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(54) **PNEUMATICS**

(57) A pneumatic device is provided which comprises: an inlet port for receiving compressed gas from an exhaust of a diaphragm pump; an external outlet port for outputting compressing gas to a further pneumatic device; an internal chamber defined by an internal housing arranged to funnel received compressed gas towards an internal outlet port of the internal chamber, the internal outlet port being located adjacent to, and spaced from, the external outlet port; and one or more exhausts posi-

tioned to exhaust compressed gas, from the pneumatic device, that is output from the internal outlet port without being output from the external outlet port. The pneumatic device may further comprise: a Venturi conduit for increasing the velocity of the compressed gas received by the inlet port; and one or more impellers arranged to drive compressed gas output by the Venturi conduit towards the external outlet port.

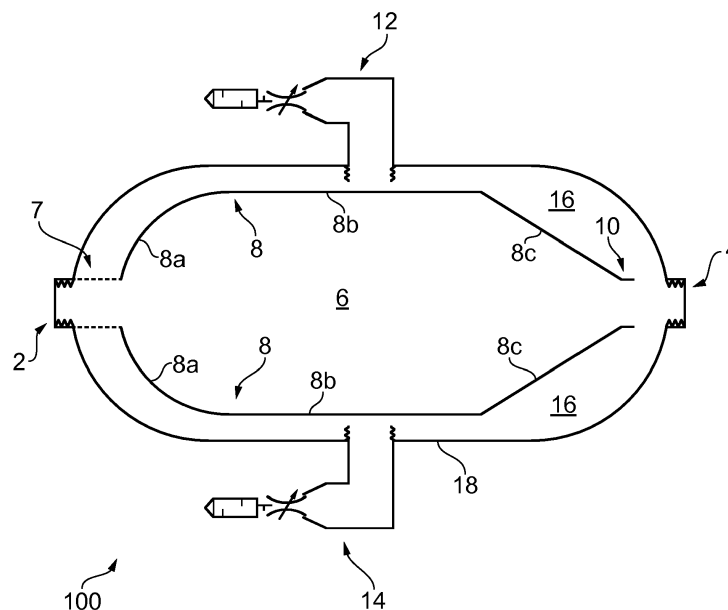


FIG. 1

Description

TECHNOLOGICAL FIELD

[0001] Embodiments of the present invention relate to pneumatics. In particular, they relate to a pneumatic device that enables compressed gas which is exhausted by a diaphragm pump to be captured and reused.

BACKGROUND

[0002] A diaphragm pump is a positive displacement pump that uses a diaphragm to pump a fluid. A gas/air operated diaphragm pump is powered by compressed gas (such as compressed air). When compressed gas is provided to a diaphragm pump in order to power it, compressed gas is exhausted to atmosphere via an exhaust.

BRIEF SUMMARY

[0003] According to various, but not necessarily all, embodiments of the invention there is provided a pneumatic device, comprising: an inlet port for receiving compressed gas from an exhaust of a diaphragm pump; an external outlet port for outputting compressing gas to a further pneumatic device; an internal chamber defined by an internal housing arranged to funnel received compressed gas towards an internal outlet port of the internal chamber, the internal outlet port being located adjacent to, and spaced from, the external outlet port; and one or more exhausts positioned to exhaust compressed gas, from the pneumatic device, that is output from the internal outlet port without being output from the external outlet port.

[0004] The one or more exhausts may be positioned to exhaust compressed gas that is output from the internal outlet port and flows away from the external outlet port, within the pneumatic device, without reaching the external outlet port.

[0005] The internal housing may comprise a tapered portion that is arranged to funnel received compressed gas towards the inlet port. The cross-sectional area of the internal chamber may reduce as the tapered portion extends towards the internal outlet port.

[0006] The inlet port may be for receiving compressed gas into the internal housing.

[0007] The pneumatic device may further comprise an external housing. The internal housing may be positioned within the external housing. The external outlet port may be for outputting compressed gas from the external housing. The internal outlet port may be positioned within the external housing.

[0008] The pneumatic device may further comprise a passage arranged to direct compressed gas, output from the internal outlet port without being output from the external outlet port, to the one or more exhausts. The passage may be at least partially curved.

[0009] The internal housing may be at least partially

curved. The pneumatic device may further comprise a Venturi conduit, positioned within the internal chamber, for increasing the velocity of the compressed gas received by the inlet port.

[0010] The pneumatic device may further comprise one or more impellers, positioned within the internal chamber, arranged to drive compressed gas output by the Venturi conduit towards the internal outlet port. The one or more impellers may comprise a plurality of impellers of different diameters. The diameter of the impellers may decrease as the impellers approach the internal outlet port.

[0011] A pneumatic system may be provided which comprises the diaphragm pump and the pneumatic device pneumatically connected to the exhaust of the diaphragm pump. The pneumatic system may further comprise: a pressure intensifying arrangement for increasing the pressure of compressed gas that has been output by external outlet port.

[0012] According to various, but not necessarily all, embodiments of the invention there is provided a pneumatic device, comprising: a housing; an inlet port for receiving compressed gas, into the housing, from an exhaust of a diaphragm pump; an external outlet port for outputting compressing gas to a further pneumatic device; a Venturi conduit for increasing the velocity of the compressed gas received by the inlet port; one or more impellers arranged to drive compressed gas output by the Venturi conduit towards the external outlet port; and one or more exhausts arranged to exhaust compressed gas, from the housing, that is driven by the one or more impellers towards the external outlet port without being output from the external outlet port.

[0013] The one or more impellers may comprise a plurality of impellers of different diameters. The diameter of the impellers may decrease as the impellers approach the external outlet port.

[0014] A pneumatic system may be provided which comprises the diaphragm pump and the pneumatic device pneumatically connected to the exhaust of the diaphragm pump. The pneumatic system may further comprise: a pressure intensifying arrangement for increasing the pressure of compressed gas that has been output by external outlet port.

[0015] According to various, but not necessarily all, embodiments of the invention there is provided examples as claimed in the appended claims.

BRIEF DESCRIPTION

[0016] For a better understanding of various examples that are useful for understanding the detailed description, reference will now be made by way of example only to the accompanying drawings in which:

fig. 1 illustrates a cross-section a first embodiment of a pneumatic device;

fig. 2 illustrates a cross section of a second embod-

iment of the pneumatic device; and
fig. 3 illustrates a system comprising the pneumatic device.

DETAILED DESCRIPTION

[0017] Embodiments of the invention relate to a pneumatic device 100/101 that enables compressed gas/air to be retrieved from an exhaust of a diaphragm pump and subsequently reused. This may advantageously reduce the amount of compressed air/gas that is required by a facility to operate its diaphragm pumps (or other pneumatic devices), thereby reducing cost.

[0018] In this document, the term "compressed gas" is intended to encompass compressed air and also other suitable compressed gases. The term "pneumatically connected" means that compressed gas is able to flow from one port/position to the other port/position.

[0019] Fig. 1 illustrates a cross section of a first embodiment 100 of a pneumatic device. The pneumatic device 100 comprises an outer housing 18, an inlet port 2, an outlet port 4 and one or more exhausts 12, 14.

[0020] The inlet port 2 is for receiving compressed gas, from an exhaust of a diaphragm pump, into the external housing 18. The outlet port 4 is for outputting compressed gas from the external housing 18 to a further pneumatic device. The inlet port 2 and the outlet port 4 are both "external" ports since they are externally accessible to a user. In the illustrated example, they extend outwardly from the outer housing 18 of the pneumatic device 100.

[0021] In the illustrated example, the outer housing 18 is substantially cylindrical in shape, but that need not be the case in other examples.

[0022] The pneumatic device 100 further comprises an internal chamber 6 defined by an internal housing 8 arranged to funnel compressed gas, received at the inlet port 2, towards an internal outlet port 10 of the internal chamber 6. The inlet port 2 comprises a internal conduit 7 that extends into the external housing 18 and connects to the internal housing 8.

[0023] The internal outlet port 10 is positioned within the external housing 18 and is located adjacent to, and spaced from, the external outlet port 4. In this example, the internal outlet port 10 is separated from the external outlet port 4 by a void.

[0024] The internal housing 8 is formed by a wall having a plurality of differently shaped portions 8a, 8b, 8c. A first portion 8a of the internal housing 8 connects to the internal conduit 7 and is tapered such that the internal housing 8 increases in size in the direction of the flow of compressed gas (i.e. from the inlet port 2 to the internal outlet port 10). Put differently, the cross-sectional area of the internal chamber 6 within the internal housing 8 increases as the tapered first portion 8a extends away from the inlet port 2.

[0025] A second portion 8b of the internal housing 8 is substantially cylindrical in the illustrated example, but this need not be the case in every example. The second por-

tion 8c connects the first portion 8a to a third portion 8c, which is shaped to funnel compressed gas towards the internal outlet port 10.

[0026] The third portion 8c of internal housing 8 is tapered such that the internal housing 8 decreases in size in the direction of the flow of compressed gas, thereby creating the funneling effect. Put differently, the cross-sectional area of the internal chamber 6 within the internal housing 8 reduces as the tapered third portion 8c extends towards the internal outlet port 10.

[0027] In the example illustrated in fig. 1, the tapered third portion 8c of the internal housing 8 is conical, but in other embodiments it might be curved in shape. For example, the tapered third portion 8c might be symmetrical with the tapered first portion 8a.

[0028] When the inlet port 2 is pneumatically connected to the exhaust of a diaphragm pump, the diaphragm pump will continuously push compressed air into the internal chamber 6, and the only outlet for that compressed gas is the internal outlet port 10.

[0029] Some of the compressed gas that is output from the internal outlet port 10 flows directly to the external outlet port 4 and is subsequently output from the external outlet port 4, exiting the pneumatic device 100. The rest of the compressed gas that is output by the internal outlet port 10 fails to reach the external outlet port 4 and enters a peripheral chamber 16 that is positioned outside the internal housing 6 and within the external housing 18.

[0030] As the inlet port 2 is directly connected to the internal housing 8 by the conduit 7, compressed gas that enters the inlet port 2 cannot enter the peripheral chamber 16 without entering the internal housing 8 first.

[0031] The peripheral chamber 16 provides a passage that is arranged to direct compressed gas that is output from the internal outlet port 10, without being output from the external outlet port 4, to the exhausts 12, 14. The exhausts 12, 14 are positioned to exhaust that compressed gas. In some embodiments, the passage is at least partially curved (e.g. due to a curvature of the external housing 18 and/or a curvature of the internal housing 8).

[0032] If the internal outlet port 10 were directly connected to the external outlet port 4 such that compressed gas were not able to enter the peripheral chamber 16, over time, as compressed air is input into the inlet port 2 by the exhaust of the diaphragm pump, pressure would build up in the pneumatic device 100 and make it harder for compressed gas to be exhausted into it from the diaphragm pump. This is known as a "back pressure". It would affect the operation of the diaphragm pump, causing it to slow down and potentially stop working. However, in the case of the pneumatic device 100, the presence of an exhaust path (via the peripheral chamber 16) for the compressed gas that is output by the internal outlet port 10 but which does not reach the external outlet port 4 means that such a "back pressure" does not develop when the pneumatic device 100 is employed.

[0033] The pneumatic device 100 therefore advanta-

geously enables compressed gas (which would otherwise be exhausted to atmosphere by a diaphragm pump) to be retrieved from the exhaust of a diaphragm pump and potentially reused.

[0034] Fig. 2 illustrates a second embodiment 101 of the pneumatic device. The pneumatic device 101 illustrated in fig. 2 is similar to that illustrated in fig. 1 in that it comprises an inlet port 2, an external outlet port 4, an internal chamber 6 defined by an internal housing 8 and one or more exhausts 12, 14. A peripheral chamber 16 is positioned between an external housing 18 and the internal housing 8.

[0035] The third portion 8c of the internal housing 8 in fig. 2 differs from that in fig. 1 in that it is curved rather than conical, although it was explained above that the third portion 8c of the internal housing 8 of the first embodiment 100 of the pneumatic device might instead be curved. The third portion 8c of the internal housing 8 in fig. 2 could be conical instead.

[0036] The difference between the second embodiment 101 of the pneumatic device illustrated in fig. 2 and the first embodiment 100 illustrated in fig. 1 is the presence of a Venturi conduit 9 and an impeller arrangement 11 in the second embodiment 101.

[0037] The Venturi conduit/tube 9 is positioned within the internal chamber 6 in the illustrated example and is for increasing the velocity of compressed gas received by the inlet port 2. The Venturi conduit 9 includes a first, wider, portion 9a which is followed by a second, narrower, portion 9b in the direction of the gas flow (from the inlet port 2 to the outlet ports 4, 10). The second, narrower, portion 9b of the Venturi conduit 9 is followed by a third portion 9c that acts as an outlet and is wider than the second portion 9b.

[0038] The impeller arrangement 11 is positioned at the outlet of the Venturi conduit 9 and includes impellers 11a, 11b, 11c, 11d, 11e of different diameters. Each of the impellers 11a-11e is fixed to a rotatable shaft 13. The diameter of the impellers 11a-11e decreases as the impellers 11a-11e approach the internal outlet port 10. That is, the largest impeller 11a is positioned closest to the Venturi conduit 9 and the smallest impeller 11d is positioned closest to the internal outlet port 10. This configuration of impellers 11a-11e is designed to urge and guide compressed air through the internal outlet port 10.

[0039] The Venturi conduit 9 increases the velocity of compressed gas that enters it, and the impeller arrangement 11 then drives compressed gas exiting the Venturi conduit 9 towards the internal outlet port 10.

[0040] The second embodiment 101 of the pneumatic device is similar to the first embodiment 100 in that some of the compressed gas which is output from the internal outlet port 10 flows directly to the external outlet port 4 and is subsequently output from the external outlet port 4, exiting the pneumatic device 100. The rest of the compressed gas that is output by the internal outlet port 10 fails to reach the external outlet port 4 and enters the peripheral chamber 16 that is positioned outside the in-

ternal housing 6 and within the external housing 18. The exhausts 12, 14 exhaust the compressed gas that enters the peripheral chamber 16.

[0041] As in the first embodiment 100, the presence of an exhaust path for the compressed gas that is output by the internal outlet port 10 but does not reach the external outlet port 4 means that a "back pressure" does not develop when the pneumatic device 101 is employed. This allows compressed gas exiting the exhaust of a diaphragm pump to be retrieved and recaptured without adversely affecting the performance of the diaphragm pump.

[0042] Fig. 3 illustrates a pneumatic system 200 comprising a compressed gas source 20, a diaphragm pump 30 which is operated by compressed gas, the pneumatic device 100/101 described above in relation to fig. 1 or fig. 2, a swing check valve 40 and a pressure intensifying arrangement 103.

[0043] The pressure intensifying arrangement 103 includes first and second repositories 50, 150 for storing a reservoir of compressed gas, a plurality of one-way valves 60, 130, 140, a pressure relief valve 70, a control valve 80, a plurality of pressure decay sensors 90a, 90b, a first pneumatic cylinder 110 and a second pneumatic cylinder 120.

[0044] In use, compressed gas is supplied to the diaphragm pump 30 in order to operate it. During operation of the diaphragm pump 30, compressed gas is output to the pneumatic device 100/101 which, in this example, is directly connected to the exhaust of the diaphragm pump 30. Here, "directly connected" means there are no intervening pneumatic devices between the exhaust of the diaphragm pump and the pneumatic device 100/101.

[0045] The compressed gas passes through the pneumatic device 100/101 in the manner described above in relation to fig. 1 or fig. 2. The swing check valve 40 that is connected to the external outlet 4 of the pneumatic device 100/100 allows compressed air to be output by the pneumatic device 100/101 to the pressure intensifying arrangement 103 without generating a "back pressure" which would affect the performance of the diaphragm pump 30.

[0046] The pressure of compressed gas that is output by the external outlet port 4 of the pneumatic device 100/101 is typically lower than that which is input into the diaphragm pump 30. It may be desirable to increase the pressure of the compressed gas that has been retrieved from the exhaust of the diaphragm pump 30, for example, to a level which matches (or is similar to) the pressure of the compressed gas that is input into the diaphragm pump 30. This may, for example, enable the retrieved compressed gas to be reused to operate the diaphragm pump 30 or other pneumatic devices.

[0047] The purpose of the pressure intensifying arrangement 103 is to increase the pressure to a suitable level for the recaptured compressed air to be reused. It will be appreciated by those skilled in the art that other pressure intensifying arrangements could be used other

than the one shown in fig. 3. In some implementations of the invention, it might not be necessary to increase the pressure of the recaptured compressed air prior to its reuse.

[0048] Where a structural feature has been described, it may be replaced by means for performing one or more of the functions of the structural feature whether that function or those functions are explicitly or implicitly described.

[0049] Although embodiments of the present invention have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without departing from the scope of the invention as claimed.

[0050] Features described in the preceding description may be used in combinations other than the combinations explicitly described.

[0051] Although functions have been described with reference to certain features, those functions may be performable by other features whether described or not.

[0052] Although features have been described with reference to certain embodiments, those features may also be present in other embodiments whether described or not.

[0053] Whilst endeavoring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

Claims

1. A pneumatic device, comprising:

an inlet port for receiving compressed gas from an exhaust of a diaphragm pump;
an external outlet port for outputting compressing gas to a further pneumatic device;
an internal chamber defined by an internal housing arranged to funnel received compressed gas towards an internal outlet port of the internal chamber, the internal outlet port being located adjacent to, and spaced from, the external outlet port; and
one or more exhausts positioned to exhaust compressed gas, from the pneumatic device, that is output from the internal outlet port without being output from the external outlet port.

2. The pneumatic device of claim 1, wherein the one or more exhausts are positioned to exhaust compressed gas that is output from the internal outlet port and flows away from the external outlet port, within the pneumatic device, without reaching the

external outlet port.

3. The pneumatic device of claim 1 or 2, wherein the internal housing comprises a tapered portion that is arranged to funnel received compressed gas towards the inlet port.
4. The pneumatic device of claim 3, wherein the cross-sectional area of the internal chamber reduces as the tapered portion extends towards the internal outlet port.
5. The pneumatic device of any of the preceding claims, wherein the inlet port is for receiving compressed gas into the internal housing.
6. The pneumatic device of any of the preceding claims, further comprising an external housing, wherein the internal housing is positioned within the external housing.
7. The pneumatic device of claim 6, wherein the external outlet port is for outputting compressed gas from the external housing.
8. The pneumatic device of claim 6 or 7, wherein the internal outlet port is positioned within the external housing.
9. The pneumatic device of any of the preceding claims, further comprising a passage arranged to direct compressed gas, output from the internal outlet port without being output from the external outlet port, to the one or more exhausts.
10. The pneumatic device of any of the preceding claims, further comprising a Venturi conduit, positioned within the internal chamber, for increasing the velocity of the compressed gas received by the inlet port.
11. The pneumatic device of claim 10, further comprising one or more impellers, positioned within the internal chamber, arranged to drive compressed gas output by the Venturi conduit towards the internal outlet port.
12. The pneumatic device of claim 11, wherein the one or more impellers comprise a plurality of impellers of different diameters.
13. The pneumatic device of claim 12, wherein the diameter of the impellers decreases as the impellers approach the internal outlet port.
14. A pneumatic system comprising the diaphragm pump and the pneumatic device of any of the preceding claims pneumatically connected to the exhaust of the diaphragm pump.

15. A pneumatic device, comprising:

a housing;
an inlet port for receiving compressed gas, into
the housing, from an exhaust of a diaphragm pump;
an external outlet port for outputting compress-
ing gas to a further pneumatic device;
a Venturi conduit for increasing the velocity of
the compressed gas received by the inlet port;
one or more impellers arranged to drive com-
pressed gas output by the Venturi conduit to-
wards the external outlet port; and
one or more exhausts arranged to exhaust com-
pressed gas, from the housing, that is driven by
the one or more impellers towards the external
outlet port without being output from the external
outlet port.

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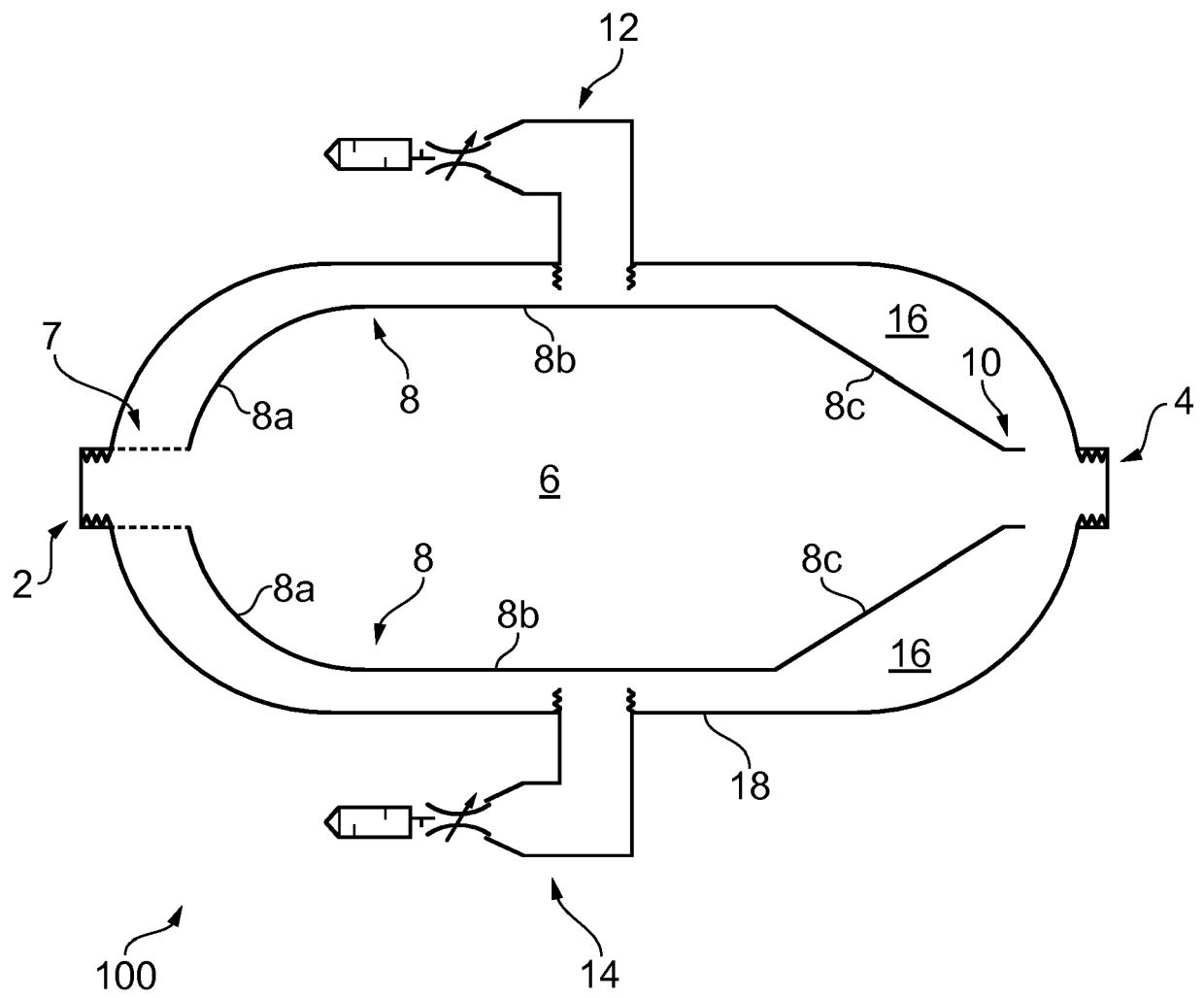


FIG. 1

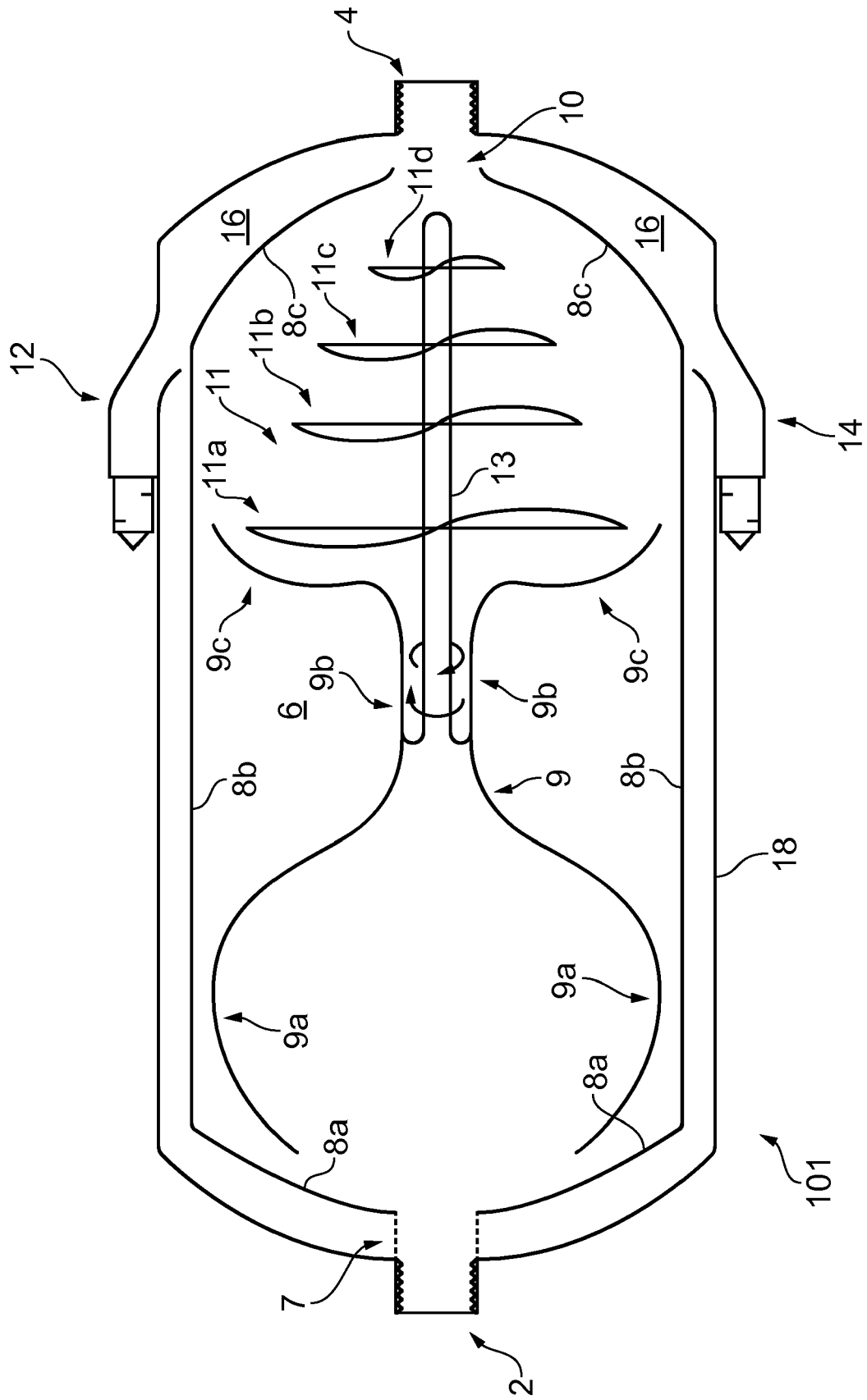


FIG. 2

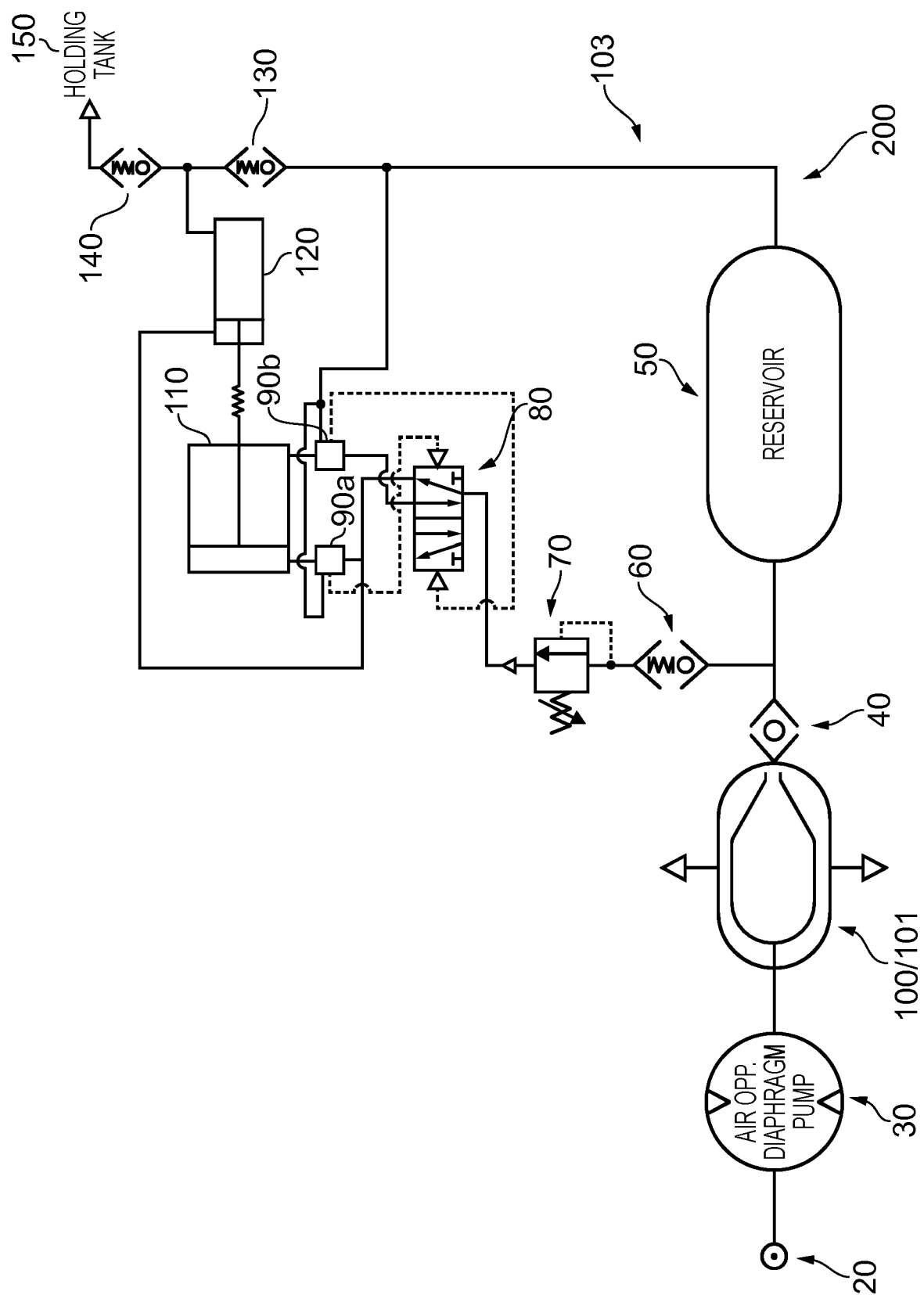


FIG. 3



EUROPEAN SEARCH REPORT

Application Number
EP 17 19 6223

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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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 3 May 2018	Examiner Homan, Peter
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			

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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 17 19 6223

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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03-05-2018

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