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(54) Workpiece manipulating and processing system.

(57) The present invention relates to a workpiece manipulating and processing system, in particular for removing runners from molded products, wherein a robot (1) having a moveable manipulating arm (53) comprises shock absorbing means (65) which are interposed between the workpiece gripping unit (9) and the manipulating arm (53) when the workpiece is processed, said shock absorbing means (65) remaining by-passed by another affixing structure rigidely connecting the workpiece gripping unit with the manipulating arm in case of workpiece positioning operation.

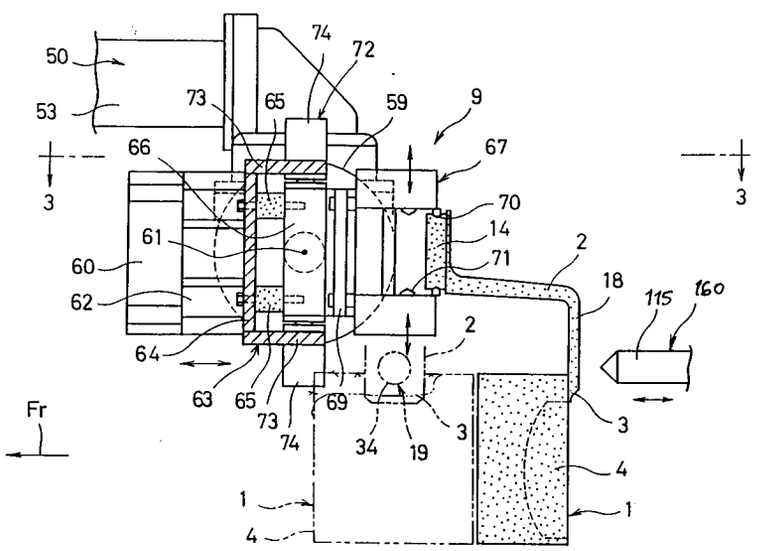

Fig. 2

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The present invention relates to a workpiece manipulating and processing system as indicated in the preamble of claim 1.

When handling and manipulating workpieces robots are increasingly used in automated processing lines. One in the field of increasing use of robots is the handling of molded products, for example, made by injection molding of synthetic resin or aluminum or other metals. Thus, it is necessary to remove the runner and gate areas from the molded product after same has been ejected from the mold. Usually, to remove the runner the product removed from the mold cavity was struck with a hammer manually and the shocks from the blows to the gate zone where the runner is attached to the final product would cause it to break so that the runner could be removed.

In order to meet the increasing demand for automated production it has be deliberated to perform the afore-indicated removal of the runner from a molded product by machine rather than manually. In conjunction herewith the use of a robot and of a robot arm to hold either the product part or the runner part of the molded product in the condition as it is removed from the mold cavity and hammering the molding to remove the runner was considered. However, as the shocks from the hammering in such an arrangement would be transfered to the robot arm and put an unnecessary vibrating load thereupon. Moreover, the shock effect absorbing capacities of the arm would cause the removal procedure to take longer than desired.

Using a shock absorbing material between the product to be subject to shocks for removing a part of it, such as a runner, and the arm could be deliberated, but this would cause shaking betweeen the product and the arm and would affect the accuracy of positioning the workpiece (molded product to be further processed) to its proper position.

Moreover, in view of using an automated vibrator device having the hammering means for removing the runner it might be possible to use a vibrator device driven by a pneumatic cylinder, so that air pressure is used to make the hammering means collide with the molded article in order to remove the runner, directing the hammering means to the spot where the runner connects to the molded product. In such a device the hammer would be positioned at the end of a piston rod, the associated piston being moved longitudinally by means of pressurised air alternately introduced in front and behind the piston, triggering a reciprocating movement of same so that the hammer means strikes the molded product repeatedly. In such cases a valve structure is employed to switch over the supply of pressurised air from the region in front of the piston to the region behind the piston and vice-versa, in order to trigger the reciprocating movement. Problems with such devices are encountered in that there was no way to determine the position of the hammering means when the pressurised air valves shut off. In other words, there is a possibility that the piston is stopped in an intermediate position between its fully advanced and fully retracted position, introducing that the switching control valve is likely to remain in the neutral position with the negative effect that the resumption of pressurised air supply will not cause the vibrator device to restart operating immediately again.

While it could be deliberated to by-pass this drawback by establishing a separate pneutmatic cylinder to feed air, for example, to the hammer side of the piston so that upon stopping the operation of the hammering means said separate cylinder could be used to provide the pressure to bring the hammering means into its fully retracted or advanced position for restarting operation, this would require an additional structure and would deteriorate the most efficient operation of the robot, aside from the additional costs involved.

Accordingly, it is an objective of the present invention to provide a workpiece manipulating and processing system as indicated above, which allows using a robot having a manipulating arm for supporting a workpiece which undergoes shocks or vibrations from processing such as hammering, or which, the other way around may support the tool which performs such shocks' or vibrations' triggering motions wherein the manipulating arm is protected from the transmission of shocks or vibrations to it during the processing of a workpiece, while, on the other hand, assuring precise positioning of a workpiece or a tool through said manipulating arm during the phase of positioning the workpiece or the tool.

Moreover, an advantageous development of such a workpiece manipulating and processing system as desired comprising a vibrator device should allow a reciprocable moving member of said vibrator device to be put in a predetermined rest position when the vibrator device is de-energised in order to assure immediate restarting of the vibrator device after newly energising same.

In order to perform the above identified objective the present invention improves a workpiece manipulating and processing system as indicated above, in that a shock absorbing means is disposed between the gripping suport means and the manipulating arm at least during a period of workpiece processing to prevent shock or vibrations from being transmitted from the gripping support means to the manipulating arm of the robot during a workpiece processing operation of the tool.

In this way the transmission of shocks or vibrations during the processing of the workpiece to the manipulating arm could be sufficiently suppressed, while the positioning accuracy during the positioning of the manipulating arm is maintained rendering the shock absorbing means to be effective essentially only during a workpiece position period, while establishing direct attachment between the gripping support means and the manipulating arm during a manipulating arm positioning phase of the robot.

According to a preferred embodiment of the present workpiece manipulating and processing system, said shock absorbing means is adapted to form part of a fastening means affixing the gripping support means to the manipulating arm of the robot.

According to yet another preferred embodiment of the present invention, said shock absorbing means is disposed in parallel to a workpiece positioning means also provided within the frame work of the fastening means, said workpiece positioning means rigidely connect the gripping support means directly to the manipulating arm of the robot.

According to a further preferred design of the robot the manipultaing am same comprises an arm tip at the projecting end of the manipulating arm, which is removably attached to the manipulating arm at right angles, said arm tip being adapted to rotably support a slide supporting table which is rotable, preferrably by one turn, about the centre axis of the arm tip and which supports a sliding table along that surface which faces away from the arm tip, said sliding table being movable radially with respect to the centre axis of the arm tip.

It is preferred that the sliding table supports a box-shaped bracket via projecting support am, with a bottom plate of said box-shaped bracket extending substantially either in parallel or perpendicularly to the centre axis of the arm tip.

Moreover, it is preferred that the workpiece positioning means which forms part of the fastening means, comprises a support plate which is disposed within said box-shaped bracket and which is connected to the bottom plate thereof through said shock absorbing means.

In order to provide a space saving shock absorbing arrangement having the capability to absorbe shocks and vibrations coming from different directions, said shock absorbing means comprises a plurality of parallel shock absorbing members made of rubber, preferrably a plurality of columnar rubber cylinders, the axes of which substantially extends either perpendicularly or in parallel to the centre axis depending on the position of the bottom plate of the box-shaped bracket.

Preferrably said workpiece positioning means provided in parallel to the shock absorbing means and rigidely connecting the support plate to the box-shaped bracket comprises a plurality of holding working cylinders attached to the side plates of the box-shaped brackets, said working cylinders comprise piston rods which are reciprocable between an advanced engaging position under workpiece positioning conditions, engaging holes provided in the support plate, and a retracted position under workpiece processing conditions in which the piston rods remain in a non-engaged rest position.

Moreover, according to yet another preferred embodiment of the present invention the support plates supports a work chuck comprising jaws which are operated via a toggle mechanism to be oppositely movable relative to each other to clamp a clamping area of the workpiece, preferrably the runner of a molded product, said jaws being provided with at least one pair of oppositely disposed outer chuck teeth adapted to clamp the clamping area of the workpiece.

According to yet another preferred embodiment of the present invention the arm tip of the manipulating arm may comprise a rotatably supported sliding table which, in turn, supports a supporting table which is disposed substantially in parallel to the centre axis of the arm tip, said supporting table being provided with holding working cylinders, the piston rods thereof are movable between first and second position while the working cylinders are movable when said piston rods assume their first or second positions, said working cylinders being provided with axially protruding cylindrical projections which are slideably received in slide holes of the supporting table, said projections being engagable with engagement holes of a mounting bracket of the gripping support means, while the shock absorbing means are disposed in parallel to the slideable projections between the supporting table and the mounting bracket.

According to yet another preferred embodiment of the present invention in terms of the vibrator device normally supporting a hammering means for processing the workpiece, but also conceivable to support the workpiece, a vibrator is provided supported by a support pillar rising from the top of a stand.

Preferrably, said vibrator, which can also be used independently of the robot having a manipulating arm as described above, comprises a working cylinder unit and a vibrating piston rod supported on a piston sliding inside said cylinder unit, the protruding tip portion of said piston rod supporting a hammer unit having a tapered tip portion.

Preferrably, said cylinder unit comprises a pneumatic cylinder connected to a pressurised air supply via an automatic switching device disposed at the rear of the cylinder unit.

Preferrably, either an air volume in front or behind the piston is vented to atmosphere when the vibrator device ceases operation dispersing the piston either in its most advanced or most retracted rest position.

According to yet another preferred embodiment of the present invention there is an air passages-defining block provided and disposed between the automatic switching device and the rear end of the cylinder unit closing off the pneumatic cylinder.

In order to provide appropriate controlling of the vibrator device the cylinder unit comprises both piston-advancing air holes provided in the wall of the cylinder unit, said piston-advancing air holes extending from a rear end surface of the cylinder unit axially and opening on the inner surface of the pneumatic cylinder in proximity of a rearward end portion of same, and the cylinder unit comprises piston-retracting air holes provided in the wall of the cylinder unit as well and extending from the rear end surface of the cylinder unit axially to open on the inner surface of the pneumatic cylinder in proximity to a forward end portion of the pneumatic cylinder.

According to yet another preferred design of the vibrator device of the workpiece manipulating and processing system according to the present invention, there are exhaust holes which extend in the axial direction of the pneumatic cylinder, said exhaust holes open at axially spaced distant spots on the inner surface of the pneumatic cylinder and allow air to escape.

Moreover, preferrably there is a release valve provided as a control valve venting either the piston-advancing air holes or the air exhaust holes to atmosphere, said piston advancing air holes remain closed when the vibrator device is operating and are opened to atmosphere when the vibrator device is switched off. In greater detail, preferrably said release valve is a three-way valve connected to both either the piston advancing air holes and the piston retracting air holes of the cylinder unit on the one hand and is connected to the exhaust air holes of the other hand, so that during vibrating operation of the vibrator device the piston advancing and retracting air holes remain closed while the exhaust air holes are opened to atmosphere while during a non operating condition of the vibrator device the piston advancing and retracting air holes are opened to atmosphere while the exhaust air holes are closed.

Thus, the present invention generally provides a robot having a manipulating robot arm which supports a support means for holding and disengaging either the runner or the product part of a molded product that has been ejected from a mold cavity and a means for attaching and disengaging (in terms of the transmission of shocks or vibrations) by shock absorbing members this support means to and from said manipulating robot arm, wherein means are provided for removably affixing the above mentioned support means to the manipulating arm of the robot, and a hammering means is provided for striking the above mentioned product zone or runner zone. Thus, when the runner zone is to be separated from the molded product first either the product or the runner is held by the gripping support means and then it is struck by the hammering means. In this way the runner can be removed from the product. As, at least under certain operating conditions, the gripping support means is attached to the manipulating arm of the robot by shock absorbing members and this affixing means allows the attachment between the gripping support means and the manipulating arm to be disengaged under other operating conditions vibrations produced by the hammer striking on the product or the runner are prevented from being transmitted to the manipulating arm.

As a result, even when striking the runner zone to remove it, the arrangement prevents an undue load from being put on the manipulating robot arm and the load is concentrated on the connection between the product and the runner whereby speedy removal of the runner is enhanced.

On the other hand, when the manipulating robot arm is positioning the workpiece such as the molded product ejected from the mold cavity and is transporting same, the affixing means rigidely and solidely affixes the gripping support means to the manipulating arm, so that the movement of the workpiece precisely follows the movement of the manipulating arm so that it can be accurately transported and positioned in the proper position.

Moreover, it is possible to reliably set the hammering means in a most advanced or most retracted position so that restarting of the hammering means after de-energising same does not incur an difficulties.

Further preferred embodiments of the present invention are laid down in the other subclaims.

In the following the present invention is explained in greater detail by means of several embodiments thereof in conjunction with the accompanying drawings, wherein:

Figure 1 is a schematic overall side view of a first embodiment of the workpiece manipulating and processing system according to the present invention,

Figure 2 is a side elevational view, partially in cross-section, of the arm tip and workpiece gripping unit of the system shown in Figure 1,

Figure 3 is a plan view of Figure 1 partially sectioned along line 3-3 of Figure 2,

Figure 4 is an enlarged cross-sectional view of the part of the fastening means and the shock absorber arrangement according to Figures 2 and 3,

Figure 5 is a side elevational view of the arm tip and workpiece supporting structure of a second embodiment, similar to Figure 2,

Figure 6 is a plan view partially in cross-section along the line 6-6 of Figure 5,

Figure 7 is an overall side view of a third embodiment of the present workpiece manipulating and processing system, similar to Figure 1,

Figure 8 is a side elevational view partially in cross-section of the arm tip of said third embodiment, similar to Figures 2 and 5,

Figure 9 is a side elevational view partially in cross-section of the arm tip of a manipulating arm of the robot according to a fourth embodiment of the present invention corresponding to the views of Figures 2, 5 and 8,

Figure 10 is a back view of Figure 9,

Figure 11 a side view of the working unit of a vibrator device of the workpiece manipulating and processing system,

Figure 12 an enlarged cross-sectional view of back end of the vibrator device of Figure 11,

Figure 13 an enlarged cross-sectional view of the front end of the vibrator device according to Figure 11,

Figure 14 a partially sectional elevational view of the back end of the vibrator device similar to Figure 11,

Figure 15 a view along arrow A in Figure 14,

Figure 16 a cross-sectional view along the line VII-VII of Figure 12,

Figure 17 is a cross-sectional view along the line VIII-VIII of Figure 12,

Figure 18 is a cross-section along the line IX-IX of Figure 17, and

Figure 19 is a control scheme of the vibrator device according to an embodiment of the present invention wherein

Figure 19a refers to a condition of moving the piston towards a fully forward advanced position,

Figure 19b is a diagram referring the moving of the piston towards the rearward retracted position, and

Figure 19c refers to a resting position of the piston.

Firstly, the basic structure of the workpiece manipulating and processing system as shown in Figure 1 is explained followed up by the description of the preferred further embodiments of the design of the robot 1, specifically of the design of the projecting tip portion of the manipulating arm 53. The following description refers to the manipulating and processing of an alumimun casting such as an engine part for engines used in automobiles or motorcylcles.

When, as shown in Figures 1 and 2, a runner 2 is to be removed from the final product 4 regarding the molded product 1 as ejected from the mold cavity preferrably either the zone of the final product 4 or the runner zone 2 is held by a gripping support means 9. In the embodiments shown in Figures 1 to 6, 9 and 10 respectively the runner 2 which is held by the gripping support means 9. In the embodiment of Figures 7 and 8 it is the product area 4 which is grasped. Then, either the zone of the finalised product 4 or the runner 2 (which ever is not being held by the afore-indicated support gripping means 9) is struck with a hammering means 115 of a vibrator 160 of a vibrator device 101, said vibrator 160 being supported by a support pillar 103 rising from the top of a stand 102.

At that time the runner 2 and the heavier final product 4 vibrate at different frequencies and the load from the hammering means 115 concentrate around a gate area 3, where the final product 4 connects to runner 2 and easily serves this gate 3 to brake. In other words in this way the final product 4 is released and separated from the runner 2.

Generally, as explained in detail later on with respect to the further Figures the product 1 as removed from the cavity of a mold is grasped by the gripping support means 9 which, in turn, is disposed via a fastening means 72 at a arm tip 59 of a manipulating arm 53 of a robot 50. When hammering the workpiece a shock absorbing material 65 (see Figure 2) is positioned between the gripping support means 9 and the manipulating arm 53 of the robot. Accordingly, any shocks from striking the product 4 or runner 2 is absorbed by said shock absorbing material 65 so that shocks and vibrations are substantially prevented from being transferred to the manipulating arm 53 of the robot 50.

On the other hand, when the manipulating arm 53 is used to position the workpiece 1 as ejected from a cavity mold in its processing position and has to transport the workpiece 1, as explained hereinafter in greater detail, the fastening means 72 causes the gripping support means 9 and the manipulating arm 53 of the robot 50 to be affixed together rigidely and without the shock absorbing means 65 being interposed, so that the molded product 1 held by the gripping support means 9 precisely follows the movements of the manipulating arm 53.

In the following the first embodiment according to Figure 1 to 4 is explained in greater detail.

In the Figures, the reference numeral 1 denotes an intermediate molded product made of aluminum which was taken from a metal cavity of an injection molding machine (not shown). Said intermediate molded product 1 consists of a prod-

uct part 4 (final product) and a runner part 2, which is connected to the product part 4 via a gate 3 which has a small cross-sectional area.

A runner removal arrangement comprising the robot 50 and the vibrator device 101 is provided to remove the runner 2 from the final product 4. For convenience of the follow up explanations the arrow "Fr" in Figure 1 and also in any further Figures 2, 3, 5 and 9 indicates the front side direction.

A main part of this workpiece manipulating and processing system is defined through the robot 50. Said robot 50 consists of a base 7 subtending a verticle axis 51 about which a robot unit 52 is freely rotatable. A manipulating arm 53 is positioned at the top of the robot unit 52. The manipulating arm 53 is free to move up and down as well as in the horizontal direction. A gripping support means 9 is attached to the tip end 59 of the manipulating arm 53.

As shown in Figure 1, when the afore-indicated gripping support means 9 (which is explained in greater detail hereinafter) is holding a clamping zone 14 (see Figure 2) of the workpiece 1 a runner zone 18 of the runner 2, extending from the clamping zone 14 to the afore-indicated gate area 3 is positioned to be exposed to the hammering means 115 of the vibrator device 101. These hammering means 115 comprises a vibrator 160 composed of a cylinder unit 111 comprising a pneumatic cylinder 106 and a vibrating piston rod 110a wherein said cylinder unit 111 is attached to the top of the support pillar 103.

The afore-indicated pneumatically operated piston rod 110a projects and can freely slide forward from the front end of the cylinder unit 111. When pressurised air is supplied to the cylinder unit 111 the piston rod 110a together with the hammering means 115 vibrates reciprocatingly back and forth. Moreover, there is also a conveyor belt 57 positioned near and below the aforementioned hammering means 115 and the workpiece 1, specifically the final product 4.

In the following the arm tip 59 of the manipulating arm 53 of the robot 50 including the fastening means 72 and gripping support means 9 will explained in greater detail, specifically refering to Figures 2 and 3.

The arm tip 59 at the projecting end of the manipulating arm 53 of the robot 50 is removably attached at right angles to the manipulating arm 53. The arm tip 59 supports a slide supporting table 60 which can be fixed in a desired position. This slide supporting table 60 is supported rotatably so as it can rotate up to one revolution around a (vertical) centre axis 61 of the arm tip 59. Thus, the centre axis 61 is also the axis of rotation of the slide supporting table 60 which, in turn, supports a sliding table 62 along a surface facing away from the arm tip 59, said sliding table 62 is thus slideable in a radial direction with respect to the centre axis 61. Said sliding table 62 can slide up to a designated position with respect to the slide supporting table 60.

Attached to the sliding table 62 is a box-shape bracket 63 having a bottom plate 64, which extends roughly in parallel to the centre axis 61 of the arm tip 59. Said bottom plate 64 is attached to a support plate 66 by four rubber shock absorbing members 65 (see also Figures 4 to 6). The shock absorbing members 65 are columnar and their axes extend roughly perpendicularly to the centre axis 61 of the arm tip 5.

A work chuck 67 is supported by the box-shaped bracket 63, more specifically by the support plate 66, said work chuck 67 being opened and closed by means of a toggle mechanism 69 operated by a chuck cylinder 68. The work chuck 67 is equipped with outside chuck teeth 70 and inside chuck teeth 71 with the outside chuck teeth 70 being adapted to grasp the clamping zone 14 of the runner 2 of the "intermediate" molded product 1 when the work chuck 67 is closed. Said work chuck 67 comprises jaws 67a, 67b which are operated via the toggle mechanism 69. By the way the inside chuck teeth 71 can support another insertion work chuck or a sprayer to spray mold parting agents or the like.

In the embodiment shown in Figures 2, 3 and 4, the gripping support means 9 and the box-shaped bracket 63 have been releasably affixed by a fastening means 72, so as to allow attachment and removal. Said fastening means 72 comprises two or four holding working cylinders 74 attached to the outside side plates 73 of the box-shaped bracket 63. These holding working cylinders 74 are equally distantly disposed around the above mentioned support plate 66. Each of the piston rods 75 of the holding working cylinders 74 fit through corresponding engaging holes 76 in the support plate 66.

As shown in solid lines in Figure 4, if the piston rod 75 of the holding working cylinders 74 are retracted, the piston rods 75 are withdrawn from the insertion hole 76 of the support plate 66 and the attachment of the gripping support means 9 to the box-shaped bracket 63 on the arm side is disengaged.

On the other hand, as shown by the dashed lines in Figure 4, when the piston rods 75 of the working cylinders 74 are in their extending position, said piston rods 75 pass through said engaging holes 76 and the tips of the piston rods 75 come into contact against the bottom surfaces of the engaging holes 76 of the support plate and this keeps the gripping support means 9 rigidely and directly affixed to the box-shaped bracket 63 and,

accordingly, to the manipulating arm 53.

In the retracted condition of the piston rods 75 the gripping support means 9 is connected to the box-shaped bracket 63 and, accordingly, to the manipulating arm 53 of the robot 50 exclusively via the shock absorbing rubber cylinders 65.

When the runner part 2 of the molded product 1 is to be removed from the final molding 4, the operation of the robot 50 positions the runner 2 opposite to the vibrating piston rod 110a and the hammering means 115 of the vibrator 160.

While the robot 50 is operating, ie. under workpiece positioning, as shown by the solid lines in Figures 2 and 3 and by the dash lines in Figure 4, the piston rods 75 of the holding working cylinders 74 are advanced and engage the engaging holes 76 so that the piston rods 75 are pressing against the bottom surfaces of the insertion holes 76 to affix the support plate 66 directly and rigidely to the box-shaped bracket 63. As a result, during the operation of the robot 50, the support plate 66, the work chuck 67 and the "intermediate" molded 1 being held by them are supported at the arm tip 59 by the holding working cylinders 74 rigidely and directly. Therefore, during the positioning operation of the robot 50, the support plate 66, the work chuck 67 and the product 1 are supported firmly without any shaking with respect to the arm tip 59, so that the robot 50 and manipulating arm 53 can accurately transport and position the workpiece 1 in the desired operating position.

Then, when the runner 2 of the product 1 is positioned opposite to the vibrating piston 110a supporting the hammering means 115 the movement of the robot 50 is stopped. As shown by the solid lines in Figure 4, the piston rods 74 of the holding working cylinders 4 are retracted and disengaged from the support plate 66 which, accordingly, is no longer rigidely and directly connected to the arm tip 59 of the manipulating arm 53, but is now supported only by the shock absorbing rubber cylinders 65. Therefore, the support plate 66, the work chuck 67 and the product 1 are held on the end of the manipulating arm 53 only by the shock absorbing members 65. In this condition, the vibration of the piston rod 110a and the hammering means 115 causes blows to be struck near the gate zone 3 of the runner body 18 of the runner 2 accordingly, the runner 2 is separated from the product 4, or vice-versa.

The runner 2 which has been separated from the final product 4 as described above drops into a return bucket (not shown) and is returned for recasting. The final product 4 is then transported by the conveyor 57 to the next processing station.

In the described case the vibrations transmitted from the molded product 1 to arm tip 59 are absorbed by the shock absorbing members 65. In other words, the transmission of vibrations to the arm tip 59 is prevented. Thus, the vibrations which would otherwise have been transmitted undesirably have their load effectively concentrated on the gate area 3, so that the runner 2 can be easily removed. Since the shocks and vibrations are not transmitted to the arm tip 59 of the manipulating arm 53 and the robot 50 protected from them.

In this embodiment the shock absorbing members 65 are made of rubber and columnar and are positioned such that their axes are roughly in line with the hammering means 115 or the vibrating piston rod 110a. Thus, they absorbe vibrations and shocks by elastic deformations substantially in their axial direction and prevent them from being transmitted from the molded product 1 to the arm tip 59.

In case where the hammering means 115 applies vibrations and shocks to the runner 2 of the workpiece 1 supported by the manipulating arm 53 of the robot 50 the vibrations may also be applied from the left or right side. Also when the workpiece 1 is held in its clamping zone 14 as shown by the dashed lines in Figures 2 and 3, vibrations may be applied by the hammering means 115 in the left-right direction as shown by the dashed lines in said Figure. In this, the vibrations from the product would be effectively absorbed by the shock absorbing members 65 through elastic deformation in the shearing direction thereby preventing said shocks and vibrations from being transmitted to the manipulating arm 53.

In the following a second embodiment of the present invention is described referring to Figures 5 and 6. In this second embodiment the same elements having the same functions as in the first embodiment are denoted with the reference numerals and description is so far omitted as this embodiment complies with the preceding one. Focussing on the differences between the first and second embodiments it should be noted that in the second embodiment, different from the first embodiment, the bottom plate 64 of the box-shaped bracket 63 extends in a direction perpendicular to the axis of the arm tip 59.

Accordingly, the axes of the shock absorbing rubber cylinders 65 are roughly parallel to the centre axis 61.

The work chuck 67 again holds the clamping zone 14 of the "intermediate" molded product 1 and strikes from the vibrating rod 110a and the hammering means 115 hit the runner 2 of the workpiece 1. At this time, since the hammering means 115 is vibrating back and forth while the axes of the shock absorbing members 65 extend vertically so that vibrations which would have been transmitted to the arm tip 59 are effectively absorbed by elastic deformation of the shock absorb-

ing member 65 in the shearing direction.

In other words the difference between the two embodiments of Figures 2 and 3 and that of 5 and 6, with respect to the supporting of the gripping support means 9 only refers to the positioning of the holding box-shaped bracket with respect to the centre axis 61 of the manipulating arm 53 of the robot 50. In view of the differences of the clamping structure itself (work chuck 67 and jaws 67a, 67b) the respective explanation is provided with respect to another embodiment hereinafter referring to Figure 10.

Figure 7 and 8 refer to a third embodiment of the invention.

In this embodiment the outside chuck teeth 70 project outwardly from the work chuck 67 and the operation of the work chuck 67 causes the outside chuck teeth 70 to press against an inside circumferential surface of a hole 4a in the product 4, so that the product 4 is supported by the work chuck 67.

In addition there is provided a return material bucket 77 for the removed runners 2. Moreover, there is a further product bucket 78 provided into which the final product 4 is placed. Accordingly, after having removed the runner 2 the robot unit 52 swivels about its vertical axis 51 to position the finished workpiece 4 above of the product bucket 78 to drop it into said bucket 78.

As the other structure and operational details are similar to those of the afore-indicated embodiments further explanation is not considered to be required.

Rather the descriptions continues with the fourth embodiment according to Figures 9 and 10, disclosing a fourth embodiment of the present invention.

A fourth embodiment is shown in Figures 9 and 10. In this embodiment the fastening means 72 comprises a support table 80 mounted on a sliding table 62 and this support table 62 is fitted with holding working cylinders 81, which extend substantially perpendicularly to the supporting table 80 and, accordingly, to the centre axis 61.

Said holding working cylinders 81 comprise a cylinder tube 82 accommodating a slideable piston 84, which is freely slideable in the axial direction thus defining a pressure chamber 83 while at the back of the piston 84 a piston rod 85 is respectfully provided which projects backwards through the rear end of the cylinder tube 82. The projecting ends of these piston rods 85 pass through holes 86 in the support table 80 and conical retainers 87 are provided at the projecting ends of the piston rods 85.

Moreover, there are engagement projections 88 which extend rearwardly from the top and bottom as well as from the left and right rear end surfaces of the cylinder tubes 82, said engagement projections 88 being affixed to the respective cylinder tubes 82 by bolts 89.

The afore-indicated engagement projections 88 are of circular cross-section and they are supported such that they are free to slide back and forth in slide holes 90 front in the support table 80. This allows the support table 80 to be held in place by the holding cylinders 81. At their front and back the outside circumferential surfaces of the engagement projections 88 comprise a front stop 91 and a back stop 92 respectfully, projecting radially outwards to abut from both sides against the support table 80. On the other hand, the support table 80 is attached to a mounting bracket 66 which, in turn, supports the gripping support means by shock absorbing members 65. When viewed from the front, there are four of these shock absorbing members, preferrably rubber cylinders 65 surrounding the holding working cylinders 81.

The mounting bracket 66 comprises engagement depressions 94 with a conical surface for the insertion of the retainers 87 and, moreover, engagement holes 95 are provided at the mounting bracket 66 opposite to the cylindrical projections, so that the projecting ends of the engagement projections 88 can engage or disengage the engagement holes 95.

As shown above the horizontal centre line in Figure 9, when compressed air is supplied to the space in front of the piston 84 in the pressure chamber 83 of the holding working cylinder 81 then the holding cylinder 81 expands and the engagement projection 87 presses against the bottom surface of the engagement depression 94 and the cylinder tube 82 moves in the forward direction of arrow "Fr". As this happens, there is a corresponding forward movement of the engagement projection 88 and its projecting end is disengaged from the engagement hole 95. This disengages the rigid and direct attachement between the gripping support means 9 and the manipulating arm 53. At this time, the forward movement of the cylinder tube 82 causes the rear stop 92 to abut against the support table 80. On the other hand, as shown below the centre line in Figure 9, when compressed air supplied to the area behind the piston 84 inside the pressure chamber 83 of the holding working cylinder 81, then the holding cylinder 81 contracts (this refers of course to the distance between the engagement projection 87 and the front side end of the cylinder housing). At this time the engagement projection 87 abuts against the inside circumferential surface of the engagement depression 94 and the front stop 92 moves rearward by the contraction of the cylinder tube arrangement 82 with respect to the engagement member 87 until said front stop 92 abuts against the support table 80. At

this time the projecting end of the engagement projection 87 is inserted into the engagement hole 95 and, additionally, is in contact with the perimeter of the opening of engagement hole 95 whereby the gripping support means 9 is rigidely and directly affixed to the manipulating arm 53 by-passing the shock absorbing members 65.

The other structional and operational details are similar to those of the above indicated embodiments and the corresponding parts are denoted with the same reference numerals, as in the preceding Figures so that further explanation will be omitted here.

With respect to Figure 10 (and the embodiment of preceding Figurs 5 and 6) in this case the work chuck 67 clamps the workpiece 1 at a substantially circular clamping area therof and, accordingly the claws 67a, 67b are pivotably supported with respective inner and outer teeth 70, 71 being designed and provided with clamping pieces 67c to grasp the workpiece 1 at four spots, two of them being substantially opposite to each other and arranged diagonally with respect to the workpiece 1.

Summarizing the afore-indicated embodiment, they are characteristic in that either the product 4 or the runner 2 is grasped and disengaged from the rest of the workpiece and that there are shock absorbing members 65 between the gripping support means 9 and the robot manipulating arm 53 whereby vibrations from the hammering means 115 are not transmitted to the robot 50.

Moreover, the robot 50 is used for the removal of the runner 2 and there is much latitude in setting the hammering position which can be changed for each product.

When the product zone 4 is clamped into the work chuck 67, the runner part 2 can fall into a return bucket 77 while the product part 4 can be placed into a product bucket 78 for further processing.

When the runner 2 is clamped into the work chuck 67, the product 4 can be dropped onto the conveyor 57 and can be carried to the next processing station. The runner 2, on the other hand, can then be put in the return bucket 77.

By controlling the operational position of the robot 50 it is possible to optimise the direction of effectiveness of the vibrations having same applied perpendicularly or angularly without need to adjust the position of the shock absorbing members 65.

In the afore-indicated embodiments substantially two or four holding working cylinders 72 were described to affix or disengage the gripping support means 9 to and from the manipulating arm 53, but it would also be possible to use just one of more than two cylinders.

Moreover, modifications might be made as follows:

1. By changing the length of the support pillar 103 or making it variable, it would be possible to move the vibrator 160 to up or down as desired. In fact, in order to prevent strike marks to appear on the product 4 this would be an effective way to minimise the separation between the product 4 and the coveyor belt 57 below it.
2. If two products were connected by one runner with a divided flow path the runner 2 could be clamped into the work chuck 67 and two vibrators 160 could be positioned to a strike at the points where the runners 2 connect to the product 4 to effectively remove the runners 2.
3. It would also be possible not to vibrate the striking hammering means 115 but to move the robot arm 53 such that air vent zones and the overflow zone on the product would be made to impact the stationary hammering means 115 to remove same from the product.
4. The clamping zone 14 on the product 4 could be held by a seperate clamping device and the hammering means 115 could be held in the work chuck 67 so that it would strike the gate zone 3, overflow zone and air vents to remove same from the product 4.
5. A vibration sensor could be mounted on the work chuck 67 or the bracket 63 or the support plate (mounting bracket) 66 to measure the vibrations and to detect the change in vibration whenever the air vent zone or other protrusions broke off and to stop the operation of the hammering means 115 at that time.
6. The hammering device, i.e. the vibrator 160 could be disposed perpendicularly and strike the product horizontally. In such a case the products could be alligned on conveyor 57 below and this could reduce any impact marks from dropping the product on the conveyor 57.

In the following the vibrator 160 is explained in greater detail referring to several embodiments as shown in the further figures 11 to 19.

It should be noted that such a vibrator 160 could also be designed and used seperately of the robot 50 and the design and use of its manipulating arm.

The vibrator device 101 used in the framework of the workpiece manipulating and processing system according to these embodiments in its essential operating portion is shown in figure 11.

As is apparent from figures 1 and 7 the vibrator device 101 comprising the vibrator 160 is supported upon the fixture support pillar 103 at the top of the stand 2 in the vicinity of the work handling robot 50.

The vibrator device 101 comprises a pneumatic cylinder 106 and pressurised air supply 107 from an attached compressor etc. communicating with the rear of the pneumatic cylinder 106 so that

the pressurised air is supplied via an automatic switching device 108. When this happens the pneumatic cylinder 106 which is part of a cylinder unit 111 operates a piston 110 which is free to slide inside said pneumatic cylinder 106. At the rear end of the cylinder unit 111 there is a passages-defining block 112 that closes off the cylinder unit 111. At the front end of the cylinder unit 111 there is a pressure-sealing plug 114 which is threaded onto the front of the cylinder unit 111 with a cushion 113 between them to plug the front end of the cylinder unit 111 and, accordingly, the pneumatic cylinder 106.

Affixed to the front end of the aforementioned piston 110 is a piston rod 110a which projects through a hole in the above mentioned plug 114 to the outside of the pneumatic cylinder 106. The hammering means 115 is attached to the outwardly projecting part of the piston rod 110a. As shown in figure 12 the cylinder unit 111 has a support flange 116 threaded onto it at the rear end near its outside circumference so that said support flange 116 is joined to the passages-defining block 112.

As shown in figures 13 and 14 this junction with the passages-defining block 112 is implemented by four bolts 117. These bolts 117 also affix the automatic switching valve device 108 to the passages-defining block 112 as described hereinafter in greater detail. The support flange 116 is attached to the passages-defining block 112 and the automatic switching device 108 by means of the bolts 117. The respective materials have airtight seals therebetween along the adjoining surfaces and between them and the cylinder unit 111.

There are four connecting rods 118 which extend toward the front end of the cylinder unit 111 from the support flange 116 and which are parallel to the cylinder unit 111.

As shown in figure 13, these connecting rods are attached to a front-side flange 119 which is attached to the front end of the cylinder unit 111. Moreover the support flange 116 and front-side flange 119 are attached to the support pillar 103 by means of the bracket (not shown).

There are piston-advancing holes 121 provided in the wall of the cylinder unit 111 through which compressed air passes to advance the piston 110. Retraction air holes 122 are similarly provided passing compressed air to retract the piston 110. Inside the pneumatic cylinder 106 there are also exhaust holes 123 positioned in axial direction of the pneumatic cylinder 106 which allow air to escape. In this embodiment advancing of the piston 110 describes a piston movement to the right in figure 11 while the piston 110 moves to the left when it retracts.

The afore-indicated advancing air holes 121 are provided at four places in the cylinder wall of the cylinder unit 111. The upstream ends open to the rear end surface of the cylinder unit 111, while the downstream ends, as shown in Figure 12, open into port 121a on the rear end of the inside surface of the pneumatic cylinder 106. The piston-retracting air holes 122 are provided at two spots, at the top and bottom of the cylinder unit 111 between the afore-indicated advancing air holes 121 as shown in Figure 16. Their upstream ends open to the rear end surface of the cylinder unit 111 and their downstream ends, as shown in Figure 13, open into ports 122a provided on the inner surface of the pneumatic cylinder 106 at the front and side thereof.

The air exhaust holes 123 are located between the afore-indicated piston-advancing air holes 121 and, as shown in Figure 16, are provided at two spots on the left and right hand sides of the cylinder unit 111. The respective downstream ends of these air exhaust holes 123 open into the rear end surface of the cylinder unit 111 and the other ends, as shown in Figures 12, 13 and 18 have ports 123a, 123b and 123c opening into the inside circumferential surface of the pneumatic cylinder 106. These ports 121a to 123c are present spaced at intervals as shown in Figure 11. Port 123a, which is the farthest rearward, is positioned in the area of the rear end of the cylinder unit 111.

The passages-defining block 112 comprises piston-advancing air holes 124, piston-retracting air holes 125 and exhaust air holes 126 placed in positions respectfully corresponding to the air holes 121, 122 and 123 in the cylinder unit 111. The advancing air hole 124 and the retracting air hole 125 pass through the passages-defining block 112 in parallel to the axial direction of the pneumatic cylinder 106. As described hereinafter, they connect to the automatic switching valve 108. Moreover, also the piston-advancing air holes 124, as shown in Figure 17, all are interlinked by a communication hole arrangement 127 which, as shown in Figure 17, is "X"-shaped. This communication hole arrangement 127 opens on the top of the passages-defining block 112 at separate spots and nipples 128 are threaded into it. The broken line B shown in Figure 11 shows the connection by an air tube with a three way valve 109 described hereinafter.

The exhaust holes 126, as shown in Figures 17 and 18 are constituted by grooves 126a which extend in the circumferential direction of the cylinder unit 111 to a position opposite to the opening of the exhaust holes 123 in the cylinder unit 111, further by axial projections 126b, which extend in the axial direction of the cylinder unit 111, and radial extensions 126c which extend in the radial direction of the cylinder unit 111. As shown in Figure 17, they open on the left and right hand

sides of the tube end of the passages-defining block 112. These exhaust holes 126 are also connected to the three way valve 109 described hereinafter via nipples 129 threaded into it on the side of the passages-defining block 112 and through the air tube represented by the broken line C in Figure 11.

As shown in Figure 12 the automatic switching valve 8 is attached to the passages-defining block 112 by means of bolts 117, said automatic switching valve 108 comprising a valve case 131 and a valve body 132 accommodated in a front side recess 131a of the valve case 131 and covered by the air passage-defining block 112. The upper opening of the pressurised air passage 133 is attached to an air tube represented by the broken line D in Figure 11 communicated to the pressurised air supply 107.

The valve body 132 consists of a stack of three sheets or sheet-like disks of passages-defining materials 132a, 132b, 132c defining air connecting passage-ways 133a, 133b, 135, 136 and a switching valve member 134 which is disposed freely movable axially in response to a pressure difference at both sides thereof. The valve body 132 defines the advancing air holes 135 and retracting air holes 136 which connect respectively to the advancing air holes 124 and the retracting air holes 125 in the passages-defining block 112. Automatically switching the valve member 134 in response to the pressure difference at both sides thereof causes these air passages to be selectively connected to the pressurised air supply passage 133.

In fact, the space occupied by the valve member 134 is configured such that even when the position of the valve member 134 is either left or right of that shown in Figure 12, the pressurised air path 133 remains connected through the connecting paths 133a or 133b and the upstream opening of the advancing air holes 135 on the cylinder-sided wall of this space (sheet 132c) as well as the upstream openings of the retracting air holes 136 on the opposite wall of the cylinder (sheet 132a) are open.

Thereby, as shown in Figure 12, when the valve member 134 is positioned on the left side (the side of the sheet 132a), the piston advancing air holes 135 are connected via a path 133a to air path 133 and, additionally, the piston-retracting air holes 136 are closed by the valve member 134.

Conversely, when the valve member 134 is in the opposite position on the right hand side, the piston retracting air holes 136 are connected to air path 133 by means of connecting path 133b, while the piston-advancing air holes 135 are closed by the valve member 134. In the following the principles of the switching operation of the automatic switching valve 108 are explained in greater detail as well as the total operation of the pneumatic cylinder 106.

As described above, when the piston advancing air holes 135 are connected with the air path 133 and if the connecting holes 127, which connect to the air tubes B, are in a closed condition, the source 107 for supplying pressurised provides compressed air through air path 133 to the piston advancing air holes 135, 124, 121 to the rear side of the piston 110 inside of the cylinder unit 111. The compressed air at the rear end of the piston 110 propels the piston 110 forward. At this time the hammer unit 115 advances and, if the workpiece 1 is in place, it strikes the workpiece 1.

Also, when in course of advancing the piston 110 it reaches the end of its advancing course, the piston 110 causes the pressure inside the front end of the cylinder unit 111 to rise. Since this pressure it transmitted via the piston retracting air holes 122, 125 and 136 to the space occupied by the valve body 132 and the valve member 134, when the advancing of the piston 110 has been completed, the afore-mentioned pressure causes the valve 134 to move to the opposite side, ie. to right side in Figure 12.

When the position of the valve member 134 changes in this way, then the piston-retracting air holes 136 are connected to the air path 133 via a connecting path 133b and the compressed air supplied through the air path 133 passes through the piston retracting air holes 136, 125 and 122 to the area in front of the piston 110. This means that the air pressure in front of the piston 110 causes the piston 110 to be driven rearward. In other words, then the piston 110 is retracted by air pressure delivered in front of it. When the piston 110 reaches its final stage of retraction, the compressed air inside the pneumatic cylinder 106 passes through the piston advancing air holes 121, 124 and 135 and is applied to the space occupied by the valve member 134 driving the valve member 134 to the left side.

Also, when pressurised air is delivered to the inside of the pneumatic cylinder 106 through the above mentioned piston-advancing air holes or the piston retracting air holes, when the air tube C is connected with the exhaust holes 126, the amount of increase in cylinder volume caused by the movement of the piston 110 is compensated by venting air to the atomsphere via the exhaust holes 123, 126 and the air tube C.

Accordingly, the valve member 134 moves left and right as shown in Figure 13 and pressurised air from the air supply path 133 is alternately supplied to the piston advancing air holes 121, 124, 135 and the piston retracting air holes 122, 125 and 136. As long as pressurized air is continuously supplied to the air path 133, the piston 110 and the hammer

unit 115 continue to move in a reciprocating motion.

It has already been indicated that there is a three-way control valve 109 in order to additionally control the pressurisation of the piston 110 under certain conditions. Said three way valve 109 is a manual valve which selectively connects the air tube B or the air tube C to atmosphere and there is also a muffler 109a attached at the opening to the outside atmosphere. In fact, as shown in Figure 11, when the air tube C is opened to atmosphere, air tube B is closed. Conversely, when the air tube B is opened to the atmosphere, air tube C is closed.

In the following the operation of the vibrator device 101 with the afore-indicated structure will now be described with reference to Figures 19a to 19c. In Figure 19 the piston-advancing air path comprising the piston-advancing air holes 135, 124 and 121 is indicated by the reference numeral 141. The piston-retracting air path comprising piston-retracting air holes 136,125 and 122 as indicated by the reference numeral 142 and the exhaust air path comprising the exhaust holes 123 and 126 is indicated by the reference numeral 143.

Firstly, the workpiece 4 is positioned in front of the vibrator device 101 as shown in Figures 107 and the workpiece is positioned such as to set it into a strike position at gate area 3. This strike position is slightly short of a full stroke position of the pneumatic cylinder 106, corresponding to the full forward position of the hammer unit 115. In Figure 19a the hammer unit 115 is shown in its retracted position. Also as shown in said Figure 19a the three way valve 109 has been set to vent the air tube C to the atmosphere and close the air tube B. In this condition pressurised air is supplied to the automatic switching valve 108.

At this time pressurised air flows through the piston advancing air path 41 due to the operation of the automatic switching valve 8 and piston 110 advances from the position shown in Figure 19a. At the final stage of this advancing movement the hammer unit 115 strikes the workpiece. Part of the pressurised air supply to the cylinder unit 111, namely, that portion corresponding to the increase in the volume of the cylinder, moves through the exhaust passage 43 and the air tube C to the three way valve 109 and muffler 109a where it is vented to atmosphere.

On the other hand, when the piston 110 has advanced fully forward, the automatic switching valve 108 changes the flow path of the pressurised air so that after the striking of the hammer unit 115 the air flows through the piston-retracting air path 42.

The post hammer strike condition is shown in Figure 19b. After striking the workpiece by the hammer unit 115 the pressure of the pressurised air begins to drive the piston 110 rearward. It retracts until it reaches the fully retracted position and, then the automatic switching valve 108 once again causes the pressurised air to flow through the piston-advancing air path 41. Piston 110 advances again and hammer 115 once again strikes the workpiece 1. This repeated striking of the workpiece 1 causes the product part 4 just below the gate part 3 to vibrate and to separate the product 4 from the runner 2. After the runner 2 has been separated, the product is dropped onto the conveyor belt (in the example of Figure 1) and is taken to a next processing station, for example, a finishing station.

After the product 4 has been released, the operation of the three way valve 109 causes the vibrator device 101 to stop further operation. When further operation is stopped, with the pressurised air supply 107 supplying pressurised air to the automatic switching valve 108, then, by switching the three-way valve 109, as shown in Figure 19c, the air tube B is vented to the atmosphere while the air tube C is closed. By switching the three valve 109 in this manner the piston-advancing air path 141 is vented to atmosphere while the exhaust air path is closed.

When the afore-mentioned action for stopping further operation takes place during the piston-advancing process, piston 110 decelerates while moving to the front of the cylinder unit 111. Since the position of the valve member 134 of the automatic switching valve 108 switches from the position shown in Figure 19a to that shown in Figure 19b, the piston-retracting air path 142 is connected to the source of pressurised air and the piston 110 retracts. At this time the compressed air inside the pneumatic cylinder 106 is vented from the piston-advanced air path 141 through the air tube B to atmosphere. As a result there is no pressure supplied from the piston-advancing air path 141 to the automatic switching valve 108 so that, when the piston 110 reaches it fully retracted position, there is no switching of the valve member 134 back to the position shown in Figure 19a. In other words, the piston 110 retracts and stops at the rear end of the cylinder unit 111. When the stopping procedure takes place while the piston is retracting, the piston 110 stops at the back of the cylinder unit 111 as well.

Thus, after the piston 110 has been stopped in the manner described above, since the exhaust air path 143 is closed, the pressure remains inside the pneumatic cylinder 106 and the piston 110 is held in this position by the air pressure.

Accordingly, when the workpiece striking operation has been completed, the pressure in front of the piston 110 causes the piston 110 to retract bringing the hammer unit 115 to its fully rearward

position and it will not stop midway in a neutral position.

By carefully managing the flow of pressurised air in this embodiment to retract the hammer unit 115 fully the weight of the pneumatic cylinder 106 can be decreased over conventional arrangements there is no need to have an auxiliary cylinder to retract the hammer unit 115. Consequently, the supporting stand 102 and the pillar 103 for the pneumatic cylinder 106 can be made smaller and lighter and need not to be engineered as extremely strong. In particular, in conventional assemblies having a hammer-retracting cylinder positioned at the front of a vibrator device the weight of the cylinder became a problem, so that it was necessary to have a massive support for the hammering pneumatic cylinder in order to allow hammering in the horizontal direction. These difficulties are completely eliminated through the embodiment explained above.

Although an embodiment was described above where the hammering unit was pushed to its fully retracted position upon cease of operation the hammering unit 115 can also be stopped in its fully forward position by connecting the three-way valve 109 to the piston-retracting air path 142 instead of the piston-advancing air path 141 as shown in Figure 19.

Moreover, although it has been described to connect the exhaust path 143 to the three way valve 109 for selectively venting to atmosphere, it is not absolutely necessary to open and close the exhaust path 143. Even when always venting to atmosphere one can obtain the same effects as described above, that is, either the piston-advancing air path 141 or the piston-retracting air path 142 may be vented to atmosphere by a valve (not shown). In this example, the exhaust air path 143 was closed when the striking operating was stopped and the air pressure kept the piston 110 in a stationary position. Therefore, the hammering unit 115 is always in a constant position when the operations are stopped.

Accordingly, the vibrator device 101 is structured such that when either the piston-advancing air path, which supplies air to behind the piston driving the hammer, or the piston-retracting path which supplies air to the front of the piston, are vented to atmosphere in a manner such that the venting valve is closed during vibrating operations and is open when the operations are stopped, then the piston and the hammer unit can be set either in the fully forward or fully rearward position by the action of the pressurised air either to the back or the front of the piston when the operation of the vibrator device is stopped.

Accordingly, when hammering is completed, the hammering unit will not remain in a neutral position between the fully forward or fully backward position. This assures stability in the resumption of operations. Hence, stopping the hammering operation takes place smoothly and with a high degree of efficiency. Moreover, this structure, including the automatic switching control valve, which controls the flow of pressurised air, renders unnecessary the auxiliary pneumatic cylinder required in the conventional systems to retract the hammer to its fully rearward position or to advance it completely forwardly.

According to a second embodiment of the present invention a three-way valve was added to the vibrator device 101 of the first embodiment, which closes either the piston advancing air path or the piston retracting air path when the vibrator is operating tile the exhaust path is vented to atmosphere but which vents the afore-indicated piston advancing or piston retracting air paths to atmosphere when the vibrator operations are stopped closing the exhaust path so that the hammer can be brought to rest in either fully retracted or fully advanced positions and be held there by pressurised air acting from one side upon the piston. Thus, there is the same assurance of smooth resumption of operation as in the embodiment 1 and a definite control of the position of the hammering unit when the operations are stopped.

Claims

1. Workpiece manipulating and processing system, in particular device for removing runners from molded products, comprising a robot having a moveable manipulating arm terminating at a gripping support means for holding the workpiece or a processing tool, and a vibrator device for holding the tool or the workpiece, respectively, **characterised in that** a shock absorbing means (65), at least during a period of workpiece processing, is disposed between the gripping support means (9) and the manipulating arm (53) to prevent shocks or vibrations from being transmitted from the gripping support means (9) to the manipulating arm (53) during a workpiece processing operation of the tool (34).

2. Workpiece manipulating and processing system as claimed in claim 1, **characterised in that** said shock absorbing means (65) forming part of a fastening means (72) affixing the gripping support means (9) to the manipulating arm (53) of the robot (50).

3. Workpiece manipulating and processing system as claimed in claims 1 or 2, **characterised in that,** said shock absorbing means

(65) is disposed in parallel to a workpiece positioning means (74,75,76) of the fastening means (72), rigidely connecting the gripping support means (9) directly to the manipulating arm (53) of the robot (50).

4. Workpiece manipulating and processing system as claimed in at least one of the preceding claims 1 to 3, **characterised in that**, the manipulating arm (53) of the robot (50) comprises an arm tip (59) at the projecting end of the manipulating arm (53), which is removeably attached to the manipulating arm (53) at right angles, said arm tip (59) rotatably supporting a slide supporting table (60) which is rotatable about the centre axis (61) of the arm tip (59) and which supports a sliding table (62) along its surface facing away from the arm tip (59), said sliding table (62) is moveable radially with respect to the centre axis (61).

5. Workpiece manipulating and processing system as claimed in claimed in claim 4, **characterised in that**, said sliding table (62) supports via a projecting support arm (62a) a box-shaped bracket (63), a bottom plate (64) thereof extends substantially in parallel or perpendicularly to the centre axis (61) of the arm tip (59).

6. Workpiece manipulating and processing system as claimed in at least one of the preceding claims 3 to 5, **characterised in that**, said workpiece positioning means (74,75,76) forming part of the fastening means (72) comprising a support plate (66) which is disposed within said box-shaped bracket (63) and which is connected to the bottom plate (64) through said shock absorbing means (65).

7. Workpiece manipulating and processing system as claimed in at least one of the preceding claims 1 to 6, **characterised in that**, said shock absorbing means, comprising a plurality of parallel shock absorbing members (65) made of rubber, preferrably of columnar rubber cylinders (65), the axes of which substantially extend perpendicularly or in parallel to the centre axis (61).

8. Workpiece manipulating and processing system as claimed in claim 6, **characterised in that,** said workpiece positioning means (74,75,76) rigidely connecting the support plate (66) to the box-shaped bracket (63) comprising a plurality of holding working cylinders (74) attached to side plates (73) of the box-shaped (63), said working cylinders (74) comprise piston rods (75) which are reciprocable between advanced engaging position under workpiece positioning, engaging holes (76) in the support plate (66), and a retracted position under workpiece processing in which the piston rods (75) remain in a non-engaged rest position.

9. Workpiece manipulating and processing system as claimed in at least one the preceding claims 4 to 8, **characterised in that**, the support plate (66) supports a work chuck (67) comprising jaws (67a, 67b) operated via a toggle mechanism to be oppositely moveable relative to each other to clamp a clamping area of the work piece, preferrably the runner of a moulded product, said jaws (67a, 67b) being provided with at least one pair of oppositely disposed outer chuck teeth (70) adapted to clamp the clamping area of the workpiece.

10. Workpiece manipulating and processing system as claimed in claim 9, **characterised in that**, the clamping jaws (67a, 67b) either are moveable linearly or pivotably about a pivoting axis, respectively.

11. Workpiece manipulating and processing system as claimed in claim 9, **characterised in that**, the outer chuck teeth (70) are disposed at the outside of the jaws (67a, 67b) to engage an inside circumferential surface of a hole (4a) of the product (4).

12. Workpiece manipulating and processing system as claimed in claim 4, **characterised in that** a supporting table (80) which is disposed substantially in parallel to the centre axis (61) is mounted to the sliding table (62), said supporting table (80) being provided with holding working cylinders (81), the piston rods (85) thereof are moveable between first and second positions and the working cylinders (81) are moveable between their first or second positions, said working cylinders (81) being provided with axially protruding cylindrical projections (88) which are slideably received in slide holes (90) of the supporting table (80), said projections (88) being engagable with engagement holes (95) of a mounting bracket (66) of the gripping support means (9) while the shock absorbing means (65) are disposed in parallel to the slideable projections (88) between the supporting table (80) and the mounting bracket (66).

13. Workpiece manipulating and processing system as claimed in at least one of the preceeding claims 1 to 12, **characterised in that,** the

vibrator device (101) comprises a vibrator (160) supported by a support pillar (103) rising from the top of a stand (102).

14. Workpiece manipulating and processing system as claimed in claim 13, **characterised in that,** the vibrator (160) comprises a working cylinder unit (111) and a vibrating piston rod (110a) supported by a piston (110) sliding inside said cylinder unit (111), the protruding tip portion of said piston rod (110a) supporting a hammer unit (15) having a tapered tip portion.

15. Workpiece manipulating and processing system as claimed in claim 13 or 14, **characterised in that,** the cylinder unit (111) comprises a pneumatic cylinder (106) connected to a pressurised supply (107) via an automatic switching device (108) disposed at the rear of the cylinder unit (111).

16. Workpiece manipulating and processing system as claimed in the claims 14 or 15, **characterised in that,** either an air volume in front or behind the piston (110) is vented to atmosphere when the vibrator device (101) ceases operation dispersing the piston (110) either in its most advanced or most retracted rest position.

17. Workpiece manipulating and processing system as claimed in claims 15 or 16, **characterised in that** a pressurised air passages-defining block (112) is disposed between the automatic switching device (108) and the rear end of the cylinder unit (111) closing off the pneumatic cylinder (106).

18. Workpiece manipulating and processing system as claimed in at least one of the preceeding claims 13 to 17, **characterised in that,** the cylinder unit (111) comprises both piston-advancing air holes (121) provided in the wall of the cylinder unit (111) extending from a rear end surface of the cylinder unit (111) axially and opening on the inner surface of the pneumatic cylinder (106) in proximity of a rearward end portion of the pneumatic cylinder (106), and piston-retracting air holes (122) provided in the wall of the cylinder unit (111) extending from the rear end surface of the cylinder unit (111) axially and opening on the inner surface of the pneumatic cylinder (106) in the proximity of a forward end portion of the pneumatic cylinder (106).

19. Workpiece manipulating and processing system as claimed in at least one of the preceeding claims 13 to 18, **characterised in that,** exhaust holes (123) extend in the axial direction of the pneumatic cylinder (106) which open at axially spaced distant spots on the inner surface of the pneumatic cylinder (106) and allow air to escape through to the rear end of the pneumatic cylinder (106).

20. Workpiece manipulating and processing system as claimed in at least one of the preceeding claims 13 to 19, **characterised in that,** a release valve (109) venting either the piston-advancing air holes (121) or the air exhaust holes (123) to atmosphere is provided which remains closed when the vibrator device is operating and which opens to atmosphere when the vibrator device is switched off.

21. Workpiece manipulating and processing system as claimed in claim 20, **characterised in that,** said release valve is a three-way valve (109) connected to both either the piston-advancing air holes (121) or the piston-retracting air holes (122) of the cylinder unit (111), on the one hand, and connected to the exhaust air holes (123), on the other hand, so that during vibrating operation of the vibrator device the piston-advancing and retracting air holes (121, 122) are closed while the exhaust air holes (123) are opened to the atmosphere while in the non-operating condition of the vibrator device the piston-advancing and retracting air holes (121, 122) are opened to atmosphere while the exhaust air holes (123) are closed.

22. Workpiece manipulating and processing system as claimed in at least one of the preceeding claims 17 to 21, **characterised in that,** the air passages-defining block (112) comprises piston-advancing air holes (124), piston-retracting air holes (125) and exhaust air holes (126), all in register with the associated air holes (121, 122, 123) opening to the air passages defining block (112) at the back of the cylinder unit (111) wherein the piston-advancing air holes (124) and the piston-retracting air holes (125) pass through the air passages defining block (112) in parallel to the axial direction of the cylinder unit (111) thereby connecting to the automatic switching valve (108).

23. Workpiece manipulating and processing system as claimed in claim 22, **characterised in that,** the piston-advancing air holes (124) of the air passages-defining block (112) are all connected to each other by a X-shaped interconnecting bore arrangement (127) which opens circumferentially spaced on the top of

the air passages-defining block (112) into nipples (128) adapted to be connected to a pressurised air supply means, specifically air control means such as a three-way valve (9).

24. Workpiece manipulating and processing system as claimed in claims 22 to 23, **characterised in that** the venting air exhaust holes (126) provided in the air passages-defining block (112) comprise grooves (126a) which extend into the circumferential direction of the pneumatic cylinder (106) to positions opposite to the rearward opening of the air exhaust holes (123) of the cylinder unit (111) to connect thereto, and a radial extension (126c) opening radially on the left and right side surfaces of the air passages-defining block (112).

25. Workpiece manipulating and processing system as claimed in claim 24, **characterised in that** the air exhaust holes (126) open into nipples (129) adapted to be connected to an air flow controlling means, in particular the three-way valve (109).

26. Workpiece manipulating and processing system as claimed in at least one of the preceeding claims 15 to 25, **characterised in that,** said automatic switching device comprising an automatic switching valve (108) attached to the air passages-defining block (112) by bolts (117), said automatic switching valve (108) having a valve case (131) and valve body (132) accommodated in a front-sided recess (131a) of the valve case (131) covered by the air passages-defining block (112).

27. Workpiece manipulating and processing system as claimed in claim 26, **characterised in that** the valve case (131) comprises an air passage (133) opening at a top portion of the valve case (131) and extending to a bottom area of the valve body accommodating recess (131a) to connect to a plurality of air connecting passageways (133a, 133b) provided in the valve body (132) said opening at the top portion of the valve case (131) being adapted to be connected to a source of pressurised air (107).

28. Workpiece manipulating and processing system as claimed in 27, **characterised in that,** said valve body (132) comprises a stack of three sheets of discs (132a, 132b, 132c) defining air connecting passageways (133a, 133b, 135, 136), and a switching valve member (134) surrounded by said connecting passages defining discs (132a, 132b, 132c) said switching valve member (134) being freely moveable axially in response to a pressure difference of the air pressure acting upon the axially facing end faces of the switching valve member (134).

29. Workpiece manipulating and processing system as claimed in claim 28, **characterised in that,** said valve body (132) having a piston-advancing air hole (135) and piston-retracting air holes (136) which connect to the corresponding piston advancing air holes (124) and piston-retracting air holes (125) defined in the air passages-defined block (112), and that the automatically switching valve member (134) causes these air holes (124, 125) to be selectively connected to the pressurised air supplying air passages (133).

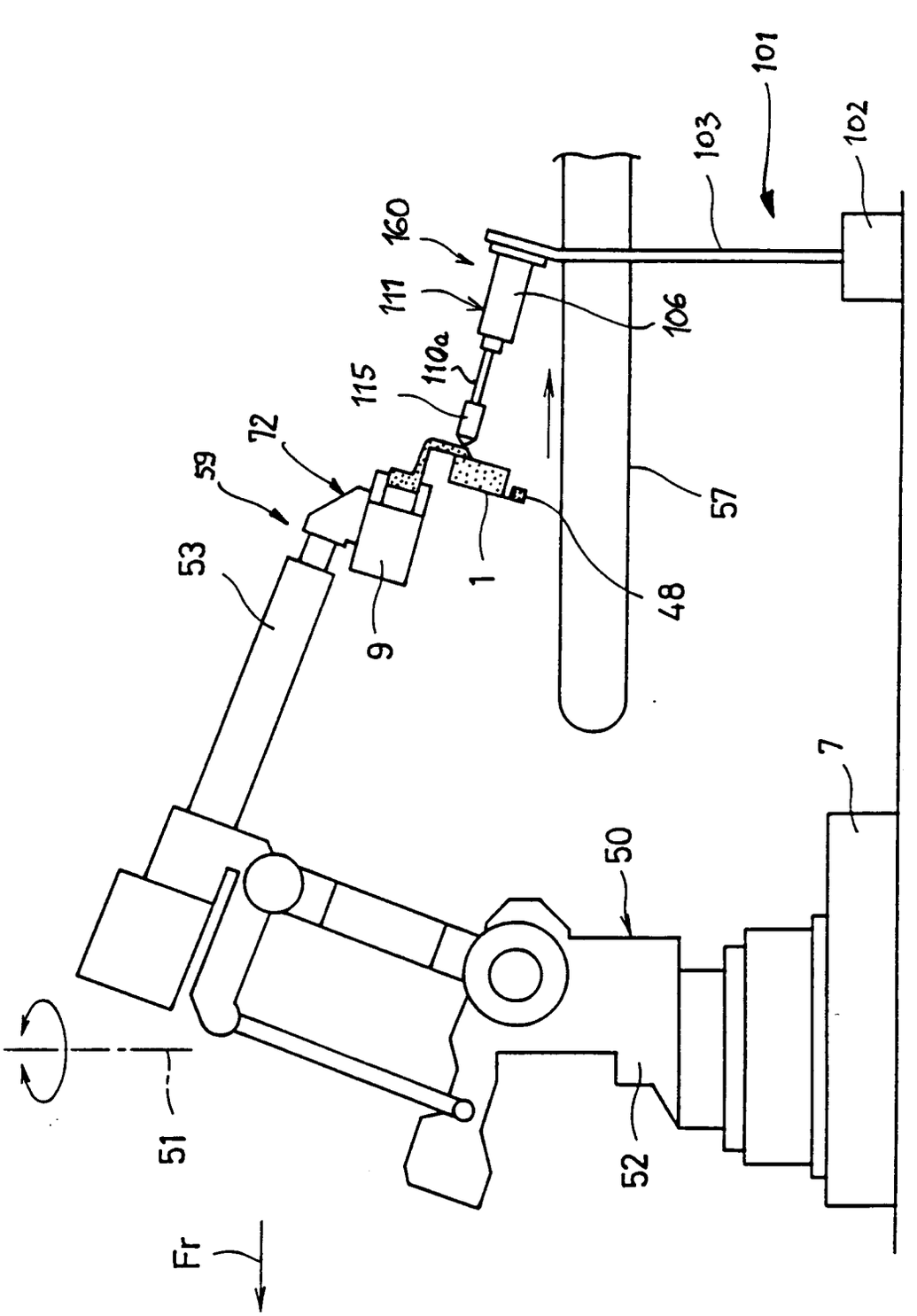

Fig. 1

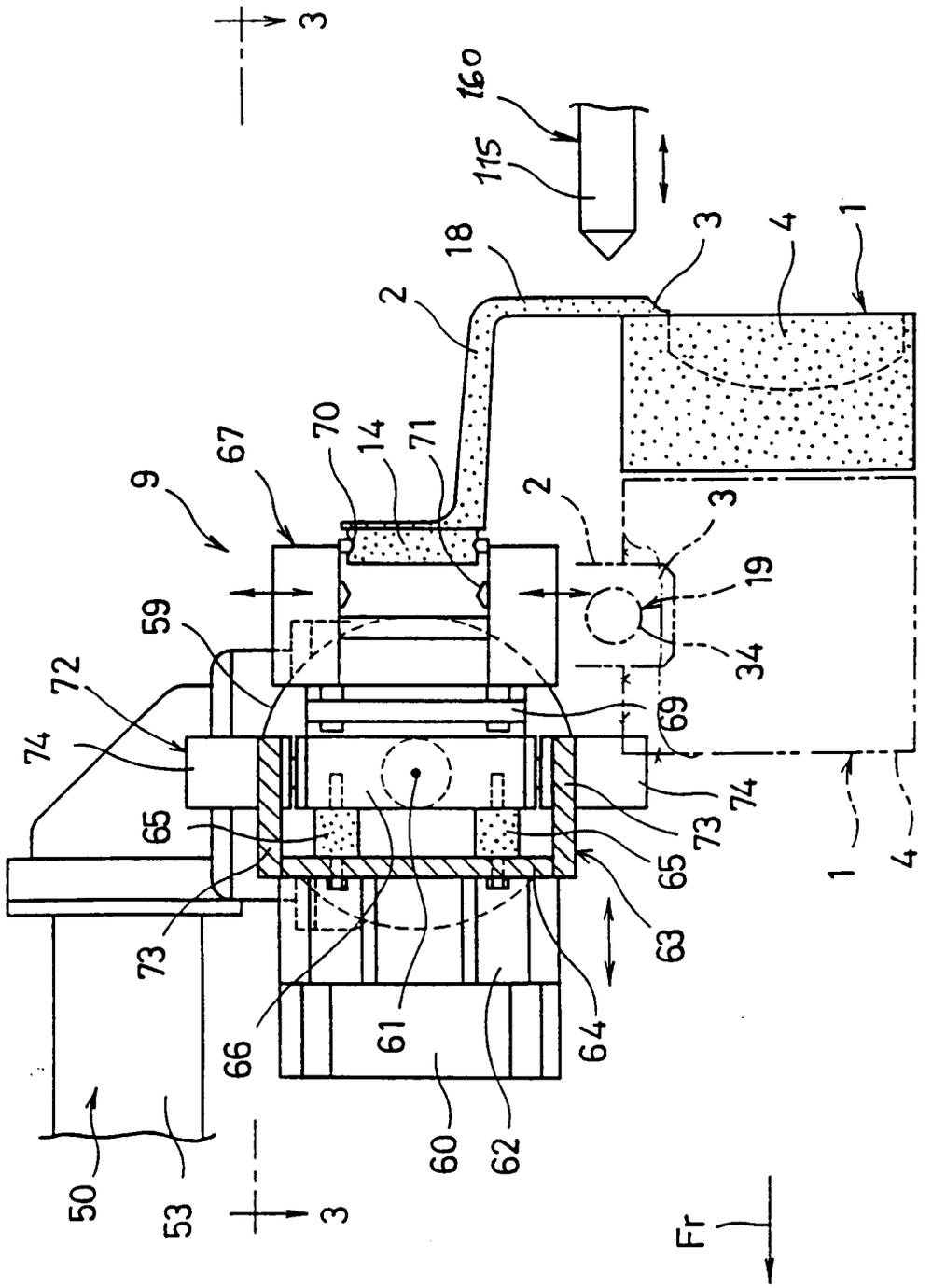
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Fig. 2

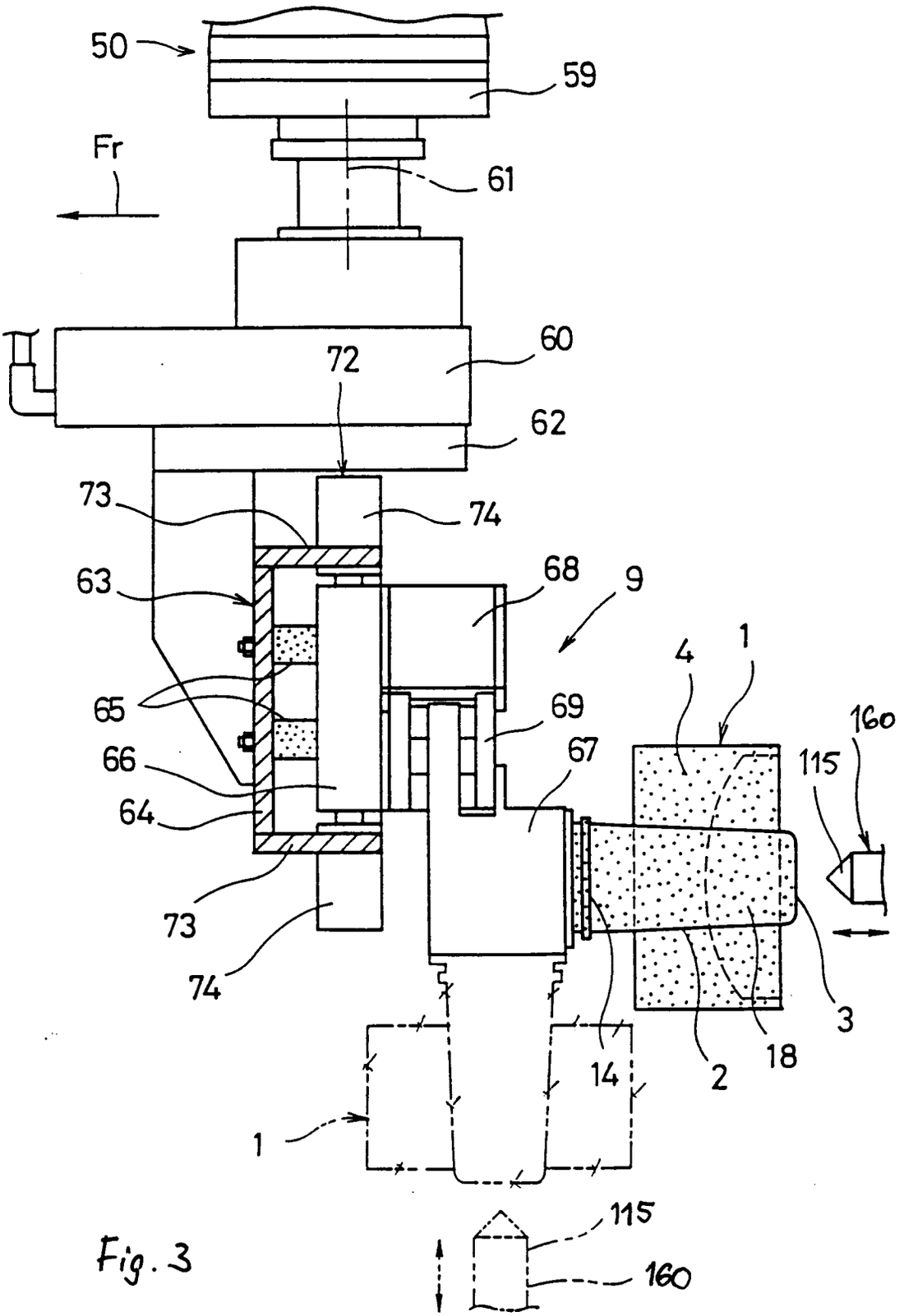
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Fig. 3

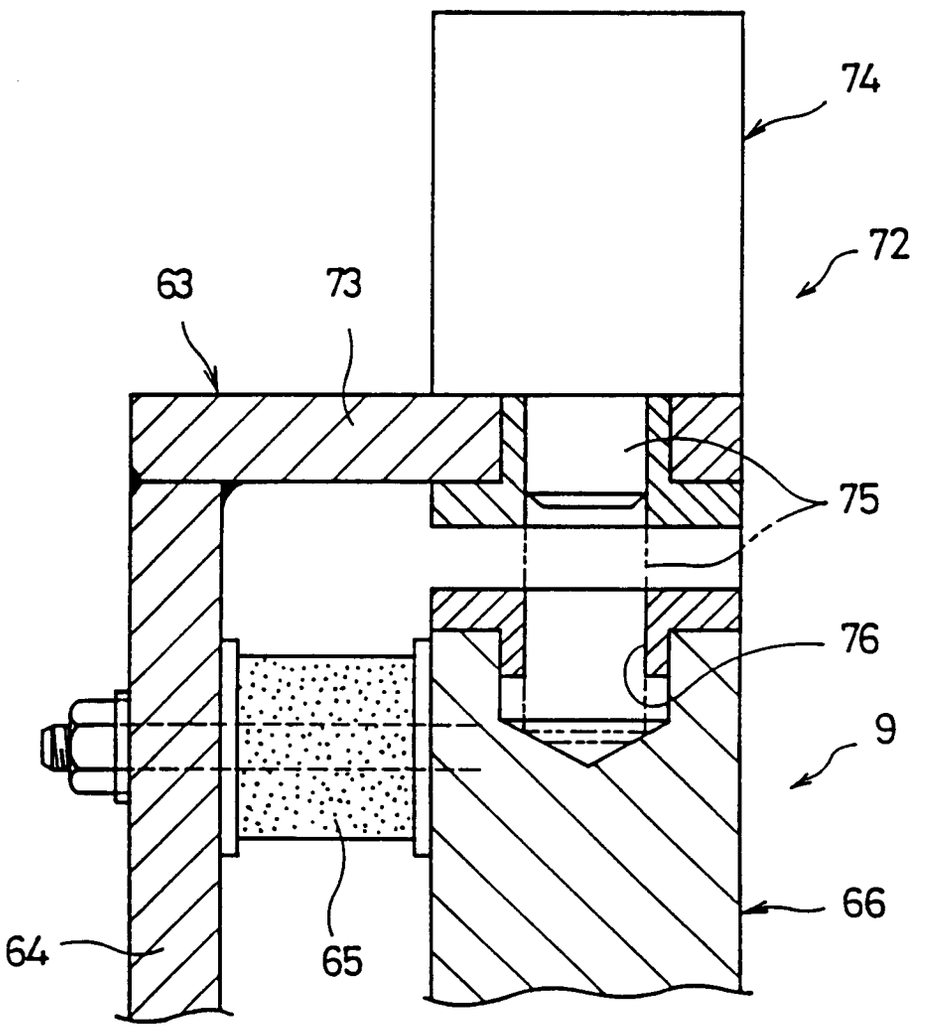

Fig. 4

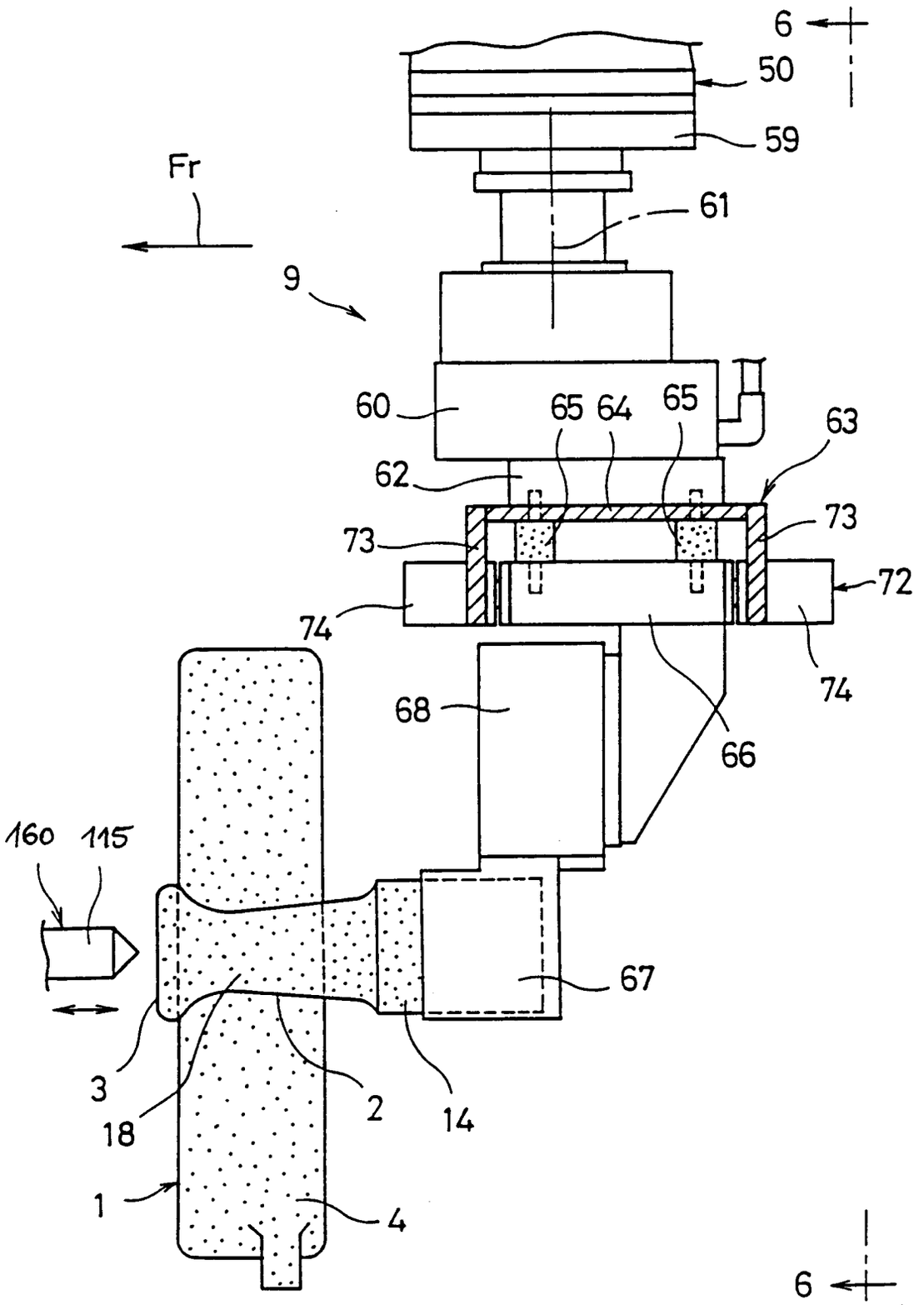
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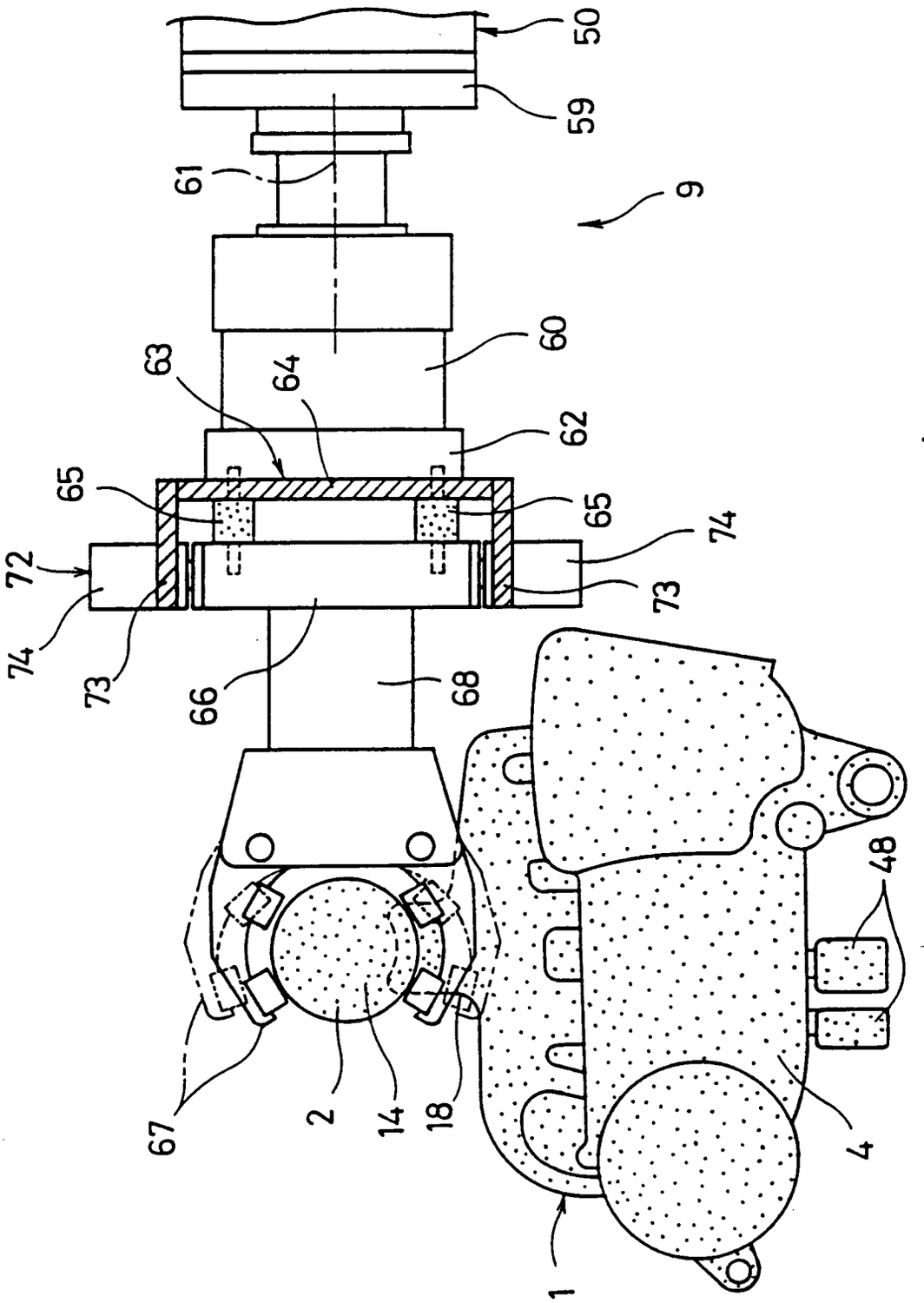
Fig. 5



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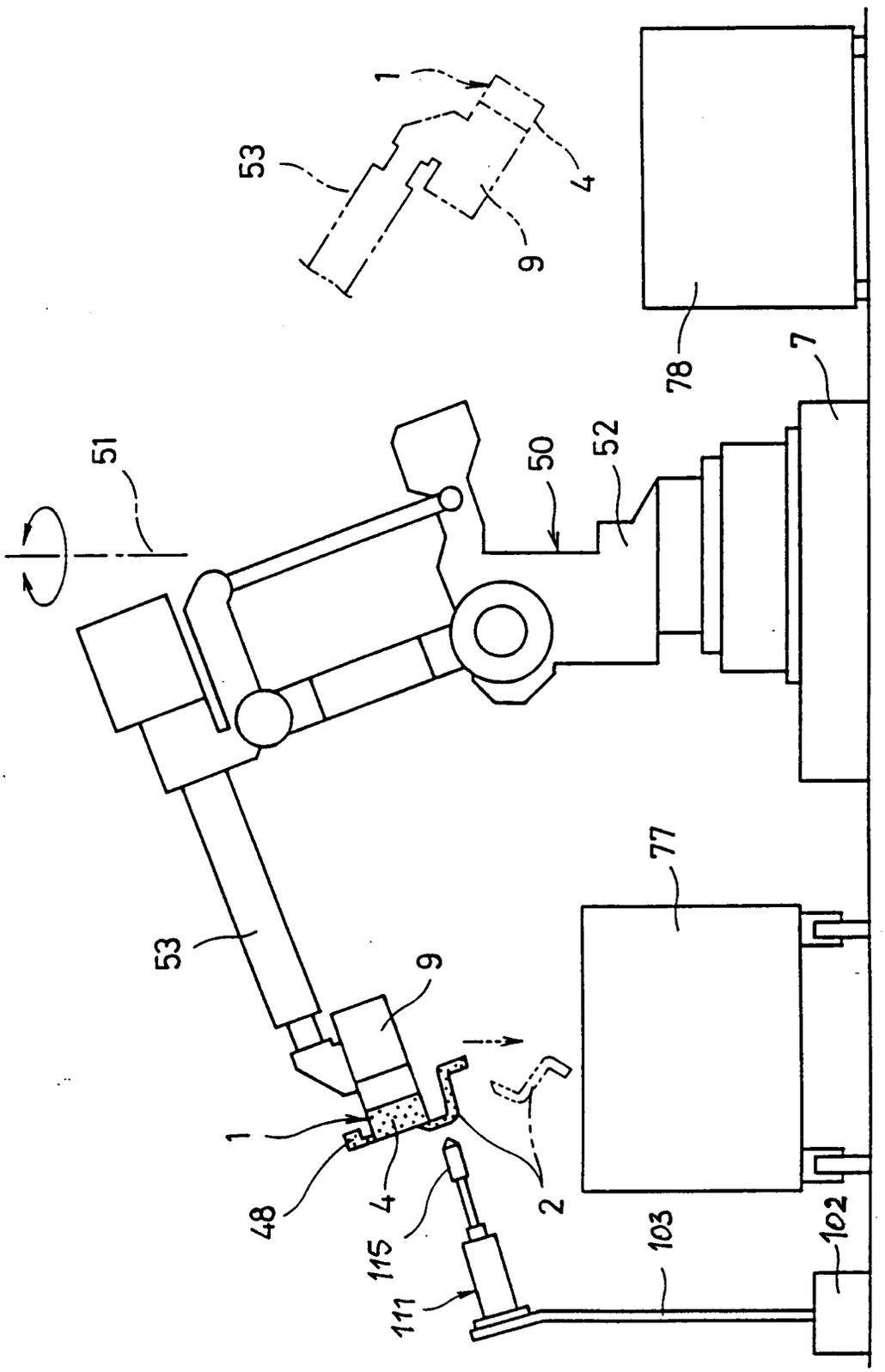

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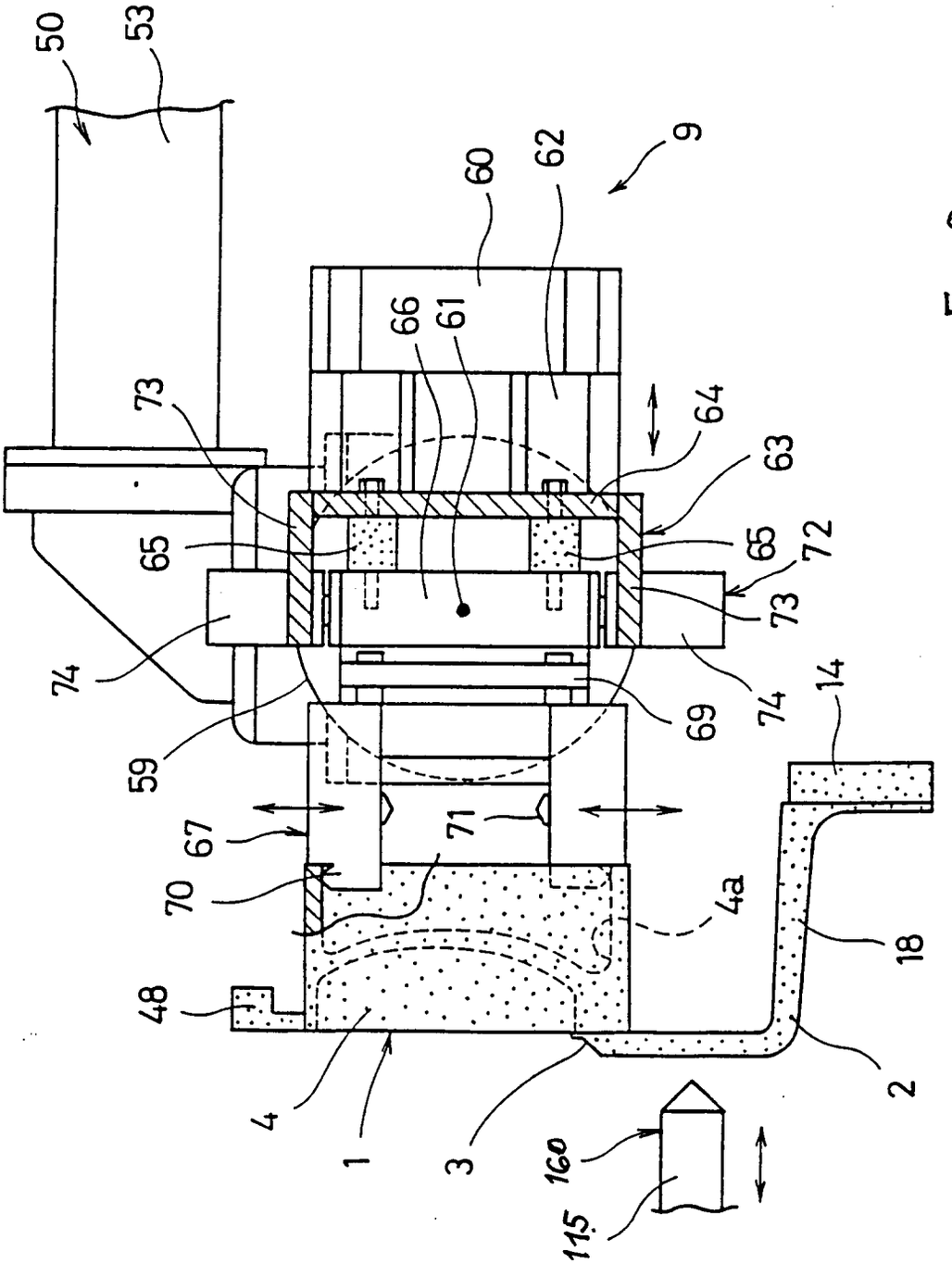
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4a
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48
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160
115

Fig. 8

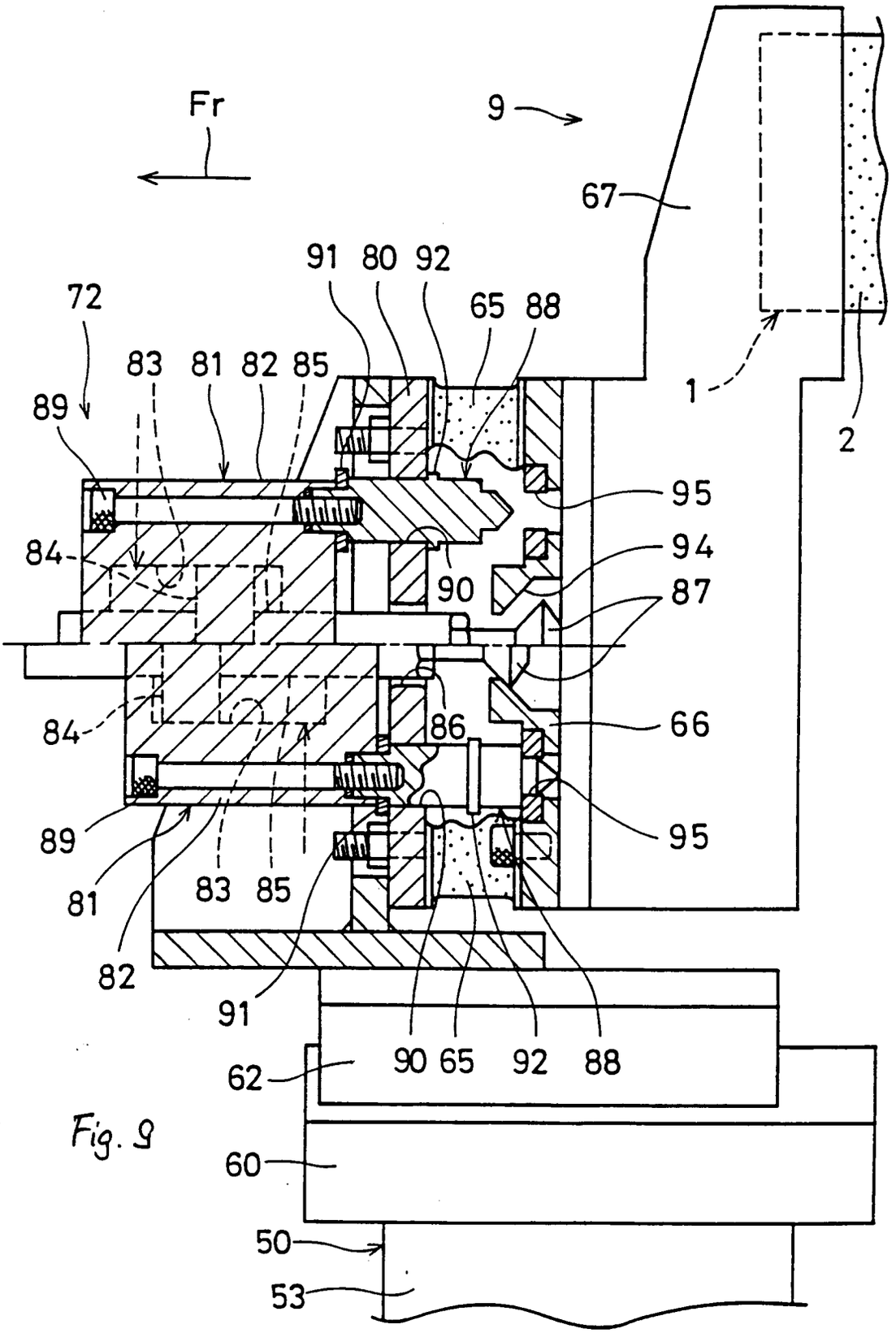
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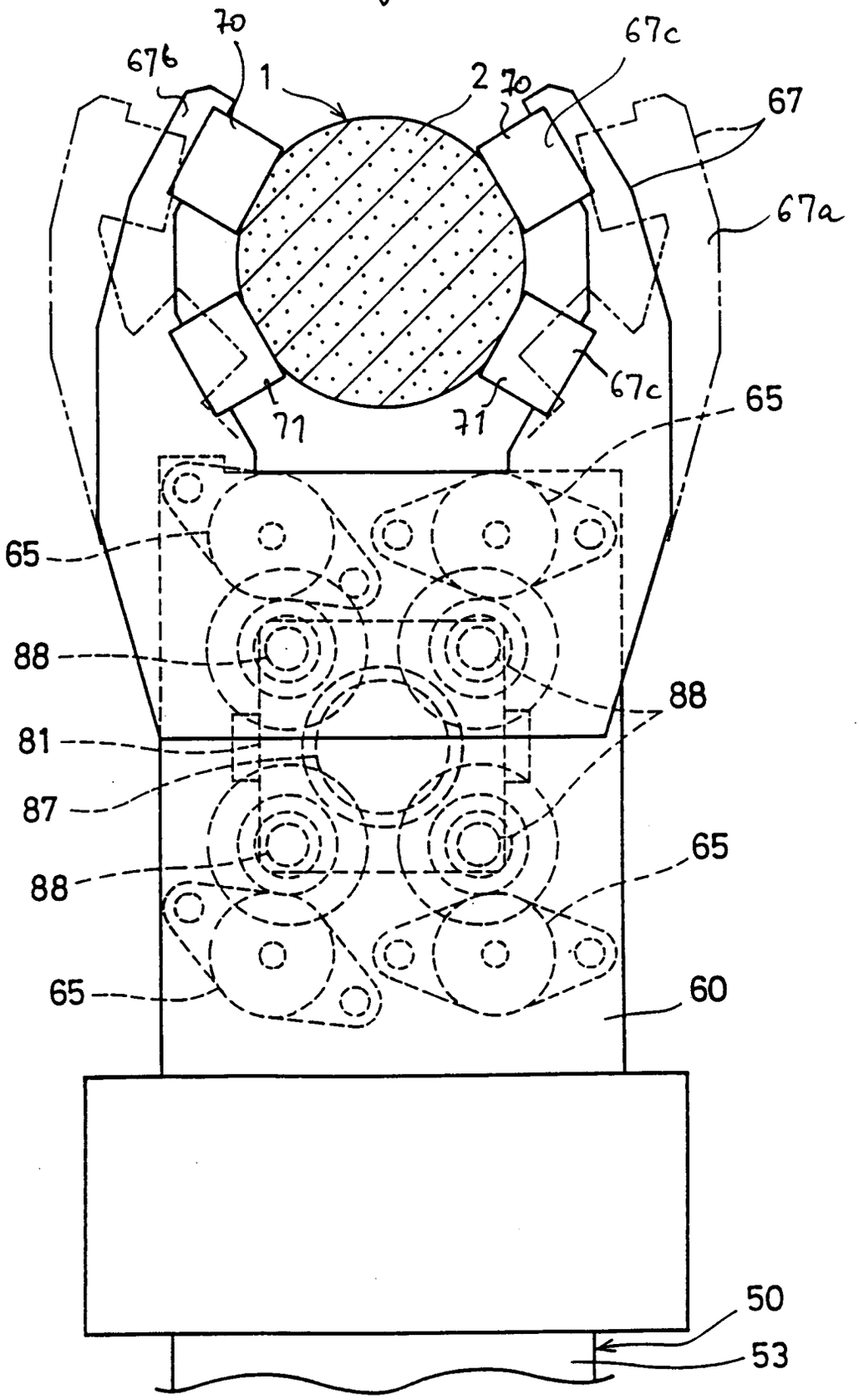
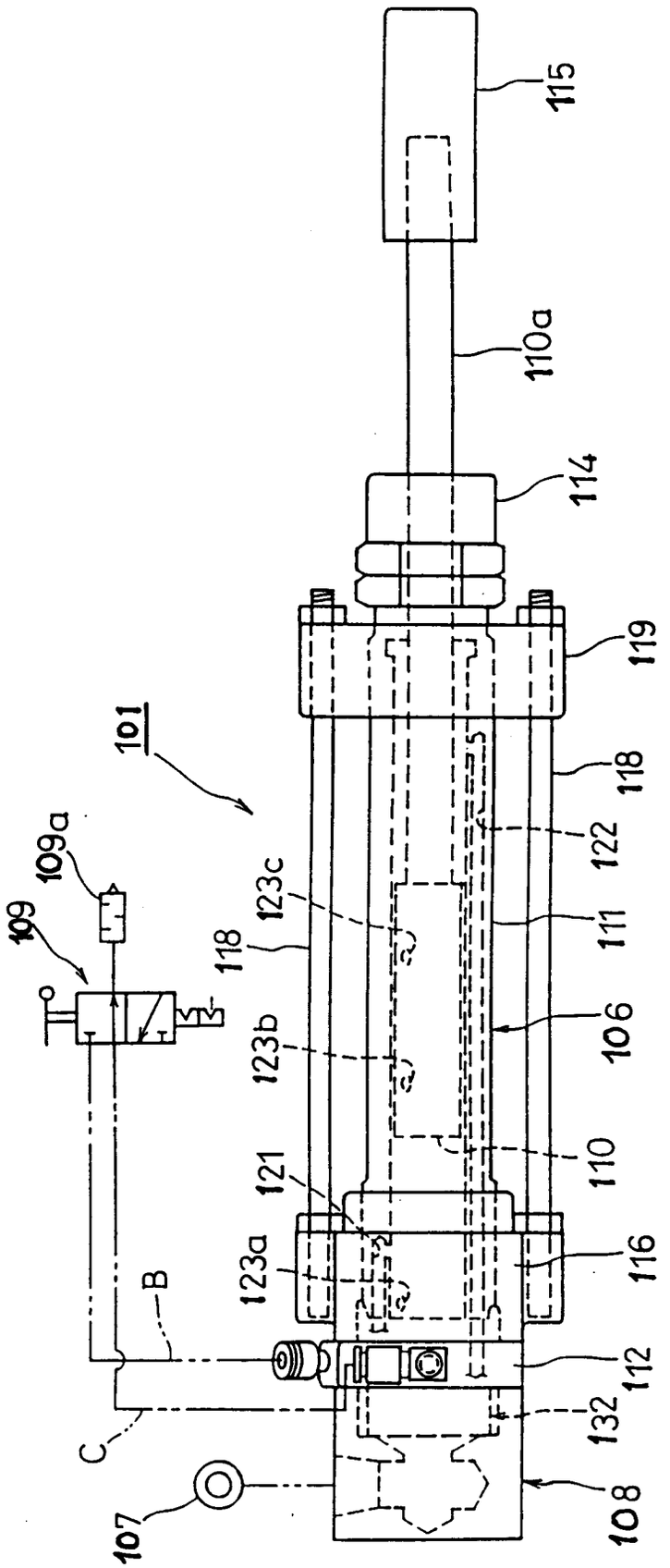
Fig. 9

Fig. 10

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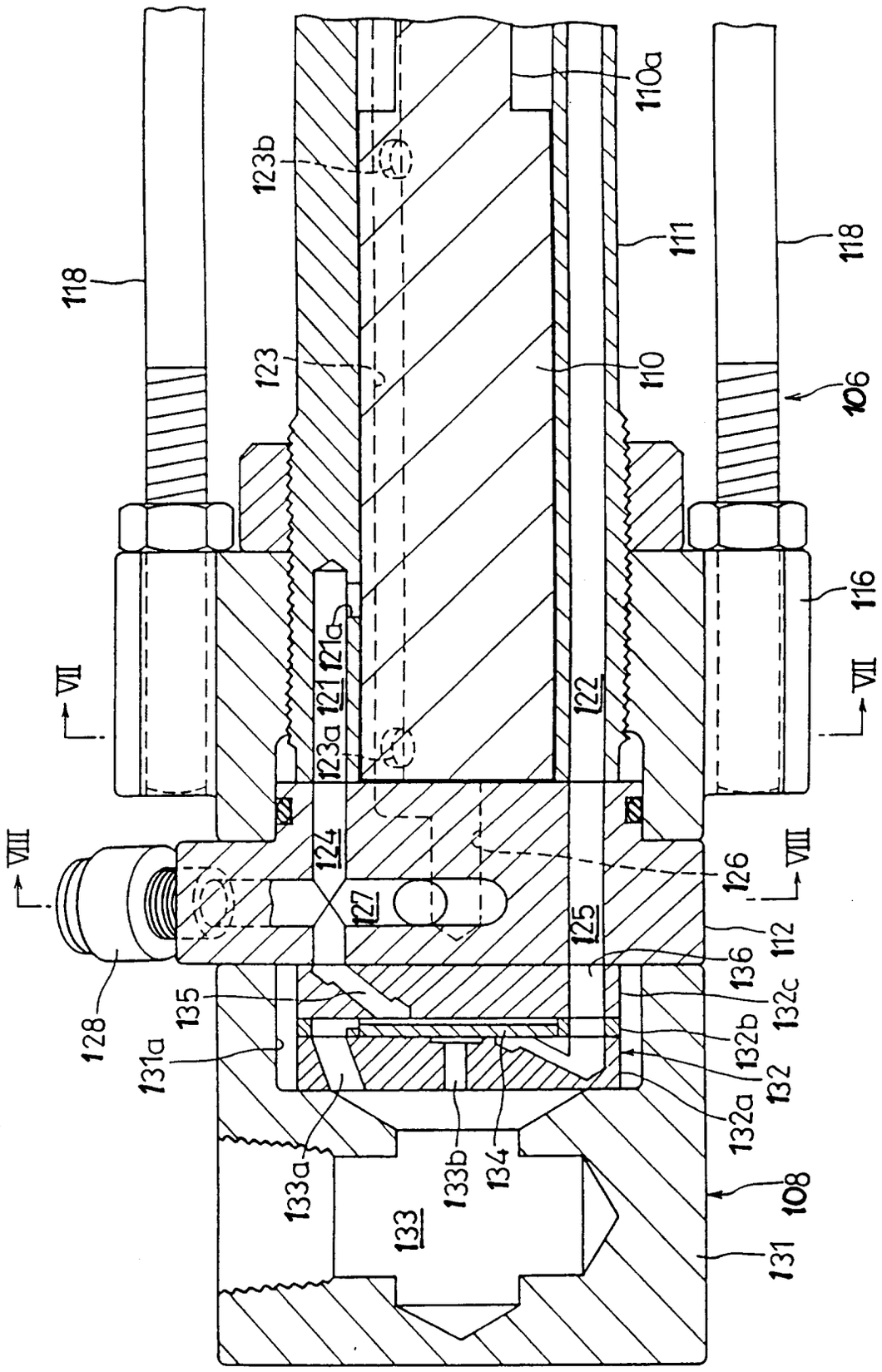
132
C
108
107

Fig. 11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133
108
131

Fig. 12

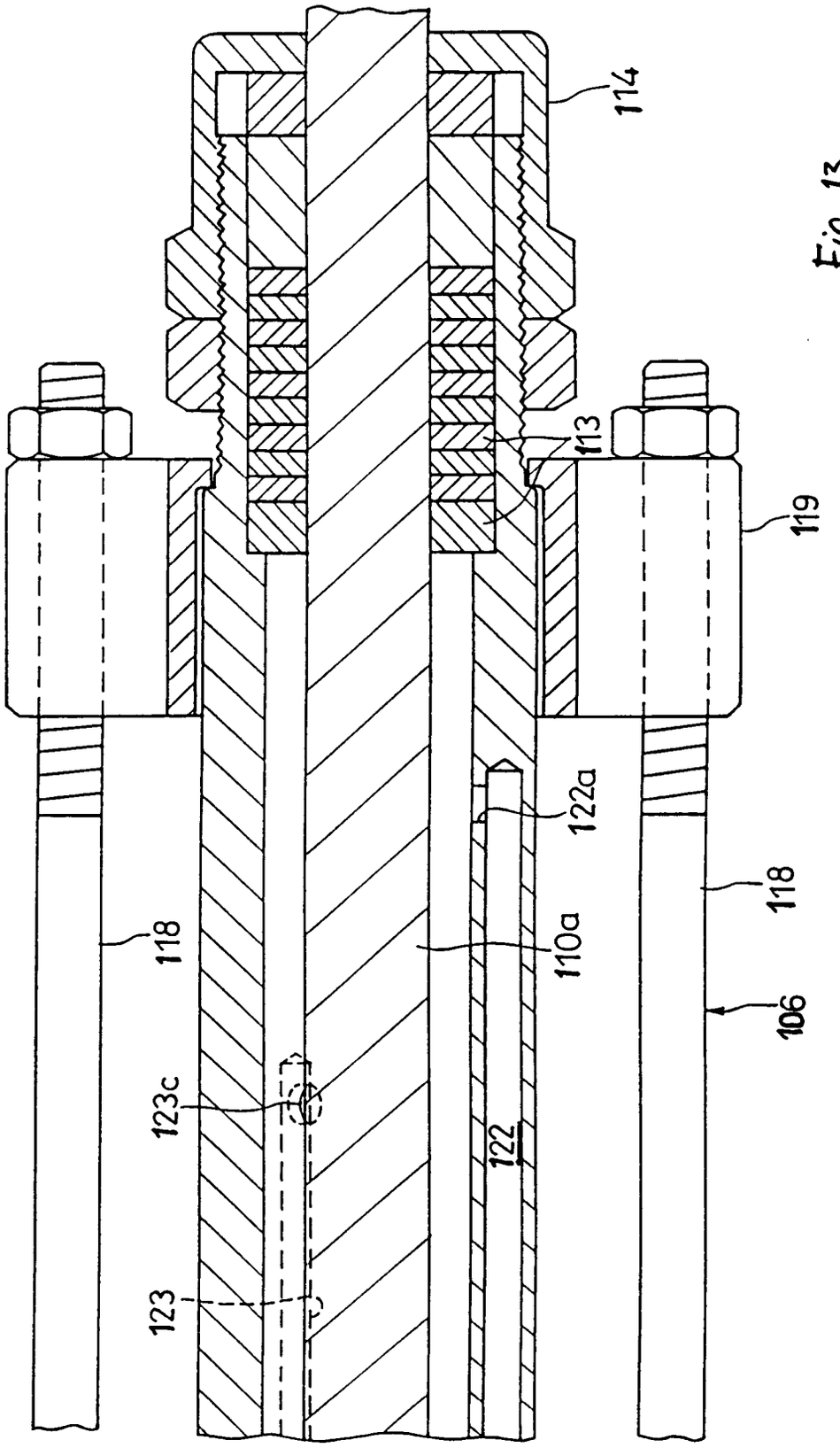

Fig. 13

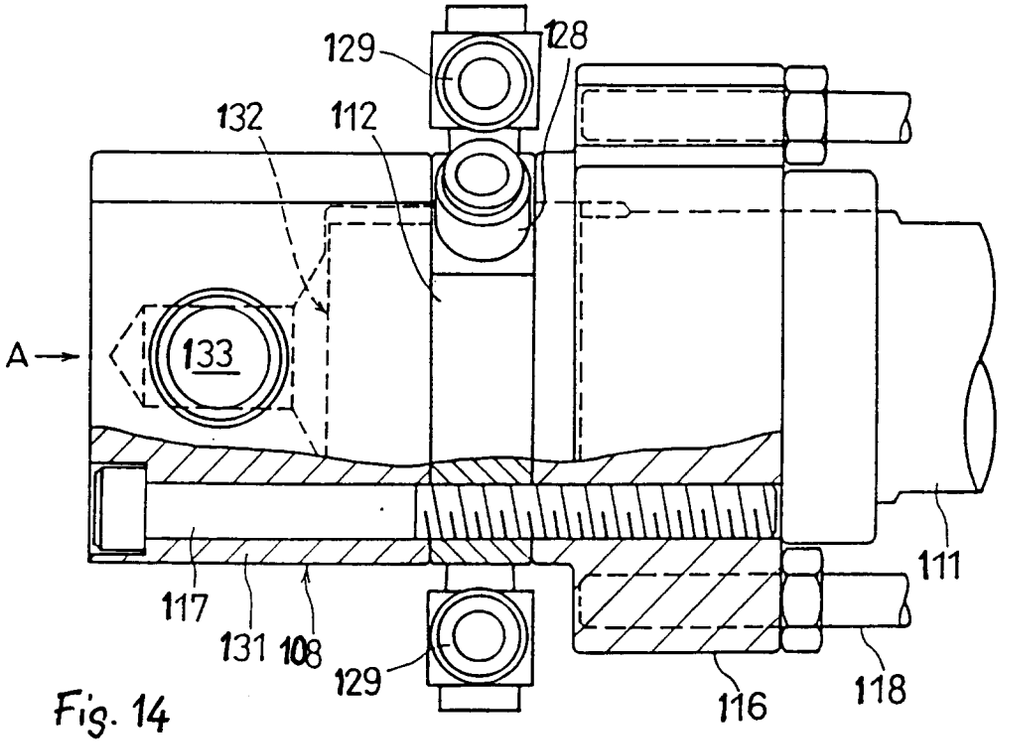
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Fig. 14

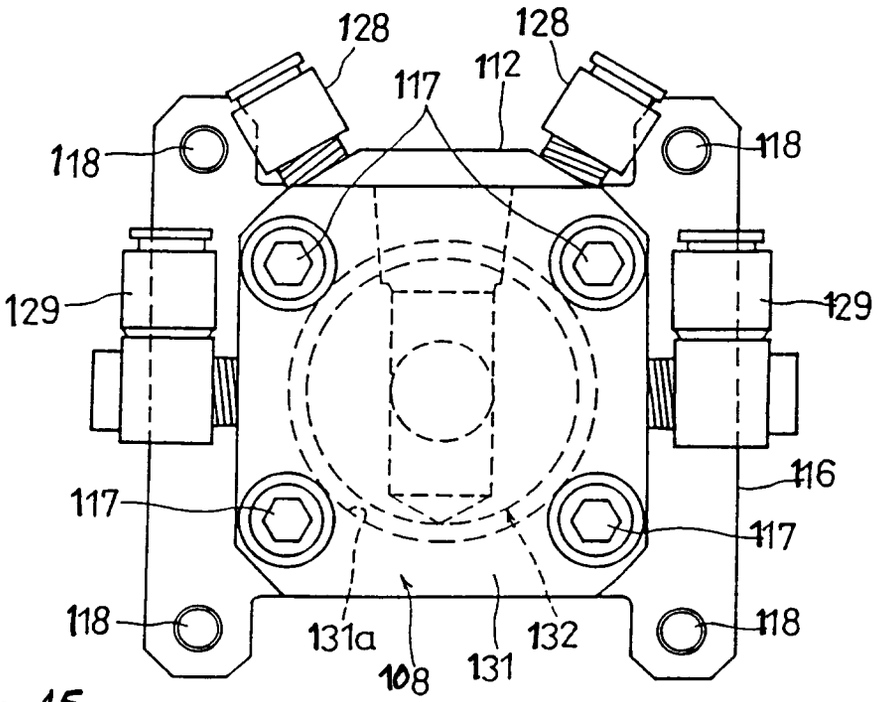
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Fig. 15

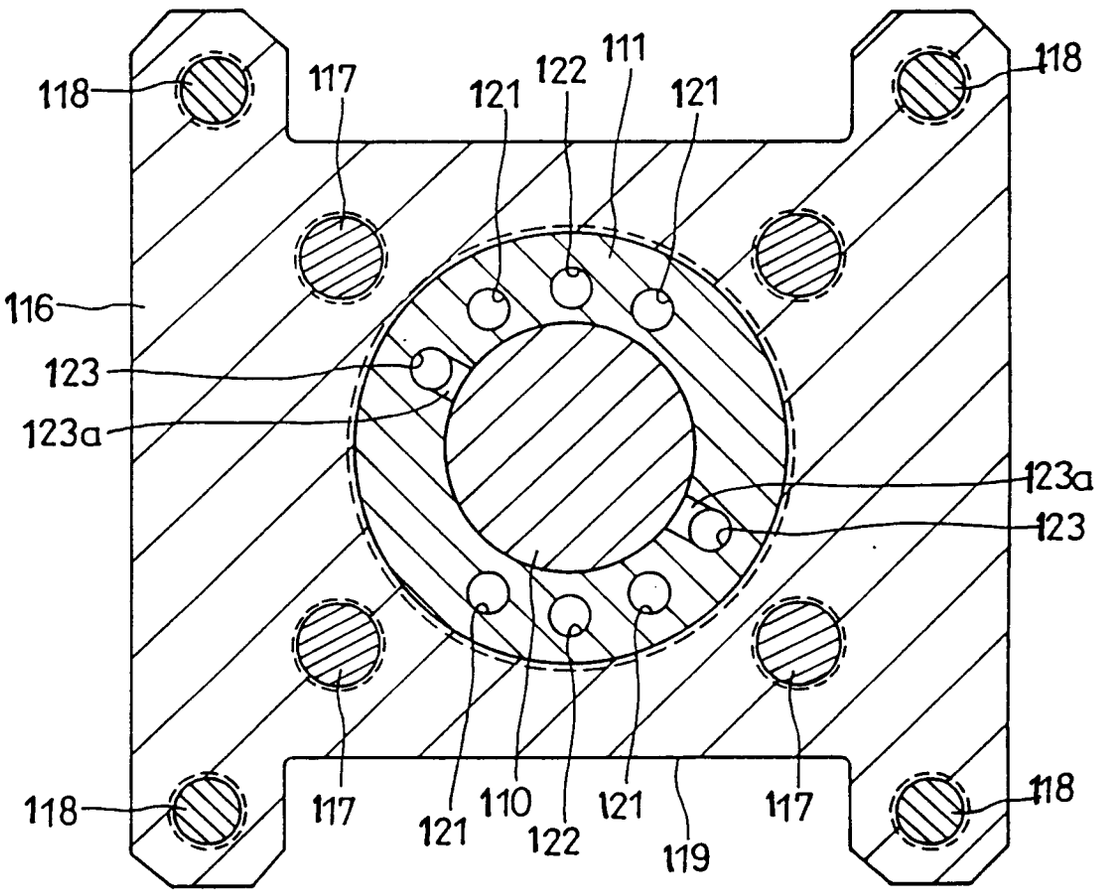
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Fig. 16

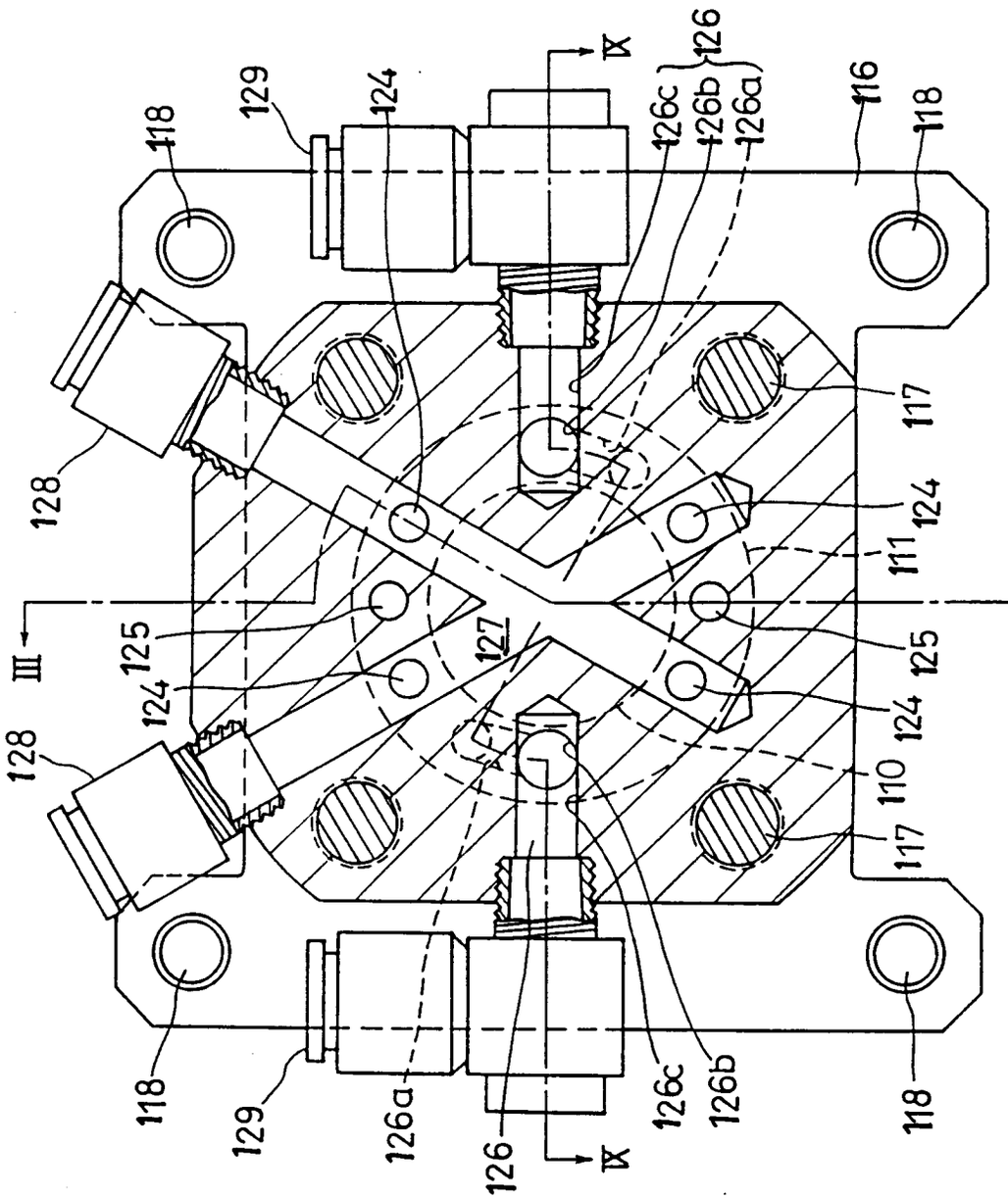
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Fig. 17

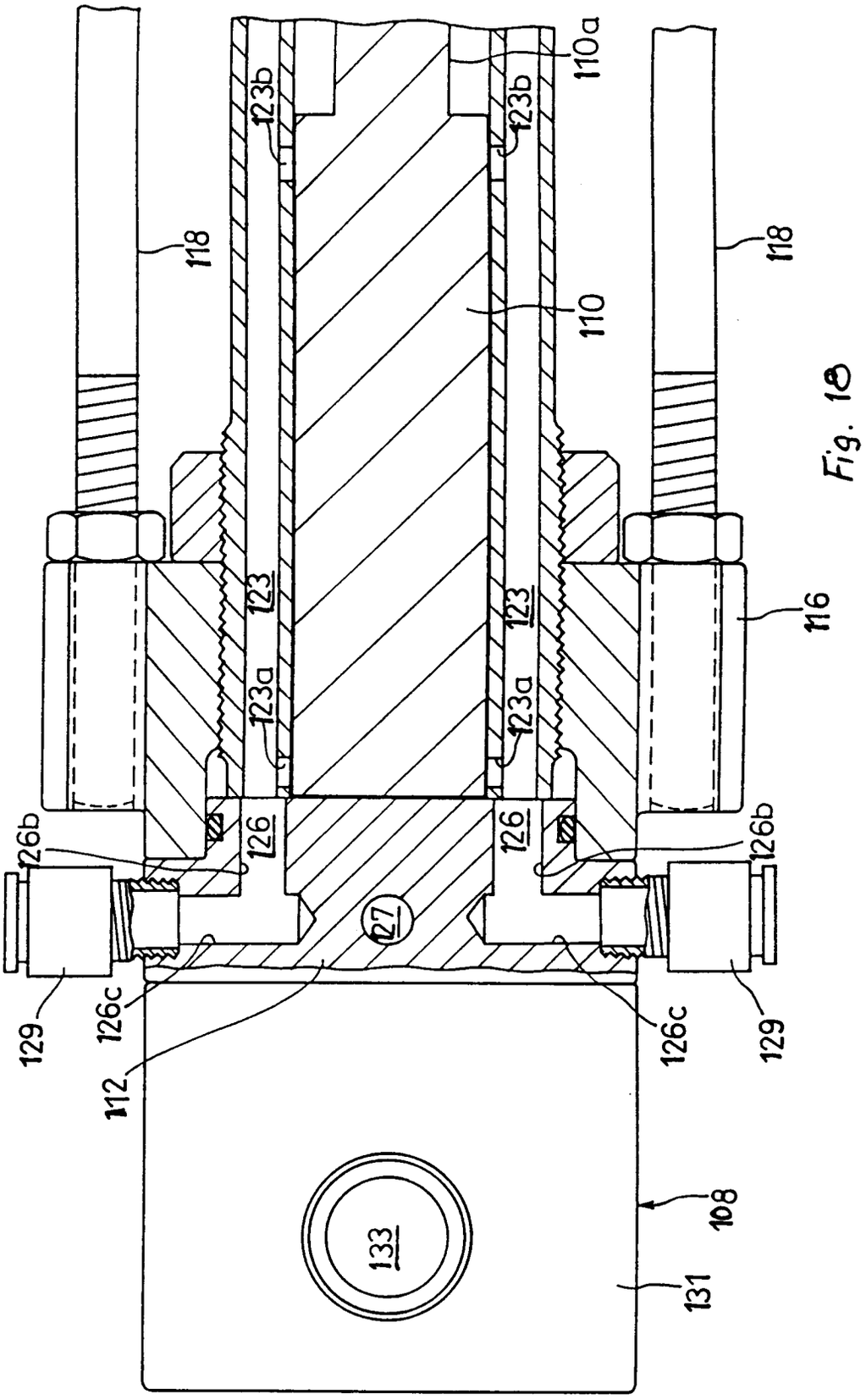
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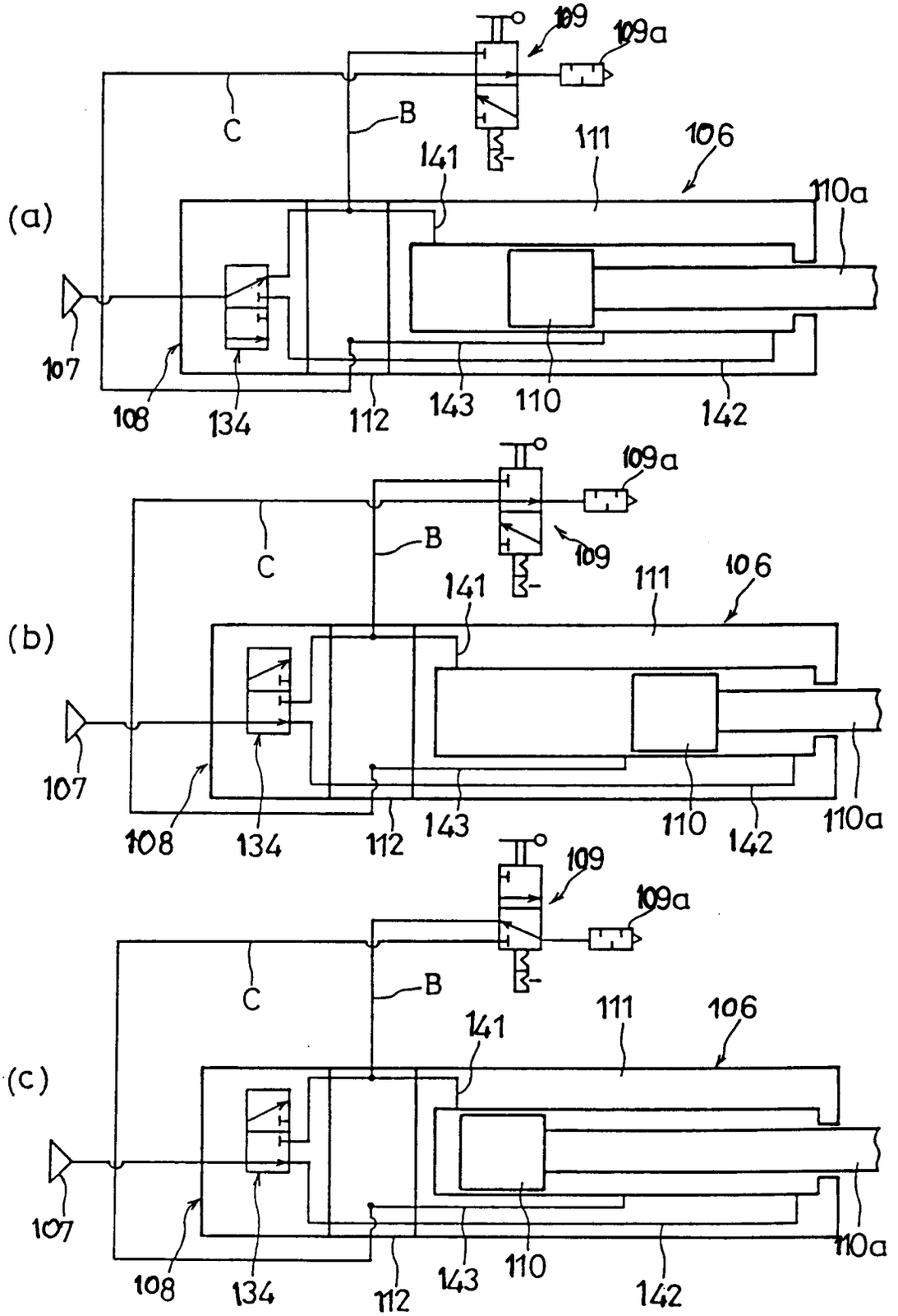
Fig. 18

Fig. 19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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 10 2919

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
A	DATABASE WPI Week 9213, Derwent Publications Ltd., London, GB; AN 92-097354 & DD-A-293 079 (VEB LEICHTMET RACKW) 22 August 1991 * abstract * ---	1-29	B22D17/20 B22D31/00
A	DATABASE WPI Week 9026, Derwent Publications Ltd., London, GB; AN 90-199241 26! & SU-A-932 704 (AS UKR ELECTROHYDRA) 15 November 1989 * abstract * ---	1	
A	DE-A-31 23 651 (ZEH, WILHELM) -----		

TECHNICAL FIELDS SEARCHED (Int.Cl.5)
B22D B29C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	1 August 1994	Hodiamont, S

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E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

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