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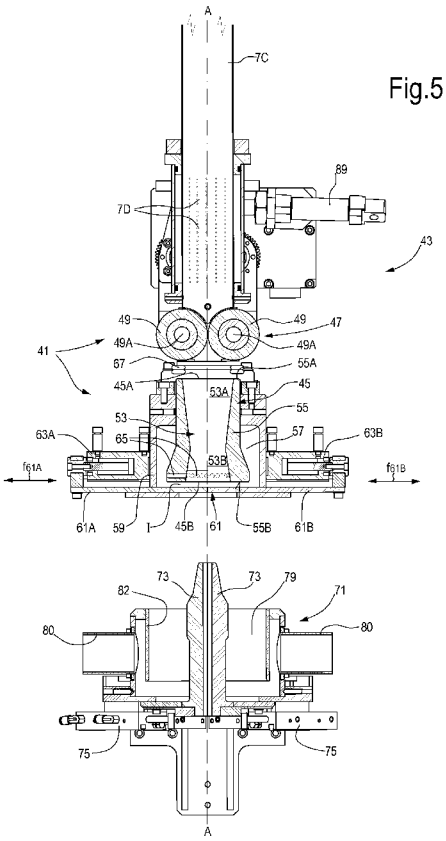

Fig.5

(57) Abstract: The device (41) to open an elastic edge (E) of a tubular knitted article (M) includes: - a hollow body (45) comprising a wall (55) surrounding an inner volume (53), an entrance opening (45A) for the insertion of a tubular knitted article (M), and an exit opening (45B) for the extraction of the tubular knitted article (M), the entrance opening (45A) and the exit opening (45B) being approximately coaxial and spaced along a longitudinal axis (A-A) of the hollow body (45); - a suction arrangement, associated with the exit opening (45B) of the hollow body (45), surrounding the longitudinal axis (A-A) of the hollow body (45), configured and arranged to open and annularly stretch, through suction, the elastic edge (E) of the tubular knitted article (M), causing it to adhere to the wall (55) of the hollow body (45) adjacent to the exit opening (45B).

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DEVICE FOR OPENING THE ELASTIC EDGE OF A TUBULAR KNITTED ARTICLE, MACHINE INCLUDING THE DEVICE AND RELATED METHOD

DESCRIPTION

TECHNICAL FIELD

The present invention relates to the field of machines for hosiery and knitting industry. More in particular, the invention relates to improvements to machines for handling tubular knitted articles, such as socks, stockings and the like. Embodiments described herein relate in particular to methods and devices for opening the elastic edge of a tubular knitted article. Other embodiments described herein relate to machines for handling, boarding or pre-boarding tubular knitted articles provided with an elastic edge.

BACKGROUND ART

In the hosiery and knitting industry, circular knitting machines are used for producing tubular garments, for instance socks and stockings provided at one end with an elastic edge, and, at the other end, with a toe, usually closed by means of sewing or linking. The articles are packed after having been boarded and folded. Usually, socks are loaded onto so-called boarding forms in order to be boarded through heat and to take the flat shape that allows the subsequent packing thereof. The articles are usually loaded onto the boarding forms manually; this is a very onerous work also from a physical point of view, as the operator shall take the single tubular knitted articles, load them onto the boarding form and orient them correctly before the boarding form moves through a heat-treatment chamber or an oven where the tubular knitted article is heat-treated and boarded.

There is therefore the need for devices, methods and machines able to make these operations lighter, simpler and easier for the operator.

One critical aspect in handling hosiery articles, such as sucks, is the opening of the elastic edge as a preliminary step for subsequent handling operations.

WO 2006/137097 and WO 03018891 disclose a method and a device for opening the elastic edge of a tubular knitted article, such as a sock, by means of a combination of pneumatic and mechanical members. The elastic edge of the sock is introduced between two twisted profiles which keep the edge folded. Downstream of the twisted profiles four suction members are arranged around a longitudinal axis and are movable orthogonal to said axis to pneumatically grasp the folded elastic edge of

the sock and open the edge such that it can be subsequently engaged by stems of a handling member.

US 6155466 and US 2004/0244237 disclose an apparatus for stretching apart an end of a tubular knitted article, such as a sock. The apparatus comprises a converging-diverging duct, wherethrough the article is fed. Downstream of the converging-diverging duct a pin and a suction duct are located. Air suction causes the tubular knitted article to move through the converging-diverging duct and to be loaded on the pin, with the elastic edge of the tubular knitted article being opened when advancing along the converging-diverging duct and surrounding the pin member. At the inlet of the duct, in the converging portion thereof, air blowing holes are provided, which add turbulence to the air flow, in order to open the elastic edge of the tubular knitted article.

These known devices are not entirely satisfactory. They are unable to handle short socks and in particular so-called “no-show” socks.

A need therefore exists for more efficient devices and methods for opening the elastic edge of tubular knitted articles, in particular socks.

SUMMARY OF THE INVENTION

According to a first aspect, a device is disclosed for opening an elastic edge of a tubular knitted article, including a hollow body with a wall surrounding an inner volume and defining an entrance opening for the insertion of a tubular knitted article, and an exit opening for the extraction of the tubular knitted article. The entrance opening and the exit opening may be approximately coaxial with each other and spaced from each other along a longitudinal axis of the hollow body. The entrance opening and the exit opening may be surrounded by an entrance edge and an exit edge formed by the wall of the hollow body.

Advantageously, the device may further comprise a suction arrangement associated with the exit opening of the hollow body. The suction arrangement may be so configured and arranged as to surround the longitudinal axis of the hollow body and to open and annularly stretch, through suction, the elastic edge of the tubular knitted article, causing it to adhere to the wall of the hollow body adjacent to the exit opening.

When the tubular knitted article is inserted in the inner volume of the hollow body with the elastic edge as the leading edge, the elastic edge is sucked by means of the suction arrangement and is stretched, i.e. it opens, thus adhering to the inner

surface and/or to the exit edge of the wall defining the inner volume of the hollow body. The opened elastic edge can be then engaged by a pick-up member or other handling member that transfers it, for example onto a boarding form.

According to some embodiments of the device, in order to facilitate the opening of the elastic edge the wall of the hollow body may define an inner volume having a converging portion and a diverging portion. The converging portion is arranged between the entrance opening and the diverging portion, i.e. upstream of the diverging portion with respect to the direction in which the tubular article is inserted into the hollow body.

Converging portion means a portion of the inner volume, the cross-section whereof becomes smaller in the direction in which the tubular knitted article is inserted, i.e. from the entrance opening towards the exit opening. Vice-versa, diverging portion means a portion of the inner volume, the cross-section whereof becomes larger in the direction in which the tubular knitted article is inserted.

The succession of a converging portion and a diverging portion facilitates the opening of the elastic edge of the tubular knitted article, as, generating an air flow through the hollow body from the entrance opening towards the exit opening, in the diverging portion the flow slows down and the flow threads of the air flow divaricate and help the movement of the elastic edge towards the wall of the hollow body.

In some embodiments, the suction arrangement comprises a plurality of suction ports arranged annularly around the longitudinal axis of the hollow body, near the exit opening of the hollow body. The suction ports may be provided in the form of holes extending through the wall delimiting the inner volume of the hollow body of the device, in order to open the elastic edge of the tubular knitted article. If the inner volume has a converging portion and a diverging portion, the suction ports are provided in the diverging portion. Advantageously, the suction ports are preferably provided adjacent to the exit opening of the hollow body.

In some embodiments, the suction arrangement comprises a first suction chamber, at least partially surrounding the hollow body. The first suction chamber may be fluidly coupled to at least one suction pipe or a plurality of suction pipes, for instance connected to the suction side of a compressor or other vacuum source. The first suction chamber may be fluidly coupled to the inner volume of the hollow body through the suction ports, so that the lower pressure generated by suction in the suction chamber causes an air flow through the suction ports.

In some embodiments, the device comprises a closing member arranged in front of the exit opening of the hollow body and spaced from said exit opening. The distance between the closing member and the exit edge surrounding and forming the exit opening may be such as to form a peripheral suction aperture, in the form of a suction gap between the closing member and the exit edge of the hollow body when the closing member is in closing arrangement.

The closing member may be comprised of movable elements, for instance preferably flat leaves or walls, controlled and arranged to be brought in a position where they are near to one another, to form a closed wall arranged in front of the exit opening of the hollow body, and in a position distanced from one another, where they form a passage for the exit of the tubular knitted article from the hollow body.

In some embodiments the closing member is configured and arranged to selectively open and close an air passage of the first suction chamber substantially surrounding the exit opening of the hollow body. The suction gap between the exit edge of the hollow body and the closing member, formed when the closing member is in the closed arrangement, puts the inner volume of the hollow body in fluid communication with the first suction chamber, so that a suction generated in the first suction chamber causes an air flow in the gap. The air flow pulls the open elastic edge into the gap, so that the elastic edge arranges itself in open position along the exit edge of the hollow body.

In some embodiments, the device comprises a pick-up member to take the tubular knitted article from the hollow body engaging the elastic edge thereof after it has been opened, i.e. stretched, and arranged adhering to the exit edge of the wall of the hollow body, which surrounds the exit opening.

In some embodiments, the pick-up member and the hollow body are movable with respect to each other according to a direction parallel to the axis of the hollow body . In this way, it is possible to at least partially insert the pick-up member in the hollow body through the exit opening and to extract it from the hollow body. This makes it easier for the tubular knitted article to pass from the hollow body of the device to the pick-up member.

In some embodiments, the pick-up member comprises a stretching device configured and arranged to receive the elastic edge of the tubular knitted article when this latter is removed from the hollow body. In some embodiments, the stretching device comprises a plurality of fingers movable with respect to one another so as to

take a spread-apart position and a position of reciprocal approach to one another. Position, shape and number of fingers may vary, for instance based on the operations to be performed on the tubular knitted article after this latter has been removed from the elastic edge opening device. In the embodiment described in greater detail below, four stretching fingers are provided, to load the tubular knitted article onto a tubular boarding form, for instance a cylindrical form. In other embodiments, for instance if flat forms are used, only two stretching fingers can be provided.

The movement of the fingers may be approximately orthogonal to the longitudinal axis of the hollow body. In other embodiments, at least three fingers, and preferably four fingers are provided. The fingers of the stretching device may have a longitudinal extension parallel to the axis of the hollow body and thus approximately orthogonal to their moving-apart direction.

In advantageous embodiments, when the inner volume of the hollow body has a converging portion and a diverging portion, the fingers of the stretching device may have a tapered shape, so that, by inserting the stretching fingers in the inner volume of the hollow body through the exit opening, a passage with an annular cross-section is formed between the inner surface of the wall defining the inner volume of the hollow body and the set of the fingers adjacent to one another in the position of maximum approach to one another.

The fingers may be so shaped that, when arranged adjacent to one another, they substantially form a solid body, shaped like a pin, onto which the elastic edge of the tubular knitted article can be transferred.

In some embodiments, the pick-up member comprises a second suction chamber with a suction opening configured and arranged so as to be fluidly coupled to the inner volume of the hollow body, in order to generate an air flow through the hollow body. When a first suction chamber surrounds the hollow body, the first suction chamber and the second suction chamber may be fluidly coupled together.

In advantageous embodiments, the pick-up member is carried by a slide movable along a guide parallel to the longitudinal axis of the hollow body.

In order to insert the tubular knitted articles in the hollow body, the device can comprise a feeding device arranged in front of the entrance opening of the hollow body. In some embodiments, the feeding device can comprise a pair of rollers with axes substantially parallel to each other and transverse with respect to the longitudinal axis of the hollow body, at least one of the rollers, and preferably both

the rollers, being motorized. The rollers may be movable so as to move away from each another and be kept one against the other, for instance by means of a, preferably pneumatic, cylinder-piston actuator. The two rollers form a nip where the tubular knitted article is inserted. The controlled rotation of the rollers allows moving the tubular knitted article forwards in the hollow body in a gradual and controlled way.

According to a further aspect, a machine is described for boarding tubular knitted articles, comprising:

- a device for opening the elastic edge of the tubular knitted articles as defined above;
- at least one boarding form, configured to receive a tubular knitted article from said device.

The machine may comprise a pneumatic pipe to feed the tubular knitted articles towards the hollow body of said device. The pneumatic pipe may comprise an entrance end for the tubular knitted articles and an exit for the tubular knitted articles, and may be subdivided into a plurality of sections that can be pneumatically separated from one another, so as to receive therein a plurality of tubular knitted articles in sequence. In this way, a stock of tubular knotted articles is formed in the pneumatic pipe, that are individually fed to the opening device for opening the elastic edge of the tubular knitted articles. The exit end of the tubular knitted articles is functionally coupled with the device for opening the elastic edge. A tubular connection may be for example provided, exiting in front of the device hollow body, or in front of the nip formed by the two rollers of the feeding device, if provided.

It is also possible to design a simpler machine, wherein the individual articles are fed manually directly to the hollow body or to a feeding device arranged in front of the entrance opening of the hollow body.

If a feeding pneumatic pipe is provided, the tubular knitted articles may be loaded in the entrance end manually. However, it is also possible to use an automatic loading device. It is advisable that the tubular knitted articles are inserted in the pneumatic pipe correctly oriented, preferably with the elastic edge in the leading position with respect to the feeding direction in the pneumatic pipe. This avoids the need for reversing the orientation of the tubular knitted article before arriving at the opening device for opening the elastic edge. Moreover, it is not necessary to provide, along the pneumatic pipe, members for detecting the orientation of the tubular knitted article.

The machine may comprise a boarding or heat-treatment chamber, the boarding form being configured and arranged to pass through the boarding chamber. In the boarding or heat-treatment chamber, the tubular knitted article inserted onto the boarding form is heated, for example through hot air and/or steam, so as to be stretched and boarded.

In advantageous embodiments, the machine may comprise a rotating carousel, or other conveyor, carrying a plurality of boarding forms, that are moved, for example by rotating the carousel, along a path where several stations are arranged, for example for loading the tubular knitted articles, for orienting the tubular knitted articles and for boarding the tubular knitted articles through heat inside the heat-treatment chamber.

The boarding forms may be flat. In other embodiments, the boarding forms may be tubular, for instance cylindrical. The use of tubular boarding forms simplifies the angular orientation of the tubular knitted article, as it will be more apparent from the detailed description below of embodiments of the machine described herein.

If tubular boarding forms are used, after having been boarded in the heat-treatment chamber on the tubular boarding form, the tubular knitted articled may be subjected to a further final boarding step. To this end, the machine may comprise a pair of conveyor belts opposite to each other, configured and arranged for picking up the tubular knitted article from the boarding form and for boarding it by pressing it between the two opposite conveyor belts.

The boarding form may be supported on a support, rotatably around a longitudinal rotation axis. In this case, the machine may comprise an actuator to rotate the boarding form around the support and angular positioning members for angularly positioning the boarding form with respect to the support.

In order to remove the tubular knitted article from the boarding form an extractor can be provided, axially movable with respect to the boarding form. The boarding form may be angularly orientable around its longitudinal axis, with respect to the position of the extractor, in order to angularly orient the tubular knitted article and put it in the correct position before extracting it from the boarding form. The extractor may have a flat shape, so as to be inserted between the two conveyor belts which take the tubular knitted article from the boarding form.

According to a further aspect, a method is described for opening an elastic edge of a tubular knitted article, comprising the steps of:

- feeding a tubular knitted article with the elastic edge inside a hollow body comprising a wall surrounding an inner volume, an entrance opening for the tubular knitted article and an exit opening for the tubular knitted article, the entrance opening and the exit opening being approximately coaxial and spaced apart from one another along a longitudinal axis of the hollow body;
- generating an air flow from the inner volume towards the outside of the hollow body in the area of the exit opening, the air flow annularly sucking the elastic edge of the tubular knitted article, thus causing the elastic edge to be stretched and to rest on the exit opening.

The step of generating an air flow from the inner volume towards the outside of the hollow body in the area of the exit opening may comprise, in turn, the steps of:

- arranging a closing member in front of the exit opening, at such a distance from the exit opening to leave a suction gap between the hollow body and the closing member, the gap putting the inner volume of the hollow body in fluid communication with a first suction chamber;
- generating an air flow from the inner volume of the hollow body through the gap and drawing, by means of the air flow, the elastic edge in the gap.

The method may also comprise the following steps:

- arranging a pick-up member approximately coaxially with the hollow body;
- generating an air flow from the inner volume of the hollow body through the exit opening towards the pick-up member;
- by means of the air flow from the inner volume of the hollow body towards the pick-up member, releasing the elastic edge of the tubular knitted article from the hollow body and drawing the elastic edge from the hollow body onto the pick-up member.

The step of positioning the pick-up member approximately coaxially with the hollow body may, in turn, comprise the step of inserting the pick-up member at least partially inside the hollow body through the exit opening.

In case the pick-up member comprises, as mentioned above, a stretching device including a plurality of fingers movable with respect to one another so as to take a spread-apart position and a position of reciprocal approach to one another, a step may be provided of opening the fingers thus stretching the elastic edge of the

tubular knitted article, so as to prepare it to be transferred onto a boarding form by reciprocally moving the fingers and the boarding form with respect to one another, the fingers being able to translate along the boarding form parallel to the longitudinal axis of the boarding form.

The method may comprise a step of angularly orienting the tubular knitted article around a longitudinal axis of the boarding form.

Further advantageous features and embodiments of the device, the machine and the method according to the present invention are described hereunder with reference to the attached drawings and in the appended claims, which form an integral part of the present description.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood by following the description and the accompanying drawings, which show non-limiting practical embodiments of the invention. More particularly, in the drawing:

Fig. 1 is a schematic plan view of a machine for boarding tubular knitted articles, such as stockings or socks, provided with an elastic edge at one end thereof;

Fig. 2 shows a schematic of the pneumatic pipe for feeding the tubular knitted articles to the boarding members;

Figs. 3 and 4 are axonometric views of the device for opening the elastic edge of the tubular knitted article and of the pick-up member transferring the tubular knitted articles onto the tubular boarding forms;

Figs. 5 and 6 show two cross-sections according to the longitudinal planes, orthogonal to each other, of the device and the related pick-up member of Figs. 3 and 4;

Fig. 7 is an axonometric view of a tubular boarding form;

Figs. 8A and 8B illustrate longitudinal cross-sections of the upper end and the lower end of the tubular boarding form of Fig. 7;

Figs. 9A and 9B illustrate the unit for rotating the tubular boarding forms in two different operating conditions;

Fig. 10 illustrates an axonometric view and the area where the tubular boarding forms enter the heat-treatment chamber;

Figs. 11A and 11B show a side view of the pick-up station for the tubular knitted articles boarded by means of the tubular boarding forms;

Figs. 12A to 12S show an operating sequence of opening the elastic edge of a

tubular knitted article and loading the tubular knitted article on a tubular boarding form;

Figs. 13A to 13D show unloading steps of a tubular knitted article in a situation wherein the opening of the elastic edge failed.

DETAILED DESCRIPTION OF EMBODIMENTS

The following detailed description of the exemplary embodiments refers to the accompanying drawings. The same reference numbers in different drawings identify the same or similar elements. Additionally, the drawings are not necessarily drawn to scale. Also, the following detailed description does not limit the invention. Instead, the scope of the invention is defined by the appended claims.

Reference throughout the specification to "one embodiment" or "an embodiment" or “some embodiments” means that the particular feature, structure or characteristic described in connection with an embodiment is included in at least one embodiment of the subject matter disclosed. Thus, the appearance of the phrase "in one embodiment" or "in an embodiment" or "in some embodiments" in various places throughout the specification is not necessarily referring to the same embodiment(s). Further, the particular features, structures or characteristics may be combined in any suitable manner in one or more embodiments.

Fig. 1 schematically illustrates a plan view of a machine 1 for boarding tubular knitted articles, such as stockings and socks provided with an elastic edge. Schematically, the machine 1 comprises a rotating carousel 3 with a substantially vertical rotation axis 3A. Tubular boarding forms 5 are provided on the rotating carousel 3, arranged around the rotation axis 3A of the carousel 3. The number of boarding forms 5 may vary, for example depending on the size of the machine 1. Greater details on the boarding forms 5 will be described below. It should be noted that, in the illustrated embodiment, the boarding forms 5 have a circular cross-section rather than a flat cross-section as usually occurs in the prior art boarding machines.

A pneumatic pipe, indicated as a whole with number 7, is associated with the machine 1 for feeding individual tubular knitted articles to the boarding machine 1; greater details of the pneumatic pipe will be described below.

The boarding machine 1 comprises a plurality of stations, and more particularly a first station 9, where tubular knitted articles coming from the pneumatic pipe 7 are opened by stretching, i.e. by annularly enlarging the elastic edge, and are loaded on the tubular boarding forms 5. The boarding machine 1 also

comprises a second station 11 for orienting the boarding form 5 around a vertical rotation axis (B-B) of the boarding form 5, substantially parallel to the rotation axis 3A of the carousel 3. Reference number 12 generally indicates an angular orientation device for angularly orienting the boarding forms 5. The boarding machine 1 also comprises an boarding station 13, comprising an oven or heat-treatment chamber 15, which can extend according to a portion of circular ring around the rotation axis 3A of the carousel 3. A station 17 is also provided for removing or picking up the individual tubular knitted articles from the boarding forms 5 and for feeding them to a packing machine, not shown.

Fig. 2 illustrates in greater detail the configuration of the pneumatic feeding pipe for feeding the tubular knitted articles towards the machine 1. The pneumatic pipe 7 comprises an entrance end 7A and an exit end 7B, the latter being fluidly coupled with an opening device for opening the elastic edge of the tubular knitted articles, which will be described in greater detail with reference to the following Figs. 3 to 6. Between the entrance opening 7A and the exit opening 7B, the pneumatic pipe 7 is provided with a series of elements subdividing the same pneumatic pipe 7 into sections. Starting from the entrance end 7A, along the pneumatic pipe 7 there are provided a first closing gate 21, a first air intake 23 and a first passage sensor 25 for detecting the passage of the tubular knitted article along the pneumatic pipe 7, a first suction mouth 27, a second gate 29, a second air intake 31, a second passage sensor 33. A branch line 35 is associated with the pneumatic pipe 7; the branch line ends with a discharge bell 37 fluidly coupled, through a third gate 39, to a second suction mouth 41, for the purposes described below.

Each air intake 23 and 31 has a respective opening and closing gate 23A and 31A, respectively. The suction mouth 27 has an opening and closing gate 27A. In the illustrated embodiment, the individual tubular knitted articles are inserted manually, according to a preset orientation, inside the entrance end 7A of the pneumatic pipe 7, and are conveyed towards the exit end 7B of the pneumatic pipe 7, in order to be introduced in the opening device for opening the elastic edge of the tubular knitted article and allow then to load it onto the boarding form 5.

The sequence of feeding the individual tubular knitted articles inside the pneumatic pipe 7 will be described with reference to the sequence of Figs. 12A- 12S.

The opening device for opening the elastic edge of the tubular knitted article is arranged in the station 9 of machine 1, where the tubular knitted article is

conveyed by means of the pneumatic pipe 7 and is loaded onto one of the boarding forms 5 of the machine 1.

The structure of the opening device for opening the elastic edge of the tubular knitted article is illustrated in detail in Figs. 3 to 6. The device is indicated as a whole with number 43. The device 43 is connected to the pneumatic pipe 7 by means of a connection 7C. The connection 7C is arranged approximately coaxially with a hollow body 45, with a longitudinal axis A-A. Between the hollow body 45 and the tubular connection 7C a feeding device is provided, indicated as a whole with number 47.

In the illustrated embodiment, the feeding device 47 comprises a pair of rollers 49 rotating around axes 49A, which are substantially parallel to each other and orthogonal to the axis A-A of the hollow body 45. In Figs. 3 and 4, number 51 indicates an electric motor that controls the rotation of at least one of the rollers, and preferably both the rollers 49 of the feeding device 47. The rotation of the rollers 49 can be controlled clockwise or counterclockwise depending on the handling steps for the tubular knitted article, as described in greater detail below. The rollers 49 are counter-rotating, so that a tubular knitted article inserted in the nip defined between the rollers can be moved forward or backward depending on the direction of rotation of the rollers 49.

In some embodiments an actuator, for example a cylinder-piston actuator 89, may be provided to move the rollers 49 of the feeding device 47 towards and away from each other, with a movement orthogonal to the rotation axes 49A of the rollers.

The terminal part, i.e. the part closer to the rollers 49, of the tubular connection 7C can be provided with holes 7D fluidly coupling the inside of the tubular connection 7C to a suction mouth 91, for purposes that will be explained below.

The hollow body 45 has an inner volume 53 delimited by a wall 55, which may have a substantially axial-symmetrical shape with respect to axis A-A. The inner volume 53 of the hollow body 45 may have a first converging portion 53A and a second diverging portion 53B. The two portions 53A and 53B of the inner volume 53 of the hollow body 45 may have a substantially frustum-conical shape and be connected at an intermediate position of the longitudinal extension of the hollow body 45. In the illustrated embodiment, the converging portion 53A has a greater longitudinal extension, approximately twice the longitudinal extension of the

diverging portion 53B. In other embodiments, the lengths of the converging portion 53A and the diverging portion 53B can be different than those represented.

The hollow body 45 has an entrance opening 45A and an exit opening 45B for the tubular knitted article. The entrance opening 45A and the exit opening 45B are preferably coaxial with each other and longitudinally spaced from each other along the axis A-A of the hollow body 45. The cross-section of the inner volume 53 and of the entrance and exit openings 45A and 45B may be circular.

The wall 55 of the hollow body 45, delimiting the inner volume 53, has an entrance edge 55A surrounding the entrance opening 45A and an exit edge 55B surrounding the exit opening 45B.

A suction arrangement is associated with the hollow body 45. In the illustrated embodiment, around the hollow body 45 a first suction chamber 57 is provided, which forms part of the suction arrangement and which can be delimited by a wall 59. The first suction chamber 57 is provided with one or more suction mouths 58, see in particular Fig. 6. In the illustrated embodiment two suction mouths 58 are provided, diametrically opposite to each other. It is also possible to provide a different number of suction mouths.

The first suction chamber 57 has a downwards facing air passage, which can be selectively opened and closed by means of a closing member 61, which may form an openable wall. The closing member 61 may comprise a plurality of leaves, for example two leaves 61A and 61B, movable with respect to each other. In the drawing, the double arrows f61A and f61B indicate the opening and closing movement of the two leaves 61A, 61B to open and close the first suction chamber 57. Numbers 63A and 63B indicate two actuators, for example two pneumatic or hydraulic cylinder-piston actuators used to control the movement of the two leaves 61A, 61B forming the closing member 61. In other embodiments, the closing member 61 may have a different shape, for example it may comprise only one leaf or can be shaped like and openable and closable diaphragm, like an optical diaphragm.

In Figs. 5 and 6 the closing member is shown in a closed position, with the two leaves 61A and 61B forming a wall arranged in front of the exit opening 45B of the hollow member 45, at a certain distance from the edge 55B.

The distance between the exit edge 55B of the wall 55 and the surface of the leaves 61A and 61B facing the hollow member 45 is such as to leave a gap I between the exit edge 55B of the wall 55 and the closing member 61. Through the gap I, that

substantially forms an annular space surrounding the longitudinal axis A-A of the hollow member 45, the first suction chamber 57 is fluidly coupled to the inner volume 53 of the hollow body 45.

Near the exit opening 45B and the exit edge 55B, the hollow body 45 is provided with radial suction ports 65 that, together with the suction chamber 57, form part of the suction arrangement. In the illustrated embodiment, the ports 65 have a substantially circular cross-section, but this is not binding. They are constituted by through holes which extend through the whole thickness of the wall 55. The ports 65 are arranged preferably as close as possible to the exit edge 55B and, anyway, in the diverging portion 53B of the inner volume 53. The ports 65, arranged circumferentially or annularly around the longitudinal axis A-A, fluidly couple the inner volume 53 of the hollow member 45 to the first suction chamber 57.

Forks 67 may be arranged between the rollers 49 of the feeding device 47 and the entrance opening 55A of the hollow member 55; these forks can move towards and away from each other under the control of linear actuators, for example cylinder-piston actuators 69. Reference f67 indicates the opening and closing movement of the forks 67.

A pick-up member, indicated as a whole with number 71, is arranged under the hollow member 45. The pick-up member 71 is shown in two different operating positions in Figs. 3 and 4. In the illustrated embodiment, the pick-up member 71 has a stretching device which can be formed by four fingers 73 movable with respect to one another so as to take a spread-apart position and a position close to one another. In Figs. 5 and 6, the fingers 73 of the pick-up member 71 are illustrated in the close to one another, i.e. in a position of minimal distance with respect to the longitudinal axis A-A. Vice-versa in Fig. 4 the fingers 73 are shown in spread-apart position. Actuators 75 may be provided, carried for example by a plate 77, to control the spread-apart movement and the movement towards one another of the fingers 73.

In the illustrated embodiment, the pick-up member 71 also comprises a second suction chamber 79 fluidly coupled to one or more suction mouths 80. The second suction chamber 79 is carried by the plate 77.

The plate 77 forms a slide and may be provided with shoes 81 (see in particular Figs. 3 and 4) which slidably engage on linear guides 83 having a longitudinal extension substantially parallel to the longitudinal axis A-A. The movement of the slide 77 according to f77 along the guides 83 may be controlled by

means of a motor 85 (Figs. 3 and 4).

Through the movement according to the double arrow f77 of the slide 77, the pick-up member 71 can be moved from one to the other of the two positions illustrated in Figs. 3 and 4, and can be also carried in a position even lower than the one shown in Fig. 4, to load single tubular knitted articles onto the boarding forms 5 according to an operating cycle that will be described with reference to the sequence of Figs. 12A to 12S.

Figs. 7 and 8 show respectively an axonometric view and a longitudinal cross-section of a tubular boarding form 5. In the illustrated embodiment, the boarding form 5 comprises an outer sleeve 93 of substantially cylindrical shape, which can be supported, for example by means of bearings 95, on a central support 97 extending inside the sleeve 93 according to a longitudinal axis B-B of the boarding form 5. The central supports 97 of the various boarding forms 5 carried by the rotating carousel 3 can be fixed with respect to the rotating carousel 3. In advantageous embodiments, the outer sleeve 93 is integral with an inner sleeve 99 which forms a friction wheel 101, radially projecting with respect to the cylindrical sleeve 93. The support 97 is integral with a tubular body 103 with a flange 105 for anchoring the support 97 to the rotating carousel 3.

The described structure allows the sleeve 93 forming the outer surface of the boarding form 5 to rotate around the longitudinal axis B-B on the bearings 95 with respect to the inner support 97.

Coaxially to the support 97 and to the outer sleeve 93, inside the boarding form 5, and preferably inside the support 97, a stem 107 is provided, ending with an extractor 109 of flat shape, for example approximately rectangular, which can axially project from an upper closing disc 111 of the boarding form 5, fixed with respect to the support 97. The stem 107 is provided with an axial extraction and retraction movement according to the double arrow f107 to extract the extractor 109 through the closing disc 111. In some embodiments, the stem 107, which may be internally hollow, may have a lower end 107A opposite to the extractor 109, to which a feeler 115 is attached that co-acts with a cam or with an actuator that controls the movement according to the double arrow f107 for the extraction and retraction of the stem 107 and of the extractor 109.

The friction wheel 101 is configured to co-act with a driving friction wheel 121, shown in particular in Figs. 9A and 9B of the angular orientation device 12 for

angularly orienting the boarding forms 5. The friction wheel 121 is arranged in the station 11 of the boarding machine 1 and controls the rotation of each boarding form 5 around its own longitudinal rotation axis B-B in order to angularly position the outer sleeve 93 and the tubular knitted article inserted thereon with respect to the inner support 97 and thus with respect to the extractor 109. As schematically shown in Fig. 1, the station 11 comprises an optical reader or other reader schematically indicated with 123, detecting the angular position of the boarding form 5 with the tubular knitted article inserted thereon, in order to angularly orient the tubular knitted article, orienting it as required for the subsequent packing operation.

In some embodiments, the motorized friction wheel 121 can be driven into rotation by an electric motor 123, through a pair of pulleys 125, 127 and a belt 129. In some embodiments, the friction wheel 121, the motor 123 and the transmission members 125, 127, 129 are carried by a slide 131 sliding along a guide 133 radially oriented with respect to the rotating carousel 3. As can be easily understood by comparing Figs. 9A and 9B, a movement according to the double arrow f131 of the slide 131 can bring the motorized friction wheel 121 alternately in a position of contact with the friction wheel 101 of an boarding form 5 (Fig. 9A) or in a cleared position, where the motorized friction wheel 121 does not obstruct the passage of the boarding forms 5 moved along a circular trajectory by means of the rotating carousel 3 that rotates around the axis 3A according to the arrow f3.

Fig. 10 shows an axonometric view of the entrance area of the heat-treatment chamber or oven 15 arranged in the boarding station 13 of the boarding machine 1. The heat-treatment chamber 15 comprises an entrance 15A, which can be closed by flexible sheets 132 that can be deformed when the boarding forms 5 pass, so as to allow the boarding forms 5 to pass avoiding excessive heat loss through the entrance opening 15A. A similar arrangement can be provided on the opposite side where the boarding forms exit the heat-treatment chamber 15.

Pipes 134, 135 for hot air circulation, a fan 137 for hot air circulation, and a filter 139 are schematically indicated in Fig. 10. The air may be heated through electrical resistances, not shown. In some embodiments, the heat-treatment may be dry, while in other embodiments moist air or steam can be used. The time the boarding forms 5 and the tubular knitted articles remain in the heat-treatment chamber may vary depending on the temperature inside the heat-treatment chamber. For example, with temperatures in the order of about 75°-85°C, this time may be

comprised between 20 and 30 seconds.

In some embodiments, not shown, the tubular knitted article M may be moistened before entering the heat-treatment chamber 15. To this end, a specific station may be provided, for example provided with nozzles that spray atomized water onto the tubular knitted article M.

In the station 17 of the boarding machine 1 a final boarding and removing unit may be arranged for boarding and removing the tubular knitted article from the boarding forms 5, the final boarding unit removing the tubular knitted articles from the tubular boarding forms 5 after the heat-treatment in the heat-treatment chamber 15, and downloading them onto an exit conveyor 141 (Figs. 11A, 11B) which carries the boarded tubular knitted articles toward a packing machine, not shown.

Figs. 11A and 11B show the final boarding and removing unit for boarding and removing the boarded tubular knitted articles. The unit is indicated as a whole with number 151. The final boarding and removing unit 151 may comprise two conveyor belts 153, 155 controlled by a motor 157 and driven around wheels 159, 161 carried by arms 163, 165. As can be seen by comparing Figs. 11A and 11B, the arms 163 and 165 are movable, for example pivotally, in order to take a first position (Fig. 11A), where the conveyor belts 153, 155 are mutually spaced, at least in the area of the wheels 159, 161, and a closed position, where the conveyor belts 153 and 155 are close to each other at least along a substantially vertical rectilinear segment (Fig. 11b). The reciprocating pivoting movement of the arms 163 and 165 according to the double arrows f163 and f165 can be controlled by means of an actuator 169, and by means of tie rods 171, 173, connecting the two oscillating arms 163, 165 to a rotating member 175 provided with alternate reciprocating rotation movement that can be seen by comparing Figs. 11A and 11B.

As shown in broken line in Fig. 11A, each boarding form 5 passes under the final boarding and removing unit 151 with the extractor 109, extending between the arms 163, 165, in extracted position. When a tubular knitted article is inserted onto the boarding form 5 and partially lifted by the extractor 109, the closure of the arms 163, 165 causes the movement of the conveyor belts 153, 155 towards the extractor 109 and the tubular knitted article is thus pinched and pressed between the extractor 109 and the two conveyor belts 153, 155. The subsequent actuation of the conveyor belts according to the double arrows f153 and f155 causes the removal of the tubular knitted article from the boarding form 5 and the feeding thereof towards the exit

conveyor 141. Since the tubular knitted article is still hot due to the heat-treatment in the heat-treatment chamber 15, the pressure of the two conveyor belts 153, 155 boards and stabilizes the fold of the tubular knitted article before it is downloaded onto the exit conveyor 141.

Having described the main members of the boarding machine 1, with reference to the sequence of Figs. 12A- 12S, a work cycle will be now described in detail for loading a tubular knitted article onto an boarding form 5, which will move the tubular knitted article through the stations 11-13 and 17, for boarding the tubular knitted article and removing it from the boarding form 5 in order to deliver it to the packing machine.

Figs. 12A to 12G illustrate the sequence of inserting a tubular knitted article into the pneumatic pipe 7 and of feeding the tubular knitted article along the pneumatic pipe 7 up to the opening device 43 for opening the elastic edge of the tubular knitted article.

In Fig. 12A, the tubular knitted article is schematically indicated with M. It has a closed toe P at a first end and an elastic edge E at a second end. In some embodiments, on the tubular knitted article M writing or other elements can be provided in a given position with respect to the shape of the tubular knitted article M. These elements are schematically indicated with S. The tubular knitted article M can be a sock or a stocking, which may have a heel T. The angular orientation elements S have a predetermined position with respect to the shape of the toe P and the position of the heel T, if any.

The tubular knitted article is inserted, for example manually, into the entrance end 7A and is sucked inside the pneumatic pipe 7. In this operating phase, the first gate 21 is in open position, the first air intake 23 is closed by means of the gate 23A, while the first suction mouth 27 is open and air is sucked (arrow A) through said first suction mouth 27, so as to generate an air flow C1 flowing from the entrance end 7A up to the suction mouth 27.

When the tubular knitted article M is inserted at the entrance end 7A, it is drawn due to the suction effect towards the first suction mouth 27. The passage sensor 25 detects passage of the tubular knitted article M and causes the closing of the gate 21, the opening of the first air intake 23 and, after a given time, the stopping of the suction through the first suction mouth 27. The tubular knitted article M continues its movement along the pneumatic pipe 7 due to inertia after the closing of

the first suction mouth 27, beyond the point where the latter is arranged, to enter (as shown in Fig. 12C) in the pneumatic pipe portion between the first suction mouth 27 and the closing gate 29 that, in this step, is closed. The gate 29 is subsequently opened, and the tubular knitted article passes through the gate 29 to pass beyond the second passage sensor 33, which generates a signal when the tubular knitted article M passes, said signal causing the first air intake 23 and of the gate 29 to close (see Fig. 12E). Also the second air intake 31 is opened by opening the gate 31A. The tubular knitted article M continues its travel towards the device 43 due to inertia up to the device 43, arranging itself in the end part of the tubular connection 7C (Fig. 12F).

In the first section of the pneumatic pipe 7, upstream of the gate 29, a second tubular knitted article M can enter, as described above, which will be arranged to be subsequently fed to the device 43, when the elastic edge of the already introduced tubular knitted article M has been opened and the article removed from the device 43.

In Fig. 12G suction has been activated through the branch 35 of the pneumatic pipe 7 by opening the gate 39 and generating in this way an air flow represented by the arrow A in Fig. 12G. Air flow A stretches the tubular knitted article M upstream of the rollers 49 of the device 43. In fact, when the tubular knitted article arrives in the lower part of the tubular connection 7C, the elastic edge E thereof is caught in the nip between the rollers 49, the rotation whereof (arrow f49 in Fig. 12H) causes the forward movement of the tubular knitted article, and in particular of the elastic edge E thereof, up and beyond the nip between the rollers 49, downstream whereof a photocell or other sensing member 191 is provided.

When the elastic edge E of the tubular knitted article M covers the photocell 191, the signal from the photocell causes the suction activation through the branch 35 and the second suction mouth 41, so as to stretch upward the portion of the tubular knitted article M tube upstream of the nip between the rollers 49.

When the tubular knitted article M is stretched due to the suction effect (arrow A in Figs. 12H and 12I), the suction through the first suction chamber 57 can be activated. Continuing the rotation of the rollers 49 according to the arrow f49, the elastic edge E of the tubular knitted article M moves forwards towards the inner volume of the hollow body 45, as shown in the following Fig. 12J. In order to facilitate this forward movement of the elastic edge E, air is sucked through the

suction mouths 58, the first suction chamber 57, the ports 65, the gap I, the inner volume 53 of the hollow body 45, and the entrance opening 45A, as shown by the arrows A1 in Fig. 12J.

The air flow generated in the inner volume 53 of the hollow body 45 causes stretching or opening of the elastic edge E of the tubular knitted article M, which moves gradually forwards inside the hollow body 45.

Fig.12K shows the effect of the forward movement of the tubular knitted article M with its elastic edge E toward the exit opening 45B of the hollow body 45, under the effect of the continuous suction through the first suction chamber 57, the radial ports 65 and the gap I. This suction causes the elastic edge E to adhere initially to the inner surface of the diverging portion 53B of the inner volume 53 of the hollow body 45, and subsequently to enter the gap I.

When the tubular knitted article M with its elastic edge E is arranged as illustrated in Fig. 12K, the radial suction ports 65 are substantially closed by the fabric of the tubular knitted article and the annular gap I is at least partially blocked by the fabric of the elastic edge E. Consequently, the suction inside the first suction chamber 57 causes a pressure drop, which is detectable by a vacuum switch (not shown). When the vacuum switch detects a certain degree of vacuum, i.e. a pressure lower than the atmospheric pressure in the first suction chamber 57, this means that the tubular knitted article M is properly arranged as shown in Fig. 12K, blocking for the most part the gap I and the radial suction ports 65. When the under-pressure has been achieved inside the suction chamber 57, suction can be interrupted.

In the next step shown in Fig. 12L, the rollers 49 stop rotating, keeping in the nip therebetween the end part, i.e. the part adjacent to the toe P, of the tubular knitted article M. The closing member 61 is opened and, continuing the suction through the first suction chamber 57, air begins to enter from the outside, according to the arrows A3, through the air passage opened by the moving away of the leaves 61A, 61B forming the closing member 61. This causes the elastic edge E, brought into contact with the wall 55 of the hollow body 45, to remain adhering to the exit edge 55B of the wall 55.

In the next step, shown in FIG. 12M, the pick-up device 71 is lifted to bring the fingers 73 thereof partially inside the inner volume 53 of the hollow body 45, passing through the exit opening 45B. Conveniently, the fingers 73 may be so shaped as to have a distal tapered portion, which can be easily inserted into the diverging

portion 53B of the inner volume 53 of the hollow body 45. By lifting the pick-up member 71 in the position shown in Fig. 12M, the second suction chamber 79 is fluidly coupled to the first suction chamber 57 and to the inner volume 53 of the hollow body 45 through a suction inlet of the second suction chamber.

At this point, air suction through suction mouths 80 can be initiated. The air flow, represented by the arrows A4 in Fig. 12N, flows through the inner volume 53 of the hollow body 45 entering through the entrance opening 45A, exits the inner volume 53 of the hollow body 45 through the exit opening 45B, enters the second suction chamber 79 and exits through the suction mouths 80. The air flow that is generated in the narrow passage left between the inner surface of the wall 55 of the hollow body 45 and the fingers 73 draws the tubular knitted article M detaching it from the exit edge 55B and bringing the elastic edge E of the tubular knitted article M to surround the fingers 73 and to slide along them until it reaches the position shown in Fig. 12N. The air flow A4 required for this purpose is conveyed towards the bottom of the second suction chamber 79 by means of a collar 82 approximately coaxial with the fingers 73 of the pick-up member 71, wherein said collar 82 extends toward the bottom of the suction chamber 79 partially covering the suction mouths 80 so that the air flow A4 flows along the pin formed by the fingers 73 adjacent to one another and generates the force required to insert the elastic edge E of the tubular knitted article M onto the fingers 73 that are adjacent to one another.

Figure 12O is an axonometric view of the device 43 with the pick-up member 71 in this operating step. Fig. 12P shows the next step, wherein the closing member 61 returns in the closed position after the pick-up member has started its downward movement (arrow f71 in Fig. 12P), removing the fingers 73 from the inside of the hollow body 45. At this point, a next tubular knitted article M1 can enter the nip between the rollers 49, which start again to rotate to initiate a new processing cycle, while the tubular knitted article M inserted onto the fingers 73 of the pick-up member 71 can be brought downwards and loaded onto an boarding form 5 which is positioned coaxial to the device 43 and the pick-up member 71.

Fig. 12Q schematically shows an boarding form 5 in a position coaxial to the pick-up member 71, the fingers 73 whereof have been spread-apart.

Continuing its downward movement according to arrow f71, the pick-up member 71 loads the tubular knitted article M onto the boarding form 5, having previously opened the fingers 73. The fingers are arranged at such a mutual distance

as to allow the insertion of the tubular form 5 between the four spread-apart fingers 73. By continuing the lowering movement of the pick-up member 71 according to the arrow f71, the fingers 73 are removed from the tubular knitted article M, which is gradually loaded onto the boarding form 5, until the position of Fig. 12R is achieved. Now the tubular knitted article M is completely loaded onto the boarding form 5, and the pick-up member 71 with the fingers 73 is below the elastic edge E of the tubular knitted article M loaded onto the upper part of the boarding form 5.

Fig. 12S is an axonometric view of the device 43 with the pick-up member 71 and the boarding form 5 in the position achieved in this step. At this point, movement of the pick-up member 71 can be reversed, and can be brought to a level above the distal end of the boarding form 5. This latter can thus move angularly, drawn by the rotating carousel 3 towards the subsequent angular orientation station 11. In the station 11, by means of the friction wheel 101 integral with the outer sleeve 93 of the boarding form 5 and the motorized friction wheel 121 (Figs. 9A and 9B), the tubular knitted article M can be rotated, together with the external sleeve 93 of the boarding form 5, so as to bring the tubular knitted article M in the desired angular position with respect to the extractor 109. In this step, the extractor is completely withdrawn inside the boarding form 5, below the upper surface of the disc 111. The angular orientation may be also performed in a step following boarding inside the heat-treatment chamber 15.

In the sequence described with reference to Figs. 12A-12S it has been observed that the correct and complete opening of the elastic edge E, as well as the adhesion thereof to the inner surface of the wall 55 of the hollow member 45, is determined by detecting the pressure in the first suction chamber 57. If the tubular knitted article fails to position itself correctly, i.e. if the elastic edge E thereof does not properly cover the suction ports 65 and/or is not inserted in the gap I, inside the first suction chamber 57 there will not be a sufficient degree of vacuum, i.e. a sufficient negative pressure with respect to the external ambient pressure. This condition is detected by the vacuum switch (not shown).

Since the stretching, i.e. the opening of the elastic edge E of the tubular knitted article M up to close the suction ports 65 and the gap I requires a certain time, if the pressure within the first suction chamber 57 does not decrease below a predetermined threshold within a given time interval, this is interpreted by a control unit (not shown) of the boarding machine 1 as a non-opening or a partial opening of

the elastic edge E of the tubular knitted article M; consequently, a procedure is initiated for repeating the opening, or a discharge cycle for discharging the tubular knitted article which has not been properly opened.

In the first case (repeating of the opening operations), the rotational motion of the rollers 49 is reversed to bring the elastic edge E of the tubular knitted article M back at the level of the photocell 191 and the cycle described with reference to the sequence of Figs. 12H to 12S is repeated.

Alternatively, or if, despite the repetition of the opening operations, a fail in the opening and stretching of the elastic edge E of the tubular knitted article M is detected, the tubular knitted article M which has been not properly opened can be discharged. This may occur according to the sequence illustrated in figures 13A-13E.

Fig. 13A schematically shows a situation in which the tubular knitted article has not been properly arranged inside the hollow member 45. The elastic edge E of the tubular knitted article M has adhered to only a portion of the inner surface of the wall 55 of the hollow body 45, blocking only some of the suction ports 65 and only a part of the gap I. Inside the suction chamber 57 the necessary vacuum degree, which is required for the subsequent loading the tubular knitted article M onto the boarding form 5, has not been generated. Consequently, the motion of the rollers 49 is firstly stopped and then reversed, as shown by the arrows f49X in Fig. 13B. Simultaneously, suction through the second suction mouth 41 is actuated by opening the gate 39. The air flow, indicated by the arrow A6, which is generated in the tubular connection 7C, draws the tubular knitted article M upwards once this latter has been released by the rollers 49. The air flow A6 draws the tubular knitted article M inside the discharge bell 37. From here, the tubular knitted article is removed by interrupting the suction by closing the gate 39. Due to the weight of the tubular knitted article M, a bottom closing door 37A of the discharge bell 37 is opened, thus discharging the tubular knitted article M, for example into a container below (not shown).

While the disclosed embodiments of the subject matter described herein have been shown in the drawings and fully described above with particularity and detail in connection with several exemplary embodiments, it will be apparent to those of ordinary skill in the art that many modifications, changes, and omissions are possible without materially departing from the novel teachings, the principles and concepts set forth herein, and advantages of the subject matter recited in the appended claims.

Hence, the proper scope of the disclosed innovations should be determined only by the broadest interpretation of the appended claims so as to encompass all such modifications, changes, and omissions.

CLAIMS

1. A device (41) for opening an elastic edge (E) of a tubular knitted article (M), comprising a hollow body (45) comprised of: a wall (55) surrounding an inner volume (53), an entrance opening (45A) for the insertion of a tubular knitted article (M), and an exit opening (45B) for the extraction of the tubular knitted article (M); wherein the entrance opening (45A) and the exit opening (45B) are approximately coaxial and spaced along a longitudinal axis (A-A) of the hollow body (45); wherein the wall (55) defines a converging portion (53A) and a diverging portion (53B) of the inner volume (53) of the hollow body (45); and wherein the converging portion (53A) is arranged between the entrance opening (45A) and the diverging portion (53B); characterized in that a suction arrangement surrounding the longitudinal axis (A-A) of the hollow body (45) is associated with the exit opening (45B) of the hollow body (45); the suction arrangement comprises a plurality of suction ports (65) in the diverging portion (45B) of the inner volume (53) of the hollow body (45) and arranged annularly around the longitudinal axis (A-A) of the hollow body (45); a closing member (61A, 61B) is arranged in front of the exit opening (45B) of the hollow body (45) and spaced therefrom; a suction gap (I) being defined between the closing member (61A, 61B) and the hollow body (45) when the closing member (61A, 61B) is in a closed arrangement.

2. Device according to claim 1, wherein the suction ports (65) are arranged adjacent the exit opening (45B) of the hollow body (45).

3. Device according to claim 1 or 2, wherein the suction arrangement further comprises a first suction chamber (57) at least partially surrounding the hollow body (45).

4. Device according to claim 3, wherein the first suction chamber (57) is fluidly coupled to the inner volume (53) of the hollow body (45) through the suction ports (65).

5. Device according to claim 3 or 4, wherein the closing member (61A, 61B) is configured and arranged so as to selectively open and close an air passage of the first suction chamber (57), and wherein the suction gap (I) is arranged and configured to place the inner volume (53) of the hollow body (45) in fluid

communication with the first suction chamber (57).

6. Device according to claim 5, wherein the air passage of the first suction chamber (57) is approximately coaxial with the hollow body (45).

7. Device according to one or more of the previous claims, further comprising a pick-up member (71) to take the tubular knitted article (M) from the hollow body (45) by engaging the elastic edge (E) of the tubular knitted article (M).

8. Device according to claim 7, wherein the pick-up member (71) and the hollow body (45) are movable with respect to each other according to a direction parallel to the axis (A-A) of the hollow body (45), so as to at least partially introduce the pick-up member (71) in the hollow body (45) through the exit opening (45B) and to extract it from said hollow body (45).

9. Device according to claim 7 or 8, wherein the pick-up member (71) comprises a stretching device including a plurality of fingers (73) movable with respect to one another so as to take a spread-apart position and a position close to one another.

10. Device according to one or more of claims 7 to 9, wherein the pick-up member (71) comprises a second suction chamber (79) with a suction opening configured and arranged so as to be put in fluid communication with the inner volume of the hollow body (45).

11. Device according to claim 9 and 10, wherein the second suction chamber (79) at least partially surrounds the stretching device.

12. Device according to one or more of claims 7 to 11, wherein the pick-up member (71) is carried by a slide (77) movable along a guide (83) parallel to the longitudinal axis (A-A) of the hollow body (45).

13. Device according to one or more of the previous claims, further comprising a feeding device (47) arranged in front of the entrance opening (45A) of the hollow body (45).

14. Device according to claim 13, wherein the feeding device (47)

comprises a pair of rollers (49) with axes (49A) substantially parallel to each other and transverse to the longitudinal axis (A-A) of the hollow body (45), at least one of the rollers being motorized.

15. Device according to claim 14, wherein the axes (49A) of the rollers (49) are oriented substantially at 90° with respect to the longitudinal axis (A-A) of the hollow body (45).

16. A machine for boarding tubular knitted articles, comprising:

- a device (43) for opening the elastic edge (E) of the tubular knitted articles (M) according to one or more of the previous claims;
- at least one boarding form (5), configured to receive a tubular knitted article from said device (43).

17. Machine according to claim 16, further comprising a pneumatic pipe (7) to feed the tubular knitted articles (M) towards the hollow body (45) of said device (43).

18. Machine according to claim 17, wherein the pneumatic pipe (7) comprises an entrance end (7A) for the tubular knitted articles (M) and an exit (7C) for the tubular knitted articles (M), and is subdivided into a plurality of sections that can be pneumatically separated from one another, so as to receive therein a plurality of tubular knitted articles in sequence.

19. Machine according to one or more of claims 16 to 18, wherein the device (43) for opening the elastic edge (E) of the tubular knitted article (M) comprises a pick-up member (71), configured and arranged to be arranged coaxially with the boarding form (5) and to translate parallel to the boarding form (5), so as to release a tubular knitted article (M) on the boarding form.

20. A method for opening an elastic edge (E) of a tubular knitted article (M), comprising the following steps:

- inserting a tubular knitted article (M) with the elastic edge (E) inside a hollow body (45) comprising: a wall (55) surrounding an inner volume (53), an entrance opening (45A) for inserting the tubular knitted article (M), and an exit opening (45B) for extracting the tubular knitted article (M), the entrance

opening (45A) and the exit opening (45B) being approximately coaxial and spaced along a longitudinal axis (A-A) of the hollow body (45); the inner volume (53) having a converging portion (53A) and a diverging portion (53B), the converging portion (53A) being arranged between the entrance opening (45A) and the diverging portion (53B);

- generating an air flow from the inner volume (53) towards the outside of the hollow body (45) in the area of the exit opening (45B), through a plurality of suction ports (65) arranged annularly around the longitudinal axis (A-A) of the hollow body (45), in the diverging portion (45B) of the inner volume (53), and through a suction gap (I) provided between the hollow body (45) and a closing member (61A, 61B) arranged in front of the exit opening (45B) of the hollow body; the air flow annularly sucking the elastic edge (E) of the tubular knitted article (M), thus causing the elastic edge (E) to be stretched and adhere to the wall (55) of the hollow body (45) adjacent to the exit opening (45B).

21. Method according to claim 20, wherein the step of generating an air flow from the inner volume (53) towards the outside of the hollow body (45) in the area of the exit opening (45B) comprises the following steps:

- arranging a first suction chamber (57) at least partly surrounding the hollow body (45) in fluid communication with the inner volume (53) of the hollow body (45) through the suction gap (I) and the suction ports (65);
- generating suction in the first suction chamber thus generating the air flow though the suction ports (65) and the suction gap (I).

22. Method of claim 20 or 21, further comprising the step of drawing the elastic edge (E) in the suction gap (I) by means of the air flow.

23. Method according to claim 20, 21 or 22, further comprising the following steps:

- arranging a pick-up member (71) approximately coaxially with the hollow body (45);
- generating an air flow from the inner volume (53) of the hollow body (45) through the exit opening (45B) towards the pick-up member (71);
- through the air flow from the inner volume (53) of the hollow body (45) towards the pick-up member (71), releasing the elastic edge (E) of the tubular

knitted article (M) from the hollow body (45) and drawing the elastic edge (E) from the hollow body (45) onto the pick-up member (71).

24. Method according to claim 23, wherein the step of arranging the pick-up member (71) approximately coaxial with the hollow body (45) comprises the step of inserting the pick-up member (71) at least partially inside the hollow body (45) through the exit opening (45B).

25. Method according to claim 24, wherein the pick-up member (71) comprises a stretching device including a plurality of fingers (73) movable with respect to one another so as to take a stretched position and a position close to one another, and wherein the method comprises the step of spreading the fingers (73) apart thus stretching the elastic edge (E) of the tubular knitted article (M).

26. Method according to claim 24 or 25, further comprising the step of transferring the tubular knitted article (M) to an boarding form by means of the pick-up member (71).

27. Method according to claim 26, wherein the step of transferring the tubular knitted article (M) onto the boarding form (5) comprises the step of translating the pick-up member (71) parallel to the boarding form (5) thus removing the tubular knitted article (M) from the pick-up member (71).

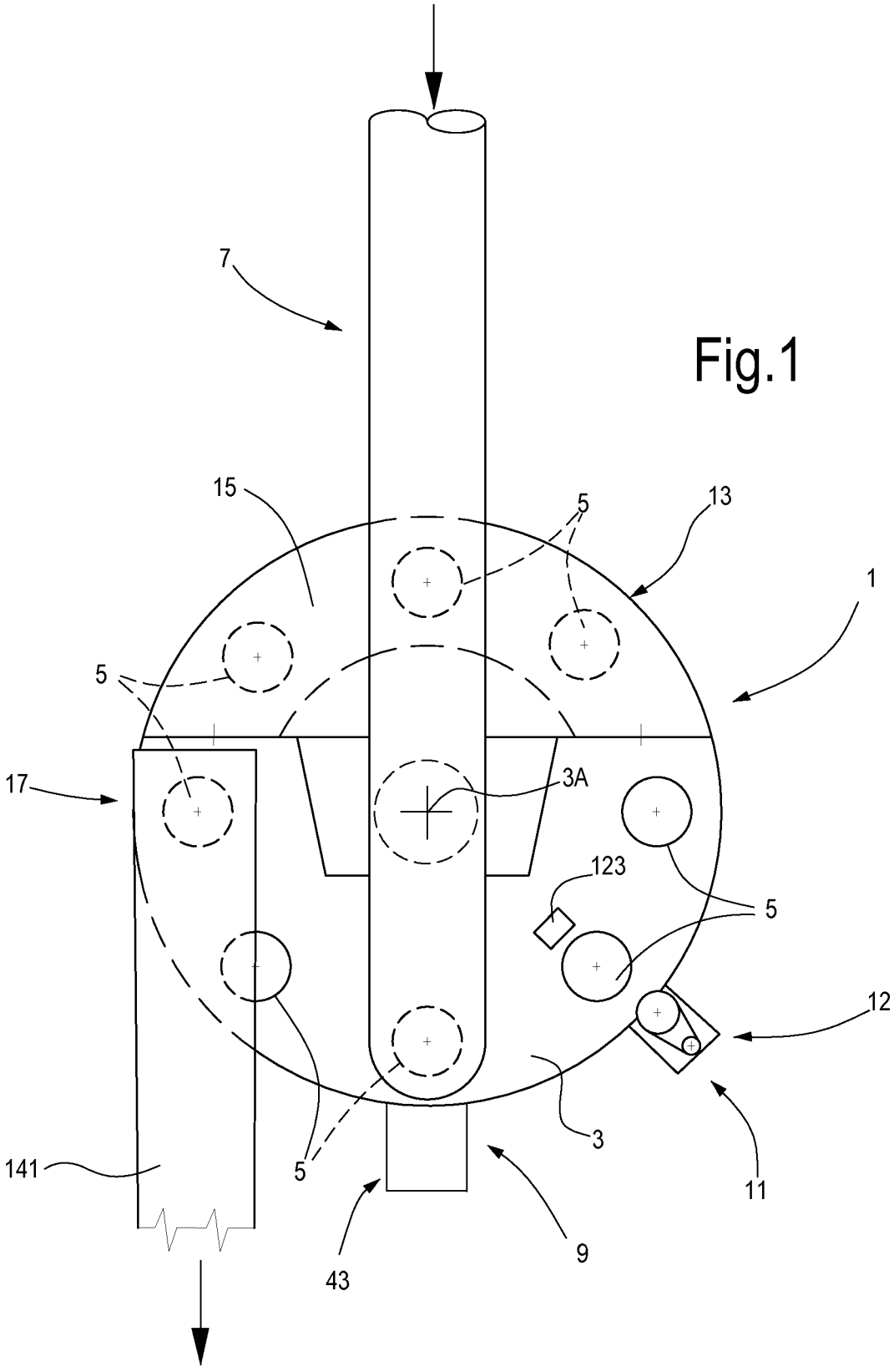

Fig.1

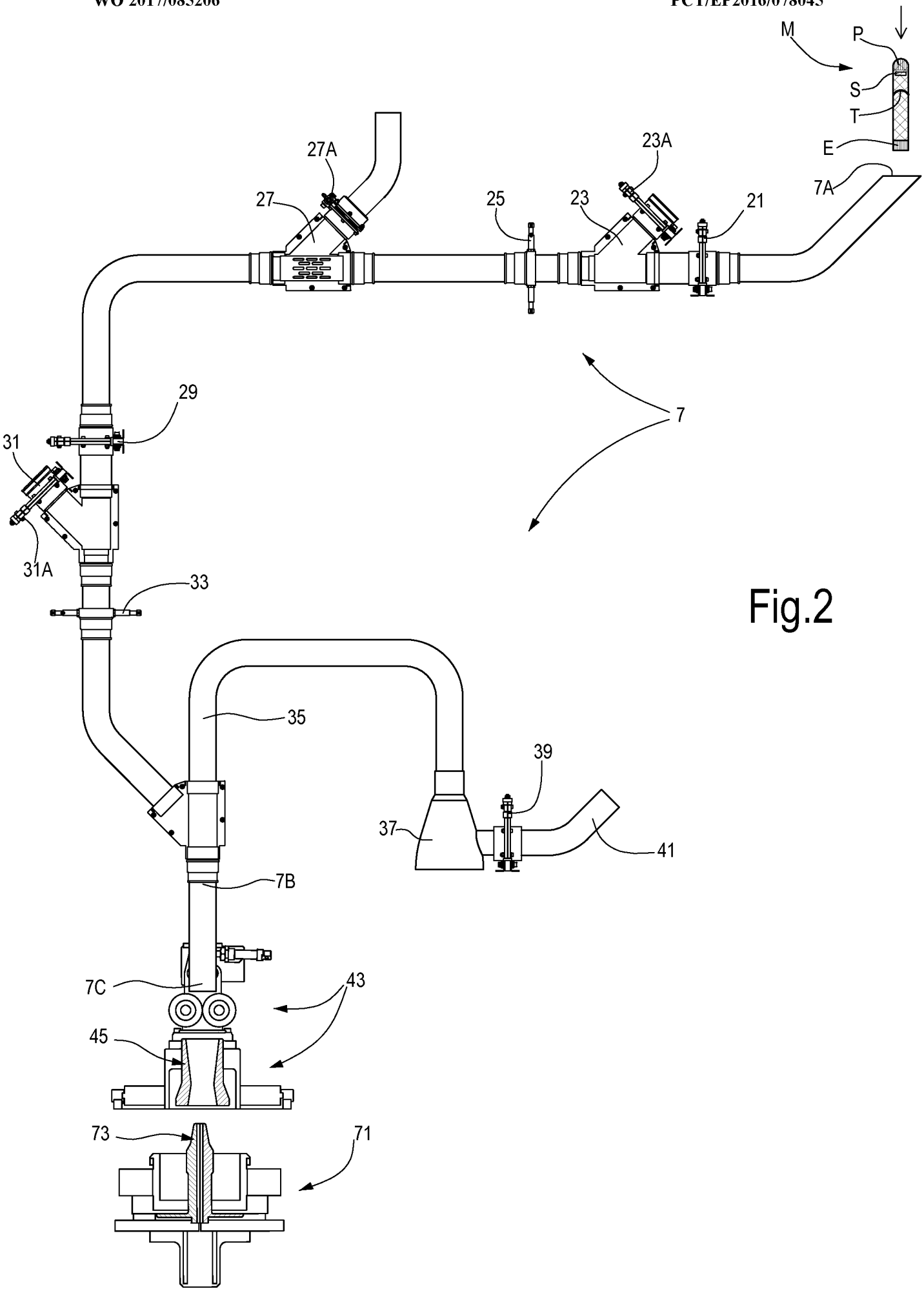
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Fig.2

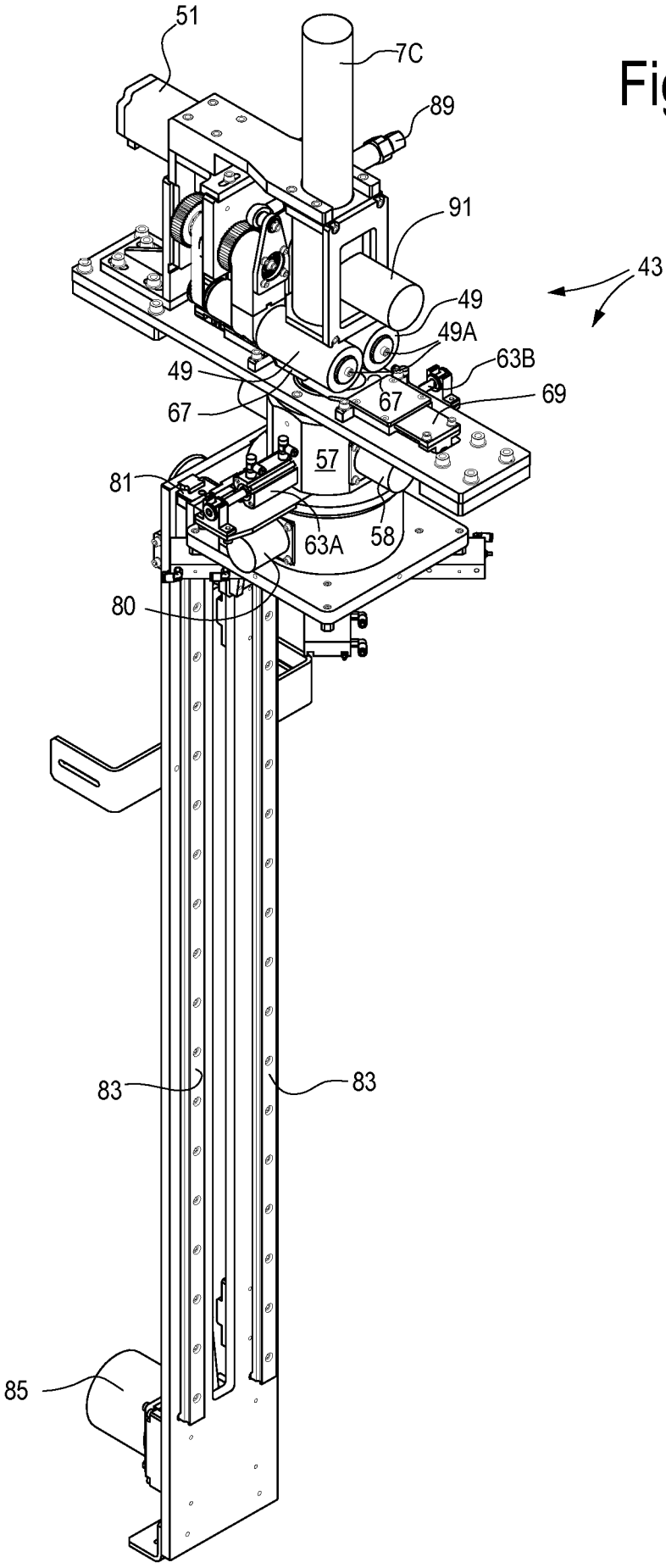

Fig.3

Fig.4

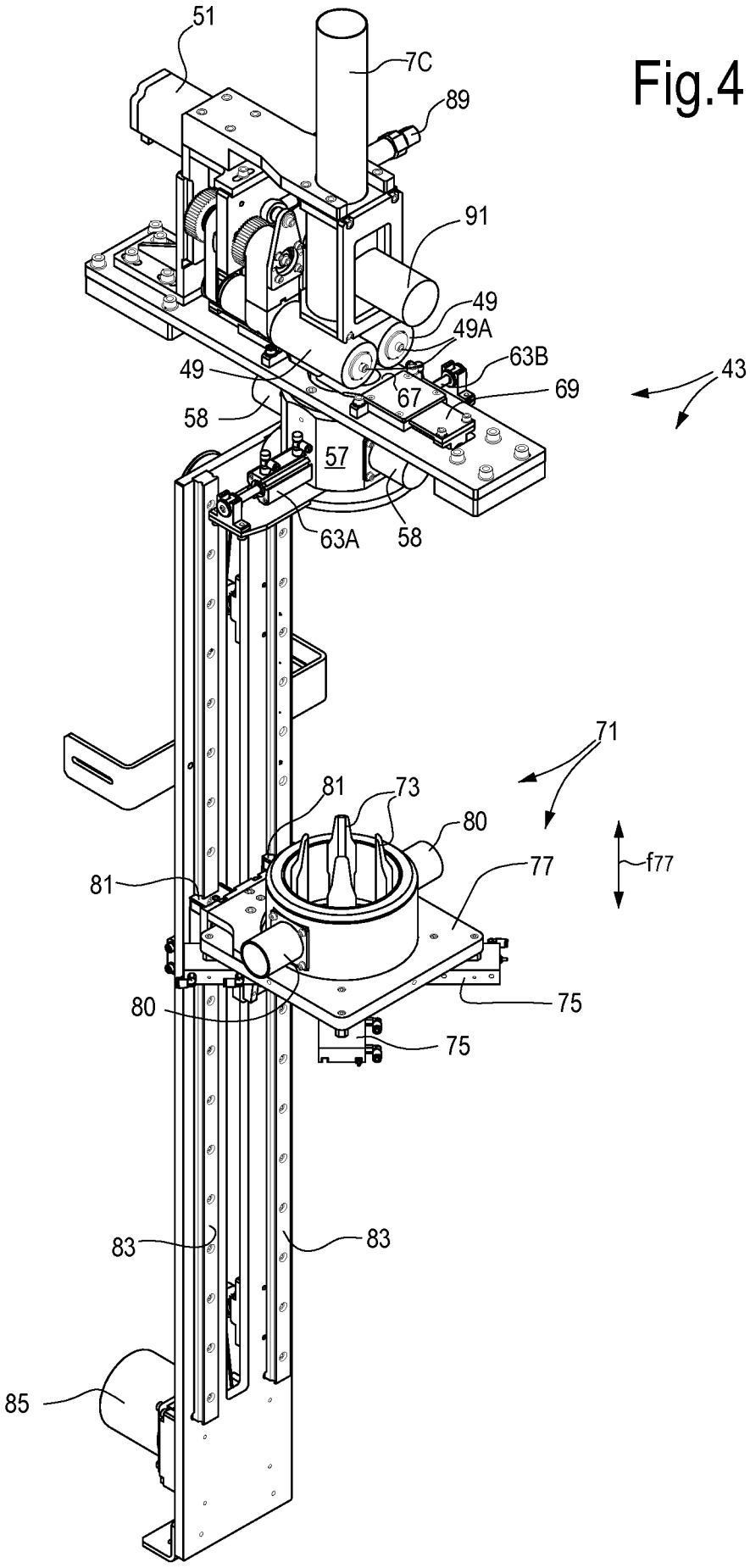
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Fig.5

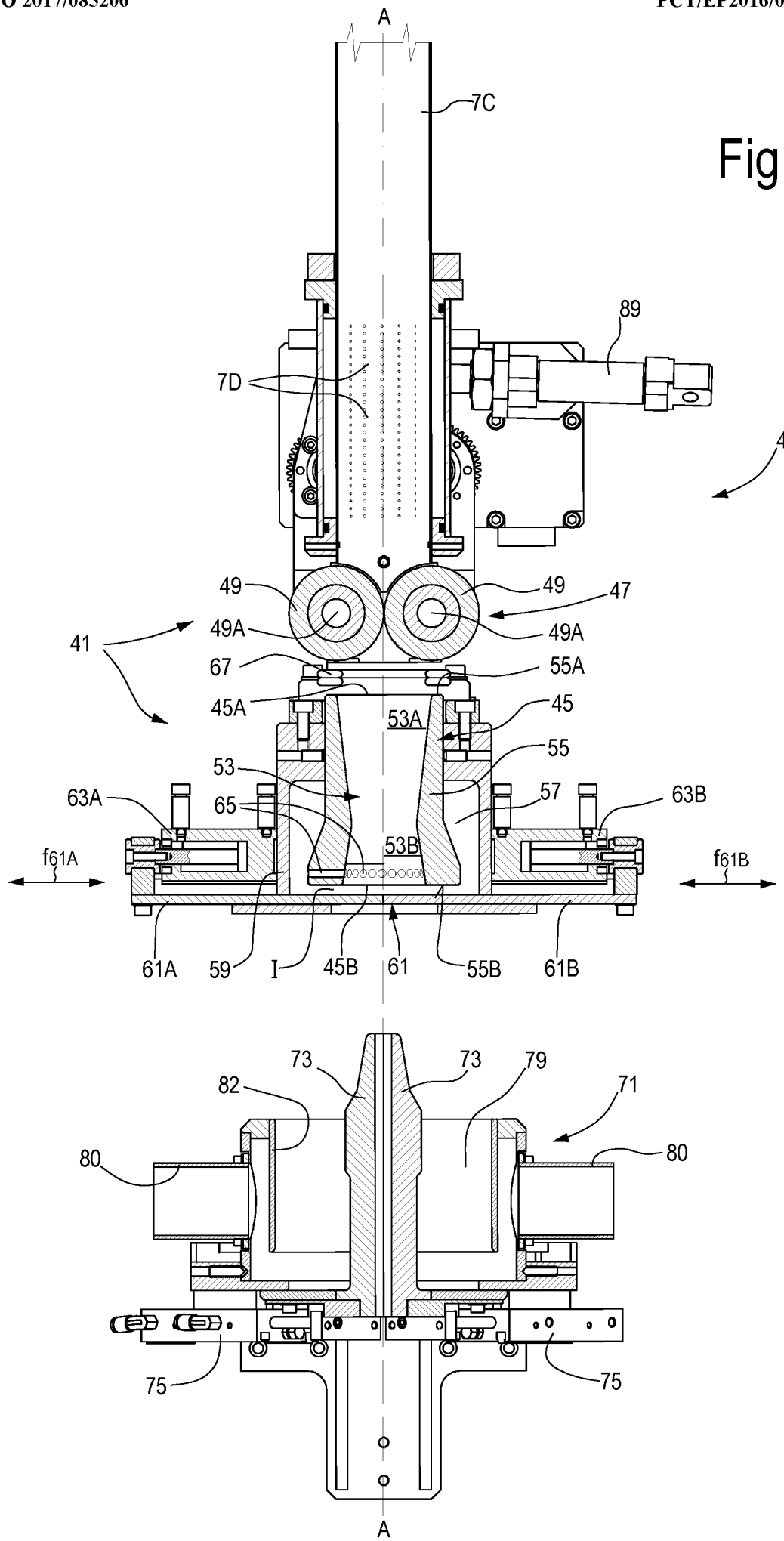
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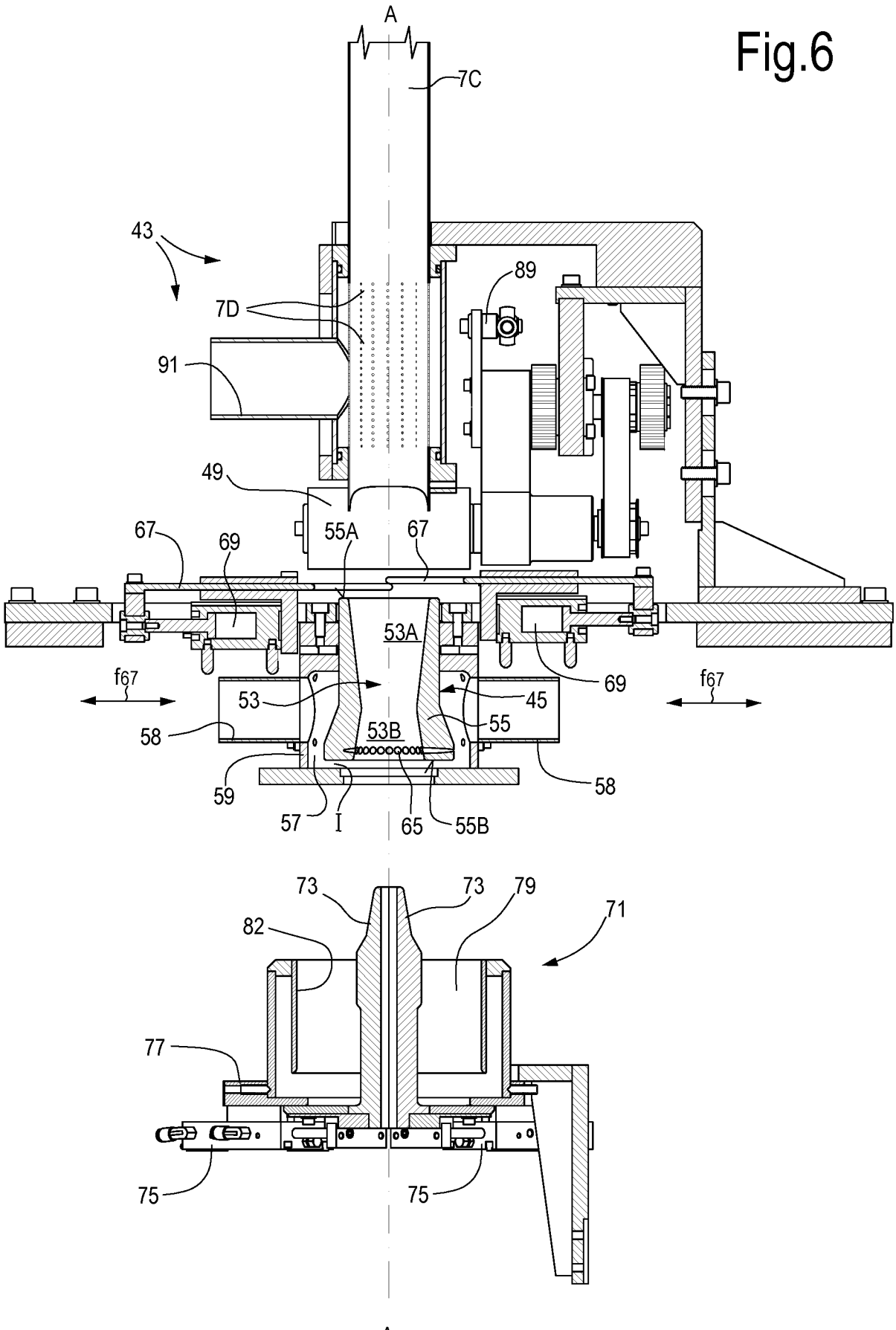
Fig.6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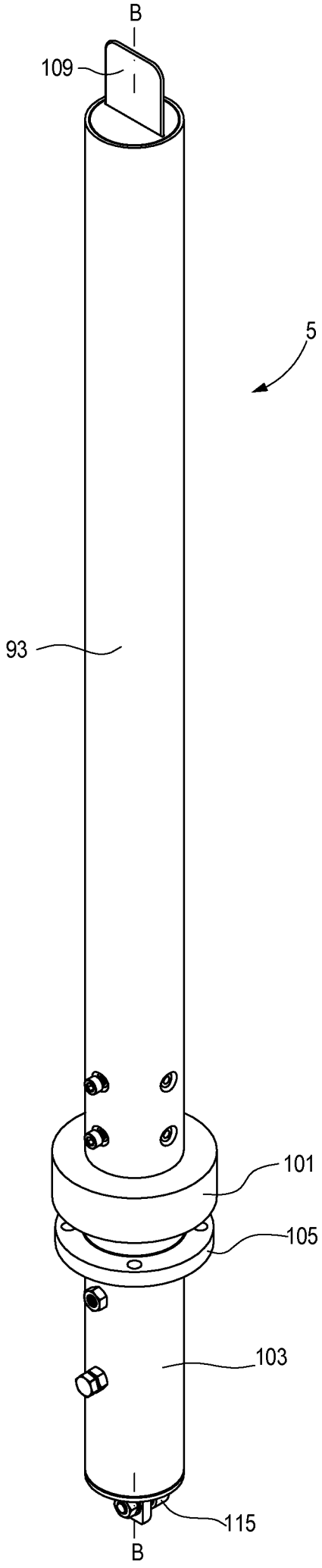

Fig.7

Fig.8A

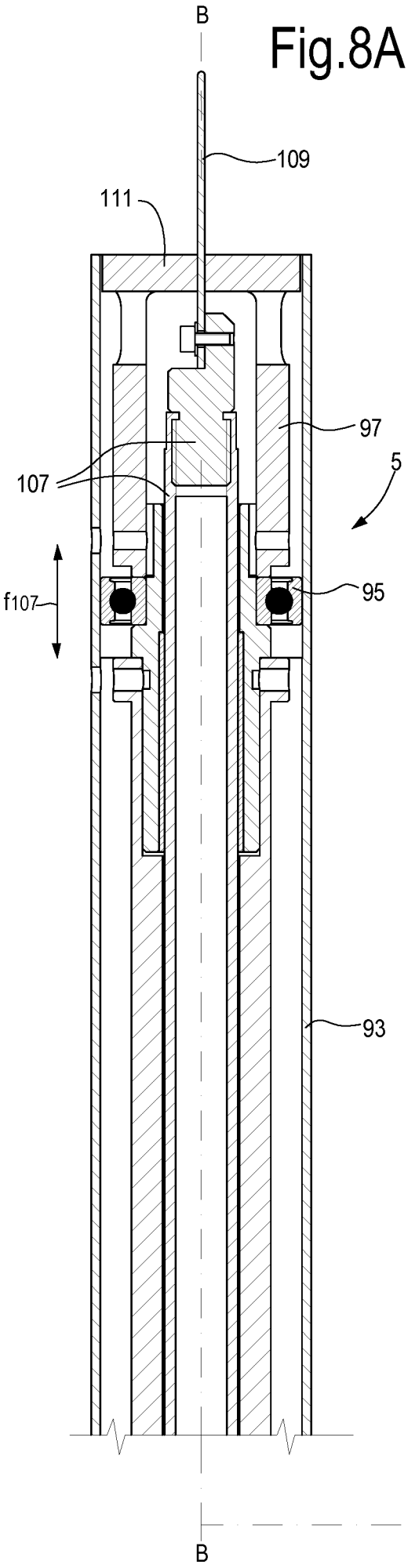
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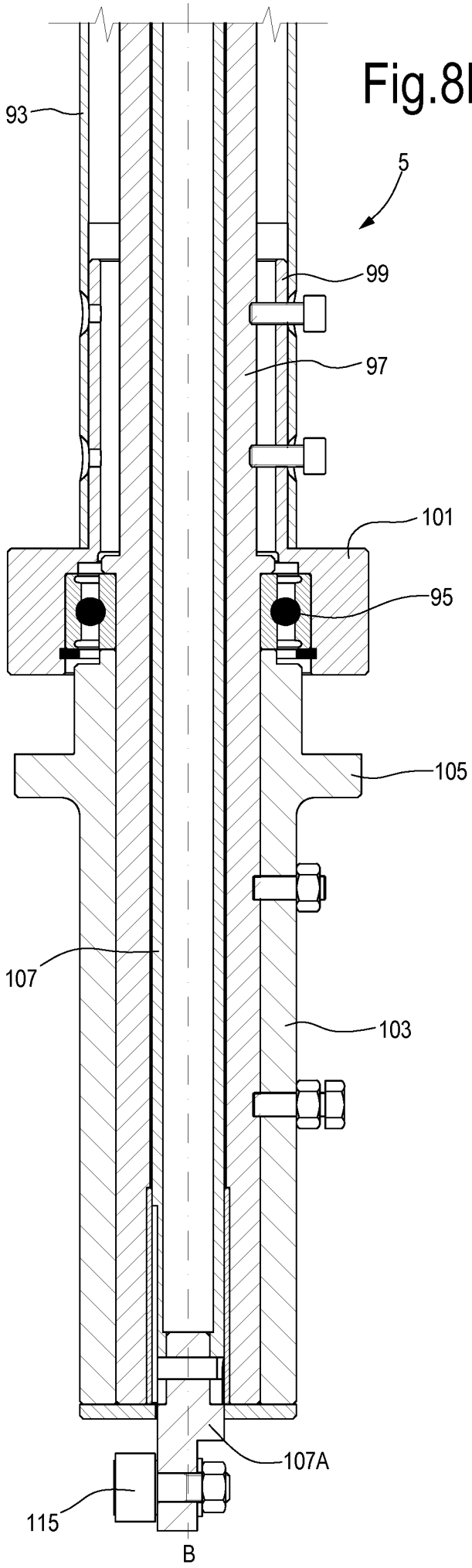
Fig.8B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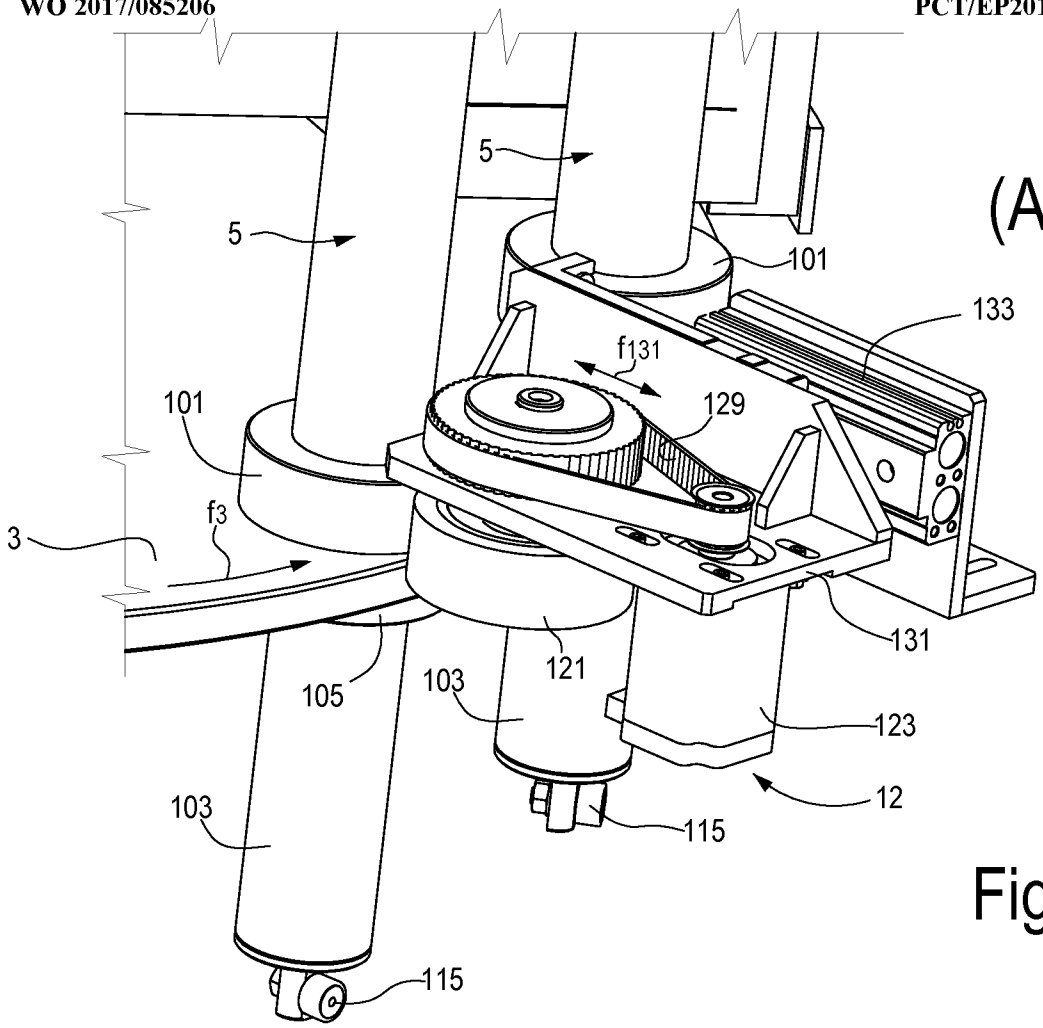
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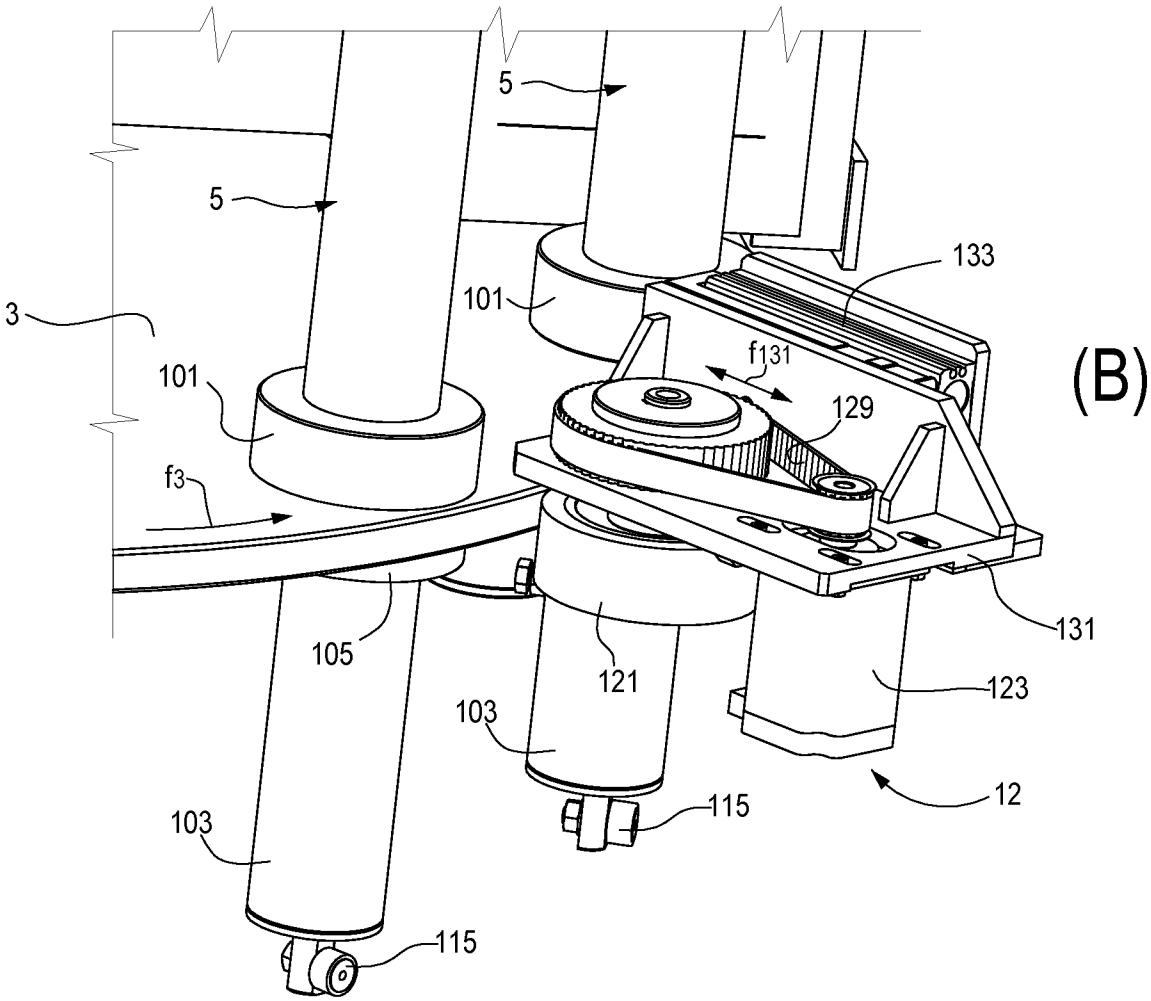
Fig.9


(B)
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115

Fig.10

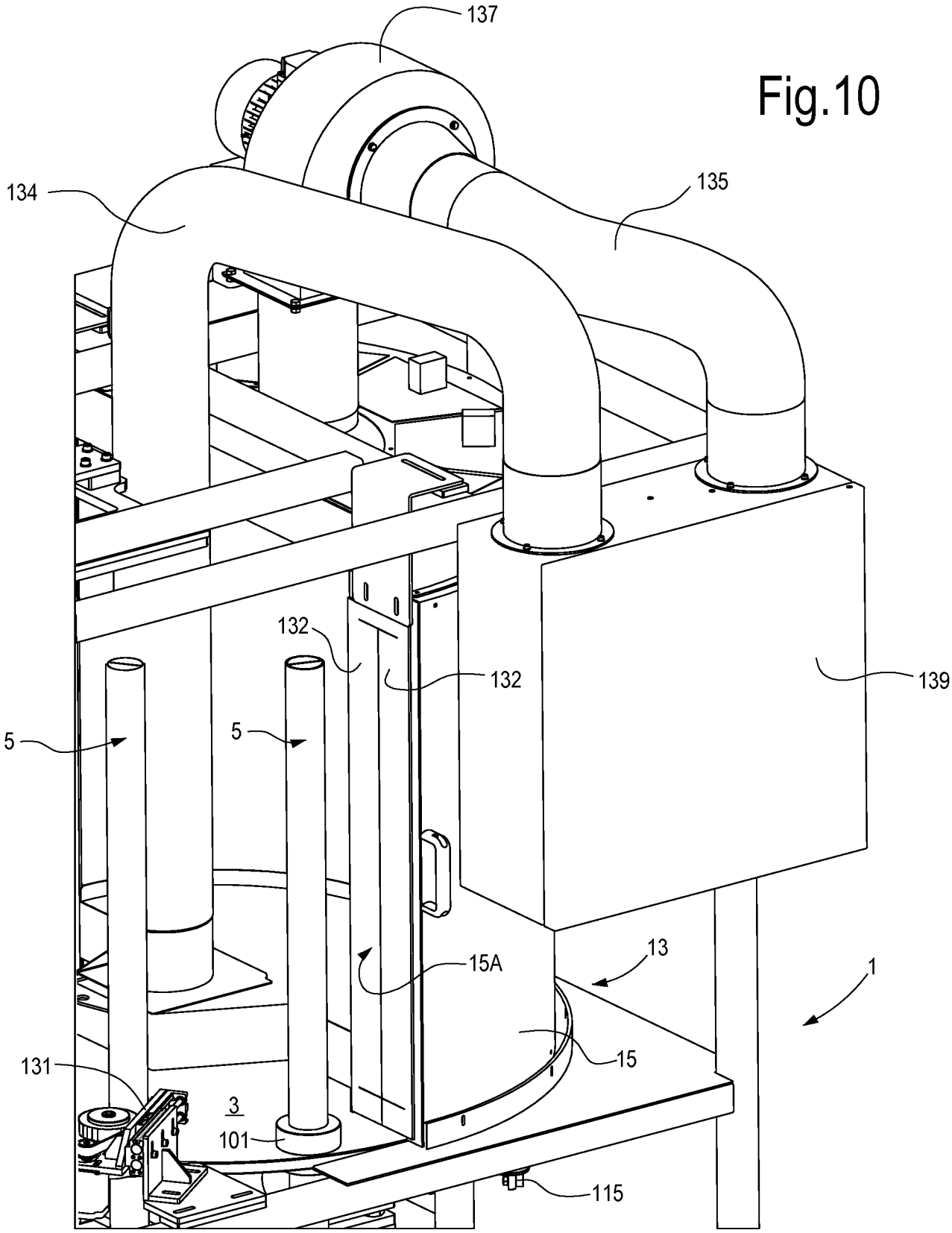

Fig.11A

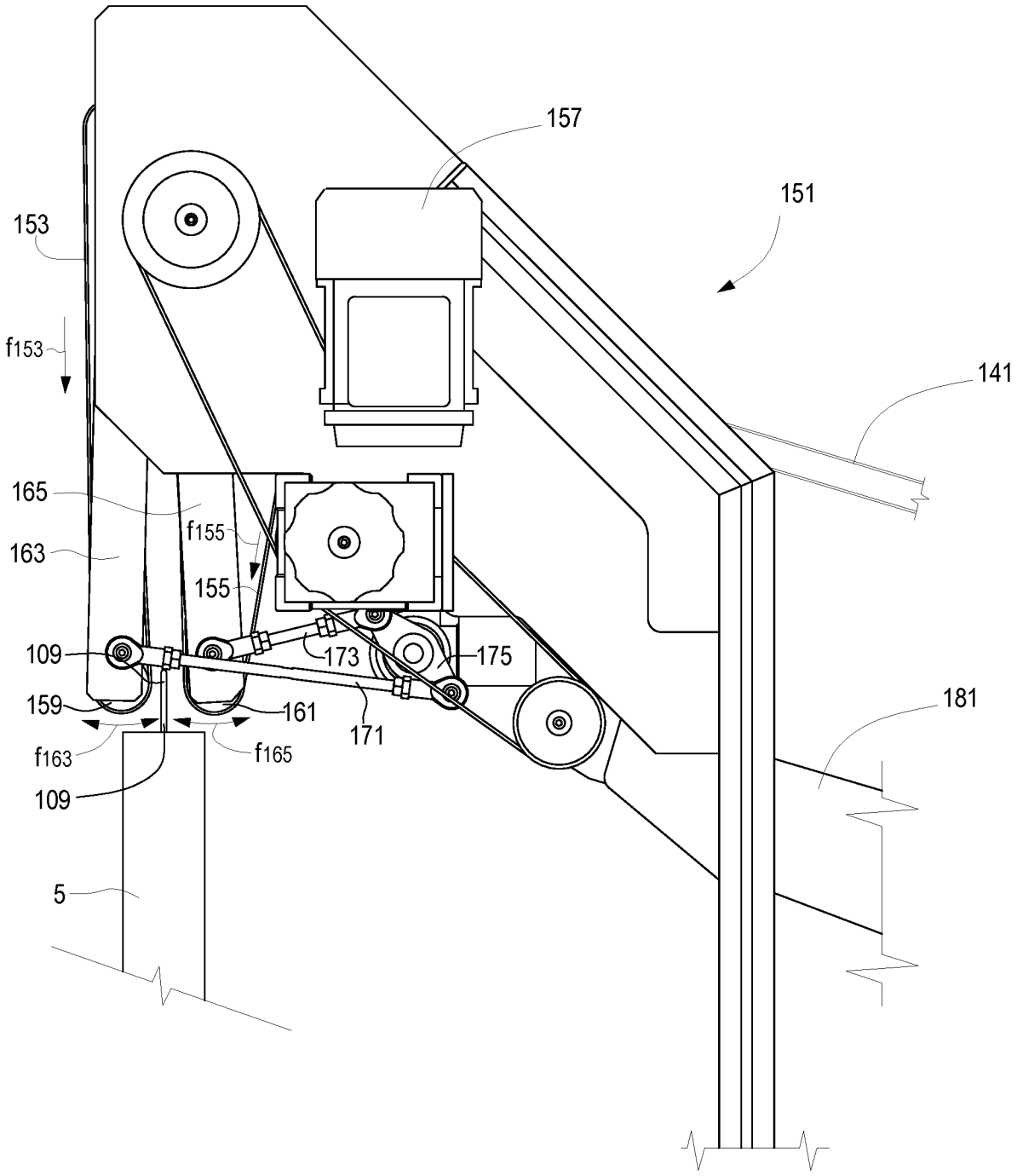
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Fig.11B

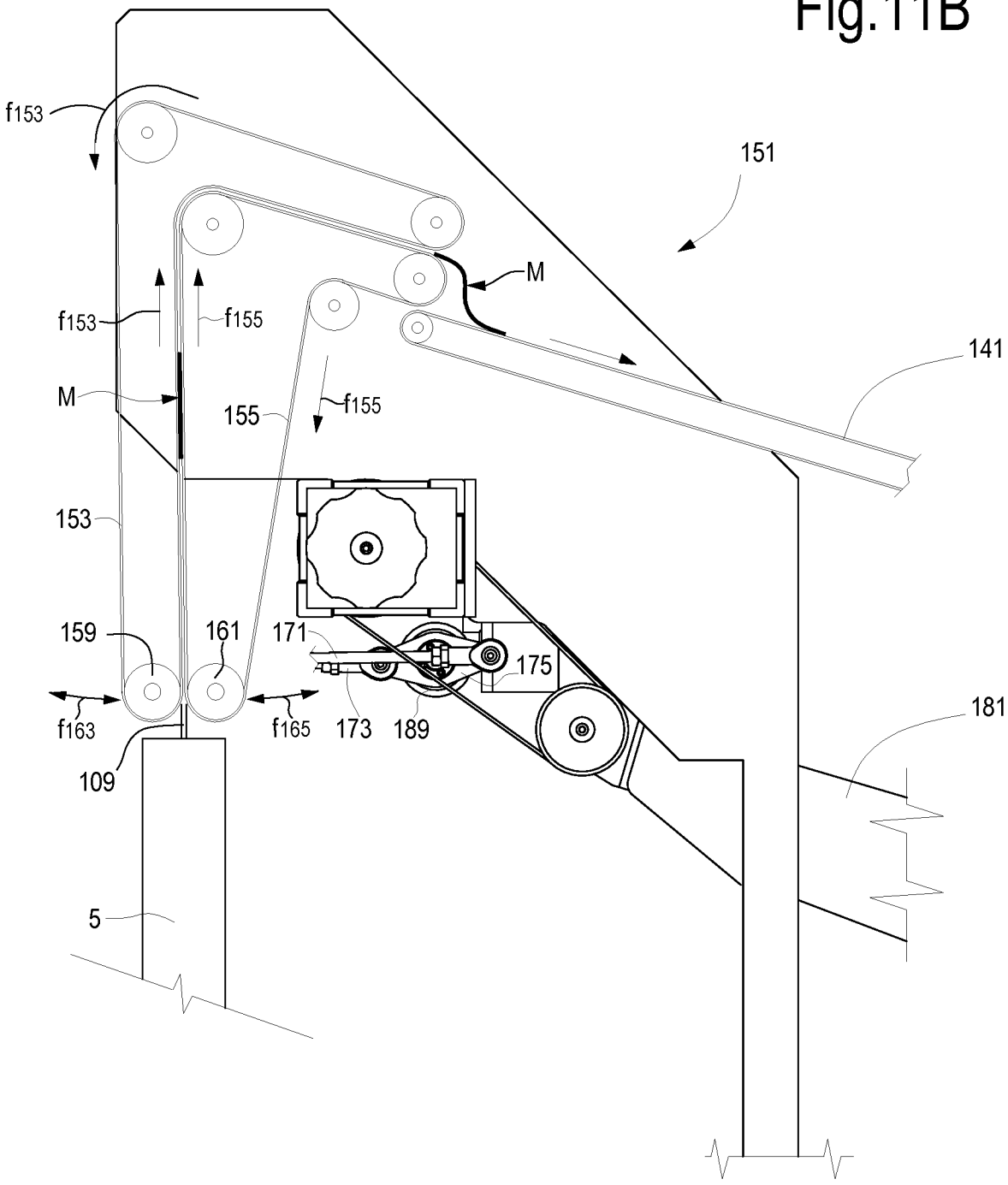
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Fig.12A

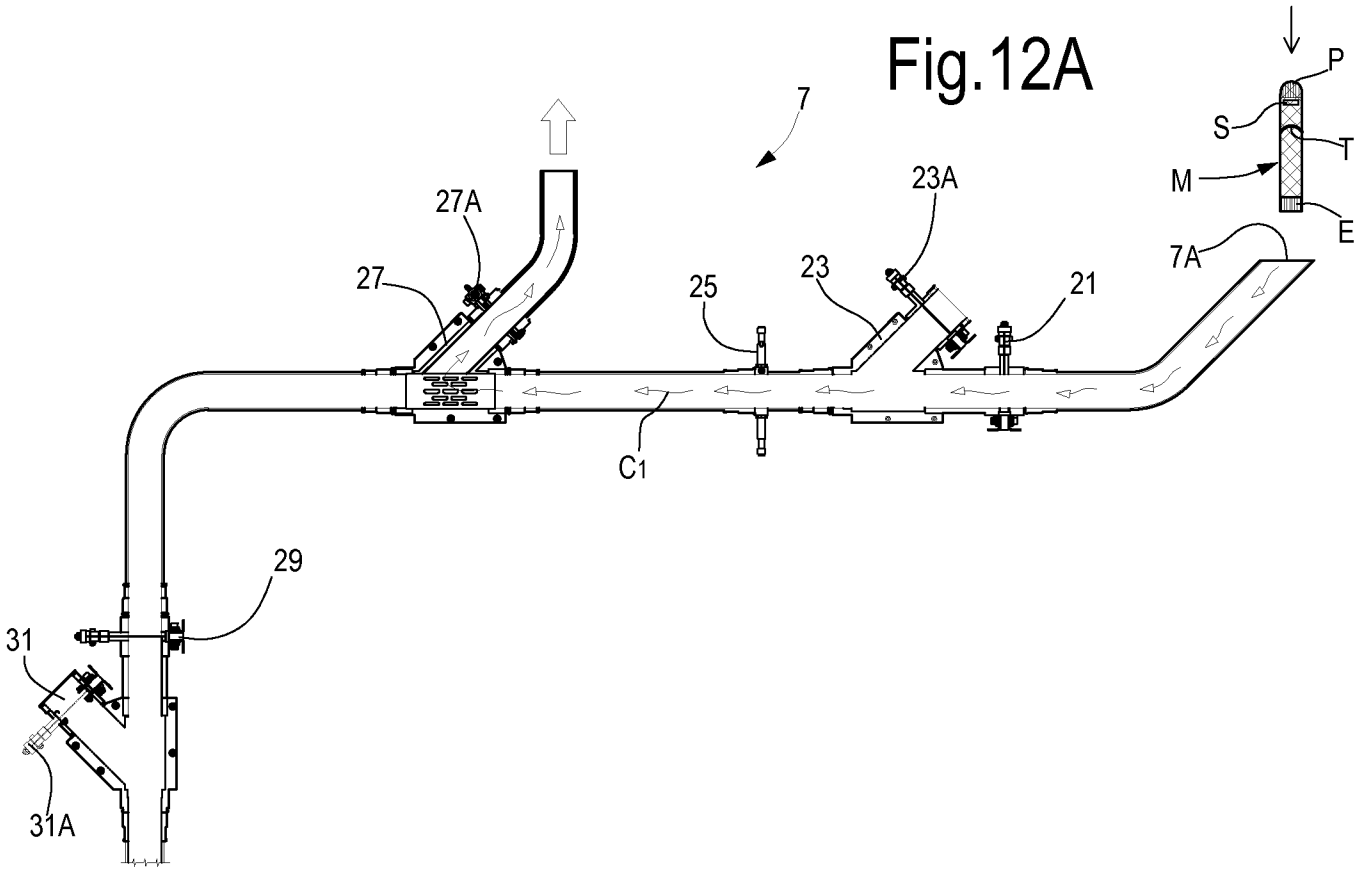


Fig.12B

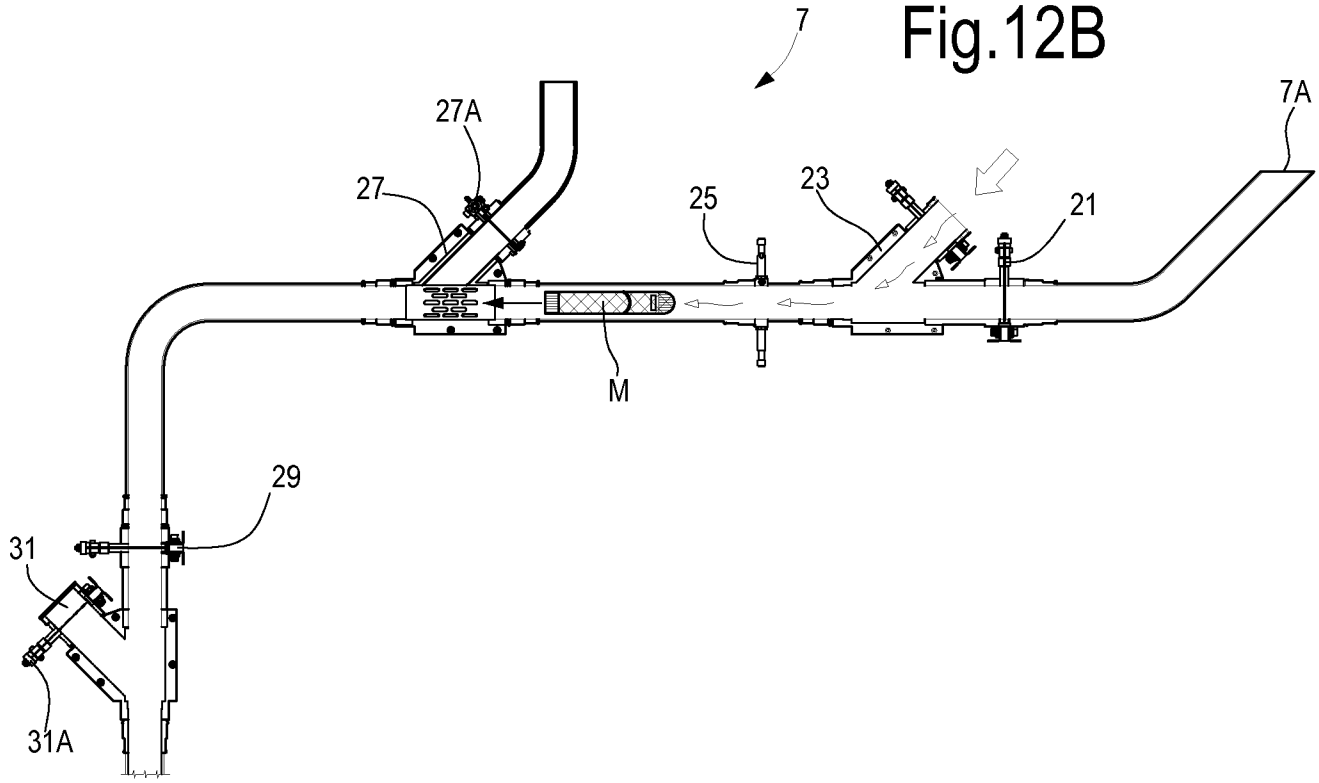
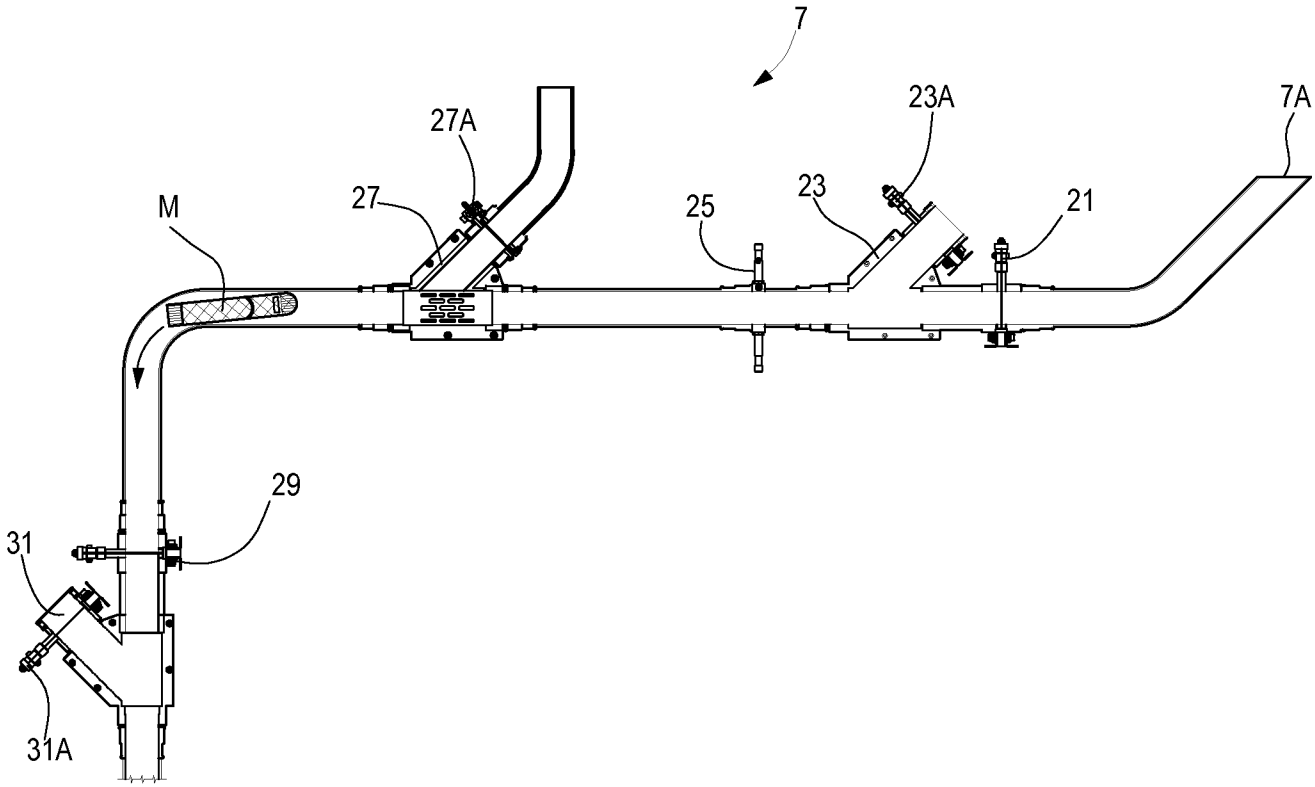


Fig.12C



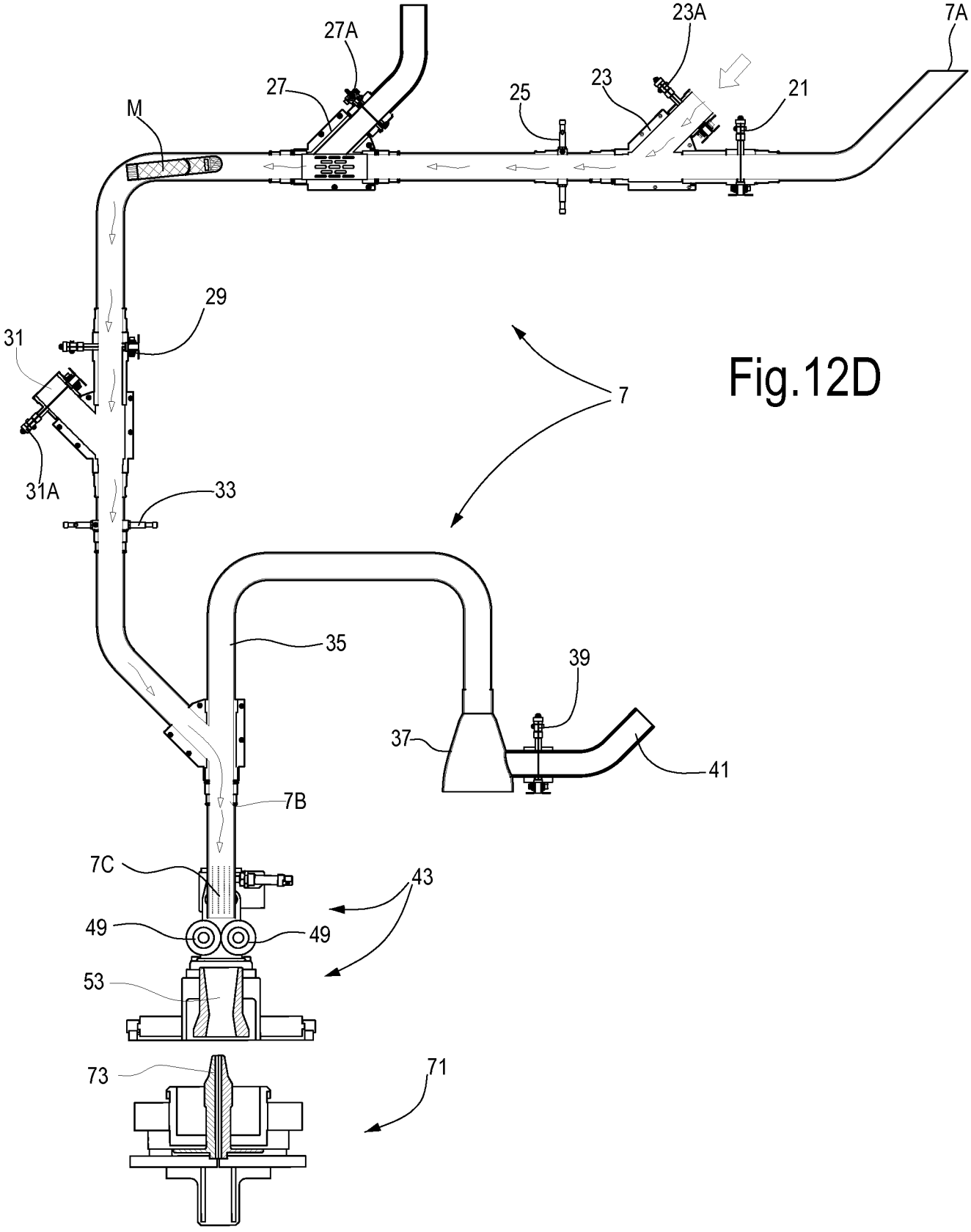

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Fig.12D

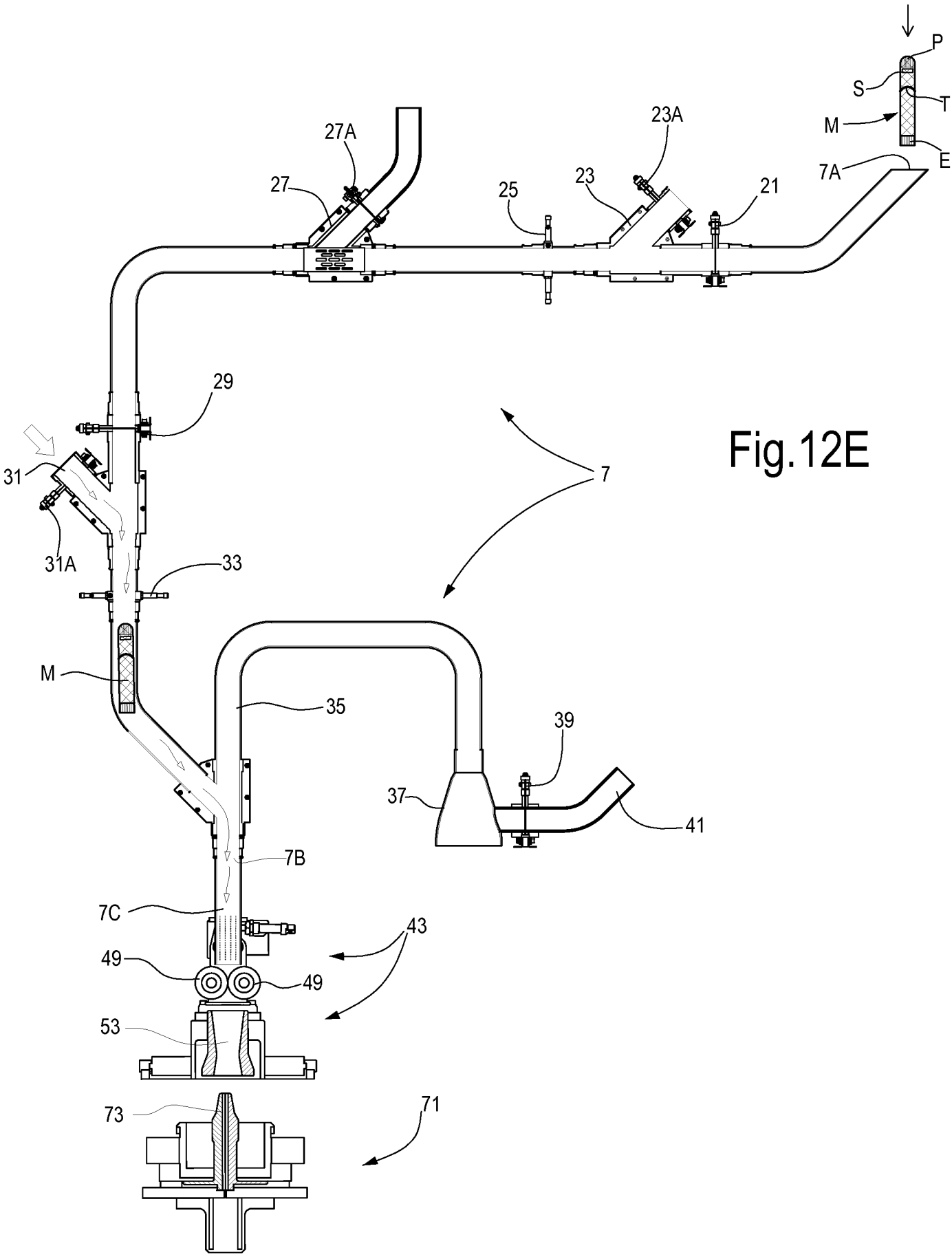
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Fig.12E

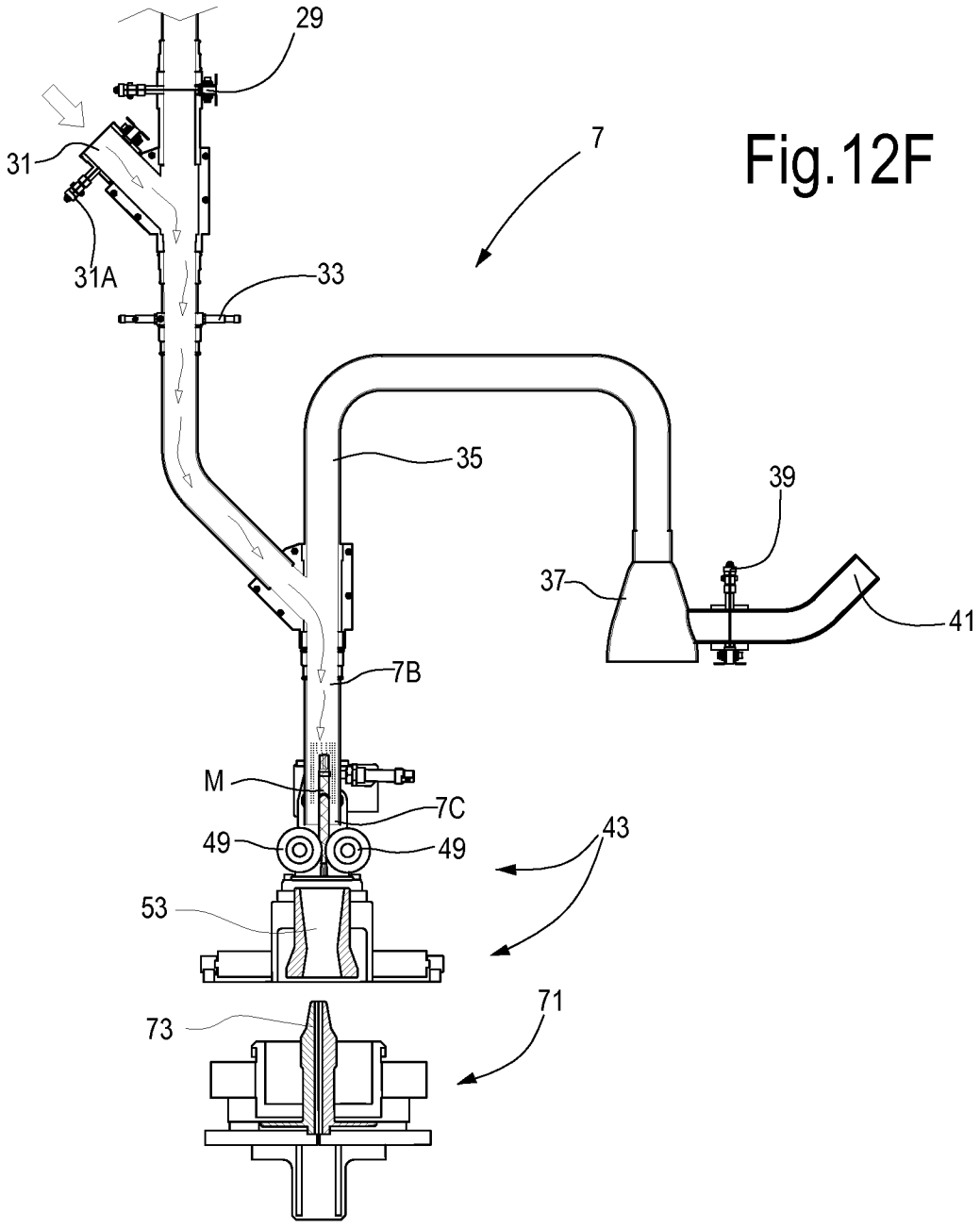

Fig.12F

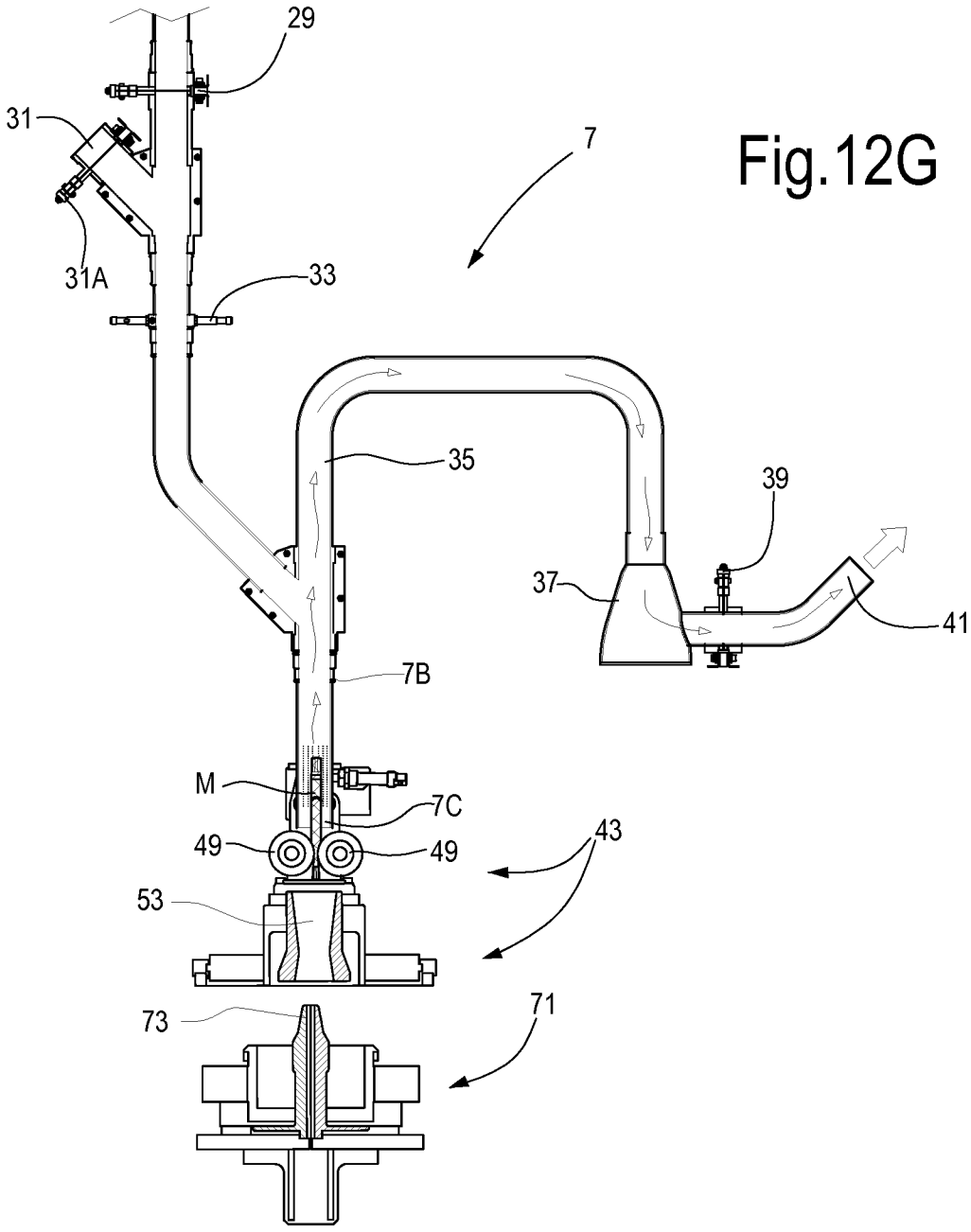

Fig.12G

Fig.12H

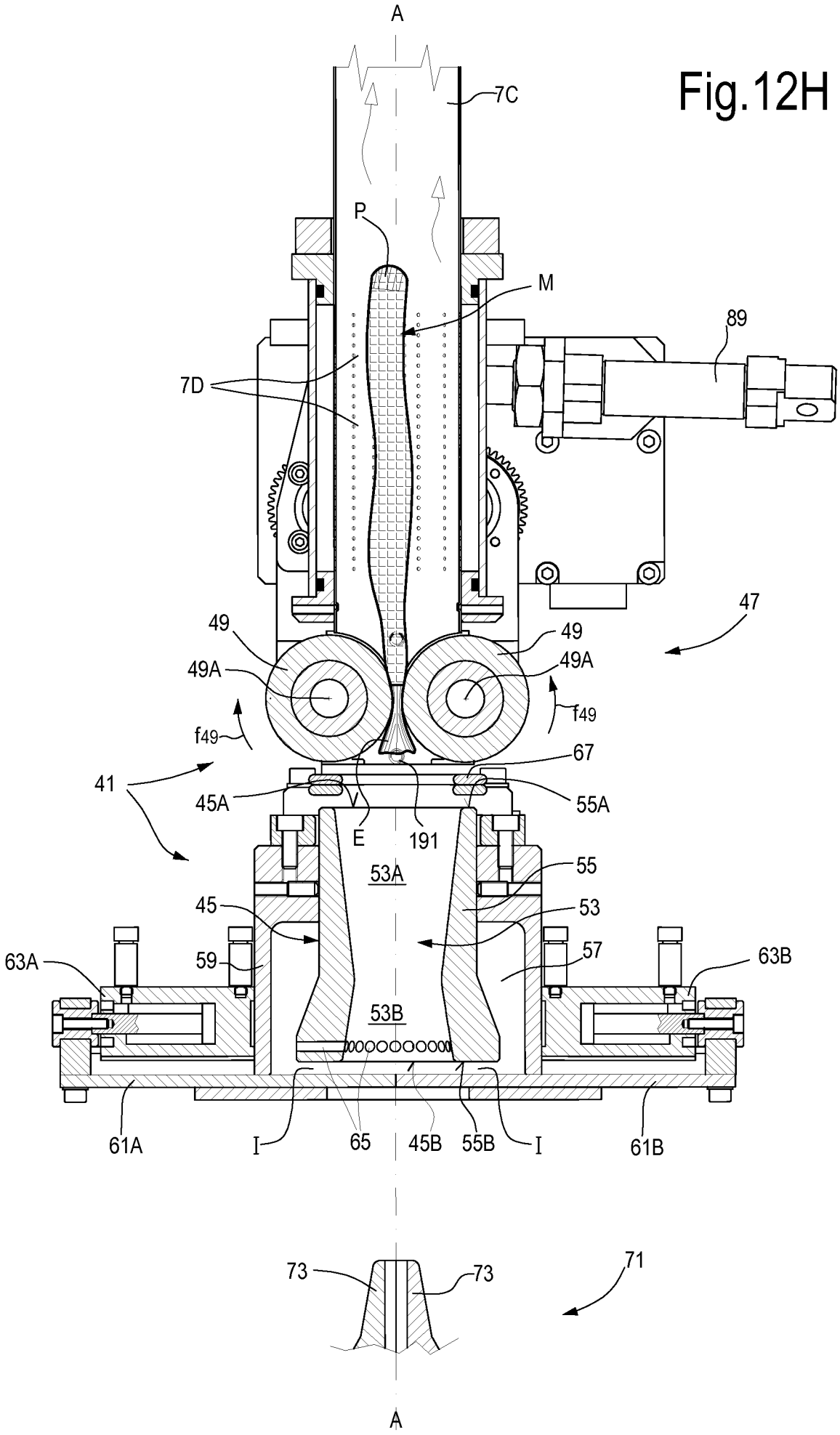
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Fig.12I

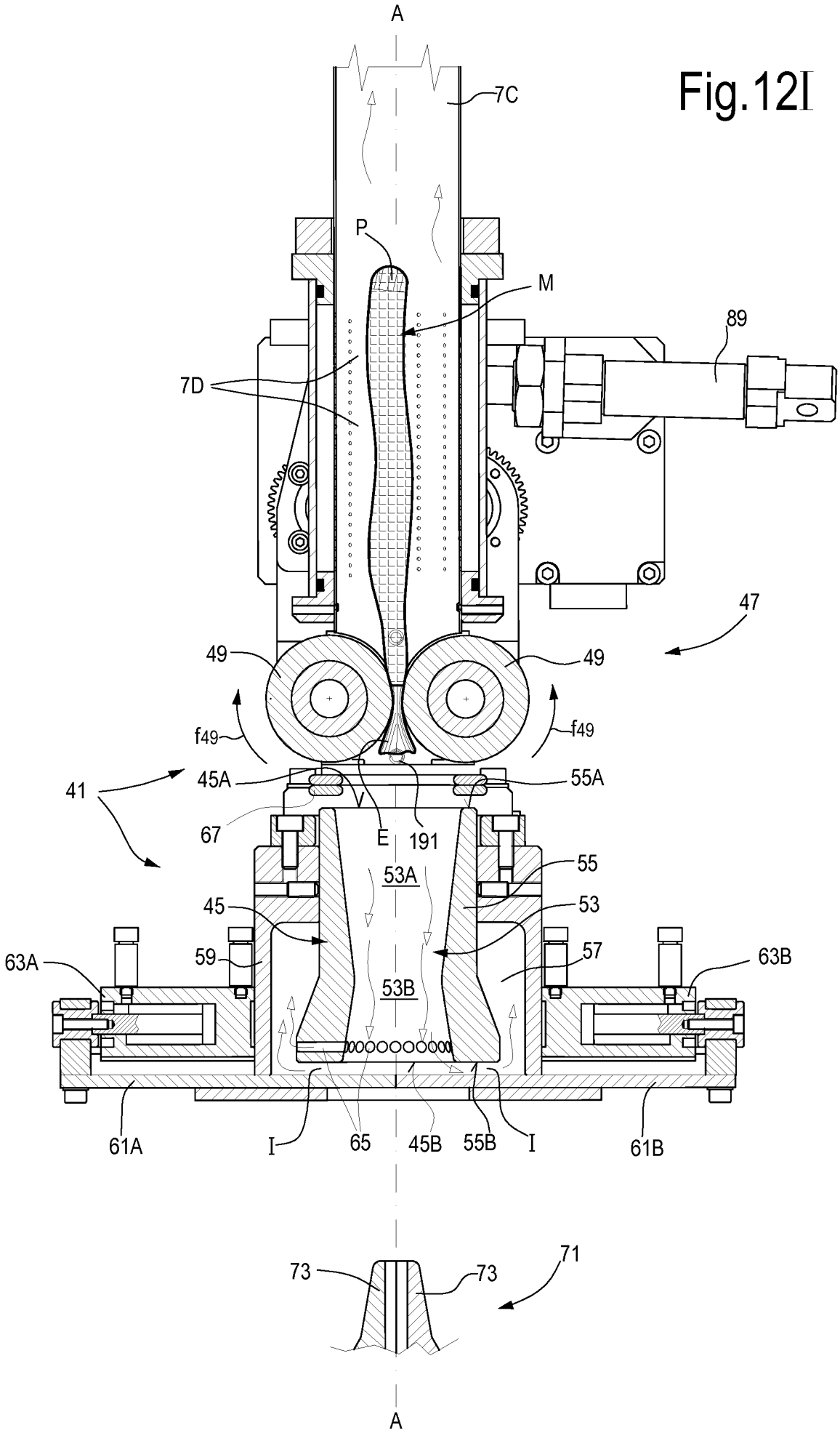
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Fig.12J

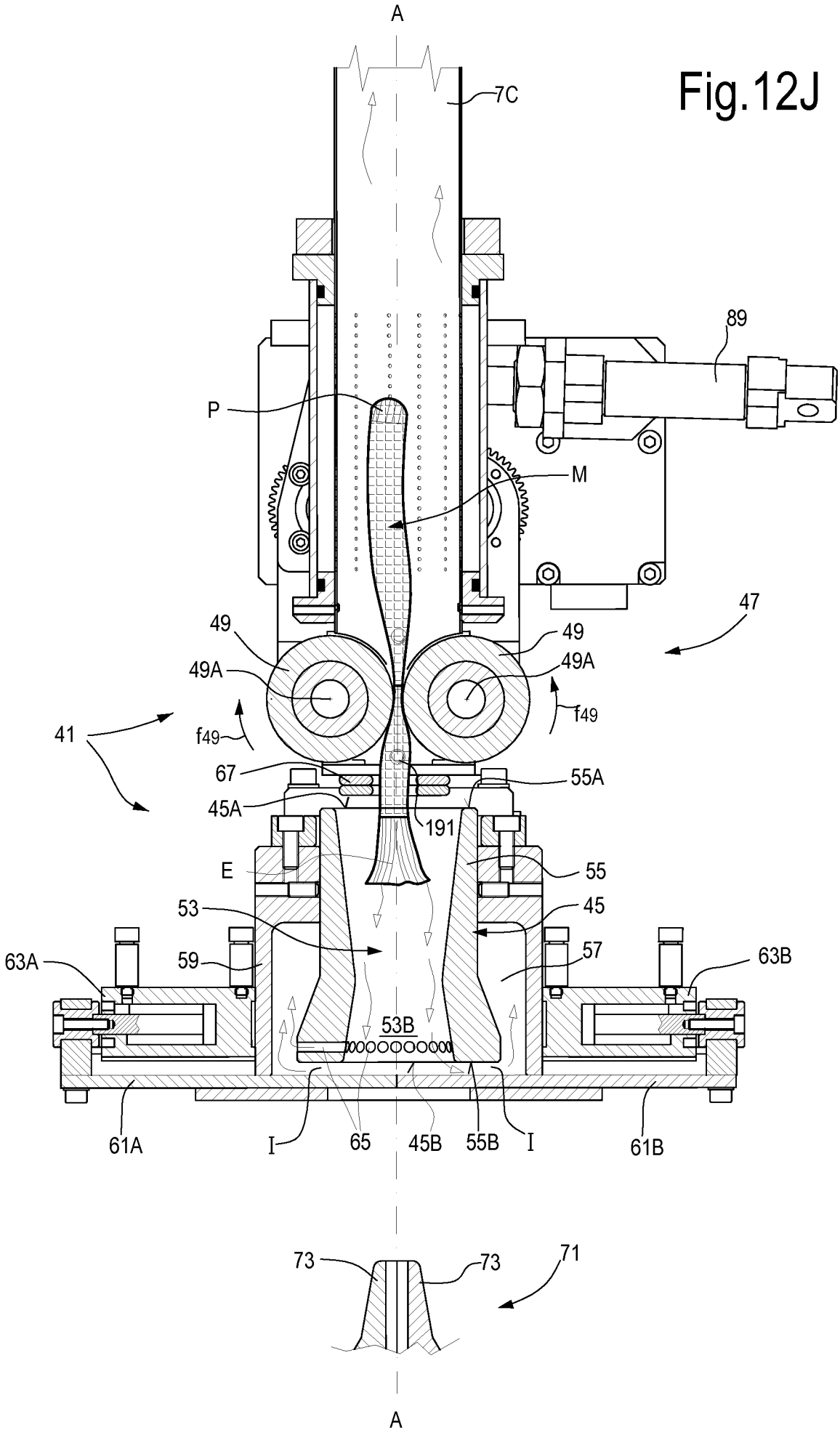
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Fig.12K

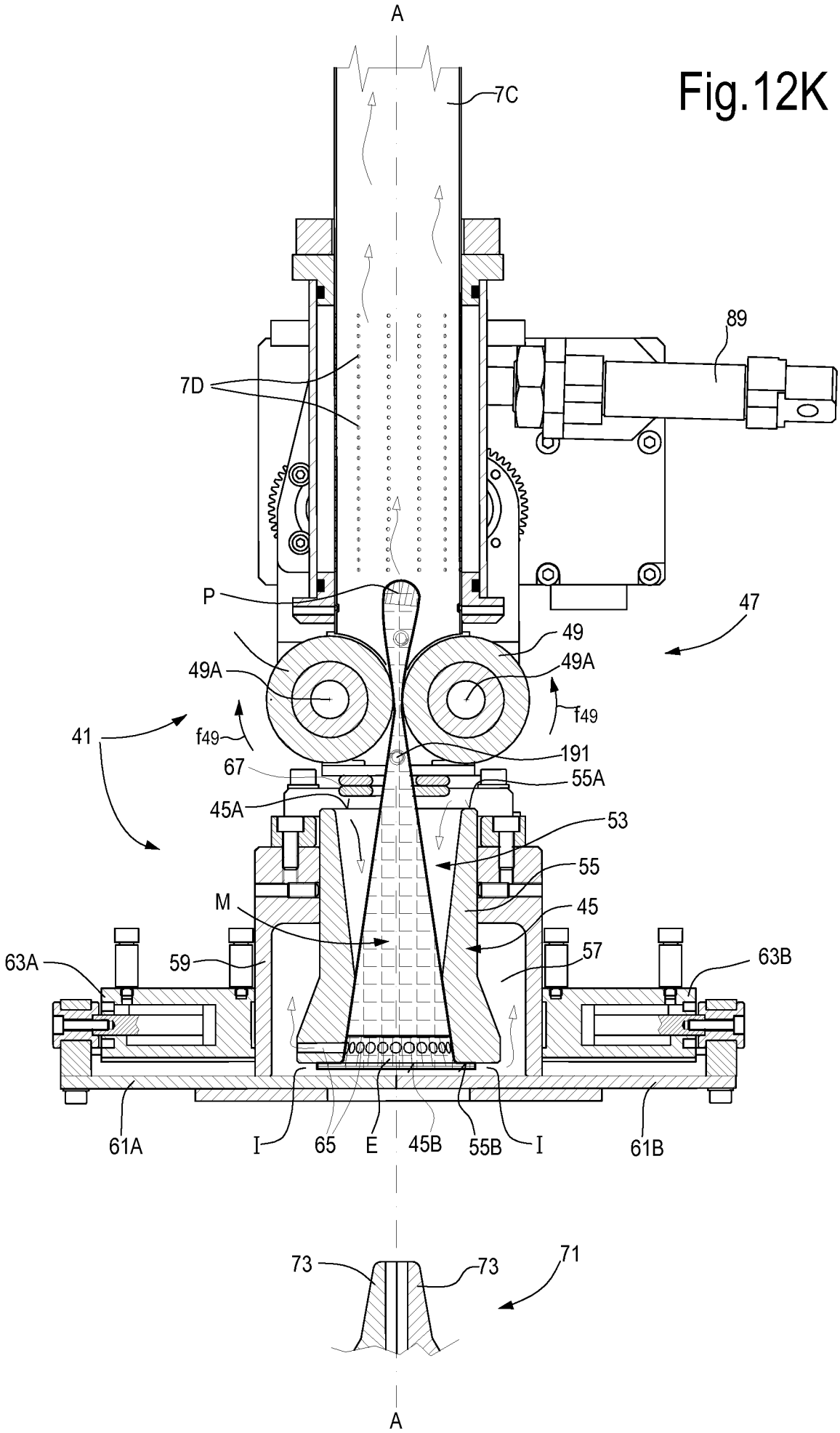
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Fig.12L

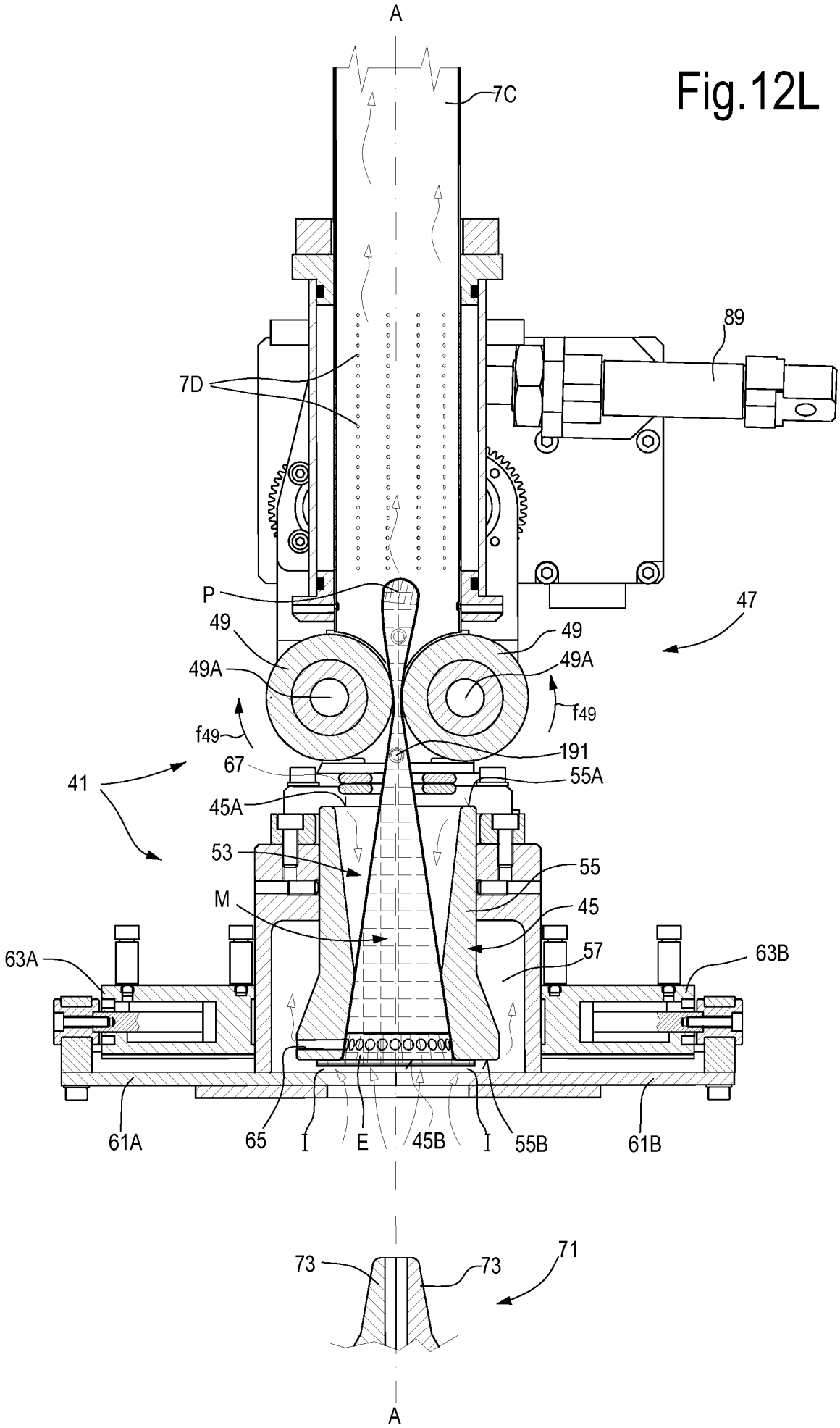
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Fig.12M

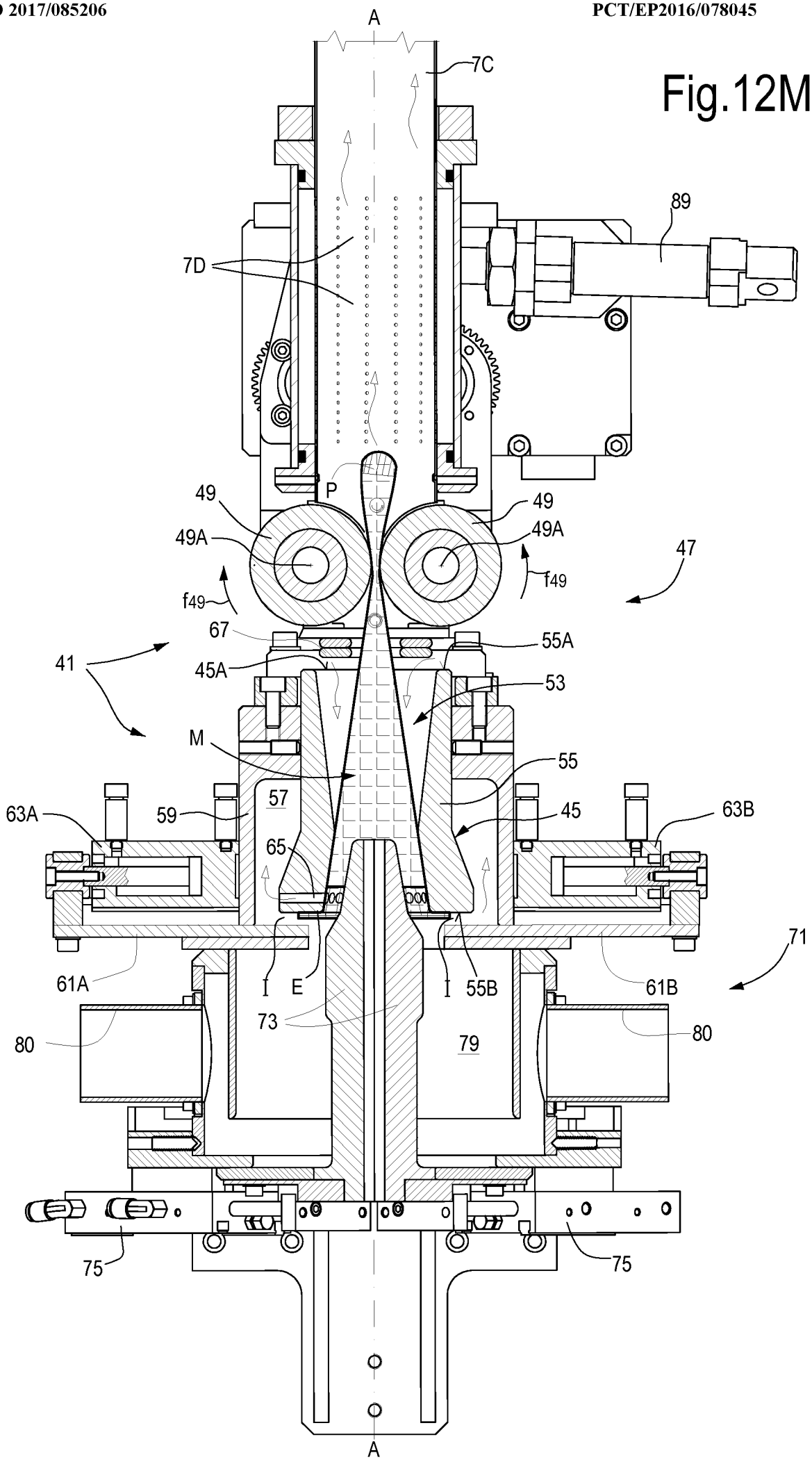
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Fig.12N

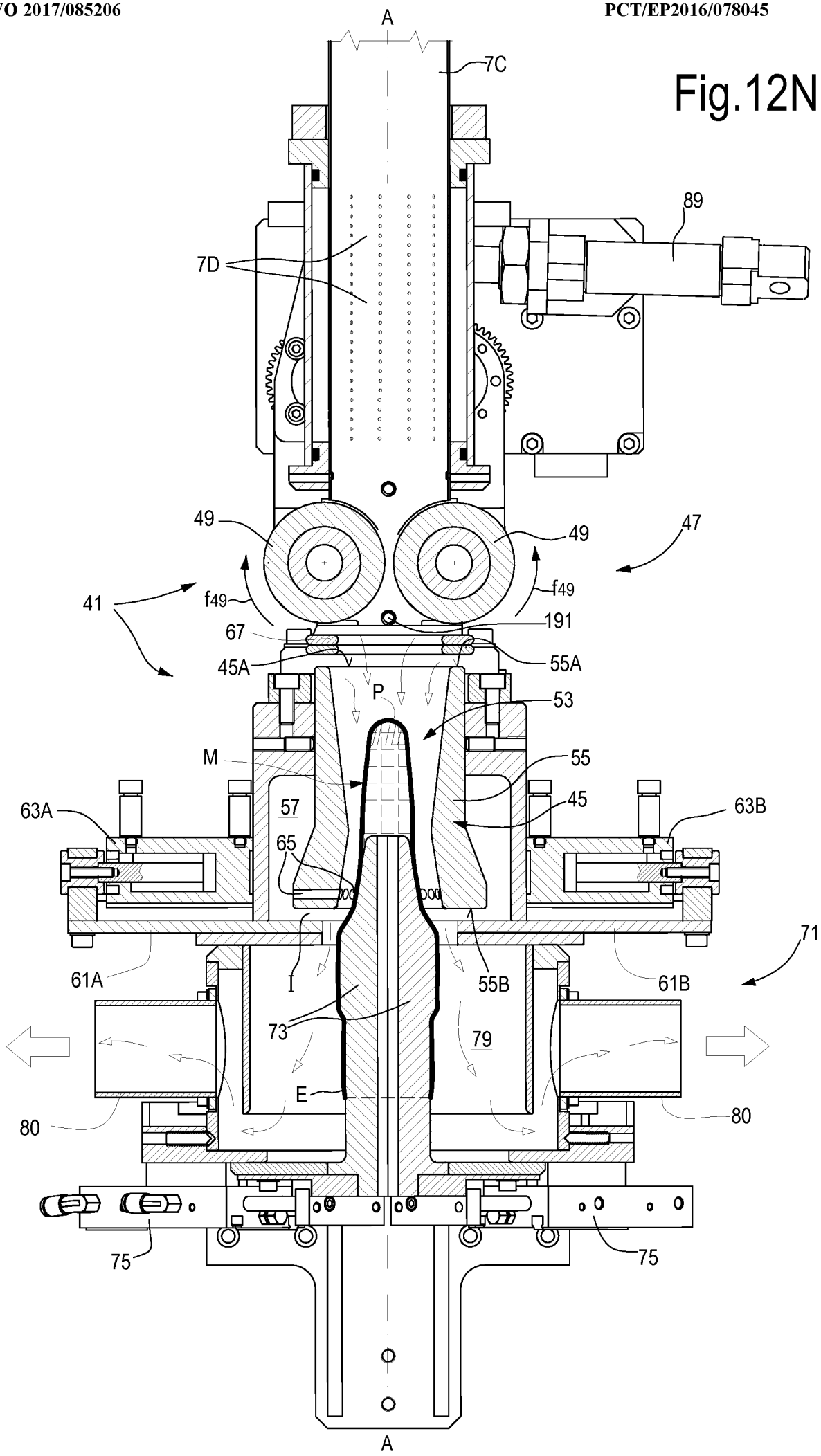
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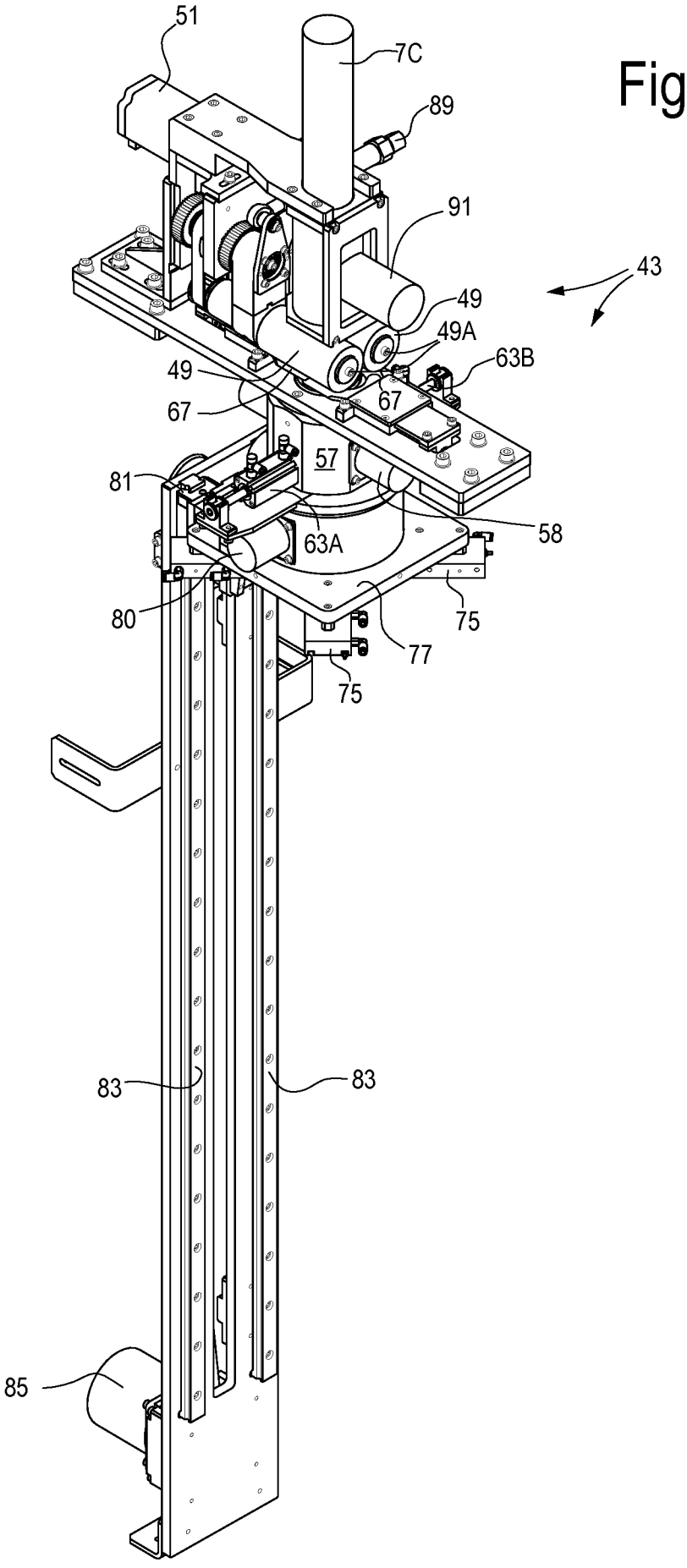
Fig.12O



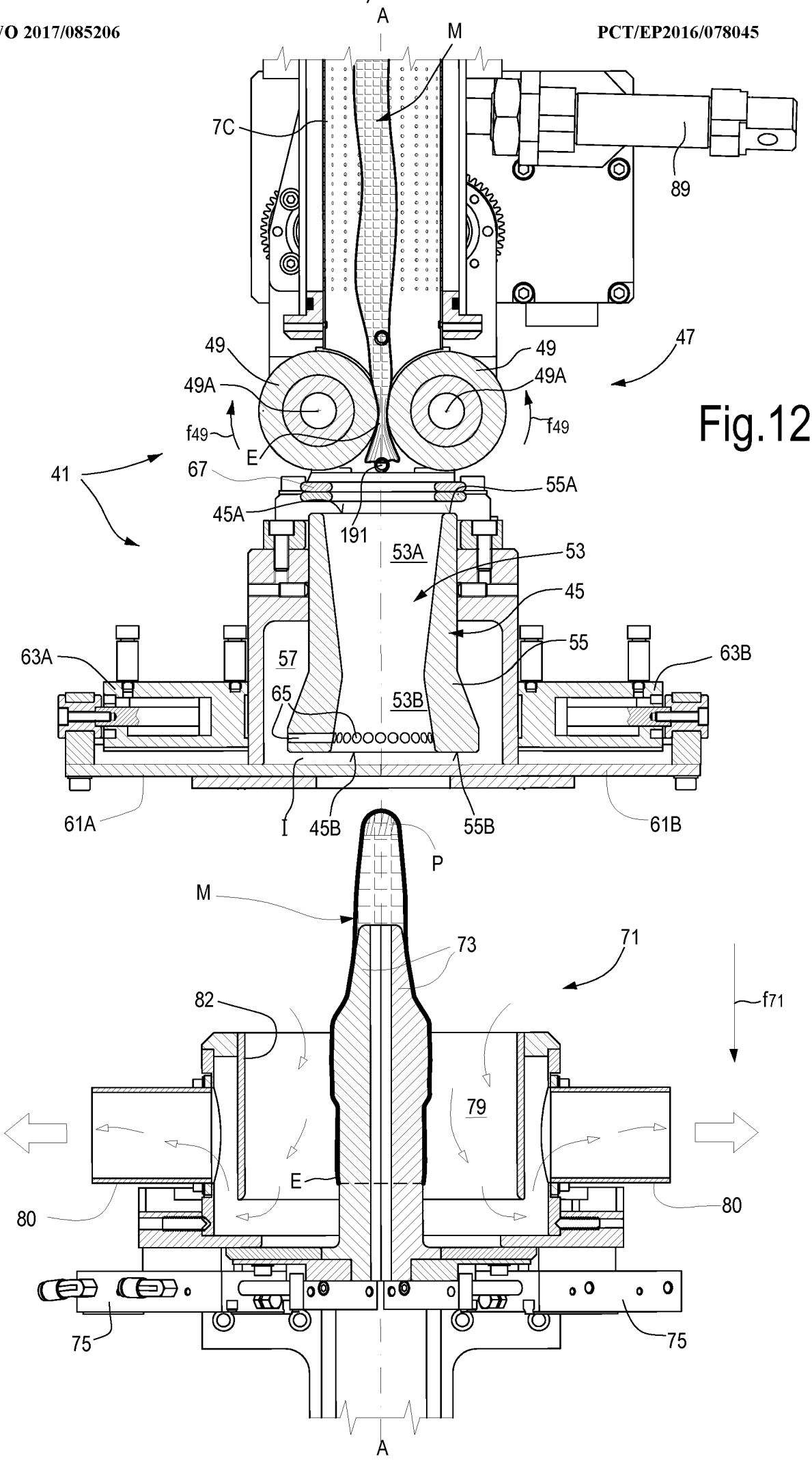

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Fig.12P

Fig.12Q

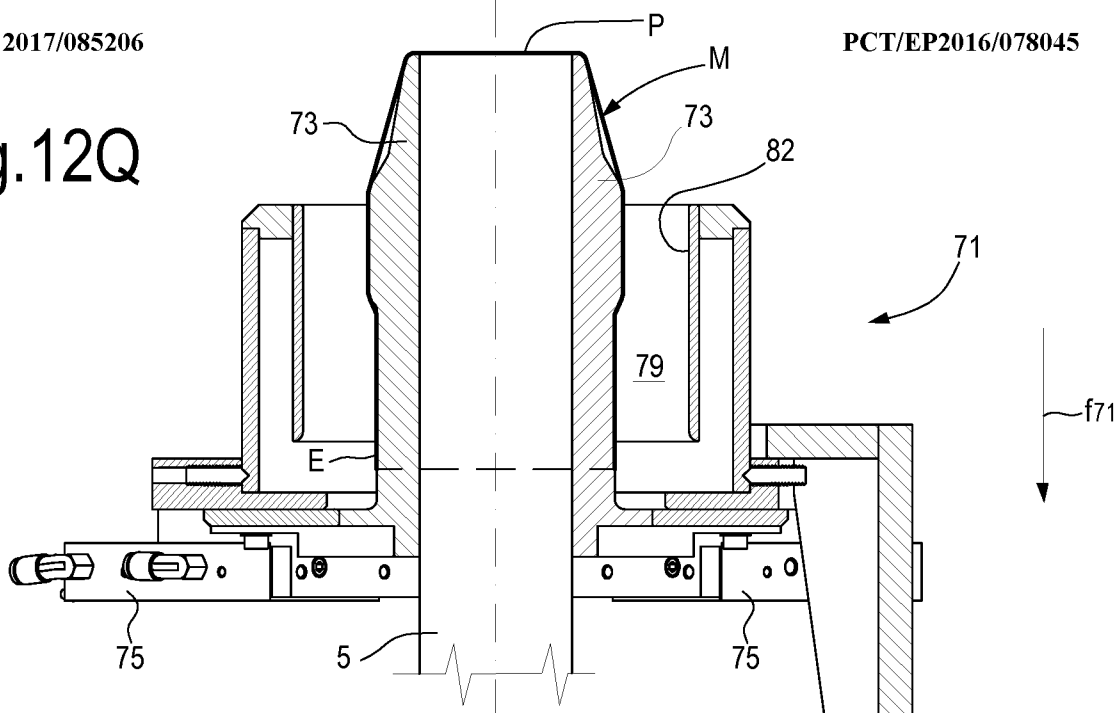
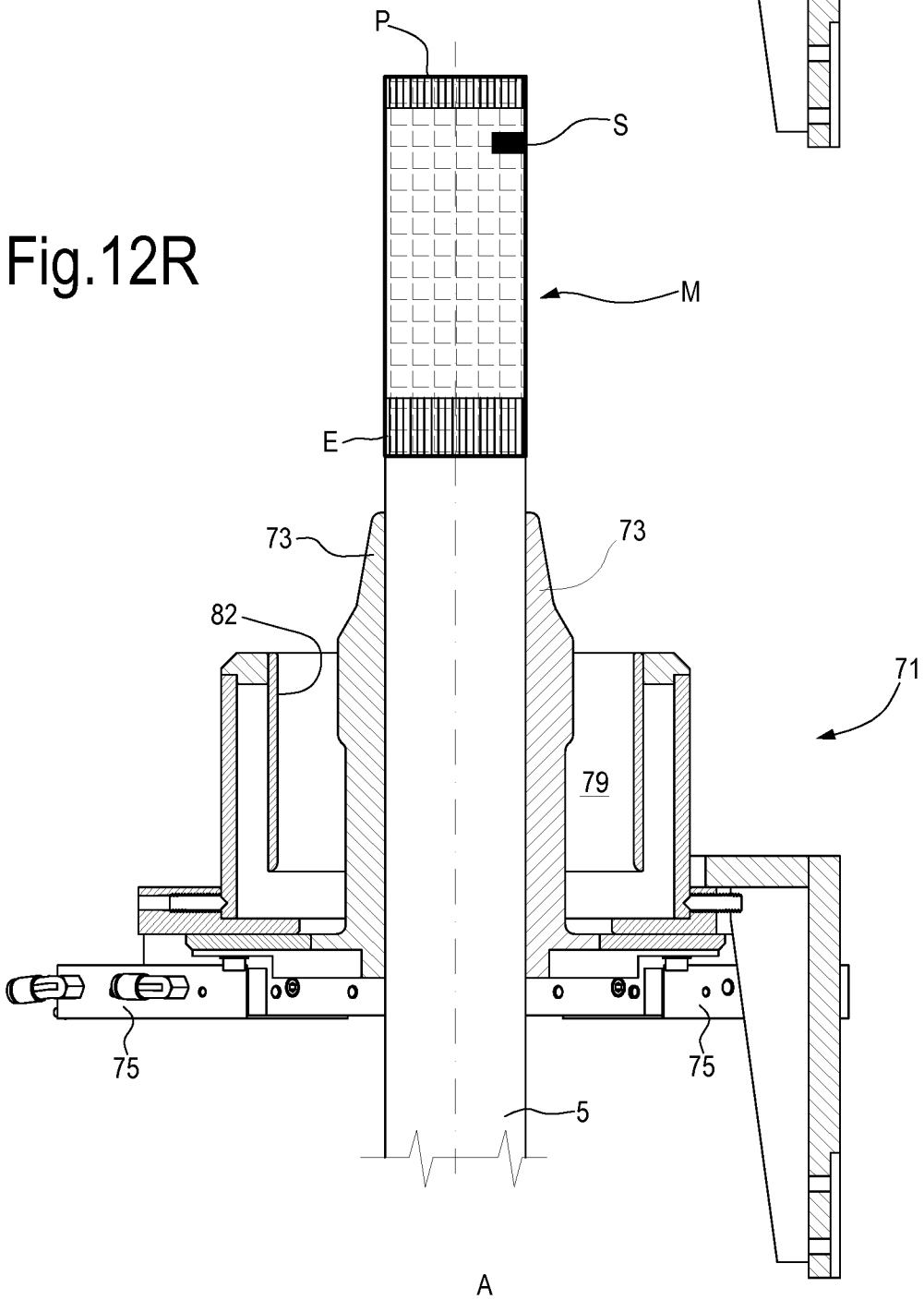


Fig.12R



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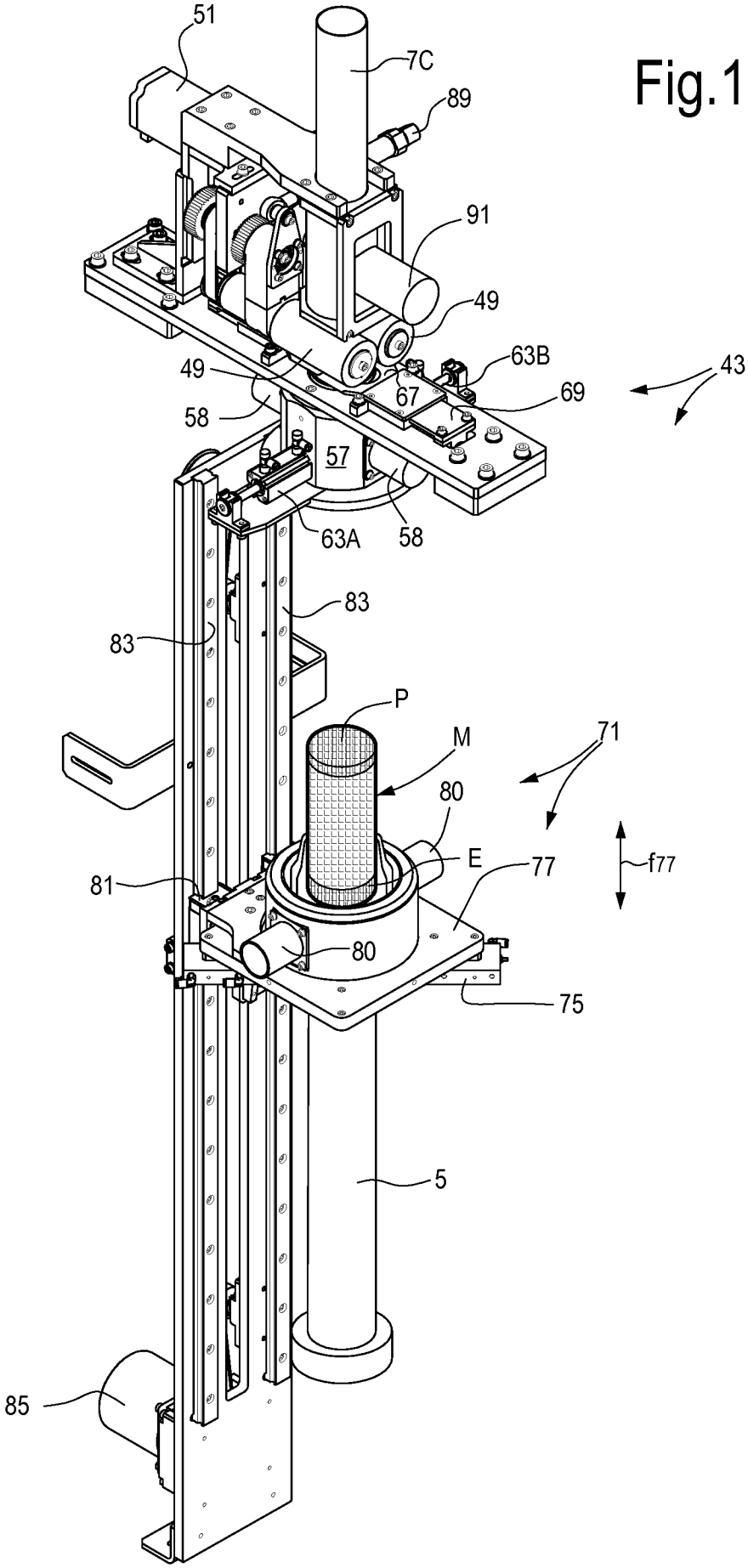
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Fig.13A

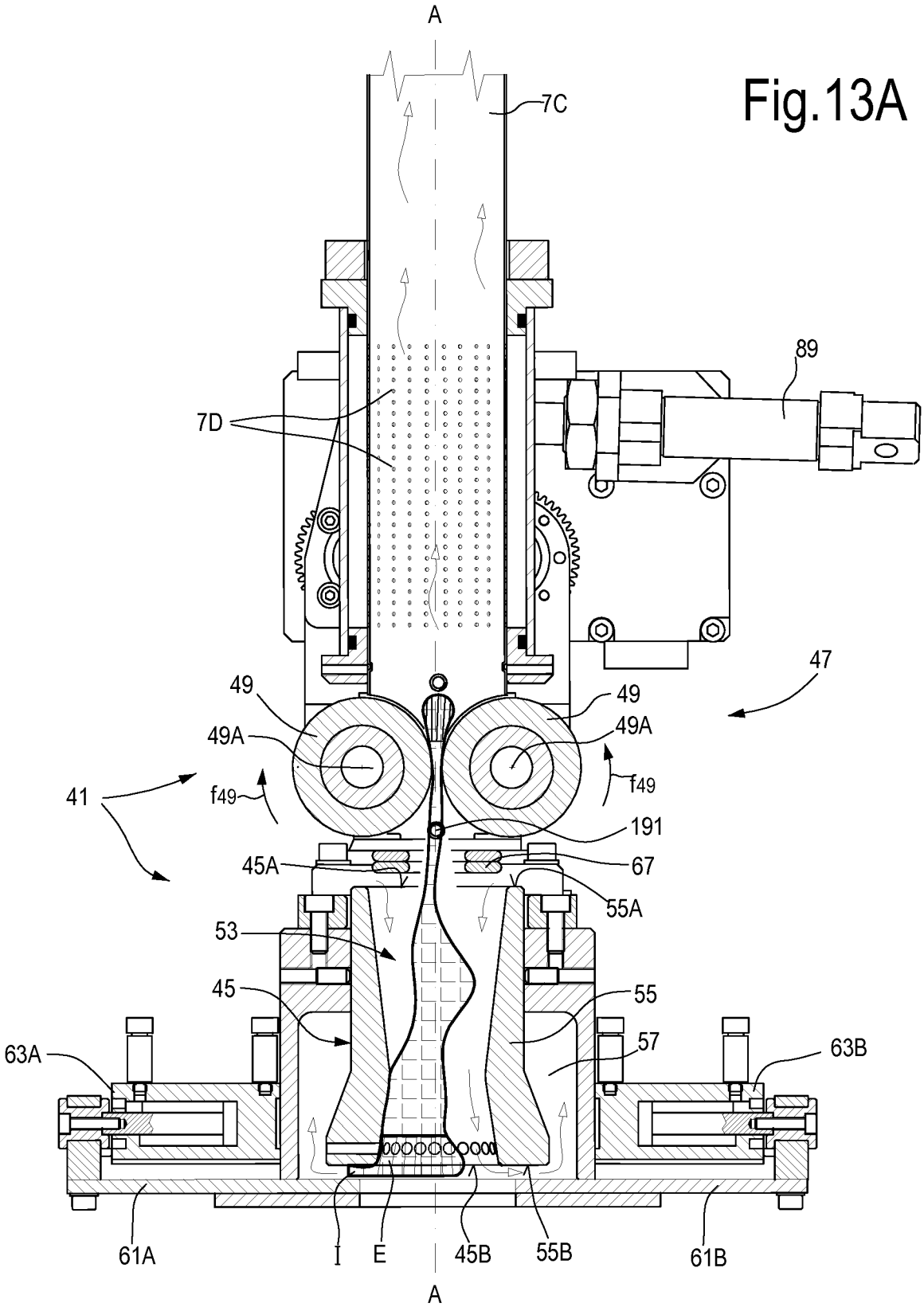
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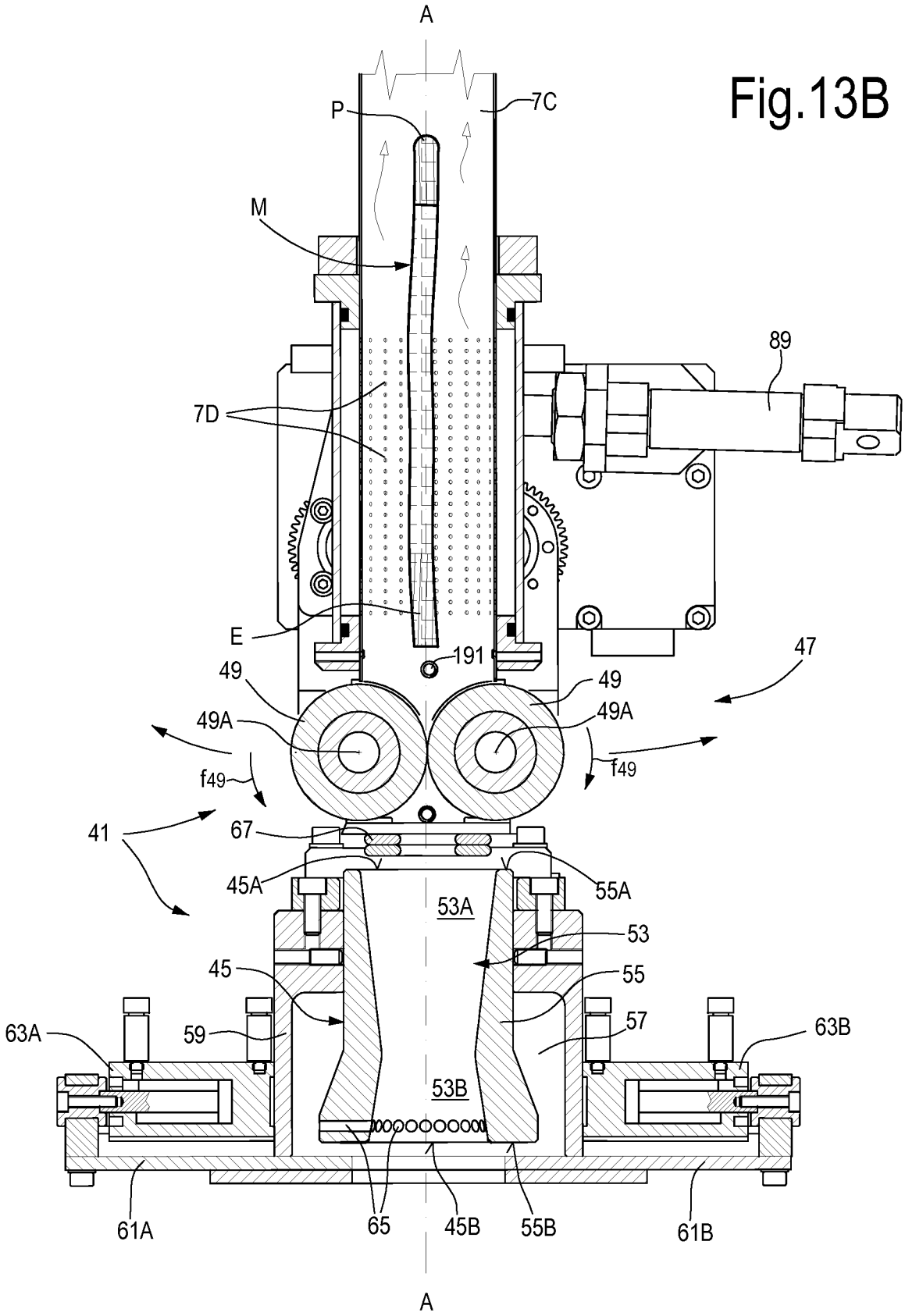
Fig.13B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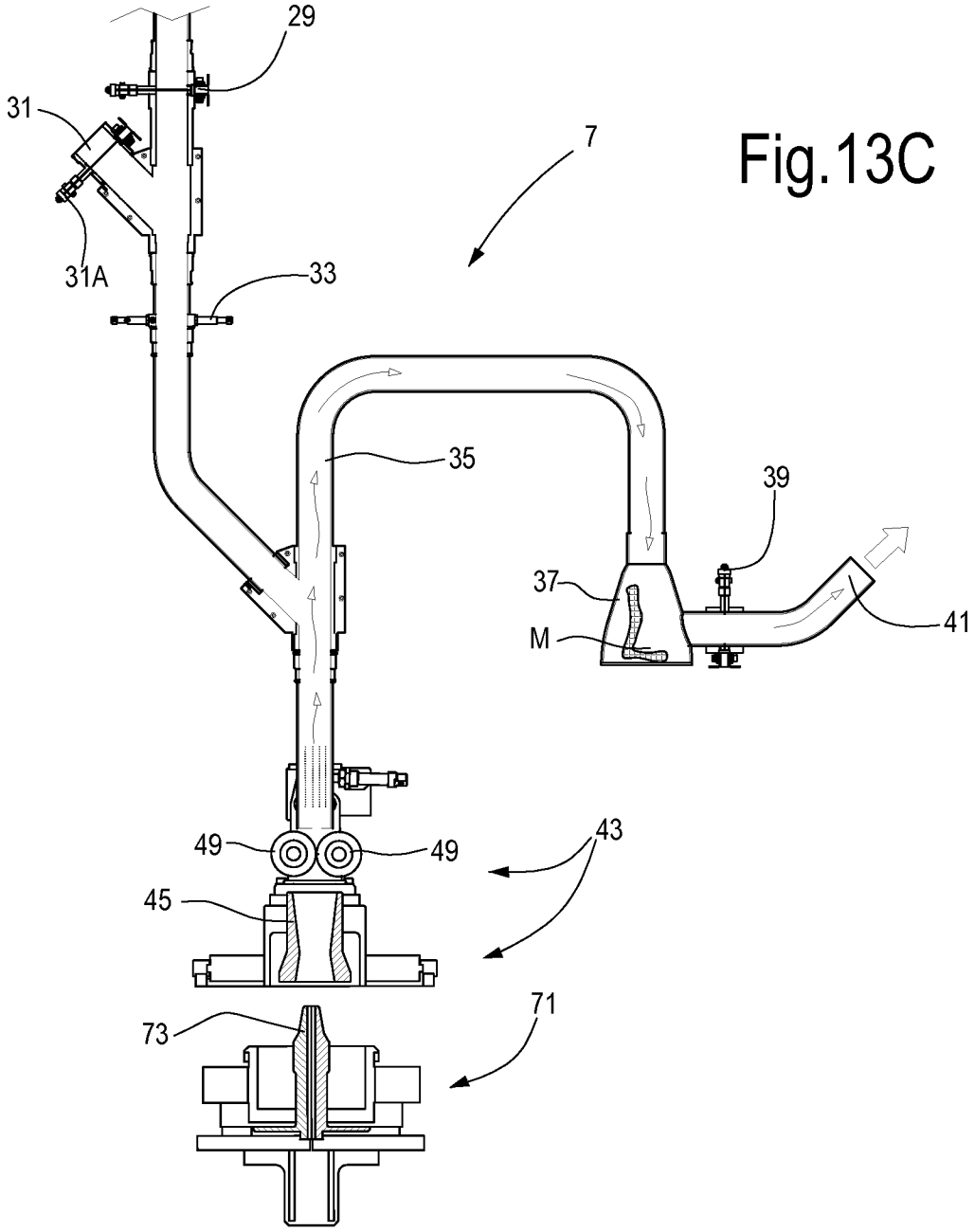

Fig.13C

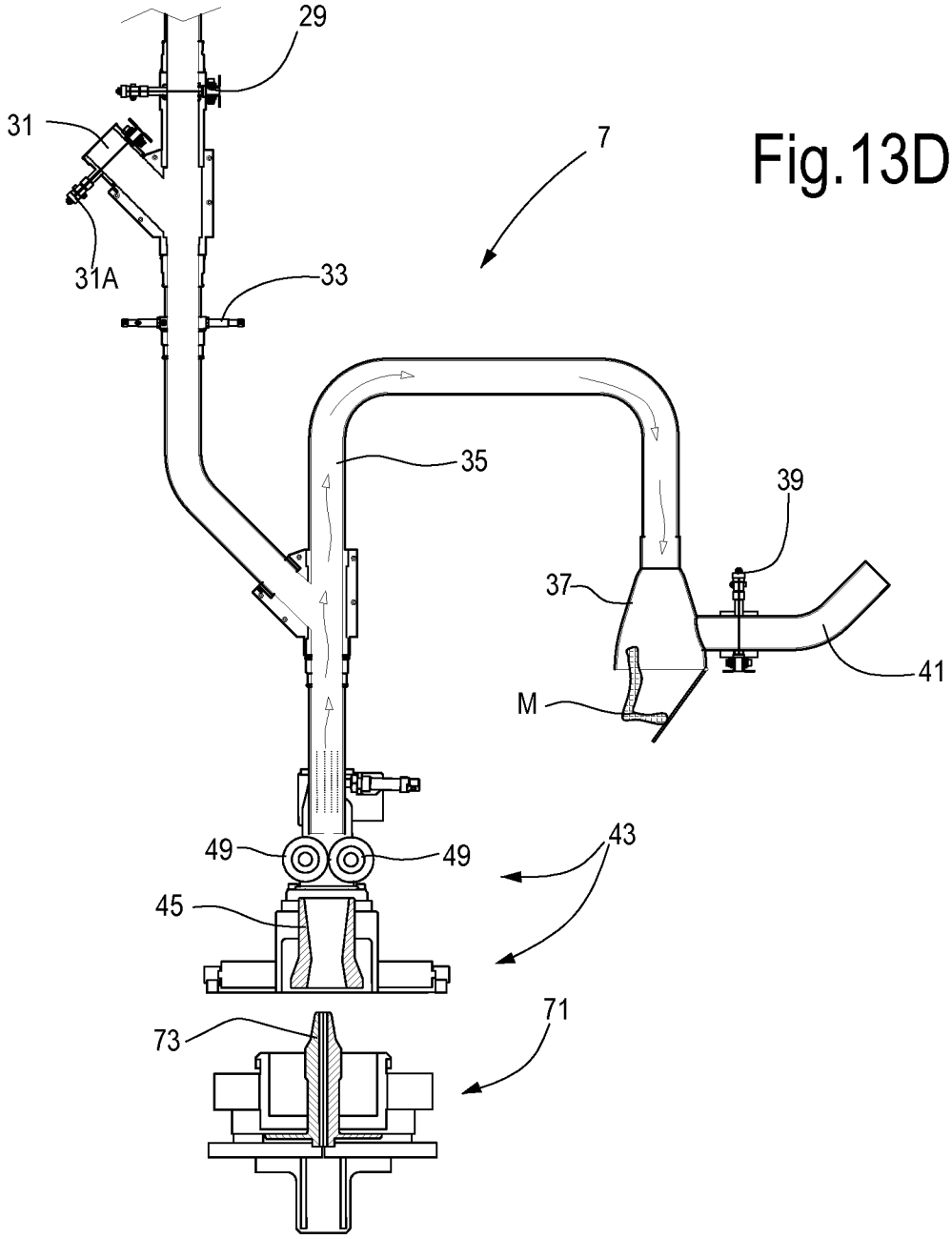

Fig.13D

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/078045

A. CLASSIFICATION OF SUBJECT MATTER
INV. D06C5/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D06C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2006/137097 A1 (GOLDEN LADY CO SPA [IT]; GRASSI NERINO [IT]; MAGNI ANTONIO [IT]) 28 December 2006 (2006-12-28) page 6, line 20 - page 7, line 3; figure 2	1-27
A	US 6 155 466 A (MIGLIORINI PIER LORENZO [IT]) 5 December 2000 (2000-12-05) column 1, line 45 - column 5, line 22	1-27
A	US 2004/244237 A1 (BASSI GINO [IT]) 9 December 2004 (2004-12-09) abstract	1-27
A	WO 01/77432 A1 (S R A S R L [IT]; MANINI BENITO [IT]) 18 October 2001 (2001-10-18) the whole document	1-27

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 February 2017	14/02/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Bichi, Marco

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/078045

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