(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
09 January 2025 (09.01.2025)

WIPO | PCT

(10) International Publication Number
WO 2025/008352 A1

(51) International Patent Classification:
H01M 10/04 (2006.01) *H01M 10/42* (2006.01)

(21) International Application Number:
PCT/EP2024/068610

(22) International Filing Date:
02 July 2024 (02.07.2024)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
102023000013746 03 July 2023 (03.07.2023) IT

(71) Applicant: **I.M.A. INDUSTRIA MACCHINE AUTOMATICHE S.P.A IN SIGLA IMA S.P.A.** [IT/IT]; VIA EMILIA, 428-442, 40064 OZZANO DELL'EMILIA (IT).

(72) Inventor: **FURLOTTI, Filippo**; VIA BRIZZI, 19, 43029 TRAVERSETOLO, FRAZIONE CAZZOLA (IT).

(74) Agent: **MODIANO, Micaela Nadia** et al.; Modiano & Partners, Via Meravigli, 16, 20123 Milano (IT).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) **Title:** METHOD AND STATION FOR REMOVING ELECTROLYTE RESIDUES FROM CELLS

(57) **Abstract:** The invention relates to a method for removing external electrolyte residues from partially processed electrochemical cells, which comprises a step of moving, at least partly along a transit path of partially processed electrochemical cells, a plurality of suction units, wherein a temporary coupling is performed of at least one of the suction units with a respective cell or with a transport puck for that cell, so as to keep the suction unit substantially integral with the cell or with the puck along at least part of the transit path; and, during such temporary coupling, any electrolyte residues present on an external surface of the head portion of the cell are aspirated.

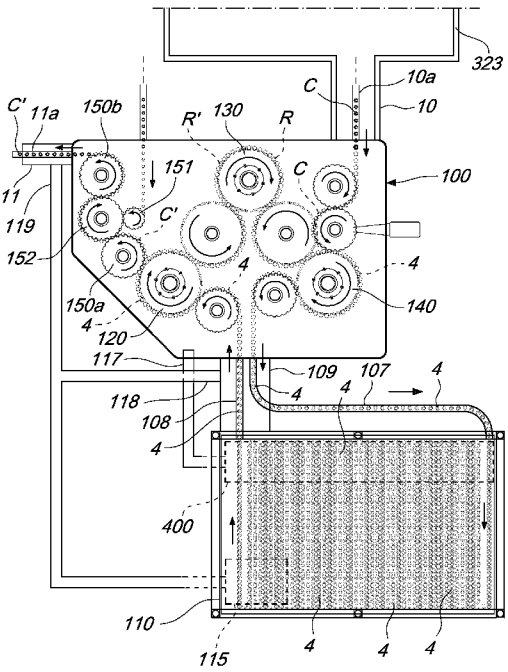

Fig. 3a

WO 2025/008352 A1

METHOD AND STATION FOR REMOVING ELECTROLYTE RESIDUES FROM CELLS

The present invention relates to a method and a station for removing any external electrolyte residues from partially processed cells (preferably electrochemical cells), as well as a battery production method and production line that respectively comprise such a method and such a station.

Although the invention is particularly adapted to the production of batteries (primary or secondary) of the electrochemical cylindrical (single or multiple) cell type, for example lithium ion batteries, the invention is in any case also adapted to the production of other electrolytic or electrochemical cells or other forms of cell packaging, for example prismatic cells or pouch cells.

Battery production lines (for single-cell or multiple-cell batteries), for example for producing lithium ion batteries, require that at least some of the processing steps take place in a "dry room", i.e. a sealed and ultra-dry room, i.e. with an extremely low rate of controlled humidity (typically of the order of 1% by volume) and with a dew point that can be lower than -40°C. This occurs, in particular, in those cases in which the materials of the electrodes and/or the electrolytes that fill the battery are sensitive to humidity, i.e. they react with water.

Typically, the steps of filling an electrochemical cell during manufacture entail loading an electrolyte (typically in the form of a liquid or gel) into the container into which electrodes have been previously inserted, through a filling inlet located in the upper part, or head, of the cell.

Subsequently, still in the dry room, there is a step of sealing the battery so as to plug it, so isolating the internal volume of the battery, occupied by the electrolyte, from the outside environment. This sealing can be temporary and be obtained by inserting a temporary plug or pin which is then removed in a subsequent degassing station.

This conventional method for making batteries is not devoid of

drawbacks, among which is the fact that, during the steps of filling, electrolyte residue can be accidentally deposited around the filling inlet of the electrochemical cell and, considering the corrosive and inflammable properties of the electrolyte, can compromise the hermetic seal of the battery, its operation and/or the safety of the operations following the sealing, whether temporary or final.

In more detail, corrosion can imply the deterioration of the external surface of the battery, at the sealing plug, so altering the geometry of the inlet and allowing the passage of gas – and therefore of air – from the outside environment to the internal volume of the battery and vice versa.

Furthermore, considering the toxicity of the electrolytes used in batteries, any external residues can damage the persons handling the batteries outside of the production line, for example if such electrolyte residues should come into contact with their eyes and/or their skin.

There is also a risk that the electrochemical cell may catch fire if the electrolytic residue should come into contact with the environmental humidity outside the dry room.

The aim of the present invention is to provide a battery production method and production line, as well as a method and a station for removing any external electrolyte residues from electrochemical cells, particularly for said production method and said production line, that are capable of improving the prior art in one or more of the above-mentioned aspects.

Within this aim, an object of the invention is to provide electrochemical cells or batteries that are free from external residues of the electrolyte with which they are filled.

Another object of the invention is to eliminate or in any case reduce the risks to health of the persons who work on a battery production line in which the batteries are filled with electrolytes that are potentially harmful to health.

Another object of the invention is to enable the removal of external

electrolyte residues from electrochemical cells while they are transiting with continuous motion along the production line.

Another object of the invention is to enable the removal of external electrolyte residues while not interfering with any temporary sealing plugs which protrude from the electrolyte filling inlet of the cell.

Furthermore, the present invention sets out to overcome the drawbacks of the prior art in a manner that is alternative to any existing solutions.

Another object of the invention is to provide a battery production method and production line, as well as a method and station for removing any external electrolyte residues from electrochemical cells, particularly for said production method and line, which are highly reliable, easy to implement and at low cost.

This aim and these and other objects which will become better apparent hereinafter are achieved by a method according to claim 1, optionally provided with one or more of the characteristics of the dependent claims.

The aim and the objects of the invention are likewise achieved by a suction station according to claim 13, optionally provided with one or more of the characteristics of the dependent claims.

The aim and objects of the invention are likewise achieved by a method and by a production line according to claims 9 and 24, optionally provided with one or more of the characteristics of the dependent claims.

Further characteristics and advantages of the invention will become better apparent from the description of preferred, but not exclusive, embodiments of the invention, illustrated by way of non-limiting example in the accompanying drawings wherein:

- Figure 1 is a block diagram of a battery production line according to the invention;

- Figures 2a, 2b and 2c are three block diagrams of machinery on the

production line of the previous figure, in three different embodiments according to the invention;

- Figure 3a is a schematic plan view of a filling station and of a suction station according to the invention;

- Figure 3b is a detail view of the transit path of the filling units during their electrolyte filling cycle;

- Figure 3c is a detail view of the transit path of the electrochemical cells through the suction station of the previous figure;

- Figures 4 and 5 are two perspective views, respectively from above and from below, of a first suction unit used in the suction stations according to the invention;

- Figure 6 is an axial cross-sectional view of the suction unit of Figure 4 or 5 coupled to an electrochemical cell inserted in a transport puck;

- Figure 7 is the same as the previous figure but with the first suction unit in the position for aspirating the electrolyte;

- Figure 8 is an axial cross-sectional view of a variation of the first suction unit according to the invention;

- Figure 9 is the same as the previous figure but with the variation of the first suction unit in the position for aspirating the electrolyte;

- Figure 10 is an axial cross-sectional view of a second suction unit according to the invention;

- Figure 11 is the same as the previous figure but with the second suction unit in the position for aspirating the electrolyte;

- Figure 12 is a schematic axial cross-sectional view of a sealing unit that can be used in sealing stations upstream or downstream of the suction station according to the invention.

With reference to the figures, a battery production line according to the invention, generally designated by the reference numeral 1, generally comprises an electrode production unit 301, a cell assembly unit 302 and an optional cell finishing unit 303, which can however be separate from the

line 1.

The line 1 is preferably an at least partially continuous production line and is particularly adapted to the production of batteries of the cylindrical-cell type, for example lithium ion batteries. However, the electrochemical cells that can be manufactured with the line 1 can also be prismatic, pouch or button cells.

In the discussion below reference will be made, for the sake of simplicity, to the production of single cylindrical cells.

Each unit 301, 302, 303 comprises one or more processing stations, each one consisting of an apparatus adapted to perform one or more operations on one or more elements that will go to make up the final cell or, in the case of the cell finishing unit 303, on the final cell. A dehumidification unit 400 is associated with at least one of such processing stations.

In particular, the electrode production unit 301 can comprise:

- a mixing station 310, adapted to perform a step of mixing the raw materials of the electrodes (for example, materials based on graphite for the anode and, separately, materials based on the lithium oxide of a metal for the cathode) with a conductive binder to form a mixture with a solvent;

- a coating station 311, adapted to perform a step of coating, with the mixtures obtained from the station 310, respective sheets of anode and of cathode, the function of which is to act as a current collector;

- a drying station 312 which receives the coated sheets from the station 311 and performs the evaporation of the solvent of the mixtures;

- a compression station 313, adapted to perform a compression operation (for example, via calendering) of the dried sheets arriving from the station 312;

- an optional cutting or "slitting" station 314, for cutting the electrode foils arriving from the compression station 313 into narrower strips, which will become the electrodes of the cell.

The cell assembly unit 302 can comprise:

- a stacking station (if the production line is for pouch cells) or a winding or folding station 320 (if the production line is for cylindrical or prismatic cells) for stacking the strips of cathode and anode arriving from the electrode production unit 301, in order to obtain a stack (called just a "stack") or a roll (called a "jelly roll") in which separator layers are interposed between the layers of cathode and anode;

- a station 321 for connecting contact terminals or "tabs" to the electrodes (stacked or rolled) arriving from the previous station, for example using laser welding or ultrasound welding;

- an insertion station 322 for inserting the electrodes (stacked or rolled) into respective casings (pouch, cylindrical or prismatic, on the basis of the type of cell to be produced). For cylindrical cells, the casing is substantially a cylindrical can, open at the insertion end. The casings can optionally be accommodated in respective transport pucks in the station 322 and/or in the stations downstream, as better described below;

- a closing station 323 for closing the casings, in which the cell casings containing the electrodes (stacked or rolled) and arriving from the station 322 are closed in an upward region with a lid, thus obtaining a container C. However, an inlet 30 is preferably left on the closing lid, in order to allow the subsequent filling of the container C with an electrolyte without needing to remove the lid, or without needing to make a perforation on the lid for filling purposes;

- a filling station 324 for filling the containers C with an electrolyte, which is typically in liquid or gel form. With this filling, filled containers C' are thus obtained which, in the discussion below, will also be called partially processed (electrochemical) cells C'. For example, for lithium ion cells, the electrolyte can consist of lithium salts dissolved in a non-aqueous organic solvent and with optional additives, or it can be another fluid or gel that is normally used as an electrolyte in this type of battery.

According to an aspect of the invention, the cell assembly unit 302 (in, or downstream of, the filling station 324) or the finishing unit 303 can comprise at least one suction station 328a and/or 328b in which steps are performed to remove any external electrolyte residues present around the inlet 30 (which may be temporarily plugged) and/or on the crimped rim 40 of the partially processed electrochemical cells C'.

The finishing unit 303, which can optionally be partially separate from the line 1, can furthermore comprise:

- a sealing station 329 for the filled containers C, which is adapted to seal (for example with a temporary plug or with a plug that is then welded after optional degassing) the inlet 30 used to fill the container C with electrolyte, and so complete the cell;

- a forming station 330, in which steps of charging and discharging the cell are performed, in particular according to predefined voltage and current curves;

- an aging station 331, in which the cells arriving from the forming station are stored and monitored for a certain period, for example by periodically measuring the open-circuit voltage, optionally at different temperatures;

- an end-of-line ("EOL") testing station 332 in which the cells stored in the aging station are further checked (for example, for any losses).

More specifically, in the embodiment illustrated, the sealing station 329 is placed between two suction stations 328a and 328b, as shown in Figure 2a and, in detail, in Figure 3c, in such a manner that the two suction units, shown respectively in Figures 4 to 7 (or in Figures 8-9) and in Figures 10 and 11, can interact, again respectively, directly with the inlet 30 and with the crimped rim 40 of the partially processed electrochemical cell.

However, in two possible variations of the embodiment illustrated, shown respectively in Figures 2b and 2c, there can be only one suction station 328a or 328b, positioned respectively upstream or downstream of the

temporary sealing station, in which a plug is temporarily inserted in the inlet 30 after filling and is then removed downstream, for optional degassing operations in the forming station 330, where at this point the final sealing of the filling inlet 30 is performed.

Conveniently, one or more of the processing stations that perform steps of the production process in which an ultra-dry environment is required can comprise walls that enclose a space of the processing station so as to form a respective dry room 100, which is advantageously kept at a (slightly) higher pressure than the outside environment via the injection of ultra-dry air originating from the dehumidification unit 400 which is connected, and optionally dedicated, to that processing station.

The side walls of the dry room 100 of the one or more processing stations are advantageously fixed to a supporting frame, to a footing or to a table of the apparatus that constitutes the processing station or which forms part of it.

With a dedicated dry room 100, which advantageously forms a single block with the respective processing station(s), the volume of the space in which to drastically lower the humidity is thus minimized, and can be for example less than 20 cubic meters (for example between 5 and 15 cubic meters) with consequent great savings of electricity to maintain an ultra-dry environment in such room. The operations to clean and restore the ultra-dry environment are also considerably reduced and simplified by this reduced volume.

With the positive pressure that is continuously maintained in such a dedicated dry room 100, it is possible to prevent the entry of contaminants and of humidity into the dry room 100 even though there is, on at least one of the walls of the dry room 100, one or more passage openings which are adapted to be passed through in entry and/or in exit, continuously or otherwise, by the products that are processed in the ultra-dry environment at those one or more processing stations.

Having confined the space in which the ultra-dry environment is required, the workers can operate freely along the battery production line 1 without the special contrivances required by conventional dry rooms and without running the associated risks, since during the operation of the line 1 the workers will always operate outside the stations that are fitted with a respective dry room.

The apparatus of the station fitted with the dry room 100 can optionally be designed so as to leave outside its dry room 100, while remaining within the apparatus, the components made mainly of materials that are incompatible with battery production or with the processing performed by that apparatus. For example, motors, with their copper windings, can be positioned outside the dry room 100 and connected via gear transmissions to the moving parts that manipulate or convey the products inside the dry room 100.

The dry room 100 can be integrated in the stations 324, 328a, 328b and 329 which perform, respectively, the filling with electrolyte of the containers C, the suction of any electrolyte residues present on the filled containers C' and the sealing of the latter or, in other words, the dry room 100 contains exclusively those stations 324, 328a, 328b and 329, as in the embodiment of Figure 3a.

Advantageously, the dry room 100 is defined by (moisture-proof) walls which enclose (laterally, above and below) the operating parts of the stations 324, 328a, 328b and 329, so as to be able to maintain in the dry room 100 a given (slightly) positive pressure $\Delta P1$ with respect to the atmospheric pressure. This preset positive pressure is adapted to prevent the entry of contaminants and of humidity into the dry room 100 and can be comprised between 10 and 20 pascals, for example 15 pascals.

The stations 324, 328a, 328b and 329 contained in the dry room 100 comprise a conveyance path for a series of containers C which arrive from the stations 322 or 323 and which, as mentioned previously, are preferably

casings closed by a lid and contain the electrodes of the battery, for example in the form of rolls or "jelly rolls". The containers C are conveyed, preferably with continuous motion, from an entrance 10 where containers C to be filled enter the dry room 100, to an exit 11 from which containers C leave which are filled, cleaned and preferably sealed temporarily or finally (also indicated here with C'), with a predetermined volume of electrolyte inside them.

The portion of the conveyance path of the containers that passes through the suction stations 328a and 328b and optionally the sealing station 329 is called, in the discussion below, the transit path T.

The entrance 10 and the exit 11 are preferably, but not necessarily, in the form of tunnels and communicate with passage openings which are provided on the walls of the dry room 100 and which have an area that is preferably of the minimum dimension necessary to allow the transit of the containers C or C' and the passage of linear conveyors 10a and 11a for the containers (for example belt, chain, roller, or screw feeder conveyors).

The entrance tunnel 10 and/or the exit tunnel 11 can also be kept at extremely low humidity levels, for example because they are connected to other dry rooms in other stations, or groups of stations, for processing upstream and/or downstream of the dry room 100. However, if the containers C arrive at the entrance 10, and/or the filled containers C' leave from the exit 11, sealed with a (temporary) plug, it is not necessary to have a tunnel at such entrance and/or exit, respectively, nor is it necessary to have a dry environment at the linear conveyors 10a and/or 11a.

Considering that the container C has its internal volume mostly taken up by electrodes, for example in "jelly roll" form, these obstruct what would otherwise be a faster introduction of the electrolyte into the container C, and they make it preferable to use the solution involving a buffer station 110 which is described below.

The container C can have a cylindrical shape with a circular base, as

in the case shown in the drawings, or a prismatic shape, a pouch shape or a button shape.

In the preferred embodiment of the invention, each container C along the conveyance path is advantageously accommodated in a respective transport puck 3, which is a beaker-like body that is open above at a rim 31 thereof so as to allow the container C to be slid (automatically) into the puck through the rim 31, leaving an upper inlet 30 thereof exposed, and to be stabilized during the various operations along the conveyance path and optionally along the paths upstream and/or downstream of the dry room 100.

The puck 3 is preferably adapted to remain integral with the container C at least along all of the path that passes through the dry room 100, by interference-fit coupling and/or by form-fit coupling with the external surface of the container C, but leaving preferably at least one lateral interspace 36 in order to allow the creation of a vacuum in the container C before its filling and/or in order to allow the washing of the container C before and/or after it is filled with the electrolyte. For example, the puck 3 can also have a substantially cylindrical shape. The height of the puck 3 is such that the rim 31 is substantially flush with the head portion (i.e. with the upper surface of the lid) of the container C when the latter is inserted in the puck 3.

The puck 3 can have on its lateral surface a fixing surface, for example in the form of at least one depression 32 which, in the embodiment illustrated, is coaxial with the central axis of the puck and advantageously annular. The fixing surface 32 is preferably arranged proximate to the upper rim 31 of the puck 3.

On the end that is axially opposite to the rim 31 the puck 3 has a base 33 which is suitable to give internal support to the container C and/or in any case to provide a resting surface outward, used for conveying the puck – and therefore the container C – along at least the conveyance path that passes through the dry room 100 or some sections thereof. The base 33 can have at

least one through hole 34, for example in the center, to provide an optional entrance for washing the container C after it is filled, or an optional vent during the insertion/removal of the container C with respect to the puck 3 and/or during the creation of a vacuum in the container C before it is filled, described below.

The lateral surface of the puck 3 can have an enlarged radial portion 35 which substantially acts as a radial spacer when the pucks are side-by-side, in particular on the buffer station 110 (described below) associated with the dry room 100 and preferably outside it.

The filling station 324 comprises filling units R (not shown in detail but configured substantially as independent syringe bodies which are recirculated in the filling station 324) which contain a preset quantity of electrolyte and are adapted to temporarily engage with the containers C of the battery (for example, using a grapple to latch on to the depression 32 of the puck 3) so as to form hermetically sealed unitary assemblies 4 and make such preset quantity of electrolyte – contained in them – flow by gravity or by means of direct injection into the containers C through the inlet 30 on the closing lid of the containers C.

With reference to Figures 4 to 11, according to an aspect of the invention, the suction stations 328a and 328b comprise respective pluralities of suction units 2a and 2b which can move with continuous motion along a part of the transit path T and toward/away from such transit path, in order to be coupled temporarily with respective partially processed electrochemical cells C', or with the respective pucks that contain them, which were previously filled in the filling station 324.

The suction units 2a and 2b are, in particular, circulated with continuous motion along a respective closed circular trajectory S1 and S2 by means of respective movement means. The circular trajectories S1 and S2 overlap on the above-mentioned part of the transit path T for the partially processed cells C'.

The suction stations 328a and 328b comprise, respectively, two carousels 150a and 150b, between which a temporary sealing carousel 152 can be interposed. These carousels rotate, preferably with continuous motion, about a respective central rotation axis and are adapted to transport the partially processed cells C' arriving along the part of the transit path T onto which the above-mentioned circular trajectories S1 and S2 overlap, for example by picking up the cells C' (or the pucks 3 that contain them) individually with grippers arranged spaced apart from, and at a constant pitch about, a central rotation axis of the carousels 150a, 150b and 152 and holding them for all of the above-mentioned part of the transit path T.

As an alternative to the carousels 150a and 150b, two transfer starwheels (not shown) can be used, which also rotate with continuous motion about a central rotation axis and which are adapted to entrain the partially processed cells C' (or the pucks 3 that contain them) along the above-mentioned part of the transit path T onto which the above-mentioned circular trajectories S1 and S2 overlap, while keeping these cells or pucks spaced apart at a constant pitch about the rotation axis of the starwheel. In this case, the transfer starwheels can have recesses on the respective peripheral region, which are adapted to receive the flank of respective cells C' or pucks 3 and to entrain them along the part of the transit path T that runs about the rotation axis of the starwheel.

The suction units 2a and 2b are integral with the rotation of the respective carousel 150a or 150b (or of the analogous transfer starwheel, not shown) and are arranged, at the constant pitch mentioned above, about the rotation axis of the respective carousel 150a or 150b (or of the transfer starwheel, not shown) so as to be superimposed on the electrochemical cells C' or on the pucks 3 conveyed or entrained by the respective carousel 150a or 150b (or by the transfer starwheel), i.e. superimposed on the grip clamps of the respective carousel 150a or 150b (or on the recesses of the respective transfer starwheel).

With reference to the first suction station 328a and to Figures 4 to 7, each first suction unit 2a comprises a main body 5 which is adapted to engage the head portion 38 of the filled containers C' (or, in an alternative embodiment, the rim 31 of the corresponding puck 3). The main body 5 can have a geometric structure that is substantially bell-shaped, with the open face of the bell directed toward the transit path T (i.e. downward) and configured to engage the head portion 38 (i.e. the top face) of the containers C' (or the rim 31 of the puck 3) so as to center the single suction units 2 on the respective container C' (or on the puck 3 that contains it).

In more detail, the open face of the bell is delimited by a circumferential profile 6, optionally toothed and with a bevel on the internal edge so as to define an inner surface that is substantially frustum-shaped and to facilitate the centering of the main unit 5 on the container C'.

Coupled to the main body 5 is a suction plunger 7, which functionally communicates (in particular, is in fluid communication) with suction means (for example a vacuum pump coupled with a demister or a pressurization line coupled to a Venturi ejector) and can slide with respect to the main body 5 along a direction substantially coaxial to the main body, so that, when the main body 5 is coupled to the filled container C' or to its puck 3, the corresponding suction plunger 7 can move in a direction that is normal and central to the inlet 30, between a position further away and a position closer to, or in contact with, the inlet 30. These two positions can be defined by two corresponding stroke limiting stops which protrude radially from the suction plunger 7.

The coupling between the suction plunger 7 and the main body 5 is a form-fit coupling that preferably only allows sliding (prismatic coupling or sleeve coupling). However, the form-fit coupling can be adapted to also allow a rotation of the suction plunger 7 about its own central axis and, to this end, the suction plunger can have a substantially cylindrical shape with a circular cross-section as, for example, shown in the drawings. This relative

rotation between the plunger 7 and the main body 5 optionally allows the cleaning by friction of the surroundings of the inlet 30 and of the inlet itself, when the plunger is in the contact position.

In this embodiment, consistently with the fact that the first suction step occurs before the sealing step (as shown in Figure 2a and Figure 2b) and that therefore the container C' containing the electrolyte is, at the moment of the suction step, open at the inlet 30, the suction plunger 7 advantageously comprises a head 8 with a blind central portion 9 (so as to plug or reduce the opening of the inlet 30 when arranged in the contact position) and a plurality of lateral suction channels 70 which come out in the outer peripheral region of the inlet 30. The lateral channels are in communication with an internal duct in the suction plunger 7 which comes out in an internal chamber of the main body 5 which is connected to the suction means.

The blind portion 9 can optionally be provided in the form of a flow control element, protruding axially from the head 8 and adapted to completely plug the inlet 30 when the suction plunger 7 is in the contact position.

In all the illustrated embodiments, the head 8 of the suction plunger 7 is advantageously contoured so that it can be partially accommodated in a recess 37 provided on the closing lid of the containers C', around the inlet 30, the function of which is to collect and contain any electrolyte residues that have dripped from the respective filling units of the filling station 324.

With reference to Figures 8 and 9, as an alternative to the first suction unit 2a, an embodiment 2a' can be provided, which is a variation of the unit 2a.

The embodiment 2a' of the first suction unit comprises a first suction body 44 which functionally communicates (in particular, is in fluid communication) with suction means and has a substantially cylindrical shape with a circular cross-section and is internally hollow as, for example,

shown in the drawings.

In the illustrated embodiment, consistently with the fact that the first suction step occurs before the sealing step (as shown in Figure 2a and Figure 2b) and that therefore the container C' containing the electrolyte is, at the moment of the suction step, open at the inlet 30, the first suction body 44 advantageously comprises a head 45 with a blind central portion 46 (so as to plug or reduce the opening of the inlet 30 when arranged in the contact position) surrounded by a plurality of lateral suction channels 47 which come out in the outer peripheral region of the inlet 30. The lateral channels 47 are in communication with an internal duct in the first suction body 44 which comes out in an internal chamber which is connected to the suction means. The suction means (not shown) can be implemented with a Venturi ejector, in which the (dry) air of an external pump or of a pressurization line is injected into a nozzle inside the ejector which first narrows and then widens out, causing a depression that enables the suction of the electrolyte residue, through a side port of the ejector connected to the internal chamber of the first suction body 44. In this way the electrolyte residue is expelled from an exit port in the ejector which is substantially coaxial to the nozzle inside the ejector and this residue can be collected in a container.

The blind portion 46 of the head 45 can optionally be provided in the form of a flow control element 48, protruding axially from the head 45 and adapted to completely plug the inlet 30 when the first suction body 44 is in the contact position.

The head 45 of the first suction body 44 is advantageously contoured so that it can be partially accommodated in a recess 37 provided on the closing lid of the containers C', around the inlet 30, the function of which is to collect and contain any electrolyte residues that have dripped from the respective filling units of the filling station 324.

Structurally, the first suction body 44 can be fixed in a cantilevered manner on a first vertical sliding rod 49 which is integral in rotation with

the carousel 150a, so that the first suction body 44 is superimposed on the transit path T and can be lowered directly onto the underlying cell C' transported by the suction carousel.

In more detail, the first suction body 44 can move with the first sliding rod 49 in contrast with and by the action of first elastic means 50, so that it is loaded toward its position in contact with the cell C' (Figure 9).

Advantageously, the first sliding rod 49 is connected to a cam follower that rests on a fixed cam so as to vertically move the first suction body 44 during the rotation of the respective carousel.

With reference to the second suction station 328b and to Figures 10 and 11, each second suction unit 2b comprises a second suction body 41, which functionally communicates (in particular, is in fluid communication) with suction means and has a substantially toroidal shape, internally hollow, which is adapted to be passed through without interference by the sealing plug or pin 20 protruding from the cell and to be positioned at the rim 40 (which can be crimped) of the upper lid (or head) of that cell.

Structurally, the second suction body 41 can be fixed in a cantilevered manner on a second vertical sliding rod 42, which is integral in rotation with the carousel 150b, so that the second suction body 41 is superimposed on the transit path T and can be lowered directly onto the underlying cell C' transported by the suction carousel 150b.

The second suction body 41 comprises one or more peripheral suction channels 43 which are connected with the suction means by means of the annular cavity inside the body 41. The peripheral suction channels 43 are directed downward i.e. toward the grip clamps or the supporting surface of the puck 3 or of the cell C', so as to face toward the cell, or the puck, at the (crimped) rim 40 of the cell C'.

The second suction body 41 can move with the second sliding rod 42 in contrast with and by the action of second elastic means 51, so that it is loaded toward its position in contact with the cell C'.

Advantageously, the second sliding rod 42 is also connected to a cam follower that rests on a fixed cam so as to move the second suction body 41 during the rotation of the respective carousel.

The suction means of the suction units 2a, 2a' and 2b described up to now can comprise a Venturi ejector (or Venturi meter) for each suction body 5, 44, 41, in which the air (preferably dry) of an external pump or of a pressurization line is injected into a nozzle (inside the ejector), the cross-section of which narrows and then widens out along the longitudinal axis of the ejector, causing a depression that enables (owing to the Venturi effect) the suction of the electrolyte residue through a lateral port of the ejector. This lateral port is connected to the internal chamber of the plunger 7, or of the first suction body 44, or of the second suction body 41, according to the suction unit 2a, 2a' and 2b in question. In this way the electrolyte residue is expelled from an exit port in the ejector (which is substantially coaxial to the entrance nozzle of the ejector) and can be collected in a container.

With regard to the sealing station 329, with reference to Figure 12, this can comprise a plurality of compressed air-powered syringes 12 which are adapted to take a respective sealing plug 20 from a magazine feeder and to insert it into the inlet 30 of the filled containers C'. These syringes 12 can be arranged on the sealing carousel 152 in a position coaxially above means for gripping the containers C' which are provided on the carousel 152 in mutually equidistant positions about the axis of rotation of the carousel 152. The syringes 12 on the sealing carousel 152 can thus individually take, during the continuous rotation of that carousel, the plugs 20 fed continuously to the carousel 152 by, for example, a star conveyor for loading plugs 151.

In the preferred embodiment, the stations 324, 328a, 328b and 329 comprise a plurality of carousels 120, 130, 140, 150a, 150b and 152 which are configured to define the conveyance path so as to enable the entrance of the empty container C into the dry room 100, the exit of the filled container

C' from the dry room 100, and the exchange of the unitary assemblies 4 with the buffer station 110.

In more detail, the conveyance path can comprise segments that are superimposed so as to minimize its bulk.

With reference to Figure 3a, 3b or 3c, for example, there can be a first conveyance path and a second conveyance path which comprise arcs of circumferences traced ideally by the grip means of the carousels and of the transfer starwheels with their rotation about the respective central rotation axes. Arcs of the first and of the second conveyance path are superimposed preferably along the circumferences traced ideally by grip means of a separation carousel 120 and of a coupling carousel 140.

Other superimposed segments between the first and the second conveyance path are along the buffer station 110 and along feeding 107 and unloading 108 conveyors for the unitary assemblies 4 to/from the buffer station 110. Preferably, such feeding and unloading conveyors pass through, for a portion thereof, a tunnel 109 which is connected to a lateral wall of the dry room 100 and they pass through this wall at passage openings, each one or all of which have a preset cross-section, preferably minimized so as to be able to maintain a modified pressure with respect to the atmospheric pressure inside the dry room 100 and optionally inside the tunnel 109.

In the embodiment, there can be:

- a separation carousel 120 adapted to separate the emptied filling units R' from the respective containers C' filled with the predetermined volume of electrolyte,
- a filling carousel 130 for filling the filling units R with electrolyte,
- a coupling carousel 140 adapted to temporarily fix the filled filling units R to respective containers C to be filled, so as to define the unitary assemblies 4,
- and at least one of the two suction carousels 150a and 150b which are adapted to remove any traces of electrolyte from the filled containers C’.

Any starwheels or carousels 151 or 152 that are located between the two suction carousels 150a and 150b can be used to apply the sealing plugs 20 to the inlet 30 of the filled containers C'.

Each one of the above-mentioned carousels can rotate, preferably with continuous motion, about a respective central rotation axis, which is preferably vertical for all the carousels.

Each carousel 120, 130, 140, 150a, 150b and 152 is advantageously provided with a plurality of grip means which are arranged evenly along its peripheral region and are adapted to retain or support, during the rotation of the respective carousel, at least a respective one of the filling units and/or a respective container C/C' or a respective puck 3 that contains a container C/C'.

Advantageously, transfer starwheels are also present upstream and downstream of each one of the carousels 120, 130, 140, 150a and 150b in order to transfer the conveyed object (filling unit R/R', suction unit 2a/2a'/2b, syringe 12, container C/C' or unitary assembly 4) from one carousel to another or from one carousel to a linear conveyor or vice versa.

The buffer station 110 is arranged along a superimposed portion of the paths which goes from the coupling carousel 140 to the separation carousel 120 and is associated with the conveyors for feeding (107) and unloading (108) the unitary assemblies 4, which conveyors respectively feed the unitary assemblies 4 to, and unload them from, the buffer station 110 at the production speed of the stations 324, 328a, 328b and 329.

The buffer station 110 is a buffer of the FIFO (First In, First Out) type and can be an accumulation table or an assembly of accumulation conveyors, arranged preferably outside the dry room 100, for example beside it or above it. The FIFO buffer can have one or more moving pads, conveyor belts, motorized roller conveyors or sliding surfaces, optionally arranged so as to form a serpentine route and in any case a route suitable to accumulate a (large) number of unitary assemblies 4 (in particular, N * t

unitary assemblies, where N is the production speed of the stations 324, 328a, 328b and 329 in terms of containers C' per minute and t is the time - in minutes – necessary to fill the individual container C with the predetermined volume of electrolyte), by distributing them over a wide surface or making them travel tortuous and/or lengthened paths in order to make them remain in the buffer station 110 for the length of time necessary for the containers C of the unitary assemblies 4 to be filled with the respective predetermined volume of electrolyte.

The unitary assemblies 4 arrive at the buffer station 110 preferably continuously, in a neat row and optionally mutually spaced apart with the same pitch as that between the grip means of the carousels of the stations 324, 328a, 328b and 329 and between the receptacles of the transfer starwheels.

The buffer station 110 is adapted to advance the unitary assemblies 4 arriving from the feeder conveyor 107 toward the unloading conveyor 108, at a speed and on a path length defined by the time (t) necessary to fill the individual container C with the predetermined volume of electrolyte. Such incoming unitary assemblies 4 each comprise the filling unit R filled with the predetermined volume of electrolyte and the container C not yet filled with such volume.

While the unitary assembly 4 is parked in the buffer station 110, the slow transfer of the electrolyte from the filling unit R to the container C takes place.

The complete transfer is ensured by virtue of the fact that each unitary assembly 4 can remain parked for the entire time necessary to complete the transfer of the volume of electrolyte from the filling unit R to the container C of the unitary assembly 4.

The dry room 100 is connected, via a delivery pipe 117, to a dehumidification unit 400 which is suitable for generating and injecting an ultra-dry air flow into the dry room 100, i.e. an air flow with a controlled

humidity percentage of the order of a few percent by volume, for example less than 3% by volume, more preferably less than 2% or 1% by volume, and suitable for maintaining a very low dew point, for example at a value of approximately -40°C or lower (for example, -60°C).

The operation of the invention is evident from the foregoing description.

In particular, with reference to Figures 3a, 4-7, and 10-11, the partially processed electrochemical cells C' arrive (each one preferably in its own puck 3) at the suction stations 328a and 328b, respectively, from the separation carousel 120 and from the sealing station 329 (in particular from the sealing carousel 152).

These cells C’ are then conveyed along the transit path T (by the suction carousels 150a and 150b and, if any, the sealing carousel 152) to the exit 11.

In the first suction station 328a, when the cells C' are picked up by the continuously-rotating first suction carousel 150a, a downward movement is performed of the first suction units 2a which, with the rotation of the carousel 150a, transit through the region from which the cells C' arrive. With the mutual approach between the main bodies 5 and the respective cells C', the main bodies 5 thus engage a respective cell C' (or the respective puck 3), so as to keep the first suction unit 2a substantially integral with the cell C' (or with the puck 3) for an arc of the circumference of rotation of the carousel 150a.

During this temporary coupling, the plunger 7 is lowered by sliding toward the cell C' and the suction means are activated to remove any electrolyte residues present on the external surface of the head portion 38 of the container C', in particular around the inlet 30.

With reference to the embodiment in Figures 8 and 9, as an alternative to the embodiment in Figures 4-7, when the cells C' are picked up by the continuously-rotating first suction carousel 150a, a downward movement is

executed of the first suction bodies 44 of the first suction units 2a' which, with the rotation of the carousel 150a, transit through the region from which the cells C' arrive.

With the mutual approach between the first suction bodies 44 and the respective cells C', the first suction bodies 44 thus engage a respective cell C' (or the respective puck 3), so as to keep the first suction unit 2a' substantially integral with the cell C' for an arc of the circumference of rotation of the carousel 150a.

During this temporary coupling, the suction means are activated to remove any electrolyte residues present on the central surface of the head portion 38 of the container C', in particular in the recess 37.

Meanwhile the flow control element 48, which closes the opening 30, prevents the suction means from sucking out the electrolyte contained in the container C' and prevents the electrolyte from being spattered outside the container C' owing to the movement thereof.

Subsequently, the container C' is handed over to the sealing carousel 152, which is provided with the syringes 12 which have previously picked up the sealing plugs 20 from the star conveyor 151.

These plugs are then inserted by pressure into the inlet 30 of the container C'.

In the second suction station 328b, when the cells C' are picked up by the continuously-rotating second suction carousel 150b, a downward movement of the suction bodies 41a of the second suction units 2b is performed which, with the rotation of the carousel 150b, transit through the region from which the cells C' arrive. With the mutual approach between the second suction bodies 41 and the respective cells C', the second suction bodies 41 thus engage a respective cell C' (or the respective puck 3), so as to keep the second suction unit 2b substantially integral with the cell C' for an arc of the circumference of rotation of the carousel 150b.

During this temporary coupling, the suction means are activated to

remove any electrolyte residues present on the external surface of the head portion 38 of the container C', in particular around the crimped rim 40.

In practice it has been found that the invention fully achieves the intended aim and objects. In particular, by virtue of the invention it is possible to remove electrolyte residues without resorting to operations such as blowing, which entail displacing or spreading the electrolyte residue onto the external surfaces of the electrochemical cell. The use is also avoided of cleaning cloths, which require frequent changing, as well as of other hazardous cleaning techniques such as thermal ablation.

The invention, thus conceived, is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims. Moreover, all the details may be substituted by other, technically equivalent elements.

In practice the materials employed, provided they are compatible with the specific use, and the contingent dimensions and shapes, may be any according to requirements and to the state of the art.

The disclosures in Italian Patent Application No. 102023000013746 from which this application claims priority are incorporated herein by reference.

Where technical features mentioned in any claim are followed by reference signs, such reference signs have been inserted for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

CLAIMS

1. A method for removing external electrolyte residues from partially processed cells originating from a station for filling with electrolyte for battery production lines, said method comprising a step of conveying said cells along a transit path (T), each one of said cells comprising a container (C') having a head portion (38) provided with an inlet (30) for access to an internal volume of the container (C'), said internal volume containing a predetermined amount of said electrolyte, said method being characterized in that it comprises a step of moving, at least partly along said transit path, a plurality of suction units (2a, 2a', 2b),

and in that it comprises, during said movement step, the steps of:

- temporary coupling of at least one of said suction units (2a, 2a', 2b) with a respective one of said cells or with a transport puck of said respective cell, so as to keep said suction unit (2a, 2a', 2b) substantially integral with said cell or said puck along at least part of said transit path; and

- during said temporary coupling, suction of possible residues of said electrolyte present on an external surface of said head portion of the container (C').

2. The method according to the preceding claim, wherein said suction unit comprises one or both of a first suction unit (2a, 2a'), configured for the suction of said possible residues of said electrolyte centrally to said head portion of the container (C'), and a second suction unit (2b), configured for the suction of said possible residues of said electrolyte peripherally to said head portion of the container (C').

3. The method according to the preceding claim, wherein said first suction unit (2a) comprises a main body (5) and a suction plunger (7) which is slideably coupled to said main body and functionally communicates with suction means, said temporary coupling step comprising the steps of:

- relative approach of said main body and said cell;

- engagement of said main body with said head portion of the

container (C') or with said puck;

- sliding of said suction plunger with respect to said main body (5) and toward said external surface of the head portion of the container (C').

4. The method according to the preceding claim, wherein said main body (5) is substantially bell-shaped, with an open base configured to engage said head portion or said puck so as to center said first suction unit (2a) with respect to said container (C'), said suction plunger (7) being able to slide in said main body (5) along a direction that is substantially coaxial to said main body (5).

5. The method according to claim 2, wherein said first suction unit (2a') comprises a first suction body (44) which functionally communicates with suction means, said temporary coupling step comprising the steps of:

- relative approach of said first suction body and of said container (C');

- engagement of said first suction body (44) with a central surface (37) of the head portion of the container (C').

6. The method according to the preceding claim, wherein said first suction body (44) comprises a head (45) provided with a blind central portion (46) adapted to temporarily plug said inlet (30) during the suction.

7. The method according to one or more of claims 2-6, wherein said second suction unit (2b) comprises a second suction body (41) which functionally communicates with suction means, said temporary coupling step comprising the steps of:

- relative approach of said second suction body and of said container (C');

- engagement of said second suction body (41) with the peripheral region of the head portion of the container (C').

8. The method according to the preceding claim, wherein said second suction body (41) has a substantially toroidal shape adapted to be passed through by a sealing plug (20) which protrudes from the inlet (30) and to

position itself on the rim of the head portion (38) of the container (C').

9. A method for manufacturing batteries, which comprises an electrode production step (301), a cell assembly step (302) and a step for finishing said cells (303), said cell assembly step comprising a step of filling containers with said electrolyte at a filling station, characterized in that it comprises, after said filling step, the method for removing residues according to one or more of the preceding claims.

10. The method according to the preceding claim, wherein said cell assembly step comprises a step of sealing said containers (C) which is performed after a first suction step, which is performed by means of said first suction unit (2a, 2a'), and/or before a second suction step, which is performed by means of said second suction unit (2b).

11. The method according to one or more of the preceding claims, wherein said method for removing residues is performed inside a dry room (100).

12. The method according to one of claims 9-11, wherein a plurality of said suction units (2a, 2a', 2b) are recirculated along a closed trajectory (S1, S2), which overlaps that part of said transit path (T) along which said steps of temporary coupling and suction are performed.

13. A suction station (328a, 328b) for removing external electrolyte residues from partially processed cells following their filling with an electrolyte, which comprises a transit path for said cells, or for pucks adapted to each contain at least a respective one of said cells, said suction station being characterized in that it comprises at least one suction unit (2a, 2a', 2b) which can move along a portion of said transit path and toward/away from said transit path in order to temporarily couple itself to respective cells, or with the respective pucks, conveyed along said transit path.

14. The suction station (328a, 328b) according to the preceding claim, comprising means for moving said suction units (2a, 2a', 2b) with a

continuous motion along a closed circular trajectory (S1, S2), which overlaps with said part of the transit path (T) of the cells.

15. The suction station (328a, 328b) according to claim 13 or 14, comprising a carousel or starwheel (150a, 150b), which can rotate with a continuous motion about a rotation axis and is adapted to convey or entrain said cells or said pucks along said part of the transit path while keeping said cells or said pucks spaced apart at a constant pitch about said axis of rotation, said suction units (2a, 2a', 2b) being arranged, with said constant pitch about said axis of rotation, on said carousel or starwheel so as to be superimposed on said cells or said pucks.

16. The suction station (328a) according to one or more of the preceding claims, wherein said at least one suction unit comprises a first suction unit (2a) which comprises a main body (5) and a suction plunger (7) which is slideably coupled to said main body and functionally communicates with suction means.

17. The suction station (328a) according to the preceding claim, wherein said main body (5) is substantially bell-shaped, with an open base configured to engage a head portion of the cell or a cell transport puck so as to center said first suction unit (2a) with respect to said cell, said suction plunger (7) being able to slide in said main body (5) along a direction that is substantially coaxial to said main body (5).

18. The suction station (328a) according to claim 16 or 17, wherein said suction plunger (7) comprises a head (8) having a blind central portion (9), so as to plug a filling inlet (30) of the cell when said suction plunger is placed in a position closer to said part of the transit path, and one or more lateral suction channels (70) which communicate with said suction means and which come out at a position that is adjacent to said blind central portion (9).

19. The suction station (328a) according to one or more of claims 16 to 18, wherein said suction plunger (7) is coupled to said main body (5) by

means of a form-fit coupling adapted to allow said sliding and possibly an axial rotation of said suction plunger with respect to said main body.

20. The suction station (328a) according to one or more of claims 13-15, wherein said at least one suction unit comprises a first suction unit (2a') having a first suction body (44), which functionally communicates with suction means and has a substantially cylindrical shape with a cross-section adapted for coupling to a head portion (38) of the cell (C').

21. The suction station (328a) according to the preceding claim, wherein said first suction body (44) comprises one or more suction channels (47), which communicate with said suction means and which come out downwardly and centrally to said first suction body, so as to be able to aspirate said residues at a region which is adjacent to said inlet (30).

22. The suction station (328b) according to one or more of claims 13 to 21, wherein said at least one suction unit comprises a second suction unit (2b) comprising a second suction body (41) which functionally communicates with suction means, wherein said second suction body (41) has a substantially toroidal shape, adapted to be passed through by a sealing plug (20) which protrudes from said cell[,] and to position itself on the rim (40) of the head portion (38) of said cell.

23. The suction station (328b) according to claim 22, wherein said second suction body (41) comprises one or more peripheral suction channels (43) which communicate with said suction means and come out downwardly, so as to face toward said rim (40) of the head portion (38) of a respective cell during transit.

24. A battery production line (1), comprising a group of electrode production stations (301), a group of cell assembly stations (302), and a cell finishing unit (303), each one of said groups (301, 302, 303) comprising a plurality of processing stations (310-314, 320-324, 328a, 328b, 329) which perform respective processes on one or more elements that make up the manufactured batteries, at least one of said processing stations comprising a

station (324) for filling with electrolyte containers (C) containing the electrodes of said cells, characterized in that at least one of said processing stations downstream of said filling station is the suction station (328a, 328b) according to one or more of claims 13-23.

25. The line according to the preceding claim, characterized in that said suction station (328a, 328b) is contained in a dry room (100) preferably shared with said filling station.

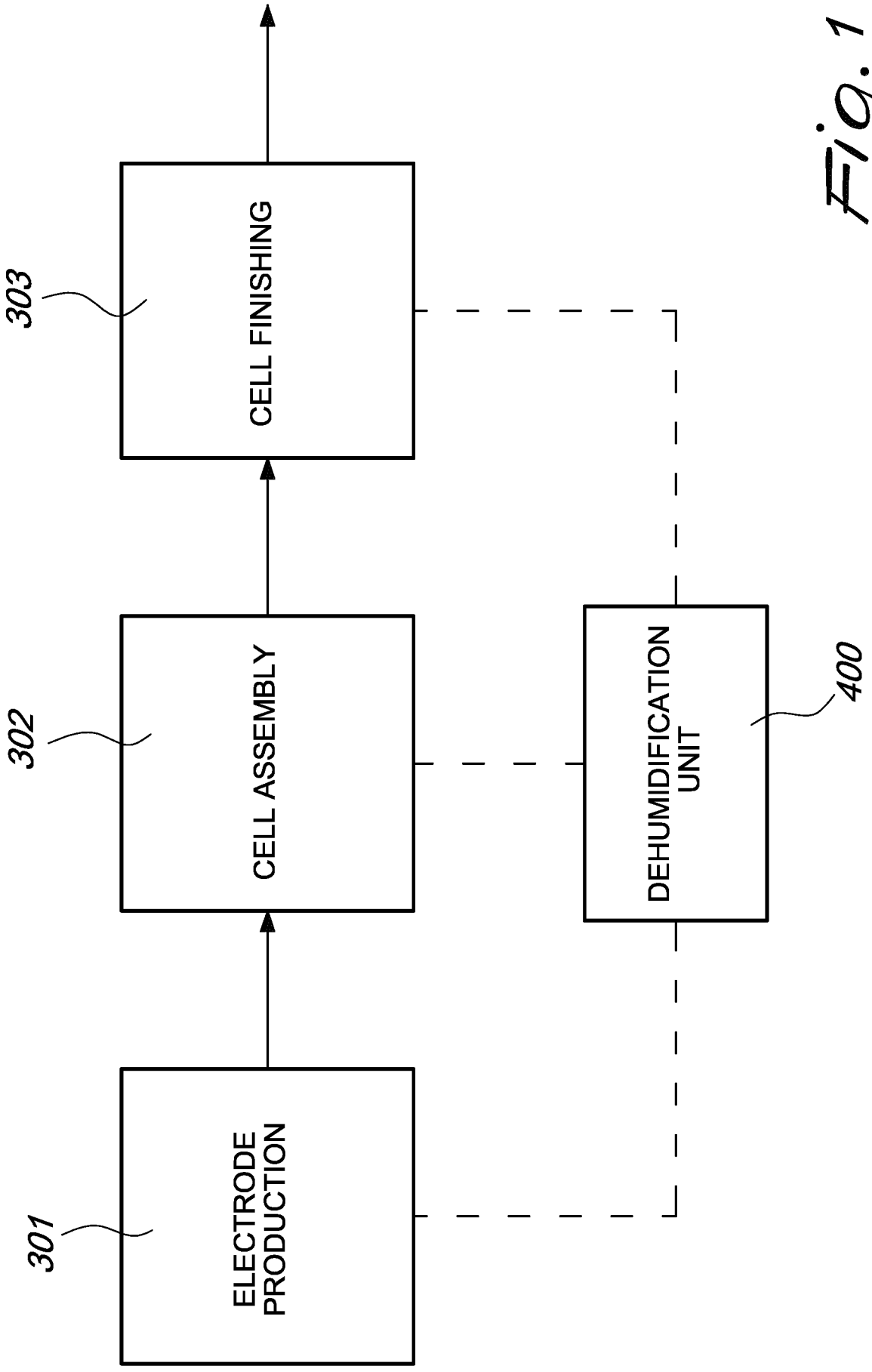
ELECTRODE PRODUCTION
301
CELL ASSEMBLY
302
CELL FINISHING
303
DEHUMIDIFICATION UNIT
400

Fig. 1

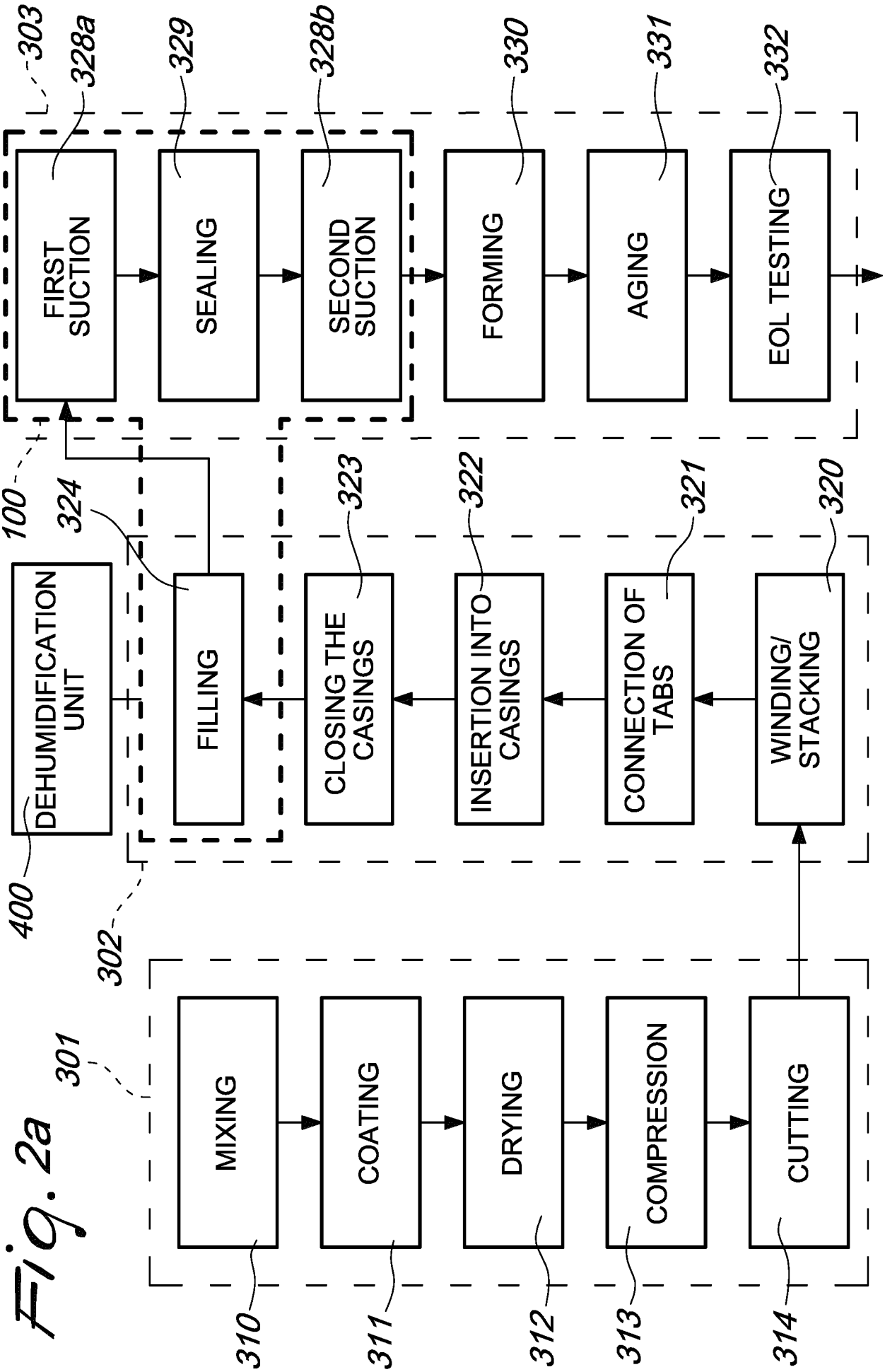
303
328a
329
328b
330
331
332
FIRST SUCTION
SEALING
SECOND SUCTION
FORMING
AGING
EOL TESTING
100
324
323
322
321
320
DEHUMIDIFICATION UNIT
FILLING
CLOSING THE CASINGS
INSERTION INTO CASINGS
CONNECTION OF TABS
WINDING/ STACKING
400
302
301
MIXING
COATING
DRYING
COMPRESSION
CUTTING
310
311
312
313
314

Fig. 2a

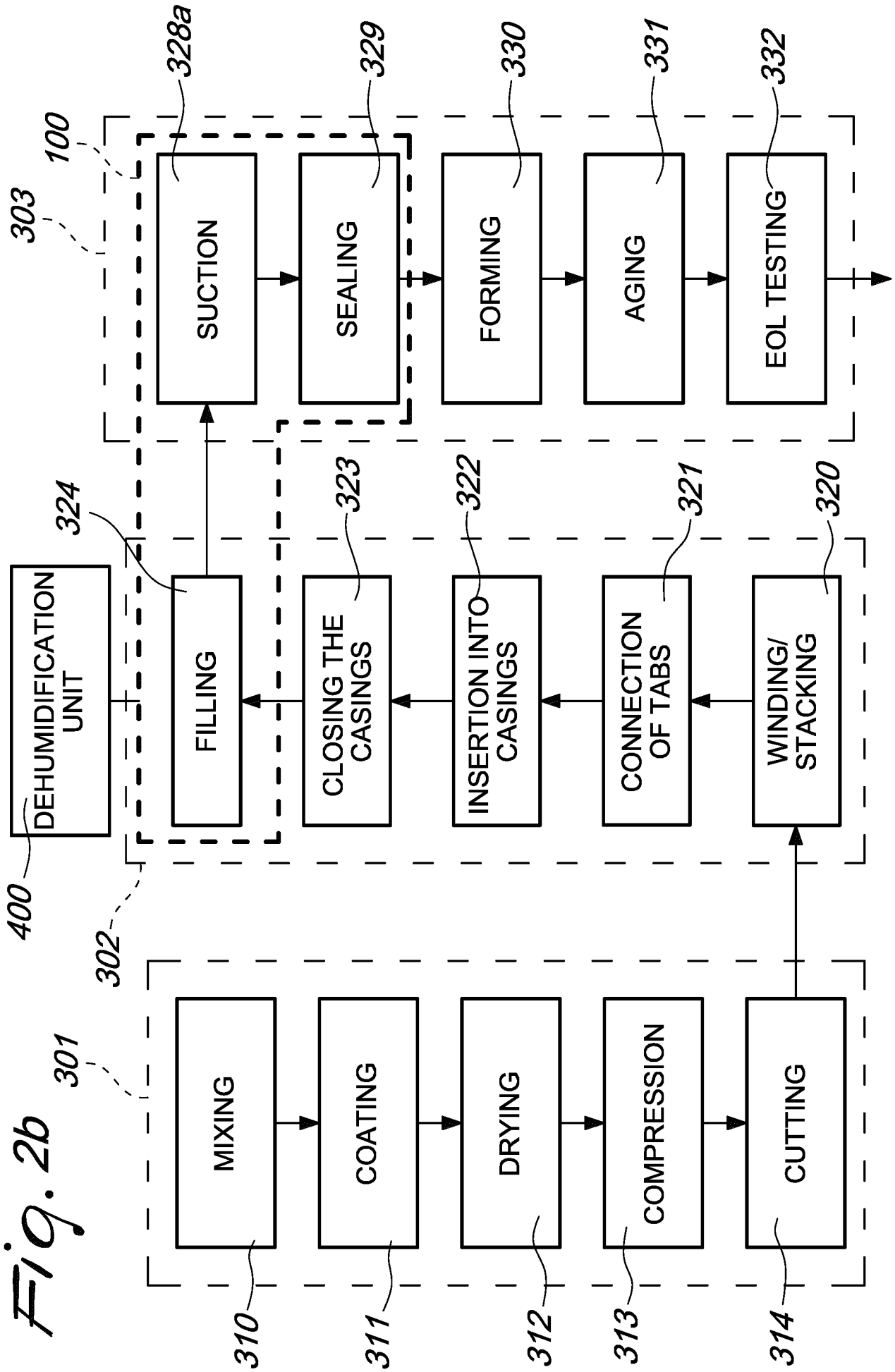
100
303
328a
329
330
331
332
SUCTION
SEALING
FORMING
AGING
EOL TESTING
324
323
322
321
320
DEHUMIDIFICATION UNIT
FILLING
CLOSING THE CASINGS
INSERTION INTO CASINGS
CONNECTION OF TABS
WINDING/ STACKING
400
302
301
MIXING
COATING
DRYING
COMPRESSION
CUTTING
310
311
312
313
314

Fig. 2b

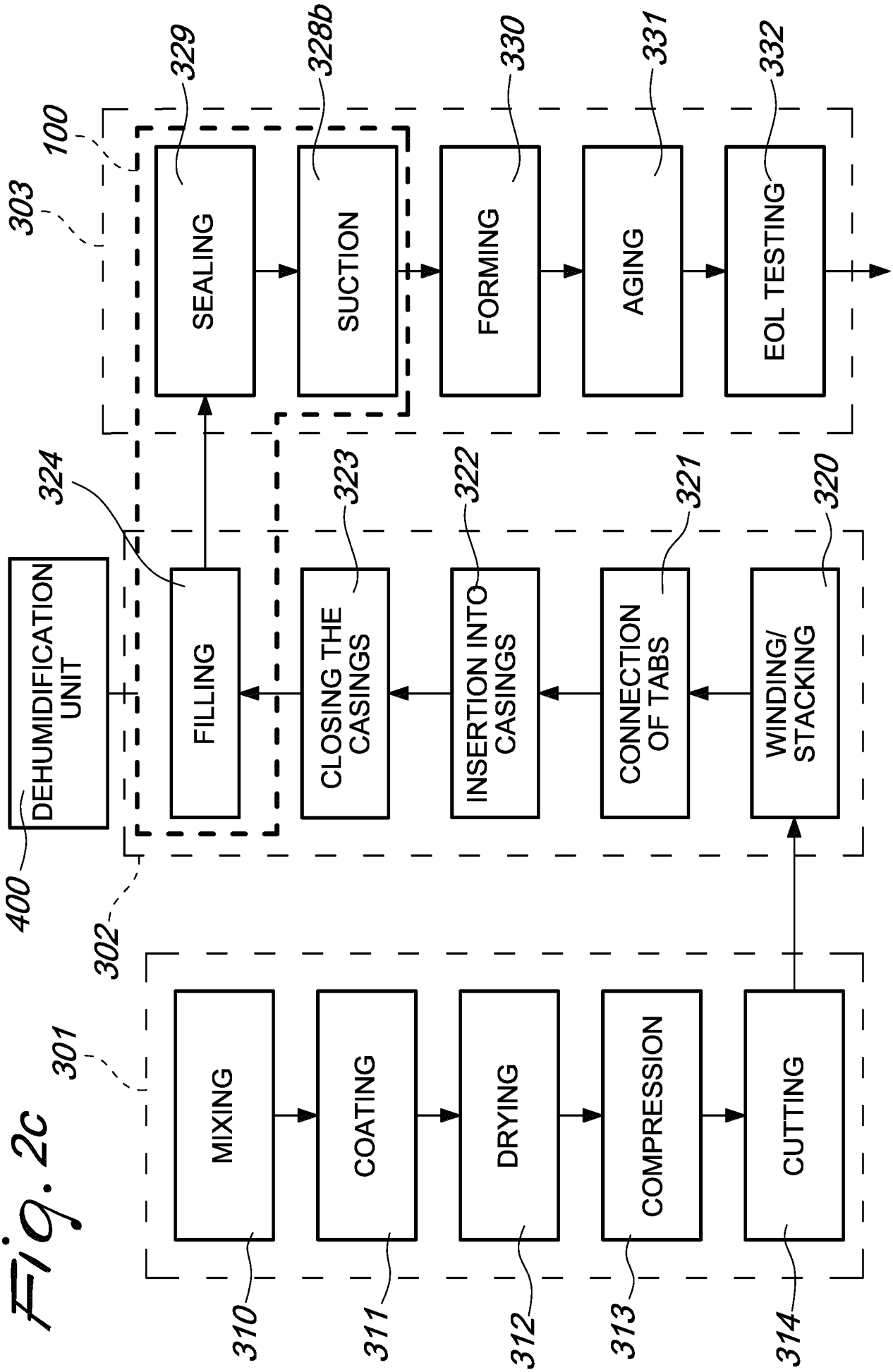
100
303
329
328b
330
331
332
SEALING
SUCTION
FORMING
AGING
EOL TESTING
324
323
322
321
320
DEHUMIDIFICATION UNIT
FILLING
CLOSING THE CASINGS
INSERTION INTO CASINGS
CONNECTION OF TABS
WINDING/ STACKING
400
302
301
MIXING
COATING
DRYING
COMPRESSION
CUTTING
310
311
312
313
314

Fig. 2c

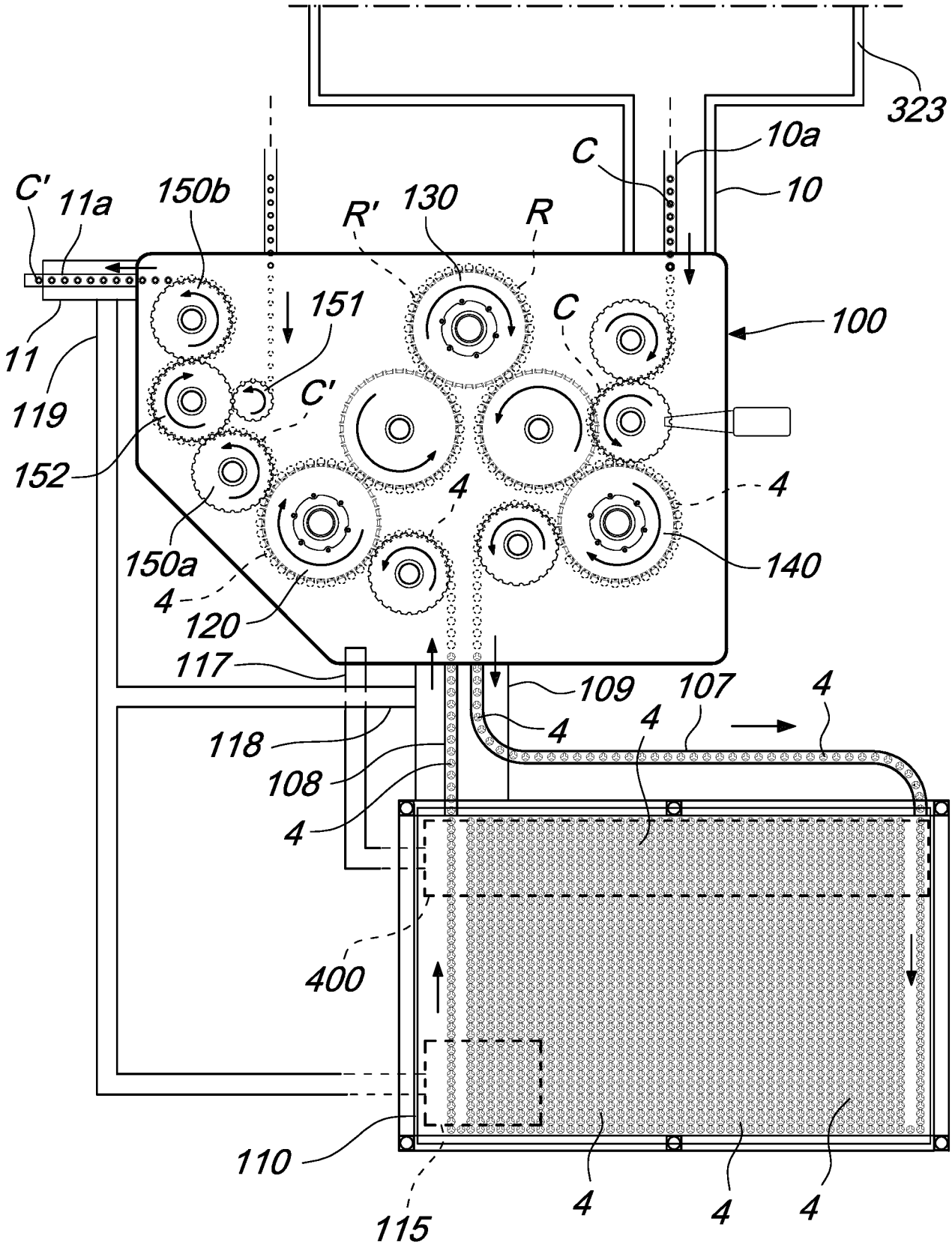
323
10a
C
10
C'
11a
150b
R'
130
R
151
C
100
11
119
C'
152
4
4
150a
140
4
120
117
109
107
4
4
4
118
108
4
400
110
115
4
4
4

Fig. 3a

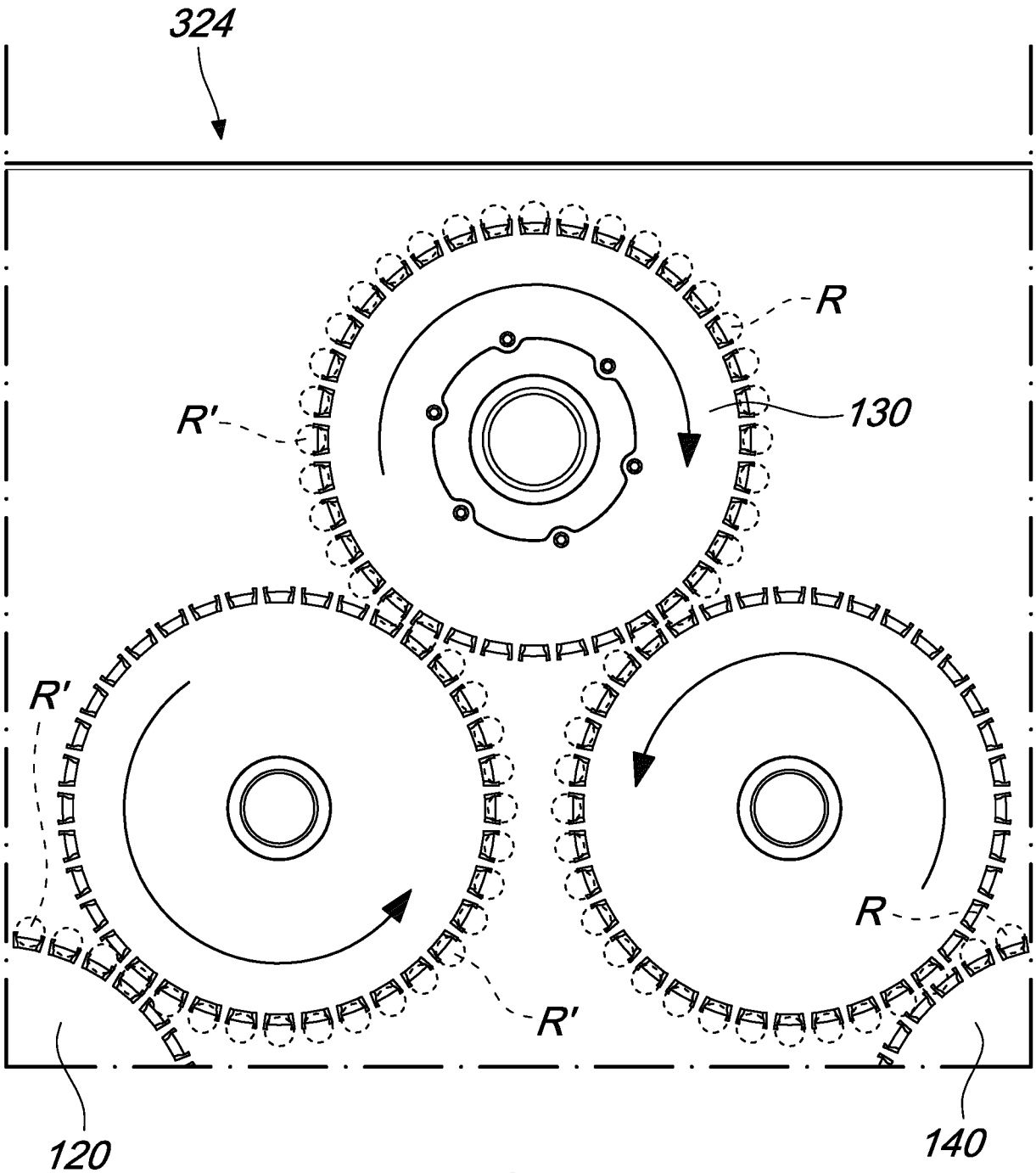

Fig. 3b

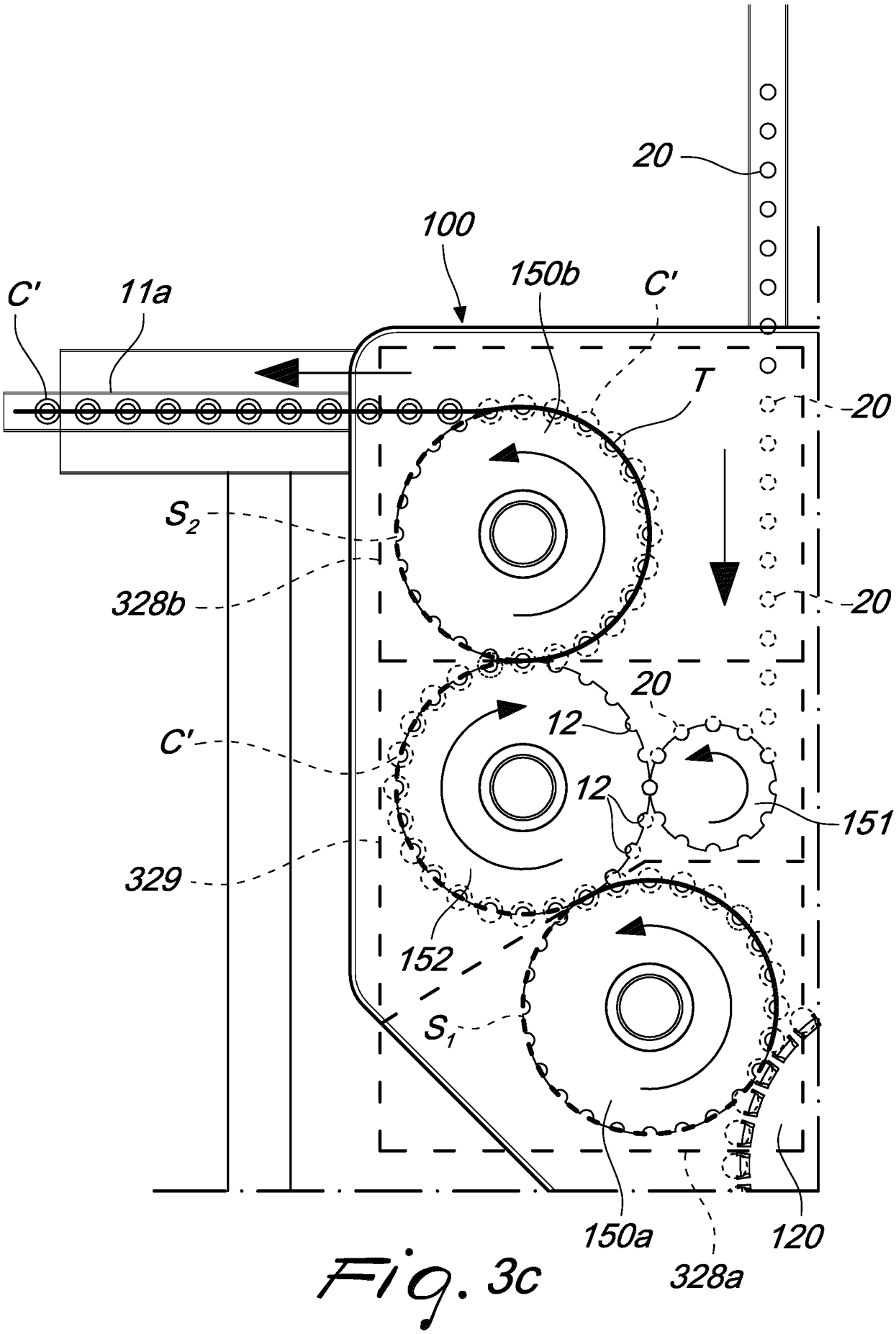
20
100
150b
C'
C'
11a
T
20
S2
328b
20
20
12
C'
12
151
329
152
S1
150a
120
328a

Fig. 3c

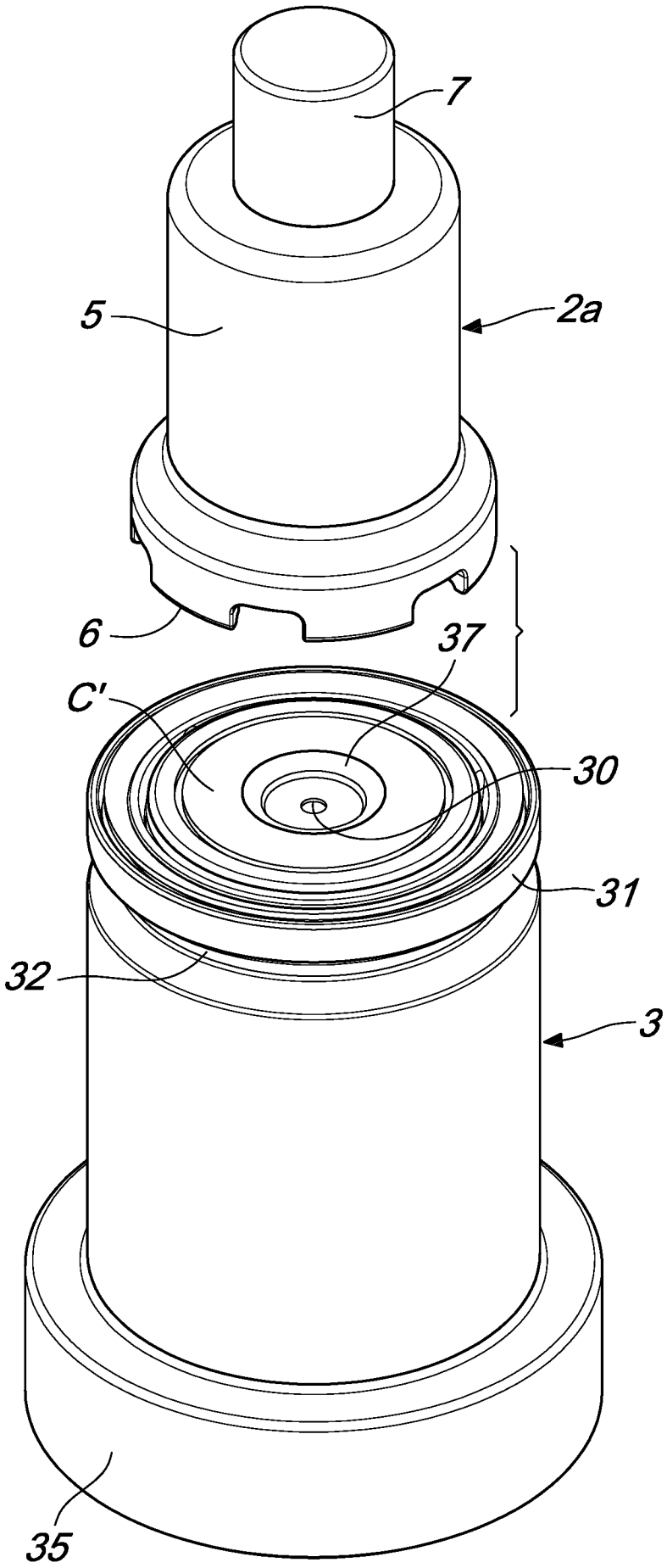

Fig. 4

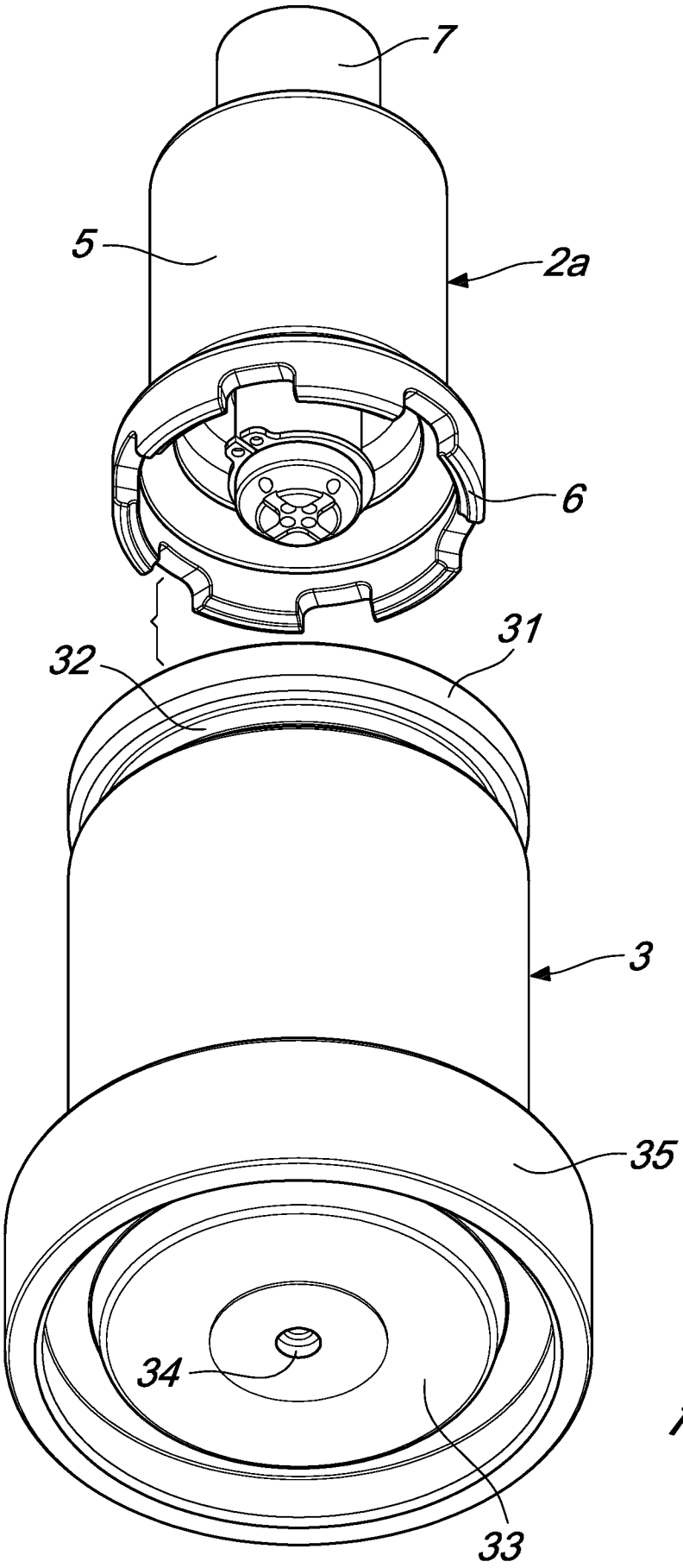

Fig. 5

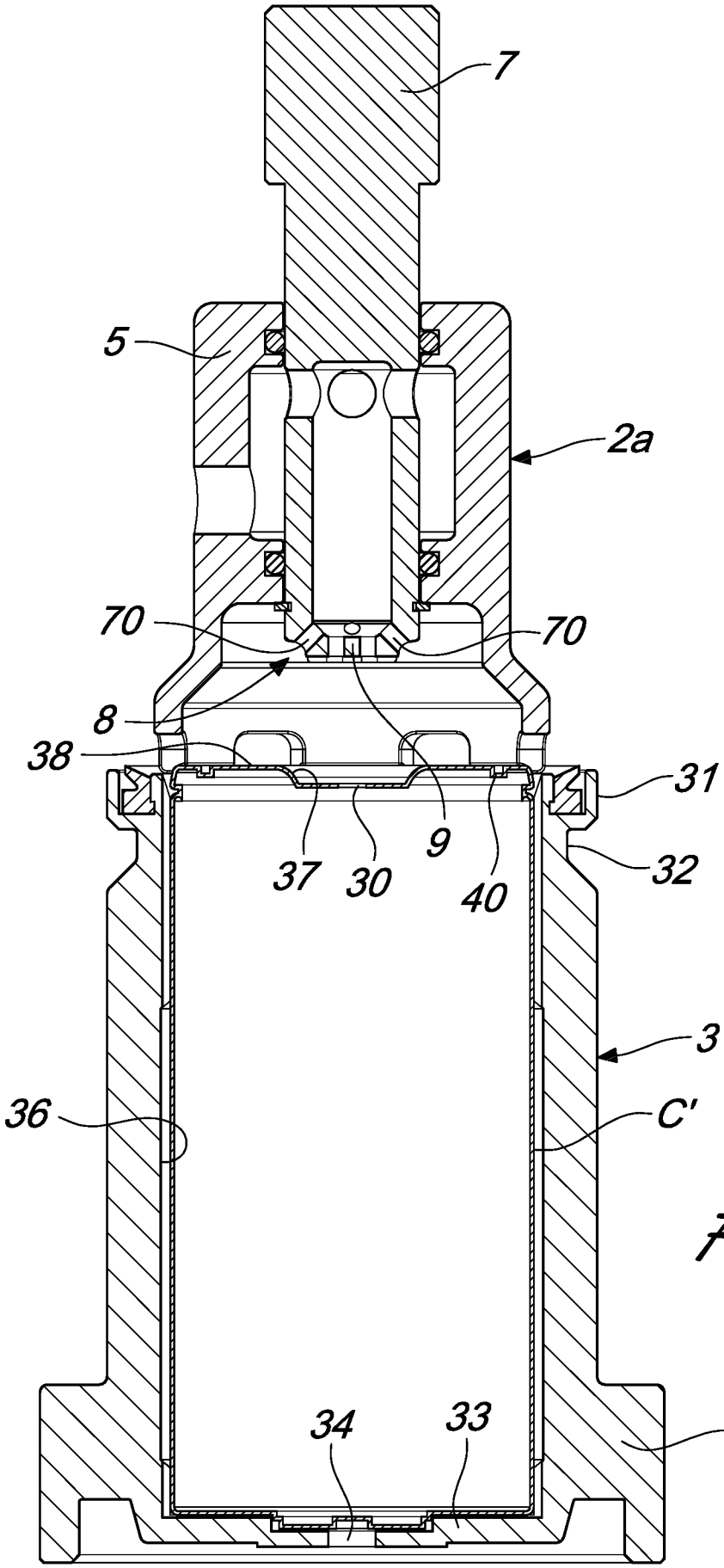

Fig. 6

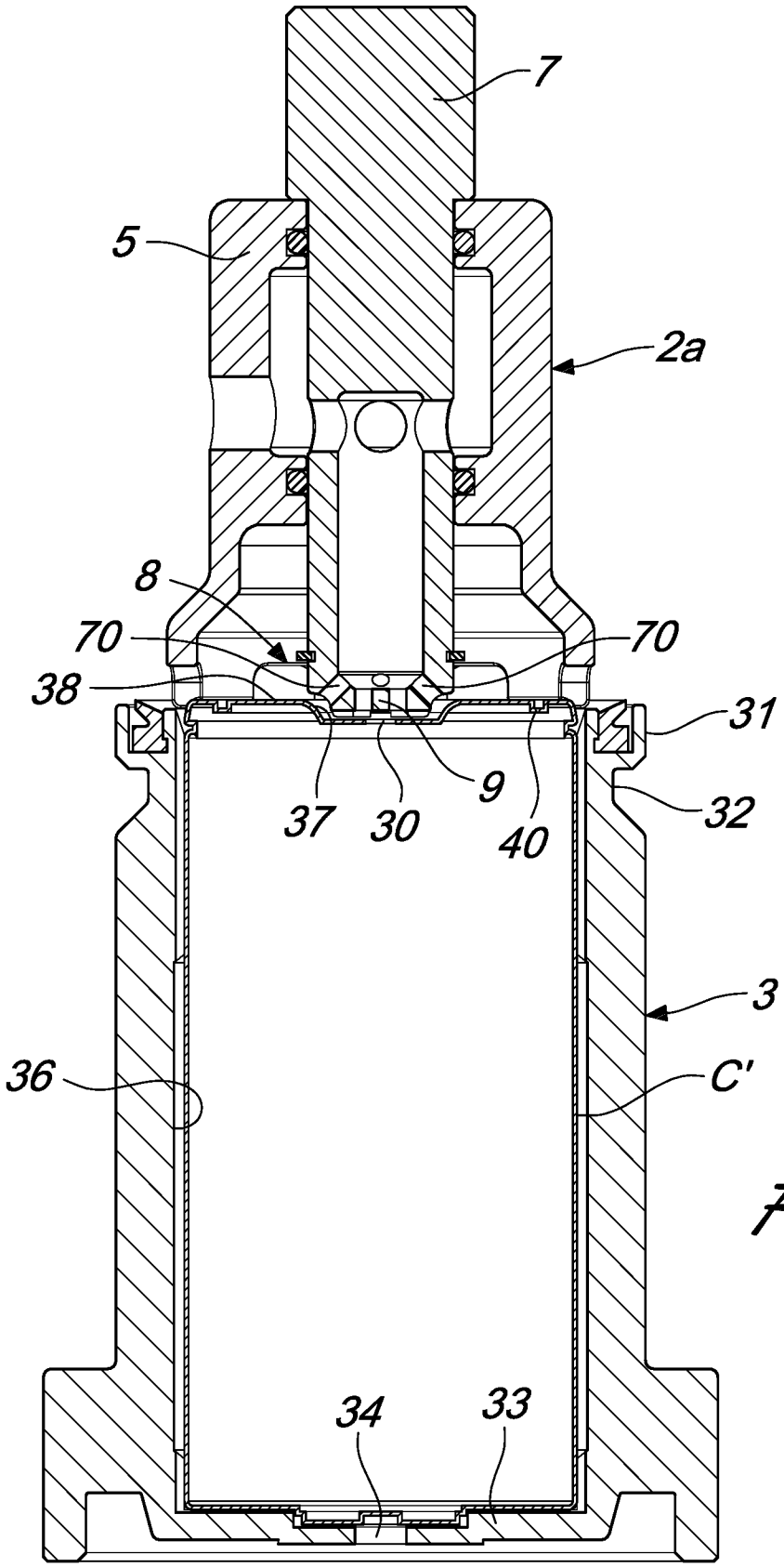

Fig. 7

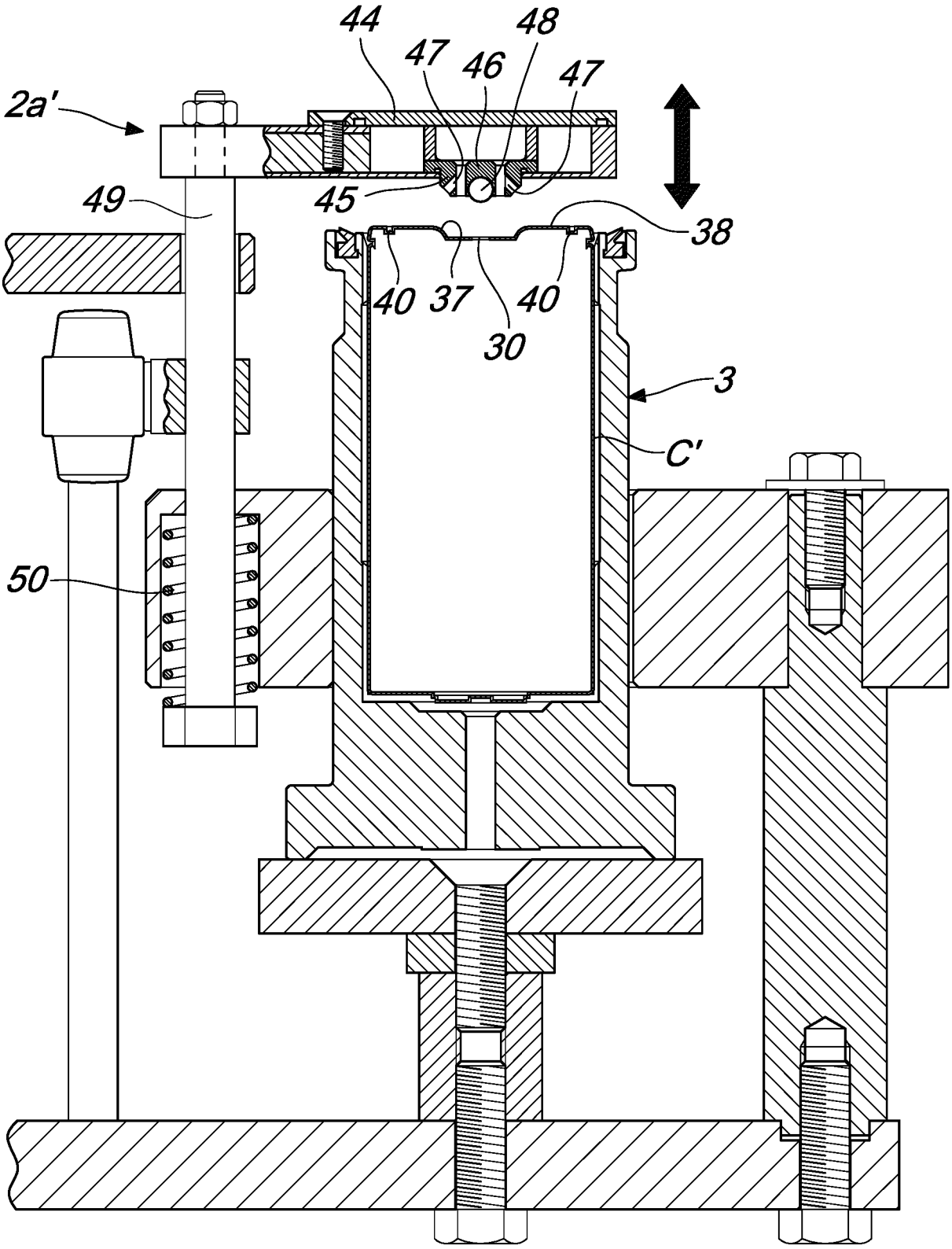

Fig. 8

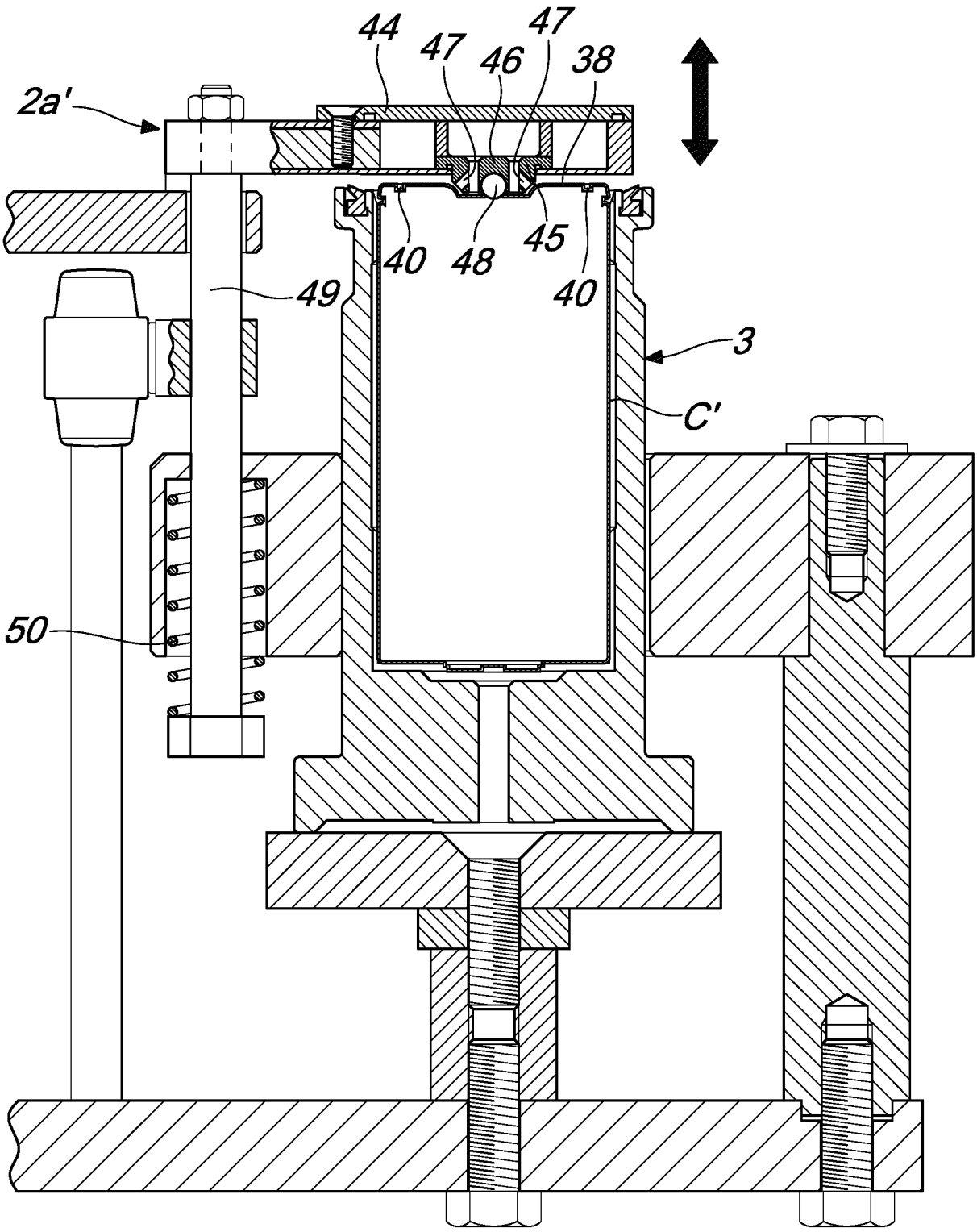

Fig. 9

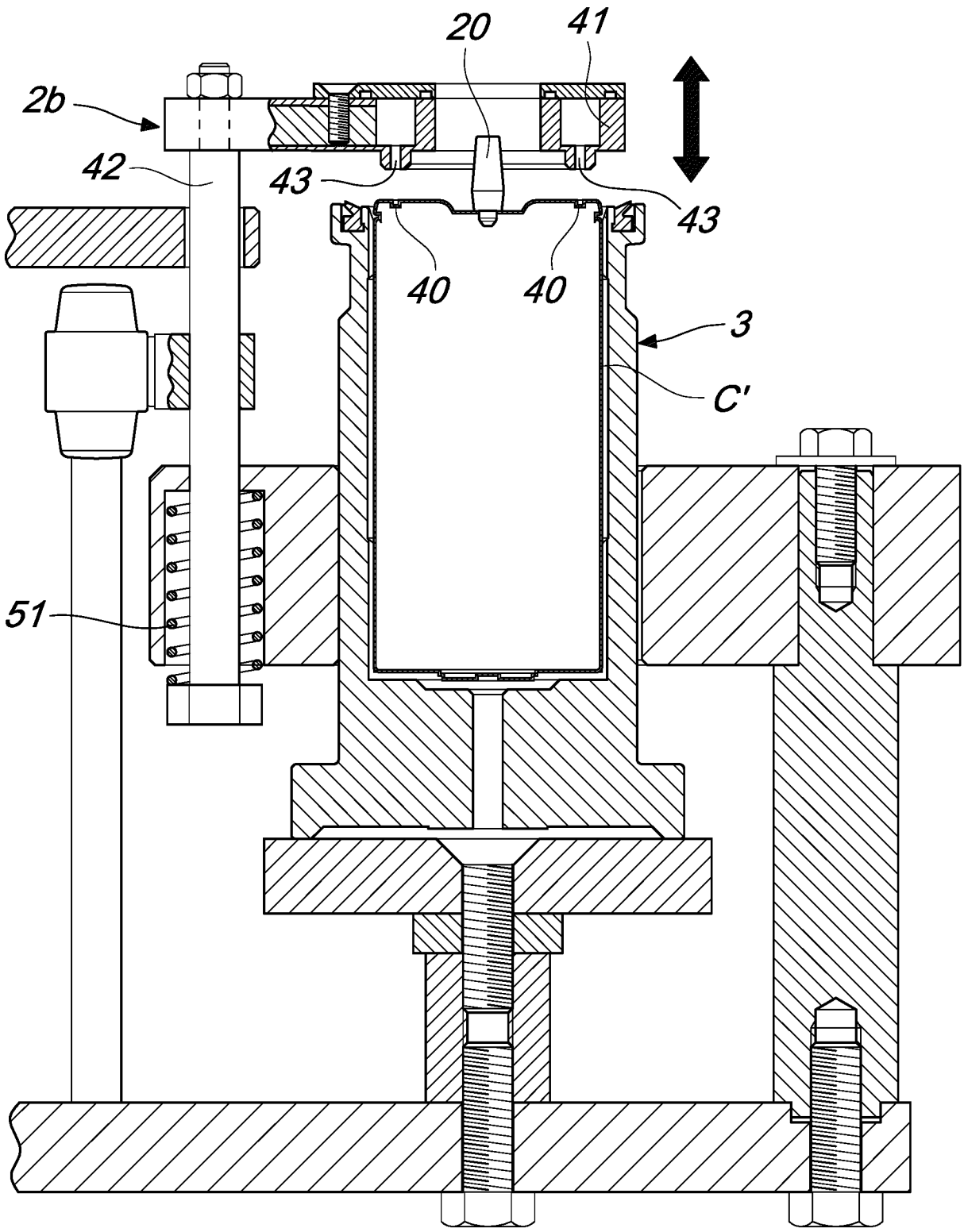

Fig. 10

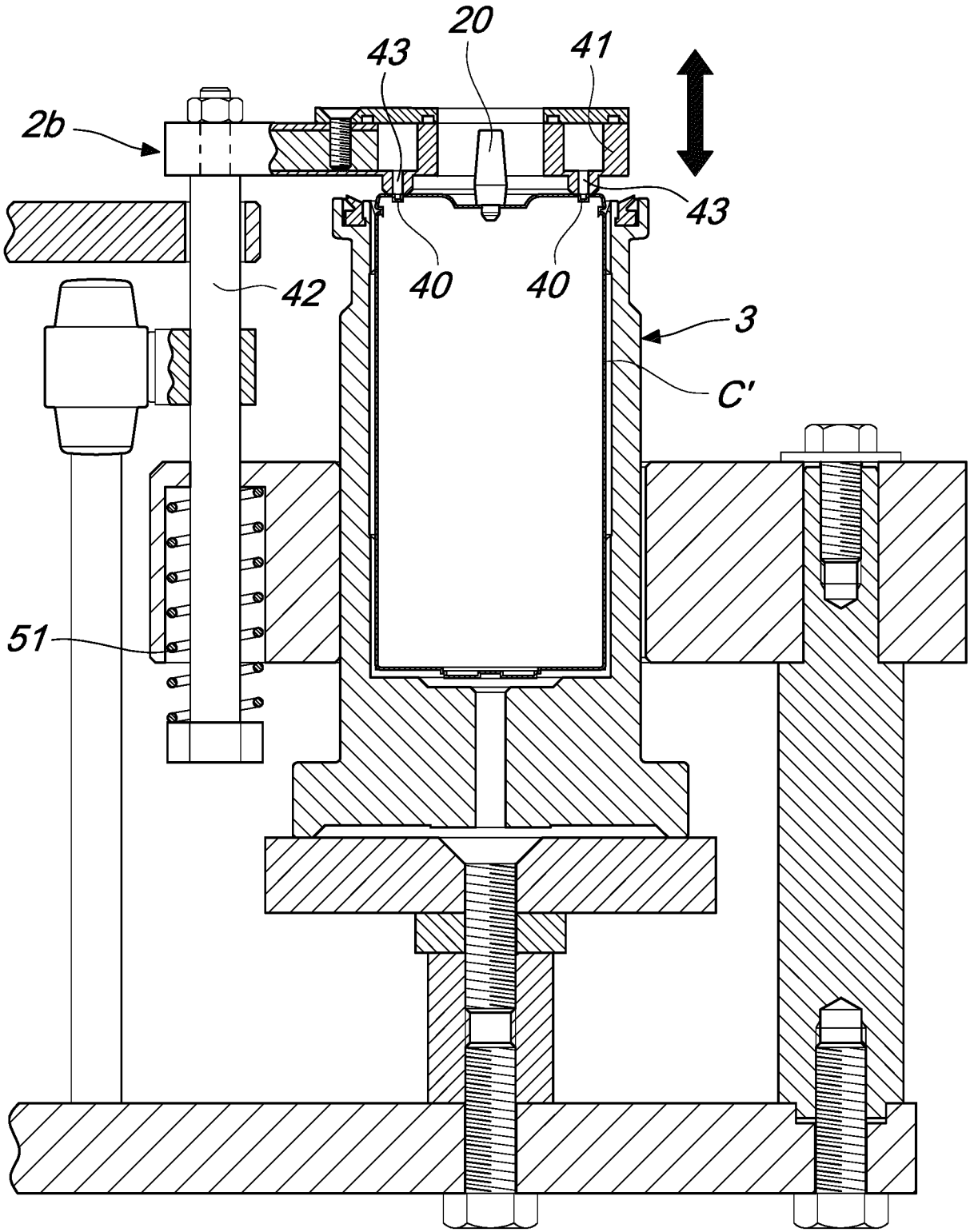

Fig. 11

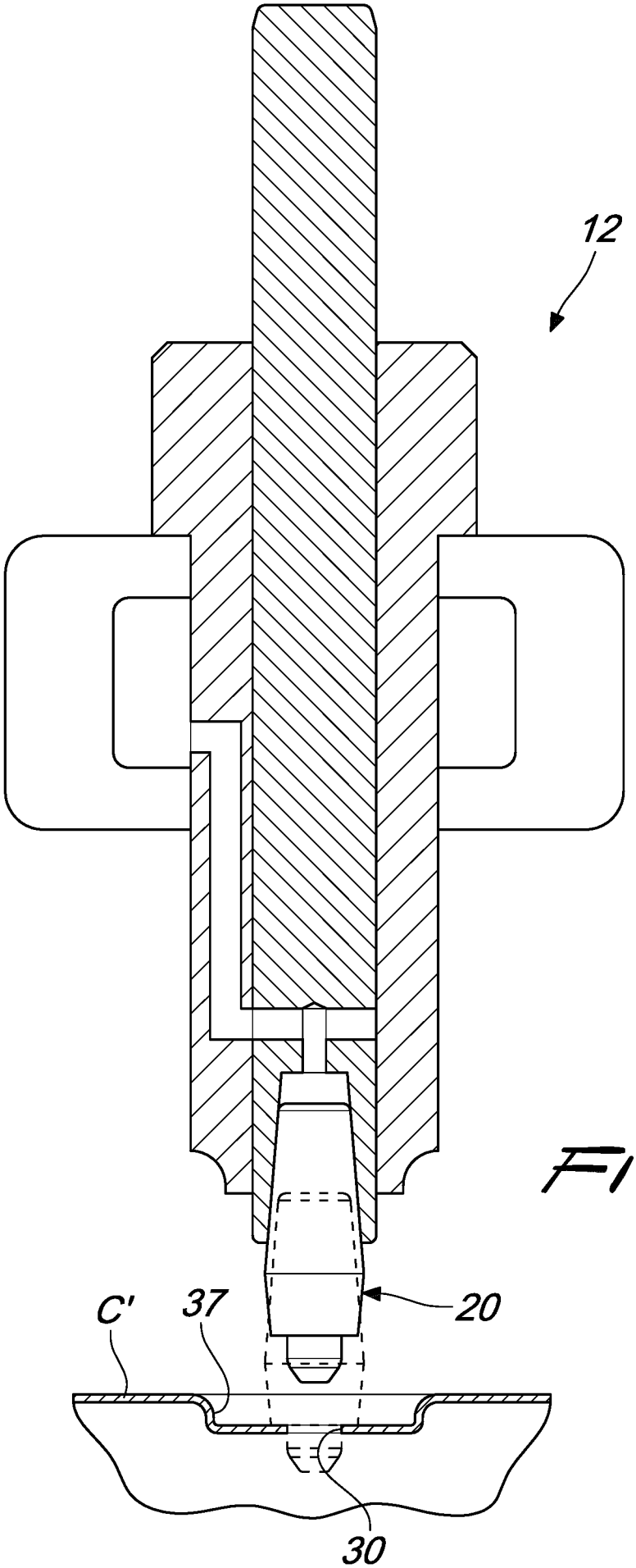

Fig. 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/068610

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01M10/04 H01M10/42
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)
H01M

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 205 723 746 U (CAMA ELECTROMECHANIC CO LTD) 23 November 2016 (2016-11-23) figure 2	1-25
A	CN 113 245 261 A (HEFEI GUOXUAN HIGH TECH POWER ENERGY CO LTD) 13 August 2021 (2021-08-13) claims 1-8	1-25
A	US 2 917 768 A (WALBERER WILLIAM A) 22 December 1959 (1959-12-22) claims 1-3; figures 1,2	1-25
A	WO 2009/117809 A1 (HIBAR SYTEMS LTD [CA]; RESCHKE BILL [CA]) 1 October 2009 (2009-10-01) figures 1-8	1-25

-/--

[x] Further documents are listed in the continuation of Box C.

[x] 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
20 August 2024	09/09/2024

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	Badcock, Gordon

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/068610

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2 883 815 A (MAITINO FRED P) 28 April 1959 (1959-04-28) claims 1-26 -----	1-25
A	EP 3 306 736 A1 (HONDA MOTOR CO LTD [JP]) 11 April 2018 (2018-04-11) paragraphs [0043], [0055]; claim 1; figures 1-6 -----	1-25

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2024/068610

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 205723746 U	23-11-2016	NONE	
CN 113245261 A	13-08-2021	NONE	
US 2917768 A	22-12-1959	NONE	
WO 2009117809 A1	01-10-2009	CN 101682021 A	24-03-2010
		US 2009242073 A1	01-10-2009
		WO 2009117809 A1	01-10-2009
US 2883815 A	28-04-1959	NONE	
EP 3306736 A1	11-04-2018	CN 107851860 A	27-03-2018
		EP 3306736 A1	11-04-2018
		JP 6162754 B2	12-07-2017
		JP 2017016941 A	19-01-2017
		US 2018198112 A1	12-07-2018
		WO 2017006667 A1	12-01-2017