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(54) **EJECTOR DEVICE FOR SUCTION CUPS**

(57) An ejector device (10) that is driven by compressed air in order to generate an under-pressure applicable for suction cups or similar devices used for transportation or lifting purposes, the ejector device (10) comprising a suction channel (12), a compressed air channel (14), a pressure sensor (16) arranged to measure a pressure related to the suction channel (12), a valve unit (11) arranged to either close or open the compressed air channel (14) in response to the pressure, and a controller (16) for controlling the valve unit (11) and arranged to communicate with the pressure sensor (16), wherein the valve unit (11) and/or the controller (16) are coupled to an energy reservoir (18) for supplying power to the valve unit (11) and/or the controller (16). The valve unit (11) comprises a directly controlled, typically a bi-stable magnetic, valve (13), and a pilot-valve (15), wherein the pilot valve (15) is controlled by the directly controlled valve (13) and arranged in the compressed air channel (14) to either close or open the air channel (14), thereby switching off or on, compressed air to a unit (19) producing under-pressure by means of the supplied compressed air, wherein the valve unit (11) is arranged such that when the directly controlled valve (13) is in open position, the pilot-valve (15) is in inverted closed position (CLOSED), closing the compressed air channel (14); and such that when the directly controlled, valve (13) is in closed position, the pilot-valve (15) is in open position (OPEN), opening the compressed air channel (14), under-pressure is provided by the ejector device (10).

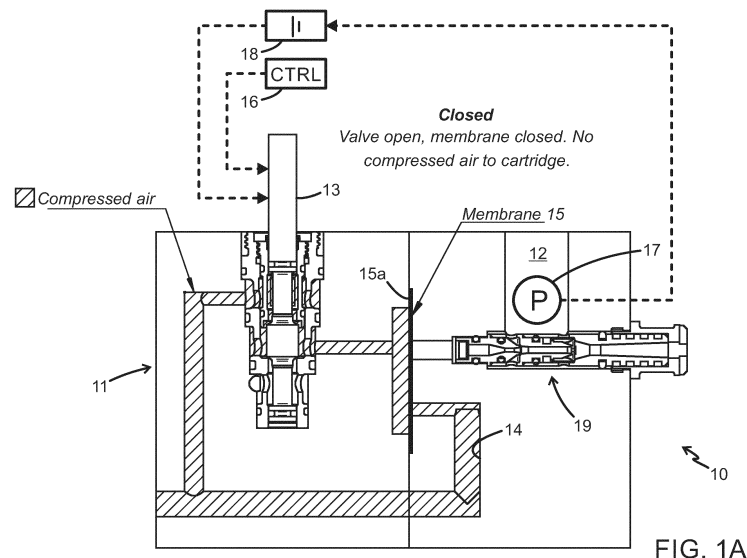


FIG. 1A

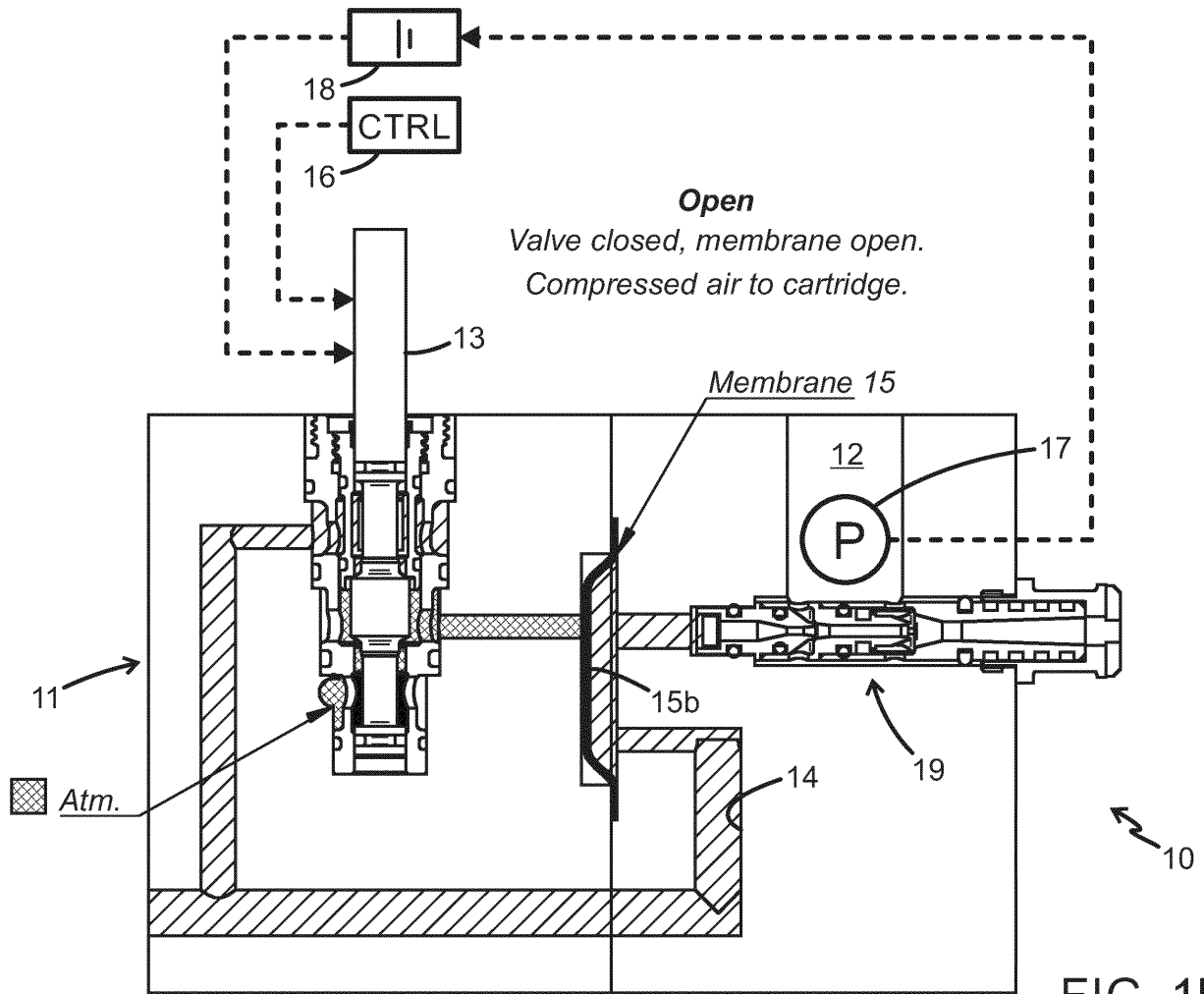


FIG. 1B

Description

Technical field

[0001] The present disclosure relates to an ejector device that is driven by compressed air in order to generate a negative pressure applicable for suction cups or similar devices used for transportation or lifting purposes. The present invention may also be applicable to containers. In particular, the present disclosure is related to an ejector device having a valve unit including a bi-stable valve.

Background

[0002] It is known to provide a material handling system that includes suction cups such as vacuum cups that are adapted to be moved into engagement with an object, such as a substantially flat object or panel or the like, and to lift and move the object to a desired location. Such suction cups may be moved into engagement with the object, and an under-pressure source such as a vacuum source may be actuated to create an under-pressure such as vacuum between the object and the cup such that the object is retained to the cup as it is transported to the targeted area.

[0003] Ejector devices are typically used in material handling systems for saving conduits having under-pressure, sometimes also referred to as negative pressure, since the ejector devices produces negative pressure, typically vacuum, by means of compressed air coming from a compressed air supply.

[0004] The under-pressure generated by the ejector device at the suction cup may be provided by an ejector such as a venturi nozzle, whereby compressed air is supplied to a venturi nozzle and the air forced through the venturi nozzle creates an under-pressure, such as vacuum, supplied to the suction cup.

[0005] The venturi nozzle has an inlet port connected to the compressed air supply and an exit port through which the air is blown. An internal cavity defined by the suction cup and object is in fluid communication with the venturi nozzle so that air is drawn out of the cavity as the air is blown through the venturi nozzle. When the compressed air supply is deactivated, the under-pressure, typically vacuum, within the suction cup cavity may dissipate through a vent port that connects the suction cup cavity to the outside of the device, and when the under-pressure has dissipated a sufficient amount the suction cup may be released from the object.

[0006] Prior art devices are known from e.g. EP-1064464 where it is disclosed an ejector device for generating a negative pressure used for transportation or lifting purposes.

[0007] The ejector devices are typically supplied with both compressed air for generating the under-pressure, typically vacuum, but also with electrical energy for instance for control. The ejector devices are typically controlled by a controller that controls when compressed air

supplied to the ejector providing under-pressure is to be switched on or off. Typically under-pressure switched on, such as vacuum, means suction of the object and under-pressure off, such as no vacuum releases the object.

[0008] After an object has been gripped by means of a suction cup for instance for transportation to a targeted area, the ejector device supplying the suction cup with under-pressure, typically vacuum, is controlled by the controller. Sophisticated ejector devices typically have sensors sensing if a required level of under-pressure has been reached, and when the level is reached, the ejector is turned off. In this way, energy is saved since compressed air is only switched on as long as the required vacuum level has not been reached. If the suction cup sucks the object and there is no leakage between the suction cup and the object, no under-pressure is consumed and the ejector device may remain switched off.

[0009] But, if there is a leakage between the object and the suction cup, for instance if a surface of the object is uneven, or if the object is porous, the under-pressure can only be maintained if new under-pressure is produced, permanently, or intermittently. In this case, the ejector device is switched on whenever required.

[0010] Ejector devices having a bi-stable magnetic valve provided in the compressed air channel supplying the ejector device with compressed air are also known. In case there is a power drop out, or just a voltage-drop, the bi-stable magnetic valve still remain in its current position. This provides that the sucked object remains at the suction cup without falling off from the suction cup, since the bi-stable valve retains its position even in a situation without power supply such as may arise for instance during a voltage drop. If on the contrary, the valve is closed, it will remain closed also when there is a voltage drop or power drop out.

[0011] Problems may arise when the under-pressure, typically vacuum, cannot be preserved, for instance if the suction cup, typically vacuum cup is default, such as default sealing, or if the object is porous. Then, there is a risk that the object may fall off from the suction cup.

[0012] Problems arise when the object cannot be held due to vacuum loss due to leakage, or porous object as described above. In this case a voltage drop implies that a completely power loss, or insufficient voltage, cannot switch the valve to open position to supply vacuum. Then there is a risk that the object simply will fall off from the suction cup.

Summary

[0013] An object of the present invention is to provide an alternative ejector device that eliminates, or at least mitigates, the above stated drawbacks, and wherein when the bi-stable magnetic valve, or any other directly controlled valve, is in open position, no under-pressure is provided by the ejector device, and wherein when the bi-stable valve, or any other directly controlled valve, is in closed position, under-pressure is provided by the

ejector device.

[0014] Herein, this disclosure the term "directly controlled valve" means a valve that is no pilot-valve controlled by another valve, but directly controlled by means of a controller for instance.

[0015] The above-mentioned object is achieved by the present invention according to the independent claim.

[0016] One embodiment of the present invention provides an alternative ejector device that is driven by compressed air in order to generate an under pressure applicable for suction cups or similar devices used for transportation or lifting purposes. The ejector device may also alternatively be used for containers. The ejector device comprises a suction channel, and a compressed air channel and a unit producing under-pressure by means of the supplied compressed air. A pressure sensor is arranged to measure a pressure related to the suction channel and a valve unit is arranged to either close or open the compressed air channel in response to the pressure. A controller is arranged for controlling the valve unit and arranged to communicate with the pressure sensor, wherein the valve unit and/or the controller are coupled to an energy reservoir for supplying power to the valve unit and/or the controller. The ejector device comprises a valve unit, which also during voltage drop, secures the under-pressure by supplying the valve unit and/or a controller for controlling the valve unit with energy from an energy reservoir during voltage drop. The valve unit comprises a directly controlled, typically a bi-stable magnetic valve, and a pilot-valve, wherein the pilot valve is controlled by the directly controlled valve and arranged in a compressed air duct to close or open the air duct thereby switching off or on, compressed air to the unit producing under-pressure by means of the supplied compressed air. The valve unit is arranged such that when the directly controlled, typically bistable magnetic, valve is in open position, the pilot-valve is in inverted closed position, closing the compressed air channel and no under-pressure is provided by the ejector device; and such that when the directly controlled, typically bistable magnetic, valve is in closed position, the pilot-valve is in open position, opening the compressed air channel, under-pressure is provided by the ejector device.

[0017] An advantage with using a valve unit having a pilot-valve in addition to a directly controlled conventional valve only is that a larger flow of compressed air in the compressed air channel can be controlled.

[0018] Typically, the directly controlled, typically bi-stable magnetic, valve is arranged to communicate with and control the pilot-valve comprising a movable valve body, typically movable in the compressed air channel, movable between an open or a closed position, opening or closing the compressed air duct, by means of compressed air pressing on the first valve body side and thereby closing the compressed air channel. The bi-stable magnetic valve is further arranged to, in a second closed position, not supply any compressed air to the pilot-valve, wherein the valve body side is opened by

means of pressurised air pressing on the second side thereby opening the pressurised air duct.

[0019] According to one embodiment, the movable valve body is a flexible membrane.

[0020] According to this embodiment, the directly controlled, typically bi-stable magnetic, valve is arranged to communicate with and control the pilot-valve comprising a movable flexible membrane, movable between an open or a closed position, opening or closing the compressed air duct. The directly controlled valve is arranged to in an open position provide compressed air on a first membrane side and to in the first open position close the membrane by means of the compressed air pressing on the first membrane side and thereby close the compressed air duct. The bi-stable magnetic valve is further arranged to, in a second closed position, not supply any compressed air to the membrane, wherein the membrane is opened by means of compressed air in the compressed air channel pressing on the second membrane side thereby opening the compressed air channel.

[0021] According to an alternative embodiment, the movable valve body is a movable piston.

[0022] According to this embodiment, the directly controlled, typically bi-stable magnetic, valve is arranged to communicate with and control the pilot valve comprising a movable piston, movable between an open or a closed position, opening or closing the compressed air duct. The directly controlled valve is arranged to in an open position provide compressed air on a first piston body side and to in the first open position close the pilot-valve by means of the compressed air pressing on the first piston body side and thereby close the compressed air duct. The bi-stable magnetic valve is further arranged to, in a second closed position, not supply any compressed air to the movable piston, wherein the pilot valve is opened by means of compressed air in the compressed air channel pressing on the second piston body side thereby opening the compressed air channel.

[0023] This energy reservoir supplies energy to power the bi-stable valve and/or the controller if there is a power drop or voltage level is too low. In this way, the valve can be opened also in case of a power drop or too low voltage level. The energy stored in the energy reservoir is large enough to both power the bi-stable valve, as well as the controller and possibly the under-pressure sensor. At least during a sufficient period of time.

[0024] According to an embodiment, the energy reservoir is provided in the ejector device. An advantage with this embodiment is that the directly controlled valve can be controlled even if the power to the ejector device drop out, or the voltage level is too low.

[0025] According to another embodiment, the directly controlled valve is embodied as a bi-stable magnetic valve. Magnetic valves can be electronically controlled and require little energy to switch between positions, such as opened or closed.

[0026] The bi-stable magnetic valve can have a permanent magnet and a spring. In a first position when

power is cut off, the magnet will provide the valve to remain in position. In a second position, when power is cut off, the spring will provide the valve to remain in position. Depending on use, it can be the spring or the magnet being used when the valve is open or closed.

[0027] Further preferred embodiments are set forth in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] For a more complete understanding of the present disclosure and further advantages thereof, reference is now made to the following detailed description taken in conjunction with the drawing in which:

[0029] FIG. 1A-B illustrates an ejector device having a valve unit according to an embodiment of the present invention, of which FIG. 1A shows the valve unit in closed position and FIG. 1B shows the valve in open position.

DETAILED DESCRIPTION

[0030] Reference will now be made to the accompanying drawings, which are intended to at least assist in illustrating the various pertinent features of the presented inventions. In this regard, the following description is presented for purposes of illustration and description. Furthermore, the description is not intended to limit the disclosed embodiments of the inventions to the forms disclosed herein. Consequently, variations and modifications commensurate with the following teachings, and skill and knowledge of the relevant art, are within the scope of the presented inventions.

[0031] Now is referred to FIG. 1A and B, which illustrates an ejector device 10 having a valve unit 11 according to one embodiment of the present invention. The ejector device 10 is driven by compressed air (illustrated by a striped pattern and labelled COMPRESSED AIR) in order to generate an under-pressure in a way applicable for suction cups or similar devices used for transportation or lifting purposes.

[0032] The ejector device 10 comprises a suction channel 12 (only schematically illustrated), and a compressed air channel 14 and a unit 19 producing under-pressure in the suction channel 12 by means of the supplied compressed air. The unit 19 is typically an ejector. The compressed air may be provided by any suitable source providing compressed air for an ejector device. A pressure sensor 17 is arranged to measure a pressure P related to the suction channel 12 and the valve unit 11 is arranged to either close or open the compressed air channel 14 in response to the pressure P. A controller 16 is arranged to control the valve unit 11 and arranged to communicate (illustrated by dashed lines) also with the pressure sensor 17. The valve unit 11 and/or the controller 16 are coupled to an energy reservoir 18 for supplying power (illustrated by the dashed lines) to the valve unit 11 and/or the controller 16.

[0033] The pressure sensor 17 may sense the under-

pressure in the suction channel 12 and detect any leakages which may result in sensed pressure drop. The leakages may be the result of porous objects being gripped, or worn seals at gripping means (not illustrated).

[0034] The ejector device 10 comprises an energy reservoir 18 (schematically illustrated only), which also during voltage drop, secures the under-pressure by supplying the valve unit 11 and/or the controller 16 with energy from an energy reservoir such as a battery during voltage drop. The energy reservoir can be a battery, such as an accumulator, but is not limited to these but to any energy reservoir only.

[0035] FIG. 1A-B illustrates an ejector device 10 having a valve unit 11 according to an embodiment of the present invention. The valve unit 11 is provided for either opening or closing the compressed air channel 14 supplying compressed air to a, of which FIG. 1A shows the valve unit 11 in closed position (CLOSED), closing the compressed air channel 14 and FIG. 1B shows the valve unit 11 in open position (OPEN), opening the compressed air channel 14.

[0036] The valve unit 11 comprises a directly controlled valve 13, and a pilot-valve 15, wherein the pilot-valve 15 is controlled by the directly controlled valve 13 and arranged in the compressed air channel 14 to either close or open the air channel 14 thereby switching off or on, compressed air to the unit 19 producing under-pressure by means of the supplied compressed air. The unit 19 may for instance be an ejector such as a venture nozzle as described in the background section of this disclosure. Sometimes the ejector is also referred to as a "cartridge" as illustrated in the drawing. The valve unit 11 is arranged such that when the directly controlled valve 13 is in open position, the pilot-valve 15 is in inverted closed position (see FIG. 1A), closing the compressed air channel 14 and no under-pressure is provided by the ejector device 10; and such that when the directly controlled valve 13 is in closed position, the pilot-valve 15 is in open position (See FIG. 1B), opening the compressed air channel (illustrated by dashed lines in whole compressed air duct 14), under-pressure is provided by the ejector device 10.

[0037] Typically, the directly controlled, typically bi-stable magnetic, valve 13 is arranged to communicate with and control the pilot valve 15 comprising a movable valve body, which may be the whole valve 15, movable between a closed (See FIG. 1A) or an open position (See FIG. 1B), closing or opening the compressed air channel 14. The compressed air channel 14 is embodied such that compressed air pressing on the first 15a body side of the pilot valve closes the compressed air channel. The directly controlled valve 13 is further arranged to, in a second closed position (See FIG. 1B), not supply any (illustrated by no dashed lines in pilot channel 15c) compressed air to the pilot-valve 15, wherein the pilot valve 15 is opened by means of compressed air pressing on a second side thereof 15b thereby opening the compressed air channel 14 so that compressed air is supplied

to the unit 19 thereby producing under-pressure in the suction channel 12.

[0038] According to one embodiment, as illustrated in FIG. 1A-B, the movable valve body 15 is a flexible membrane.

[0039] According to this embodiment, the directly controlled, typically bi-stable magnetic, valve 13 is arranged to via the pilot channel 15c communicate with and control the pilot valve 15 comprising a movable flexible membrane, movable between a closed (See FIG. 1A) or an open position, closing or opening the compressed air channel 14. The directly controlled valve 13 is arranged to in an open position provide compressed air on a first membrane side 15a and to in the first open position close the membrane 15 by means of the compressed air pressing on the first membrane side 15a and thereby close the compressed air channel 14 by means of the other second membrane side 15b closing the compressed air channel 14. The directly controlled valve 13 is further arranged to, in a second closed position (See FIG. 1B), not supply any compressed air to the membrane 15, wherein the membrane is opened by means of compressed air in the compressed air channel pressing on the second membrane side 15b thereby pressing the membrane to flex and thereby opening the compressed air channel 14 for flow through.

[0040] According to an alternative embodiment, the movable valve body is a movable piston. This embodiment is not further illustrated, but only described, since the operating principle is considered already described above.

[0041] According to this embodiment, the directly controlled, typically bi-stable magnetic, valve is arranged to communicate with and control the pilot valve comprising a movable piston, movable between an open or a closed position, opening or closing the compressed air duct. The directly controlled valve is arranged to in an open position provide compressed air on a first piston body side and to in the first open position close the pilot-valve by means of the compressed air pressing on the first piston body side and thereby close the compressed air duct. The bi-stable magnetic valve is further arranged to, in a second closed position, not supply any compressed air to the movable piston, wherein the pilot valve is opened by means of compressed air in the compressed air duct pressing on the second piston body side thereby opening the compressed air duct.

[0042] This energy reservoir 18 supplies energy to power the directly controlled valve 13 and/or the controller 16 if there is a power drop out. In this way, the directly controlled valve 13 can be either closed or opened also in case of a power drop out, or just a voltage drop. As soon as the power, or voltage, has returned to normal levels, the energy reservoir is cut off and power is supplied as before. The energy stored in the energy reservoir 18 is large enough to both power the direct controlled valve 13, as well as the controller 16 and possibly the pressure sensor 17.

[0043] According to an embodiment, the energy reservoir is provided in the ejector device. An advantage with this embodiment is that the valve unit can be controlled even if the power to the ejector device fails.

5 **[0044]** According to another embodiment, the directly controlled valve is embodied as a bi-stable magnetic valve. Magnetic valves can be electronically controlled and require little energy to switch between positions, such as opened or closed.

10 **[0045]** The bi-stable magnetic valve can have a permanent magnet and a spring. In a first position when power is cut off, the magnet will provide the valve to remain in position. In a second position, when power is cut off, the spring will provide the valve to remain in position. Depending on use, it can be the spring or the magnet being used when the valve is open or closed.

15 **[0046]** During power fall out, or power drop, the energy reservoir closes the directly controlled valve 13, which then opens the pilot valve 15, which opens the compressed air channel 14, such that sufficient under-pressure can be provided by means of the ejector device 10. Typically, the pressure sensor 17, senses if the under pressure is above a threshold and triggers the controller 18 and/or the directly controlled valve 13 to close the valve 13.

20 **[0047]** A voltage controller (not illustrated) may be arranged to control the voltage and be arranged to communicate with the controller 16. The voltage controller may be part of the controller 16.

30 **[0048]** As an example, during power drop out, which may be detected by means of the voltage controller 18, the directly controlled valve 13, the pressure sensor 17 and the controller 16 are supplied with power from the energy reservoir 18 such that the functionality is retained and under-pressure is retained.

35 **[0049]** In this way, under-pressure is retained, since the ejector device is independent of external power at least during a period of time.

40 **[0050]** To be able to detect fault functions fast, the voltage controller may be coupled directly to the controller 16 and even part of the same.

Claims

- 45
1. An ejector device (10) that is driven by compressed air in order to generate an under-pressure applicable for suction cups or similar devices used for transportation or lifting purposes, the ejector device (10) comprising a suction channel (12), a compressed air channel (14), a pressure sensor (16) arranged to measure a pressure related to the suction channel (12), a valve unit (11) arranged to either close or open the compressed air channel (14) in response to the pressure, and a controller (16) for controlling the valve unit (11) and arranged to communicate with the pressure sensor (16), wherein the valve unit (11) and/or the controller (16) are coupled to an energy
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reservoir (18) for supplying power to the valve unit (11) and/or the controller (16), **characterized in that** the valve unit (11) comprises a directly controlled, typically a bi-stable magnetic, valve (13), and a pilot-valve (15), wherein the pilot valve (15) is controlled by the directly controlled valve (13) and arranged in the compressed air channel (14) to either close or open the air channel (14), thereby switching off or on, compressed air to a unit (19) producing under-pressure by means of the supplied compressed air, wherein the valve unit (11) is arranged such that when the directly controlled valve (13) is in open position, the pilot-valve (15) is in inverted closed position (CLOSED), closing the compressed air channel (14); and such that when the directly controlled, valve (13) is in closed position, the pilot-valve (15) is in open position (OPEN), opening the compressed air channel (14), under-pressure is provided by the ejector device (10).

2. The ejector device according to claim 1, wherein the directly controlled valve (13) is a bi-stable magnetic valve.
3. The ejector device according to claim 1 or 2, wherein the directly controlled valve (13) is arranged to communicate with and control the pilot valve (15) comprising a movable flexible membrane (15), movable between an open or a closed position, opening or closing the compressed air channel (14), wherein the directly controlled valve (13) is arranged to in an open position provide compressed air on a first membrane side (15a) and to in the first open position close the membrane (15) by means of the compressed air pressing on the first membrane side (15a) and thereby close the compressed air channel (14), wherein the directly controlled valve (13) is further arranged to, in a second closed position, not supply any compressed air to the membrane (15), wherein the membrane (15) is opened by means of compressed air in the compressed air channel pressing on the second membrane side (15b) thereby opening the compressed air channel (14).
4. The ejector device according to claim 1 or 2, wherein the directly controlled valve (13) is arranged to communicate with and control the pilot valve (15) comprising a movable piston (15), movable between an open or a closed position, opening or closing the compressed air channel (14), wherein the directly controlled valve (13) is arranged to in an open position provide compressed air on a first (15a) piston body side and to in the first open position close the pilot-valve (15) by means of the compressed air pressing on the first (15a) piston body side and thereby close the compressed air channel (14), wherein the directly controlled valve (13) is further arranged to, in a second closed position, not supply any com-

pressed air to the movable piston (15), wherein the pilot valve (15) is opened by means of compressed air in the compressed air channel (14) pressing on the second (15b) piston body side thereby opening the compressed air channel (14).

5. The ejector device according to any one of the previous claims, wherein the energy reservoir (18) is provided in the ejector device (10).
6. The ejector device according to any one of the previous claims 1-5, wherein the energy reservoir (18) is provided for powering the directly controlled valve (13).
7. The ejector device according to any one of the previous claims 1-5, wherein the energy reservoir (18) is provided for powering the controller (18).
8. The ejector device according to any one of the previous claims, wherein a voltage controller is arranged to communicate with the controller (18).

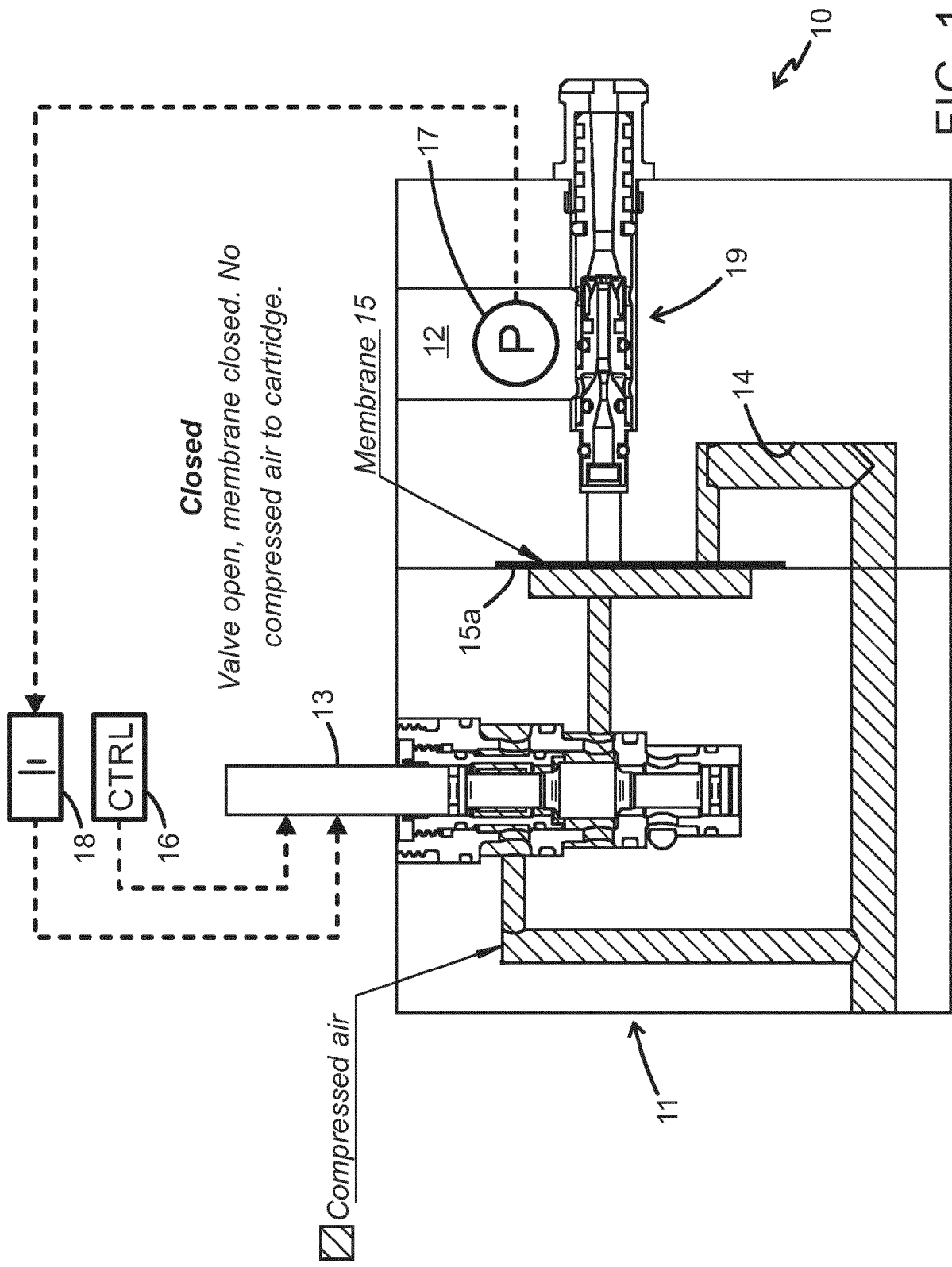
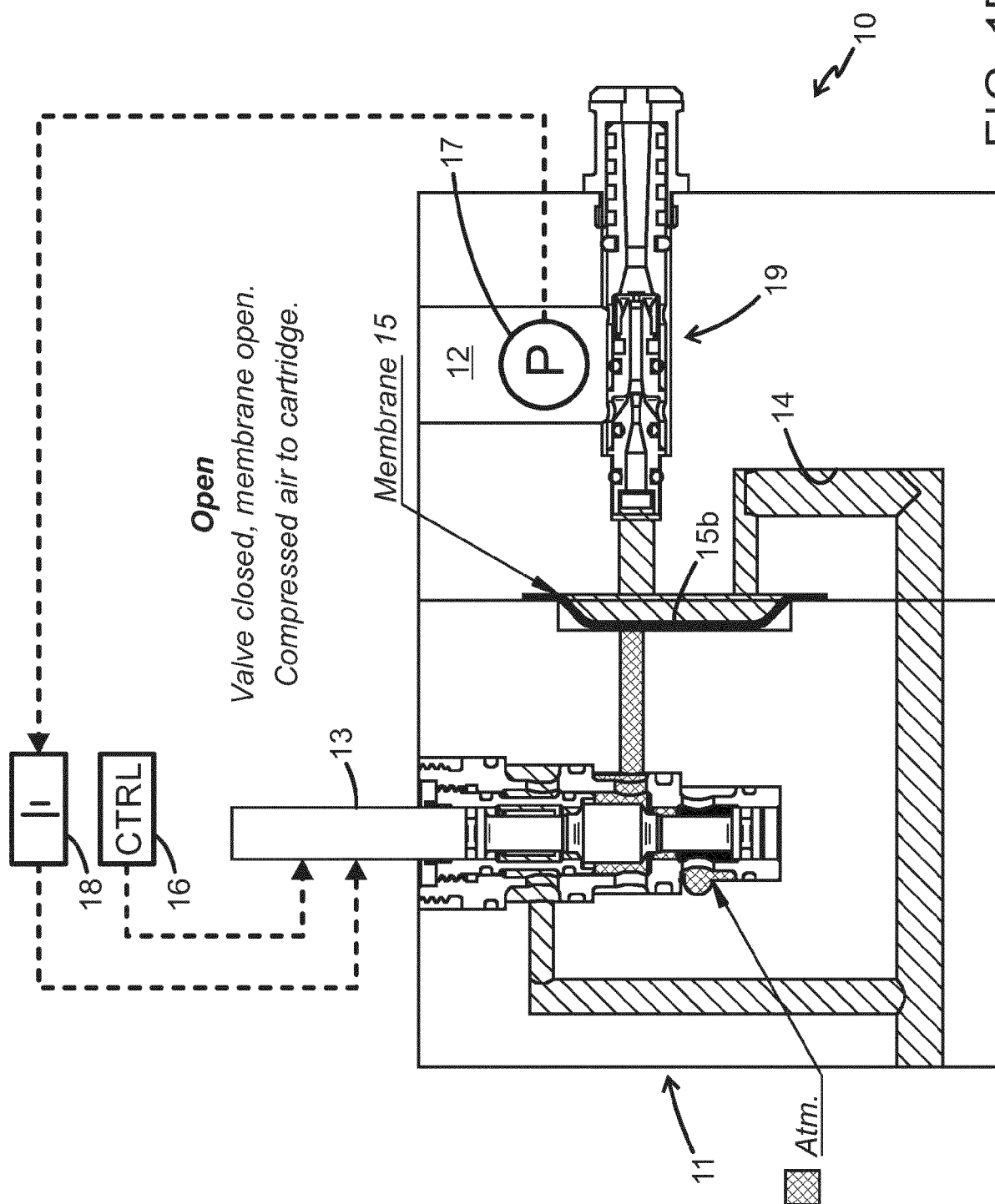


FIG. 1A





EUROPEAN SEARCH REPORT

Application Number
EP 16 17 3864

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 16 November 2016	Examiner Ziegler, Hans-Jürgen
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 16 17 3864

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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