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(54) ROLLING MACHINE FOR FORMING A THREADED PORTION ON A CYLINDRICAL BODY

(57) Rolling machine for forming a threaded portion on a cylindrical body comprising two or more operating heads (60) mounted on the load-bearing structure (2) of the machine (1), each of which is mechanically associated with a corresponding forming roller (6) actuatable to rotate around the rotation axis (Z) thereof. The forming rollers (6) are suitable to plastically deform a cylindrical body (C) arranged along a central work axis (A) of the machine (1) between the forming rollers (6) in order to form, on the cylindrical body (C), a threaded portion that is substantially counter-shaped with respect to that provided for on the forming rollers (6). The machine (1) also comprises at least two linear actuators (7), each provided with a movable stem (9) carrying, mechanically mounted thereon, a corresponding operating head (60) in order to move the forming roller (6) along a respective first transversal axis (R) perpendicular to the work axis (A) of the machine (1). Each operating head (60) comprises a support group (61) integral with the movable stem (9) of the linear actuator (7) and a mandrel-holder plate (62), which supports the corresponding forming roller (6) and is mechanically connected to the support group (61) by means of at least one rotation pin (63) with a first substantially horizontal rotation axis (O) that is substantially perpendicular to said work axis, and by means of first fixing means (64) susceptible of removably locking the mandrel-holder plate (62) to the support group (61) in the selected angular position. The first fixing means (64) comprise first magnetic means actuatable to lock and release the mandrel-holder plate (62) with respect to the support group (61) as in claim 1 and advantageously constituted by two or more electropermanent magnets (640) actuatable to be activated and deactivated by an electrical pulse.

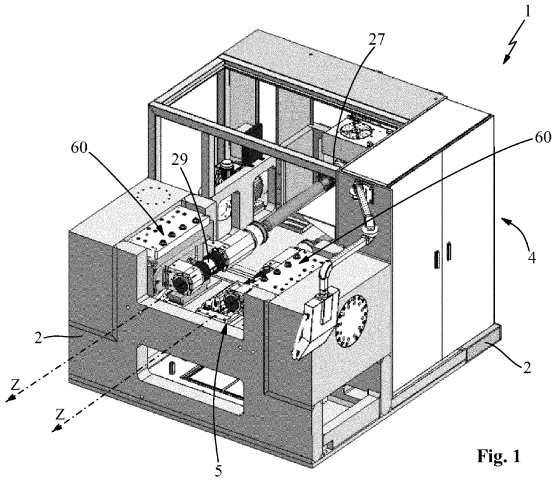

Fig. 1

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Description

Field of application

[0001] The present invention regards a rolling machine for forming a threaded portion on a cylindrical body, according to the preamble of the main independent claim.

[0002] The present rolling machine is included in the industrial field of precision mechanical processing obtained by means of cold plastic deformation and capable of conferring to the processed metallic components high mechanical performance and in particular tenacity and fatigue strength.

[0003] The machine and the method, object of the invention, are advantageously intended to be employed for forming threaded portions on metallic cylindrical bodies such as shafts, bars, rods etc.

State of the art

[0004] Rolling machines provided with a load-bearing structure are currently available on the market. On such structures, two or more operating heads are mounted, each associated with a corresponding forming roller peripherally having a first threaded portion obtained thereon, in order to make an impression, i.e. a corresponding second threaded portion, on the cylindrical body to be formed. The surface processing of the single forming rollers cooperate with each other in succession in order to plastically deform the surface of the cylindrical body to be processed placed along a central work axis of the machine and in order to form the profile of the desired threaded portion thereon. Therefore, the impression left by the forming rollers forms the final threaded portion desired for the cylindrical body and in particular, as is known, the threaded portion is substantially constituted by a helical groove made on the external cylindrical wall of the cylindrical body to be processed.

[0005] In this manner, the cylindrical body provided with the aforesaid desired final threaded portion is susceptible of being coupled by means of shape coupling with a screw internally provided with a corresponding threaded portion.

[0006] Hereinbelow, with the expression "cylindrical body" it will be indicated the mechanical piece/part or member to be formed, whether it is a shaft, a bar, a rod or another cylindrical metallic body on which it is desired to form the impression by means of cold plastic deformation.

[0007] As is known, the forming by means of rolling machine with cold plastic deformation allows producing cylindrical bodies provided with threaded portion that mechanically are particularly strong. Indeed, the metallic crystalline chains, for example made of steel, of the body to be processed with the deformation are not cut, as instead occurs in a conventional milling process, but progressively deformed up to obtaining the necessary impression.

[0008] The rolling machine confers, during the particular cold processing, forging properties to the processed cylindrical body which increase the fatigue strength of the metal with which the cylindrical body to be processed is made as well as increase the static load at the base of the thread. It is known that the mechanical strength of a threaded portion made by means of a rolling machine is on the order of 30% greater than that made with a normal cutting process.

[0009] More in detail, the rolling machines of known type provide for that each forming roller is mounted on a tool-holder shaft, which is actuated to rotate by a corresponding motor. In addition, each forming roller, mounted on the relative operating head, is driven by a corresponding linear actuator to move along a transversal axis substantially perpendicular to the work axis, in order to impart, by means of compression, with its threaded portion, an impression on the metallic body to be formed.

[0010] The impression of a threaded portion left by each forming roller on the metallic body to be processed must follow - in an extremely precise manner - the impression made by the threaded portion of the preceding forming roller in order to compose the final threaded portion desired on the metallic body to be processed as a succession of threading processes.

[0011] As is known in operation, each forming roller during the forming step progressively advances towards the cylindrical body in order to embed its threaded portion on the external surface of the cylindrical body itself; in this manner, part of the material of the cylindrical body is moved onto the external surface thereof in order to leave space for the impression defining the threaded portion.

[0012] The forming operations are controlled by means of a logic control unit, for example of the numerical control type, managed by an external computer (CNC).

[0013] More in detail, the operating head is provided with various adjustments in order to allow the threaded portion to act in the best possible way on the cylindrical body to be formed. For such purpose, each operating head comprises a support group integral with the movable stem of the linear actuator and a mandrel-holder plate, which supports the corresponding forming roller and is mechanically connected to the support group by means of a substantially horizontal rotation pin.

[0014] The latter allows the forming roller to rotate along a horizontal axis in order to vary the angle of the forming roller axis with respect to the central work axis of the machine. Also present are first fixing means for removably locking the mandrel-holder plate to the support group in the selected angular position.

[0015] The adjustment of the angle between the work axis and hence the axis of the cylindrical body to be formed and the axis of the forming rollers has the object of allowing varying the component of the drag force of the cylindrical body along the work axis exerted by the forming rollers.

[0016] In turn, the support group is formed by a driving

body fixed to the stem of the linear actuator, and by a sliding body on which the forming roller is mounted. The sliding body is actuatable to slide on the driving body by rotating around a vertical axis.

[0017] Also present are second fixing means for removably locking the sliding body with respect to the driving body in the selected angular position.

[0018] The adjustment of the angle of the slide and hence of the forming roller around a vertical axis instead has the object of varying the cutting action of the first rings of threaded portion of the forming roller on the cylindrical body to be processed. In other words, for example in the case of particularly hard bodies to be processed, it is preferred that the forming roller starts its action with the first revolutions of threading in a less incisive manner in order to preserve such first rings of threaded portion. This is obtained by slightly spreading, for example, the axis of the forming rollers in order to create an introduction for the entering of the cylindrical body to be formed.

[0019] An example of rolling machine of known type, briefly addressed up to now, is described in the patent EP 3130972.

[0020] The rolling machine of known type briefly described up to now has in practice shown that it does not lack drawbacks.

[0021] The main drawback lies in the fact that the first fixing means currently employed for locking the mandrel-holder plate to the support group, in the selected angular position, are generally manual and this makes the adjustment operations of the dragging of the cylindrical bodies to be formed particularly long and complex each time the production is changed. Solutions with oil-pressure retention jacks are hard to make, since difficult hydraulic seals must be made on the support group, in turn provided with adjustments and hence moving parts.

[0022] A further drawback lies in the fact that in current rolling machines of the above-described type, the angular adjustment along a vertical axis of the position of the sliding body (and hence of the forming roller) with respect to the driving body entails the separation between the relative slide surfaces in contact, when in order to carry out the adjustment the second fixing means are loosened. The weight of the sliding body, supporting the forming roller projectingly on the driving body, determines the separation of the slide surfaces in contact and, as stated, adjustment difficulties.

Presentation of the invention

[0023] In this situation, the problem underlying the present invention is therefore to overcome the drawbacks manifested by the abovementioned solutions of known type by providing a rolling machine for forming a threaded portion on a cylindrical body, which allows maintaining the components of the operating heads, which through the forming rollers form the threaded portion on the cylindrical body to be processed, firmly assembled together even during the compression stresses of the rollers caused against the cylindrical body to be formed.

[0024] A further object of the present invention is to provide a rolling machine for forming a threaded portion on a cylindrical body, which allows easily and safely adjusting the angular position of each forming roller with respect to a horizontal rotation axis that is transversal to the axis of the forming roller for advancing towards the cylindrical body to be formed.

[0025] A further object of the present invention is to provide a rolling machine for forming a threaded portion on a cylindrical body, which allows easily and safely adjusting the angular position of each forming roller with respect to a vertical rotation axis that is transversal to the axis of the forming roller for advancing towards the cylindrical body to be formed.

[0026] A further object of the present invention is to provide a rolling machine which is simple and inexpensive to make.

[0027] These and still other objects are all attained by the machine and by the process, both object of the present invention, according to the attached claims.

Brief description of the drawings

[0028] The technical characteristics of the present invention, according to the aforesaid objects, can be seen in the content of the below-reported claims and the advantages thereof will be more evident in the following detailed description, made with reference to the attached figures, which represent a merely exemplifying and non-limiting embodiment of the invention, in which:

- figure 1 shows a front perspective view of the rolling machine, object of the present invention;
- figure 2 shows a perspective view of a front portion of the machine of figure 1 at the start of the processing step of a cylindrical body;
- figure 3 shows a detail of the rolling machine of figure 1 relative to an operating head mounted on a linear actuator but lacking the relative forming roller and with the head rotated into a first position with respect to a first horizontal adjustment axis;
- figure 4 shows the detail of figure 3 with the operating head rotated into a second position with respect to a first horizontal adjustment axis;
- figure 5 shows a sectional perspective view of the detail of the rolling machine of figure 3 made along a vertical longitudinal plane passing through the advancing axis of said linear actuator;
- figure 6 shows a sectional perspective view of the detail of the rolling machine of figure 3 made along a horizontal longitudinal plane passing through the advancing axis of said linear actuator;
- figure 7 shows an enlarged sectional perspective view of figure 6, with underlined second movement means, which are provided for, for adjusting the position of the sliding body with respect to the driving

body, with respect to a second vertical adjustment axis;

- figure 8 shows the detail of the rolling machine of figure 3 with some parts removed in order to better illustrate other parts and in particular for underlining first movement means for adjusting the position of the operating head along a first horizontal adjustment axis;
- figures 9 and 10 show the detail of the rolling machine of figure 3 with some parts removed in order to better illustrate other parts and in particular for underlining a sliding body provided with first magnetic means for fixing a mandrel-holder plate of an operating head according to two different embodiments of the invention, after an angular adjustment around a first horizontal rotation axis;
- figure 11 shows the sliding body of figure 9 isolated from the remaining members of the same figure 9;
- figure 12 shows the detail of the rolling machine of figure 3 with some parts removed in order to better illustrate other parts and in particular for underlining a driving body provided with second magnetic means for retaining a sliding body not illustrated in the selected position, after an angular adjustment around a second vertical rotation axis;
- figure 13 shows a detail of the forming roller in a longitudinal sectional view of the threaded portion thereof.

Detailed description of several preferred embodiments

[0029] With reference to the attached drawings, reference number 1 overall indicates a rolling machine for forming threaded portions on cylindrical bodies in accordance with the present invention.

[0030] This is generally intended to be employed for making threading treatments or other impressions on cylindrical bodies of mechanical members such as shafts, bars, rods etc. for many different applications.

[0031] The aforesaid treatments are obtained, in a per se known and conventional manner, by means of cold plastic deformation of the surface of the cylindrical body to be formed, by compressing it between multiple forming rollers placed peripherally with respect to the cylindrical body itself.

[0032] Hereinbelow, therefore, the expression "cylindrical body" will refer to the mechanical piece or member on which it is desired to make a threading processing, such as a shaft, a bar, a rod or still another cylindrical member.

[0033] The threaded portions are obtained, in a per se known and conventional manner, by means of cold plastic deformation of the surface of the cylindrical body to be formed by compressing the same cylindrical body between multiple forming rollers 6 placed peripherally with respect to the cylindrical body itself, which is therefore centered with respect to the forming rollers.

[0034] More in detail, the rolling machine 1 is provided with a load-bearing structure 2 intended to be set on the ground, with which at least two operating heads 60 are mechanically associated. The operating heads have corresponding aforesaid forming rollers 6 mechanically associated thereto. As described in detail hereinbelow, such rollers act with their threaded portion against the lateral surface of the cylindrical body to be formed, being actuated to work by rotating, in a first approximation around axes parallel to each other, in a common rotation direction, and in compression on the same lateral surface of the cylindrical body to be formed.

[0035] The load-bearing structure 2 is obtained by means of a metallic framework between a front part, from which the supplying of the cylindrical body to be formed occurs, and a rear part in which the motorizations of the forming rollers 6 are generally provided for. Between such front and rear parts, a central work axis A is thus identifiable at which the cylindrical body C to be formed is substantially coaxially arrangeable.

[0036] In accordance with the embodiment of the attached figures, the load-bearing structure 2 extends longitudinally between a front wall 3 and a rear wall 4, each advantageously provided with a central opening 5 for the passage of the cylindrical body to be processed.

[0037] The central work axis A is arranged orthogonally to the front wall 3 and to the rear wall and passes through the center of the aforesaid openings 5, which are then crossed by the cylindrical body to be processed.

[0038] Each of the two forming rollers 6 is actuatable to rotate around the rotation axis Z thereof and is peripherally provided with a first threaded portion 8 having at least one first thread extending around the rotation axis Z.

[0039] The forming rollers 6 are susceptible of plastically deforming the cylindrical body C that can be arranged along a central work axis A of the machine 1 interposed between the forming rollers 6, in order to form on the cylindrical body C a second threaded portion provided with at least one second thread that is substantially counter-shaped with respect to the first thread of the forming rollers 6.

[0040] Each forming roller 6 is constituted, in a per se conventional manner, by a cylindrical body C, preferably made of steel, provided with a central symmetry axis that corresponds to the rotation axis Z thereof, and that is peripherally provided with the first threaded portion 8 formed by at least one first thread.

[0041] With the term thread, it must be intended hereinbelow a single rib in relief with spiral shape, prearranged on the external cylindrical surface of each forming roller 6. The first threaded portion 8 of each forming roller 6 can be constituted by a single thread or by multiple side-by-side and parallel threads. With the term threaded portion it is thus intended a thread if single or the set of multiple threads that extend on the external lateral surface of the forming rollers 6. Only for the sake of description simplicity, hereinbelow the threaded portion will be considered consisting of a single thread such that such terms coincide as well as the reference number "8"; nev-

ertheless, of course, the first threaded portion 8 can also be consisting of multiple threads without departing from the protective scope of the present patent.

[0042] Each thread 8 extends without interruption with a spiral shape, which develops by winding on the external surface of the forming roller 6, advancing along the longitudinal extension and rotation axis Z thereof.

[0043] Each thread 8 appears consisting of, in a longitudinal reading direction parallel to the axis Z thereof, a succession of profiles 12 (with particular reference to the attached figure 13) which of course are circumferentially connected to each other without interruption to form a single thread 8 wound as a spiral.

[0044] The thread 8 has a transversal section with respect to its spiral extension that is for example approximately triangular or trapezoidal shaped with external crests 24 tapered with respect to an enlarged base. At the crests 24, the radius of the forming roller 6 is maximum, while at the troughs 10, which are alternated with the crests 24, the radius of the forming rollers 6 is minimum.

[0045] The crests 24 and the troughs 10 are connected by tilted flanks 32. The pitch P of the threaded portion remains defined by the axial distance between two crests 24 in succession while the radial distance between the crests 24 and the troughs 10 defines the depth L of the threaded portion 8.

[0046] The thread 8 therefore extends on the external peripheral surface of the roller 6 and around the rotation axis Z with a helical extension and with shape and pitch characteristics that vary in accordance with the application needs of the cylindrical body to be formed.

[0047] In accordance with the example illustrated in the attached figures, the machine 1 provides for two forming rollers 6, placed at 180 degrees from each other.

[0048] The machine can of course provide for a different number of forming rollers 6, in particular three forming rollers 6 arranged at 120 degrees from each other, without departing from the protective scope of the present patent.

[0049] According to the invention, the forming rollers 6 are suitable to plastically deform under cold conditions the cylindrical body to be formed positioned along the central work axis A of the machine and supported in such position, in order to form a second threaded portion provided with at least one second thread substantially counter-shaped with respect to the first thread of said forming rollers 6.

[0050] The machine 1 also comprises two or more linear actuators 7 mounted on the load-bearing structure 2, each mechanically connected to a corresponding forming roller 6 of the operating head 60 in order to move it along a respective first transversal axis R substantially perpendicular to the work axis A.

[0051] The linear actuators 7 actuate the forming rollers 6 to translate along the first transversal axes R moving towards and away from the central work axis A and consequently towards and away from the cylindrical body to be formed.

[0052] For such purpose, the forming rollers 6 are positioned around the central work axis A with their extension axes Z in first approximation substantially parallel to the central work axis A and at an adjustable radial distance due to the actuation of the linear actuators 7. More precisely, the axes Z of the forming rollers 6 are slightly tilted with respect to each other in order to determine the advancement of the cylindrical body to be processed.

[0053] More in detail, in accordance with the embodiment illustrated in the attached figures, the linear actuators 7 are obtained with hydraulic actuators, in particular hydraulic pistons, that are oriented with the displacement axis aligned with the first transversal movement axis R of the corresponding forming roller 6 and passing through the work axis A.

[0054] Each hydraulic actuator of the linear actuators 7 is advantageously provided with a hollow cylindrical body fixed to the front wall 3 of the load-bearing structure 2 of the machine 1.

[0055] Within the hollow cylindrical body, a piston is slidably mounted along the first transversal axis R. Such piston is provided with a movable stem 9, which mechanically supports the corresponding operating head 60.

[0056] The hydraulic actuator 7 is connected to a pressurized oil hydraulic plant capable of moving the stem 9 and the forming roller 6 supported thereby along such first transversal axis R as well as capable of placing the forming roller 6 under pressure with an adjustable force against the external surface of the cylindrical body to be formed. Advantageously the mechanical connection between the forming rollers 6 and the linear actuators 7 occurs through mechanical members that allow at least two adjustments, as described in detail hereinbelow.

[0057] Advantageously, are further provided for motor means, which are prearranged on the load-bearing structure 2 in the rear part of the machine 1 (of per se known type and not illustrated in the attached figures), mechanically connected to the forming rollers 6 in order to drive them in rotation in abutment against the cylindrical body to be formed, so as to impart the aforesaid cold plastic deformation on the external surface thereof.

[0058] For such purpose, the forming rollers 6 have a seat, e.g. a through hole made along the longitudinal extension axis Z thereof, in which is inserted in a coupling relationship a tool-holder shaft 29, connected by means of a transmission to the motor means.

[0059] The latter are for example obtained with electric motors, in particular of brushless type, each associated to a corresponding forming roller 6, and provided with a drive shaft connected to the tool-holder shaft by means of a cardan joint transmission 27, in accordance with the particular embodiment illustrated in the attached figures.

[0060] The motor means, and in particular the brushless motors, are capable of precisely controlling the rotation speed of the shafts thereof and their angular position (and hence of the forming roller that they drive in

rotation) with respect to an angular reference position.

[0061] As is known, the cardan joints 27 interposed between the drive shafts and the tool-holder shafts 29 allow the transmission of the rotation without having to align the drive shafts with the axes of the forming rollers 6, which can therefore rotate at different distances from the central work axis A and they can also have a tilt with respect to the rotation axes of the drive shafts.

[0062] The combination of the transversal compression action due to the linear actuators 7 which compress the forming rollers 6 on the cylindrical body to be formed, with the rotation motion of the forming rollers 6 around their rotation axis Z due to the motor means, allows plastically deforming the cylindrical body placed along the central work axis A, forming progressive impressions on its peripheral external surface until the desired threaded portion is attained.

[0063] Advantageously, in accordance with the embodiment of the machine 1 illustrated in the attached figures, two forming rollers 6 are provided for that are arranged at 180° from each other with respect to the work axis A in a manner such to equally distribute the stresses on the cylindrical body to be formed.

[0064] The rolling machine 1, object of the present invention, also comprises a support base 14 mechanically connected to the load-bearing structure 2, that is substantially interposed between the forming rollers 6 and it is intended to mechanically support the cylindrical body for its plastic deformation.

[0065] More in detail, the operating head 60 comprises a support group 61, integral with the movable stem 9 of the linear actuator 7, and a mandrel-holder plate 62, which supports the corresponding forming roller 6 and it is mechanically connected to the support group 61. The mechanical connection between such support group 61 connected to the stem 9 of the piston 7 and the mandrel-holder plate 62, with which the forming roller 6 is integral, occurs by means of at least one rotation pin 63, and by means of first fixing means 64. More in detail, the rotation pin 63 allows the mandrel-holder plate 62 and hence the forming roller 6 to rotate around a first substantially horizontal axis O, perpendicular to the work axis A, and preferably substantially coinciding with the first transversal movement axis R of the forming roller 6 (the two axes R and O are in any case tiltable with the adjustment described hereinbelow), in order to allow a first angular rotation of the forming roller 6 itself with respect to such first horizontal axis O and thus allow tilting the axis of the forming roller 6 with respect to the central work axis A. The first fixing means 64 are instead susceptible of rigidly locking the mandrel-holder plate 62 to the support group 61 in the selected angular position.

[0066] According to the idea underlying the present invention, the rolling machine 1 provides for that the aforesaid first fixing means 64 comprise first magnetic means actuatable to lock and release the mandrel-holder plate 62 with respect to the support group 61.

[0067] Due to the present invention, it is thus possible to deactivate the aforesaid first magnetic means 64 in order to adjust the angle of the forming roller 6 by rotating the mandrel-holder plate 62 which supports it around the rotation pin 63, i.e. around the first horizontal axis O, and with respect to the support group 61 integral with the stem 9 of the linear actuator 7 so as to vary the angle of the axis of the forming roller 6 with respect to the central work axis A of the machine (and hence with respect to the axis of the cylindrical body C to be formed), and hence reactivate the aforesaid first magnetic means 64 in order to lock the mandrel-holder plate 62, and thus the forming roller 6, in the desired angular position.

[0068] Advantageously, the aforesaid first magnetic means 64 comprise two or more electropermanent magnets 640 mounted on the mandrel-holder plate 62 or on the support group 61 and actuatable to be activated and deactivated by an electrical pulse. Generally, an electropermanent magnet, also known with the initials EPM, is a type of permanent magnet in which the external magnetic field can be activated or deactivated by a pulse of electric current in a wire winding around a part of the magnet. The magnet consists of two parts, one of "hard" magnetic material (high coerciveness) and one of "soft" magnetic material (low coerciveness). The direction of the magnetization of the magnet with low coerciveness can be switched by a current pulse in a winding of the wire that encloses it. When the two magnets made of magnetically soft and hard materials have opposite magnetizations, the electropermanent magnet does not produce any net/clear external field through its poles, while when their magnetization direction is aligned, the electropermanent magnet produces an external magnetic field.

[0069] The use of electropermanent magnets is preferable in the present invention, with respect to the use of electromagnets, in particular due to safety in case of interruption of current supply, as well as for a reduced energy consumption and for the absence of heating of the components.

[0070] Nevertheless, for the purpose of the wider definition of the present invention, it must be deemed that the first magnetic means 64 can also be constituted by electromagnets.

[0071] Advantageously, in operation it can also be provided for to adjust the angular position of the forming roller 6 around such first rotation axis T, having deactivated only some magnets so as to maintain a retention force of the mandrel-holder plate 62 to the support group 61 that avoids unloading an excessive weight of the forming roller 6 on the pin 63.

[0072] For such purpose for example, the logic control unit of the machine will be susceptible of deactivating at least one first electropermanent magnet, leaving at least one second electropermanent magnet activated in order to allow the first movement means 13 to move the mandrel-holder plate 62 with respect to the support group 61, overcoming the magnetic attraction of the second electropermanent magnet.

[0073] The machine according to the invention also comprises first movement means 13 acting on the mandrel-holder plate 62 in order to drive it in rotation around the pin 63. In accordance with a first possible embodiment of the invention, such first movement means 13 comprise a curved rack 130 fixed at a lateral edge, preferably front, of the mandrel-holder plate 62, and a worm screw 131 engaged with the rack 130 and mounted on the support group 61.

[0074] The worm screw 131 is actuatable in rotation, for example manually by means of a tool, in order to vary the angular position of the mandrel-holder plate 62 with respect to the support group 61 and hence in order to vary the angular position of the forming roller 6 with respect to the work axis A of the machine 1.

[0075] Otherwise, in accordance with another embodiment of the invention, the first movement means 13 comprise at least one actuator, which is interposed between the mandrel-holder plate 62 and the support group 61, advantageously at a rear side of the mandrel-holder plate 62, and it is once again actuatable in order to vary the angular position of the mandrel-holder plate 62 with respect to the support group 61 and hence to vary the angular position of the forming roller 6 with respect to the work axis A of the machine 1.

[0076] The support group 61 comprises a driving body 610 which is fixed to the stem 9 of the linear actuator 7, and has a first concave slide surface 611 provided with a first curvature radius. The support group 61 also comprises a sliding body 612 having a second convex slide surface 613 provided with a second curvature radius substantially coinciding with the first curvature radius. The slide surfaces 611 and 613 thereof are opposite, coupled and in contact with each other for at least part of their extension, since they are substantially counter-shaped.

[0077] The first magnetic means 64 (and in particular the electropermanent magnets) are arranged at an external face 612A of the sliding body 612 directed towards the mandrel-holder plate 62. In accordance with the examples of figures 10 and 11, two pairs of electropermanent magnets 640 are provided for, while in accordance with the embodiment of figure 9 four pairs of electropermanent magnets 640 are provided for. The sliding body 612 is actuatable to slide with respect to the driving body 610 with curved path, i.e. around the common center 100 of the two curvature radii of the two surfaces 611 and 613. For such purpose, second movement means 614 are provided for, for moving the sliding body 612 with respect to the driving body 610 around a second substantially vertical rotation axis V and passing through the aforesaid common center 100 of the two curvature radii.

[0078] During such rotation, the aforesaid first and second slide surfaces 611 and 613 remain at sliding contact with each other.

[0079] In accordance with a further advantageous characteristic of the present invention, the machine also comprises second magnetic means 14 suitable to retain the sliding body 612 engaged with the second slide surface 613 thereof within the first slide surface 611 of the driving body 610.

[0080] Second fixing means 140 are also preferably provided for. These are susceptible of locking the sliding body 612 with respect to the driving body 610 in the angular position defined by the second movement means 614. Such second fixing means 140 are for example constituted by a plurality of screws 141, which thrustingly act against a plate 142, which has a tilted profile 143 which acts against a corresponding tilted profile 144 of the slide plate 612, compressing it against the drive plate 610 as can be seen from the section figure of figure 5.

[0081] The second magnetic means 14 are permanent magnets aimed to retain the slide surfaces 611, 613 in contact with each other even when the fixing means 140 are loosened in order to allow the adjustment by means of the second movement means 614.

[0082] The second movement means 614 are designed for easily overcoming the magnetic attraction between the sliding body 612 and the driving body 610 and allowing the relative movement thereof.

[0083] The second movement means 614 are for example for such purpose constituted by at least one pair of screws 615, which are axially engaged in threaded seats 616 made in the driving body 610 transversally to the displacement direction of the forming roller 6, or transversally to the movement direction of the linear actuator 7, and act against opposite sides of a block 617 integral with the sliding body 612.

[0084] By rotating the two screws 615, for example through a manual tool or a motor, the block 617 is moved within a cavity 618 made in the driving body 610 and thus moves - along the arc subtended between the two slide surfaces - the sliding body 612 with respect to the driving body 610 itself (see figure 7).

[0085] The invention thus conceived therefore attains the pre-established objects.

Claims

1. Rolling machine for forming a threaded portion on a cylindrical body, comprising:

   - a load-bearing structure (2);
   - at least two operating heads (60) mounted on said load-bearing structure (2), each of which has mechanically associated thereto a corresponding forming roller (6), actuatable to rotate around the rotation axis (Z) thereof by a motor and peripherally provided with a first threaded portion (8) extending around said rotation axis (Z); said forming rollers (6) being susceptible of plastically deforming a cylindrical body (C) that can be arranged along a central work axis (A) of said machine (1) interposed between said forming rollers (6) in order to form, on said cylindrical body (C), a second threaded portion that

is substantially counter-shaped with respect to the first threaded portion (8) of said forming rollers (6);

- at least two linear actuators (7), mechanically supported by said load-bearing structure (2) and each provided with a movable stem (9) carrying, mechanically mounted thereon, a corresponding said operating head (60) with said forming roller (6) associated thereto, in order to move the latter along a respective first transversal axis (R) perpendicular to said work axis (A);

each said operating head (60) comprising at least one support group (61) integral with the movable stem (9) of said linear actuator (7) and at least one mandrel-holder plate (62), which supports said corresponding forming roller (6) and is mechanically connected to said support group (61) by means of at least one rotation pin (63) having a first substantially horizontal rotation axis (O) that is substantially perpendicular to said work axis (A), for the angular adjustment of said forming roller (6) around said first horizontal rotation axis (O), and by means of first fixing means (64) susceptible of removably locking said mandrel-holder plate (62) to said support group (61) in the selected angular position;

characterized in that said first fixing means (64) comprise first magnetic means actuatable to lock and release said mandrel-holder plate (62) with respect to said support group (61).

2. Machine according to claim 1, **characterized in that** said first magnetic means (64) comprise two or more electropermanent magnets (640) mounted on said mandrel-holder plate (62) or on said support group (61) and actuatable to be activated and deactivated by an electrical pulse.

3. Machine according to claim 2, **characterized in that** it comprises a logic control unit susceptible of deactivating at least one first electropermanent magnet of said electropermanent magnets (640), leaving at least one second electropermanent magnet activated in order to allow said first movement means (13) to move said mandrel-holder plate (62) with respect to said support group (61), overcoming the magnetic attraction of said second electropermanent magnet.

4. Machine according to claim 1, **characterized in that** it comprises first movement means (13) acting on said mandrel-holder plate (62) in order to drive it in rotation around said pin (63).

5. Machine according to claim 4, **characterized in that** said first movement means (13) comprise a curved rack (130) provided for at a lateral edge of said mandrel-holder plate (62), and a worm screw (131) engaged with said rack (130), mounted on said support group (61) and actuatable in rotation in order to vary the angular position of said mandrel-holder plate (62) with respect to said support group (61) and hence of said forming roller (6) with respect to the work axis (A) of said machine (1).

6. Machine according to claim 4, **characterized in that** said first movement means (13) comprise at least one actuator interposed between said mandrel-holder plate (62) and said support group (61) and actuatable to vary the angular position of said mandrel-holder plate (62) with respect to said support group (61).

7. Machine according to claim 1, **characterized in that** said support group (61) comprises a driving body (610) fixed to the stem (9) of said linear actuator (7), and having a first concave slide surface (611) provided with a first curvature radius, and a sliding body (612) having a second convex slide surface (613) provided with a second curvature radius coinciding with the first, being substantially counter-shaped with respect to said first concave slide surface (611); said sliding body (612) being actuatable to slide with respect to said driving body (610) around a second substantially vertical rotation axis (V) passing through the common center (100) of said curvature radii, second movement means (614) being provided for moving said sliding body (612) with respect to said driving body (610) around said second vertical rotation axis (V), with said first and second slide surfaces (611, 613) in contact with each other, said machine also comprising second magnetic means (14) suitable to retain said sliding body (612) engaged against said driving body (610).

8. Machine according to claim 7, **characterized in that** said second magnetic means (14) are permanent magnets.

9. Machine according to claim 7, **characterized in that** said second movement means (614) are designed for overcoming the attraction of said permanent magnets when moving said sliding body (612) with respect to said driving body (610).

10. Machine according to claim 7, **characterized in that** it comprises second fixing means (140) susceptible of removably locking said sliding body (612) with respect to said driving body (610) in the position defined by said second movement means (614).

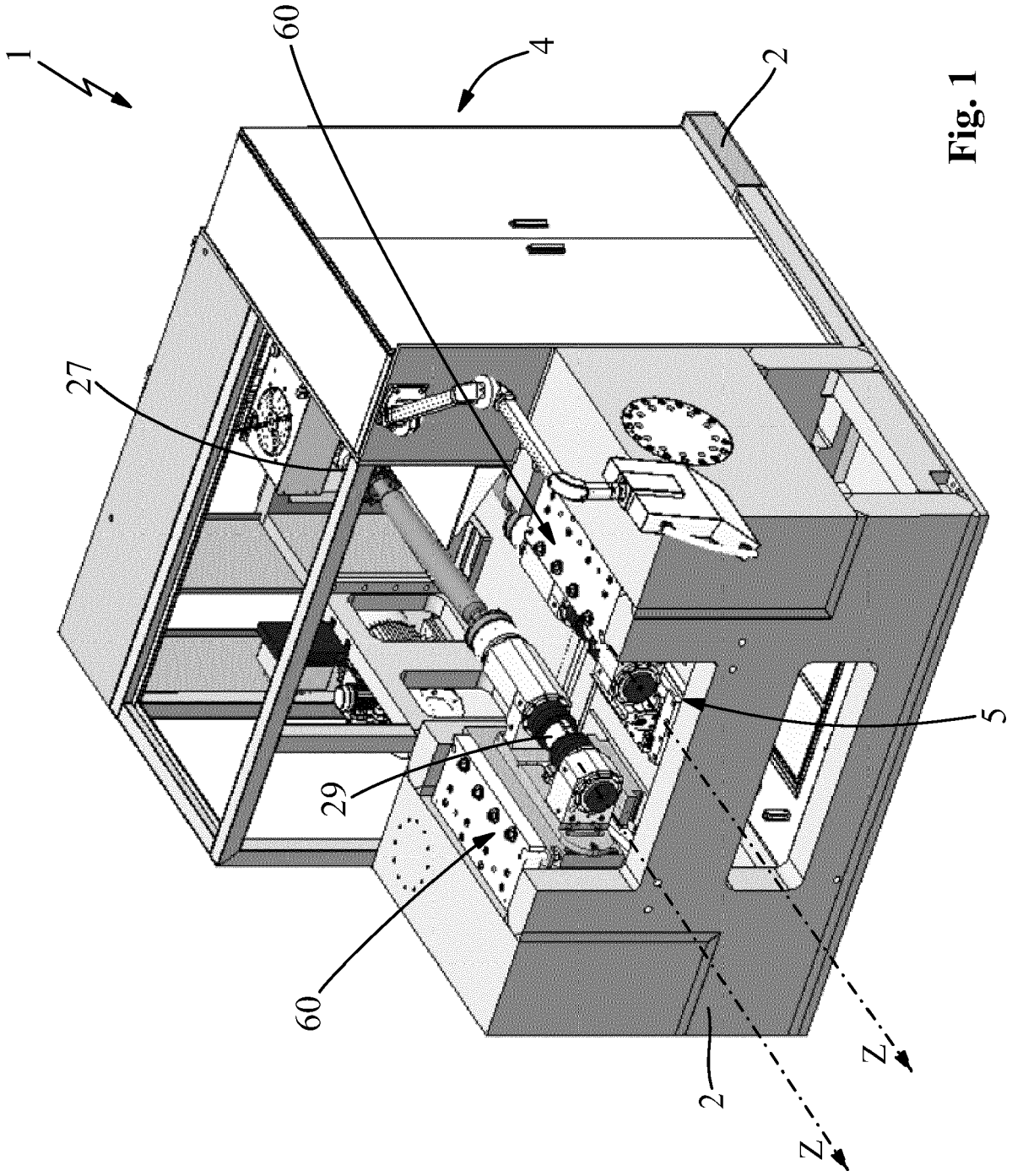

Fig. 1

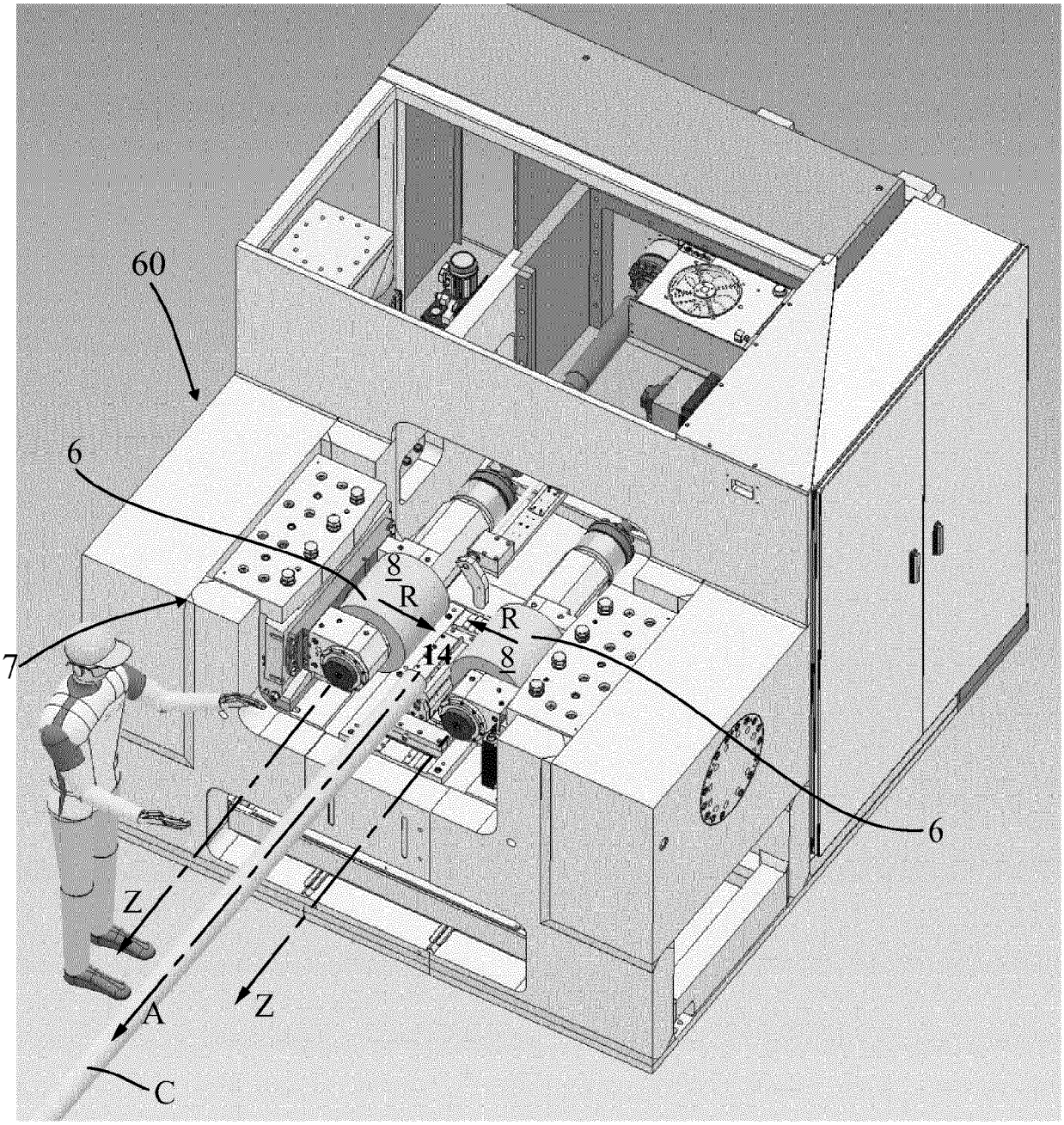

Fig. 2

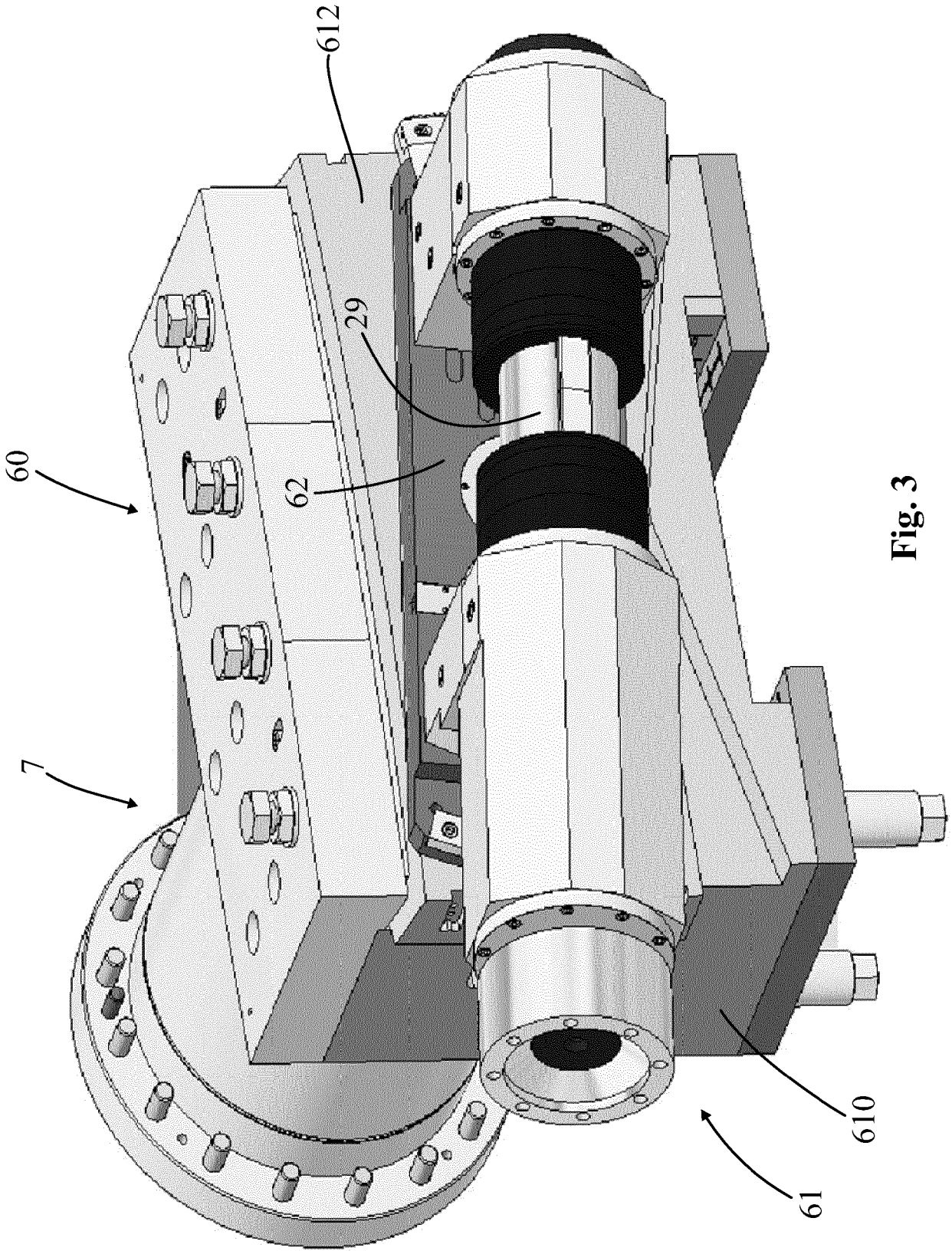

Fig. 3

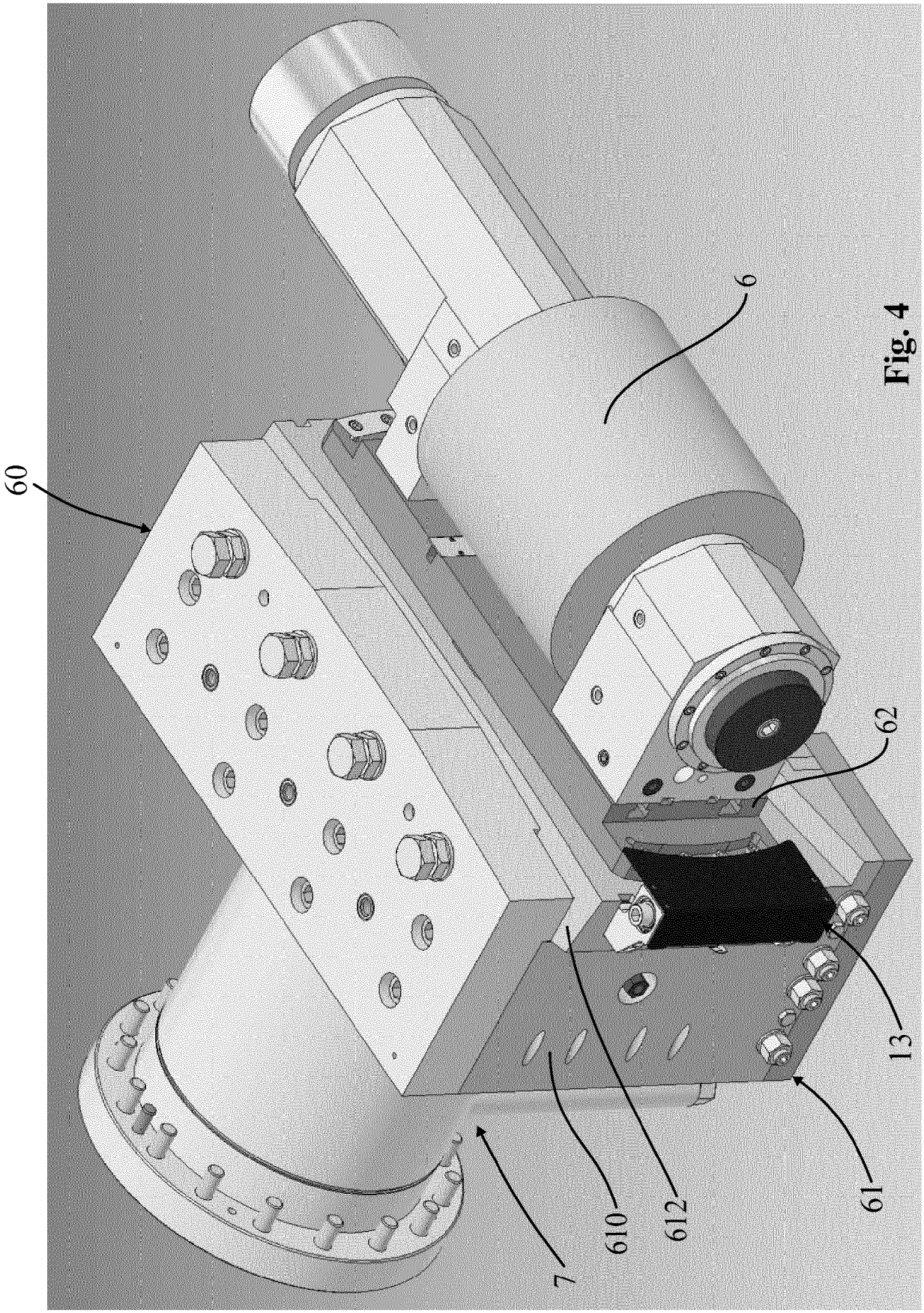

Fig. 4

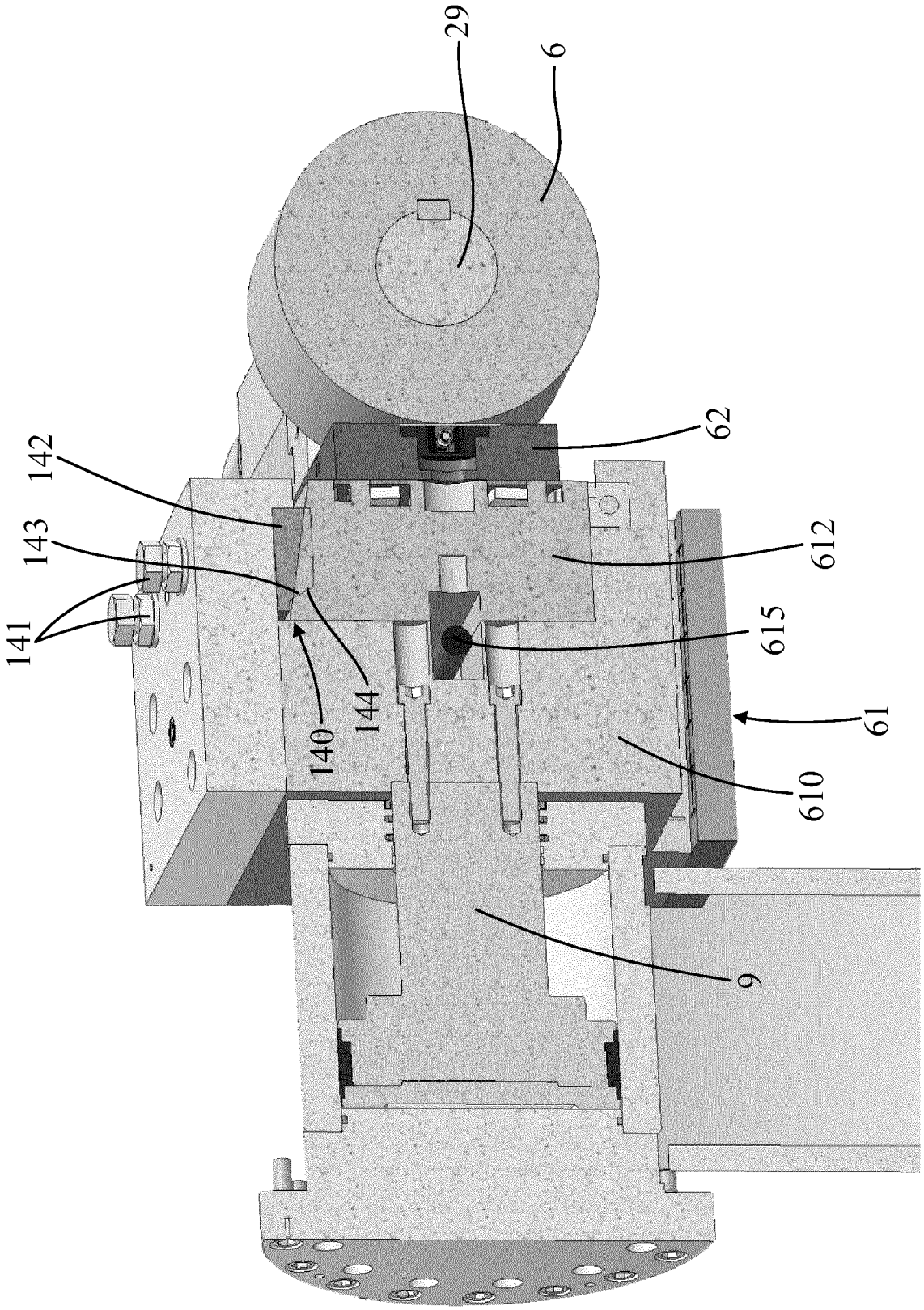

Fig. 5

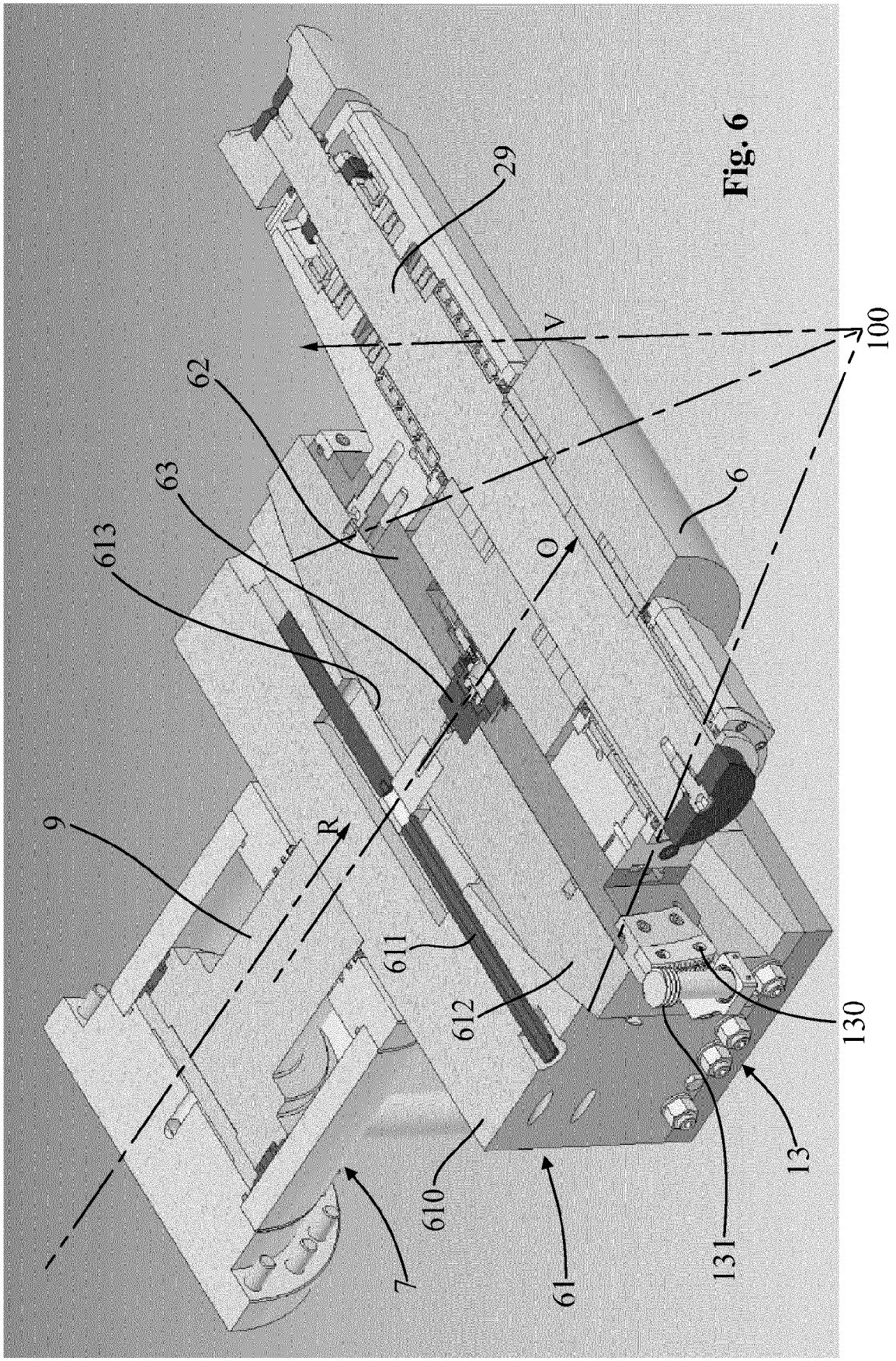

Fig. 6

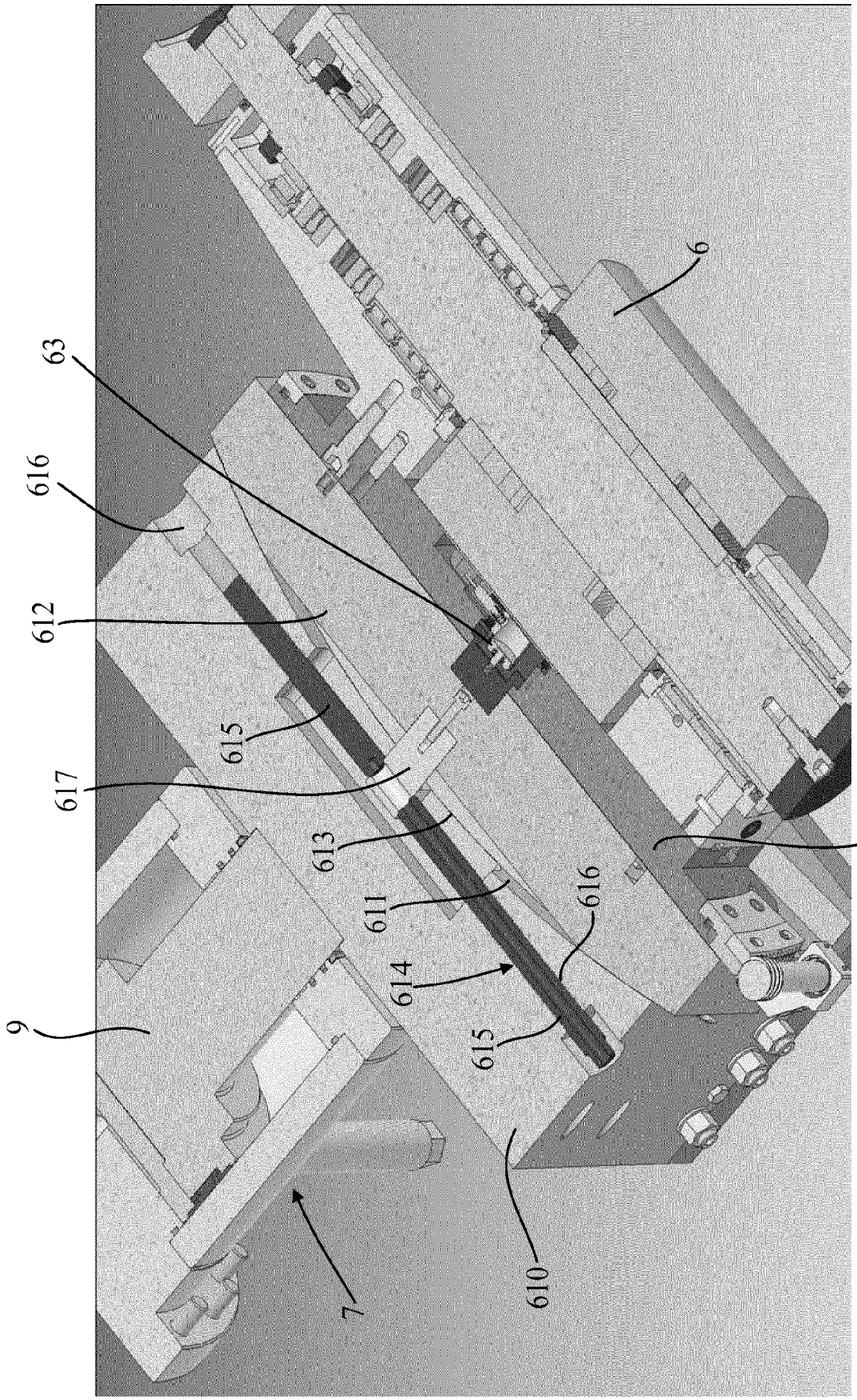

Fig. 7

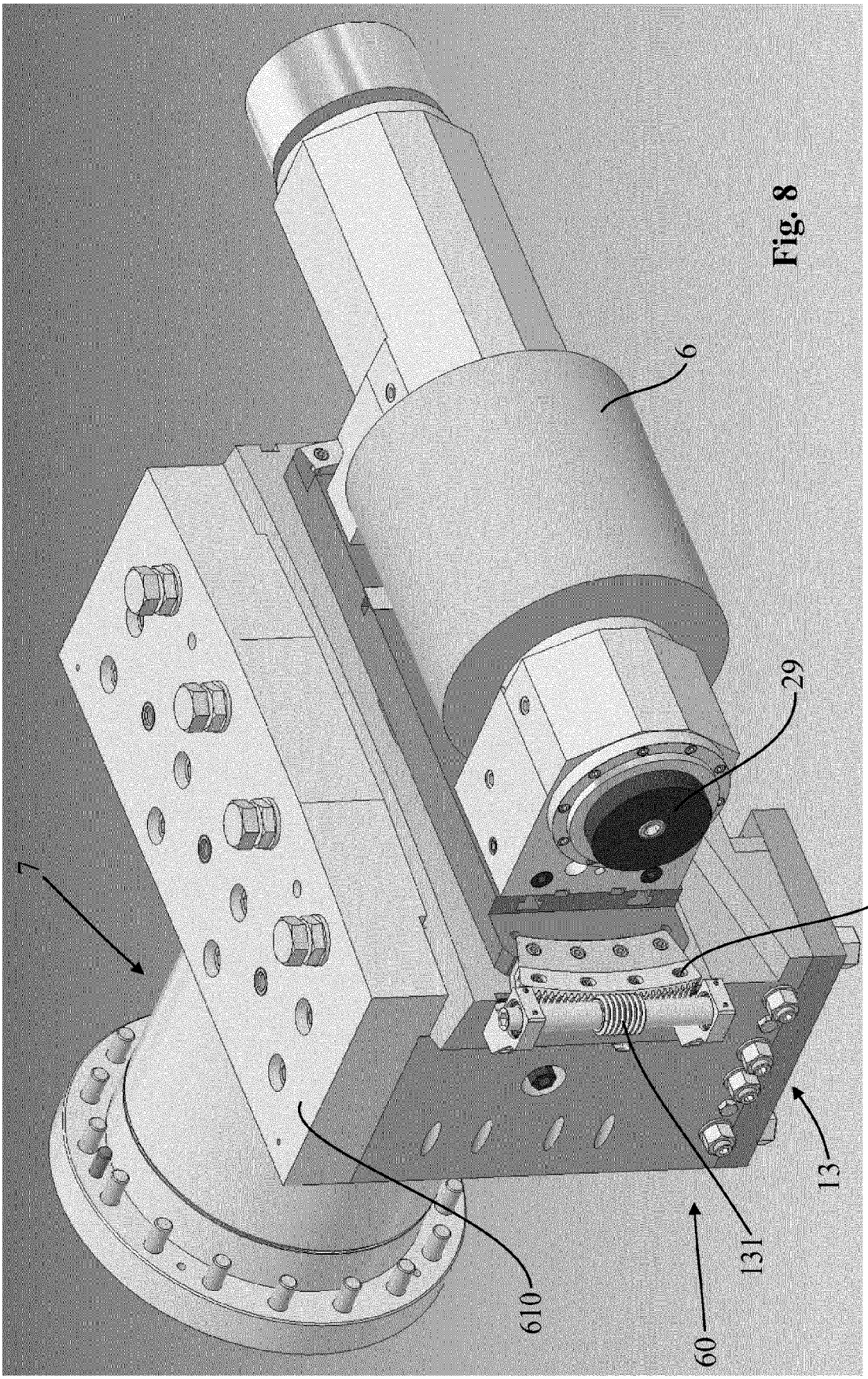

Fig. 8

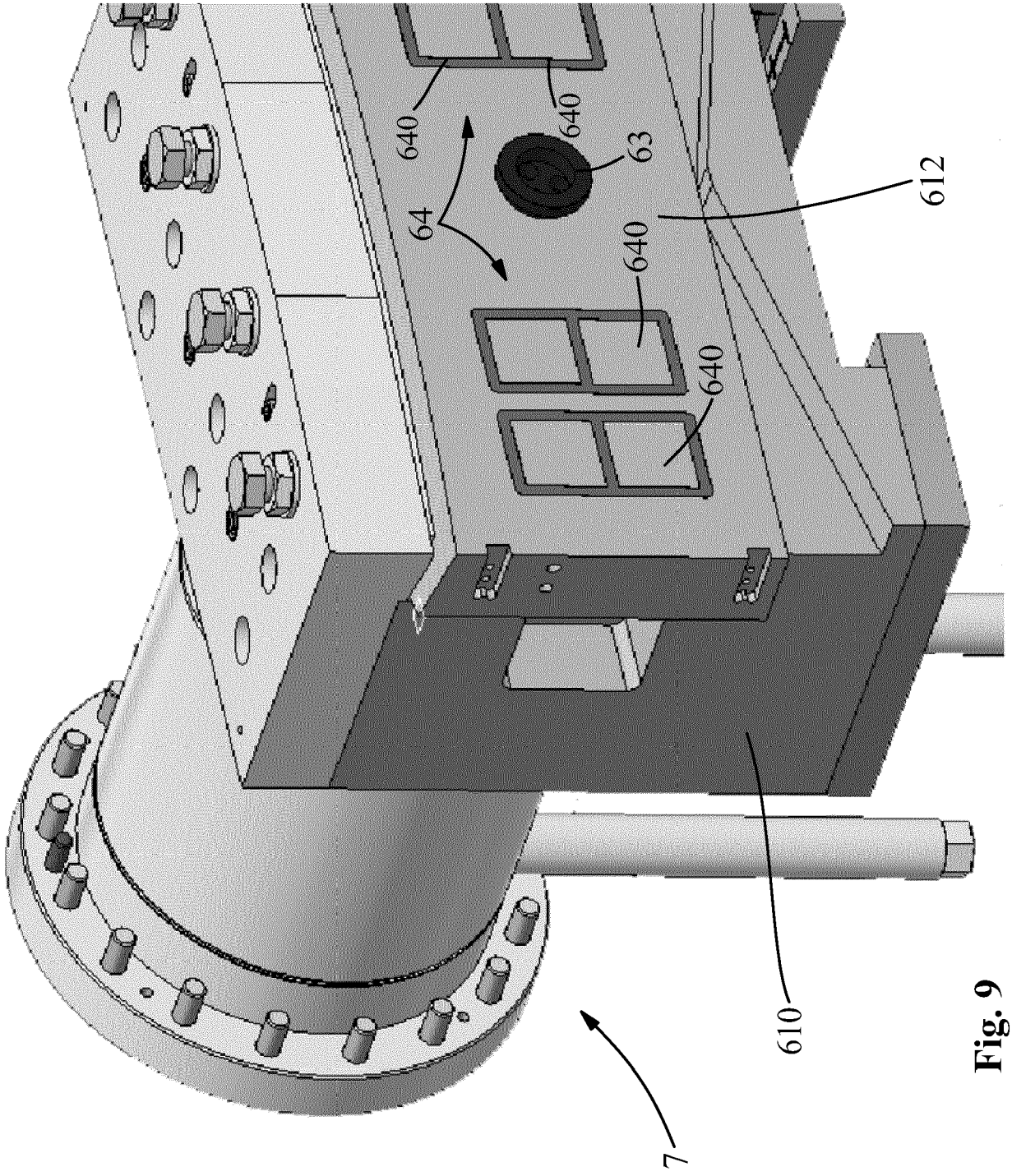

Fig. 9

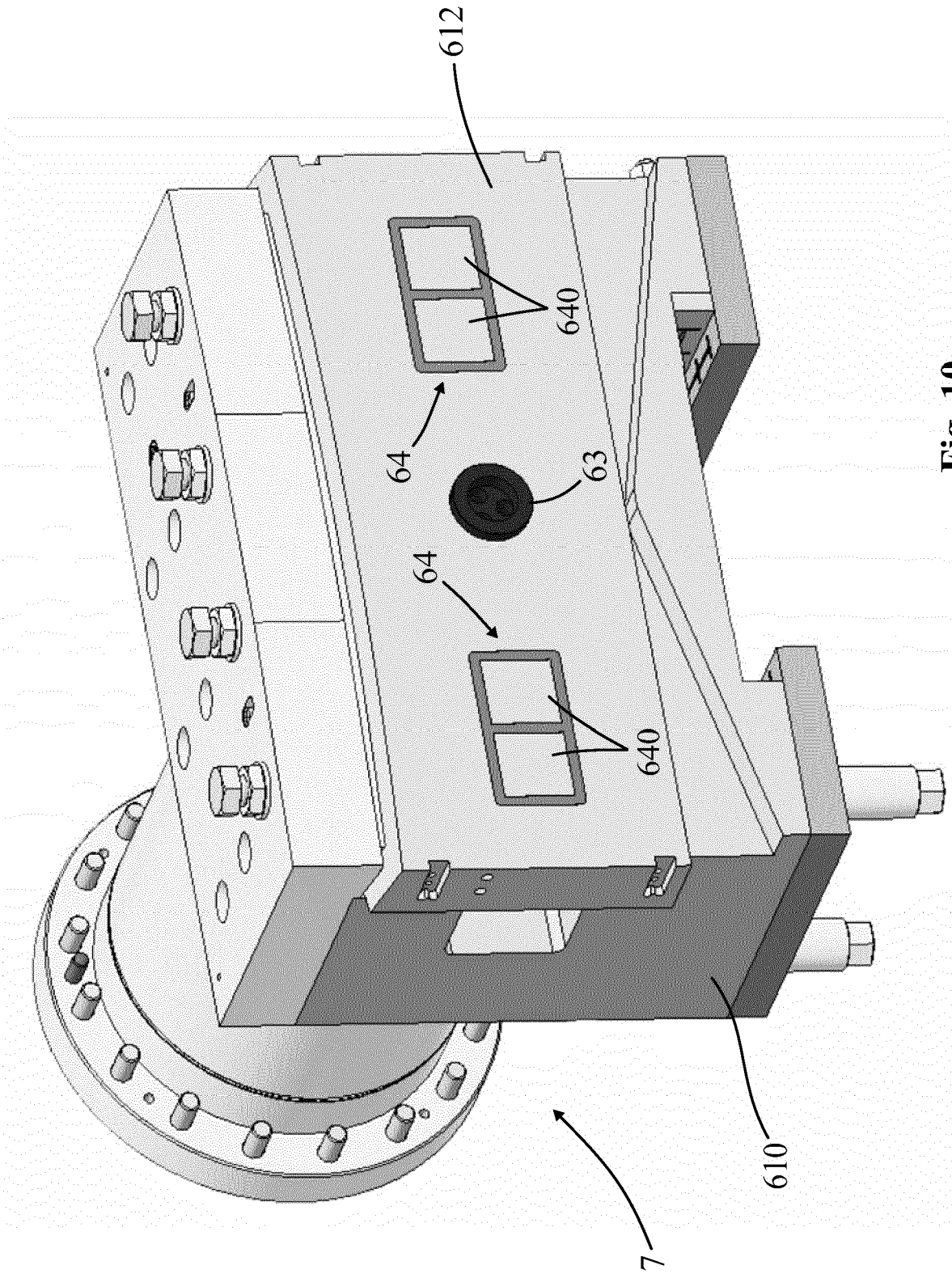

Fig. 10

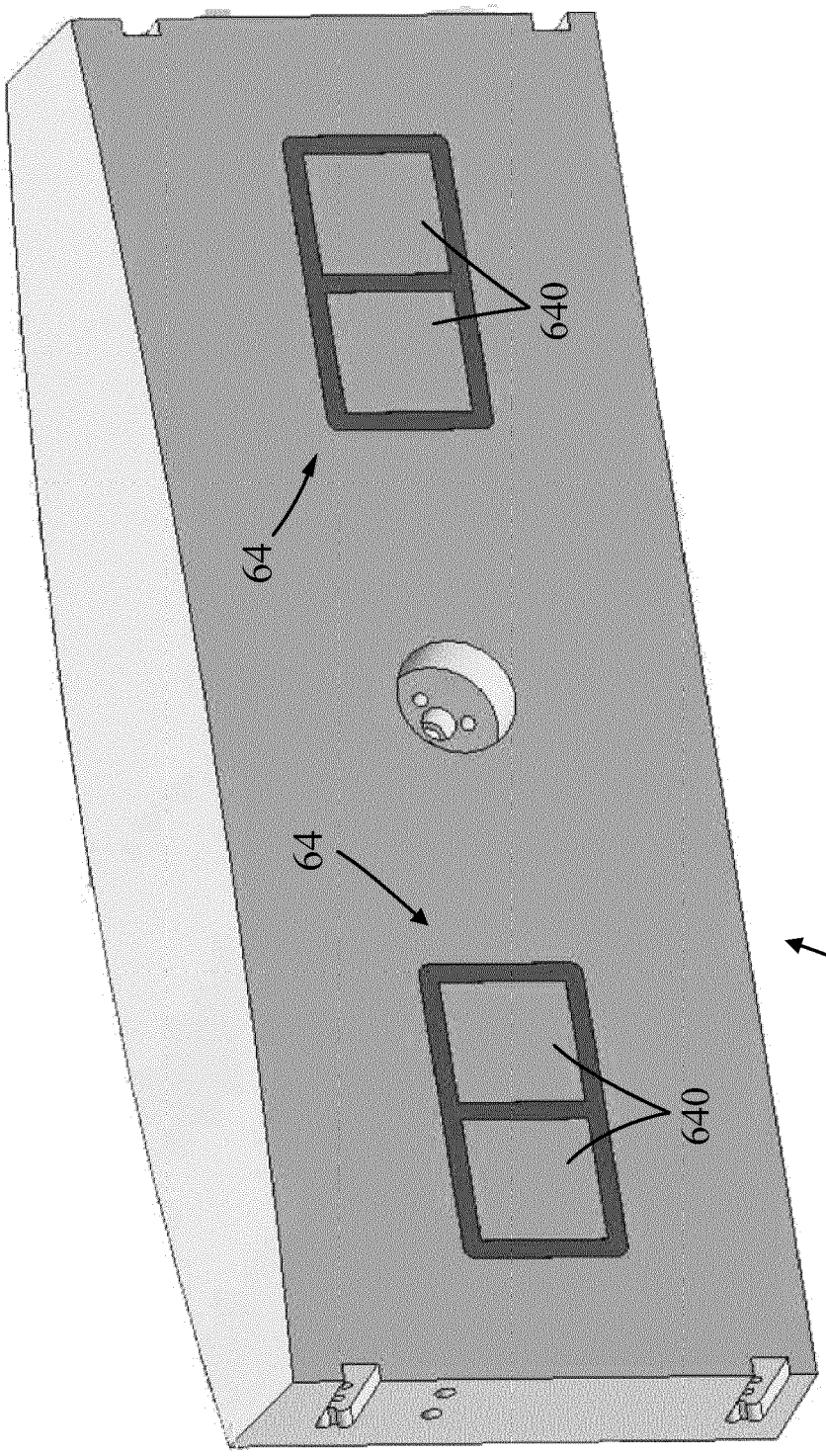

Fig. 11

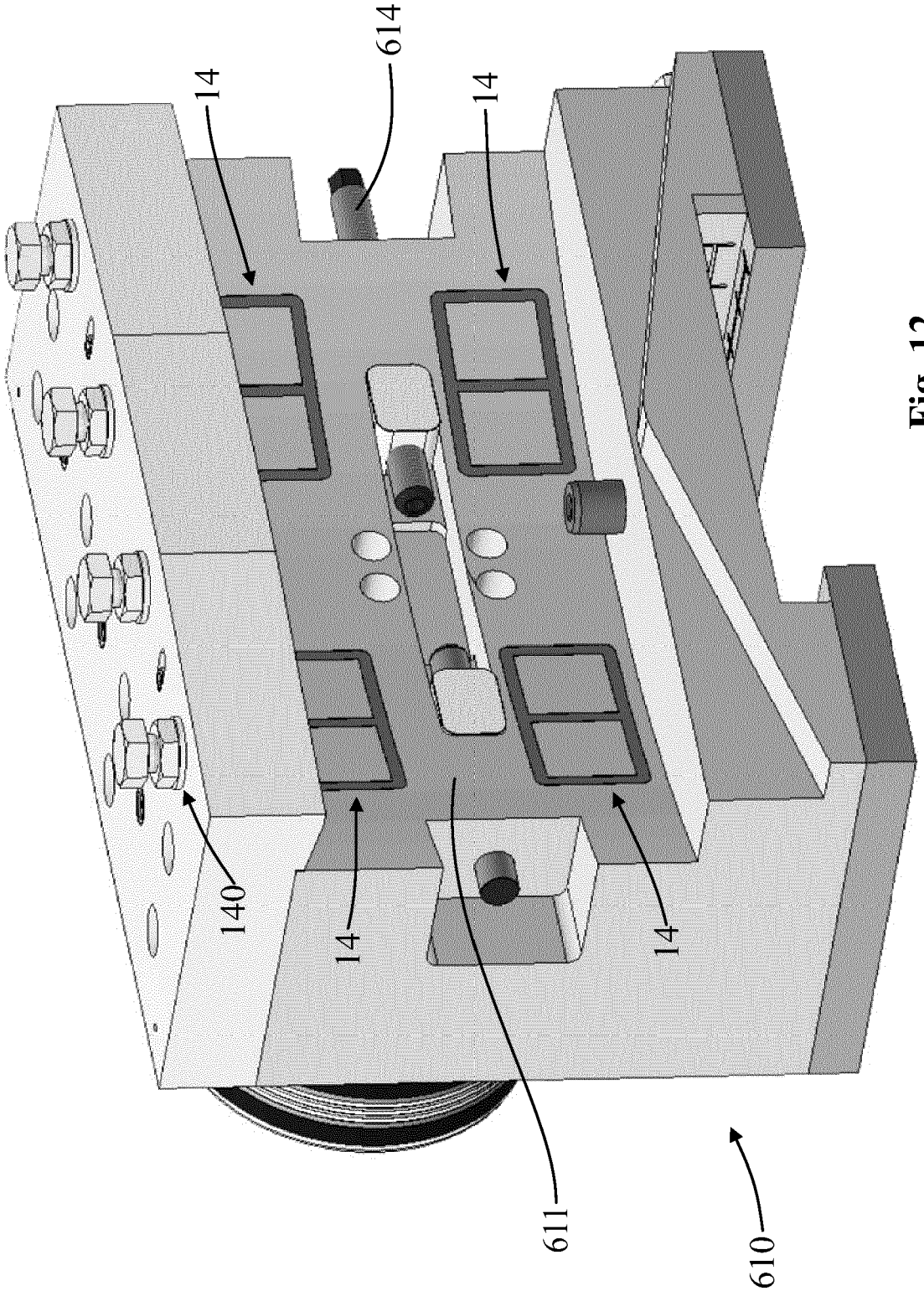

Fig. 12

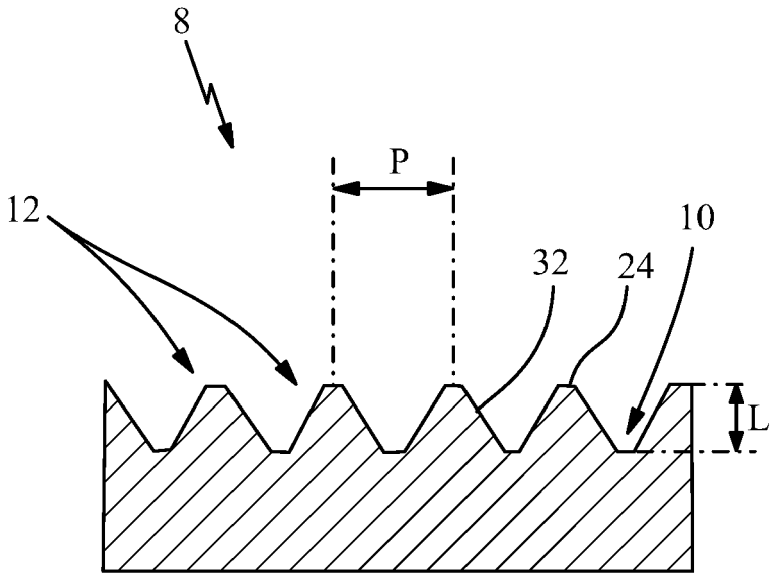

Fig. 13

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EUROPEAN SEARCH REPORT

Application Number
EP 19 17 4522

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 October 2019	Ritter, Florian

CATEGORY OF CITED DOCUMENTS

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