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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 April 2015 (23.04.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/055985 Al

(51) International Patent Classification:
F16J 15/14 (2006.01) *F16L 23/16* (2006.01) *F16L 17/10* (2006.01) *F16L 23/22* (2006.01) *F17D 5/02* (2006.01) *F16L 39/00* (2006.01) *F16L 23/10* (2006.01) *G01M 3/00* (2006.01)

(21) International Application Number:
PCT/GB20 14/053054

(22) International Filing Date:
10 October 2014 (10.10.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
13 18 127.6 14 October 2013 (14. 10.2013) GB

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, 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, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) Title: VACUUM SYSTEM PIPE COUPLINGS

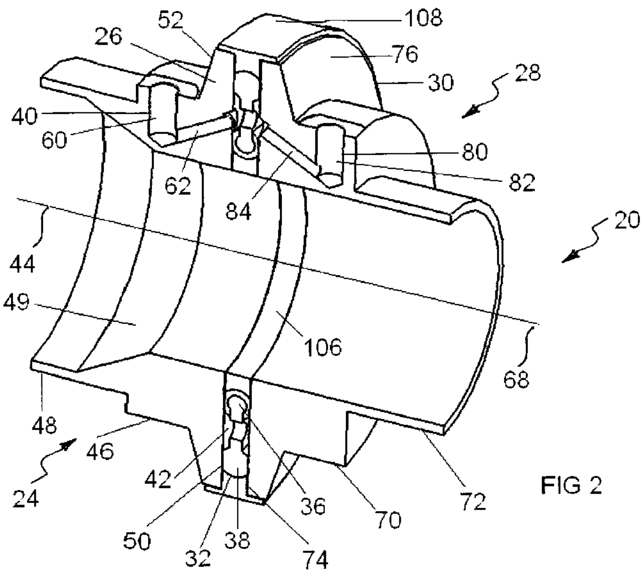

FIG 2

(57) Abstract: A vacuum system pipe coupling (20) includes a first coupling member (24) and a second coupling member (28). The vacuum system pipe coupling has a seal system (32) that is to be positioned to seal between the first and second coupling members and a securing system to releasably secure the first coupling member to the second coupling member. The seal system (32) has an inner seal element (36) and an outer seal element (38) spaced from the inner seal element. The first coupling member is provided with a flow passage (40) configured to conduct a pressurised gas to a space (42) between the inner and outer seal elements to shield the outer seal element from fluid flowing through the pipe coupling in the event of failure of the inner seal element.

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VACUUM SYSTEM PIPE COUPLINGS

Field of the Invention

The invention relates to vacuum system pipe couplings.

Background to the Invention

A vacuum system pipe coupling may be used to couple piping in an exhaust system of a vacuum system. The coupling may comprise a first coupling member having a flange, a second coupling member having flange, an O-ring disposed between the flanges to seal between them and a clamp to releasably clamp the flanges together. The clamp applies an axial force to the flanges to compress the O-ring.

Vacuum pumps are frequently deployed in applications that involve pumping substantial quantities of corrosive fluids, including halogen gases and solvents. Such materials attack the O-rings of pipe couplings, with the result that the O-ring may become excessively plastic or very brittle. This can badly affect the integrity of the seal provided.

The intensity of the attack on the O-ring is dependant on a number of variables including, for example, the pumped fluid, the material from which the O-ring is made and the pump temperature. In exhaust systems, a further variable may be the impact of trace heating used to prevent condensation forming in the exhaust piping.

These problems are particularly acute when pumping reactive gases, such as fluorine, from semi-conductor processing equipment, where gas compositions are varied by reactions in the equipment. Here, even a precise knowledge of the gas flows admitted to the process chamber is a very poor predictor of the quantity or nature of the reactive gas admitted to the pump and hence expelled through the exhaust system.

Summary of the Invention

The invention provides a vacuum system pipe coupling as specified in claim 1.

The invention also includes a vacuum system as specified in claim 15.

The invention also includes a method of protecting a seal system of a vacuum system pipe coupling as specified in claim 29.

The invention also includes a vacuum system pipe coupling as specified in claim 33.

Brief Description of the Drawings

In the disclosure that follows, reference will be made to the drawings in which:

Figure 1 is a schematic illustration of a vacuum system including a vacuum system pipe coupling;

Figure 2 is a longitudinal section view through the vacuum system pipe coupling of Figure 1;

Figure 3 is an exploded view of the upper half of the vacuum system pipe coupling shown in Figure 2;

Figure 4 is a section view of a seal system of the vacuum system pipe coupling;

Figure 5 is a schematic illustration of a pipe system comprising the vacuum system pipe coupling of Figures 2 to 4; and

Figure 6 is a section view of another seal system of a vacuum system pipe coupling.

Detailed Description

Referring to Figure 1, a vacuum system 10 comprises a processing chamber 12, piping 14 connecting the processing chamber with a vacuum pump 16 (the vacuum pump may be directly connected to the processing chamber and the piping omitted), an exhaust system 18 leading from the vacuum pump and comprising a vacuum system pipe coupling 20 connecting the vacuum pump with exhaust piping 22. The exhaust piping 22 may exhaust directly to atmosphere, optionally via filters or traps. Alternatively, the exhaust piping may conduct the exhaust from the vacuum pump to further processing equipment. Filters, traps and the processing of the exhaust from vacuum pumps are all known to those skilled in the art and will not be described further herein.

Referring to Figures 2 and 3, the vacuum system pipe coupling 20 comprises a first coupling member 24 having a first flange 26, a second coupling member 28 having a second flange 30, a seal system 32 disposed between the two flanges to seal between them and a securing system 34 (Figure 3) to releasably secure the first flange to the second flange. The seal system 32 comprises an inner seal element 36 and an outer seal element 38 that is spaced from the inner seal element. The first coupling member 24 is provided with a flow passage 40 to conduct a pressurised gas to a space 42 between the inner and outer seal elements 36, 38. The pressurised gas can shield the outer seal element 38 in the event the inner seal element 36 fails.

The first coupling member 24 has a longitudinal axis 44 (Figure 2) and comprises an annular centre section 46 connected on one side with the first flange 26 and on the opposite side with a pipe stub 48. The first flange 26 comprises a planar sealing face 50 that defines one end of the first coupling member 24 and an inclined clamping face 52 disposed generally opposite the sealing face. The inclined clamping face 52 extends outwardly from the centre section 46 and is inclined towards the sealing face 50 such that in a radially outward direction, the first flange 26 narrows.

The flow passage 40 comprises a first bore 60 that extends perpendicular to the longitudinal axis 44 and a second bore 62 that extends from the first bore to the sealing face 50. The second bore 62 is inclined with respect to the longitudinal axis 44 in the same direction as the clamping face 52, but in the illustrated example is inclined at a different angle. The first bore 60 may be configured to allow connection with standard pneumatic fittings and may, for example, be threaded for connection with an M5 fitting.

The second coupling member 28 has a longitudinal axis 68 (Figure 2) that is coaxial with the longitudinal axis 44 of the first coupling member 24 such that the axes 44, 68 define a longitudinal axis of the vacuum system pipe coupling 20. The second coupling member comprises a centre section 70 connected on one side with the second flange 30 and on the opposite side with a pipe stub 72. The second flange 30 comprises a planar sealing face 74 that defines one end of the second coupling member 28 and an inclined clamping face 76 disposed generally opposite the sealing face. The inclined clamping face 76 extends outwardly from the centre section 70 and is inclined towards the sealing face 74 such that in the radially outward direction, the second flange 30 narrows. The two clamping faces 52, 76 are inclined in opposite directions so that the portions of the two flanges 26, 30 disposed radially outwardly of the respective centre sections 46, 70 present a generally frusto-conical cross-section.

The second coupling member 28 comprises a flow passage 80 to receive pressurised gas from the space 42. The flow passage 80 comprises a first bore 82 that extends perpendicular to the longitudinal axis 68 and a second bore 84 that extends from the first bore to the sealing face 74. The second bore 84 is inclined with respect to the longitudinal axis 68 in the same direction as the clamping face 76, but in the illustrated example is inclined at a different angle. The first bore 82 may be configured to allow connection with standard pneumatic fittings and may, for example, be threaded for connection with an M5 fitting.

The first and second coupling members 24, 28 may be made of any suitable metal or engineering plastics material and may be metal castings. As best seen in Figure 2, the first and second coupling members 24, 28 may have different diameter pipe stubs 48, 72. The first coupling member 24 is shown in a configuration in which the flange and pipe stub outside diameters correspond in proportion to those of a standard KF or NW fitting. To accommodate the flow passage 40, the inside diameter of the first flange 26 and centre section 46 is reduced as compared with a standard fitting and there is a tapered transition section 49 between the inner surface of the centre section and the inner surface of the pipe stub 48. The second coupling member 28 accommodates the flow passage 80 by having a second flange 30 and centre section 70 that when compared with the proportions of a standard KF or NW fitting are oversize in relation to the pipe stub 72. For example, the pipe stub 72 may have proportions corresponding to a standard NW40 fitting, while the second flange 30 and centre section 70 have inner diameters proportionate to an NW40 fitting and outer diameters proportionate to an NW50 fitting. It is to be understood that the illustrated configuration is not essential and that the second coupling member 28 may be configured to have proportions corresponding to the first coupling member 24 and *vice versa*.

As best seen in Figure 4, the inner and outer seal elements 36, 38 are connected by an integral web 90 to form a unitary body. The web 90 acts as a spacer determining the radial positioning of the outer seal element 38 relative to the inner seal element 36. The inner and outer seal elements 36, 38 may each have a circular cross section and may have substantially the same diameter. The web 90 has a width W in a direction parallel to the longitudinal axis of the vacuum system pipe coupling 20 that is less than the diameter (width) of the inner seal element 36 and less than the diameter (width) of the outer seal element 38 so that when the seal elements are disposed between and in engagement the first and second flanges 26, 30, the space 42 is defined between the opposed sealing faces 50, 74 and the inner and outer seal elements 36, 38. In cross-section, the web 90 has a longitudinal axis disposed perpendicular to and coplanar with the respective longitudinal (circumferentially extending) axes 92, 94 of the inner and outer seal elements 36, 38 so that the web is disposed substantially centrally with respect to the seal elements. Accordingly, when the sealing system 32 is installed in the vacuum system pipe coupling 20, the web 90 is disposed generally centrally in the space 42. The web is provided with at least one transverse through-hole 96 to permit pressurised gas supplied from the flow passage 40 to fill the space 42 on either side of the web.

The inner and outer seal elements 36, 38 comprise materials that are different. The outer seal element 38 is made from a first material selected from materials having relatively good mechanical properties, for example resilience and resistance to compression set. The first material may, for example, be a fluoroelastomer such as

Viton® made and sold by DuPont. The second material is selected from materials having relatively good resistance to attack by aggressive chemicals that may flow through the vacuum system pipe coupling 20 or relatively good stability at high temperatures. The second material may be a perflouroelastomer such as a grade of Kalrez® made and sold by DuPont or a grade of Perlast® made and sold by Precision Polymer Engineering Ltd. Kalrez® and Perlast® have both been found to provide reliable, long-term service with a wide range of aggressive industrial and electronic grade chemicals of the type that may flow through the vacuum system pipe coupling 20, particularly when used in highly aggressive chemical processing and semiconductor wafer processing applications. Perflouroelastomers also have relatively good high temperature stability. Grades of Kalrez® and Perlast® are rated for maximum continuous service temperatures in excess of 275°C and up to 327°C.

The materials from which the first and second seal elements are made may have a Shore hardness of 60 to 80, with 70 being a currently preferred value.

In the example illustrated in Figure 4, the outer seal element 38, web 90 and a core, or substrate, 102 of the inner seal element 36 are made of the same first material and the inner seal element further comprises a sleeve 104 made of the second material. The outer seal element 38, web 90 and core 102 may be made of a selected grade of Viton® or another material selected for having relatively better resilience or resistance to compression set than the sleeve 104. The sleeve 104 may be made of a selected grade of Kalrez® or Perlast® or another material selected for having relatively better resistance to chemical erosion or high temperature stability than the material from which the outer seal element 38, web 90 and core 102 are formed. Since polymers such as Kalrez® and Perlast® are very expensive, having a core made of a relatively cheap material, such as Viton®, sleeved with the more expensive material reduces the cost of the seal system 32. The sealing elements 36, 38 and web 90 may be made by a co-moulding process.

The seal system 32 further comprises an inner seal carrier 106 and an outer seal carrier 108. The inner seal carrier 106 is an annular body made of a suitable metal, or engineering plastics material, and is disposed radially inwardly of the inner seal element 36. The inner seal carrier 106 has a generally rectangular cross-section with a slightly concave face facing the inner seal element 36 in order to facilitate mating of the two parts. The outer seal carrier 108 is an annular body made of a suitable metal or engineering plastics material. The outer seal carrier 108 has a generally T-shaped section, or profile, defined by an inner body portion having a cross-section similar to, or the same as, the inner seal carrier 106 and a wider plate-like outer portion disposed at the end of the body portion opposite the end provided with the concave face. The outer seal carrier 108 provides support for the outer seal element 38 and centres the coupling members 24, 28. In other examples, the outer seal carrier may be shaped generally as the inner seal carrier shown in Figures 2 and 3 and the inner seal carrier shaped generally as the outer seal carrier shown in those drawings so that it is the inner seal carrier that centres the coupling members 24, 28.

Referring to Figure 3, the securing system 34 comprises a clamp that is used to releasably secure the first and second coupling members 24, 28 to one another by engaging the clamping faces 52, 76 and pressing the coupling members towards one another. The clamp may take any suitable form and may, for example, be one such as those known in the art for clamping KF or NW fittings. Since such clamps will be known to those skilled in the art, they will not be described in detail herein.

As shown in Figure 5, in use the vacuum pipe system coupling 20 may be fitted into piping, such as the piping of the exhaust system 18 shown in Figure 1, by connecting the pipe stubs 48, 72 to respective lengths of piping. The pipe stub 48 may be connected to a length of piping 112 and the pipe stub 72 connected to a length of piping 114. The respective connections between the pipe stubs 48, 72 and the piping 112, 114 may be made by any known method that is convenient, for example by circumferential welds 115 formed using an orbital welding process. The seal system 32 is disposed between the sealing faces 50, 74 of the first and second coupling members 24, 28, which are secured to one another by the securing system 34. The securing system 34 acts on the clamping surfaces 52, 76 to press the first and second coupling members 24, 28 together so that the inner and outer seal elements 36, 38 are compressed between the sealing faces 50, 74 to seal the connection. As shown in Figure 2, the compression of the inner and outer seal elements 36, 38 results in a flattening of the sides of the seal elements against the sealing faces 50, 74.

The first flow passage 40 is connected with a gas module 116 via piping 118 and a pneumatic fitting 120 provided on an end of the piping and fitted into the upstream end of the first bore 60. Pressurised gas is supplied from the gas module 116 to the first flow passage 40 which conducts the pressurised gas to the space 42 defined between the sealing faces 50, 74 and the inner and outer seal elements 36, 38. A one-way valve 122 and a flow restrictor 124 are connected with the piping 118 upstream of the first flow passage 40. A first transducer 126 is connected with the piping 118 so as to be able to sense, or detect, the pressure of the pressurised gas in the piping upstream of the flow restrictor 124. The one-way valve 122 prevents contamination of gas at the gas module 116 by backflow that may occur in the event the pressure in the space 42 rises above the pressure at which the pressurised gas is supplied by the gas module 116. The flow restrictor 124 may be made from a slightly porous material that inhibits the flow of gas such that it acts like a dam, allowing a trickle of gas to pass through. Alternatively, the flow restrictor 124 may be a fine metering valve or a fine capillary hole provided in a solid material.

The downstream end of the second flow passage 80 is connected with a pneumatic fitting 128 provided on an end of piping 130. The piping 130 receives pressurised gas that has passed from the first flow passage 40 through the space 42 and into the second flow passage 80 to conduct the gas away from the vacuum system pipe coupling 20. The piping 130 may return the pressurised gas via suitable filters, traps or other suitable equipment 136 for resupply by the gas module 116 or conduct it to the first flow passage 40 of another vacuum system pipe coupling 20. A second transducer 132 is connected with the piping 130 to sense the pressure of the pressurised gas that has exited the second flow passage 80. The first and second transducers 126, 132 are connected with a controller, or determining unit, 134 to pass signals indicative of the sensed pressures PI (transducer 126) and P2 (transducer 132) to the controller.

The supply of pressurised gas is controlled by the gas module 116. The gas module 116 may comprise an active manifold that regulates a supply of gas from a reservoir 138. The gas module 116 is set to supply pressurised gas into the piping 118 at a pressure above that of the exhaust gases flowing through the vacuum system pipe coupling 20. The supply pressure may be 2 Bar (approximately 200 KN/m^2). The gas module 116 is configured to send signals to the controller 134 indicating the characteristics of the gas supplied into the piping 118, for example the flow rate and gas pressure. In addition to supplying the pressurised gas to the vacuum system pipe coupling 20, the gas module 116 may be used to distribute a purge gas to different locations within a vacuum system of which the pipe coupling is a part.

In use, pressurised gas from the gas module 116 is supplied to the space 42 via the piping 118 and first flow passage 40. The pressurised gas serves to inflate the sealing system 32 and passes from the space 42 to the second flow passage 80 and on into the piping 130. In normal conditions in which the inner and outer seal elements 36, 38 are intact, the pressures sensed by the pressure transducers 126, 132 should be steady and even and the signals received by the controller 134 should indicate a consistent, or steady state, difference between the two pressures. If either of the inner and outer seal elements fails, the pressure downstream of the flow restrictor 124 should fall and there will be noticeable change in the pressure difference indicated by the signals the controller 134 receives from the pressure transducers 126, 132. The controller 134 is configured to compare the signals received from the first and second transducers 126, 132 to determine the condition of the seal system 32. In the event the comparison shows a change in the relative pressures, the controller 134 may determine that one of the seal elements has failed and output a signal to cause an indicator to provide an indication the seal system 32 has failed. The indicator may provide a visual indication, for example a flashing light or another visible warning such as a message on a screen or the like, or an audible alarm, to indicate that the seal system has failed. The signal from the controller 134 may be sent to a computerised control system for the vacuum system of which the vacuum system pipe coupling 20 rather than to a dedicated indicator associated with the controller and in some examples, the controller may be integrated into such a computerised control system.

In the event of a failure of one of the seal elements 36, 38 of the seal system 32, the other seal element should continue to function so that the integrity of the vacuum coupling system 20 is not immediately compromised. This allows time for a repair to be organised and scheduled into the operation of the vacuum system.

The pressurised gas supplied by the gas module 116 may be an inert gas such as nitrogen or oxygen free nitrogen. Accordingly, if the outer seal element 38 fails, all that is released to atmosphere is an inert gas, while if the inner seal element 36 fails, the gas entering the flowpath through the vacuum system pipe coupling 20 will not trigger a reaction with the exhaust gases flowing through the coupling. This can be important if the gases flowing through the coupling are liable to spontaneously combust.

If the inner seal element 36 failed in the absence of the pressurised gas in the space 42, the outer seal element 38 would potentially be exposed to the exhaust gases flowing through the vacuum system pipe coupling 20. In many operating environments, this would expose the outer seal element 38 to chemical damage it is less well equipped to withstand than the inner seal element. However, the pressurised gas supplied into the space 42 via the first flow path 40 may act as a shield for the outer seal element 38, protecting it from the exhaust gases flowing through the vacuum system pipe coupling 20 and thereby prolonging the period in which the vacuum system pipe coupling 20 can continue in use prior to being disassembled to allow replacement of the seal system 32.

Figure 6 shows a sealing system 332 that may be used in the vacuum system pipe coupling 20 in place of the sealing system 32. The sealing system 332 comprises an inner seal element 336, an outer seal element 338 and a spacer 390.

The inner seal element 336 is an O-ring made of a material having relatively good resistance to chemical attack and good high temperature stability. The inner seal element 336 may, for example, be made from a perflouroelastomer such as Kalrez® or Perlast®. The inner seal element 336 may comprise a core, or substrate, made of a relatively cheaper material, such as Viton® coated, sleeved or otherwise suitably covered with a relatively expensive outer layer made of Kalrez, Perlast or the like. The outer seal element 338 is an O-ring made of a material having relatively good mechanical properties such as resilience and resistance to compression set and may, for example, be a fluoroelastomer such as Viton®.

In the sealing system 332, the inner and outer seal elements 336, 338 are separate bodies and instead of being connected by an integral web as in the sealing system 32, they are separated, or spaced apart, by a separate spacer 390. The spacer 390 is an annular body having a rectangular cross-section and may be made of any suitable metal, for example aluminum or stainless steel, or an engineering plastics material. The respective opposed faces 400, 402 of the spacer 390 that contact the inner and outer seal elements 336, 338 are slightly concave to facilitate mating with the seal elements and centre the spacer with respect to the seal elements.

The spacer 390 has a width W in a direction parallel to the longitudinal axis of the vacuum system pipe coupling 20 that is less than the diameter (width) of the inner seal element 336 and less than the diameter (width) of the outer seal element 338 so that when the seal elements are disposed between and in engagement with the first and second flanges 26, 30, the space 42 is defined between the opposed sealing faces 50, 74 and the inner and outer seal elements 336, 338. In cross-section, the spacer 390 has a longitudinal axis disposed perpendicular to the respective longitudinal (circumferentially extending) axes 392, 394 of the inner and outer seal elements 336, 338 so that the web is disposed substantially centrally with respect to the seal elements and consequently with respect to the sealing faces 50, 74 so as to lie centrally in the space 42.

The spacer 390 is provided with a plurality of transverse through-holes 396 to permit pressurised gas supplied from the flow passage 40 to fill the space 42 on either side of the spacer. At least on one side of the spacer 390, a depression 398 is provided around each through-hole 396.

The sealing system 332 further comprises an inner seal carrier 406 and an outer seal carrier 408. These components may be the same as the inner and outer seal carriers 106, 108 shown in Figures 2 to 4 and so will not be described in detail again.

In the illustrated examples, the securing system comprises a clamp used to releasably clamp the first and second couplings to one another. It is currently envisaged that the securing system will comprise a quick-release clamp the same as, or operating on similar principles to known quick release clamps used for securing components of KF and NW fittings known in the art. It is to be understood that the invention is not limited to this and in principle, the securing system may comprise any apparatus or arrangement of components suitable for releasably securing the first and second coupling members to one another, including, but not limited to, a plurality of bolts, screws or studs engaging nuts or threaded apertures provided in one of the coupling members.

In the illustrated examples, a separate spacer or integral web is provided to determine the spacing between the inner and outer seal elements. In another example, the spacer may be integral with one of the inner and outer seal elements and separate of the other.

In the example illustrated by Figure 5, the piping 130 is shown optionally connected to the first flow passage in the first coupling member of a second vacuum system pipe coupling 20. Connecting the pressurised gas supply to the flow passages of a series of vacuum system couplings in this way allows one gas supply to be used for seal system monitoring in two of more vacuum system pipe couplings.

In some examples the vacuum system pipe coupling may be marketed as a kit, for example to be fitted in existing installations. In other examples, the vacuum system pipe coupling may be marketed as a part of a vacuum system with the first and second coupling members ready fitted to piping of the vacuum system.

CLAIMS

1. A vacuum system pipe coupling comprising:

a first coupling member;

a second coupling member;

a seal system to be positioned between said first and second coupling members to seal between said coupling members; and

a securing system to releasably secure said first coupling member to said second coupling member,

said seal system comprising an inner seal element and an outer seal element and said first coupling member being provided with a flow passage configured to conduct a pressurised gas to a space that in use is provided between said inner and outer seal elements to shield said outer seal element from fluid flowing through said pipe coupling in the event of failure of said inner seal element.

2. A vacuum system pipe coupling as claimed in claim 1, wherein said inner and outer seal elements are separated by a spacer that is configured to be received in said space.

3. A vacuum system pipe coupling as claimed in claim 2, wherein said spacer is integral with at least one of said inner and outer seal elements.

4. A vacuum system pipe coupling as claimed in claim 2 or 3, wherein said inner seal element has a width, said outer seal element has a width and said spacer comprises at least one portion having a width less than the respective said widths of said inner and outer seal elements.

5. A vacuum system pipe coupling as claimed in claim 2, 3 or 4, wherein said second coupling member is provided with a flow passage and said spacer is provided with at least one through-hole configured to permit pressurised gas from said flow passage of said first coupling member to flow to said flow passage of said second coupling member.

6. A vacuum system pipe coupling as claimed in claim 5, comprising a first pipe to be connected to an inlet end of said flow passage of said first coupling member, a flow restrictor and a first transducer to be connected with said first pipe so that said first transducer can provide signals indicative of the pressure of a pressurised gas flowing in said first pipe pressure upstream of said flow restrictor, a second pipe to be connected with an outlet end of said flow passage of said second coupling member, a second transducer to be connected with said second pipe to provide signals indicative of the pressure of said pressurised gas flowing in said second pipe and a determining unit that receives said signals and determines seal system condition based on a comparison of the respective said seals received from said first and second transducers.

7. A vacuum system pipe coupling as claimed in any one of the preceding claims, wherein said outer seal element comprises a first material and said inner seal element comprises a second material that is different to said first material.

8. 8. A vacuum system pipe coupling as claimed in claim 7, wherein said first material has a better compression set characteristic than said second material.

9. A vacuum system pipe coupling as claimed in claim 7 or 8, wherein said second material has at least one of better:
i) high temperature stability than said first material; and
ii) resistance to chemical corrosion than said first material.

10. A vacuum system pipe coupling as claimed in claim 7, 8 or 9, wherein said first material is a fluoroelastomer.

11. A vacuum system coupling as claimed in any one of claims 7 to 10, wherein said second material is a perflouroelastomer.

12. A vacuum system pipe coupling as claimed in any one of claims 7 to 11, wherein said inner seal element comprises a substrate and said second material is carried on said substrate.

13. A vacuum system pipe coupling as claimed in any one of claims 7 to 12, wherein at least one of said first and second materials has a Shore hardness of 60 to 80.

14. A vacuum system pipe coupling as claimed in any one of the preceding claims, wherein said first coupling member comprises a first flange having a first sealing surface, said second coupling member comprises a second flange having a second sealing surface and in use said sealing system is disposed between and in engagement with said first and second sealing surfaces, said space being defined between said first and second sealing surfaces and said inner and outer seal elements.

15. A vacuum system comprising:

a first pipe;

a second pipe; and

a vaccum system pipe coupling coupling said first pipe to said second pipe, wherein said vacuum system pipe coupling comprises:

a first coupling member connected with said first pipe;

a second coupling member connected with said second pipe;

a seal system positioned between said first and second coupling members and sealing between said coupling members; and

a securing system releasably securing said first coupling member to said second coupling member,

said seal system comprising an inner seal element and an outer seal element spaced from said inner seal element and said first coupling member being provided with a flow passage configured to conduct a pressurised gas to a space between said inner and outer seal elements to shield said outer seal element from fluid flowing through said pipe coupling in the event of failure of said inner seal element.

16. A vacuum system as claimed in claim 15, wherein said inner and outer seal elements are separated by a spacer that is received in said space.

17. A vacuum system pipe coupling as claimed in claim 16, wherein said spacer is integral with at least one of said inner and outer seal elements.

18. A vacuum system as claimed in claim 16 or 17, wherein said inner seal element has a width, said outer seal element has a width and said spacer comprises at least one portion having a width less than the respective said widths of said inner and outer seal elements.

19. A vacuum system as claimed in claim 16, 17 or 18, wherein said second coupling member is provided with a flow passage and said spacer is provided with at least one through-hole configured to permit pressurised gas from said flow passage of said first coupling member to flow to said flow passage of said second coupling member.

20. A vacuum system as claimed in claim 19, further comprising a pressurised gas supply connected with said flow passage of said first coupling member by first piping, a flow restrictor connected with said first piping and a first transducer to provide signals indicative of pressurised gas pressure upstream in said first piping of said flow restrictor, second piping connected with said flow passage of said second coupling member to conduct said pressurised gas away from said vacuum system pipe coupling, a second transducer connected with said second piping to provide signals indicative of pressurised gas pressure in said second piping and a determining unit that receives said signals from said first and second transducers and judge seal system condition based on a

comparison of the respective said signals received from said first and second transducers.

21. A vacuum system as claimed in any one of claims 15 to 20, wherein said outer seal element comprises a first material and said inner seal element comprises a second material that is different to said first material.

22. A vacuum system as claimed in claim 21, wherein said first material has a better compression set characteristic than said second material.

23. A vacuum system as claimed in claim 21 or 22, wherein said second material has at least one of better:
i) high temperature stability than said first material; and
ii) resistance to chemical corrosion than said first material.

24. A vacuum system as claimed in claim 21, 22 or 23, wherein said first material is a fluoroelastomer.

25. A vacuum system as claimed in any one of claims 21 to 24, wherein said second material is a perflouroelastomer.

26. A vacuum system as claimed in any one of claims212 to 25, wherein said inner seal element comprises a substrate and said second material is carried on said substrate.

27. A vacuum system as claimed in any one of claims 21 to 26, wherein at least one of said first and second materials has a Shore hardness of 60 to 80.

28. A vacuum system as claimed in any one of claims 15 to 27, wherein said first and second pipes receive exhaust gases from a vacuum pump.

29. A method of protecting a seal system of a vacuum system pipe coupling comprising a first coupling member releasably secured to a second coupling member by a securing system with said seal system sealing between said first and second coupling members, wherein said sealing system comprises an inner seal element and an outer seal element spaced from said inner seal element and said method comprises flowing a pressurised gas through a flow passage provided in said first coupling member to a space defined between said inner and outer seal elements so that said pressurised gas can shield said outer seal element from gases flowing through said vacuum system pipe coupling in the event said inner seal element fails.

30. A method as claimed in claim 29, wherein said pressurised gas is an inert gas.

31. A method as claimed in claim 29 or 30, wherein said gases flowing through said vacuum system pipe coupling are exhaust gases from a vacuum pump.

32. A method as claimed in claim 29, 30 or 31, wherein said gases flowing through said vacuum system pipe coupling are at a first pressure and said pressurised gas is at a second pressure greater than said first pressure.

33. A method as claimed in claim 32, wherein both said pressures are above atmospheric pressure.

34. A vacuum system pipe coupling comprising:

a first coupling member;

a second coupling member;

a seal system to be positioned between said first and second coupling members to seal between said coupling members; and

a securing system to releasably secure said first coupling member to said second coupling member,

said seal system comprising an outer seal comprising a first material and an inner seal comprising a second material different to said first material.

35. A vacuum system pipe coupling as claimed in claim 34, wherein said inner and outer seal elements are separated by a spacer that is configured to be received in said space.

36. A vacuum system pipe coupling as claimed in claim 35, wherein said spacer is integral with at least one of said inner and outer seal elements.

37. A vacuum system pipe coupling as claimed in claim 35 or 36, wherein said inner seal element has a width, said outer seal element has a width and said spacer comprises at least one portion having a width less than the respective said widths of said inner and outer seal elements.

38. A vacuum system pipe coupling as claimed in any one of claims 34 to 37, wherein said first material has a better compression set characteristic than said second material.

39. A vacuum system pipe coupling as claimed in any one of claims 34 to 38, wherein said second material has at least one of better:
i) high temperature stability than said first material; and
ii) resistance to chemical corrosion than said first material.

40. A vacuum system pipe coupling as claimed in any one of claims 34 to 39, wherein said first material is a fluoroelastomer.

41. A vacuum system coupling as claimed in any one of claims 34 to 40, wherein said second material is a perflouroelastomer.

42. A vacuum system pipe coupling as claimed in any one of claims 34 to 41, wherein said inner seal element comprises a substrate and said second material is carried on said substrate.

43. A vacuum system pipe coupling as claimed in any one of claims 34 to 42, wherein at least one of said first and second materials has a Shore hardness of 60 to 80.

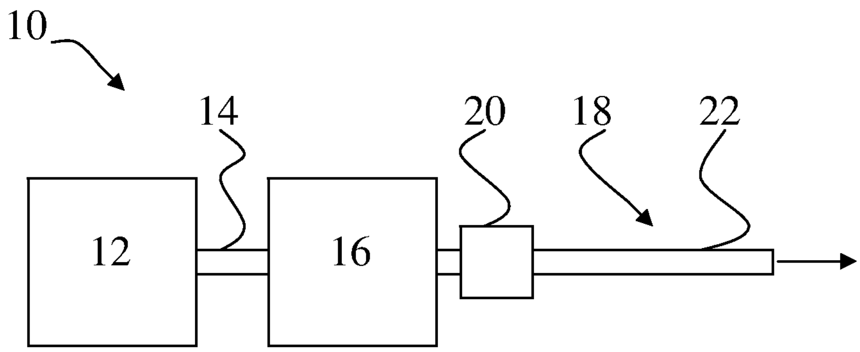

FIG 1

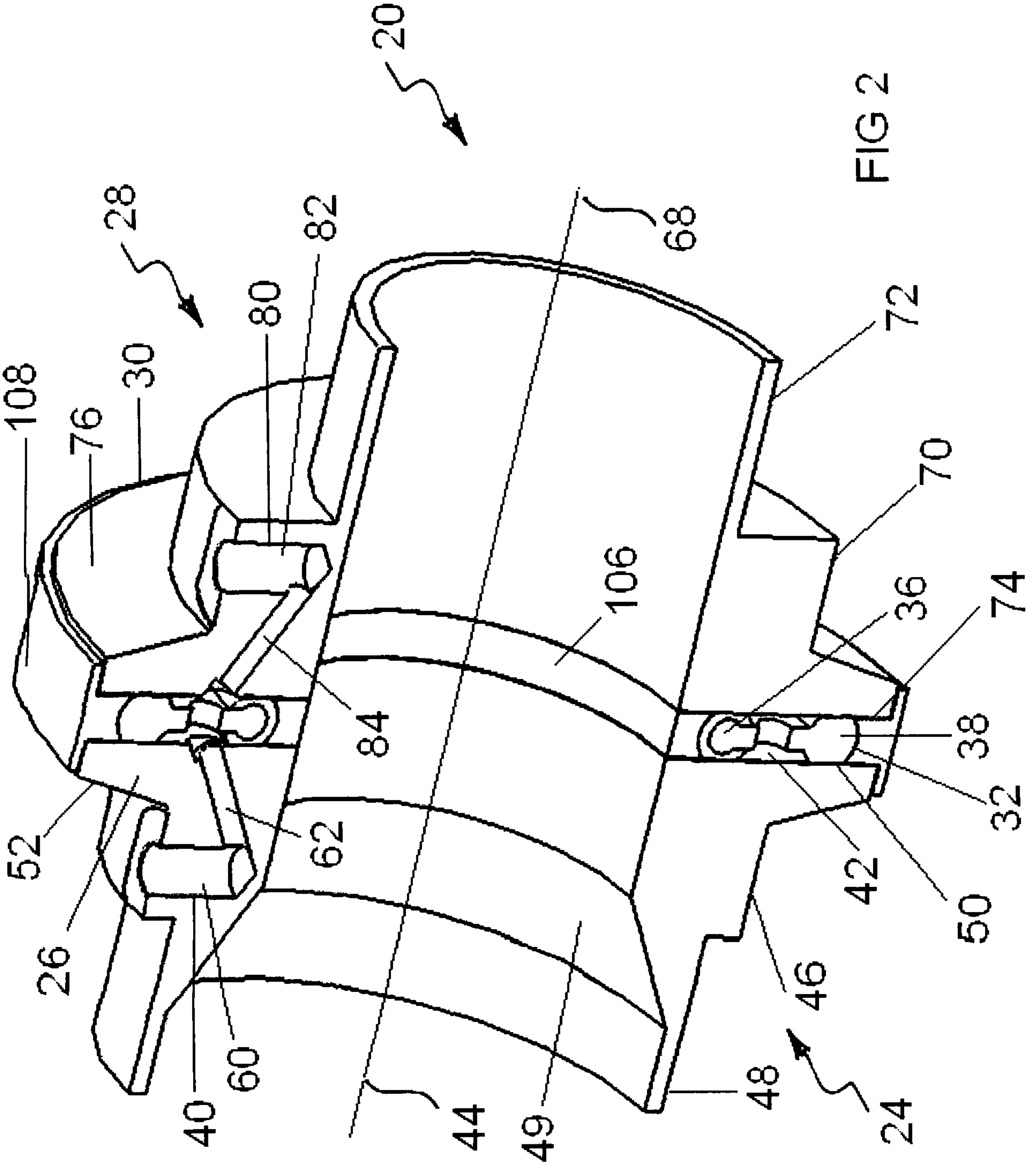
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FIG 2

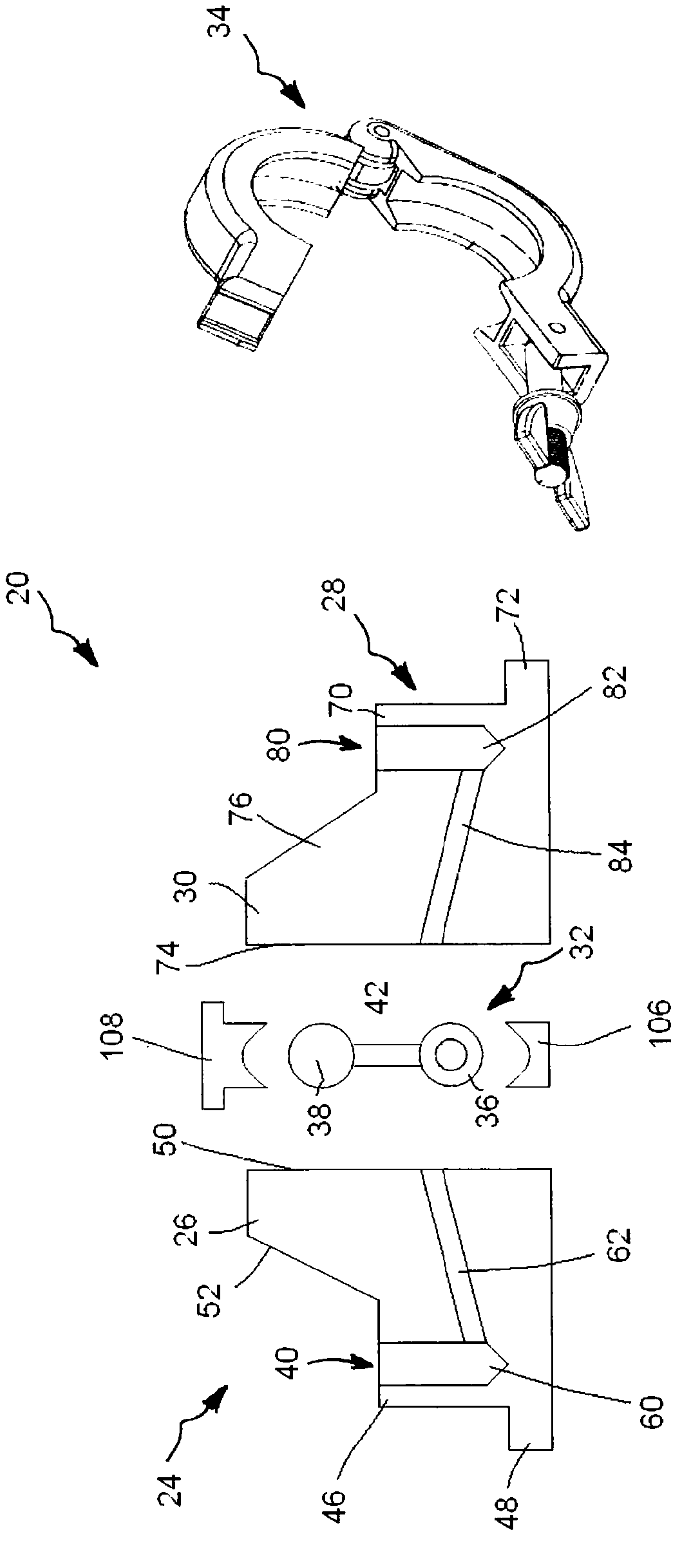
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FIG 3

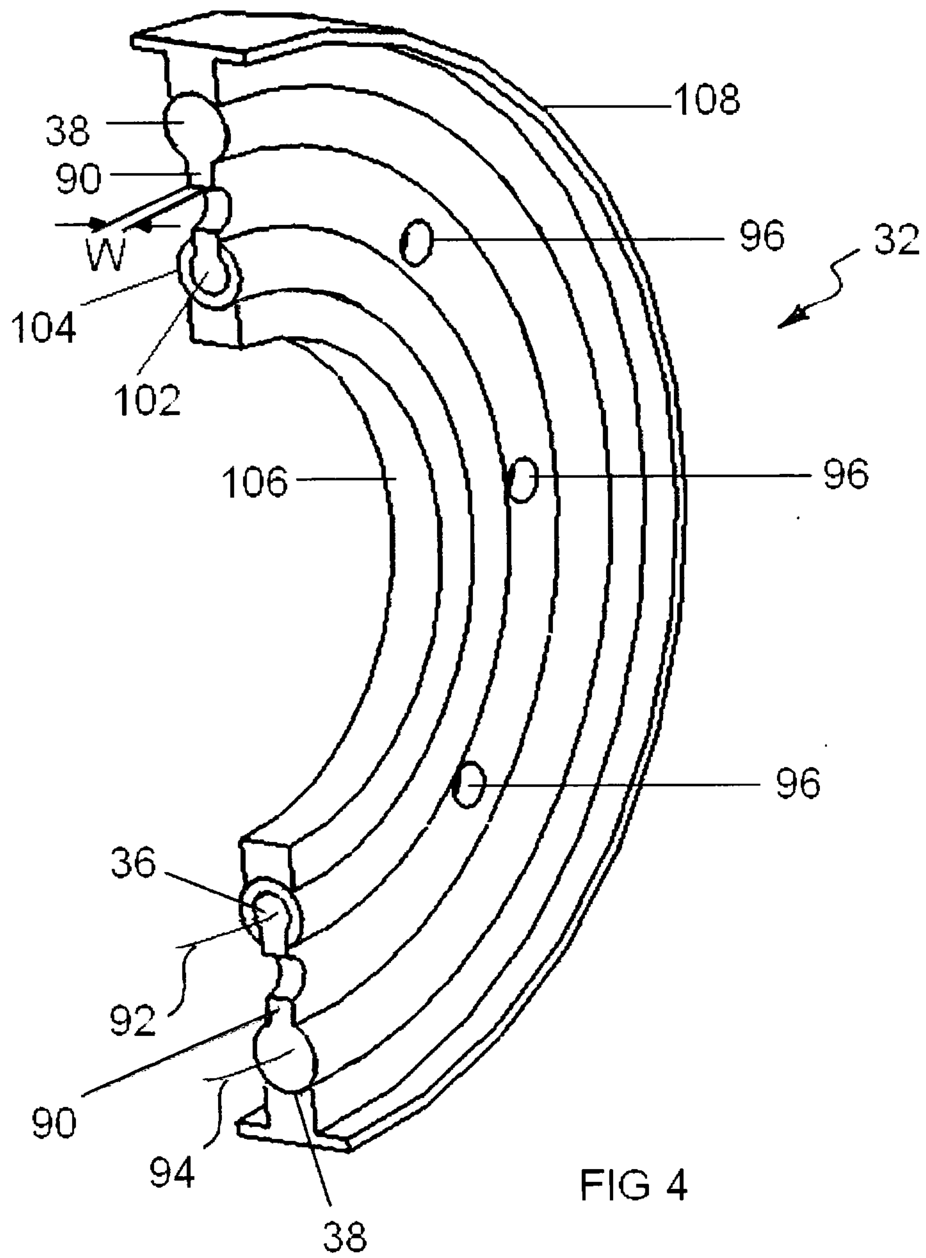

FIG 4

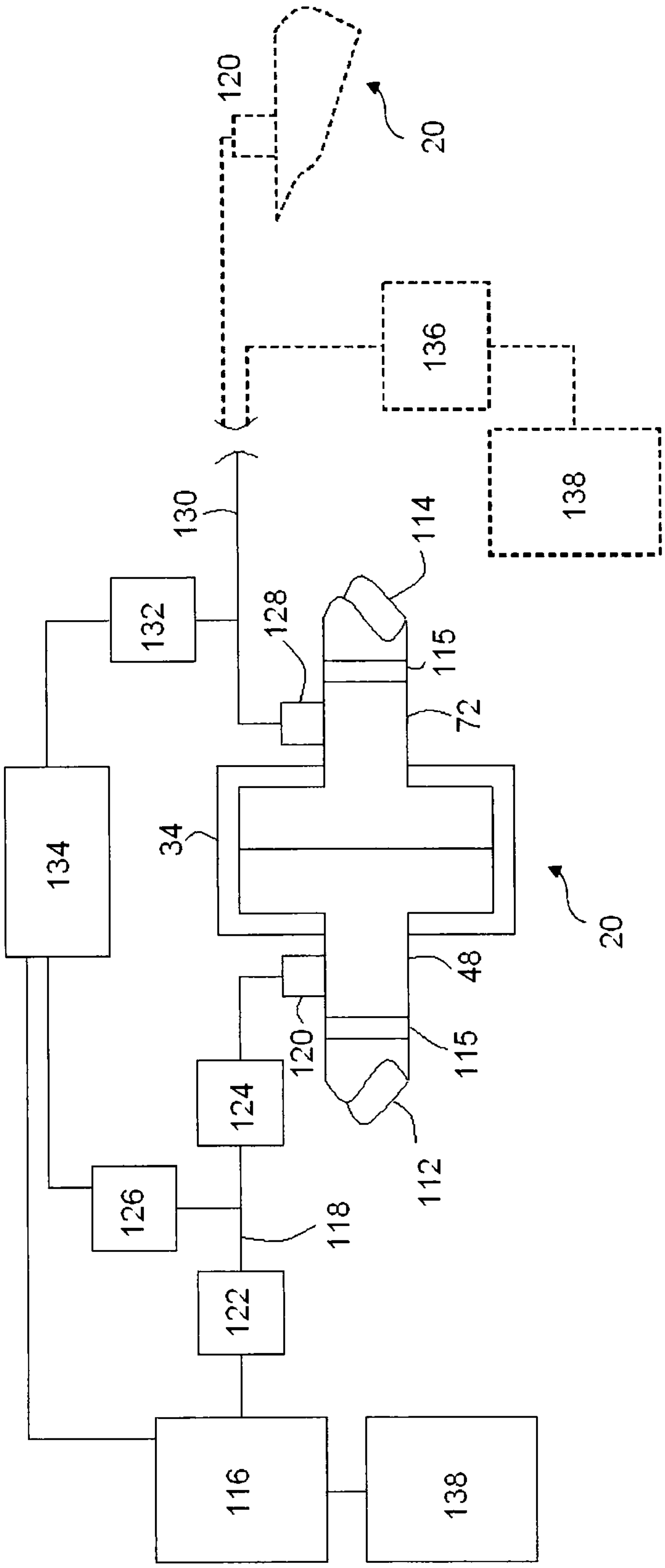
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FIG 5

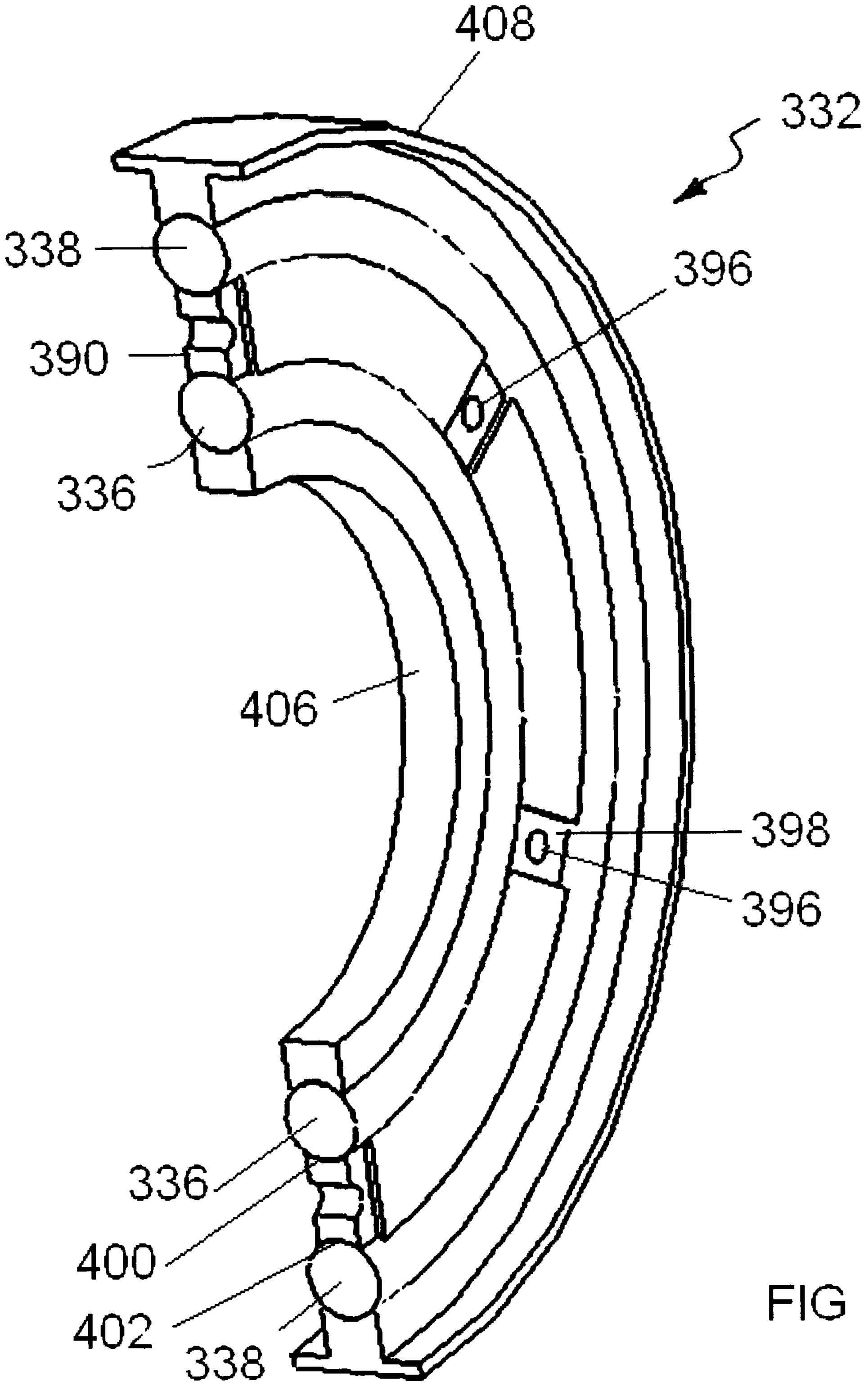

FIG 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2014/053054

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16J15/14 F16L17/10 F17D5/02 F16L23/10 F16L23/16
F16L23/22 F16L39/00 G01M3/00
ADD.

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)
F16J F16L F17D G01M

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 practicable, search terms used)

EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 141 685 A (WATTS JOHN D) 21 July 1964 (1964-07-21) figures 1,2,3 column 3, line 13 - column 6, line 26 -----	1-6, 14-20, 28-33
X	DE 10 2008 012739 Al (0ERLIKON LEYB0LD VACUUM GMBH [DE]) 10 September 2009 (2009-09-10)	1, 14, 15, 28-33
Y	paragraphs [0001], [0019] - [0029] figures 1,2	7-10, 12, 13, 21-24, 26,27, 34, 38-40, 42,43
A	 ----- -/--	6,20

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

[X] See patent family annex.

* Special categories of cited documents :

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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
9 December 2014	18/12/2014

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, Fax: (+31-70) 340-3016	Prieto Sanz, M

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	US 5 538 262 A (MATSUMURA KEIZO [JP]) 23 July 1996 (1996-07-23) figures 1-3 column 2, line 56 - column 3, line 33 -----	7-10,12, 13, 21-24, 26,27, 34, 38-40, 42,43

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2014/053054

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			US RE30311	E	24-06-1980
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