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(71) Applicant: **Do', Tiziano**
20080 Vermezzo (MI) (IT)

(72) Inventor: **Agrusta, Andrea Antonio**
34122 Trieste (IT)

(74) Representative: **Petraz, Gilberto Luigi et al**
GLP S.r.l.
Viale Europa Unita, 171
33100 Udine (IT)

(54) **Equipment for submerging/bringing to the surface a nautical apparatus**

(57) Equipment for submerging/bringing to the surface a nautical apparatus (11) comprising at least a containing compartment (12) provided with a first aperture (27) connected to a first surfacing air circuit (45) configured to selectively introduce air into said containing compartment (12), and a second aperture (46) provided with a pneumatic opening/closing member (32) configured to regulate the passage of water into the containing compartment (12). A command unit (13) is provided to command the entrance and exit of the water and air into and from the containing compartment (12). The equipment also comprises a tank (14) for storing pressurized air connected both to said first surfacing air circuit (45), for the selective introduction of air into said containing compartment (12), and also at least to a second submerging air circuit (47) configured to pneumatically drive the pneumatic opening/closing member (32). The command unit (13) is configured to selectively regulate the passage of air from the tank (14) to the first surfacing air circuit (45) or to the second submerging air circuit (47).

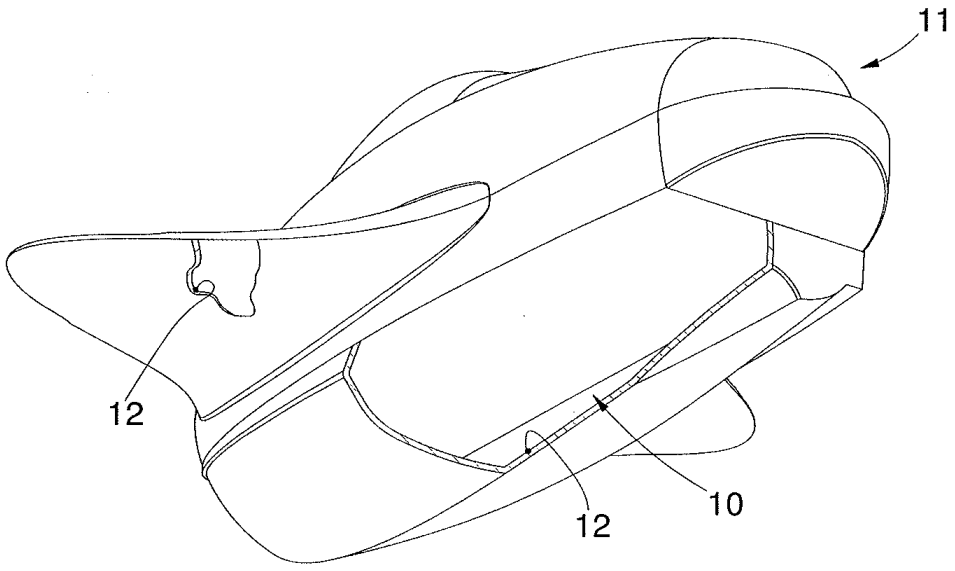

fig. 1

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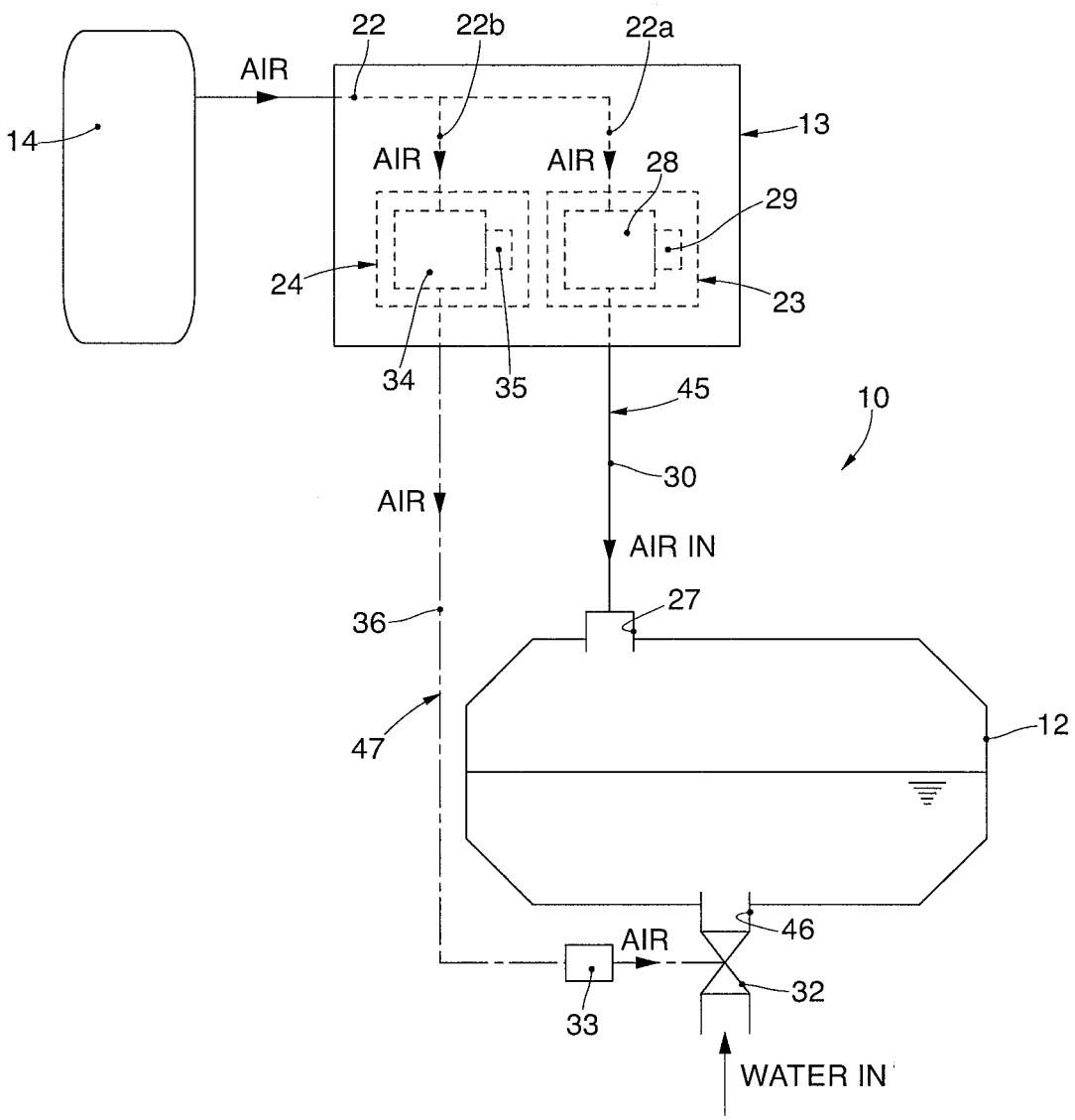
22
22b
22a
AIR
14
13
AIR
AIR
28
29
24
23
34
35
45
10
30
AIR
AIR IN
27
36
12
47
46
AIR
32
33
WATER IN

fig. 3

Description

FIELD OF THE INVENTION

[0001] The present invention concerns equipment for submerging/bringing to the surface a nautical apparatus such as a watercraft, a submersible or similar craft, suitable to remain and move submerged and on the surface.

[0002] In particular, the present invention concerns the equipment that commands and manages the submerging and surfacing modes of the nautical apparatus.

[0003] The present invention also concerns the nautical apparatus that comprises the submerging/surfacing equipment and the corresponding submerging/surfacing method of the nautical apparatus.

BACKGROUND OF THE INVENTION

[0004] Nautical apparatuses are known, such as watercraft or submersibles, suitable to remain and move submerged or on the surface.

[0005] It is also known that nautical apparatuses are provided with one or more containing compartments, also called water tanks or ballast tanks, which are filled for example with water for submersion, or with a gas, typically air, for surfacing.

[0006] To command the submersion of the nautical apparatus, electrovalves are electronically actuated which, as they open, allow to flood the water tanks.

[0007] The flooding can occur due to gravity or thanks to the hydrostatic thrust to which the air in the water tanks is subjected, or more often with the aid of electric or hydraulic pumps commanded electrically.

[0008] For bringing the apparatus to the surface, the tanks are emptied of water by the action of compressed air. Emptying is typically done by suitable electronic commands which determine the opening of valves to introduce air and manage the valves to expel the water. Emptying can be supported by operating machines such as suction pumps, usually electric.

[0009] Consequently, until today, although using water for submersion and air for surfacing, known submerging/surfacing equipment is in any case extremely complex and governed by a series of electronic valves and also often supported by electro-hydraulic pumps.

[0010] This means that a black-out of the electric command plant or an excessive fall in voltage due to an erroneous use of the electric energy on board could irremediably compromise the functioning of the equipment and the corresponding surfacing of the object, putting human life at risk.

[0011] Document EP-A-1.645.501 describes an emergency apparatus for bringing a submarine to the surface, provided with a water or ballast tank which in normal use during submersion is filled, partly or completely, with water.

[0012] This known apparatus has the purpose of preserving the water or ballast tank from peaks of superpressurized compressed air during the surfacing step. To this purpose, the water or ballast tank has not only a main entrance aperture for the compressed air, but also a secondary exit aperture for the compressed air, to vent the excess pressurized air.

[0013] This known apparatus provides that the main entrance aperture of the water or ballast tank is controlled by a non-return valve, through which compressed air is received from a connection pipe fed by a compressed air tank.

[0014] On the connection pipe, between the non-return valve and the compressed air tank, a shut-off valve is mounted. This is normally closed during submersion, and is opened in the surfacing step, to feed compressed air along the connection pipe toward the non-return valve and hence inside the water or ballast tank.

[0015] The shut-off valve is servo-commanded by a double-effect servo-cylinder, which has an upper chamber with variable pressure and a lower chamber with constant pressure, both connected to the compressed air tank.

[0016] This known apparatus also provides a closed-ring control device to control the air pressure in the water or ballast tank. In particular, the closed-ring control device includes a switch valve, able to be actuated pneumatically or manually, connected on one side to a control valve associated with a vent hole by means of an adjustment pipe, and on the other side to the double-effect servo-cylinder that commands the shut-off valve. The control valve is in turn connected to a double-effect adjustment cylinder, which includes an upper chamber connected to a compressed air outlet from the water or ballast tank, and a lower chamber connected to the water that surrounds the submarine. The pressure of the water in the second chamber is in relation to the pressure of the compressed air in the water or ballast tank. Normally, the adjustment pipe connected downstream of the switch valve is closed.

[0017] In this known apparatus, if surfacing is necessary, the switch valve is actuated, determining the activation of the servo-cylinder, which opens the shut-off valve so that the compressed air is introduced into the water or ballast tank. In particular, the switch valve opens the connection pipe with the control valve, so that the pressure of the compressed air prevailing in the upper chamber of the servo-cylinder that commands the shut-off valve is also applied to the control valve. If there is an excessive pressure of the air in the water or ballast tank, the pressure in the upper chamber of the adjustment cylinder that commands the control valve can prevail over the hydrostatic pressure in the lower chamber of the same adjustment cylinder, and opens the control valve to connect the connection pipe to the vent hole and vent the pressure of excess air in the water or ballast tank.

[0018] The solution known from document EP-A.1.645.501 focuses only on the adjustment of the superpressure of the air in the water or ballast tank in the event of emergency surfacing, and therefore does not describe

a system to command both the introduction of compressed air and also the introduction of water into the water or ballast tank; much less does it describe a system actuated pneumatically to manage both the flow of water when submerging and the flow of air when surfacing.

[0019] Document WO-A-2009/008880 describes a submarine having high speed capacity on the surface.

[0020] There is therefore a need to perfect equipment for submerging/bringing to the surface a nautical apparatus that can overcome at least one of the disadvantages of the state of the art.

[0021] In particular, one purpose of the present invention is to obtain equipment for submerging/bringing to the surface a nautical apparatus that is safe and reliable even in the event of malfunctioning of the electric command parts of the equipment.

[0022] Another purpose of the present invention is to obtain submerging/surfacing equipment that is simple and quick to install even on already existing nautical apparatuses.

[0023] Another purpose is to perfect a submerging/surfacing method for a nautical apparatus that is reliable and safe for the operators.

[0024] The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

SUMMARY OF THE INVENTION

[0025] The present invention is set forth and characterized in the independent claims, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

[0026] In accordance with the above purposes, forms of embodiment described here concern equipment for submerging/bringing to the surface a nautical apparatus. According to some forms of embodiment, the equipment comprises:

- at least one containing compartment provided with a first air entrance aperture and a second water entrance aperture;
- at least one first surfacing air circuit connected to the first aperture and configured to selectively introduce air into the at least one containing compartment through the first aperture;
- a pneumatic opening/closing member mounted on the second aperture, the pneumatic opening/closing member being commanded pneumatically and configured to selectively determine the passage of water into the at least one containing compartment through the second aperture;
- at least one second submerging air circuit connected to the pneumatic opening/closing member and configured to pneumatically drive the pneumatic opening/closing member;
- at least one tank for storing pressurized air connected both to the at least one first surfacing air circuit and also to the at least one second submerging air circuit;
- a command unit to pneumatically command the entrance and exit of the water and air into and from the at least one containing compartment, connected between the at least one tank and the at least one containing compartment, from which command unit the at least one first surfacing air circuit and the at least one second submerging air circuit branch off, the command unit being connected

[0027] upstream to the at least one tank by means of a connection pipe.

[0028] According to some forms of embodiment described here, the command unit is configured to selectively command the passage of the air from the at least one tank to the at least one first surfacing air circuit or to the at least one second submerging air circuit and comprises a first surfacing command section connected to the at least one first surfacing air circuit and a second submerging command section connected to the at least one second submerging air circuit, the first surfacing command section and the second submerging command section being configured to command the passage of the stream of air arriving from the at least one tank respectively into the at least one first surfacing air circuit and into the at least one second submerging air circuit.

[0029] According to some forms of embodiment described here, the first surfacing command section comprises at least a first distributor valve fluidically connected to the at least one tank by means of the connection pipe and to the at least one first surfacing air circuit, configured to receive the stream of air under pressure arriving from the at least one tank and to determine the selective passage of compressed air for surfacing from the at least one tank toward the containing compartment through the at least one first surfacing air circuit, the first distributor valve being provided with a pneumatic command portion of the manual type in order to determine its actuation.

[0030] According to some forms of embodiment described here, the second submerging command section comprises at least a second distributor valve fluidically connected to the at least one tank by means of the connection pipe and to the at least one second submerging air circuit and configured to receive the stream of pressurized air arriving from at least one tank and to selectively supply the stream of pressurized air to the pneumatic opening/closing member through the at least one second submerging air circuit, the second distributor valve being provided with a respective pneumatic command portion which can be selectively commanded to determine the passage of the compressed command air toward the pneumatic opening/closing member.

[0031] According to some forms of embodiment described here, the pneumatic opening/closing member is associated to a pneumatic actuation device mounted on the at least one second submerging air circuit and con-

nected to the second distributor valve of the second submerging command section, the pneumatic actuation device being configured to be pneumatically actuated, selectively receiving the stream of pressurized air arriving from the at least one tank through the at least one second submerging air circuit, in order to pneumatically command the opening of the pneumatic opening/closing member by means of the compressed air arriving from the at least one tank and to selectively allow the passage of water in the at least one containing compartment for submersion.

[0032] In this way, by suitably commanding the command unit it is possible, thanks to just one pneumatic action performed on each occasion, to submerge or bring to the surface a nautical apparatus unconstrained by commands of an electrical type. This solution makes the equipment more safe and reliable compared to known solutions and guarantees the safety of the persons transported.

[0033] Some forms of embodiment of the present invention also concern the method to submerge or bring to the surface a nautical apparatus using equipment according to the present description, which provides to selectively introduce air through a first aperture of a containing compartment by means of a first surfacing air circuit and to command the passage of water into the containing compartment through a second aperture of the containing compartment by means of a pneumatic opening/closing member.

[0034] In possible solutions of the present invention, the method provides that the first surfacing air circuit is selectively fed from a tank storing pressurized air, and that the pneumatic opening/closing member can be pneumatically driven by a second submerging air circuit fed by the tank, the selective passage of air from the tank to the first surfacing air circuit or to the second submerging air circuit being commanded by a command unit to obtain respectively the surfacing or submerging of the nautical apparatus.

[0035] These and other aspects, characteristics and advantages of the present disclosure will be better understood with reference to the following description, drawings and attached claims. The drawings, which are integrated and form part of the present description, show some forms of embodiment of the present invention, and together with the description, are intended to describe the principles of the disclosure.

[0036] The various aspects and characteristics described in the present description can be applied individually where possible. These individual aspects, for example aspects and characteristics described in the attached dependent claims, can be the object of divisional applications.

[0037] It is understood that any aspect or characteristic that is discovered, during the patenting process, to be already known, shall not be claimed and shall be the object of a disclaimer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] These and other characteristics of the present invention will become apparent from the following description of some forms of embodiment, given as a non-restrictive example with reference to the attached drawings wherein:

- fig. 1 is a perspective view from below of a possible nautical apparatus on which submersion/surfacing equipment according to the present invention is installed;
- fig. 2 is a diagram of submersion/surfacing equipment according to forms of embodiment described here;
- fig. 3 is a diagram of submersion/surfacing equipment according to forms of embodiment described here;
- fig. 4 is a diagram of submersion/surfacing equipment according to forms of embodiment described here.

[0039] To facilitate comprehension, the same reference numbers have been used, where possible, to identify identical common elements in the drawings. It is understood that elements and characteristics of one form of embodiment can conveniently be incorporated into other forms of embodiment without further clarifications.

DETAILED DESCRIPTION OF SOME FORMS OF EMBODIMENT

[0040] We shall now refer in detail to the various forms of embodiment of the present invention, of which one or more examples are shown in the attached drawings. Each example is supplied by way of illustration of the invention and shall not be understood as a limitation thereof. For example, the characteristics shown or described insomuch as they are part of one form of embodiment can be adopted on, or in association with, other forms of embodiment to produce another form of embodiment. It is understood that the present invention shall include all such modifications and variants.

[0041] Figs. 1, 2, 3 and 4 are used to describe forms of embodiment of submerging/surfacing equipment 10 according to the present description, which can be installed on a nautical apparatus 11 to command and manage the submerging/surfacing modes thereof.

[0042] According to one possible form of embodiment, the equipment 10 according to the present invention comprises at least one containing compartment 12 for water and air, also called water or ballast tank, attachable to the nautical apparatus 11 and into/from which water and air are introduced and/or discharged in a controlled manner so as to manage the submerging/surfacing modes of the nautical apparatus 11.

[0043] In some forms of embodiment it may be provided that the containing compartment 12 is made in part

of the body of the nautical apparatus 11.

[0044] In some forms of embodiment, for example described using fig. 4 and combinable with all the forms of embodiment described here, it may be provided that the nautical apparatus 11 comprises a plurality of containing compartments 12.

[0045] According to some forms of embodiment of the present invention, for example described using figs. 2 and 3, it may be provided that the containing compartment 12 is provided with at least a first air entrance aperture 27 configured to allow the introduction of air in order to command the surfacing modes of the nautical apparatus 11.

[0046] The first aperture 27 is connected to a first surfacing air circuit 45, configured to selectively introduce air into the containing compartment 12.

[0047] The containing compartment 12 is also provided with a second water entrance aperture 46, or sea intake, provided in its turn with a pneumatic opening/closing member 32, pneumatically commanded and configured to selectively determine, that is, to allow or not, the passage of water into the containing compartment 12. The entrance of water into the containing compartment 12 allows to actuate the submerging modes of the nautical apparatus. The water entering through the second aperture 46 is the same in which the nautical apparatus 11 is at least partly immersed. The second aperture 46 can be provided with a filter element, for example a grid, to prevent the introduction into the containing compartment 12 of unwanted bodies. In particular, the second aperture 46 can be a grid-like sea intake.

[0048] The entrance and exit of the air and water into/from the containing compartments 12 is selectively commandable by a command unit 13.

[0049] In possible forms of embodiment of the present invention, the command unit 13 is the pneumatic type and is connected and driven by at least a tank 14 for storing pressurized air, in the forms of embodiment described using fig. 4, by a plurality of tanks 14, for example four, even though two, three or more than four tanks 14 are possible.

[0050] In particular, in some forms of embodiment, combinable with all the forms of embodiment described here, the command unit 13 can be connected to said at least one tank 14 by means of a compressed air connection pipe 22, for example by means of a single connection pipe 22, in particular a single connection pipe 22 for example directly connected to the command unit 13.

[0051] According to one possible form of embodiment, for example described using figs. 2 and 3, the tank 14 is fluidically connected to the first surfacing air circuit 45 for the selective introduction of air into the containing compartment 12.

[0052] In still other possible forms of embodiment, for example described using figs. 2 and 3, the tank 14 is fluidically connected to a second submerging air circuit 47 to pneumatically drive the pneumatic opening/closing member 32 of the second aperture 46.

[0053] According to possible implementations, the command unit 13 is configured to selectively command and possibly regulate the passage of air from the tank 14 to the first surfacing air circuit 45 or to the second submerging air circuit 47.

[0054] According to possible forms of embodiment, the command unit 13 is interposed between the tank 14 and the first surfacing air circuit 45 and the second submerging air circuit 47 and is configured to manage the stream of pressurized air in the latter two.

[0055] The command unit 13 can comprise one or more commands drivable by an operator, one or more valves to manage the stream of air toward the first surfacing air circuit 45 and the second submerging air circuit 47, or other command devices.

[0056] With reference to some forms of embodiment, described using fig. 4, the tanks 14 are configured to each contain air at a pressure comprised between 200bar and 350bar.

[0057] In possible forms of embodiment, described using fig. 4, the tanks 14 can be connected to each other by a collector member 15. The collector member 15 has the function of making the air pressure supplied by the individual tanks 14 uniform, and therefore of preventing pressure peaks.

[0058] In possible solutions, the collector member 15 is provided with a connection element 16 configured to allow loading of the tank or tanks 14 once these have been used.

[0059] The connection element 16 can be configured for example to allow connection of a compressor outside the equipment 10.

[0060] In other solutions it may be provided that the connection elements 16 are associated directly with the tanks 14.

[0061] The collector member 15, and possibly the tanks 14 connected to it, can be provided with one or more instruments to measure the pressure 20, for example pressure gauges.

[0062] In some forms of embodiment, for example described using fig. 4, it is provided that a pressure reduction unit 17 is interposed between the tank or tanks 14 and the command unit 13. In possible solutions, the pressure reduction unit 17 is configured to reduce the pressure of the air available in the tanks 14 by about 10-30 times. Merely by way of example, the pressurized air exiting from the pressure reduction unit 17 is at a pressure comprised between 10bar and 20bar, preferably at about 15bar.

[0063] Some implementations of the present invention, for example described using fig. 4, provide that the pressure reduction unit 17 comprises one or more pressure reducers 18 of the air contained in the collector member 15.

[0064] For safety reasons of the equipment 10, it may be provided that the pressure reducers 18 are connected in parallel with each other to guarantee the safe functioning of the equipment 10 even if one of them is damaged.

[0065] In other implementations of the present invention, such as those described using fig. 4, it is provided that the pressure reduction unit 17 comprises a collector 19 into which the delivery pipes of each of the pressure reducers 18 converge.

[0066] The collector 19 allows to make uniform the pressure of the compressed air reduced by the pressure reducers 18; this prevents the onset of pressure peaks in the command unit 13.

[0067] An instrument to measure the pressure 21 can be associated with the collector 19, such as a pressure gauge to monitor the air pressure.

[0068] The pressure reduction unit 17 is connected to the command unit 13 by means of said connection pipe 22, in particular a single connection pipe 22, more particularly directly connected to the command unit 13. In this case, the one or more tanks 14 are indirectly connected to the command unit 13 by means of the pressure reduction unit 17, in turn connected to the command unit 13 by means of the connection pipe 22.

[0069] The command unit 13 can comprise at least two command portions, respectively a first surfacing command section 23 and a second submerging command section 24, configured to command respectively the surfacing and submerging of the nautical apparatus 11.

[0070] In some forms of embodiment, the first surfacing command section 23 and the second submerging command section 24 can receive the stream of pressurized air from the one or more tanks 14 by means of the connection pipe 22. In this case, one or more branches can be provided, or derivations 22a of the connection pipe 22 for connection to the first surfacing command section 23, and one or more second branches or derivations 22b of the connection pipe 22 for connection to the second submerging command section 24 (figs. 3 and 4).

[0071] In particular, it is provided that the first surfacing command section 23 is configured to command the stream of air arriving from the tank 14 in the first surfacing air circuit 45 and hence to determine the surfacing modes of the nautical apparatus 11.

[0072] The second submerging command section 24, on the contrary, is configured to selectively command the stream of air arriving from the tank 14 in the second submerging air circuit 47 and hence command the pneumatic drive of the pneumatic opening/closing member 32 to determine the submerging modes of the nautical apparatus 11.

[0073] According to possible forms of embodiment, the first surfacing command section 23 and the second submerging command section 24 are connected to the tanks 14 by means of the connection pipe 22, possibly by interposing the pressure reduction unit 17.

[0074] One possible solution of the present invention provides that the command unit 13 comprises a pressure adjustment member 25 provided to adjust the pressure of the compressed air arriving from the tanks 14 or possibly from the pressure reduction unit 17 if provided.

[0075] According to possible forms of embodiment, the adjustment member 25 can comprise a pressure adjustment valve, or a pressure switch. The pressure adjustment valve or pressure switch can be adjusted manually.

[0076] Downstream of the adjustment member 25 an instrument for measuring the pressure 26 can be provided, to monitor the pressure of the compressed air entering the command unit 13.

[0077] The first surfacing command section 23 is connected to the containing compartment or compartments 12 provided in the equipment 10, in correspondence with their respective first aperture 27 by means of the first surfacing air circuit 45.

[0078] The first surfacing command section 23 can comprise at least a first distributor valve 28 fluidically connected to the tanks 14 by means of the connection pipe 22 and possibly by the interposition of the pressure reduction unit 17. In this case, the first distributor valve 28 is connected to the connection pipe 22 by means of a respective first branch 22a of the connection pipe 22 (figs. 3 and 4). The first distributor valve 28 is configured to receive the stream of air under pressure arriving from said at least one tank 14 and to determine the selective passage of compressed air from said at least one tank 14 toward said at least one containing compartment 12.

[0079] In forms of embodiment described using figs. 3 and 4, and combinable with all the forms of embodiment described here, the first surfacing command section 23 comprises a first distributor valve 28 for each containing compartment 12 of the equipment 10.

[0080] The first distributor valve 28 is selectively drivable by an operator by means of a pneumatic command portion 29, configured to pneumatically open/close the first distributor valve 28.

[0081] The pneumatic command portion 29 for example can be a button, drivable manually by an operator. In particular, the pneumatic command portion 29 can be a pneumatic button.

[0082] According to possible implementations, if a first distributor valve 28 is provided for each containing compartment 12, it may be provided that the pneumatic command portions 29 of each of them can be driven simultaneously, for example providing a single drive button.

[0083] In possible implementations, described using figs. 3 and 4, and combinable with all the forms of embodiment described here, the first distributor valve 28 can be the two-way type, with two positions and monostable. In particular, in the condition of normal use, not driven, the first distributor valve 28 is configured to intercept the stream of pressurized air arriving from the tanks 14. When the pneumatic command portion 29 is actuated, the first distributor valve 28 is opened so that the stream arriving from the tanks 14 is sent to the first aperture 27 by means of the first surfacing air circuit 45.

[0084] In forms of embodiment described using figs. 3 and 4, the first surfacing air circuit 45 can comprise at least a surfacing air delivery pipe 30 configured to connect the first surfacing command section 23 and at least one containing compartment 12. In this case, the at least

one surfacing air delivery pipe 30 connects the first distributor valve 28 to the first air entrance aperture 27 of the respective containing compartment 12. In the case of fig. 4, several surfacing air delivery pipes 30 are provided, each of which is connected to a respective containing compartment 12.

[0085] As soon as the action of the operator on the pneumatic command portion 29 of the first distributor valve 28 stops, the valve 28 spontaneously moves to its interception condition.

[0086] During the introduction of air into the containing compartments 12, the water contained in them is expelled, for example through a discharge gap 42. The discharge gap 42 can be provided with a non-return valve 43, configured to prevent a reflux of the water into the containing compartment 12 when pressurized air is introduced.

[0087] The second submerging command section 24 is configured to determine the selective opening/closing of the pneumatic opening/closing member 32 of the containing compartment 12.

[0088] The second submerging air circuit 47 can comprise at least a submerging air delivery pipe 36 to connect the second submerging command section 24 to the containing compartment 12.

[0089] With reference to the form of embodiment described using fig. 4, for each containing compartment 12 a pneumatic opening/closing member 32 can be provided, associated with, in particular mounted on, the second water entrance aperture 46.

[0090] Some implementations of the present invention can provide that the pneumatic opening/closing member 32 is the pneumatically drivable type thanks to the compressed air contained in the tanks 14. In particular, the pneumatic opening/closing member 32 is mounted on the second submerging air circuit 47. In this case, the at least one submerging air delivery pipe 36 of the second submerging air circuit 47 connects the second distributor valve 34 to the pneumatic opening/closing member 32.

[0091] According to possible forms of embodiment of the present invention, the pneumatic opening/closing member 32 can be associated to a pneumatic actuation device 33.

[0092] In particular, the pneumatic actuation device 33 can be directly connected in line to the pneumatic opening/closing member 32, mounted upon it, incorporated or integrated or associated with it in other similar or equivalent ways. For example, the pneumatic actuation device 33 can be mounted on the second submerging air circuit 47, in particular on the submerging air delivery pipe 36, directly connected in line to the pneumatic opening/closing member 32 (figs. 3 and 4).

[0093] The pneumatic actuation device 33 can be configured to be pneumatically actuated, selectively receiving the stream of pressurized air arriving from said at least one tank 14, to pneumatically command the opening of the pneumatic opening/closing member 32 by means of the compressed air arriving from said at least one tank 14 and allow the water to pass or not into said containing compartment 12. Therefore, the pneumatic actuation device 33, when subjected to an air pressure, determines the opening of the pneumatic opening/closing member 32. The pneumatic opening/closing member 32, for example a valve, in particular a pneumatic valve, opens due to the pneumatic action of the stream of air induced by the pneumatic actuation device 33. The pneumatic opening/closing member 32 remains open for as long as the stream of air induced by the pneumatic actuation device 33 persists. For example, the pneumatic actuation device 33 can be connected upstream of the pneumatic opening/closing member 32, in particular between the submerging air delivery pipe 36, which connects the second submerging command section 24 with the containing compartment 12, and the pneumatic opening/closing member 32 (figs. 3 and 4).

[0094] In figs. 2 and 3, a line of dashes and dots indicates a line that takes command air, like the segment of the second submerging air circuit 47, in particular the submerging air delivery pipe 36, which goes from the command unit 13 to the pneumatic actuation device 33 and to the pneumatic opening/closing member 32, while a continuous line indicates an introduction line, which can be to introduce air, like the connection pipe 22 from the tank 14 to the command unit 13 and like the segment of the first surfacing air circuit 45, in particular the surfacing air delivery pipe 30, which goes from the command unit 13 to the first aperture 27 of the containing compartment 12 (arrow AIR IN in figs. 2 and 3), or to introduce water, to the second aperture 46 of the containing compartment 12 (arrow WATER IN in figs. 2 and 3). The lines of dashes inside the command unit 13 in fig. 3 indicate sections or branches of the connection pipe 22 that introduce pressurized air into the first surfacing command section 23 and the second submerging command section 24.

[0095] In forms of embodiment described using figs. 3 and 4, and combinable with all the forms of embodiment described here, it may be provided that the second submerging command section 24 comprises at least a second distributor valve 34 fluidically connected to the at least one tank 14 by means of the connection pipe 22. In this case, the second distributor valve 34 is connected to the connection pipe 22 by means of a second branch 22b of the connection pipe 22 (figs. 3 and 4). The second distributor valve 34 is configured to receive the stream of pressurized air arriving from the at least one tank 14 and to selectively supply the stream of pressurized air to the pneumatic opening/closing member 32 through the second submerging air circuit 47.

[0096] In some forms of embodiment of the present invention, for example described using fig. 4, the second submerging command section 24 comprises a second distributor valve 34 for each containing compartment 12.

[0097] In forms of embodiment described using figs. 3 and 4, and combinable with all the forms of embodiment described here, it is provided that the second distributor

valve 34 is provided with a respective pneumatic command portion 35, configured to pneumatically open/close the second distributor valve 34 and hence selectively commandable by an operator to determine the selective passage of the compressed air toward the pneumatic opening/closing member 32.

[0098] The pneumatic command portion 35 of the second distributor valve 34 can be for example a button drivable manually by an operator. In particular, the pneumatic command portion 35 can be a pneumatic button.

[0099] According to possible implementations of the present invention, and if a plurality of second distributor valves 34 are provided, their pneumatic command portions 35 can be simultaneously actuated by means of the same button.

[0100] In forms of embodiment described using figs. 3 and 4, and combinable with all the forms of embodiment described here, it may be provided that the second distributor valve 34 is a three-way valve with two positions, also known as a 3/2 valve.

[0101] One possible implementation can provide that the second distributor valve 34 is the monostable type. In particular, in the normal use of the second distributor valve 34, that is, when the pneumatic command portion 35 is not driven, the stream of compressed air arriving from the tanks 14 is intercepted.

[0102] When the pneumatic command portion 35 of the second distributor valve 34 is driven by the operator, the pressure exerted by the compressed air arriving from the tanks 14 drives the pneumatic opening/closing member 32 and allows the water to pass.

[0103] Each containing compartment 12 can be provided with an air discharge aperture 37 which allows the air to escape when the water enters into the containing compartment 12.

[0104] In possible solutions of the present invention, it may be provided that the discharge aperture 37 of each containing compartment 12 is connected to a respective control valve 38.

[0105] The control valve 38 can be the type that is normally closed and is selectively activated when the activation of the second submerging command section 24 is commanded.

[0106] In a possible solution, it may be provided that the control valve 38 is provided with a pneumatic command portion 39 connected to the second submerging command section 24. The pneumatic command portion 39, when actuated, puts the control valve 38 in the condition to discharge the air from the containing compartment 12.

[0107] In forms of embodiment described using figs. 3 and 4, and combinable with all the forms of embodiment described here, the pneumatic command portion 39 is driven pneumatically by the action of the pressurized air made available by the actuation of the second distributor valve 34.

[0108] In forms of embodiment described using figs. 3 and 4, and combinable with all the forms of embodiment described here, it may be provided that the pneumatic command portion 39 is connected to the second submerging air circuit 47, in this case to the submerging air delivery pipe 36 provided to connect the second distributor valve 34 and the containing compartment 12.

[0109] According to possible forms of embodiment of the present invention, the equipment 10 comprises a safety device 44 which can be selectively activated in breakdown conditions of the first surfacing command section 23 in order to allow the nautical apparatus 11 to surface. The safety device 44 can be installed for example on a third branch or derivation 22c of the connection pipe 22 (fig. 4). In some forms of embodiment, for example described using fig. 4, the safety device 44 is configured to intercept the connection between the first surfacing command section 23 and the containing compartment 12. In particular, the safety device 44 comprises a third distributor valve 40 connected interposed between the tanks 14 or, if present, between the pressure reduction unit 17 and the surfacing air delivery pipe 30 provided between the first surfacing command section 23 and the containing compartment 12 and configured to introduce pressurized air into the latter.

[0110] The third distributor valve 40 can be a monostable 3/2 type valve, manually driven, for example by a button.

[0111] The third distributor valve 40 can be served by one or more non-return valves 41, provided to prevent a reflux of pressurized air toward the third distributor valve 40 when the first surfacing command section 23 is in its normal functioning condition. For example, the non-return valves 41 are installed on each surfacing air delivery pipe 30 that connects the first distributor valves 28 with the respective containing compartments 12.

[0112] It is clear that modifications and/or additions of parts may be made to the submerging/surfacing equipment 10 for a nautical apparatus 11, the nautical apparatus 11 and the corresponding submerging/surfacing method described heretofore, without departing from the field and scope of the present invention.

[0113] It is also clear that, although the present invention has been described with reference to some specific examples, a person of skill in the art shall certainly be able to achieve many other equivalent forms of submerging/surfacing equipment for a nautical apparatus, having the characteristics as set forth in the claims and hence all coming within the field of protection defined thereby.

Claims

1. Equipment for submerging/bringing to the surface a nautical apparatus (11) **characterized in that** it comprises:

   - at least one containing compartment (12) provided with a first air entrance aperture (27) and a second water entrance aperture (46);

- at least one first surfacing air circuit (45) connected to said first aperture (27) and configured to selectively introduce air into said at least one containing compartment (12) through said first aperture (27);
- a pneumatic opening/closing member (32) mounted on said second aperture (46), said pneumatic opening/closing member (32) being commanded pneumatically and configured to selectively determine the passage of water into said at least one containing compartment (12) through said second aperture (46);
- at least one second submerging air circuit (47) connected to said pneumatic opening/closing member (32) and configured to pneumatically drive said pneumatic opening/closing member (32);
- at least one tank (14) for storing pressurized air connected both to said at least one first surfacing air circuit (45) and also to said at least one second submerging air circuit (47);
- a command unit (13) to pneumatically command the entrance and exit of the water and air into and from said at least one containing compartment (12), connected between said at least one tank (14) and said at least one containing compartment (12), from which command unit (13) said at least one first surfacing air circuit (45) and said at least one second submerging air circuit (47) branch off, said command unit (13) being connected upstream to said at least one tank (14) by means of a connection pipe (22), said command unit (13) being configured to selectively command the passage of the air from said at least one tank (14) to said at least one first surfacing air circuit (45) or to said at least one second submerging air circuit (47) and comprising a first surfacing command section (23) connected to said at least one first surfacing air circuit (45) and a second submerging command section (24) connected to said at least one second submerging air circuit (47), said first surfacing command section (23) and said second submerging command section (24) being configured to command the passage of the stream of air arriving from said at least one tank (14) respectively into said at least one first surfacing air circuit (45) and into said at least one second submerging air circuit (47),

said first surfacing command section (23) comprising at least a first distributor valve (28) fluidically connected to said at least one tank (14) by means of said connection pipe (22) and to said at least one first surfacing air circuit (45), configured to receive the stream of air under pressure arriving from said at least one tank (14) and to determine the selective passage of compressed air for surfacing from said at least one tank (14) toward said containing compartment (12) through said at least one first surfacing air circuit (45), said first distributor valve (28) being provided with a pneumatic command portion (29) of the manual type in order to determine its actuation,

said second submerging command section (24) comprising at least a second distributor valve (34) fluidically connected to said at least one tank (14) by means of said connection pipe (22) and to said at least one second submerging air circuit (47) and configured to receive the stream of pressurized air arriving from said at least one tank (14) and to selectively supply the stream of pressurized air to said pneumatic opening/closing member (32) through said at least one second submerging air circuit (47), said second distributor valve (34) being provided with a respective pneumatic command portion (35) which can be selectively commanded to determine the passage of the compressed command air toward the pneumatic opening/closing member (32),

said pneumatic opening/closing member (32) being associated to a pneumatic actuation device (33) mounted on said at least one second submerging air circuit (47) and connected to the second distributor valve (34) of said second submerging command section (24), said pneumatic actuation device (33) being configured to be pneumatically activated, selectively receiving the stream of pressurized air arriving from said at least one tank (14) through said at least one second submerging air circuit (47), in order to pneumatically command the opening of the pneumatic opening/closing member (32) by means of the compressed air arriving from said at least one tank (14) and to selectively allow the passage of water in said at least one containing compartment (12) for submersion.

2. Equipment as in claim 1, **characterized in that** a pressure reduction unit (17) is provided, connected interposed between said at least one tank (14) and the command unit (13).

3. Equipment as in claim 2, **characterized in that** it comprises a plurality of tanks (14) connected to each other by a collector member (15) **and in that** the pressure reduction unit (17) comprises one or more pressure reducers (18) of the air contained in the collector member (15) and a collector (19) into which the delivery pipes of each of the pressure reducers (18) converge.

4. Equipment as in any claim from 1 to 3, **characterized in that** the command unit (13) comprises an adjustment member (25) to adjust the pressure of the com-

pressed air arriving from the tanks (14).

5. Equipment as in any claim from 1 to 4, **characterized in that** said pneumatic command portion (29) is a pneumatic button.

6. Equipment as in any claim from 1 to 5, **characterized in that** said first distributor valve (28) is the two-way type, with two positions and monostable.

7. Equipment as in any claim from 1 to 6, **characterized in that** said first distributor valve (28), in a condition of normal use not driven, is configured to intercept the stream of pressurized air arriving from said at least one tank (14) through said connection pipe (22).

8. Equipment as in any claim from 1 to 7, **characterized in that** the first surfacing air circuit (45) comprises at least a surfacing air delivery pipe (30) configured to connect the first surfacing command section (23) to said at least one containing compartment (12) **and in that** the second submerging air circuit (47) comprises at least a submerging air delivery pipe (36) to connect the second distributor valve (34) of the second submerging command section (24) to said at least one containing compartment (12).

9. Equipment as in any claim from 1 to 8, **characterized in that** at least one said containing compartment (12) is provided with a discharge gap (42) for the water, possibly provided with a non-return valve (43).

10. Equipment as in any claim from 1 to 9, **characterized in that** the pneumatic opening/closing member (32) is a pneumatic valve, configured to open by pneumatic action of the stream of air induced by the pneumatic actuation device (33).

11. Equipment as in any claim from 1 to 10, **characterized in that** the pneumatic command portion (35) of the second distributor valve (34) is a pneumatic button.

12. Equipment as in any claim from 1 to 11, **characterized in that** the second distributor valve (34) is a three-way valve with two positions, of the monostable type.

13. Equipment as in any claim from 1 to 12, **characterized in that** the second distributor valve (34), in a condition of normal use not driven, is configured to intercept the stream of pressurized air arriving from said at least one tank (14) through said connection pipe (22).

14. Equipment as in any claim from 1 to 13, **characterized in that** said containing compartment (12) is provided with an air discharge aperture (37) configured to allow the air to exit when water enters into said containing compartment (12), said discharge aperture (37) being connected to a control valve (38) which can be commanded by said command unit (13).

15. Equipment as in claim 14, **characterized in that** the control valve (38) is the normally closed type and can be selectively activated when the activation of the second submerging command section (24) is commanded, said control valve (38) being provided with a pneumatic command portion (39) connected to the second submerging command section (24), which, when pneumatically actuated by the action of the pressurized air made available by the actuation of the second distributor valve (34), puts the control valve (38) in the condition of discharging the air in the containing compartment (12).

16. Equipment as in any claim from 1 to 15, **characterized in that** it comprises a safety device (44) which can be selectively activated in breakdown conditions of the first surfacing command section (23) in order to allow surfacing, which safety device (44) is configured to intercept the connection between the first surfacing command section (23) and the containing compartment (12) and comprises a third distributor valve (40) interposed between said at least one tank (14) and a surfacing air delivery pipe (30) provided between the first surfacing command section (23) and the containing compartment (12) and configured to introduce pressurized air into the containing compartment (12).

17. Nautical apparatus such as a watercraft or a submersible, comprising submerging/surfacing equipment as in any of the claims from 1 to 16.

18. Method for submerging/bringing to the surface a nautical apparatus (11) by means of equipment as in any of the claims from 1 to 16, which provides to selectively introduce air through a first aperture (27) of a containing compartment (12) by means of a first surfacing air circuit (45) and to command the passage of water into the containing compartment (12) through a second aperture (46) of said containing compartment (12) by means of a pneumatic opening/closing member (32), **characterized in that** said first surfacing air circuit (45) is selectively fed from a tank (14) storing pressurized air, **and in that** said pneumatic opening/closing member (32) can be pneumatically driven by a second submerging air circuit (47) fed by said tank (14), the selective passage of air from said tank (14) to said first surfacing air circuit (45) or to said second submerging air circuit (47) being commanded by a command unit (13) to obtain respectively the surfacing or submerging of

the nautical apparatus (11).

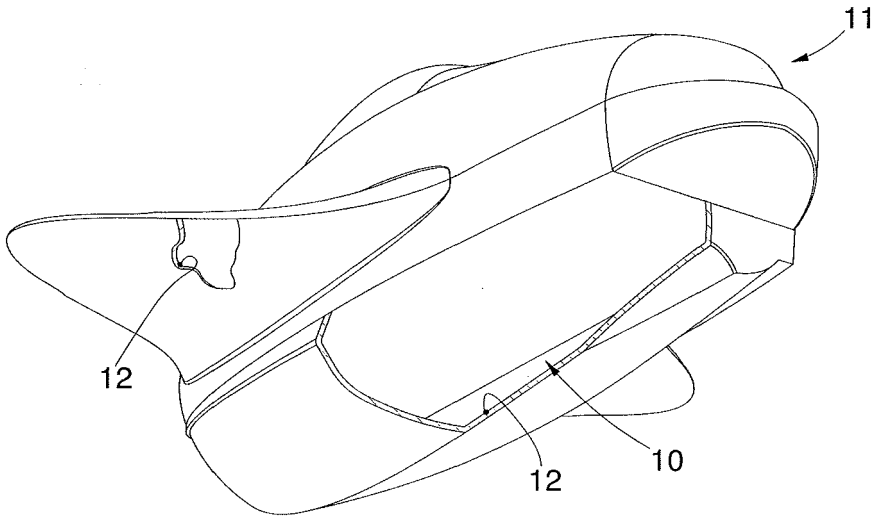
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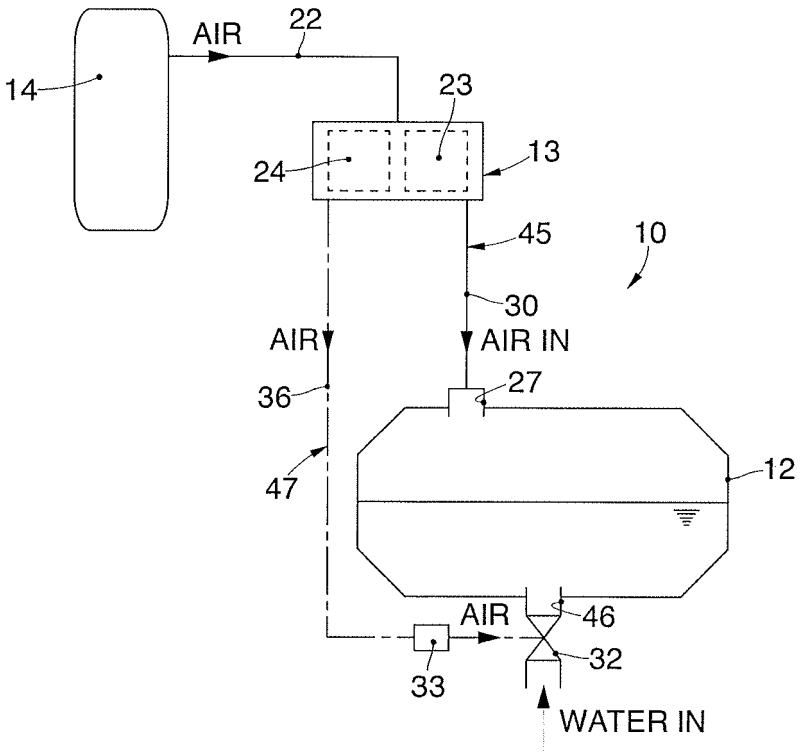
fig. 1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WATER IN

fig. 2

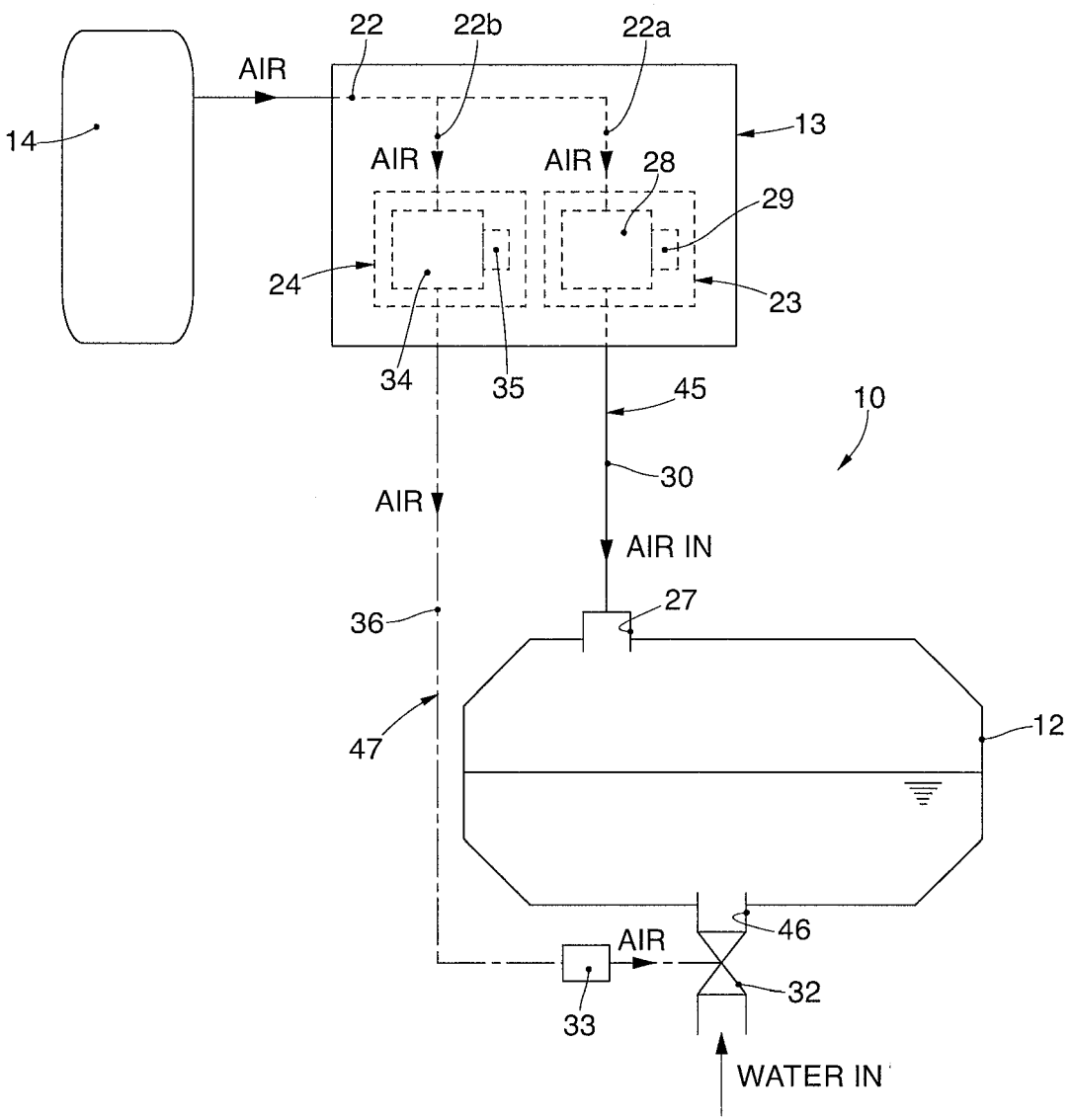
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fig. 3

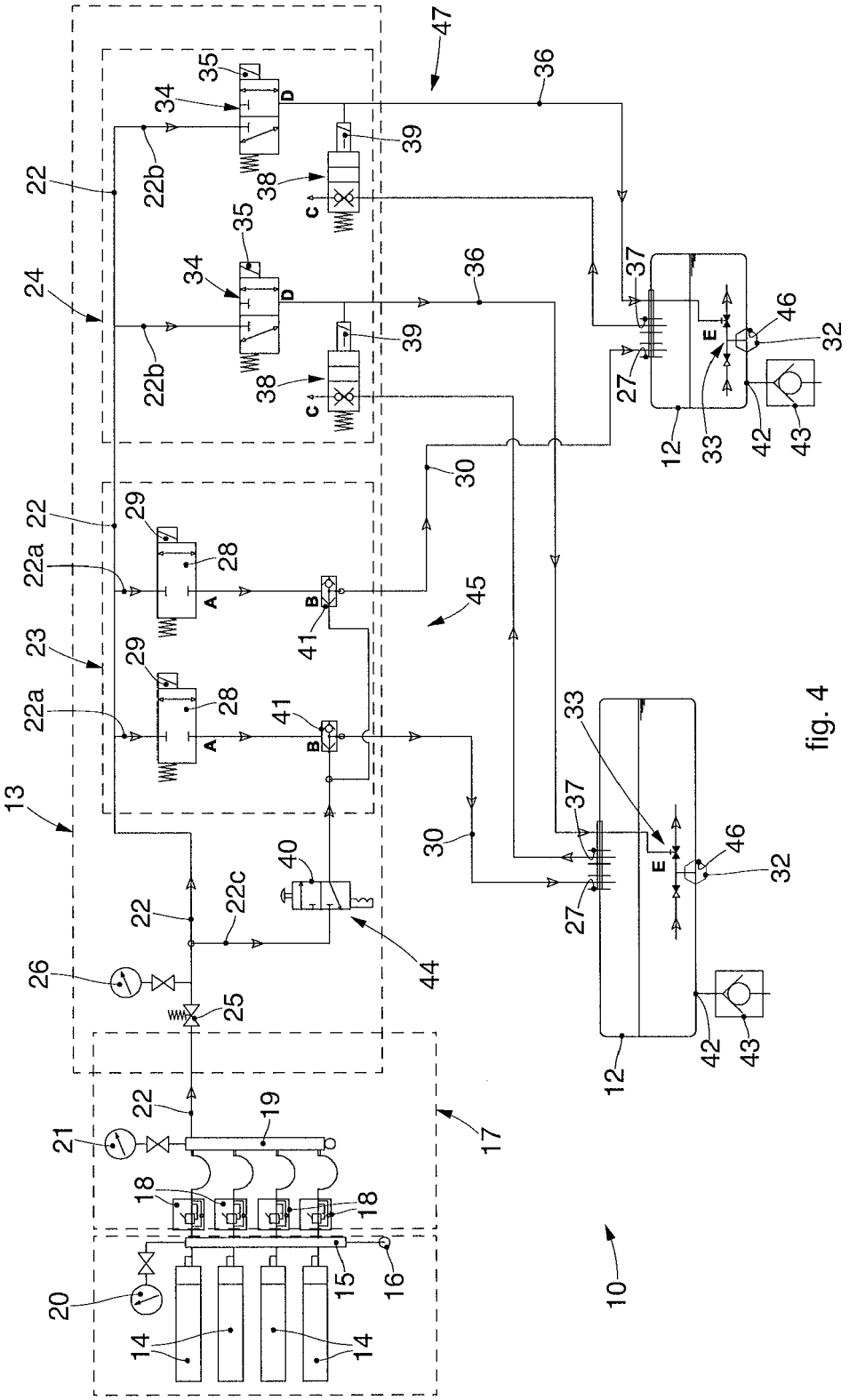
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fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 14 18 3944

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Place of search	Date of completion of the search	Examiner
The Hague	27 January 2015	Schmitter, Thierry

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27-01-2015

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