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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 September 2007 (27.09.2007)

PCT

(10) International Publication Number
WO 2007/107781 A1

(51) International Patent Classification:
F16K 3/32 (2006.01) *F16K 11/085* (2006.01)
F16K 11/065 (2006.01)

(21) International Application Number:
PCT/GB2007/050067

(22) International Filing Date:
15 February 2007 (15.02.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0605554.5 20 March 2006 (20.03.2006) GB

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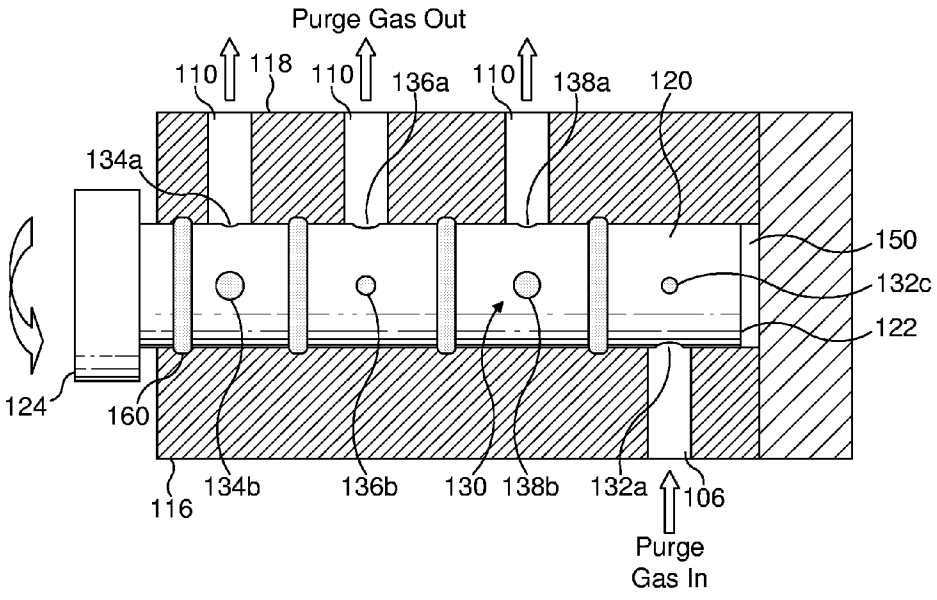
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR,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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: GAS SUPPLY APPARATUS



(57) Abstract: Apparatus is described for supplying and measuring a purge gas flow to a pumping arrangement, the apparatus comprising a manifold (104) having a gas inlet (106) and a plurality of gas outlets (110) each for supplying gas to a respective port of the pumping arrangement, and a flow selector (120) between the inlet and the outlets, the flow selector having a plurality of spaced apertures (130) of various sizes and being moveable relative to the manifold from one position in which a first set of the apertures is aligned with the inlet and the outlets to another position in which a second set of the apertures is aligned with the inlet and the outlets to vary the flow rate of gas into and from the flow selector, and enable the gas flow rate to be measured across the aperture aligned with the inlet.

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GAS SUPPLY APPARATUS

This invention relates to apparatus for supplying a purge gas to a pumping arrangement.

Vacuum pumping arrangements used to pump fluid from semiconductor tools typically employ, as a backing pump, a multi-stage positive displacement pump employing inter-meshing rotors. The rotors may have the same type of profile in each stage or the profile may change from stage to stage.

During semiconductor processes such as chemical vapour deposition processing, deposition gases are supplied to a process chamber to form a deposition layer on the surface of a substrate. As the residence time in the chamber of the deposition gas is relatively short, only a small proportion of the gas supplied to the chamber is consumed during the deposition process. Consequently, unconsumed gas molecules pumped from the chamber by a vacuum pump can pass through the pump in a highly reactive state. As a result, pump components can be subjected to damage due to corrosion and degradation resulting from the pumping of aggressive, unconsumed gas molecules. Furthermore, if the unconsumed process gas or by-product is condensable, sublimation on lower temperature surfaces can result in the accumulation of powder or dust within the pump, which can effectively fill the vacant running clearance between the rotor and stator elements of the pump. Other processes use gases that can result in potentially flammable mixtures forming in the pump.

To dilute these gases as they pass through the pump, an inert purge gas, such as nitrogen, can be supplied to the pump. As this gas can also serve to increase the longevity and effectiveness of dynamic shaft seals of the pump, and can ensure that certain sensors within the pumping arrangement are maintained in a clean and functional state, it is typically supplied through a plurality of purge ports provided at various locations about the pumping arrangement.

To reduce the cost of purge gas consumption, the quantity of purge gas supplied to the pumping arrangement is normally fixed during installation of the pumping arrangement depending on the process application. The quantity of purge gas must be carefully controlled in order to avoid both under-dilution of the process gases, as this could lead to pumping reliability problems, and over-dilution of the process gases, as this could lead to unnecessary costs and loss of pumping performance.

Figure 1 illustrates a typical system for supplying purge gas to a number of purge ports. The system 10 comprises a manifold 12 having an inlet 14 and a plurality of outlets 16. The inlet 14 is connected to a source 18 of purge gas, such as nitrogen or argon, via a conduit 20, which includes a check valve 22. As the pressure of the purge gas at the source 18 may be variable, for example, within the range from 20 to 100 psi, the conduit 20 also includes a pressure regulator 24 for adjusting the pressure of the stream of purge gas conveyed to the inlet 14.

Within the manifold 12, the received stream of purge gas passes through a mass flow transducer 26 before being split into a plurality of streams for conveyance to the outlets 16. As the flow requirement at each outlet 16 may be different, depending on the purpose for which the purge gas is being supplied to a particular purge port of the pumping arrangement, the manifold 16 contains a relatively complex and expensive arrangement of solenoid valves 28, fixed flow restrictors 30 and variable flow restrictors, for example needle valves, 32 for fixing the flow rate of each stream of purge gas supplied to an outlet 16.

The present invention provides apparatus for supplying a purge gas to a pumping arrangement, the apparatus comprising a manifold having a gas inlet and a plurality of gas outlets each for supplying gas to a respective port of the pumping arrangement, and a flow selector located between the inlet and the outlets, the flow selector comprising a plurality of spaced apertures of various sizes and being moveable relative to the manifold from one position in which a first set of the apertures is aligned with the inlet and the outlets to another position in which a

second set of the apertures is aligned with the inlet and the outlets to vary the flow rate of gas into and from the flow selector.

This can enable the required flow rate of gas to each of the ports of the pumping arrangement to be quickly and easily selected by the correct location of the flow selector within the manifold so that the appropriate set of apertures of the flow selector is aligned with the inlet and the outlets of the manifold.

When the flow selector is adjusted to change the flow rate of purge gas from the manifold, a different aperture becomes aligned with the inlet of the manifold to adjust the rate of flow of purge gas into the flow selector. This can both ensure that the flow of purge gas into the flow selector is appropriate for the required flow rate of purge gas from the selector, thereby avoiding throttling of the purge gas flow, and enable the purge gas flow rate to be monitored by achieving a measurable pressure drop across the aperture aligned with the inlet of the manifold.

Each set of apertures preferably comprises an inlet aperture for alignment with the inlet and a plurality of outlet apertures each for alignment with a respective outlet, with the outlet apertures being axially aligned. The inlet aperture may be axially aligned with the outlet apertures, or it may be angularly spaced from the outlet apertures. In one embodiment, the inlet aperture is located on the opposite side of the flow selector to the outlet apertures. The inlet aperture is preferably located towards one end of the flow selector.

The outlet apertures of a set may have the same or various sizes. For example, each set may comprises three or more outlet apertures, and some of these outlet apertures may have the same size, or they may all have different sizes depending on the required gas flow rates to the ports of the pumping arrangement. The inlet apertures of the flow selector preferably have different sizes, so that, for example, when the overall flow rate of gas from the manifold is to be reduced, a smaller inlet aperture is aligned with the inlet of the manifold.

The flow selector may be rotatably and/or axially moveable relative to the manifold. In one embodiment, the flow selector is rotatable relative to the manifold, and so the first set of apertures is angularly spaced from the second set of apertures. In another embodiment, the flow selector is axially movable relative to the manifold, with the sets of apertures being axially spaced. Alternatively, the sets of apertures may be both radially and axially spaced. In one embodiment, the flow selector is hollow, and preferably comprises a tubular member which is at least rotatable relative to the manifold to adjust the position of the flow selector within the manifold. The sets of apertures may be spaced by any angle depending on the number of sets of apertures located on the flow selector. For example, the sets may be spaced by a quarter turn of the flow selector. In other embodiment, the flow selector is a plate what is axially moveable relative to the manifold to adjust the position of the flow selector within the manifold. In this embodiment, the apertures are axially spaced

The flow selector may be located wholly within the manifold. In the preferred embodiments, one end of the flow selector is located in the manifold, and the other end of the flow selector is external of the manifold. Part of the flow selector is preferably spaced from the manifold, so that the space between the flow restrictor and the manifold can provide a measurement point for determining the pressure drop across the inlet aperture. A second measurement point may be conveniently located in the inlet of the gas manifold. The external end of the flow selector may provide a handle to enable a user to manually adjust the position of the flow selector.

Preferred features of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates a know system for supplying an inert purge gas to a pump;

Figure 2 illustrates a pumping arrangement having ports connected to an apparatus for supplying purge gas to the pumping arrangement;

Figure 3 illustrates in more detail a first embodiment of the manifold of the apparatus of Figure 2, with part of the wall of the manifold removed to reveal the flow selector; and

Figure 4 is a cross-section through a second embodiment of the manifold of the apparatus of Figure 2.

With reference first to Figure 2, apparatus 100 for supplying a purge gas to the pumping arrangement 102 comprises a manifold 104 having a gas inlet 106 for receiving a flow of purge gas from a purge gas supply 108 and a plurality of gas outlets 110 each for supplying purge gas to a respective port 112 of the pumping arrangement 102 via a flow conduit 114. In the illustrated embodiment, the manifold 104 has three gas outlets 110 each connected to the pumping arrangement 102, although the manifold 104 may have more than three gas outlets which can be selectively connected to the pumping arrangement 102 as required. The gas inlet 106 is located on a side wall 116 of the manifold 104, towards one end of the manifold 104, and the gas outlets 110 are located on the opposite side wall 118 of the manifold 104.

A first embodiment of the manifold 104 is illustrated in more detail in Figure 3. A hollow flow selector 120 is located between the gas inlet 106 and the gas outlets 110, in this embodiment partially within the manifold 104 so that one end 122 of the flow selector 120 is located within the manifold 104 and the other end 124 of the flow selector 120 is external of the manifold 104. In this embodiment, the flow selector 120 is cylindrical, but may adopt any other tubular or hollow shape. Seals 160 are located about the external periphery of the flow selector 120 to isolate the gas inlet 106 and the gas outlets 100 externally of the flow selector 120 so that purge gas flows from the gas inlet 106 to the gas outlets 110 through the flow selector 120.

The flow selector 120 is moveable relative to the manifold 104. In this embodiment, the flow selector 120 is rotatable relative to the manifold 104, with the external end 124 of the flow selector 120 being shaped to provide a handle to enable a user to manually adjust the position of the flow selector 120.

The flow selector 120 has a plurality of apertures 130 of various sizes, that is, two or more different sizes, located on its periphery. The apertures 130 are divided into a plurality of spaced sets of apertures of different sizes. Each set of apertures comprises an inlet aperture for alignment with the gas inlet 106 to enable gas to enter the flow restrictor 120, and a plurality of outlet apertures for alignment with the gas outlets 110 to enable gas to exit the flow restrictor 120. In the position located in Figure 3, inlet aperture 132a of a first set of apertures is aligned with the gas inlet 106 and outlet apertures 134a, 136a, 138a of that first set are each aligned with a respective gas outlet 110. With a quarter turn of the flow selector 120 in an anti-clockwise direction, outlet apertures 134b, 136b, 138b of a second set of apertures each become aligned with a respective gas outlet 110, and the inlet aperture (not shown) of that second set becomes aligned with the gas inlet 106. With a quarter turn of the flow selector 120 in a clockwise direction, inlet aperture 132c of a third set of apertures becomes aligned with the gas inlet 106, and the outlet apertures (not shown) of that third set each become aligned with a respective gas outlet 110.

The respective sizes of the inlet and outlet apertures of each set determines the flow rate of the purge gas from the manifold 104 in each position of the flow selector 120. The outlet apertures of each set may have the same size, various (two or more) different sizes, or they may have respective different sizes depending on the purge gas flow rate requirement of each port 112 of the pumping arrangement 102. The handle may be indexed to enable the user to readily position the flow selector 120 so that a particular set of apertures is aligned with the gas inlet 106 and the gas outlet 110 as appropriate to the required flow rate of purge gas to the pumping arrangement 102.

The provision of these sets of apertures 130 on the periphery of the flow selector 120 can enable the flow rate of purge gas into the flow selector 120 from the gas inlet 106, and out from the flow selector 120 to each gas outlet 110, to be easily changed through appropriate positioning of the flow selector 120 relative to the manifold 104. For example, when the flow rate to the pumping arrangement is to be increased, the flow selector 120 can be moved to a position in which a large set of apertures is aligned with the gas inlet 106 and the gas outlets 110, and when the flow rate to the pumping arrangement is to be reduced, the flow selector 120 can be moved to a position in which a smaller set of apertures is aligned with the gas inlet 106 and the gas outlets 110.

In conjunction with this, in any position the flow rate of gas entering the manifold 104 can be monitored by measuring the pressure drop across the inlet aperture currently aligned with the gas inlet 106. For example, a first pressure measurement may be made in the gas inlet 106, and a second pressure measurement may be made in the gap 150 between the manifold 104 and the internal end 122 of the flow selector 120. By changing the size of the inlet aperture aligned with gas outlet 106 through rotation of the flow selector 120 so that, for example, the size of the inlet aperture is decreases with a decreasing flow of purge gas from the manifold, a measurable pressure difference across the inlet aperture can be obtained for each different flow rate of purge gas from the manifold 104. Furthermore, by having an inlet aperture of appropriate size for the required flow rate of gas from the manifold 104, throttling of the purge gas flow through the manifold 104 can be inhibited.

A second embodiment of the manifold 104 is illustrated in Figure 4. In this embodiment, the flow selector 120 is in the form of a plate located between the gas inlet 106 and the gas outlets 110, and is also partially within the manifold 104 so that one end 122 of the flow selector 120 is located within the manifold 104 and the other end 124 of the flow selector 120 is external of the manifold 104. Seals 160 are located about the gas inlet 106 and the flow selector 120 to isolate the gas

inlet 106 and the gas outlets 100 externally of the flow selector 120 so that purge gas flows from the gas inlet 106 to the gas outlets 110 through the flow selector 120.

In this embodiment, the flow selector 120 is axially moveable relative to the manifold 104, with the external end 124 of the flow selector 120 providing a handle to enable a user to manually adjust the position of the flow selector 120.

As in the first embodiment, the flow selector 120 has a plurality of apertures 130 of various sizes, that is, two or more different sizes, located on its periphery. The apertures 130 are divided into a plurality of spaced sets of apertures of different sizes. Each set of apertures comprises an inlet aperture for alignment with the gas inlet 106 to enable gas to enter the manifold 104 from the gas inlet 106, and a plurality of outlet apertures for alignment with the gas outlets 110 to enable gas to exit the manifold 104. In the position located in Figure 4, inlet aperture 132b of a first set of apertures is aligned with the gas inlet 106 and outlet apertures 134b, 136b, 138b of that first set are each aligned with a respective gas outlet 110. With movement of the flow selector 120 to the right (as illustrated), inlet aperture 132a of a second set of apertures becomes aligned with the gas inlet 106, and the outlet apertures 134a, 136a, 138a of that second set each become aligned with a respective gas outlet 110. With movement of the flow selector 120 to the left (as illustrated), inlet aperture 132c of a third set of apertures becomes aligned with the gas inlet 106, and the outlet apertures 134c, 136c, 138c of that third set each become aligned with a respective gas outlet 110. As shown in Figure 4, the inlet apertures 132a, 132b, 132c have different sizes.

The respective sizes of the inlet and outlet apertures of each set determines the flow rate of the purge gas from the manifold 104 in each position of the flow selector 120. As in the first embodiment, the outlet apertures of each set may have the same size, various (two or more) different sizes, or they may have respective different sizes depending on the purge gas flow rate requirement of each port 112 of the pumping arrangement 102. The handle may be indexed to

enable the user to readily position the flow selector 120 so that a particular set of apertures is aligned with the gas inlet 106 and the gas outlet 110 as appropriate to the required flow rate of purge gas to the pumping arrangement 102.

As with the first embodiment, the provision of these sets of apertures 130 on the periphery of the flow selector 120 can enable the flow rate of purge gas into the manifold 104 from the gas inlet 106, and out from the manifold 104 to each gas outlet 110, to be easily changed through appropriate positioning of the flow selector 120 relative to the manifold 104. For example, when the flow rate to the pumping arrangement is to be increased, the flow selector 120 can be moved to a position in which a large set of apertures is aligned with the gas inlet 106 and the gas outlets 110, and when the flow rate to the pumping arrangement is to be reduced, the flow selector 120 can be moved to a position in which a smaller set of apertures is aligned with the gas inlet 106 and the gas outlets 110.

As also with the first embodiment, in any position the flow rate of gas entering the manifold 104 can be monitored by measuring the pressure drop across the inlet aperture currently aligned with the gas inlet 106. For example, a first pressure measurement may be made in the gas inlet 106, and a second pressure measurement may be made in the gap 150 between the manifold 104 and the flow selector 120.

CLAIMS

1. Apparatus for supplying a purge gas to a pumping arrangement, the apparatus comprising:

a manifold having a gas inlet and a plurality of gas outlets each for supplying gas to a respective port of the pumping arrangement; and

a flow selector located between the inlet and the outlets, the flow selector comprising a plurality of spaced apertures of various sizes and being moveable relative to the manifold from one position in which a first set of the apertures is aligned with the inlet and the outlets to another position in which a second set of the apertures is aligned with the inlet and the outlets to vary the flow rate of gas into and from the flow selector.

2. Apparatus according to Claim 1, wherein each set comprises an inlet aperture for alignment with the inlet and a plurality of outlet apertures each for alignment with a respective outlet, and wherein the outlet apertures are axially aligned.

3. Apparatus according to Claim 2, wherein the inlet aperture is angularly spaced from the outlet apertures.

4. Apparatus according to Claim 2 or Claim 3, wherein the inlet aperture is located on the opposite side of the flow selector to the outlet apertures.

5. Apparatus according to Claim 2, wherein the inlet aperture is axially spaced from the outlet apertures.

6. Apparatus according to any of Claims 2 to 5, wherein the inlet aperture is located towards one end of the flow selector.

7. Apparatus according to any of Claims 2 to 6, wherein the outlet apertures of each set have various sizes.

8. Apparatus according to any of Claims 2 to 7, wherein the inlet apertures have different sizes.

9. Apparatus according to any preceding claim, wherein the first set of apertures is angularly spaced from the second set of apertures.

10. Apparatus according to any of Claims 1 to 8, wherein the first set of apertures is angularly spaced from the second set of apertures.

11. Apparatus according to any preceding claim, wherein the flow selector is hollow, the apertures being located on the periphery thereof.

12. Apparatus according to Claim 11, wherein the flow selector is tubular.

13. Apparatus according to any of Claims 1 to 10, wherein the flow selector comprises a plate.

14. Apparatus according to any preceding claim, wherein one end of the flow selector is located inside the manifold, and the other end of the flow selector is external of the manifold.

15. Apparatus according to Claim 14, wherein the external end of the flow selector provides a handle to enable a user to manually adjust the position of the flow selector.

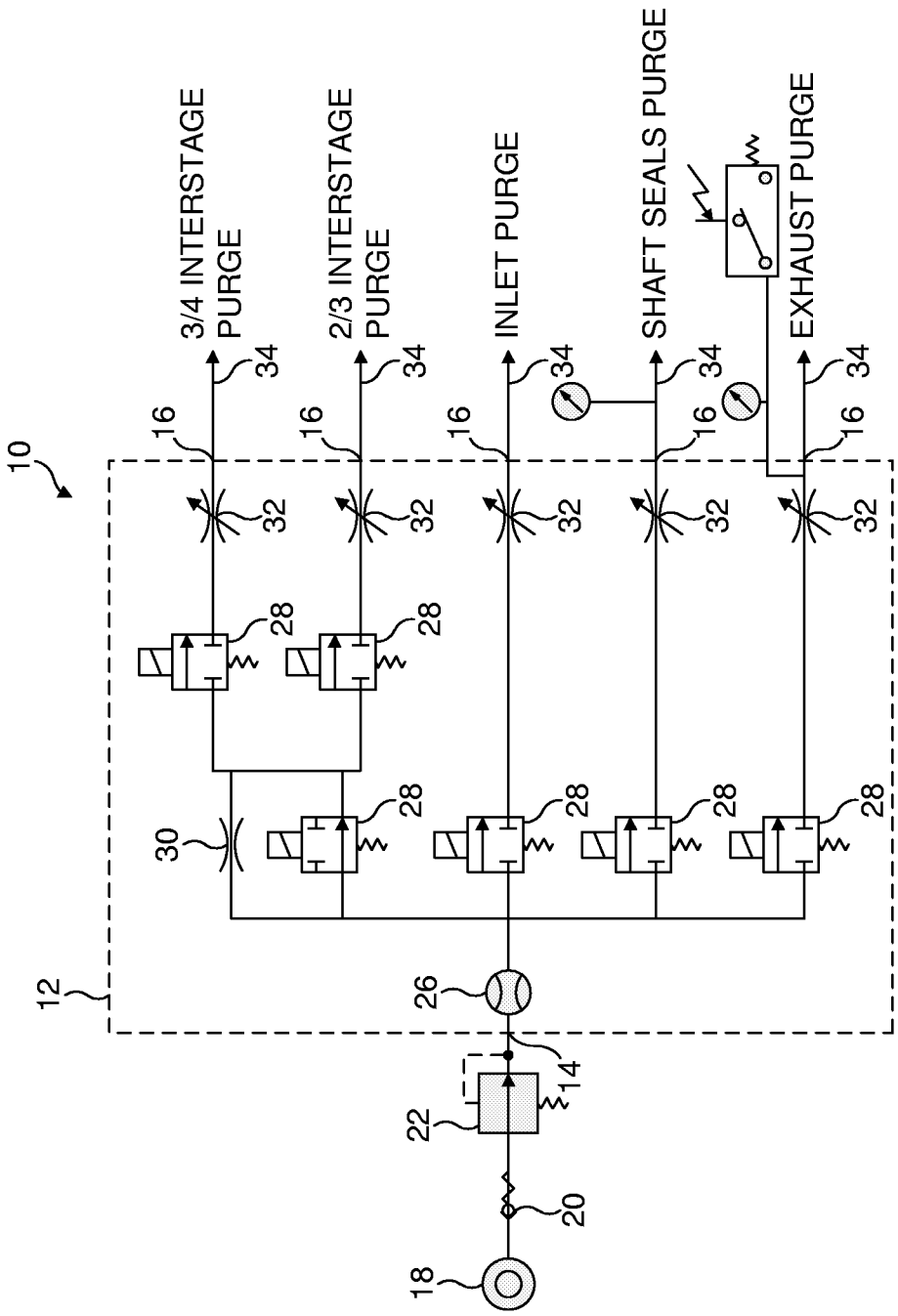

FIG. 1
(PRIOR ART)

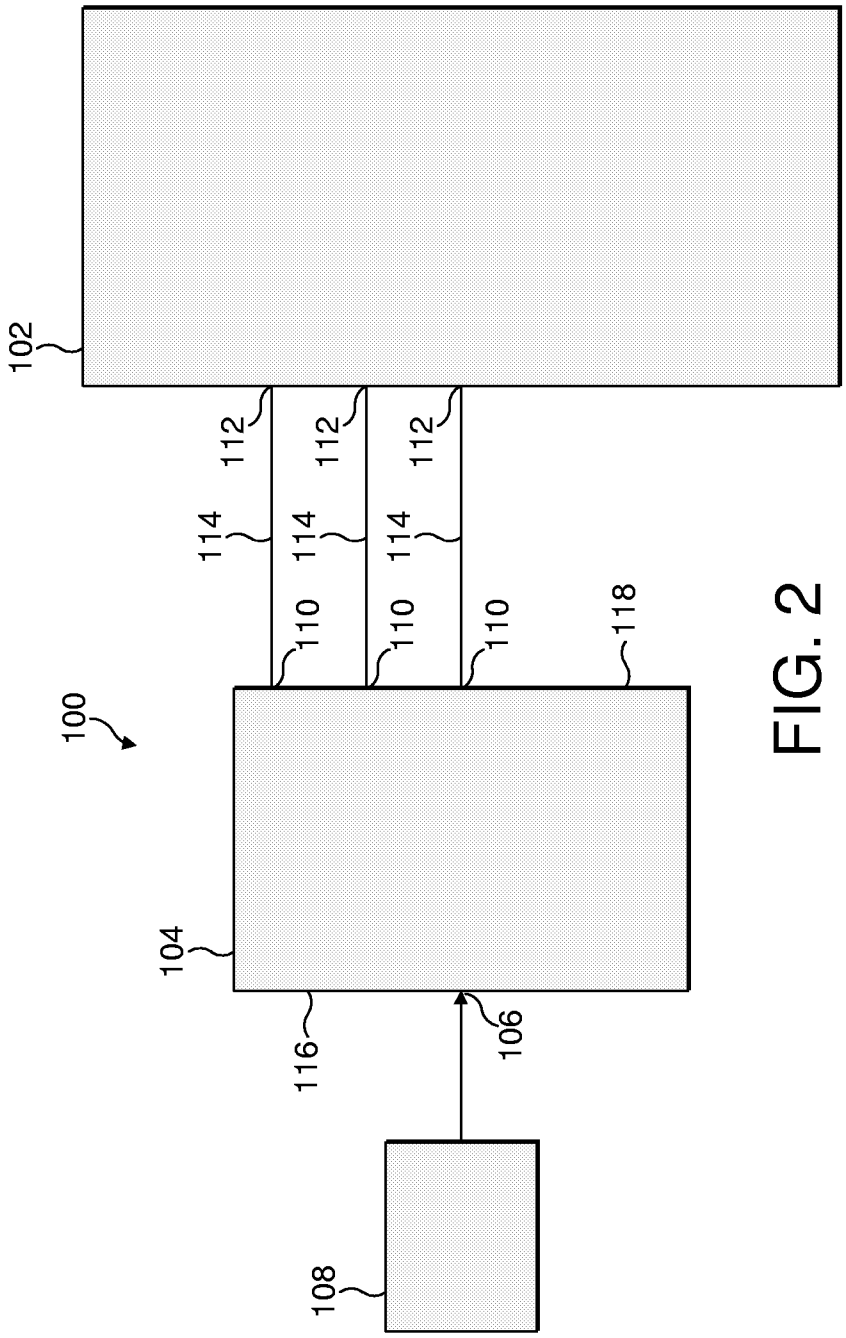

FIG. 2

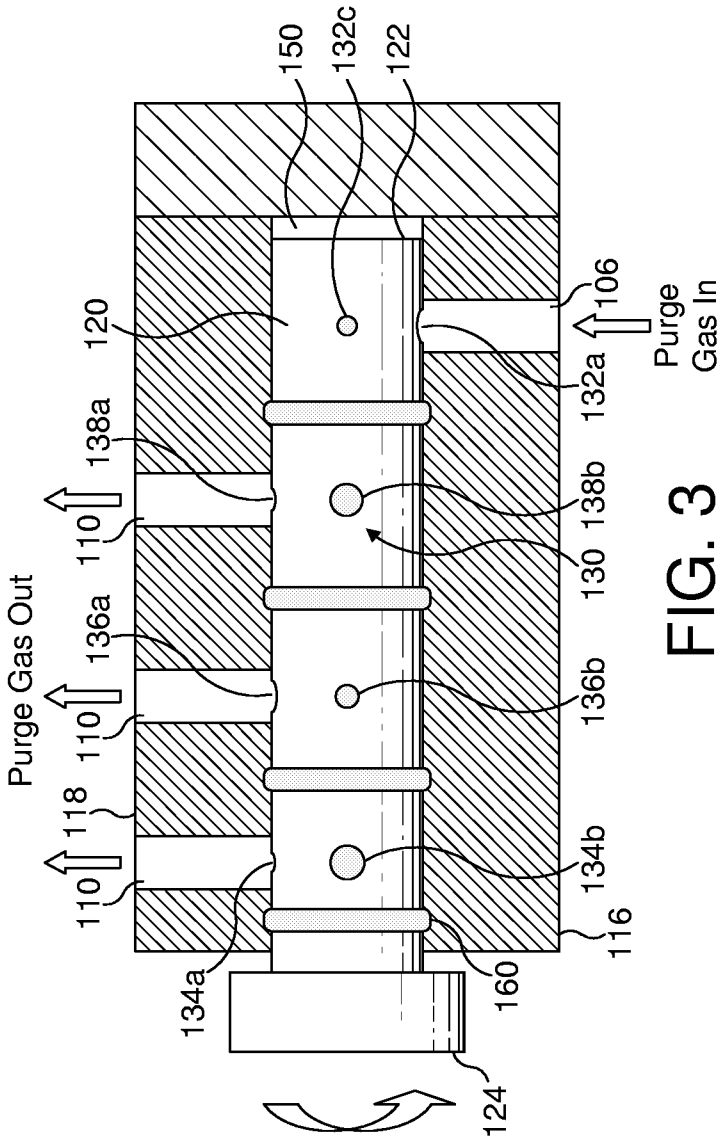
150
132c
122
120
106
Purge
Gas In
132a
138a
110
138b
130
Purge Gas Out
136a
110
136b
118
110
134b
116
134a
160
124

FIG. 3

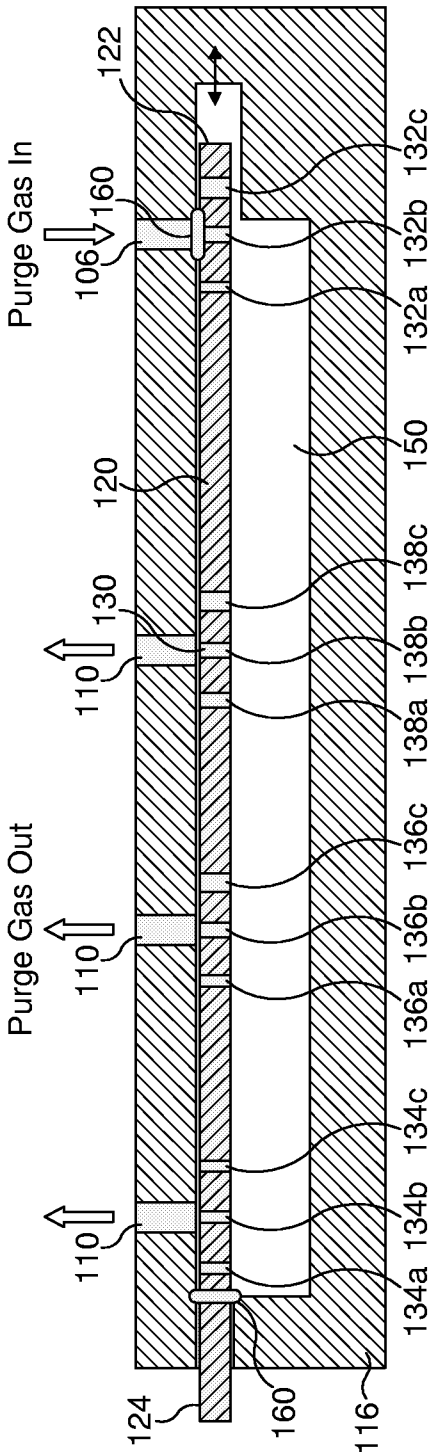
Purge Gas In
Purge Gas Out
122
160
106
132c
132b
132a
150
120
130
110
138c
138b
138a
136c
136b
136a
134c
134b
134a
124
160
116

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/050067

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16K3/32 F16K11/065 F16K11/085

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16K F15B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 101 52 186 C1 (BALLARD POWER SYSTEMS [DE]) 12 June 2003 (2003-06-12) the whole document	1-7, 9-12,14, 15
X	US 2 855 955 A (LAMAR CHARLES C) 14 October 1958 (1958-10-14) column 3, line 50 - column 8, line 14; figures	1-5,7, 9-12,14, 15
A	US 2 278 246 A (JUAN CORDOVA JOSE) 31 March 1942 (1942-03-31) figures	1,11-15
A	US 3 678 959 A (LIPOSKY RICHARD B) 25 July 1972 (1972-07-25) abstract; figures	1,13

-/--

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

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 June 2007	25/06/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lanel, François

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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/050067

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 845 187 A (TECALEMIT LTD) 17 August 1960 (1960-08-17) figures ---	1,13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2007/050067

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