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(71) Applicant: **ABB Schweiz AG**
5400 Baden (CH)

(72) Inventors:
- **Medea, Francesco**
  35040 Sant'Elena (PD) (IT)
- **Manco, Giuseppe Leonardo**
  87029 Scalea (CS) (IT)

(74) Representative: **De Bortoli, Eros et al**
Zanoli & Giavarini S.p.A.
Via Melchiorre Gioia, 64
20125 Milano (IT)

(54) A PROTECTION RELAY FOR HERMETICALLY SEALED DISTRIBUTION TRANSFORMERS

(57) A protection relay (1) for a distribution transformer (100) comprising a tank (101) adapted to contain a cooling liquid (500) characterized in that it comprises:
- a main body (2) adapted to be mechanically coupled in a removable manner with said tank, said main body including a case section (29) defining a first inner volume (295) and a duct section (27) adapted to link said case section with said tank, said case section including an inner chamber (20) in said first inner volume, said inner chamber being, in operation, in fluid-dynamic communication with said tank through said duct section and filled with said cooling liquid;
- an outer container (3) mechanically coupled in a removable manner with said case section (29), said outer container being in fluid-dynamic communication with said inner chamber and adapted to be partially filled with said cooling liquid (500);
- a floating element (4) accommodated within said outer container and adapted to be at least partially immersed in and moved by the cooling liquid (500) contained in said outer container;
- switching means (5) adapted to be actuated by said floating element when the cooling liquid contained in said outer container reaches one or more threshold levels.

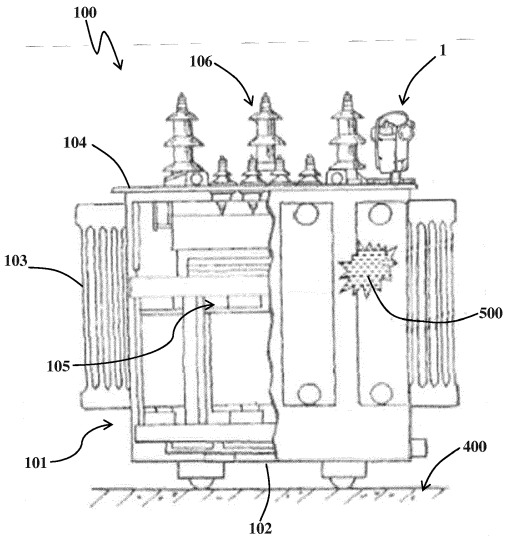

FIG. 1

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Description

[0001] The present invention relates to a protection relay for a hermetically sealed distribution transformer in electric power distribution installations.

[0002] Hermetically sealed distribution transformers are widely known in electric power distribution installations, i.e. operating at voltage levels higher than 1 kV AC and 1.5 kV DC up to tens of kV, e.g. up to 72 kV AC and 100 kV DC.

[0003] Typically, a hermetically sealed distribution transformer has live components (e.g. the magnetic core, input and output windings, and the like) accommodated in a sealed tank filled with a cooling liquid (typically a highly-refined mineral oil or a combustion-resistant vegetable oil) having excellent dielectric properties to help cooling of said components and provide electrical insulation therebetween.

[0004] During the operating life of such a transformer, specific physical quantities (e.g. volume, pressure, and the like) of the cooling liquid may vary (e.g. due to temperature fluctuations, gas accumulation within the tank, and the like) and lead to dangerous operating conditions.

[0005] For this reason, distribution transformers are typically equipped with safety devices (commonly known as "protection relays") aimed at monitoring the behavior of the cooling liquid and, possibly, providing alarm signals indicative of possible dangerous operative conditions are detected.

[0006] Although protection relays of the state of the art perform their functions in a satisfying way, there are some aspects to improve, in particular with regards of their structural layout, which is relatively complex and cumbersome, thus entailing time-consuming assembly procedures and relatively high manufacturing costs.

[0007] The main aim of the present invention is to provide a protection relay for a hermetically sealed distribution transformer, which allows overcoming the above-described disadvantages. Within this aim, another object of the present invention is to provide a protection relay having a simplified and compact structure.

[0008] Another object of the present invention is to provide a protection relay relatively easy and inexpensive to assembly and produce at industrial level.

[0009] The above aim and objects, together with other objects that will be more apparent from the subsequent description and from the accompanying drawings, are achieved by a protection relay for a distribution transformer, according to claim 1 and the related dependent claims.

[0010] In a general definition, the protection relay, according to the invention, comprises a main body mechanically coupleable in a removable manner with the tank of the distribution transformer. The main body includes a case section defining a first inner volume and a duct section adapted to link said case section with said tank.

[0011] The case section includes an inner chamber arranged in said first inner volume, which is, in operation, in fluid-dynamic communication with the tank of the distribution transformer through the duct section and it is filled with the cooling liquid of the distribution transformer. The protection relay, according to the invention, comprises an outer container mechanically coupled in a removable manner with said the case section. Said outer container is in fluid-dynamic communication with said inner chamber and, in operation, is partially filled with the cooling liquid of the distribution transformer.

[0012] The protection relay, according to the invention, further comprises a floating element accommodated within the outer container and adapted to be at least partially immersed in and moved by the cooling liquid contained in said outer container.

[0013] The protection relay, according to the invention, further comprises switching means arranged in said first inner volume and adapted to be actuated by said floating element when the cooling liquid contained in said outer container reaches one or more threshold levels. Conveniently, said switching means are operatively connected with an alarm circuit adapted to activate signalling means capable of providing alarm signals indicative of the level reached by the cooling liquid of the distribution transformer and/or with a power disconnection circuit adapted to activate disconnection means capable of causing the disconnection of the distribution transformer from a corresponding electric line.

[0014] According to an aspect of the invention, said case section and outer container respectively comprise second and third ports adapted to be in fluid-dynamic communication one with another.

[0015] According to an aspect of the invention, said case section and outer container respectively comprise mutually coupleable second and third mechanical connection means to mechanically couple said outer container with said case section in a removable manner at said second and third ports.

[0016] Preferably, said second and third mechanical connection means define at least partially said second and third ports and realize their mutual coupling to allow the flow of the cooling liquid through them.

[0017] Preferably, said second and third mechanical connection means are of the screw-less type, for example of the shape-coupling type or snap-fit type.

[0018] According to an aspect of the invention, the case section and the outer container of the protection relay comprise mutually coupleable fourth and fifth mechanical connection means to mechanically couple said outer container with said case section in a removable manner at a plurality of coupling points of said case section and said outer container.

[0019] According to an aspect of the invention, said outer container comprises first sealing means to seal a mechanical connection between said second and third mechanical connection means. According to an aspect of the invention, the protection relay comprises one or more pressure-measuring devices adapted to be in fluid-dynamic communication with said inner chamber to de-

tect a pressure of said cooling liquid.

[0020] According to an aspect of the invention, said outer container comprises a receptacle section and a cover section mechanically coupleable in a removable manner with said receptacle section.

[0021] According to an aspect of the invention, said case section and said receptacle section respectively comprise first and second contoured wall portions at which said outer container and said case section are mechanically coupled, said first and second contoured wall portions having transversal sections with geometrically conjugated profiles or complementary shapes. According to an aspect of the invention, said outer container comprises a safety valve to allow the exit of the cooling liquid from said outer container in emergency conditions.

[0022] According to an aspect of the invention, said receptacle section comprises at least a transparent or semi-transparent wall portion to allow a user to observe a level reached by the cooling liquid contained in said outer container.

[0023] Preferably, said receptacle section comprises indicator means at said transparent or semi-transparent wall portion to provide a user with information on a level reached by the cooling liquid contained in said outer container.

[0024] In a further aspect, the present invention relates to a hermetically sealed distribution transformer, according to the following claim 12.

[0025] Further characteristics and advantages of the present invention will be more apparent with reference to the description given below and to the accompanying figures, provided purely for explanatory and non-limiting purposes, wherein:

- Fig. 1 schematically illustrates a partial section view of a distribution transformer including the protection relay, according to the present invention;
- Figs. 2-5 schematically illustrate some partial perspective and section views of the protection relay, according to the present invention;
- Fig. 6 schematically illustrates a perspective view of the main body of the protection relay, according to the present invention;
- Figs. 7-8 schematically illustrate perspective and exploded views of the outer container of the protection relay, according to the present invention.

[0026] With reference to the aforesaid figures, the protection relay, according to the invention, will now be described in details.

[0027] In the following detailed description of the invention, identical components or elements are generally indicated by same reference numerals, regardless of whether they are shown in different embodiments. In order to clearly and concisely disclose the invention, the drawings may not necessarily be to scale and certain features of the invention may be shown in a schematic form.

[0028] Before proceeding with the description, it is worthy to clarify the meaning of some terms that are here repeatedly used to describe the invention.

[0029] Within the scope of the present invention, the terms "bottom", "top", "lateral", "upper", "lower", "horizontal" and "vertical" referred to some parts of said protection relay or of a hermetically sealed distribution transformer comprising said protection relay are to be intended in consideration of the normal installation conditions of said protection relay or said distribution transformer, e.g. as shown in figure 1.

[0030] Within the scope of the present invention, the expression "in fluid-dynamic communication" referred to some parts of said protection relay or of said distribution transformer is to be intended with reference to an operating condition, in which the cooling liquid can flow between said parts (through suitable ducts or suitable ports), so that said parts are filled or partially filled with said cooling liquid.

[0031] In figure 1, a hermetically sealed distribution transformer 100 for electric power transmission and distribution installations is schematically shown.

[0032] In operation, the transformer 100 contains a liquid 500 having cooling and electrical insulation properties, e.g. mineral or vegetal oil (hereinafter referred to as "cooling liquid" for the sake of brevity).

[0033] The transformer 100 comprises a sealed tank 101 adapted to be filled with the cooling liquid 500.

[0034] Normally, the tank 101 has a parallelepiped-like geometry and it comprises a base wall 102 intended to lay on a suitable basement 400, a horizontal top wall 104 in an opposite position with respect to the base wall 102 and one or more lateral walls 103.

[0035] The transformer 100 comprises first electric components 105, which are accommodated within the tank 101 and are at least partially immersed in the cooling liquid 500, and second electric components 106 protruding from the top wall 104 of the tank 101 for electrical connection with an electric line.

[0036] In general, the cooling liquid 500, the tank 101, the first electric components 105 and the second electric components 106 of the transformer 100 may be of known type and will not be here described in further details for the sake of brevity.

[0037] As shown in figure 1, the transformer 100 is equipped with a protection relay 1, according to the present invention, operatively installed on the tank 101, preferably at the top wall 104 of this latter.

[0038] According to the invention, the protection relay 1 comprises a shaped main body 2 adapted to be mechanically coupled in a removable manner with the tank 101.

[0039] The main body 2 includes a case section 29, which defines a first inner volume 295 for accommodating some components or parts 6, 20 of the protection relay 1, and a duct section 27 for linking the case section 29 with the tank 101.

[0040] Preferably, as shown in the cited figures, the

case section 29 extends along a longitudinal axis 200, for example with a substantially cylindrical-like geometry.

[0041] The case section 29 conveniently comprises a lower wall 291 solidly fixed (preferably made in one piece) with the duct section 27, an upper wall 292 in a distal position with respect to the lower wall 291 and a contoured lateral wall 290 arranged between the lower wall 291 and the upper wall 292.

[0042] Conveniently, the walls 290, 291, 292 of the case section 29 may be arranged in such a way that, when the protection relay 1 is in its normal operative position, the lower wall 291 extends along a horizontal plane (substantially parallel to the top wall 104 of the tank 101), the upper wall 292 extends along an inclined plane intersecting the extension plane of the lower wall 291 and the lateral wall 290 extends vertically, substantially perpendicular with respect to the extension plane of the lower wall 291.

[0043] The above-described arrangement of the case section 29 is quite advantageous as it prevents or remarkably reduces the deposit of dirt substances on the protection relay 1, particularly on the top side of this latter.

[0044] Preferably, the lateral wall 290 of the case section 29 comprises a first contoured wall portion 290A, at which the case section 29 is coupled with an outer component 3 of the protection relay 1, which is distinct and external with respect to the main body 2.

[0045] Conveniently, the above-mentioned first contoured wall portion 290A has a transversal section (reference is made to a transversal section plane substantially parallel to the lower wall 291) having a shaped profile designed in such a way to define a recess 24 intended to accommodate, at least partially, an outer component 3 of the protection relay.

[0046] As better evidenced in the following, this latter solution is quite advantageous since it allows reducing the overall lateral dimensions of the protection relay 1.

[0047] According to an aspect of the invention, the duct section 27 comprises a sealed probe portion 271 and a link portion 272.

[0048] The sealed probe portion 271 is, in operation, inserted through a suitable opening (not shown) of the top wall 104 of the tank 101 and immersed in the cooling oil 500.

[0049] The sealed probe portion 271 is conveniently adapted to accommodate one or more temperature sensors or probes that are operatively coupled with one or more thermostat devices and/or a control unit and/or an alarm circuit and/or a power disconnection circuit by means of suitable sealed electrical connections.

[0050] Conveniently, the link portion 272 is adapted to be in fluid-dynamic communication with the tank 101 and filled with the cooling liquid 500.

[0051] The link portion 272 is coupled to the case section 29, preferably at the lower wall 291 of this latter.

[0052] Preferably, the link portion 272 is arranged in such a way to protrude from the top wall 104 when the protection relay 1 is coupled with the tank 101, thereby maintaining the case portion 29 spaced in elevation from the aforesaid top wall 104.

[0053] According to an aspect of the invention, the duct section 27 further comprises first mechanical connection means 270 to mechanically couple the main body 2 with the tank 101 of the transformer 100.

[0054] Preferably, the first mechanical connection means 270 comprise a connection flange fixable to the top wall 104 of the tank 101 by means of bolts, screws or similar mechanical connecting elements.

[0055] The connection flange 270 may be arranged in an intermediate position between the portions 271, 272 of the duct section 27. In this way, when the connection flange 270 is fixed to the tank 101, the probe portion 271 is inserted in the tank 101 whereas the link portion 272 protrudes form the top wall 104 of this latter.

[0056] In order to obtain a hermetically sealed mechanical connection between the connection flange 270 and the tank 101 suitable sealing elements (not shown), for example one or more metallic sealing gaskets, may be conveniently arranged.

[0057] According to the invention, the case section 29 comprises an inner chamber 20 within the inner volume 295, which is adapted to be in fluid-dynamic communication with the tank 101 and filled with the cooling liquid 500.

[0058] Preferably, the inner chamber 20 comprises a first port 21 coupled with the duct section 27 to allow the flow of the cooling liquid 500 between the duct section 27 and the inner chamber 20. In this way, both the duct section 27 and the inner chamber 20 can be filled with the cooling liquid 500, when the main body 2 is mechanically coupled with the tank 101. Preferably, the first port 21 is arranged at the lower wall 291 of the main case 29 and is coupled with the link portion 272 of the duct section 27.

[0059] Preferably, the inner chamber 20 comprises a second port 22 adapted to allow the flow of the cooling liquid 500 between the inner chamber 20 and an outer component 3 of the protection relay 1, which is external to the main body 2.

[0060] Preferably, the second port 22 is arranged at the lateral wall 290 of the main case 29 in a proximal position with respect to the lower wall 291.

[0061] The arrangement of the inner chamber 20 allows detecting possible pressure variations of the cooling liquid 500 within the tank 101, which may, in turn, be indicative of gas accumulation phenomena within the tank 101, temperature fluctuations of the cooling liquid, or other abnormal condition of the transformer 100.

[0062] In fact, given that the inner chamber 20 and the tank 101 are filled with the cooling liquid 500, possible pressure variations of the cooling liquid 500 within the tank 101 are transmitted to the cooling liquid 500 contained in the inner chamber 20.

[0063] According to an aspect of the invention, the protection relay 1 comprises one or more pressure measuring devices 6 to detect the pressure of the cooling liquid

500 within the inner chamber 20.

[0064] Preferably, the pressure measuring devices 6 are positioned in a further chamber 250 arranged within the internal volume 295 of the case section 29.

[0065] Conveniently, the inner chamber 20 is adapted to be in fluid-dynamic communication with the pressure measuring devices 6 through one or more auxiliary ports 28, each coupled with a corresponding pressure measuring device 6. In this way, the pressure measuring devices 6 can interface with the cooling liquid 500 to detect its pressure within the inner chamber 20.

[0066] In general, the pressure measuring devices 6 may be of known type and will not be here described in further details for the sake of brevity.

[0067] According to the invention, the protection relay 1 comprises an outer container 3 adapted to be mechanically coupled in a removable manner with the case section 29 of the main body 2. The outer container 3 is adapted to be in fluid-dynamic communication with the inner chamber 20 and partially filled with the cooling liquid 500.

[0068] According to an aspect of the invention, the outer container 3 comprises a receptacle section 31 and a cover section 32 defining a second inner volume 315 of said outer container.

[0069] The receptacle section 31 is adapted to be mechanically coupled in a removable manner with the case section 29 of the main body 2 while the cover section 32 is adapted to be mechanically coupled in a removable manner with the receptacle section 31.

[0070] Preferably, as shown in the cited figures, the outer container 3 extends along a longitudinal axis 300, for example with a substantially cylindrical-like geometry as shown in the cited figures.

[0071] Preferably, the receptacle section 31 is arranged as an open container and it comprises a bottom wall 311, in distal position with respect to the cover section 32, and a contoured lateral wall 312.

[0072] Conveniently, the walls 311-312 of the receptacle section 31 may be arranged in such a way that, when the protection relay 1 is in its normal operative position, the bottom wall 111 and the lateral wall 312 extend respectively along a horizontal plane and a vertical plane that are respectively parallel and perpendicular with respect to the top wall 104 of the tank 101. Preferably, the lateral wall 312 has a second contoured wall portion 312A at which the container 3 is coupled with the case section 29, more particularly with the first contoured wall portion 290A of the lateral wall 290.

[0073] According to an aspect of the invention, the first and second contoured wall portions 290A and 312A have transversal sections with geometrically conjugated profiles or complementary shapes.

[0074] Conveniently, the second contoured wall portion 312A has a transversal section with a shaped profile (reference is made to a transversal section plane substantially parallel to the lower wall 311) designed in such a way that the outer container 3 can be accommodated at least partially in the recess 24 defined by the transversal section of the first contoured wall portion 290A. The above-described solution allows remarkably reducing the transversal size of the protection relay 1.

[0075] Preferably, the outer container 3 comprises a third port 33 adapted to be coupled with the second port 22 of the inner chamber 20 to allow the flow of the cooling liquid 500 between the inner chamber 20 and the container 3.

[0076] Preferably, the third port 33 is arranged at the lateral wall portion 312A of the lateral wall 312 of the outer container 3 in a proximal position with respect to the bottom wall 311.

[0077] According to an aspect of the invention, the case section 29 and the outer container 3 respectively comprise mutually coupleable second and third mechanical connection means 25, 35 to mechanically couple the outer container 3 with the case section 29 in a removable manner at the second and third ports 22, 33.

[0078] Conveniently, the second and third mechanical connection means 25, 35 are arranged in such a way to realize a mechanical connection of the screw-less type (i.e. which does not employ screws or similar connectors for being realized), for example a mechanical connection of the shape-coupling type (as shown in the cited figures) or the snap-fit type.

[0079] As shown in the cited figures, the second mechanical connection means may be formed by a shaped hole 25 at the first lateral wall portion 290A of the case section 29 and the third mechanical connection means are formed by a shaped protrusion 35 at the second contoured wall portion 312A of the receptacle section 31.

[0080] Conveniently, the shaped protrusion 25 is inserted within the shaped hole 25 to mechanically couple the outer container 3 with the case section 29 in a removable manner.

[0081] Conveniently, the shaped hole 25 and protrusion 35 define at least partially the above-mentioned second and third ports 22, 33 and realize the mutual coupling of these latter to put the inner chamber 20 and the outer container 3 in fluid-dynamic communication.

[0082] According to an aspect of the invention, the protection relay 1 comprises first sealing means 34, 34A to seal the mechanical connection between the second and third mechanical connection means 25, 35 of the case section 29 and the outer container 3.

[0083] As shown in the cited figures, said first sealing means may be formed by an O-ring 34 arranged in a suitable shaped groove 34A obtained at the second contoured wall portion 312A and arranged around the shaped protrusion 35.

[0084] According to an aspect of the invention, the case section 29 and the outer container 3 respectively comprise mutually coupleable fourth and fifth mechanical connection means 26, 36 to mechanically couple the outer container 3 with the case section 29 in a removable manner at a plurality of coupling points.

[0085] As shown in the cited figures, the fourth mechanical connection means may be formed by a plurality

of shaped seats 26 at the first lateral wall portion 290A of the case section 29 and the fifth mechanical connection means may be formed by suitable shaped connectors 36 passing through corresponding shaped holes 36A obtained at the second contoured wall portion 312A of the receptacle section 31 and aligned with the threaded holes 26.

[0086] According to an aspect of the invention, the receptacle section 31 and the cover section 32 of the outer container 3 respectively comprise mutually coupleable sixth and seventh mechanical connection means 310, 320 to mechanically couple said receptacle section and said cover section in a removable manner.

[0087] As shown in the cited figures, the sixth mechanical connection means may be formed by a threaded end portion 310 of the lateral wall 312 (in a distal position with respect to the bottom wall 311) and the seventh mechanical connection means are formed by a threaded lower portion 320 of the cover section 32.

[0088] Preferably, the outer container 3 comprises second sealing means 37 to seal the mechanical connection between the sixth and seventh mechanical connection means 310, 320 of the receptacle section 31 and the cover section 32.

[0089] As shown in the cited figures, the second sealing means 37 may be formed by a gasket arranged between suitable coupling edges (not shown) of the receptacle section 31 and the cover section 32.

[0090] Preferably, the cover section 32 of the outer container 3 comprises an upper portion 326 that is shaped as knob to favor a manual coupling or decoupling manoeuvre of the cover section 32 with the receptacle section 32 to close or open the outer container 3.

[0091] According to an aspect of the invention, the outer container 3 comprises a safety valve 39 adapted to allow the exit of the cooling liquid 500 from the outer container 3 in emergency conditions, namely when the volume of the cooling liquid 500 increases abnormally and fill the outer container 3.

[0092] Preferably, the safety valve 39 is mechanically coupled with the cover section 32 at a coupling hole 325 passing through this latter in such a way to be in fluid-dynamic communication with the inner volume 390 of the outer container 3, when the receptacle section 31 and the cover section 32 are mechanically coupled one with another. Alternatively, the safety valve 39 may be arranged at the lateral wall 312 of the receptacle section 31, conveniently in a distal position from the bottom wall 311 of this latter.

[0093] In general, the safety valve 39 may be of known type and will not be here described in further details for the sake of brevity.

[0094] Preferably, the outer container 3 comprises third sealing means 39A to seal the mechanical connection the safety valve 39 and the cover section 32.

[0095] As shown in the cited figures, said third sealing means may be formed by an O-ring 39A arranged at the coupling hole 325 of the cover section 32.

[0096] According to an aspect of the invention, the lateral wall 312 of receptacle section 31 comprises at least a transparent or semi-transparent wall portion 312B to allow a user to observe the level reached by the cooling liquid 500 contained in the outer container 3. Preferably, the receptacle section 31 comprises indicator means 38 at said transparent or semi-transparent wall portion 312B to provide a user with information on at the level reached by the cooling liquid 500 contained in said outer container.

[0097] Preferably, the indicator means 38 comprise one or more indicator labels attached or printed on the wall portion 312B, for example, as shown in the cited figures, arranged in such a way to be indicative of minimum and maximum volume levels admitted for the cooling liquid 500 within the tank 101.

[0098] The arrangement of the outer container 3 allows detecting possible volume variations the cooling liquid 500 within the tank 101, which may, in turn, be indicative of gas accumulation phenomena within the tank 101, temperature fluctuations of the cooling liquid, or other abnormal condition of the transformer 100.

[0099] As illustrated above, in operation, the outer container 3, the inner chamber 20, the duct section 27 and the tank 101 are in fluid-dynamic communication one with another while the inner chamber 20, the duct section 27 and the tank 101 are filled with the cooling oil 500 and the outer container 3 is partially filed with the cooling liquid 500.

[0100] Consequently, volume variations of the cooling liquid 500 within the tank 101 cause corresponding level variations of the cooling liquid 500 contained in the outer container 3. According to the invention, the protection relay 1 comprises a floating element 4 accommodated within the second inner volume 390 of the outer container 3 and adapted to be at least partially immersed in and moved by the cooling liquid 500 contained in the outer container 3.

[0101] Preferably, the floating element 4 has a contoured shape substantially complementary to the shape of the transversal section of the receptacle section 31 of the outer container 3 (reference is made to a transversal section plane substantially parallel to the lower wall 311).

[0102] In this way, without the need of any support rod, the floating element 4 can move linearly along the main axis 300 of the outer container 3 when the contained cooling liquid 500 is subject to a level variation (in turn indicative of a corresponding volume variation of the cooling liquid 500 within the tank 101).

[0103] According to the invention, the protection relay 1 further comprises switching means 5 adapted to be actuated by the floating element 4 when the cooling liquid 500 contained in the outer container 3 reaches one or more corresponding threshold levels.

[0104] Preferably, the switching means 5 are electrically connected with an alarm circuit (not shown) adapted to activate signalling means capable of providing alarm signals indicative of the level reached by the cooling liquid

500 and/or with a power disconnection circuit (not shown) adapted to activate power disconnection means capable of causing the disconnection of the transformer 100 from the corresponding electric power transmission and distribution line. The above-mentioned alarm circuit and/or power disconnection circuit may be at least partially internal or external to the protection relay. They may arranged according to solutions well known in the art and are therefore not described in further details for the sake of brevity.

[0105] According to some embodiments of the invention, the floating element 4 is provided or coupled with a magnetic element (not shown) and the switching means 5 comprise one or more magnetic switches, each adapted to be actuated by the floating element 4 when the cooling liquid 500 contained in the outer container 3 reaches a corresponding threshold level. Preferably, the switching means 5 comprise two distinct magnetic switches, which are actuated by the floating element 4 when the cooling liquid 500 contained in the outer container 3 reaches a minimum threshold level indicative of a minimum volume level admitted for the cooling liquid 500 within the tank 101.

[0106] This solution conveniently provides a redundant safety arrangement to signal abnormal levels of the cooling fluid 500.

[0107] According to alternative embodiments of the invention, the switching means 5 comprise only a single magnetic switch, which is actuated by the floating element 4 when the cooling liquid 500 contained in the outer container 3 reaches a minimum threshold level indicative of a minimum volume level admitted for the cooling liquid 500 within the tank 101.

[0108] In the embodiment shown in the cited figures, the protection relay 1 is arranged without a dedicated local control unit. In this case, the various transducers of the protection relay 1 (for example from the pressure-measuring devices 6 or the sensors accommodated in the probe portion 271 of the duct section 27) as well as the above mentioned alarm circuit and/or power disconnection circuit may be operatively connected in a wired or wireless manner with a remote computerized device.

[0109] According to other embodiments of the invention, the protection relay 1 may comprise a control unit arranged within the inner volume of the case section 29.

[0110] Conveniently, said control unit may be adapted to receive and process detection signals from the various transducers of the protection relay 1 and provide detection data indicative of the operating conditions of the transformer 100 (for example data indicative of the gas accumulated within the tank 101 of the distribution transformer) basing on said detection signals.

[0111] Conveniently, said control unit may be operatively connected with a remote computerised unit (not shown) to transmit the detection data so obtained.

[0112] Conveniently, said control unit may be part of the alarm circuit and/or power disconnection circuit operatively connected with the switching means 5. In this case, said control unit may be adapted to receive detection signals indicative of a level reached by the cooling liquid 500 from the switching means 5 and, in response to said detection signals, provide (even by means of a remote transmission) control signals to activate the above-mentioned signalling means and/or power disconnection means.

[0113] As those skilled in the art may appreciate, said control unit may comprise suitable and commercially available micro-processor based electronic devices.

[0114] The protection relay 1, according to the invention, allows achieving the intended aims and objects.

[0115] The protection relay 1 is capable of providing an efficient support in the monitoring activity of some physical quantities (e.g. volume, pressure, and the like) characteristic of the cooling liquid 500 contained in the transformer 100.

[0116] Thanks to the arrangement of the outer container 3 distinct and external with respect to the main body 2, the protection relay 1 has a modular simplified structure having parts (namely the main body 2 and the outer container 3) that can be easily and cheaply manufactured and assembled at industrial level.

[0117] The modular arrangement of the protection relay 1 greatly simplifies the design of structural solutions (as the embodiment shown in the cited figures) aimed at reducing or optimizing the overall size with respect to traditional devices of the same type.

[0118] The protection relay 1 can be easily installed on the tank 101 of a transformer 100 using mechanical connection means of known type.

[0119] The modular structure further of the protection relay 1 greatly simplifies possible maintenance interventions and it allows an easy replacement of the outer container 3, when required.

[0120] The protection relay 1 has thus overall industrial costs that are very competitive costs with respect to traditional devices of the same type.

Claims

1. A protection relay (1) for a distribution transformer (100) adapted to contain a cooling liquid (500) and comprising a tank (101) adapted to be filled with said cooling liquid **characterized in that** it comprises:

   - a main body (2) mechanically coupleable in a removable manner with said tank, said main body including a case section (29) defining a first inner volume (295) and a duct section (27) adapted to link said case section with said tank, said case section including an inner chamber (20) arranged in said first inner volume, said inner chamber being, in operation, in fluid-dynamic communication with said tank through said duct section and filled with said cooling liquid;
   - an outer container (3) mechanically coupled in

a removable manner with said case section (29), said outer container being in fluid-dynamic communication with said inner chamber and adapted to be partially filled with said cooling liquid (500);

- a floating element (4) accommodated within said outer container and adapted to be at least partially immersed in and moved by the cooling liquid (500) contained in said outer container;
- switching means (5) arranged in said first inner volume (295) and adapted to be actuated by said floating element when the cooling liquid contained in said outer container reaches one or more threshold levels.

2. A protection relay, according to claim 1, **characterized in that** said case section (29) and said outer container (3) respectively comprise mutually coupleable second and third mechanical connection means (25, 35) to mechanically couple said outer container with said case section in a removable manner at second and third ports (22, 32) of said case section and said outer container.

3. A protection relay, according to claim 2, **characterized in that** said second and third mechanical connection means (25, 35) are of the screw-less type.

4. A protection relay, according to one or more of the previous claims, **characterized in that** said case section (29) and said outer container (3) respectively comprise mutually coupleable fourth and fifth mechanical connection means (26, 36) to mechanically couple said outer container with said case section in a removable manner at a plurality of coupling points.

5. A protection relay, according to one of the claims from 2 to 4, **characterized in that** said outer container (3) comprises first sealing means (34, 34A) to seal a mechanical connection between said second and third mechanical connection means (25, 35).

6. A protection relay, according to one or more of the previous claims, **characterised in that** it comprises one or more pressure measuring devices (6) adapted to be in fluid-dynamic communication with said inner chamber (20) to detect a pressure of said cooling liquid (500).

7. A protection relay, according to one or more of the previous claims, **characterised in that** said outer container (3) comprises a receptacle section (31) and a cover section (32) mechanically coupleable in a removable manner with said receptacle section.

8. A protection relay, according to claim 7, **characterized in that** said case section (29) and said receptacle section (31) respectively comprise first and second contoured wall portions (290A, 312A) at which said outer container (3) and said case section (29) are mechanically coupled, said first and second contoured wall portions having transversal sections with geometrically conjugated profiles or complementary shapes.

9. A protection relay, according to one of the claims from 7 to 8, **characterized in that** said outer container (3) comprises a safety valve (39) adapted to allow the cooling liquid (500) to exit from said outer container in emergency conditions.

10. A protection relay, according to one of the claims from 7 to 9, **characterized in that** said receptacle section (31) comprises at least a transparent or semi-transparent wall portion (312B) adapted to allow a user to observe a level reached by the cooling liquid (500) contained in said outer container.

11. A protection relay, according to claim 10, **characterised in that** said receptacle section (31) comprises indicator means (38) at said transparent or semi-transparent wall portion (312B) adapted to provide a user with information on a level reached by the cooling liquid (500) contained in said outer container.

12. A distribution transformer (100) for electric transmission and distribution installations **characterised in that** it comprises a protection relay (1), according to one or more of the previous claims.

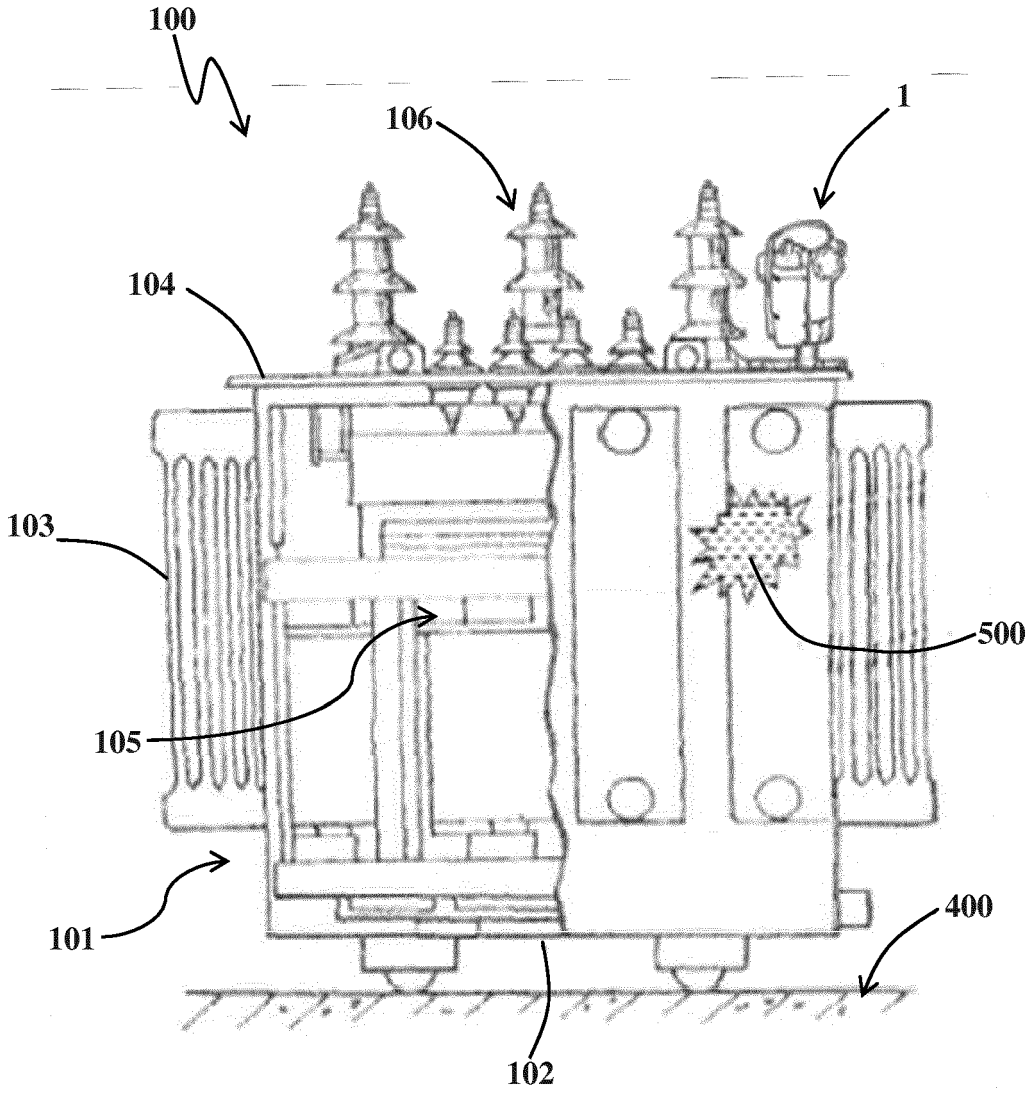

FIG. 1

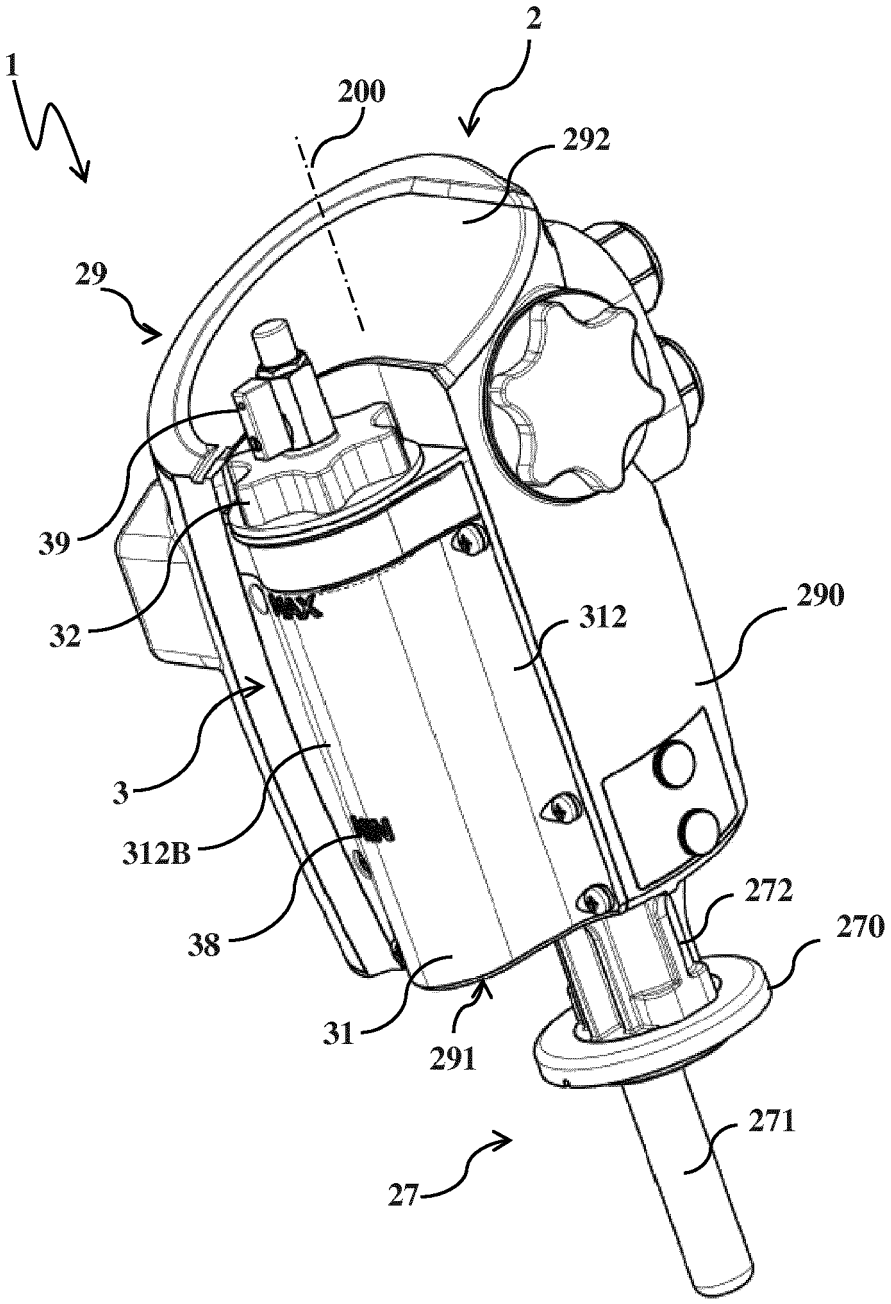

FIG. 2

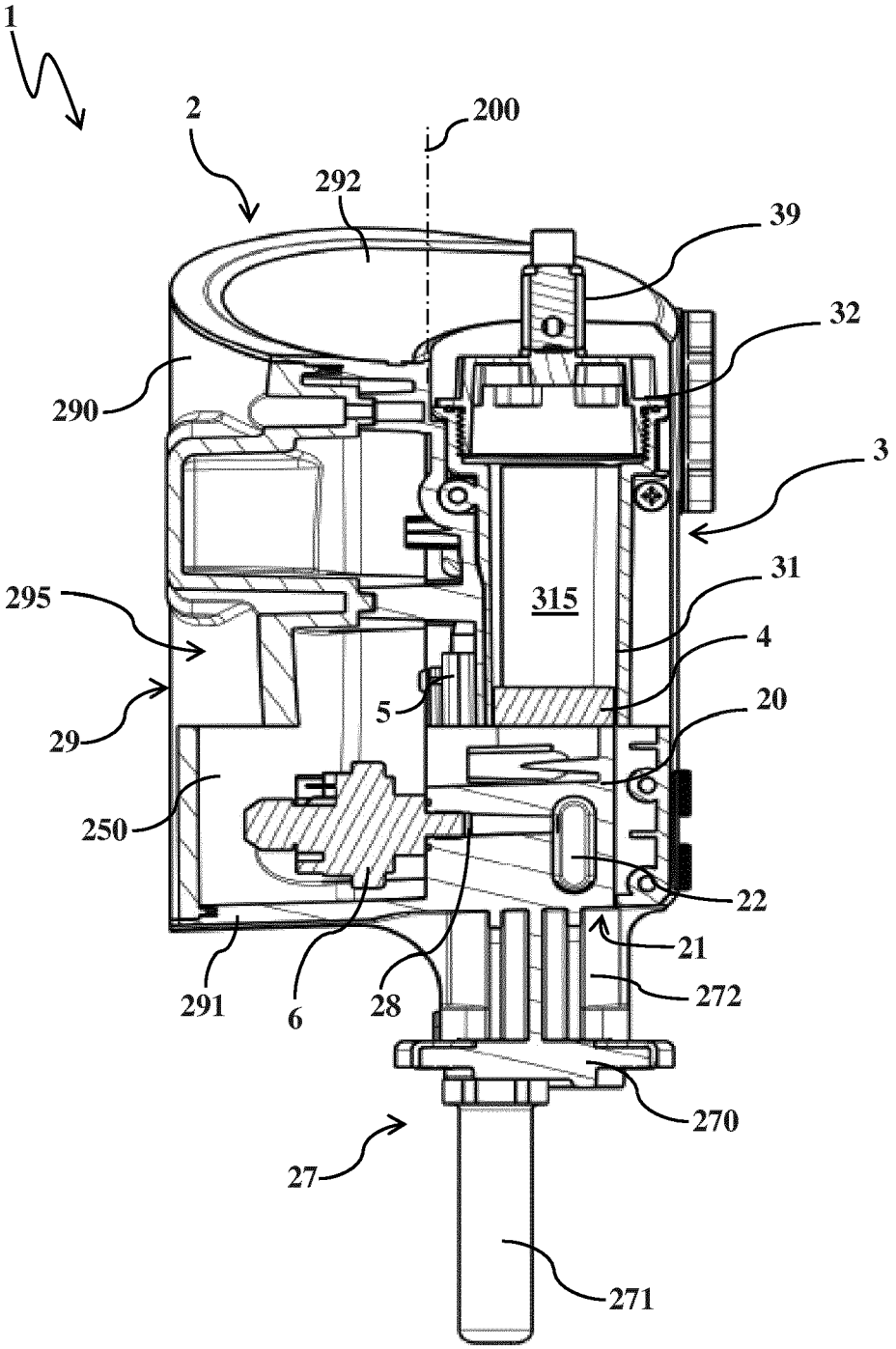
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FIG. 3

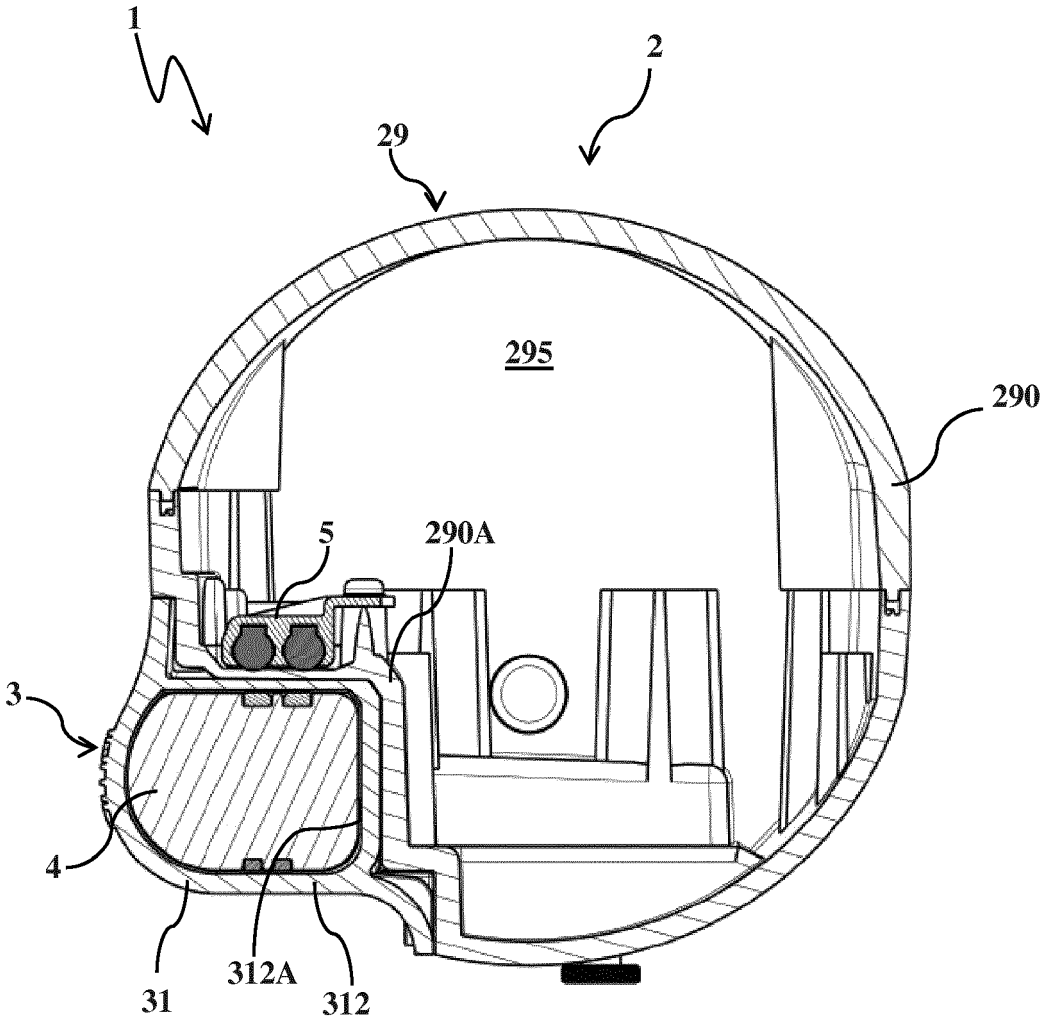

FIG. 4

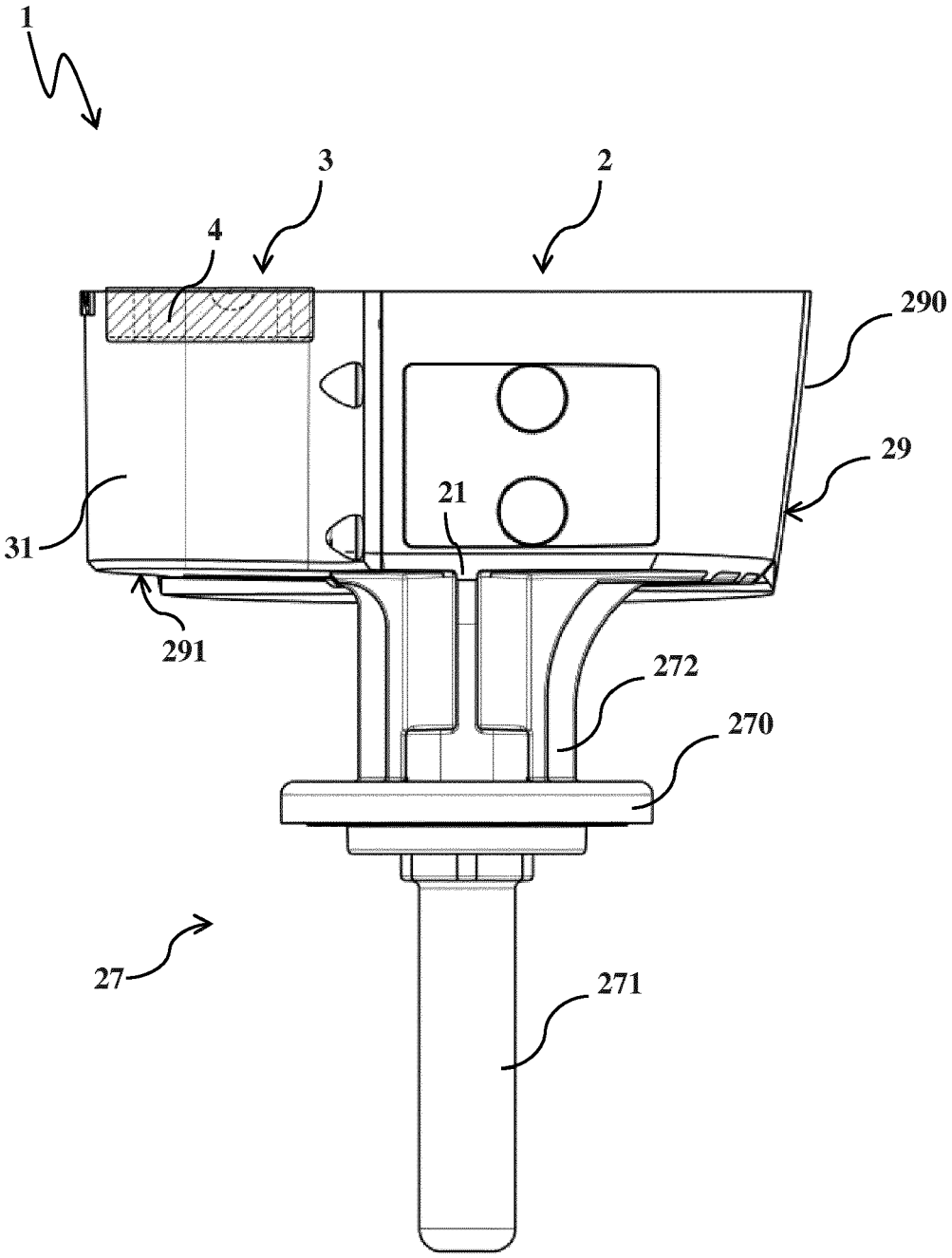

FIG. 5

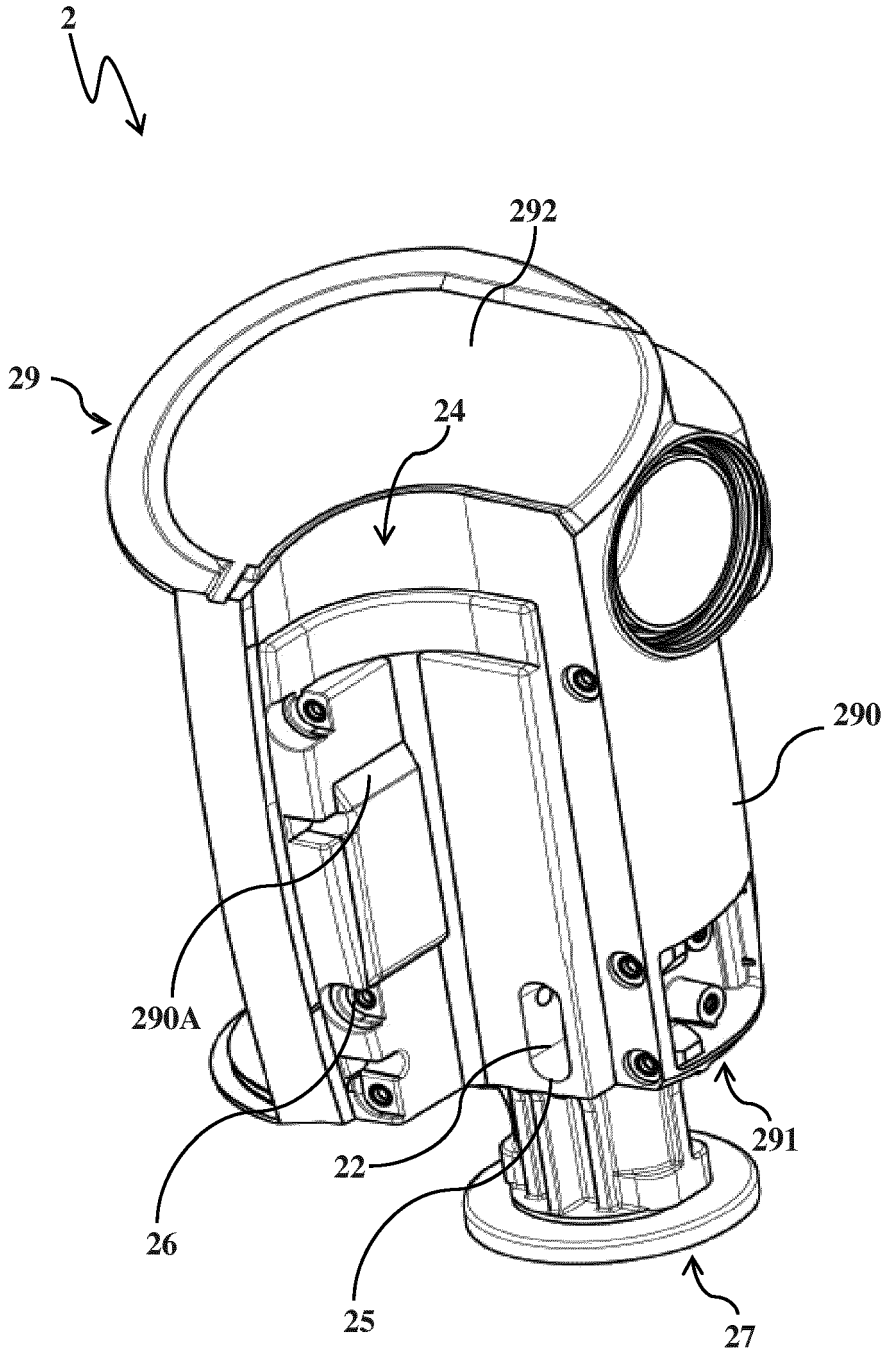

FIG. 6

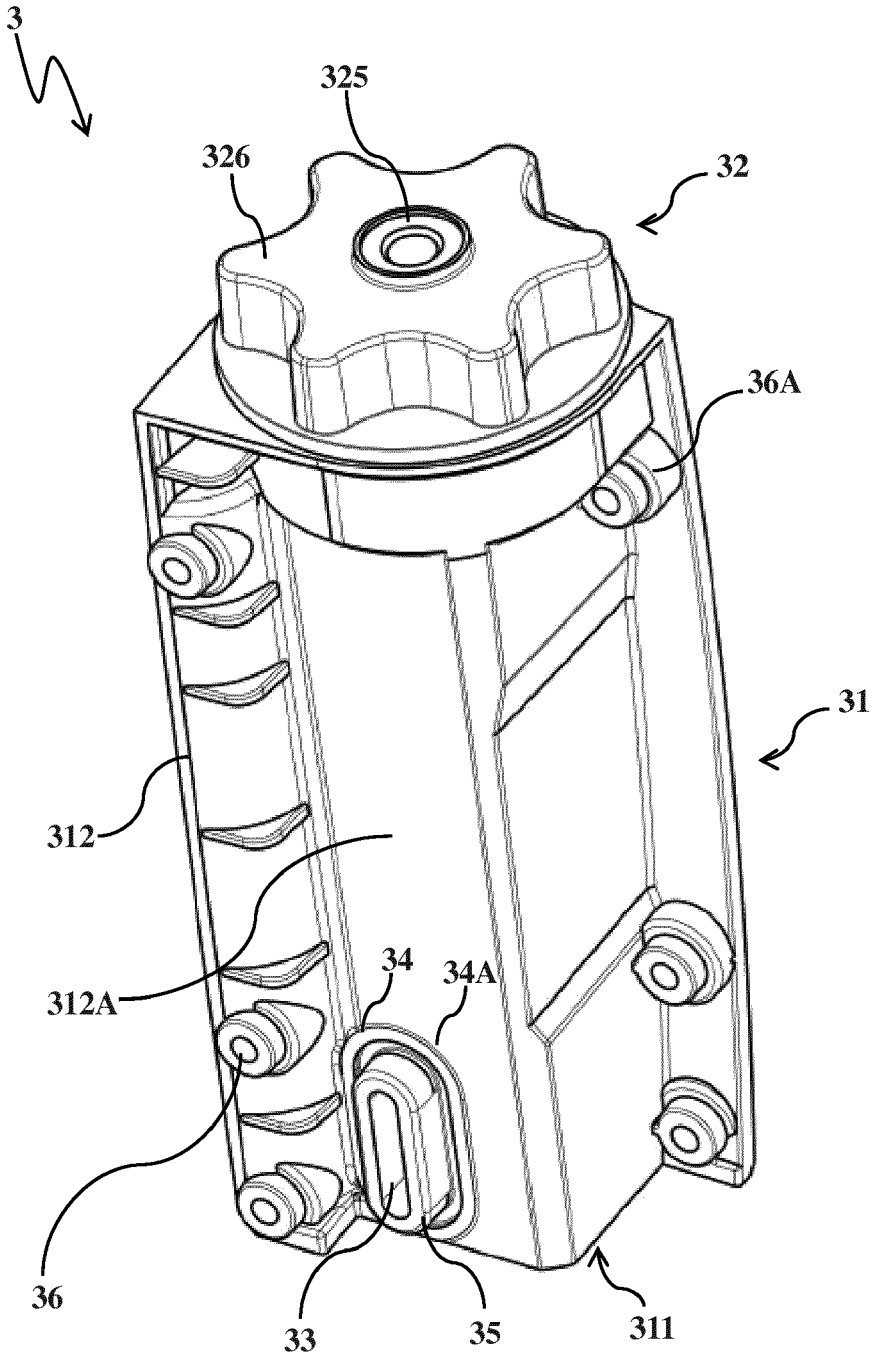

FIG. 7

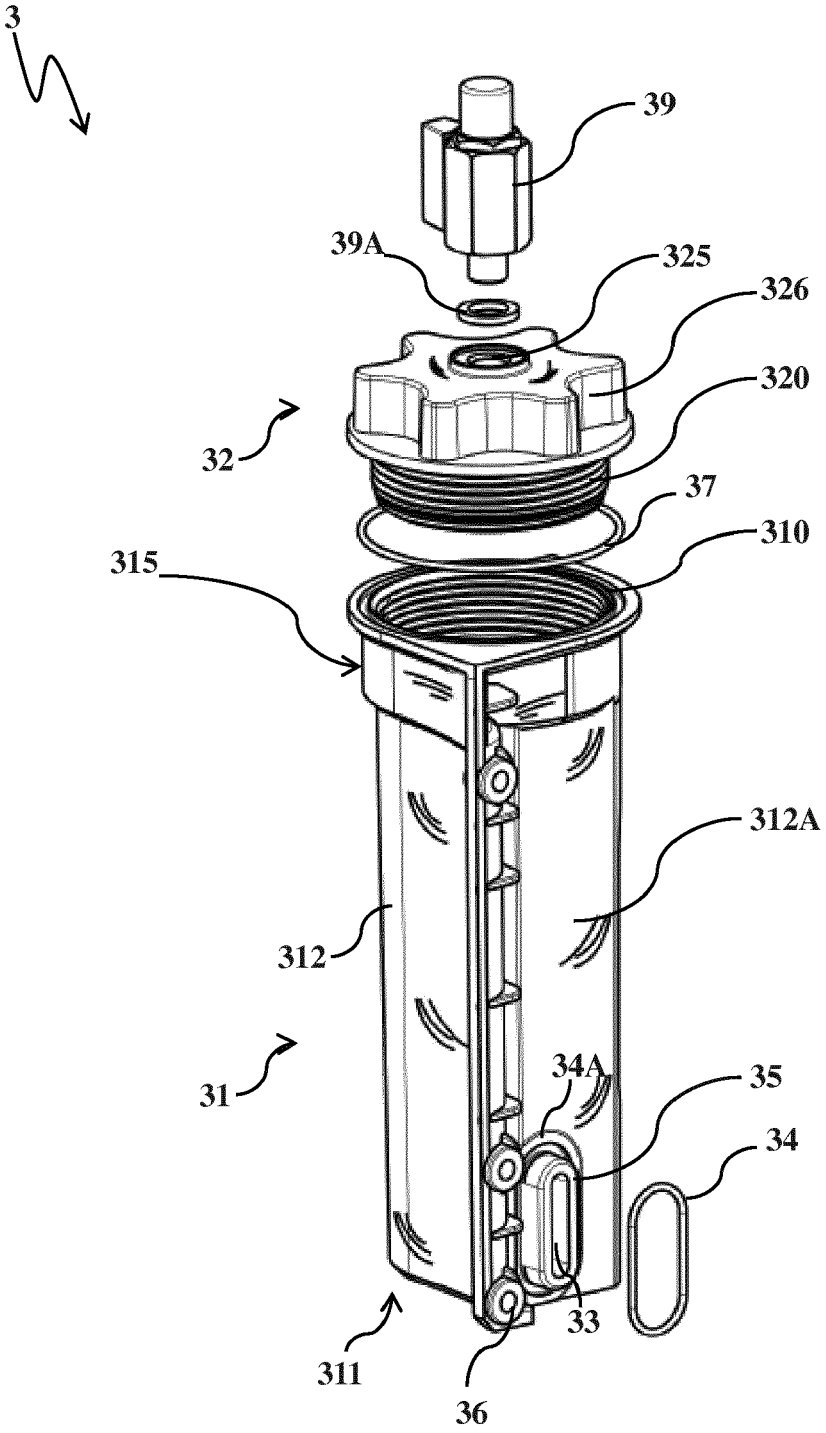

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 18 16 2762

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A	WO 2012/175252 A1 (REINHAUSEN MASCHF SCHEUBECK [DE]; HAEMEL KAI [DE]; REHNELT ULLRICH [DE) 27 December 2012 (2012-12-27) * page 2, last paragraph - page 3, last paragraph * * figure 2 *	1-12	
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H01H
H02H
H01F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 September 2018	Fribert, Jan

CATEGORY OF CITED DOCUMENTS

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