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(71) Applicant: **Prometeo S.r.l.**
37100 Verona (IT)

(72) Inventor: **Saullo, Franca**
91011 Alcamo (TP) (IT)

(74) Representative: **Premru, Rok**
Via De Amicis 4
20052 Monza (MI) (IT)

(54) **Apparatus and process for surface treatment of elongate members, particularly metal sections**

(57) It is hereby disclosed an apparatus (1) and a process for carrying out at least one surface treatment on elongate members (10) particularly metal sections for doors and window frames (10), comprising:
- a plurality of pairs of opposed clamps (2a, 2b), each of said pairs of opposed clamps being aligned along a substantially horizontal axis (X), each of said pairs of opposed clamps (2a, 2b) being designed to be intermittently and synchronously moved in one direction along a closed circuit (3), at least one clamp (2a, 2b) of each of said pairs of opposed clamps (2a, 2b) being adapted to grasp and hold said elongate member (10) suspended and under tension,
- a station (10) for loading said elongate members (10);
- a station for delivering said elongate members (10);
- at least one processing station (5) having one entry (51) and one exit (52) separate from each other, the closed circuit 3 passing therethrough.

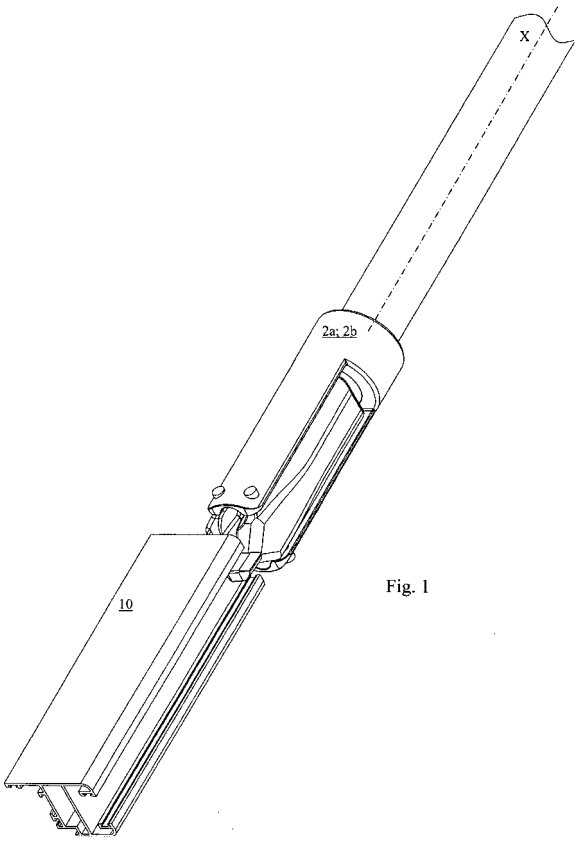

Fig. 1

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Description

[0001] There are disclosed herein an apparatus and a process for surface treatment of elongate members, particularly metal sections.

[0002] As used herein, the term surface treatment is intended to include treatments such as liquid coating, powder coating, as well as the creation of ornamental designs obtained through multilayer application (including powder-on-powder, liquid-on-powder and powder-on-liquid coating) and decoration with sublimable dyes.

[0003] The term surface treatment is intended to also include other treatments, such as chemical and/or electrochemical and/or mechanical treatments.

[0004] Particularly, there is disclosed herein an apparatus and a process for decorating aluminum sections, such as sections designed to form doors and window frames, through sublimation, i.e. by contact transfer of sublimable dyes.

[0005] Surface treatments are known to be carried out on metal sections, such as aluminum sections for doors and window frames.

[0006] In one prior art technique, aluminum extruded parts can be arranged vertically and handled in various workstations.

[0007] Currently available aluminum extruded parts can be as long as 7 meters.

[0008] Therefore, the systems for surface treatment of metal sections have huge height requirements.

[0009] Also, the vertical arrangement of sections is an obstacle to certain processing steps.

[0010] For instance, temperature homogeneity is difficult to achieve in stoving ovens (where paints are baked or cured).

[0011] Systems are also known in which the sections are horizontally laid on sliders or the like and carried to the various workstations.

[0012] In these kinds of systems, the difficulty arises of treating the part of the section that rests on or faces towards the slider.

[0013] Surfaces decorated by sublimation are preventively coated, to form a bond coat for sublimable dyes.

[0014] Decoration by sublimation - also known in the art as "sublichromy" - consists in the application of a transfer film, also known as transfer substrate, on the surface to be decorated.

[0015] Ornamental designs are formed with sublimable dyes on the inner side of the transfer film, i.e. on the side in contact with the surface to be decorated.

[0016] By appropriate heating, the dies on the transfer film will sublimate and migrate to the surface of the part to be decorated in contact with the film, where they condense, thereby recreating the designs originally present on the transfer film; after heating, the transfer film is removed.

[0017] For faithful reproduction of the ornamental design originally present on the film, the transfer film has to perfectly adhere to the surface to be decorated; in fact, where the film does not adhere adequately to the surface of the section, the decoration is of poorer quality.

[0018] EP 0 950 540 B1 discloses an apparatus for decoration by sublimation, which comprises a workbench, on which a workpiece is laid, which workpiece is sealably enclosed in a transfer substrate having the shape of a stocking, a bag or an envelope.

[0019] A suction device creates a negative pressure in the transfer substrate, for the latter to adhere to the surface to be decorated, while heating means above the workbench heat the transfer substrate to cause sublimation.

[0020] Devices are currently available for wrapping a film-like transfer substrate around aluminum substrates, whereupon the film is sealed along a direction parallel to the extension of the section, to obtain a tubular sheathe all around the section.

[0021] Adhesion between the transfer film and the surface to be decorated is obtained by creating a negative pressure within the tubular sheathe.

[0022] Once the sections are enclosed in the tubular sheathes, they are laid on sliders having opposed suction heads, which suck in air from the ends of the tubular sheathes, thereby forcing adhesion of the sheathes to the sections.

[0023] The sliders with the sections thereon come into and out of an oven having a single entry/exit opening.

[0024] Decoration systems are further known in the art, in which, after being wrapped up in their tubular sheathes, the sections are loaded onto a first end of a straight chain conveyor that passes through a tunnel oven extending along a substantially horizontal straight path.

[0025] A section delivery station is provided at the opposite end of the chain conveyor.

[0026] The straight chain conveyor further has two parallel chains at its ends, whose links are designed to drive the opposed suction heads for maintaining vacuum conditions in the tubular sheathes as they are carried along.

[0027] One apparatus of this type is disclosed in the Italian patent IT 1 336 079.

[0028] Prior art systems still suffer from certain drawbacks.

[0029] The decorations obtained thereby are not always of adequate quality.

[0030] Also, prior art systems have a low throughput and demanding labor requirements.

[0031] In case of frequent size change (involving a change of the mass of the workpieces being treated), decoration quality consistency requires control of oven power and/or residence times in the oven, to ensure sufficient homogeneity of heat on the workpieces being treated.

[0032] Nevertheless, in prior art surface treatment apparatus, oven power adjustment is affected by long transients.

[0033] The control of residence times of metal sections in the oven may further lead to dramatic throughout re-

duction.

[0034] The aim of the inventor is to obviate at least some of prior art drawbacks and particularly the above mentioned drawbacks.

[0035] This aim was achieved by an apparatus for surface treatment of elongate members as defined in claim 1, which implements the corresponding process as defined in claims 15 and 16.

[0036] Further advantages may be further achieved by the features of the dependent claims.

[0037] Certain possible embodiments of the apparatus and process of the invention are illustrated in the following annexed figures, in which:

- Figure 1 is a schematic view of a clamp grasping one end of a metal section;
- Figures 2 and 2a are views of a claw clutch that is used to adjust the opening of a clamp;
- Figures 3 and 3a are two views of an oven;
- Figure 4 is a view of a clamp with an air intake;
- Figure 4a is a perspective view of the clamp of Figure 4;
- Figure 4b is a view of two details of the clamp of Figure 4;
- Figure 4c is a view of three details of the clamp of Figure 4;
- Figures 5a and 5b are partially sectional longitudinal views of the clamp of Figure 4 in two operating positions;
- Figure 6 is a schematic sectional side view of the apparatus for decorating metal sections;
- Figure 7 is a schematic sectional side view of the apparatus for decorating metal sections in more complete form than in Figure 6;
- Figure 8 is a schematic side view of the driving chains of the conveyors of the apparatus of Figure 6;
- Figure 9 is a sectional view of a portion of the apparatus of Figure 6;
- Figure 10 is an enlarged view of a detail of the view of Figure 9;
- Figures 11 and 12 are two front views of the device as shown in Figure 9;
- Figure 13 is a longitudinal sectional view of a device for applying tension on a clamp, when the clamp can be displaced in its axial direction;
- Figure 14 is a view like Figure 13, when the clamp is locked under tensile stress;
- Figure 15 is a partially sectional detail of a slider associated to a chain;
- Figures 16a and 16b show a detail of the device for opening and closing the clamps into two different operating conditions;
- Figures 17 and 17a are schematic views of a device for temporarily unlocking the clamp of Figures 1 and 4;
- Figures 18 and 19 are two operating sequences of a rotating brush device;
- Figure 20 is a schematic front view of the apparatus in the rotating brush version (the oven being omitted);
- Figure 21 is a schematic view of an apparatus for wrapping a film material around a section that is held in a stretched state by two opposite clamps, without sealing it;
- Figure 22 shows a detail of the apparatus showing how a wrapped, unsealed film is adhered to a metal section;
- Figures 23, 23a, 23b show a hollow element for sucking in air to cause the film suspended on the section to adhere to the section itself;
- Figure 24 shows a detail of the oven of the apparatus of Figure 6;

[0038] Referring to the numerals as used in the drawings, there is herein disclosed an apparatus 1 for surface treatment, e.g. decoration by sublimation, of metal parts, particularly extruded metal sections 10 designed for making doors and window frames.

[0039] The apparatus 1 comprises a plurality of pairs of opposed clamps 2a, 2b aligned along a substantially horizontal axis X, i.e. an axis substantially orthogonal to the weight force.

[0040] Each pair of opposed clamps 2a, 2b is adapted to grasp the extruded metal section 10 at its opposed ends and to hold it suspended under tensile stress.

[0041] Each pair of opposed clamps is designed to be intermittently and synchronously moved in one direction along a closed circuit 3, i.e. a circuit extending along a closed loop.

[0042] Therefore, each extruded metal profile 10 may maintain a substantially and/or generally straight horizontal orientation and be carried along its path 3 without requiring any support surfaces such as sliders, handling pallets or linear chain conveyors.

[0043] Since the sections 10 are held in a suspended state, homogeneous quality of surface treatment such as coating or decoration by sublimation is ensured throughout the workpiece surface.

[0044] The closed-loop circuit 3 comprises a loading station, a delivery station and at least one processing station 5, having one entry 51 and one exit 52 separated from each other.

[0045] By having the sections 10 move in one direction along a closed circuit 3, overall processing times can be dramatically reduced.

[0046] The spacing between pairs of opposed clamps 2a or 2b can be adjusted along the axis X, for the apparatus to be adapted to the length of the metal sections 10 to be subjected to surface treatment.

[0047] In the illustrated embodiment, each clamp has a first member 211 and a second member 212.

[0048] The gripping portions of the two members have a substantially and/or generally rectangular shape, with the longer dimension parallel to the axis X.

[0049] In a possible embodiment, the first member 211 has a transverse gripping dimension (transverse to the

axis X) of less than half the transverse gripping dimension of the second member 212.

[0050] This solution allows the clamp to be adapted to various transverse profiles of the sections used in the field of doors and window frames.

[0051] In one embodiment, the gripping surface of one of the two members, e.g. the first member 211 has at least two claws, whereas the gripping surface of the other member 212 has at least two cavities, opposite the two claws of the first member (see Figures 4, 4a, 4b, 4c).

[0052] This solution affords a better grip at the ends of the sections 10.

[0053] In a possible embodiment, not shown, the processing station 5 may be a powder or liquid coating station.

[0054] In the embodiment of the figures, the apparatus 1 is used for decoration by sublimation, wherefore the apparatus comprises an oven 5 for heating sections 10 enclosed or wrapped up in films 101 that act as substrates for sublimable dye decorations.

[0055] The oven 5 is a tunnel oven, having one entry 51 and one exit 52 separate from each other, and the closed circuit 3 passing therethrough.

[0056] Dye sublimation requires the tunnel oven 5 to be able to reach an internal temperature of at least 200°C and preferably at least 230°C.

[0057] If the apparatus is designed for processes of decoration by sublimation, it can be equipped with air intakes 4a or 4b, also located in opposed positions, and moving along with the clamps, for sucking in air from within the envelope 101 (or stocking or tubular member) that encloses the section 10.

[0058] The air intakes 4a or 4b can be integral with the clamps 2a, 2b, and particularly oriented parallel to the axis X.

[0059] If the transfer substrate 101 has the form of a tubular sheath, the air intakes 4a, 4b are located in the end portions of the sheath.

[0060] In this case, the opposed clamps 2a, 2b can project out of the air intakes 4a, 4b.

[0061] The air intakes 4a, 4b operate along a portion of the closed circuit 3 that corresponds to the path between the loading station and the exit of the oven 5.

[0062] The oven 5 has lateral openings 58 extending along the path between the entry 51 and the exit 52, which openings are closed by lateral seals 59 in view of limiting heat losses.

[0063] The lateral seals of the oven open apart when passed over by each pair of opposed clamps 2a, 2b, and close again thereafter.

[0064] In a possible embodiment, the lateral seals of the oven are formed of sheets 59 of a material that withstands temperatures of at least 200°C - 250°C, which are pressed against each other by bending springs 591.

[0065] By having the sections 10 held suspended by the opposed clamps 2a, 2b, considerable freedom is afforded for selection of the path of the circuit 3m, as well as the conformation and arrangement of the processing stations located along the circuit 3, allowing, for example, significant reduction of the overall size of the apparatus.

[0066] Furthermore, the stations for loading and delivery of the sections 10 may be arranged on the same side of the apparatus 1, which reduces the number of operators required for operating the apparatus as well as the space required for installation thereof.

[0067] The return portion of the circuit 3 between the exit 52 of the oven and the delivery station (extending beneath the oven 5) may be used for natural or forced cooling of the sections 10.

[0068] In the embodiment of the figures, the plurality of pairs of opposed clamps 2a, 2b are driven by two parallel conveyors, such as two synchronously operating double-rail conveyors 20a, 20b.

[0069] Each double-rail conveyor 20a, 20b has a plurality of sliders 21a, 21b associated therewith (such as self-aligning roller sliders).

[0070] A clamp 2a, 2b and at least one air intake 4a, 4b are associated to each slider 21a, 21b.

[0071] Each double-rail conveyor 20a, 20b is driven by at least one chain 22a, 23a, 24a; 22b, 23b, 24b.

[0072] In the illustrated embodiment, the double-rail conveyor 20a, 20b include a plurality of pairs of chains 22a, 22b; 23a, 23b; 24a, 24b.

[0073] Each pair of chains 22a, 22b; 23a, 23b; 24a, 24b is adapted to drive the plurality of slider pairs 21a, 21b along different portions T1, T2, T3 of the closed circuit 3 with a pitch P1, P2, P3 different from that of the other pairs of chains.

[0074] For instance, three chain pulling units 22a, 22b; 23a, 23b; 24a, 24b are provided in the illustrated embodiment, which can be driven independently of one another to move the sliders 21a, 21b (and hence the extruded sections 10) along three successive portions T1, T2, T3 of the circuit 3 with three different pitches P1, P2, P3.

[0075] The first portion T1 includes the last portion before the delivery station and the path between the delivery station and the entry of the oven 5.

[0076] The second portion T2 extends along the first part of the path within the oven 5.

[0077] The third portion T3 completes the path in the oven 5 and guides the workpieces 10 out of the oven 5.

[0078] Preferably, the handling pitch P2 along the portion T2 is lower than the pitch P1 along the portion T1.

[0079] By this arrangement, the length of the path within the oven 5, i.e. the overall dimensions of the oven 5 may be reduced, without affecting the throughput per hour.

[0080] For example, the pitch P2 may be in a range from 2/3 to 1/3 of P1.

[0081] In the illustrated embodiment, the portions T3 and T1 of the circuit 3 are not contiguous; a portion T4 is provided in which the sections are temporarily stored for cooling, and are fed using special pushing means (not shown), such as air pistons.

[0082] In order that the sliders 21a, 21b can be fed along the three successive portions T1, T2, T3 of the

circuit 3, means 25a, 25b, 25 are provided for automatically coupling and uncoupling each slider 21a, 21b to and from each chain 22a, 22b; 23a, 23b; 24a, 24b.

[0083] Coupling and uncoupling occur automatically at the return points of the chains 22a, 22b; 23a, 23b; 24a, 24b.

[0084] In the illustrated embodiment, each slider 21a; 21b has two resilient opposing members or triggers 25a, 25b, hinged to the slider.

[0085] The opposing members 25a, 25b are adapted to temporarily couple each of the chains 22a, 22b; 23a, 23b; 24a, 24b.

[0086] In the illustrated embodiment, each chain 22a, 22b; 23a, 23b; 24a, 24b has a pull member 26 for engagement with the opposing members 25a, 25b.

[0087] In the illustrated embodiment, the pull member is joined to the billets of the chains 22a, 22b; 23a, 23b; 24a, 24b.

[0088] During coupling, the pulling device 26 slides against an opposing member 25a or 25b thereby progressively lifting it and, once it reaches the top of such pulling member 26 is locks between the opposing members 25a, 25b; the slider is thus coupled to the chain 22a, 22b; 23a, 23b; 24a, 24b.

[0089] During uncoupling, the pulling member 26 pivots and releases the opposing member 25a or 25b; the slider is thus released from the chain.

[0090] Coupling/uncoupling between the chains and the sliders may also occur using other technically equivalent solutions.

[0091] For example, a reversed structure may be provided, whereby the pulling members 26 might be integral with the sliders, whereas the resilient opposing members might be integral with the chains.

[0092] Preferably, the entry 51 and the exit 52 of the oven 5 are both located on one side of the oven.

[0093] Even more preferably, the oven 5 has a chamber extending along a substantially and/or generally inverted U-shaped path, in which the entry and the exit 51, 52 are located at the bottom.

[0094] This feature allows reduction of the overall dimensions of the oven 5, thereby allowing transportation of the assembled oven using ordinary means of transport, i.e. without using exceptional means of transport.

[0095] By placing the entry and exit of the oven at the bottom, heat losses are reduced and energy efficiency of the oven is improved.

[0096] In the illustrated embodiment, means 53 are provided for creating air recirculation in the chamber of the oven 5 in the direction opposite the motion of the plurality of pairs of opposed clamps 2a, 2b and hence in the direction opposite the motion of the metal sections 10.

[0097] Preferably, hot air is sucked in throughout the width of the entry of the oven 5 and sucked air is blown back into the oven throughout the width of the exit 52.

[0098] This reduces the temperature gradient inside the oven 5.

[0099] In the illustrated embodiment, hot air recirculating means 53 include a radial fan (located below the entry and the exit 51, 52), whose axial dimension substantially corresponds to the width of the entry 51 and the exit 52 of the oven 5.

[0100] A V-shaped casing can be placed below the radial fan 53 to improve hot air recirculation efficiency in the oven 5.

[0101] The oven 5 is equipped with heating means 54, 55 which preferably include IR generator means extending parallel to the axis X, throughout the width of the oven 5.

[0102] The IR generators have low thermal inertia and afford quick modulation of the thermal power being delivered.

[0103] This characteristic is particularly advantageous because it allows quick adjustment of thermal power according to the shape and size of the workpieces being treated.

[0104] Even more preferably, the heating means 54, 55 are gas-powered IR generators, which have low operating costs.

[0105] The IR generators 54, 55 are placed in the oven 5, preferably close to the exit 52.

[0106] The is a preferred solution because it allows the sections (and the sublimable ink transfer substrates) to be heated in two steps: a first step, corresponding to the upward portion and a first downward portion of the oven, at a lower temperature and for a longer time, in which heating occurs mainly by convection, and a second step, corresponding to the final downward portion, at a higher temperature and for a shorter time, in which heating occurs mainly by radiation.

[0107] This thermal treatment method was found to provide the best results in terms of decoration quality.

[0108] The pair of opposed clamps 2a, 2b can rotate about its axis X, thereby causing the section 10 wrapped up or enveloped in the transfer substrate 101 to also rotate along the portion of its path in the oven 5 in which it is exposed to IR radiation.

[0109] This provides a more homogeneous final heating all over the surface of the section 10 and the transfer substrate 101.

[0110] The opposed clamps 2a, 2b may be rotated, for instance, by means adapted to convert the linear motion of the sliders 21a, 21b into a rotary motion of the clamps.

[0111] Preferably, each air intake 4a, 4b is connected to vacuum generation means (not shown) via a contact seal 42, 47.

[0112] Those of ordinary skill in the art will appreciate that this solution allows simultaneous supply of all air intakes of the apparatus, without requiring vacuum pumps to be fitted on every slider 21a, 21b.

[0113] Furthermore, this solution allows a single vacuum pump to supply all air intakes 4a, 4b, thereby dramatically reducing the fabrication costs for the apparatus.

[0114] In the illustrated embodiment, the contact seal 42, 47 comprises a sliding track 421 extending along the path of at least one portion of the closed circuit 3, with a

plurality of intake ports 43 arranged therein along a path 431 at a (preferably constant) pitch P.

[0115] Each of the intake ports 43 is in communication with the vacuum generating means through a valve 49 having a closing member 44 that is designed to be opened against the action of return means 45, such as a helical spring.

[0116] A sliding block 47 is provided for each slider 21a, 21b, integrated therewith and in communication with an air intake 4a, 4b, which is adapted to slide on the sliding track 421 along the path 431.

[0117] Each sliding block 47 has an intake port 472 in communication with a chamber 471 facing towards the first side 421 of the track 42; the chamber 471 has such a size and shape as to be always in communication with at least one of the intake ports 43 on the sliding track 42 as the latter is moved.

[0118] At least one of the two contact surfaces of the sliding blocks 47 and the track 42 is formed of low friction, preferably self-lubricating material, such as polytetrafluoroethylene (PTFE).

[0119] The contact seal 42, 47 has means 48, 441 for keeping at least one of the intake holes 43 facing towards the chamber 472 open, to ensure a continuous intake action for each pair of air intakes 4a, 4b.

[0120] In the illustrated embodiment, the means 48, 441 for keeping at least one of the valves 49 (and hence the corresponding port 43) temporarily open include at least one first magnet 48 held within the sliding block 47 and at least one second magnet 441 received within the valve 49 and integral with the closing member 44.

[0121] Thus, when the sliding block 47 passes over a valve 49, the first magnet 48 attracts the second magnet 441 thereby causing the closing member 44 to temporarily open.

[0122] As soon as the interaction between the magnets 48, 441 ends, the return means 45 cause the closing member 44 of the valve 49 to spring back, thereby closing the intake port 43.

[0123] In the illustrated embodiment, the sliding block 47 has a plurality of cylindrical magnets 48 aligned parallel to the feed direction of the sliding block.

[0124] This is a preferred solution, due to the availability of magnets of such a shape.

[0125] Nevertheless, it shall be understood that a single elongate bar may be provided instead of this plurality of magnets 48.

[0126] In the preferred embodiment, the valves 48 are opened in response to the interaction between two magnets 48, 441.

[0127] Obviously, one of the two magnets 48 or 441 may be also envisaged to be replaced by a ferromagnetic element, such as soft iron.

[0128] In the illustrated embodiment, the valves 44 are received in a seat offset from the axis of the intake port 43.

[0129] By this arrangement, the sliding track 42 may be formed with reduced thickness.

[0130] In the illustrated embodiment, the intake ports 43 are in communication with a plurality of hollow bodies 100, which are in turn in fluid communication with the vacuum generating means.

[0131] The hollow bodies 100 act as vacuum tanks as well as support elements for the sliding track 42.

[0132] Preferably, the hollow bodies 100 are part of the bearing structure of the apparatus 1.

[0133] In a preferred embodiment, the apparatus 1 further comprises means for enclosing the sections 10, which are held under tension by the pairs of clamps 2a, 2b, in a film-like sublimable dye or ink transfer substrate 101.

[0134] According to a novel solution, means are provided, generally designated by numeral 110, which include: means 112 for unwinding a roll of film 101 having decorations formed thereon with sublimable dyes, at least two translating clamps 111 for feeding the film 101 parallel to the axis X and means, not shown, for transversely cutting out a portion of film 101.

[0135] The film 101 so cut out is laid on a section 10 in the loading station, in a substantially symmetrical position so that it has two free edges extending parallel to the axis of extension X of the section 10.

[0136] The apparatus 1 has an elongate suction element 130, integral and in fluid communication with the opposed intakes 4a, 4b, which is parallel to the axis X, i.e. the axis of extension of the metal section 10.

[0137] The elongate suction element 130 allows air to be sucked in all along the space between the film 101 and the section 10.

[0138] In one possible embodiment, the elongate suction element 130 is a hollow elongate element 130 having a generally tapered portion which is designed to be introduced between the hanging edges of the film 101.

[0139] The elongate hollow element 130 is formed with a continuous or intermittent slit parallel to the axis of extension X of the element and/or holes 131 arranged along the axis X for sucking in air from within the film envelope 101.

[0140] By this arrangement the envelope 101 may be removed by simply stopping air intake, without the need of blowing in air, unlike the prior art.

[0141] The elongate hollow element 130 is preferably made from a low specific weight and flexible material, such as fiberglass.

[0142] Thus, when a tensile stress is applied to the section 10, the hollow elongate element 130 will assume a substantially straight orientation.

[0143] In order to improve adhesion of the film material 101 to the surface of the section 10, rotary means may be further provided for exerting a pressing action a film material 101 wrapped around a metal section 10, when the latter is held under tension by the opposed clamps (2a, 2b).

[0144] The means for exerting such pressing action include a plurality of rotating brushes 141, 142a, 142b that can be moved toward and away from the section 10 held by the opposed clamps 2a, 2b - when the section

10 is downstream from the loading station - which can be displaced parallel to the axis X, i.e. along the direction of extension of the section 10.

[0145] Under the action of the centrifugal force, the bristles of the brushes 141, 142a, 142b press the film 101 against the surface of the section for improved adhesion.

[0146] This solution has the advantage that the brushes 141, 142a, 142b can fit any surface shape of the section 10.

[0147] In one illustrated embodiment, the brushes 141, 142a, 142b comprise an upper unit 141, which is designed to operate on the upper portion of the section 10, and two side units 142a, 142b.

[0148] In the illustrated embodiment, each clamp 2a, 2b is integral with a hollow stem 150 fitted in a support 160, 161, 162 rotating about the axis X, the hollow stem 150 is able to slide and be locked along the axis X and can be put under tension along the axis X.

[0149] Thus, the apparatus can process sections within a predetermined range of lengths, typically from 4 meters to 7.5 meters.

[0150] The cavity of the stem 150 can receive a control rod 27 for opening and closing the members of the clamp 2a; 2b.

[0151] The control rod 27 can be in turn operated by the rotation of a member 190, such as a claw clutch.

[0152] The cavity of the stem 150 can be also utilized as a passageway for air sucked in by the air intakes 4a, 4b.

[0153] In the illustrated embodiment, the rotating support 160, 161, 162 of the hollow stem 150 includes a first rotating support 160, a second rotating support 161 and a third rotating support 162.

[0154] The second rotating support 161 is rotatably connected to the first rotating support 160, whereas the third rotating support 162 is rotatably connected to the second rotating support 161

[0155] The second rotating support 161 is able to translate along the axis X toward the first rotating support 160 against first elastic return means 165, whereas the third rotating support 162 is able to translate along the axis X away from the second support 161, against additional elastic return means 164.

[0156] The second and third rotating supports 161, 162 define a receptacle for an elastic clamp 170 which is designed to lock the hollow stem 150 in a desired position.

[0157] Means 166 are further provided for keeping a minimum spacing between the first rotating support 160 and the third rotating support 162

[0158] Axial displacement of the second support 161 relative to the first support 160 is ensured by a first flange 167 integral with the first rotating support 160 and a second flange 168 integral with the second rotating support 161.

[0159] The two flanges may be moved toward each other by means 180, such as a pair of elements with tines 181, 182 driven by a hydraulic piston 183.

[0160] As the two flanges 167, 168 move back to their rest position, the hollow stem 150 is locked in a slightly retracted position under the action of first elastic means 165, wherefore the clamp 2a, 2b can apply a tensile stress to the section 10.

[0161] Preferably, each of the opposed clamps 2a, 2b is equipped with means 159 for holding the pressure of the members substantially constant in case of changing thicknesses of the workpieces being held.

[0162] In the illustrated embodiment, the means 159 include a helical spring that compensates for any change in the spacing between the members of the clamp, by adjusting the position of a wedge 158 that in turn adjusts the mutual angular position between the members of the clamp.

[0163] The above apparatus 1 may be used to carry out a process for surface treatment of elongate members, which comprises the steps of:

- loading a member 10 in a loading station;
- putting the elongate member 10 under tension, while holding it suspended in a substantially horizontal orientation;
- causing the elongate member to pass through at least one processing station 5 having one entry 51 and one exit 52 separate from each other;
- carrying the member 10 to a delivery station;
- removing the member 10.

[0164] Particularly, a surface treatment of decoration by sublimation may be carried out on metal sections 10 designed for making doors and window frames, which comprises the steps of:

- covering the elongate member, particularly an extruded metal section 10, with an enclosure in the form of a bag or a socking or an envelope or a tubular member, made from a film 101 with designs or decorations formed thereon with sublimable inks and facing towards the surface to be decorated;
- loading the section 10 in a loading station;
- putting such elongate member 10 under tension, while holding it suspended;
- sucking in air from within the enclosure for causing the film 101 to adhere to the outer surface of the elongate member 10;
- heating the elongate member 10 and the film 101 to such a temperature as to cause sublimation of said sublimable inks on the surface of said elongate member (10);
- cooling the elongate member 10;
- stopping air intake;
- blowing air into the enclosure 101;
- carrying the section 10 to a delivery station;
- removing the cover 101.

[0165] Alternatively, the above apparatus can be used to carry out a process for decorating articles, particularly

metal sections 10, by sublimation, comprising the steps of:

- loading the section 10 in a loading station;
- putting an elongate member 10 under tension, while holding it suspended;
- covering the elongate member with an enclosure in the form of an envelope or a bag or a socking or a tubular member, wherein the cover is made from a film 101 with sublimable inks thereon, facing towards the surface to be decorated;
- sucking in air from within the envelope for causing the film 101 to adhere to the elongate member;
- heating the elongate member 10 and the film 101 to such a temperature as to cause sublimation of the sublimable inks from the film 101 to the surface of the elongate member 10;
- cooling the elongate member 10;
- stopping air intake;
- blowing air into the cover 101;
- carrying the section 10 to a delivery station;
- removing the cover 101.

[0166] Also, the above apparatus can be used to carry out a process for surface treatment of elongate members, particularly metal sections 10 designed for making doors and window frames, by sublimation, comprising the steps of:

- carrying the section 10 to a loading station;
- putting an elongate member 10 under tension, while holding it suspended;
- wrapping a film 101 with sublimable inks thereon around such elongate member 10, without sealing the film on itself either laterally or at the ends thereof;
- sucking in air from within the envelope for causing the film 101 to adhere to the elongate member;
- heating the elongate member 10 and the film 101 to such a temperature as to cause sublimation of the sublimable inks from the film 101 to the surface of the elongate member 10;
- cooling the elongate member 10;
- stopping air intake;
- carrying the section 10 to a delivery station;
- removing the film 101.

[0167] Since the envelope is not sealed on itself, the air blowing step is no longer indispensable for easy removal of the cover 101.

[0168] Particularly, in the three main variants as described above the elongate member 10 can be moved with a certain pitch along a closed path 3 comprising:

- a loading station,
- a tunnel oven station, i.e. an oven having one entry and one exit separate from each other,
- a cooling path,
- a delivery station.

[0169] The motion in the tunnel oven 5 can occur with smaller pitches as compared with those of the motion between the loading station and the oven.

[0170] In any case, the decoration process may include a first heating step, substantially by convection, and a second heating step, mainly by radiation.

[0171] During radiation heating, the elongate member 10 can be rotated about its own axis of extension, for more uniform application of radiant energy.

[0172] Cooling may be of the forced type, to reduce the overall processing cycle times.

Claims

1. An apparatus (1) for carrying out at least one surface treatment on elongate members (10) particularly metal sections for doors and window frames (10), comprising:

   - a plurality of pairs of opposed clamps (2a, 2b), each of said pairs of opposed clamps being aligned along a substantially horizontal axis (X), each of said pairs of opposed clamps (2a, 2b) being designed to be intermittently and synchronously moved in one direction along a closed circuit (3), at least one clamp (2a, 2b) of each of said pairs of opposed clamps (2a, 2b) being adapted to grasp and hold said elongate member (10) suspended and under tension,
   - a station (10) for loading said elongate members (10);
   - a station for delivering said elongate members (10);
   - at least one processing station (5) having one entry (51) and one exit (52) separate from each other, the closed circuit 3 passing therethrough.

2. An apparatus as claimed in claim 1, wherein each of said clamps has a first member (211) and a second member (212), said first member (211) having a transverse gripping dimension of less than half the transverse gripping dimension of said second member (212).

3. An apparatus (1) as claimed in claim 1 or 2, wherein each of said pairs of opposed clamps (2a, 2b) is adapted to rotate about said axis (X) along at least one portion of the path in said at least one processing station (5).

4. An apparatus (1) as claimed in claim 1 or 2 or 3, wherein each clamp (2a, 2b) is integral with a stem (150) fitted in a support (160, 161, 162) rotating about said axis (X), said stem (150) being able to slide along said axis (X) and be locked under tension along said axis (X), said rotating support (160, 161, 162) includes a first rotating support (160), a second ro-

tating support (161) and a third rotating support (162), said second rotating support (161) being rotatably connected to said first rotating support (160), said third rotating support (162) being rotatably connected to said second rotating support (161), said second rotating support (161) being able to translate along said axis (X) toward said first rotating support (160) against first elastic return means (165), said third rotating support (162) being able to translate along said axis (X) away from said second support (161), against second elastic return means (164), said second and third rotating supports (161, 162) defining a receptacle for an elastic clamp (170) which is designed to lock said stem (150) in a desired position, said first elastic means (165) holding said stem (150) under tension, means (166) being further provided for keeping a minimum spacing between said first rotating support (160) and said third rotating support (162) and wherein there are provided a first flange (167) integral with said first rotating support (160) and a second flange (168) integral with said second rotating support (161), means (180) being further provided for moving said first and second flanges (167, 168), against said first elastic means (165) for temporarily releasing said elastic clamp (170) too allow translation of said stem (150) along said axis (X).

5. Apparatus (1) as claimed in claim 4, wherein said stem (150) has a hollow construction and wherein a control rod (27) is received in said hollow stem for opening and closing together the members of said clamps (2a, 2b).

6. An apparatus (1) as claimed in any one of the preceding claims, wherein said plurality of opposed clamps (2a, 2b) is moved along said closed-loop circuit by two conveyors (20a, 20b), each conveyor (20a, 20b) having a plurality of sliders (21, 21b), a clamp (2a, 2b) being associated with each slider (21a, 21b).

7. An apparatus (1) as claimed in claim 6, wherein said two conveyors are double-rail conveyors (20a, 20b) which include a plurality of pairs of chains (22a, 22b; 23a, 23b; 24a, 24b), each of said pair of chains (22a, 22b; 23a, 23b; 24a, 24b) being adapted to move said plurality of sliders (21a, 21b) along different portions (T1, T2, T3) of the closed circuit (3), each of said pairs of chains (22a, 22b; 23a, 23b; 24a, 24b) being movable with a different pitch (P1, P2, P3) from the other chains of pairs and wherein means (25, 26) are provided for automatically coupling and uncoupling each slider (21a, 21b) to and from each chain (22a, 22b; 23a, 23b; 24a, 24b), to allow motion thereof along said different portions (T1, T2, T3).

8. An apparatus (1) as claimed in any one of the preceding claims, wherein said at least one processing station (5) is an oven (5), particularly an oven (5) that has a chamber extending along a substantially and/or generally inverted U-shaped path, with said entry (51) and said exit (52) separate from each other and located at the bottom of said oven, said oven (5) having lateral openings (58) extending along the path between the entry (51) and the exit (52), for the passage of said opposed pairs of clamps (2a, 2b) and wherein air intakes (4a, 4b) are provided, that can be driven along said closed-loop circuit (3) along with said opposed clamps (2a, 2b).

9. An apparatus (1) as claimed in claim 8, wherein said stem (150) is hollow to allow connection of said air intakes (4a, 4b).

10. An apparatus as claimed in claim 8 or 9, wherein each air intake (4a, 4b) is connected to vacuum generation means via a contact seal (42, 47).

11. An apparatus (1) as in claim 10, wherein said contact seal (42, 47) comprises:

- a sliding track (42), having a first side (421) with a plurality of intake ports (43) arranged therein along a path (431),
- a sliding block (47) integral with each slider (21a, 21b) and in communication with said air intake (4a, 4b), said sliding block (47) being adapted to slide on said first side (421) of said track (42) along said path (431), wherein each of said intake ports (43) of said sliding track (42) is in communication with vacuum generating means and wherein each of said intake ports (43) is normally closed by a valve (49) having a closing member (44) that is designed to be opened against the action of elastic return means (45), and wherein each sliding block (47) has a chamber (471) facing towards said first side (421) of said track (42), said chamber (471) having such a size and shape as to be always in communication with at least one of said intake ports (43) in the sliding track (42), and wherein means (48, 441) are provided for keeping said intake holes (43) temporarily open when they face towards a chamber (471) of a sliding block (47).

12. An apparatus (1) as claimed in any one of claims 8 to 11, wherein an elongate suction element (130), parallel to said axis (X) is integrally joined with each pair of opposed air intakes (4a, 4b), in fluid communication with said opposed air intakes (4a, 4b), said elongate suction element being an elongate hollow element (130) formed with a continuous or intermittent slit parallel to said axis (X) or suction holes arranged along said axis (X).

13. An apparatus (1) as claimed in claim 12, comprising means for unwinding a roll of film (101), at least two translating clamps (111) for feeding the film (101) parallel to said substantially horizontal axis (X) and means for transversely cutting out a portion of film (101) and hanging said portion of film (101) on a section (10), held under tension by a pair of clamps (2a, 2b).

14. An apparatus (1) as claimed in claim 12 or 13, wherein a plurality of rotating brushes (141, 142a, 142b) are further provided, that can be moved toward and away from said section (10) held by the opposed clamps (2a, 2b) when said section (10) is in the loading station, said plurality of rotating brushes (141, 142a, 142b) being adapted to be displaced parallel to said axis (X) for exerting pressure on a film material (101) wrapped around a metal section (10) held under tension by said opposed clamps (2a, 2b).

15. A process for surface treatment of elongate members (10), particularly metal sections designed for making doors and window frames, comprising the steps of:

- covering said elongate member (10), with a film material (101) in the form of a bag, a socking, a bag, or a tubular member, said film (101) having designs or decorations formed on one side thereof with sublimable inks;
- putting an elongate member (10) under tension, while holding it suspended;
- sucking in air from within said cover (101) for causing said film (101) to adhere to said elongate member;
- heating said elongate member (10) and said film (101) to such a temperature as to cause sublimation of said sublimable inks on the surface of said elongate member (10);
- - stopping air intake from within said cover 101;
- cooling said elongate member (10);
- blowing air into said cover;
- removing said cover.

16. A process for surface treatment of elongate members (10), particularly metal sections designed for making doors and window frames, comprising the steps of:

- putting an elongate member (10) under tension, while holding it suspended;
- hanging a film (10) with designs or decorations formed thereon with sublimable inks on said elongate member (10);
- joining the opposite edges of said film (101) and sucking in air from within said cover envelope to cause said film (101) to adhere to said elongate member;
- heating said elongate member (10) and said film (101) to such a temperature as to cause sublimation of said sublimable inks on the surface of said elongate member (10);
- stopping air intake;
- cooling said elongate member (10);
- removing said wrapped film (101).

17. A process as claimed in claim 15 or 16, wherein said elongate member is moved with a certain pitch along a closed path comprising:

- a loading station,
- a tunnel oven,
- a cooling path,
- a delivery station;

and wherein the motion in said tunnel oven (5) occurs at smaller pitches as compared with those of the motion between said loading station and said oven.

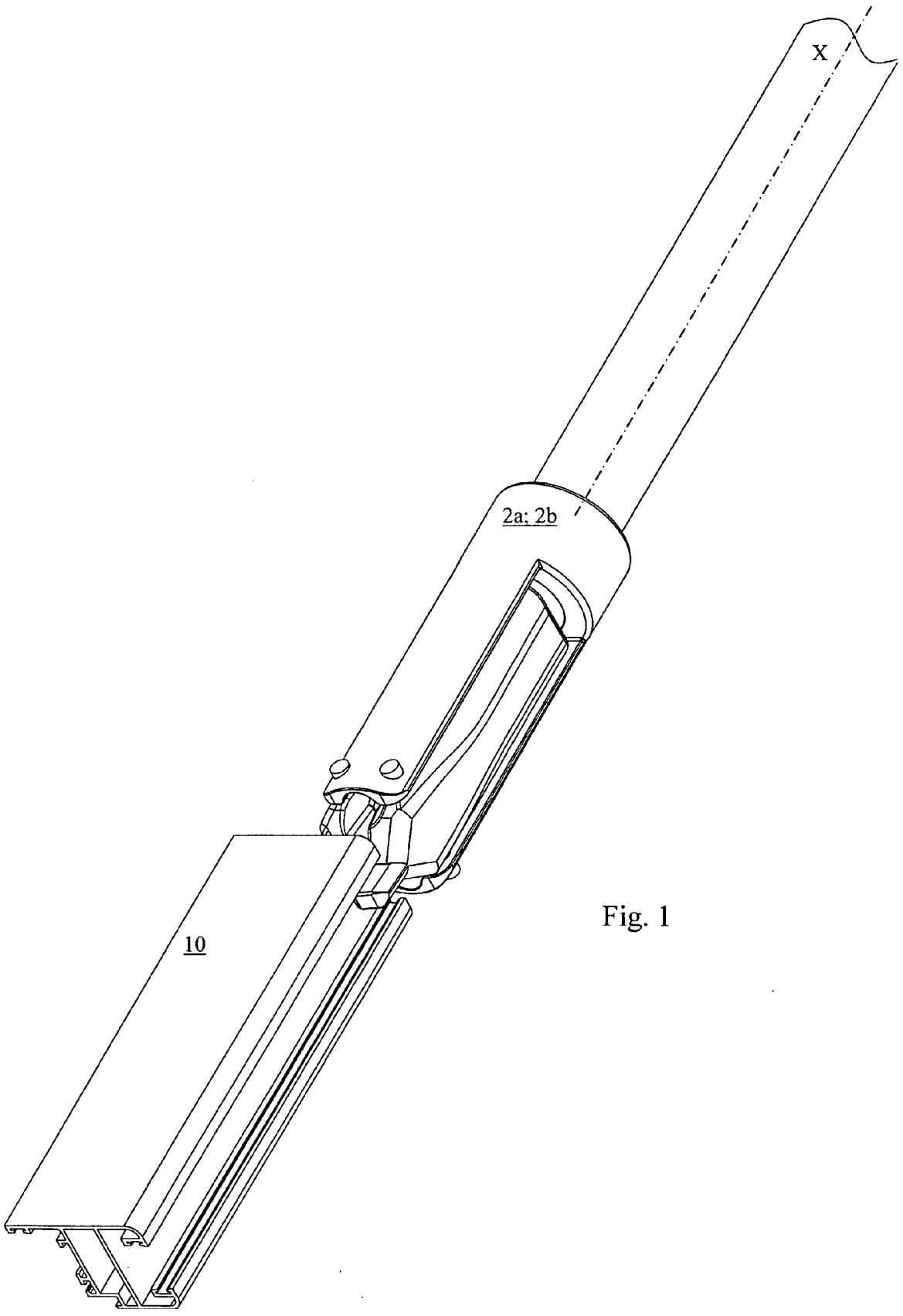


Fig. 1

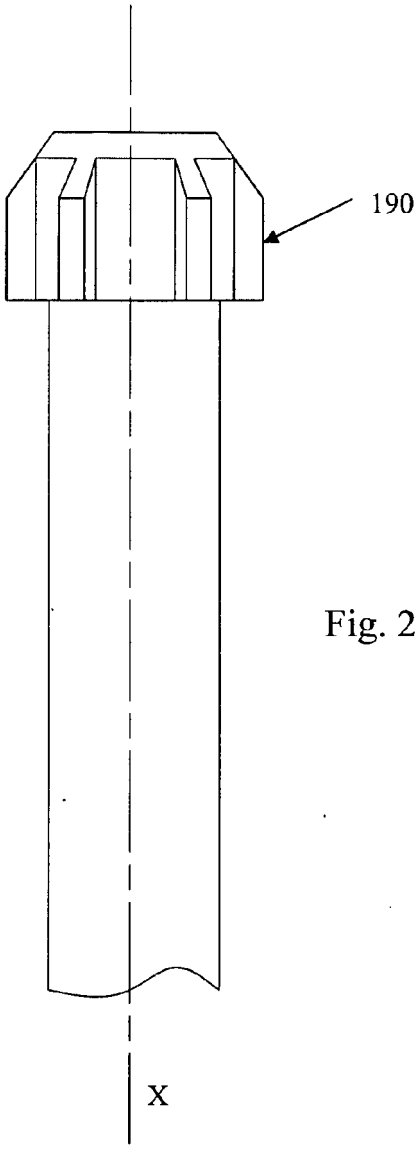


Fig. 2

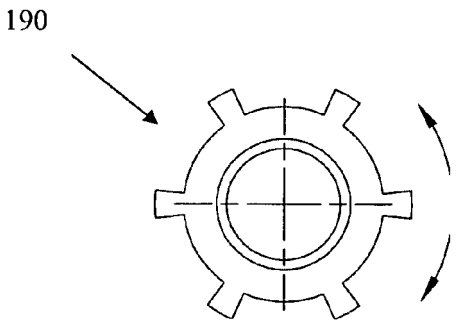


Fig. 2a

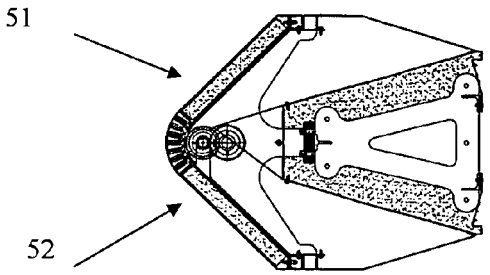


Fig. 3

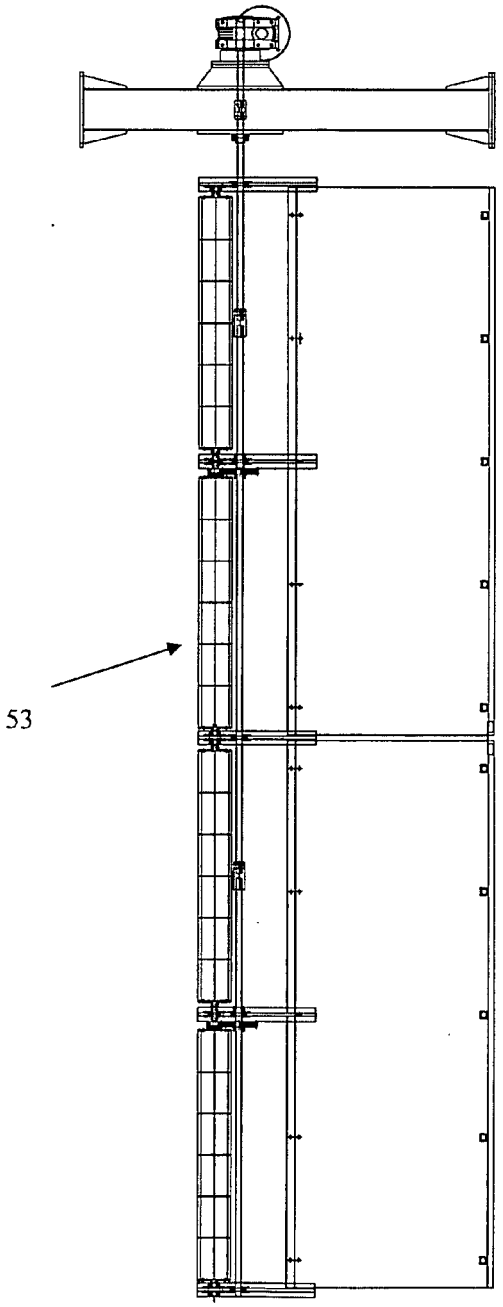


Fig. 3a

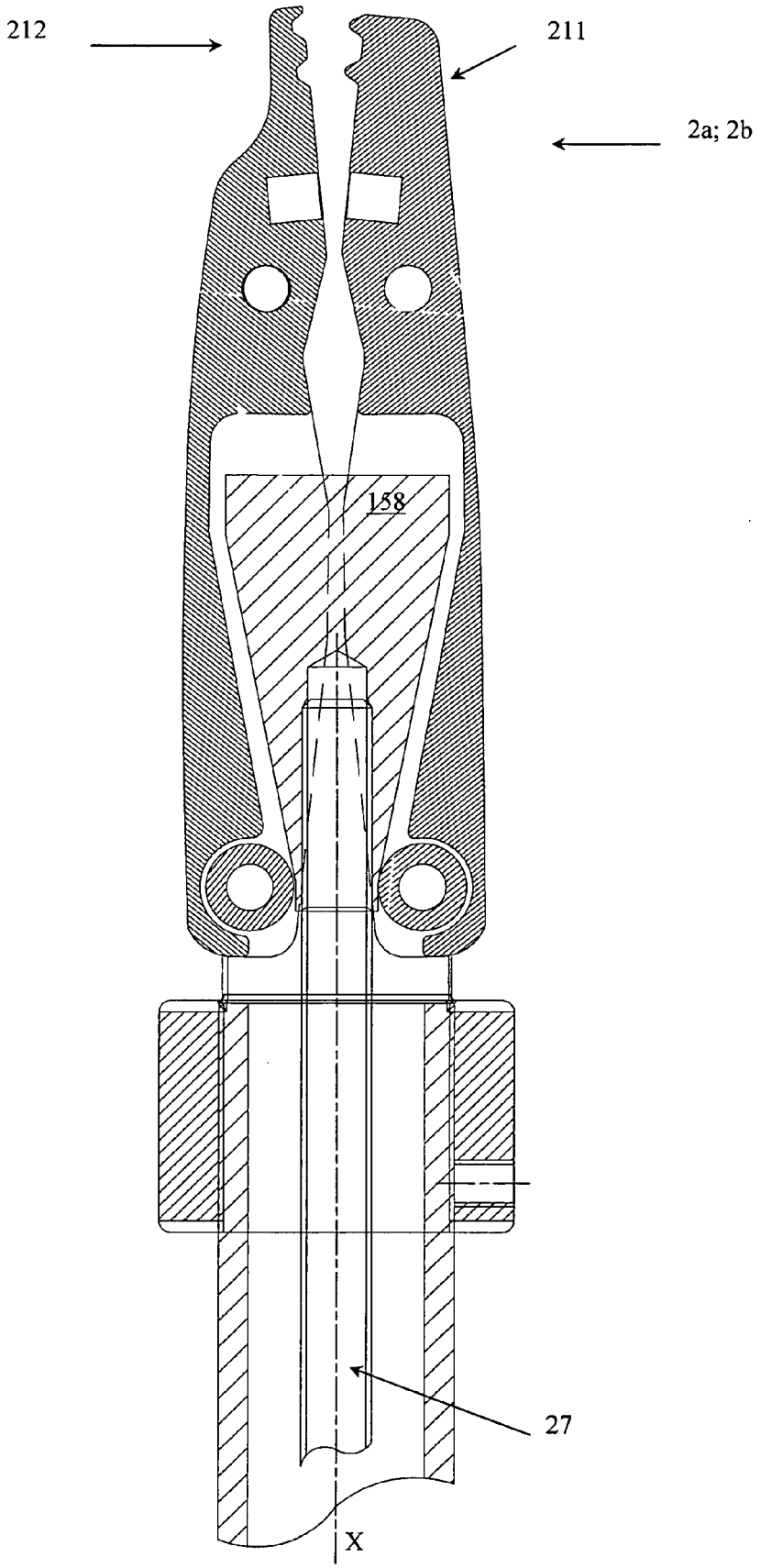


Fig. 4

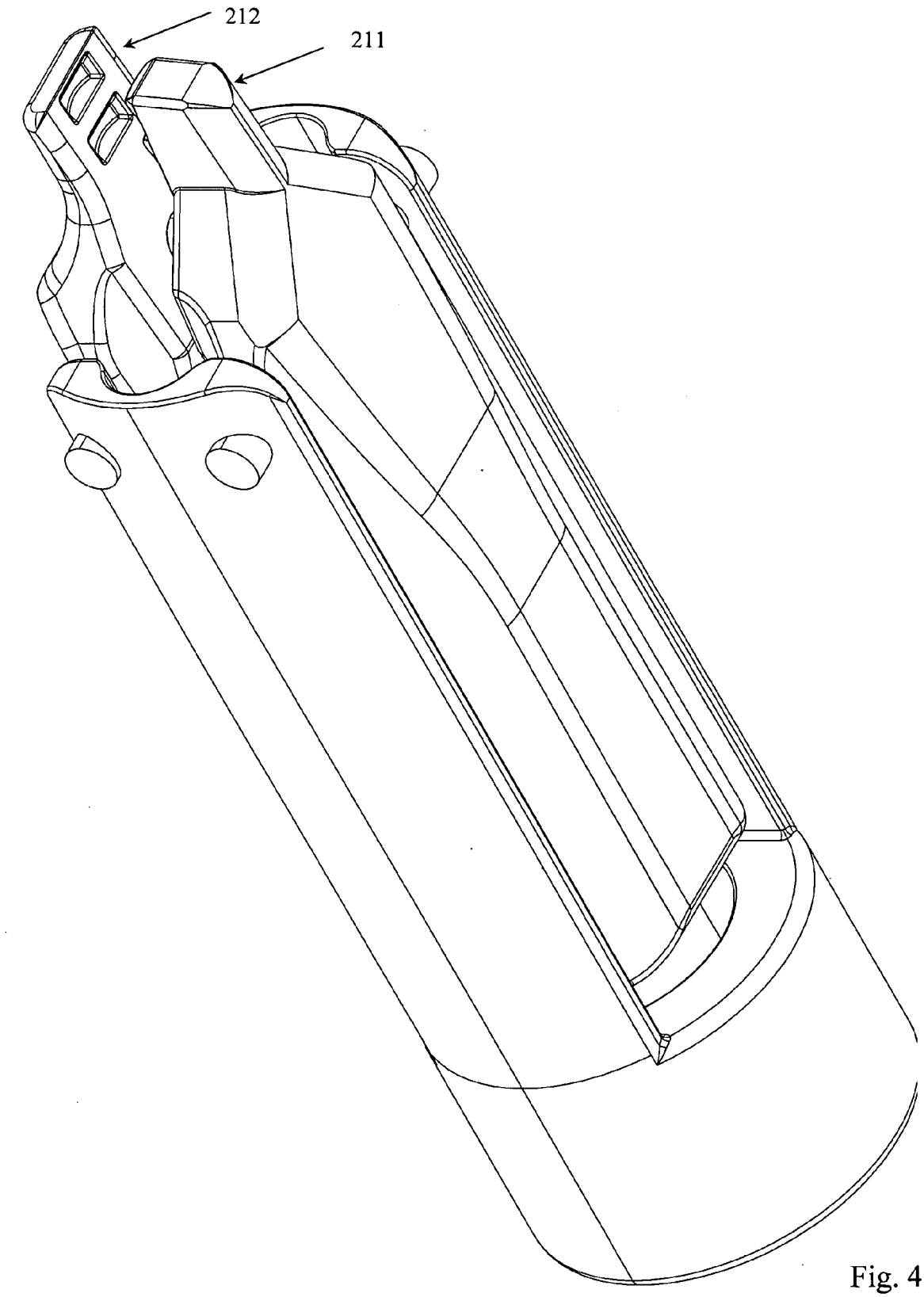


Fig. 4a

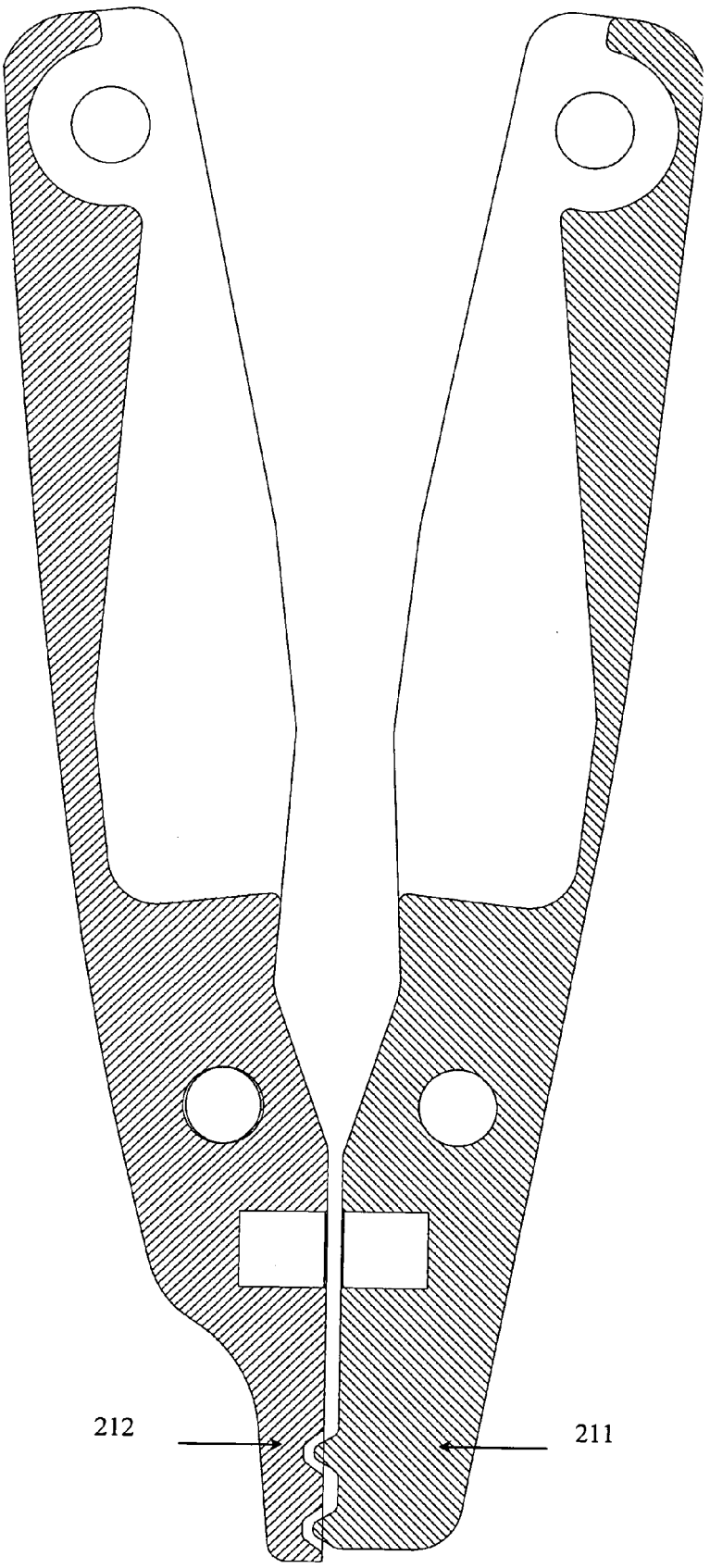


Fig. 4b

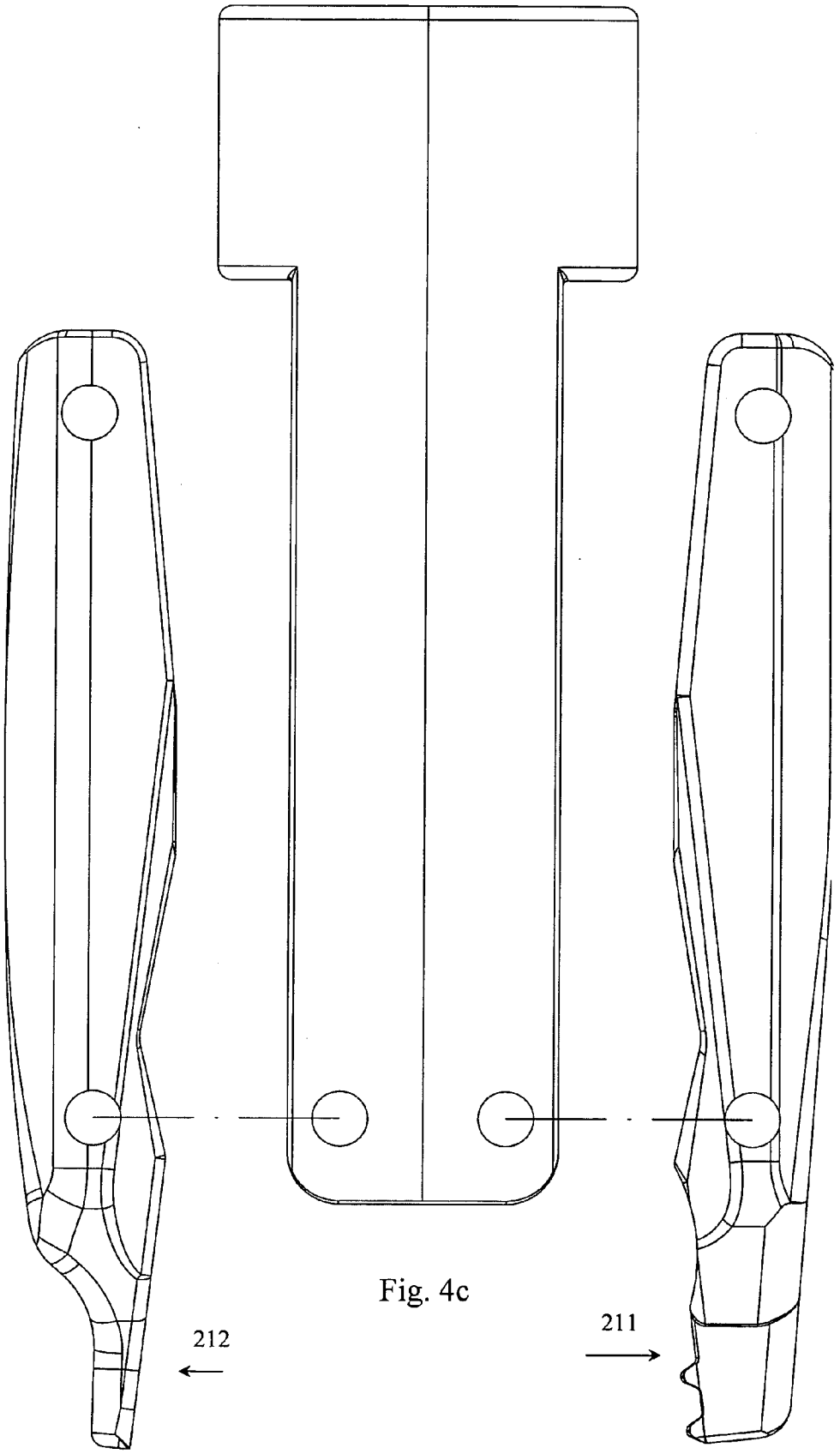


Fig. 4c

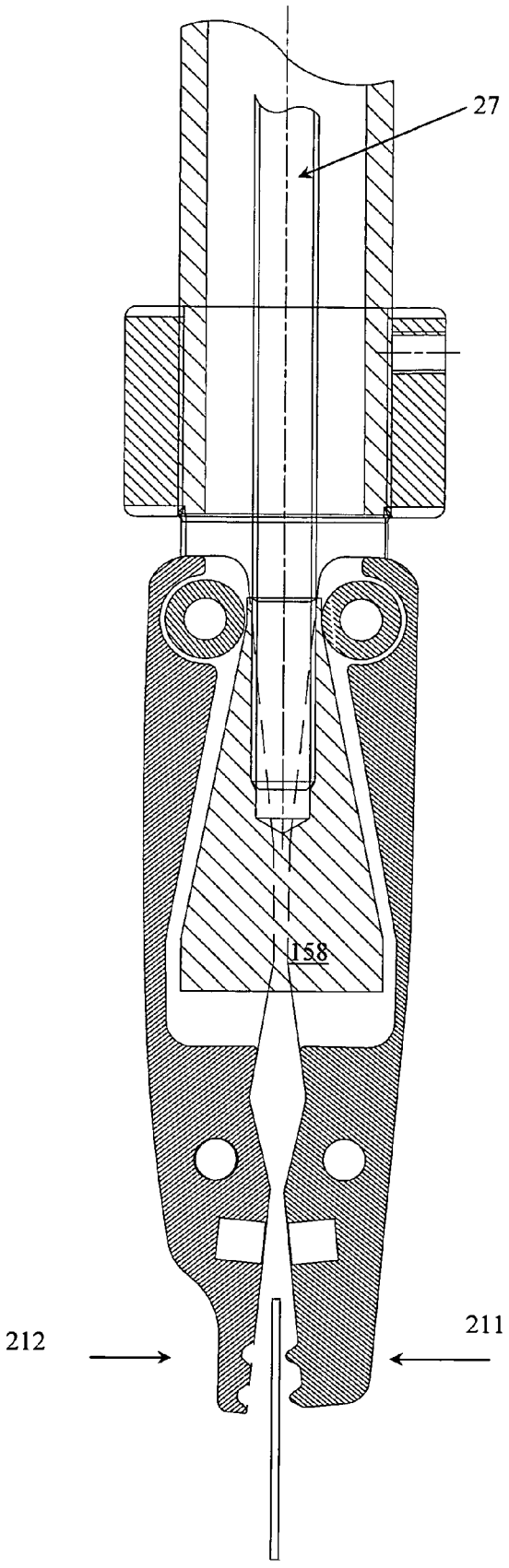


Fig. 5a

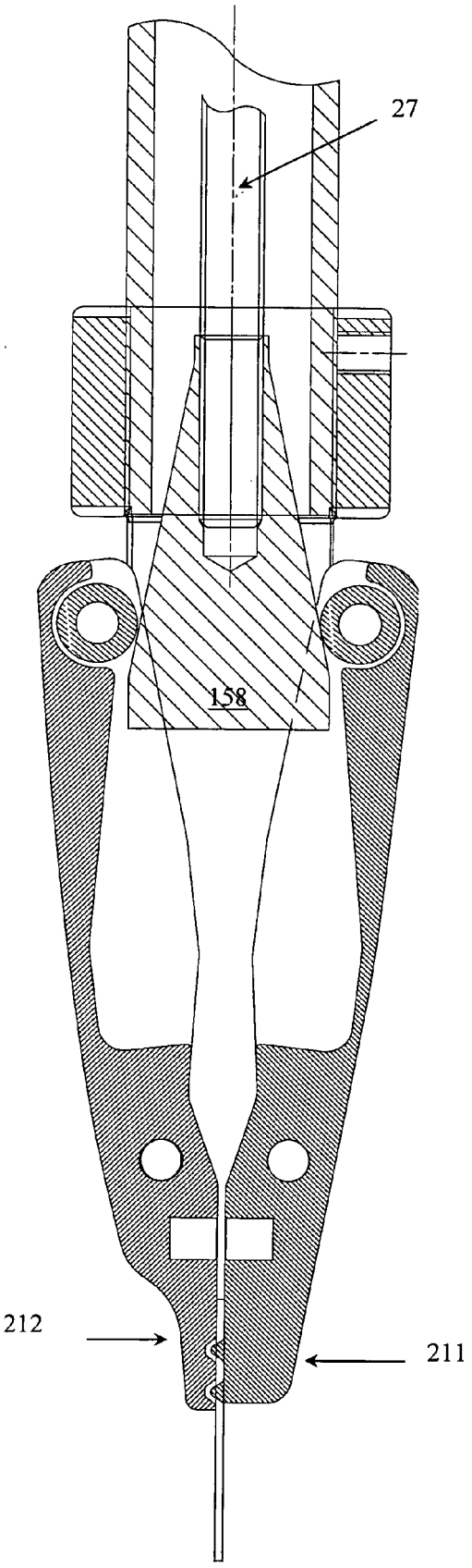


Fig. 5b

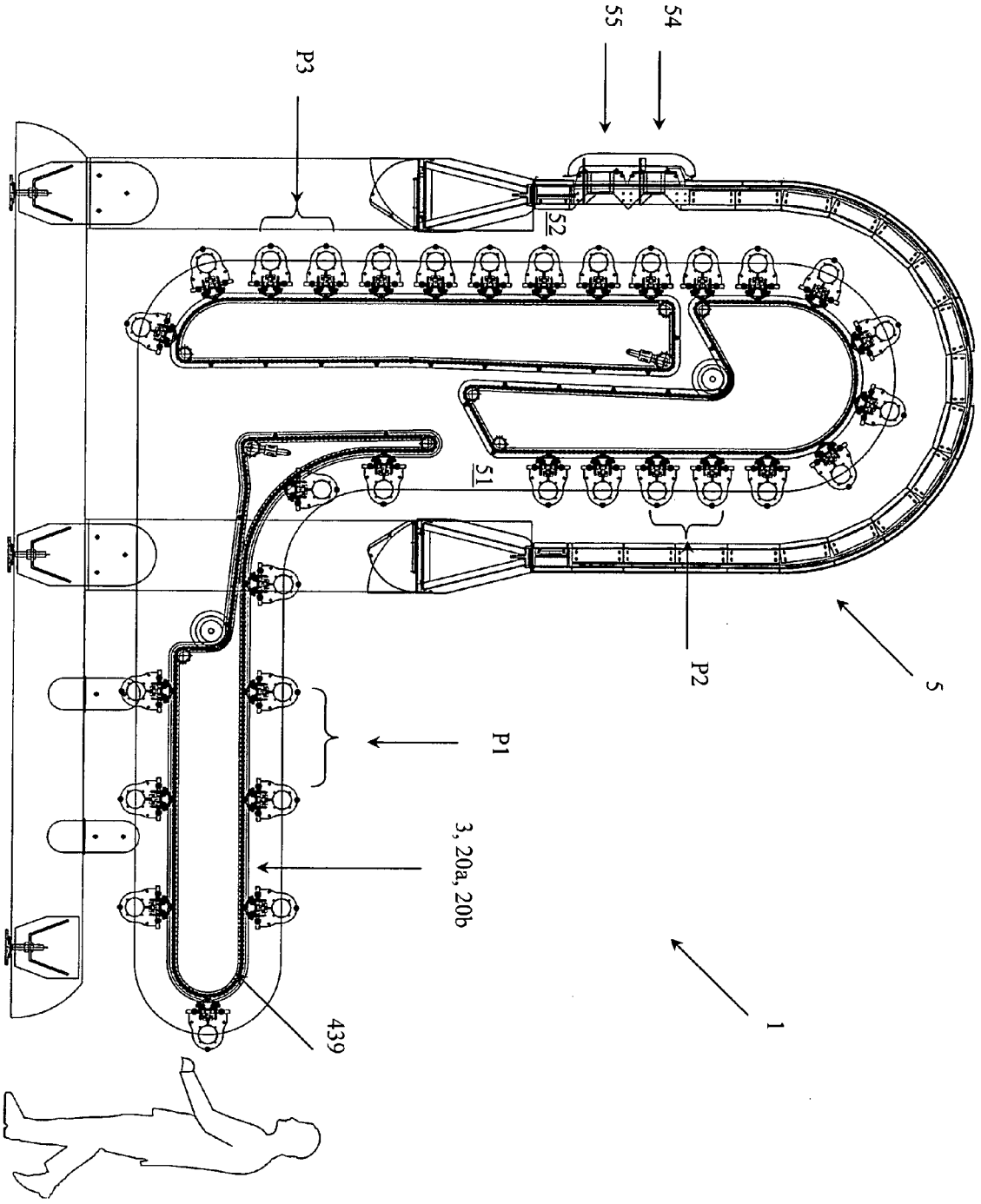


Fig. 6

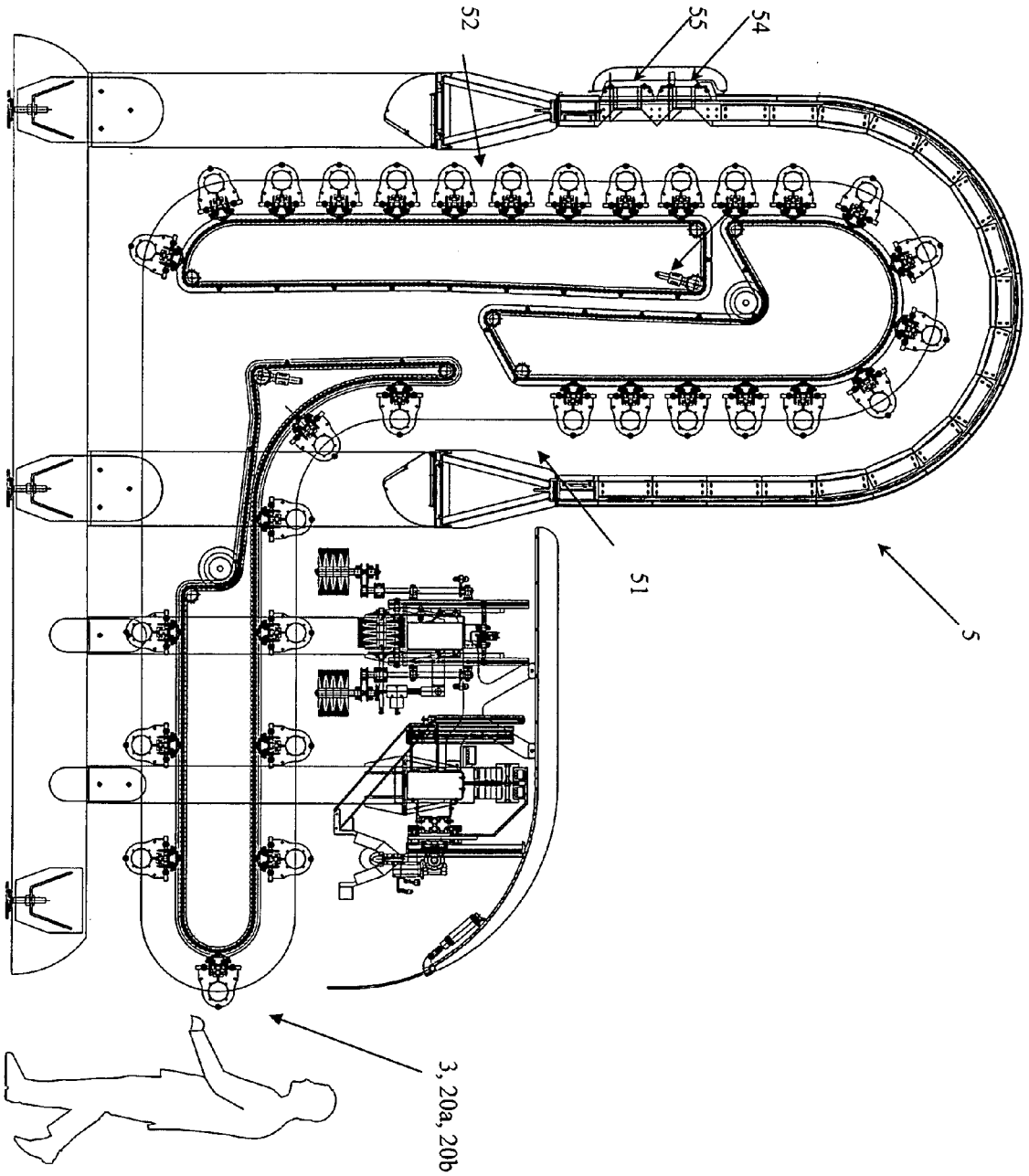


Fig. 7

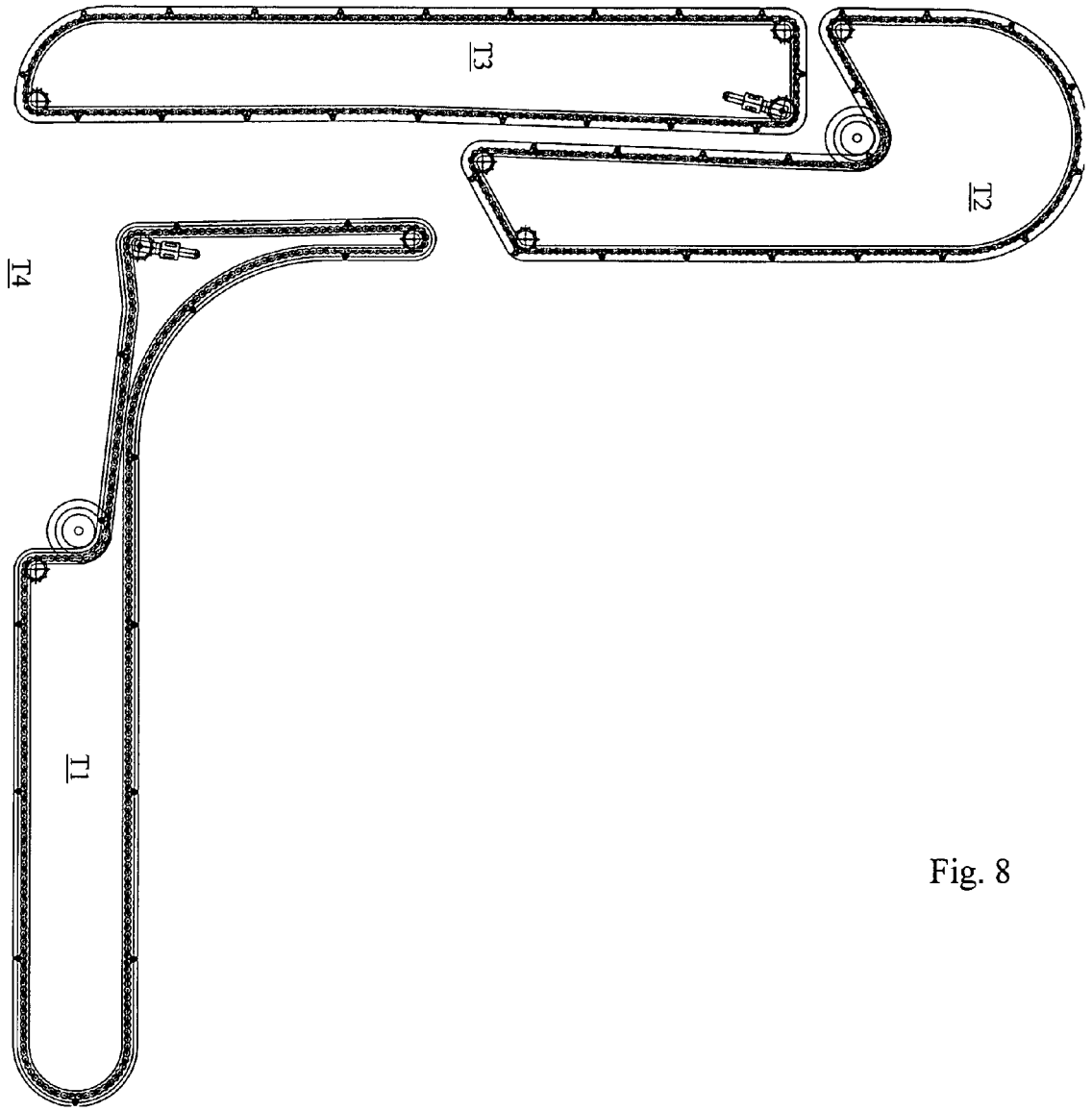


Fig. 8

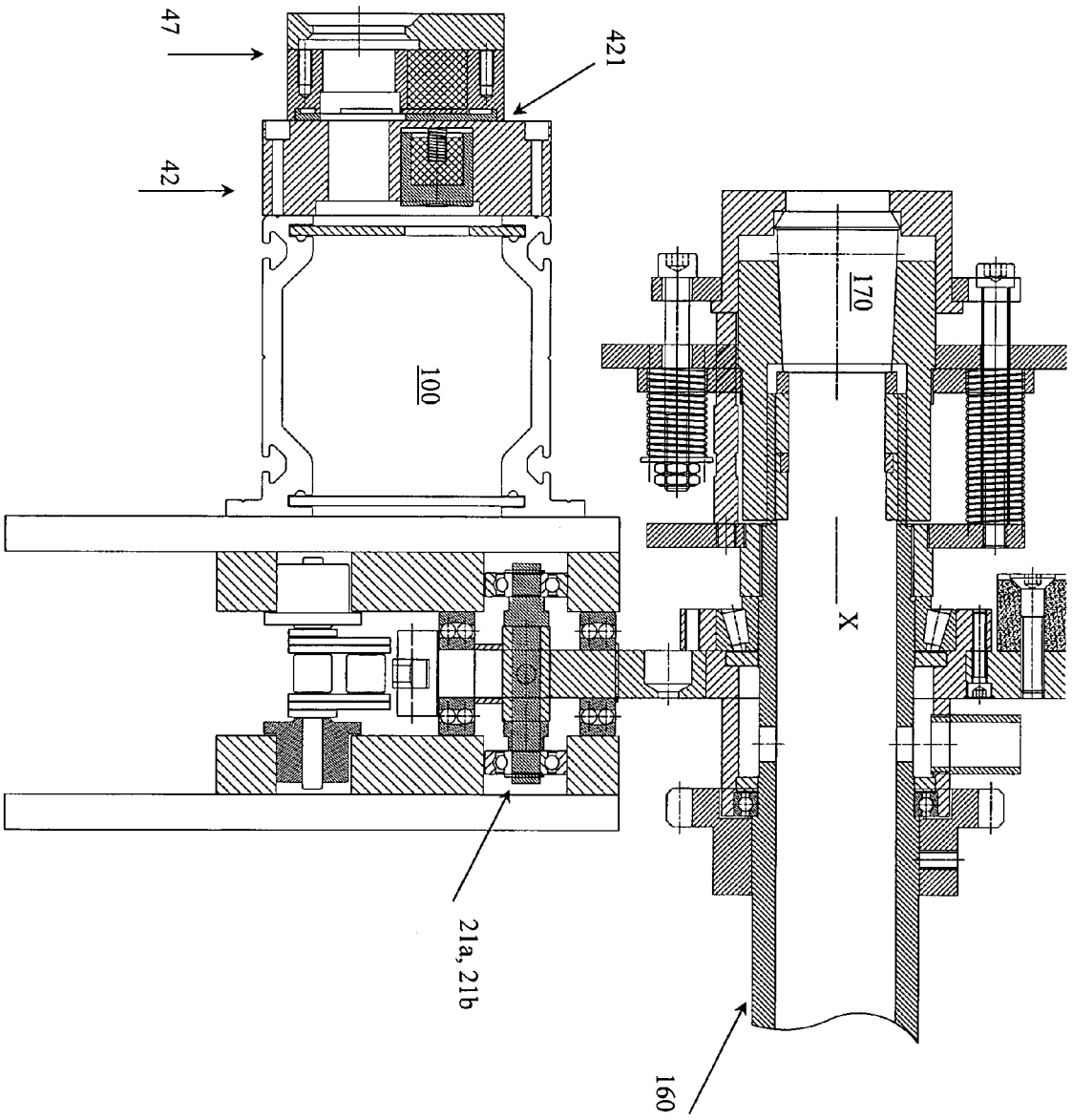


Fig. 9

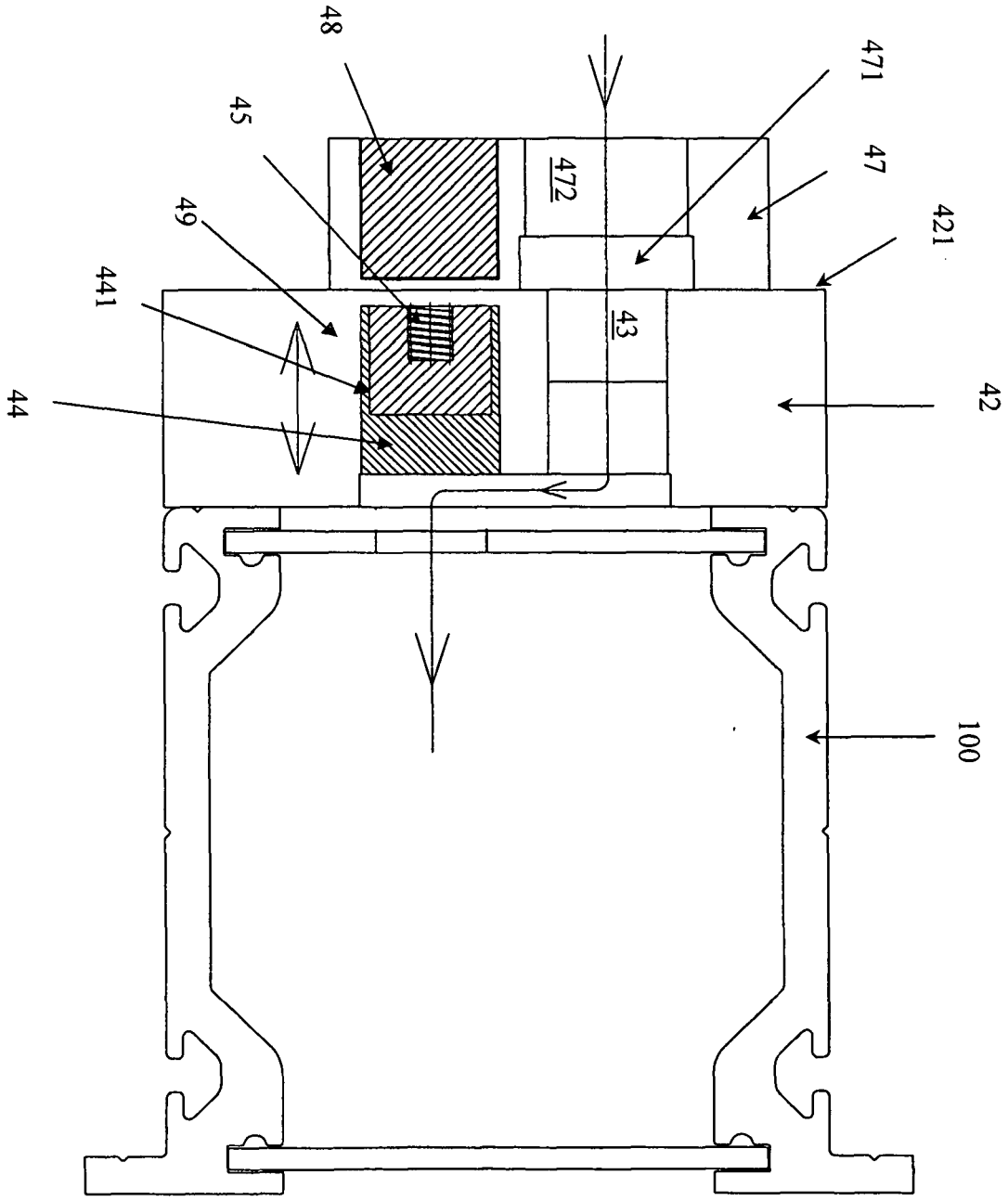


Fig. 10

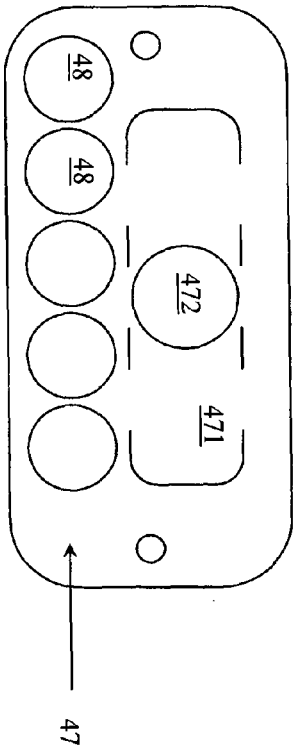


Fig. 11

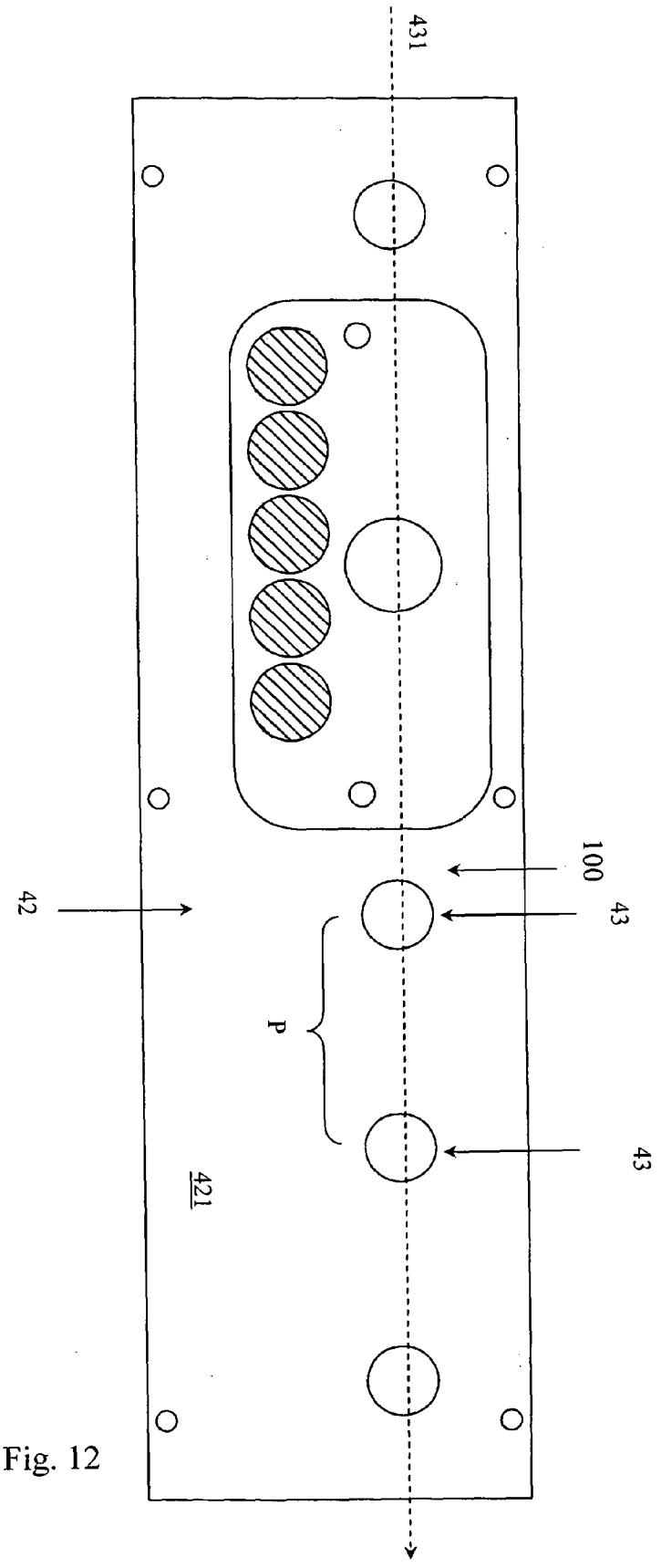


Fig. 12

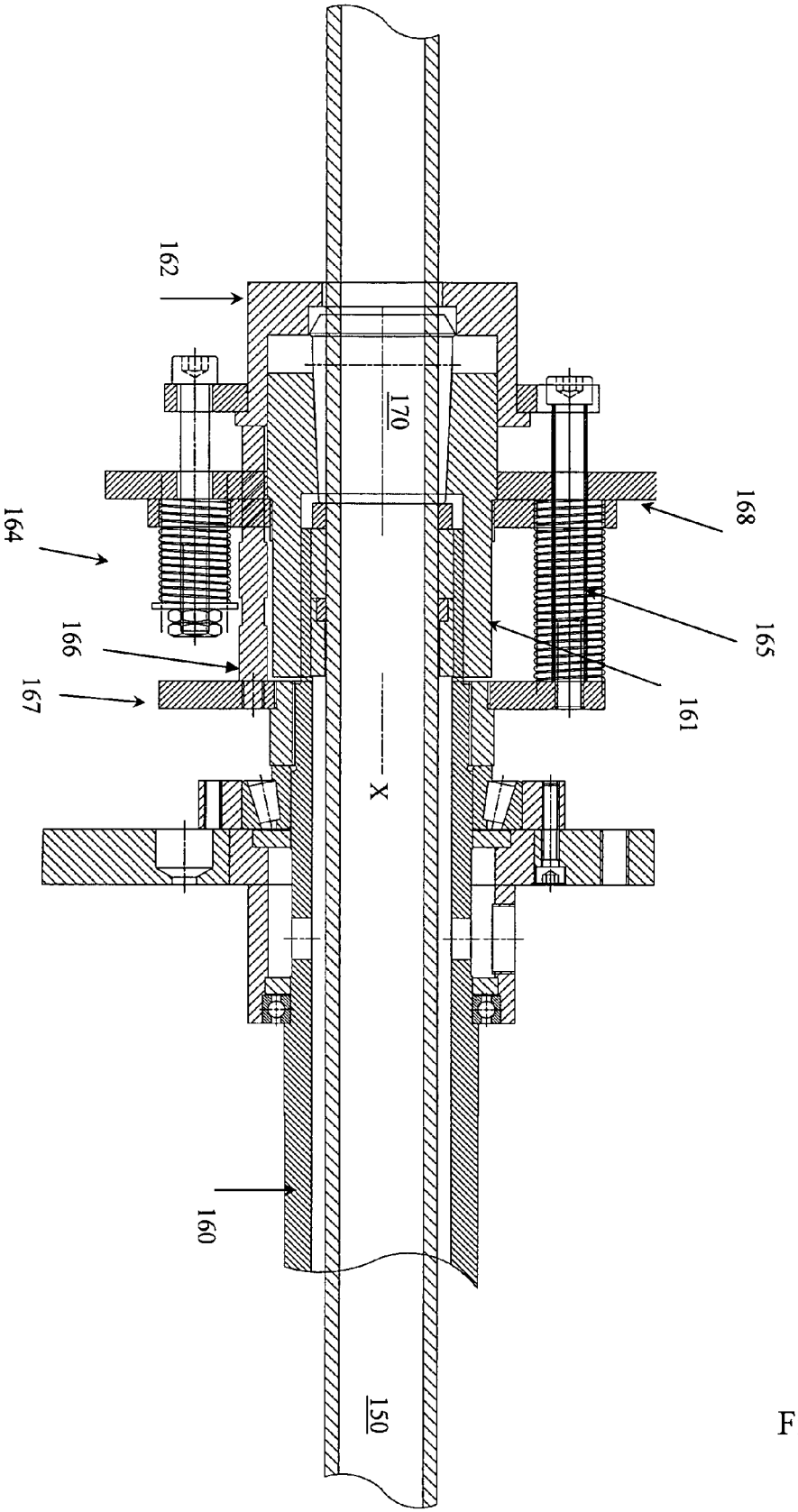


Fig. 13

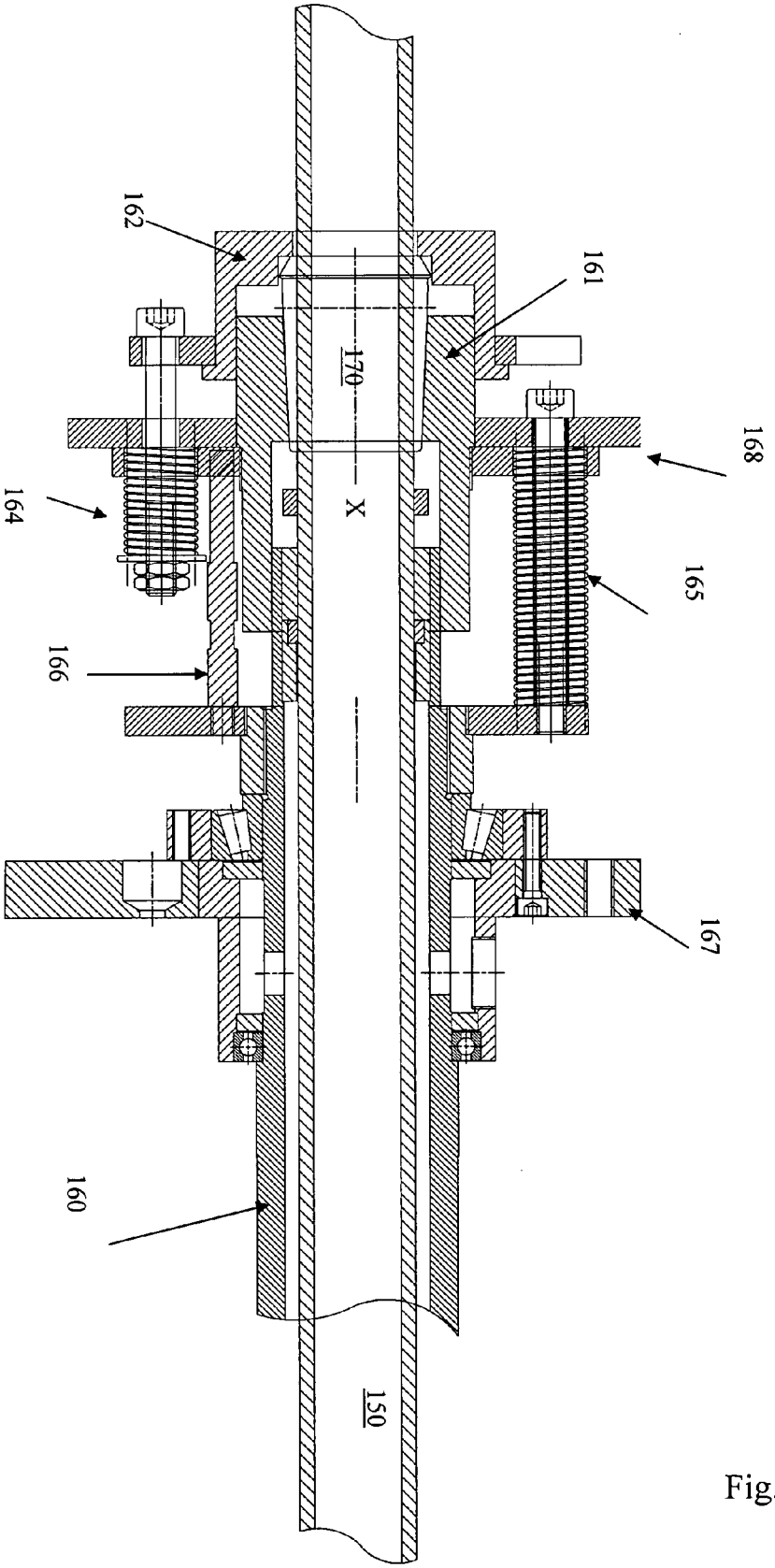


Fig. 14

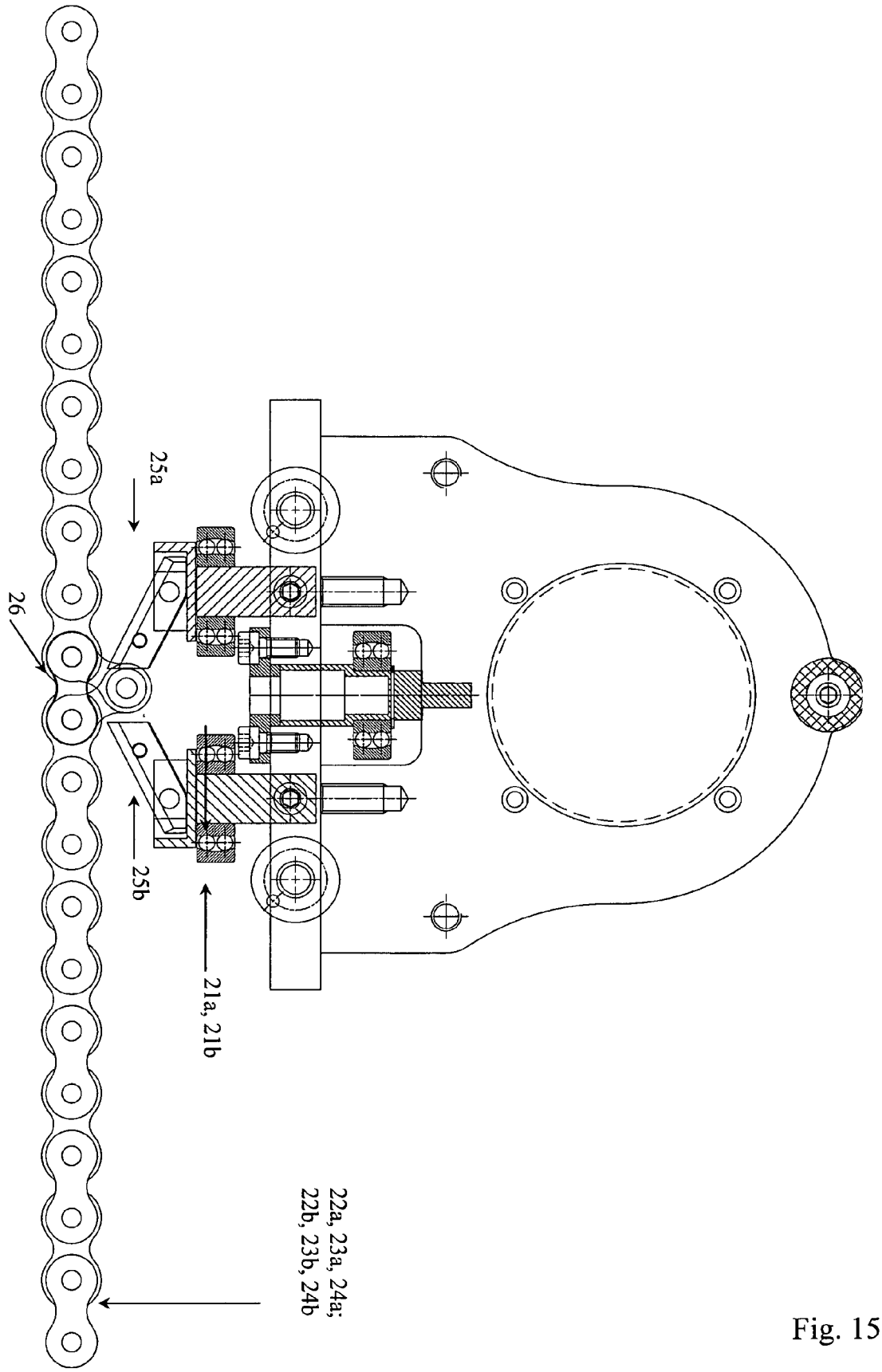


Fig. 15

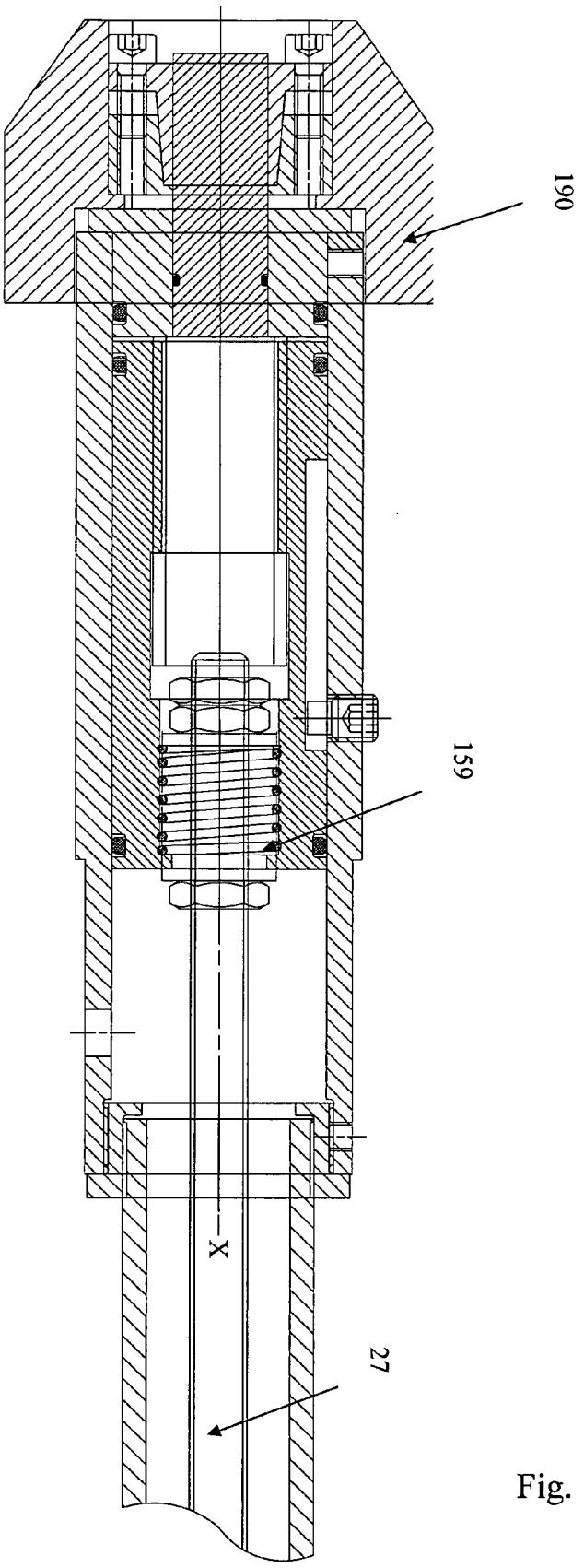


Fig. 16a

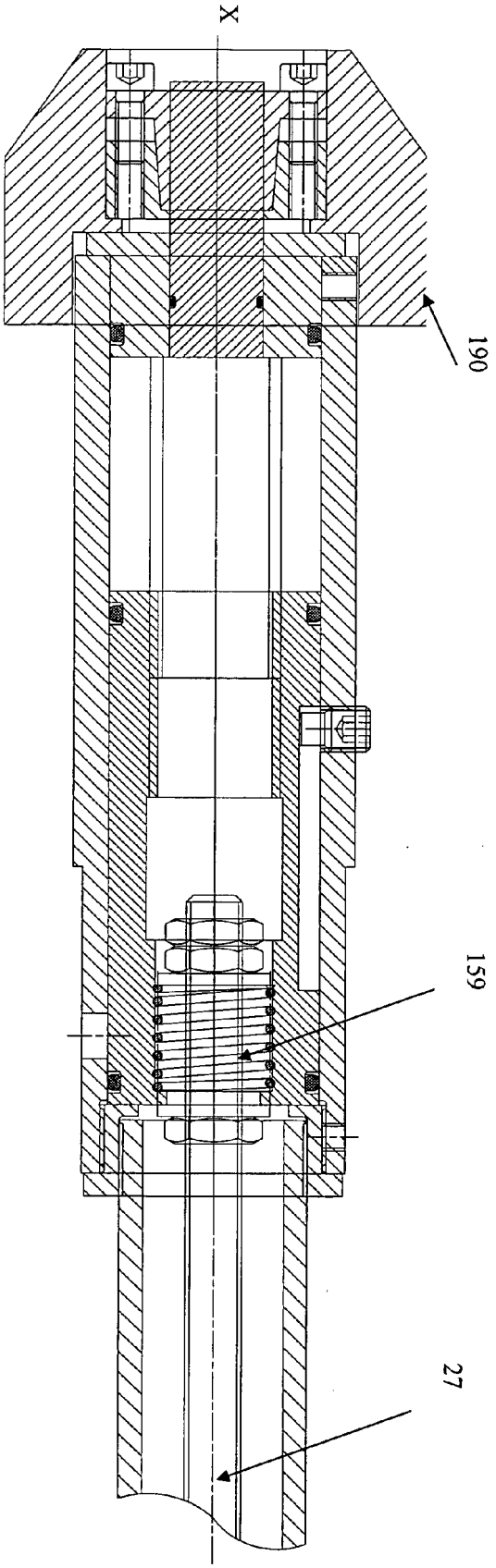


Fig. 16b

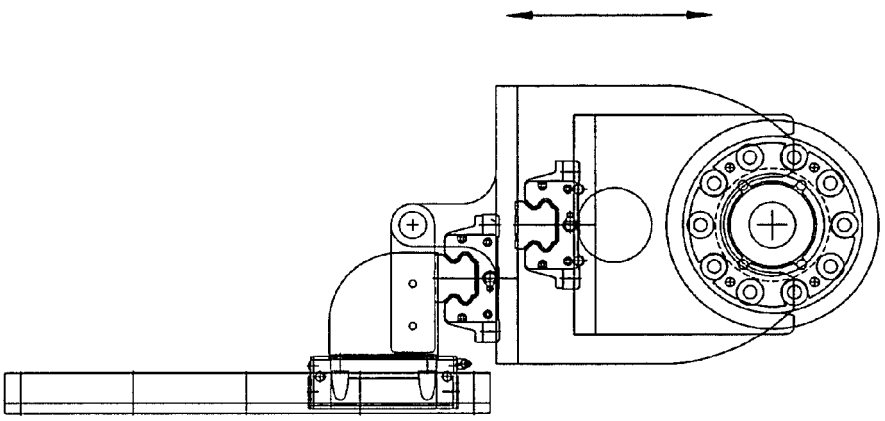


Fig. 17a

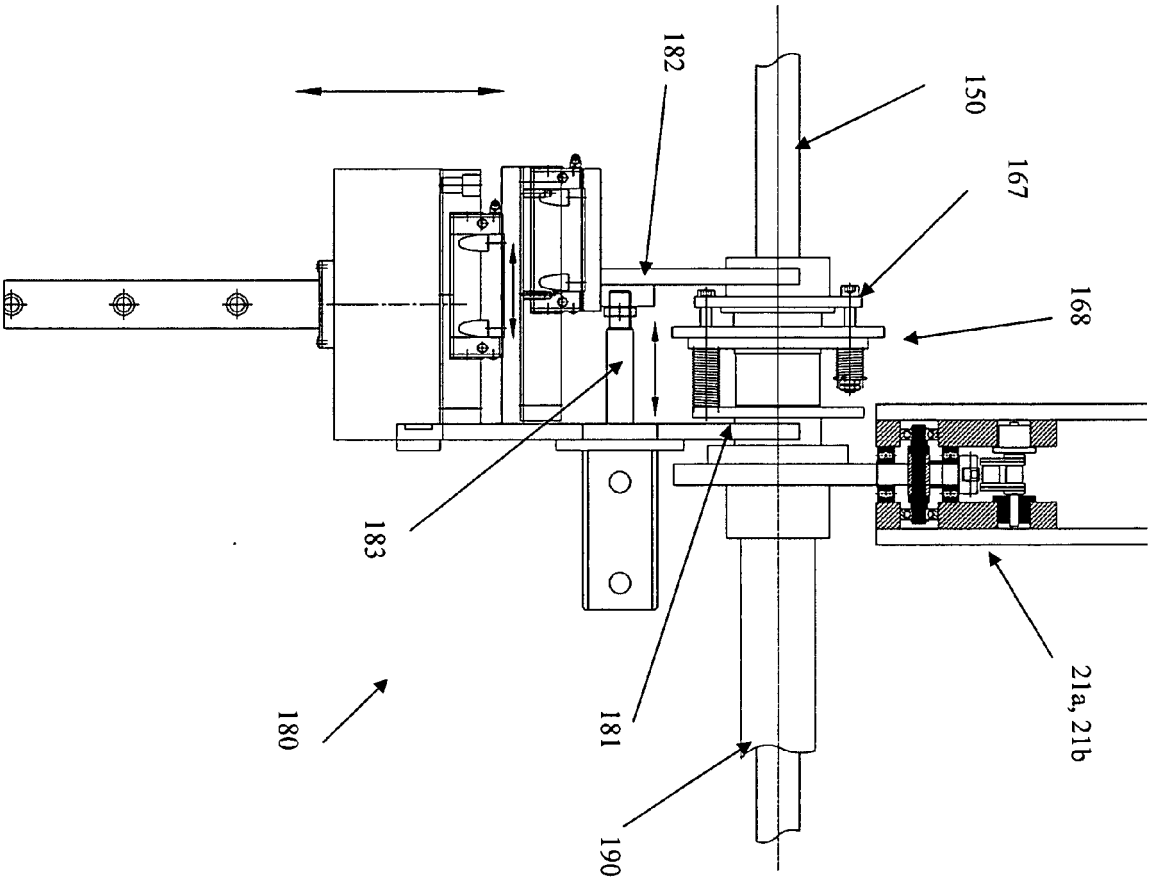
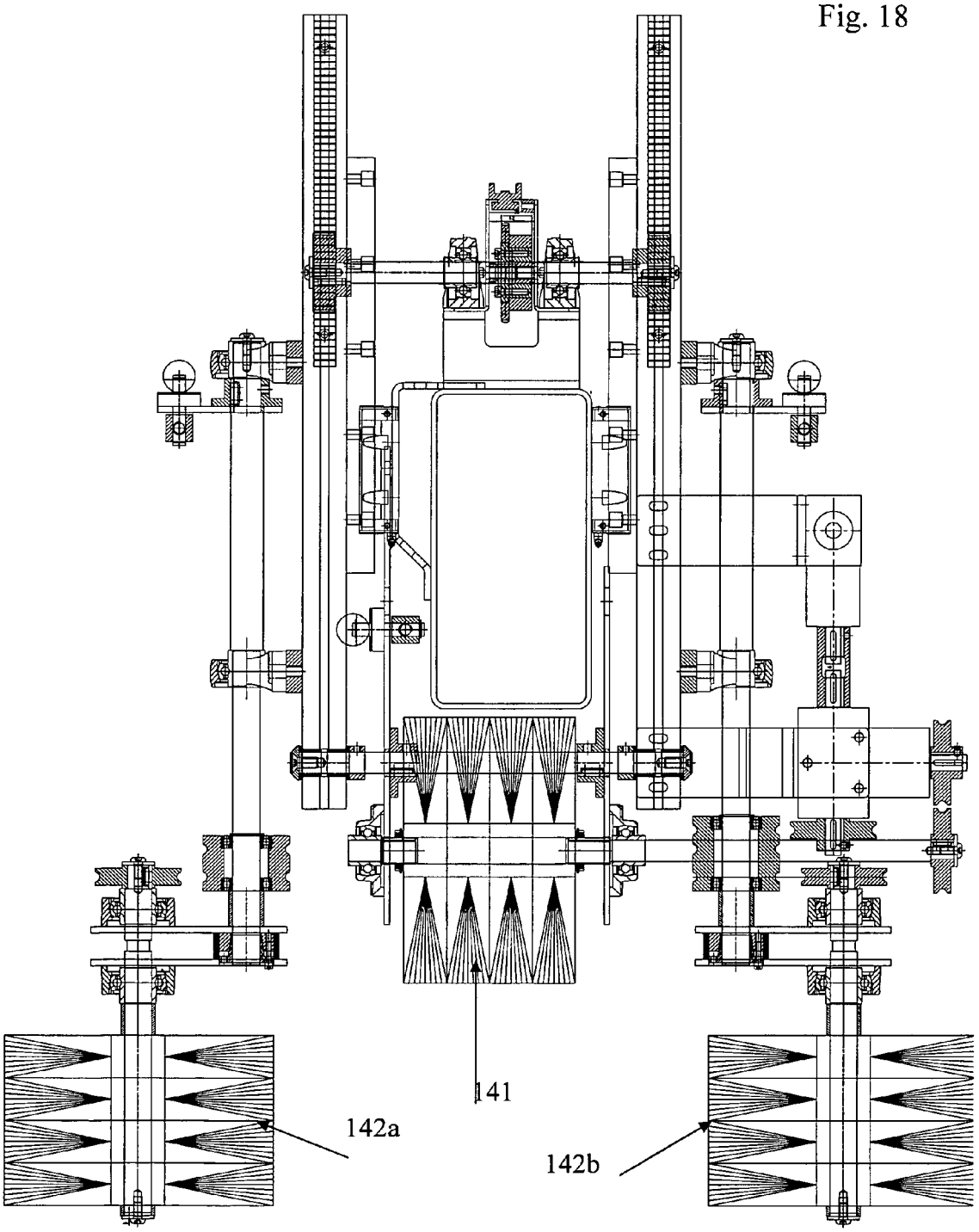


Fig. 17

Fig. 18



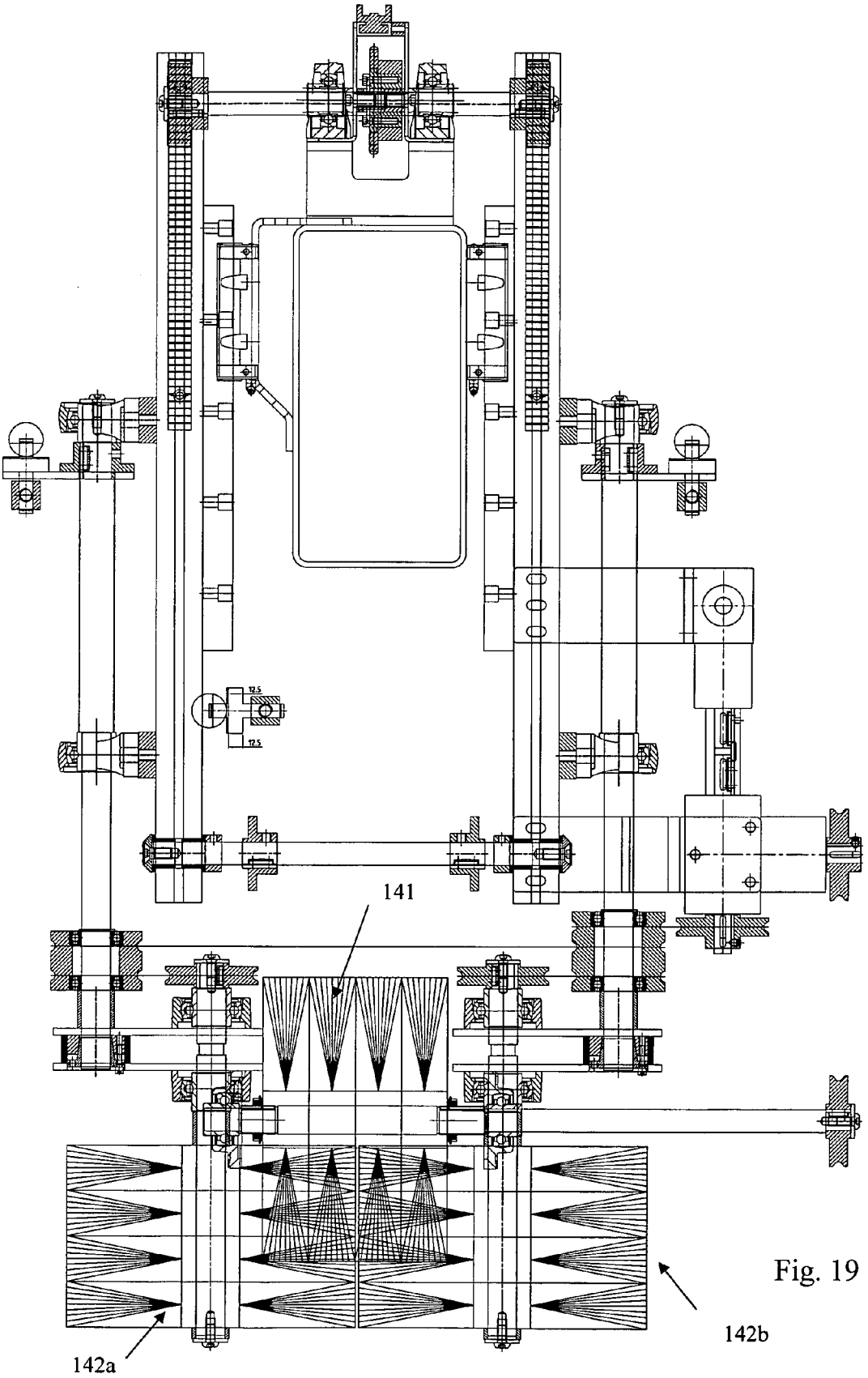


Fig. 19

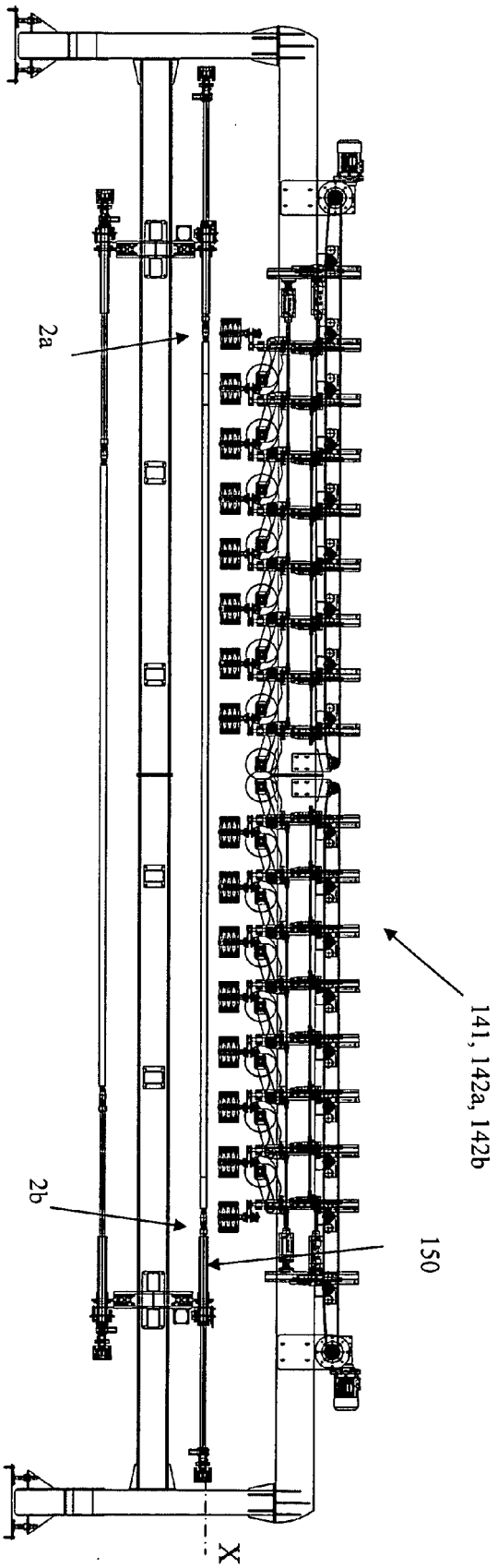


Fig. 20

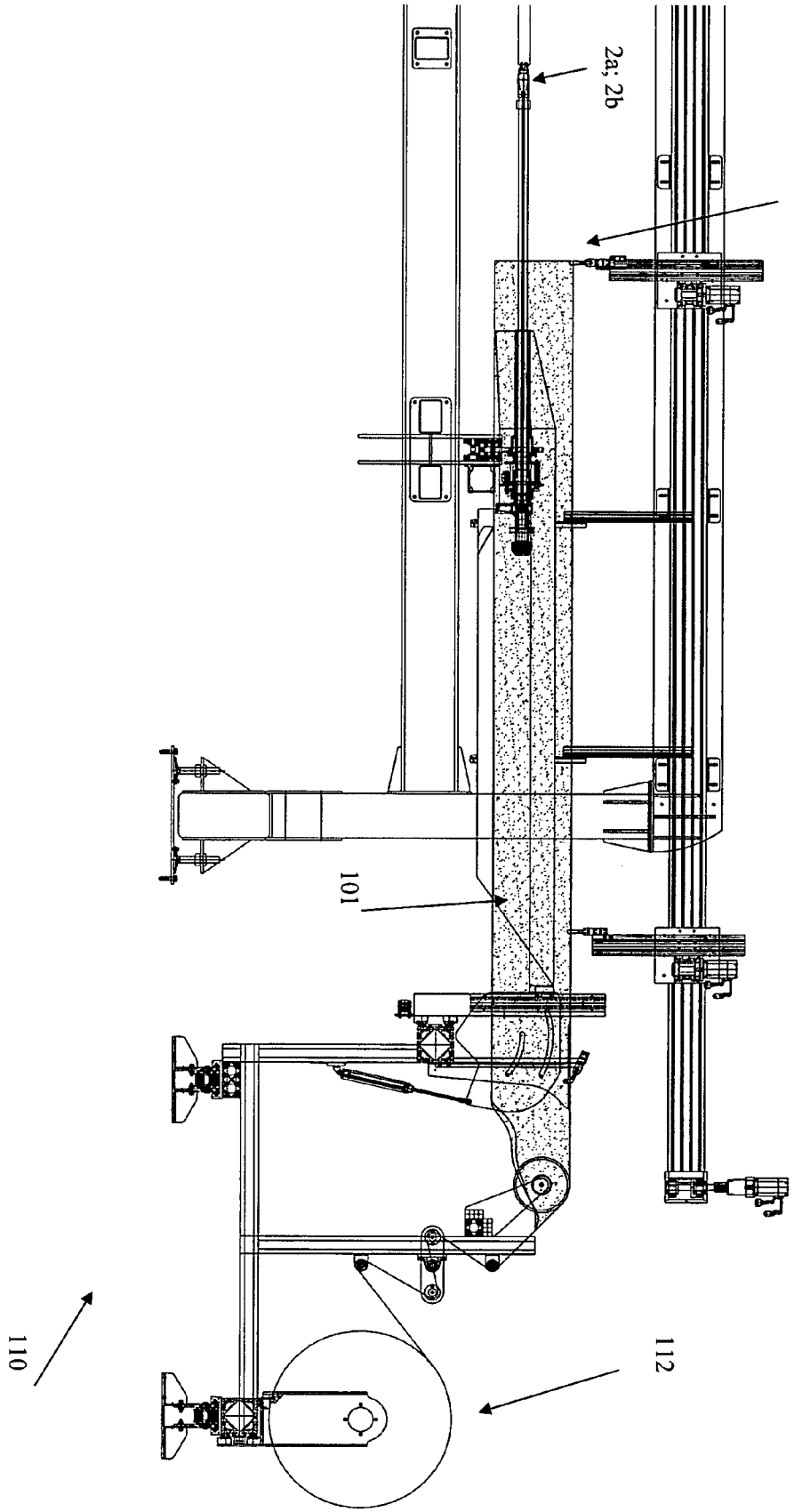


Fig. 21

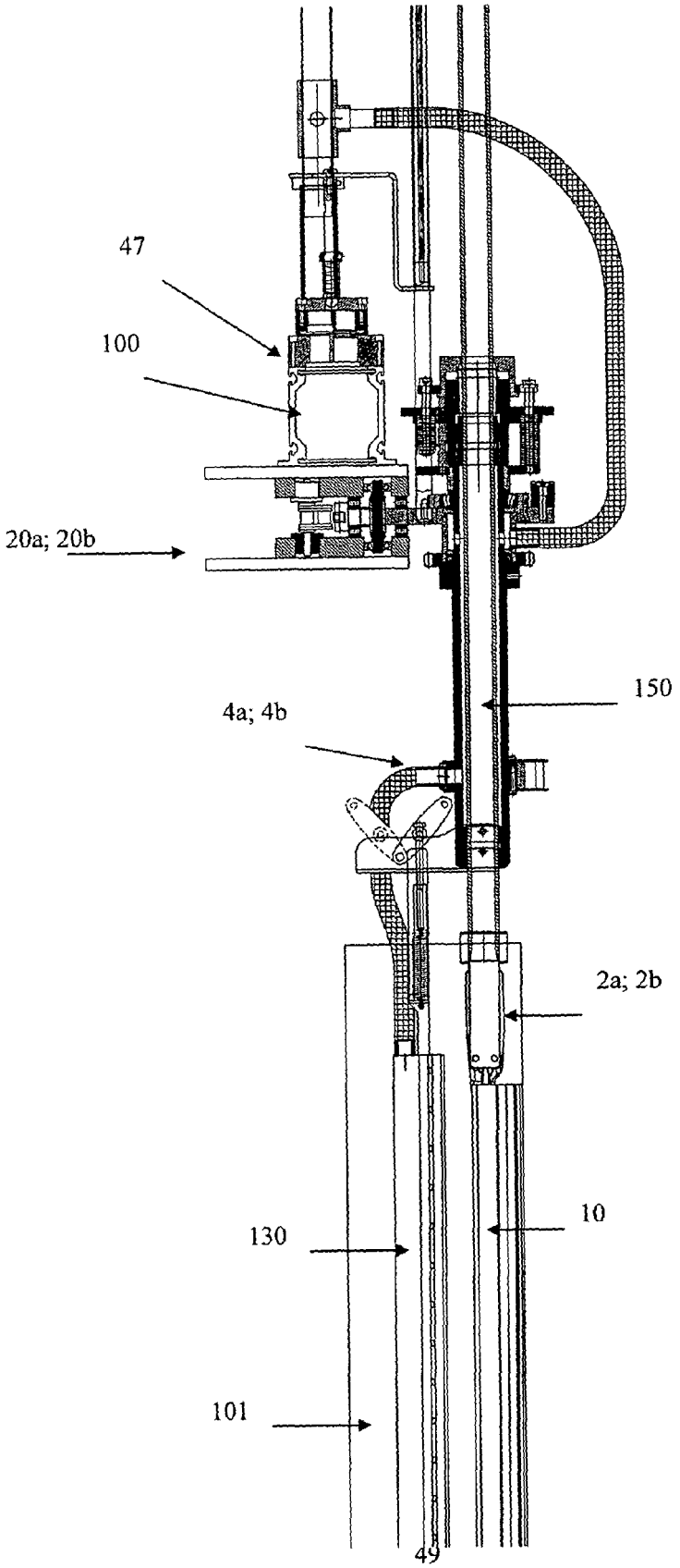


Fig. 22

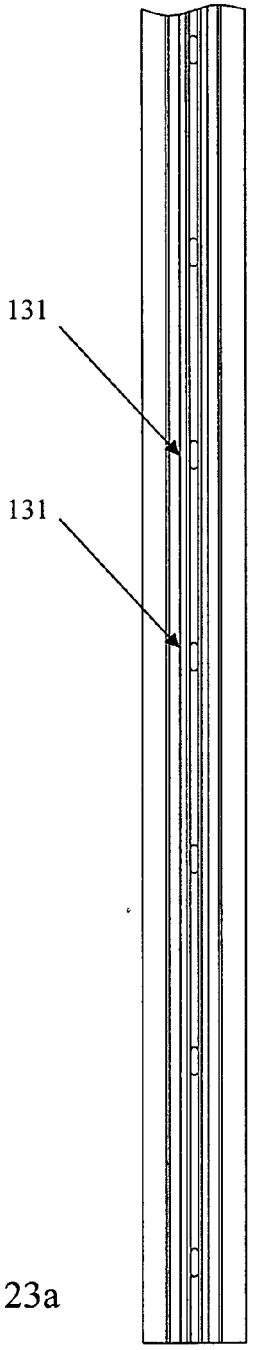


Fig. 23a

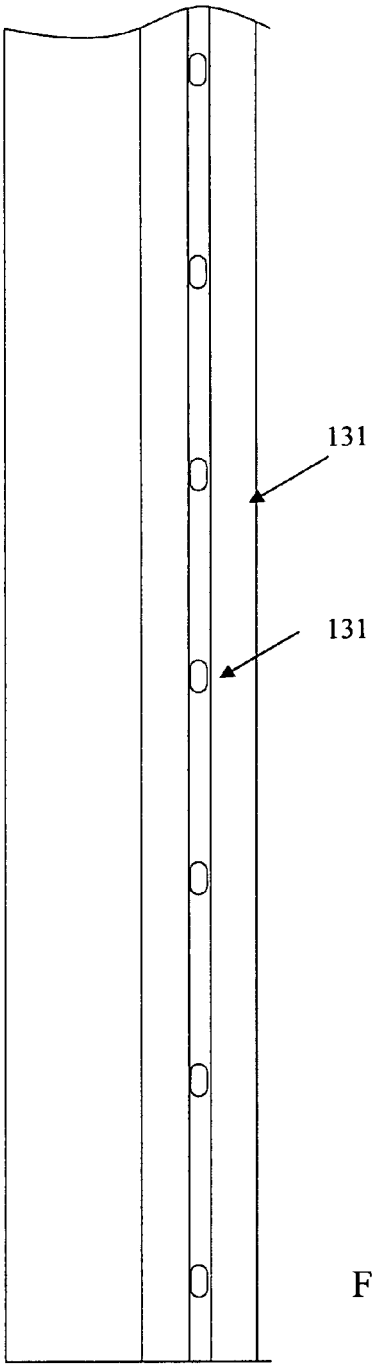
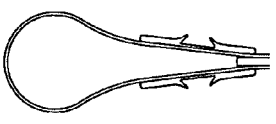


Fig. 23

Fig. 23b



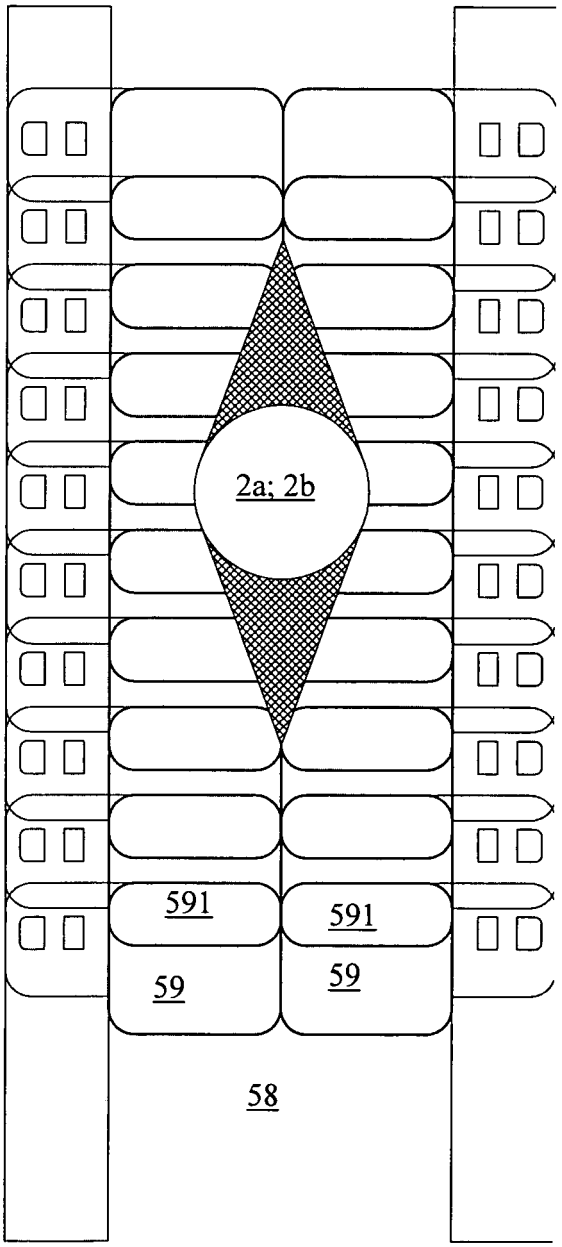


Fig. 24

REFERENCES CITED IN THE DESCRIPTION

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- IT 1336079 **[0027]**