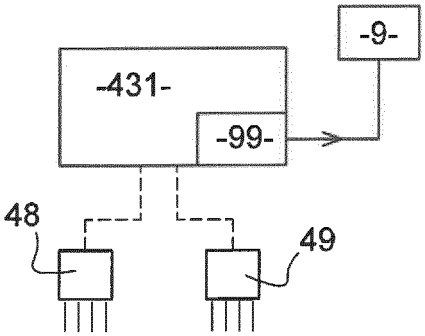


Fig. 28a

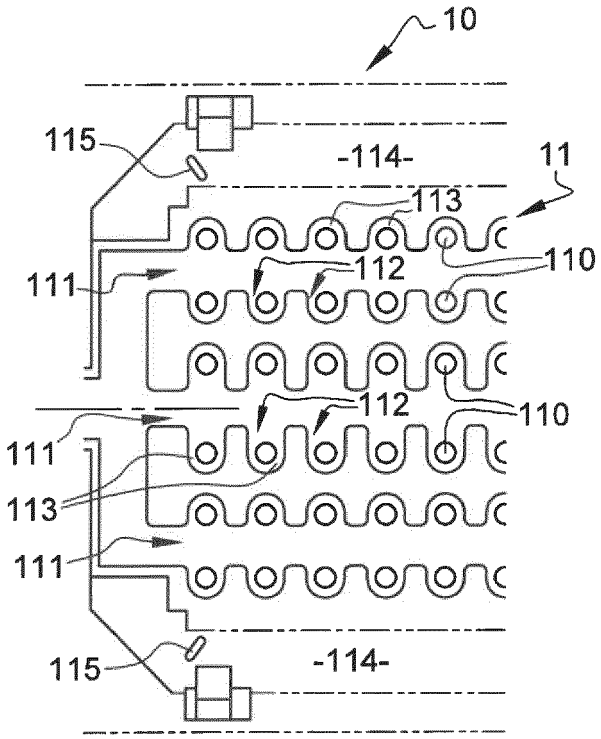


Fig. 28c

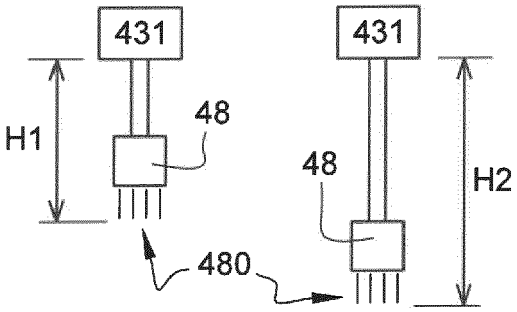
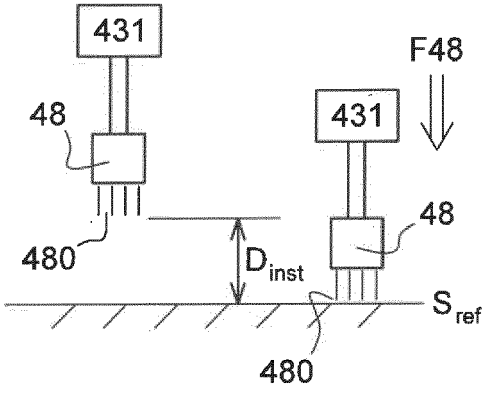


Fig. 28d



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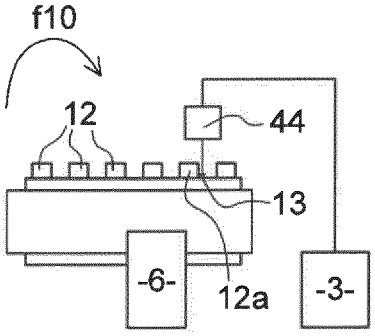

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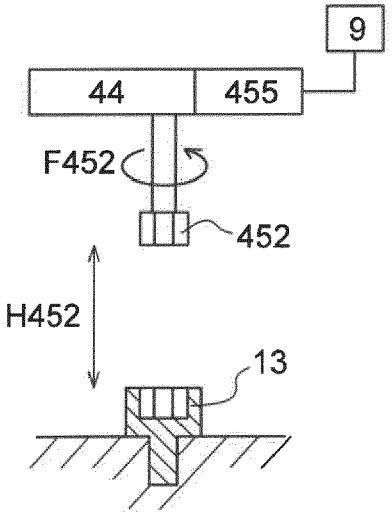

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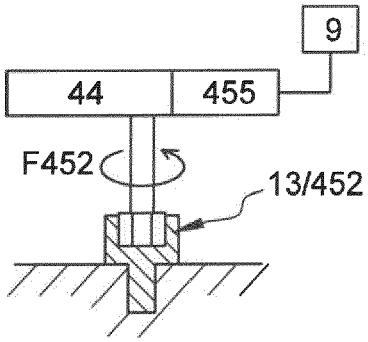

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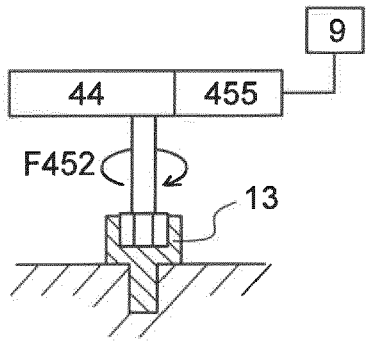

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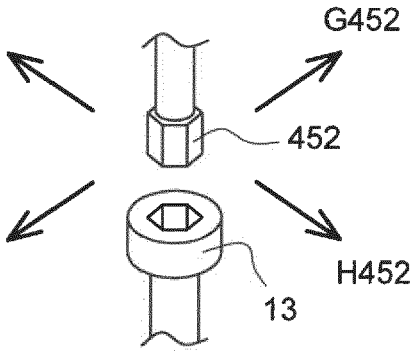

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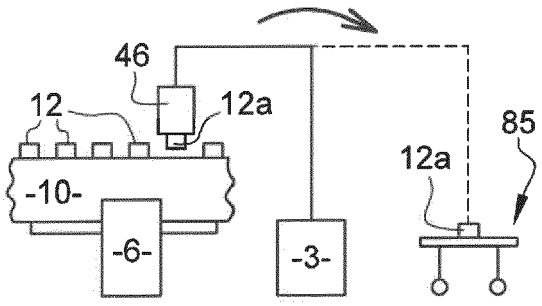

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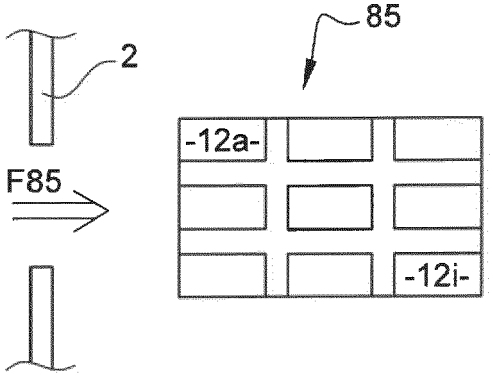

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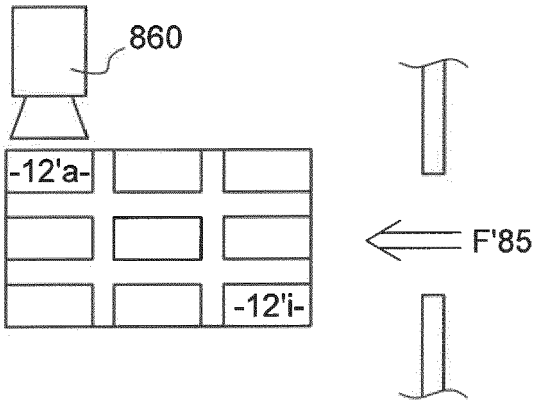

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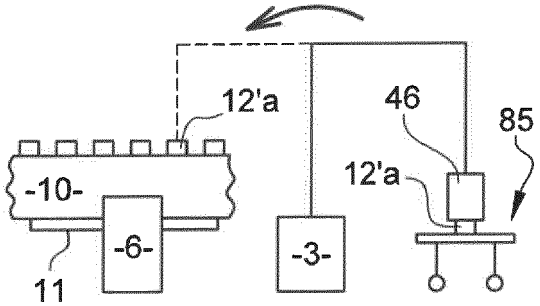

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EUROPEAN SEARCH REPORT

Application Number
EP 23 17 3020

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	JP H07 16739 A (SHINAGAWA REFRACTORIES CO) 20 January 1995 (1995-01-20) * paragraphs [0001], [0017]; figure 1 *	1-15	INV. B22D11/04 B22D11/049 B22D11/16 ADD. B22D11/14 B22D47/02

TECHNICAL FIELDS SEARCHED (IPC)

B22D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 September 2023	Momeni, Mohammad

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22-09-2023

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JP H0716739 A	20-01-1995	JP 3179251 B2	25-06-2001
		JP H0716739 A	20-01-1995

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