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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : F16J 15/10 — A1

(11) International Publication Number: **WO 96/00355**

(43) International Publication Date: 4 January 1996 (04.01.96)

(21) International Application Number: PCT/GB95/01492

(22) International Filing Date: 23 June 1995 (23.06.95)

(30) Priority Data:
9412635.6 23 June 1994 (23.06.94) GB

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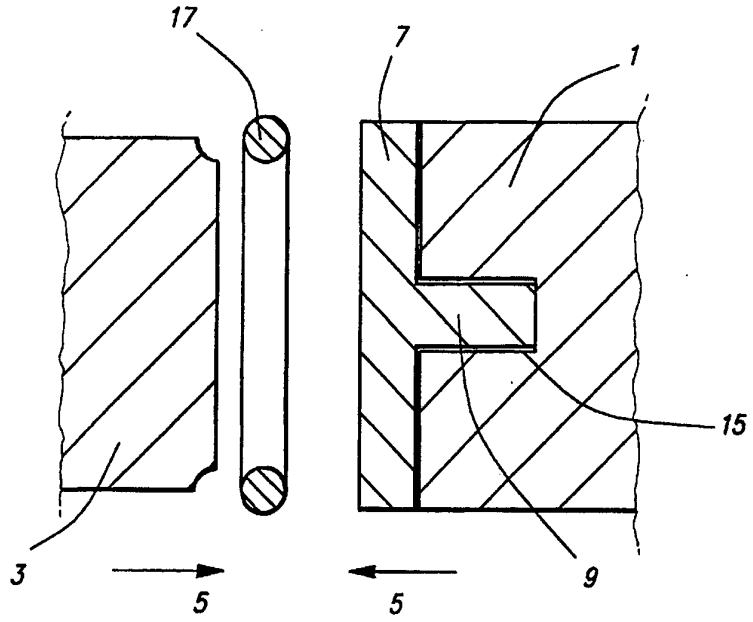
(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ, UG).

Published
With international search report.

(54) Title: SEALS FOR BAKABLE VACUUM SYSTEMS



(57) Abstract

The invention relates to a sealing means, articles incorporating the sealing means and apparatus in which said sealing means are used to advantage. The sealing means incorporates at least a first sealing element having at least an outer surface of polymeric material and a second sealing element having at least an outer surface of elastomeric material. This allows the sealing means to be baked for use in high vacuum or ultra high vacuum environments, without damage to the seal and in a closed position. Furthermore, the force required to be applied to create the seal between the sealing elements in such that automated actuation means can be used to operate the sealing means.

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Seals for Bakable Vacuum Systems

This invention relates to sealing means primarily, but not exclusively, for use in bakable vacuum systems for the conditioning and processing of devices and components and in particular to sealing means for use articles provided in such systems and on compartments for such apparatus.

It is normal practice when preparing a vacuum system to bake it for a considerable period of time and to temperatures of up to 450 degrees celsius but more usually 200 - 250 degrees celsius. The baking process removes contaminant gases from the system and the components therein which otherwise would release uncontrollably into the system to prevent the attainment of an ultra or high vacuum. The reduction in the vacuum caused by "outgassing" is considerable and therefore baking the system is a fundamental requirement.

One area of the system which is susceptible to damage during the baking process are seals, such as those used in valves or between flanges in the system.

It is a known and longstanding aim to provide seals which can both withstand the baking process and also withstand it to such an extent that the same can be reused in successive baking processes. Conventional seals are formed of metals of hard and soft compounds. It is known to use copper, aluminium indium or gold as the soft compound with stainless steel as the hard compound. In use the deformation of the soft compound causes the seal between the components to be obtained. The main disadvantage with all metal seal components is that they are relatively expensive to manufacture and also the costs involved in maintaining the same are relatively high. Furthermore, continued opening and closing of the components is known to cause damage to the

seals to such an extent that it eventually leads to the seal leaking, and, yet more due to the tendency of the materials to fuse if in contact during the baking process the sealing means of this type are required to be held in an open position during baking. This is extremely inconvenient if for example, the sealing means is used to control a volatile material which could not be exposed to heat as would be the case if the sealing means is required to be baked when in an open position.

Another problem with this type of seal is that a relatively large closing force is required to ensure that the stainless steel or other hard metal edge bites into the soft metal to ensure that a proper seal is achieved between the two elements. This leads to the components of this type of seal being required to be actuated under relatively high applications of force and therefore does not lend itself to actuation by automated means such as hydralic, pneumatic or electromagnetic means.

As a means of obviating the use of all metal seals, various attempts have been made to manufacture seals from elastomeric polymers. While certain advances have been made in identifying the most suitable materials problems still exist and in particular in relation to the problem of "compression set". This is a name given to the result of baking a seal when the seal is in the closed sealing condition wherein the seal remains in a compressed position even when released such that upon subsequent use an inadequate seal is obtained.

Several attempts have been made to overcome this problem. One attempt was based around coating a seal face with PTFE (polytetrafluoroethylene). The coating did show improved results in the ability to reuse the seal after several bakes but the addition of the coatings to the components was found

to increase the risk of outgassing from both impurities in the PTFE coating and impurities trapped between the coating and the base surface.

The aim of the present invention is to provide a sealing system which utilises the advantages to be gained when using polymers and elastomeric materials in the same and to utilise these materials in a manner which allows repeated baking of the same without damage to the integrity of the system.

In a first aspect of the invention there is provided a sealing means, which is bakeable, for use in a high vacuum environment for effecting a gas tight seal, said sealing means including at least two components, at least one of which is movable between a seal open position and a seal closed position and including at least a first sealing element attached to a component and a second sealing element having at least an outer surface formed of an elastomeric material and wherein the first sealing element has at least a seal forming face formed of polymeric material arranged to contact with the second sealing element in a seal closed position.

This arrangement allows the sealing means to be baked in a closed sealing position as the materials resist any compression set or adherence problems and do not fuse together as is the case with all metal seals. Furthermore the force required to be applied to the components to create a seal between the sealing elements is reduced in comparison to all metal seals.

In one embodiment, the first sealing element is formed as an integral part of the component.

Typically the first sealing element is in the form of a pad

of polymeric material applied to the component. Preferably the pad includes at least one aperture to allow the release of any contaminants during the baking and vacuum of the surrounding environment without affecting the integrity of the seal.

In a further embodiment the first sealing element is in the form of a gasket. This embodiment is of particular advantage where the first sealing element is adapted to be located between the two components in the form of matching flanges which are brought together into a seal closed position.

In on embodiment the sealing means is provided in a valve which has a first component in the form of a valve head and a second component in the form of a valve seat and the sealing means is provided between these two components. Preferably the first sealing element is located on either of the valve seat and/or the valve head and the second sealing element is located on the other of the valve head or valve seat. Typically the second component has at least the second sealing element located thereon in the form of an O-ring.

In one embodiment the first sealing element includes location means formed therein which match with location means formed in the component to locate the said sealing element in engagement with the component. Typically the location means in the component is a threaded aperture and the sealing element portion is provided with a matching threaded shaft and the threaded portion is formed as an integral part of the sealing element. The location means in the component and/or first sealing element includes at least one vent to allow gas created during the baking of the components to escape from the vicinity of the sealing element. Preferably the threaded portions further include a venting system to ensure that any expanded gas which arises during baking in the location means

can escape, thereby preventing the entrapment of unwanted gases.

Typically the second sealing element is an o-ring and the means for location of the same can be an annular groove in the component. Typically the sealing ring is made from any elatomeric material such as VITON, fluoroelastomer, silicone or material sold under the registered trade marks KALREZ or CHEMRAZ.

In whichever format, the polymeric material used for the first sealing element is preferably virgin PTFE, a fluourocarbon polymer or polymide material and the same is provided in one embodiment in the form of a flat pad with location means formed thereon.

In a further aspect of the invention there is provided a sealing system for effecting a gas tight seal between two components, comprising a first sealing element compressed between second and third sealing elements in the form of sealing rings or gaskets received in respective recesses of the components between which the seal is formed.

Preferably the first sealing element is in the form of a substantially flat pad, for example a disc or annulus, and the second and third sealing elements between which it is compressed comprises O-rings received in respective annular channels formed on the surfaces of the respective components in which they are mounted. It is envisaged that this embodiment is particularly suited to the provision of a seal between two flange elements. In whichever format it is preferred that the O-ring be formed of any of viton, silicone or KALREZ or CHEMRAZ and that the first sealing element has at least an outer face of polymeric material such as, for example, PTFE.

In a further aspect of the invention there is provided a valve for use in Ultra High Vacuum apparatus, said valve comprising a sealing means formed between a valve seat and a valve head and wherein the valve and sealing means is movable between a valve open position and a valve closed position and wherein the sealing means includes mutually contacting surfaces when in the closed position and wherein at least one of said surfaces is formed of a polymeric material such as PTFE.

In one embodiment the polymeric material is provided in the form of a pad of solid material which is mechanically located to a support plate as part of the valve seat or valve head. Typically the valve head includes a first sealing element attached thereto which is formed at least partially from polymeric material and the valve seat includes a second sealing element of elastomeric material located thereon.

Preferably the valve includes means for urging the sealing means into a closed, sealed position and the valve components are moved between the open and closed positions by any of the automation types of, pneumatic, hydraulic or electromagnetic control means or alternatively the valve components are moved between the open and closed positions by manual actuation including means to give mechanical advantage in the manual movement of the same. Such means may be a lead screw or lever system which enables easier movement of the components.

Thus the present invention allows a sealing means fitted to a valve or other article which can be actuated between open, and closed sealed positions by automation means as the force required to be applied to ensure that a seal is achieved is substantially less that for conventional all metal seals and thus the range of uses for the sealing means of the invention is increased over conventional sealing means.

In a yet further aspect of the invention there is provided apparatus for operation with an Ultra High Vacuum, said apparatus baked to a temperature of at least 250 degrees Celsius prior to use to remove contaminants from interior surfaces and wherein at least one article is included therein incorporating a sealing means and the sealing means of the at least one article includes at least a first sealing element formed from a polymeric material and a second sealing element formed substantially of elastomeric material so that during baking the at least one article can be maintained in a closed, sealed position.

In one embodiment the at least one article is provided so that when the same is in a sealed, closed position the apparatus to be subjected to baking is isolated from the surrounding environment and in one form the article is fitted to a port into a chamber which is to be baked and said article consists of a first component surrounding the port entrance or exit and a second component which is movable between an open position, and a closed position, when at least a portion of an outer surface of the second component contacts the first component to form a seal and wherein at least the portion of the surface of the second component which contacts the first component is formed of a polymeric material and there is provided a second sealing element formed from elastomeric material. The apparatus closure may further include at least one second sealing element in the form of an O-ring of elastomeric material such that the first sealing element contacts the same when in a closed position to form the seal with the first component.

Specific embodiments of the invention will now be described with reference to the accompanying drawings wherein:

Figure 1 illustrates a diagrammatic simplified illustration

of an embodiment of the sealing means according to the invention;

Figure 2 illustrates a cross sectional elevation of an automatically actuated valve for use in an Ultra High Vacuum system in accordance with an aspect of the invention and including sealing means according to the invention;

Figure 3 illustrates schematically a typical high vacuum system incorporating different types of ports and valves which can incorporate seals in accordance with the present invention;

Figure 4 shows a manually operated valve incorporating a valve seal in accordance with a further aspect of the invention; and

Figure 5 shows a sealing means as shown in Figure 4 in accordance with the second aspect of the invention between two flanges.

Referring firstly to Figure 1 there is shown a sealing means comprising a first component 1 and a second component 3 which can be brought together as shown by arrows 5 to a seal closed position. Attached to the first component 1 is a first sealing element 7 which is in the form of a pad of PTFE material. The pad is provided with a location means 9 in the form of a threaded shaft which is locatable in a threaded aperture 15 in the first component 1. A second sealing element 17 is provided in the form of an O-ring such that when the components 1,3 are brought together the first and second sealing elements 7,17 contact to form a closed seal which can be baked in this form.

Referring now to Figure 2 there is shown an automatically

actuated valve 2 to be connected between a vacuum chamber and a vacuum pump and utilising sealing means of the sort described in Figure 1. Contaminants from the vacuum chamber pass into the valve in the direction of arrow A and out towards the pump in the direction of arrow B.

The valve comprises a valve body 10 in the form of a substantially cylindrical chamber with an axial inlet duct 11 with a flange 12 to allow the same to be connected to inlet piping and a radial outlet duct 13 with a flange 14. At the top of the body there is provided an automatic actuating means 16, the operation of which causes a valve head 18 to be moved between a first open position and a second, closed, position as shown in the figure.

In the closed position a seal is formed by the pressing of a first sealing element 20 of a polymer, i.e. a fluorocarbon polymeric material, typically PTFE, which is attached to the valve head 18, onto a second sealing element in the form of an O-ring 22 formed of elastomeric material and mounted in the valve seat 21. The first sealing element 20 is mounted on the valve head 18 by means of a threaded shaft 24 which is an integral part thereof and the same is received in a threaded aperture 26 in the valve head 18. Thus the sealing element of PTFE is mounted on the valve head by screwing the threaded shaft 24 into the valve head 18 thus eliminating any requirement for adhesives or other attachment materials to be used and thus reducing the occurence of outgassing of contaminants while utilising the advantages of the materials. While a threaded location means is described it should be appreciated that any mechanical location and engagement means can be advantageously used.

Typically the elastomeric material used for the o-ring 22 is VITON, a fluoroelastomer, or alternatively silicone , KALREZ

or CHEMRAZ.

In movement of the valve head and the sealing element 20 the valve head is prevented from rotation as the same is mounted on a ball race, thus the valve head can be moved upwardly and downwardly by the automated actuation means 16 without rotating and, when moved to its fullest extent, the sealing element 20 and the o-ring 22 are compressed to form an effective seal between the inlet duct 11 and the outlet duct 13.

Figure 3 illustrates a typical vacuum system employing a number of seals, all of which could be in accordance with the present invention. The broken line indicated by reference numeral 30 indicates a baking oven surrounding a system to bake the same to enhance the vacuum created by evaporation and to evacuate any contaminants from interior surfaces.

The system itself comprises a vacuum chamber 32 having an entry port 34 for inserting and removing samples. Pumps 36, 38 and 40 are provided for evacuating the chamber 32. These include a first pump 36 which may be of a conventional piston type, for a preliminary evacuation of the chamber through a conduit 42. Pump 36 could not withstand the high temperatures used for baking and must therefore be located outside the oven. A valve 44 is located within the oven close to the chamber 32 so as to isolate the chamber 32 from the conduit 42 and thereby prevent contaminants from entering the system.

A similar arrangement is used for pump 38 which is typically a diffusion pump and connected to the chamber 32 by a conduit 46 via valve 48 which is positioned adjacent the chamber 32 so as to isolate it from the conduit 46 which could contain oil released from the pump 38.

Final evacuation of the chamber is effected by means of a high vacuum pump 40 which can withstand the baking process and is located within the oven 30. The pump can be isolated from the chamber 32 by a gate valve 50.

All of the valves 44, 48, 50 and port 34 incorporate sealing means according to this invention. Thus valves 44 and 48 are as shown in Figure 2. The port 34 can be constructed analogously to the valve of Figure 2; the port having a radial flange 52 and a door 54 with mutually opposed mating surfaces. The mating surface of the flange 52 includes an annular channel to receive an o-ring and the mating surface of the door 54 is formed from a polymeric material pad which is screwed or otherwise mechanically located to the door body such that when the two sealing elements are brought together a tight seal is formed.

The gate valve can be of conventional design and by turning a lever the two valve gates are pressed against respective opposing valve seats to close off the communication between the vacuum chamber and the pump. In accordance with the invention, the valve seats against which the gates are pressed may incorporate a channel for the reception of an o-ring while the gates are provided with polymeric material portions mechanically located therein so as to form a seal when the gate is thrust against its valve seat.

Referring now to Figure 4 there is shown an alternative arrangement of the invention wherein there is shown a valve which is manually actuable by means of a threaded spindle 60 which is turned by the handle 62. At the inner end of the spindle 60 there is mounted a valve head 64 which is mounted on a ball race 66 so that it can be thrust downwardly against the valve seat 68 without itself rotating to form a seal.

The valve head 64 accommodates a sealing element disc 70 of pure fluorocarbon polymer material such as PTFE. The disc 70 rests against a flat bearing surface 72 in which is formed an annular recess 74 accommodating an additional elastomeric o-ring 80.

The sealing element disc 70 is retained in position by an annular flange 76. No adhesive or other means is used to retain the disc in position. The disc has a central aperture 78 to release any contaminants which might otherwise become trapped between the disc and the bearing surface or in the annular recess 74. This enables the o-ring 80 to be degassed as the pressure is reduced and all potential contaminants to be evacuated from the system before the valve is closed to seal the vacuum.

When the valve member is screwed down to its fullest extent, the disc 70, the o-ring 80 and the o-ring 82 which is mounted on the valve seat 68, are compressed between the valve head and the valve seat to give an effective seal between the inlet duct and outlet duct.

Figure 5 illustrates the sealing technique of Figure 4 used to provide a seal between two flanges 84 and 86 wherein the seal comprises a sealing element 88 of polymeric material in the form of a gasket which is held in cavities 90, 92 formed in each of the flanges 84, 86. The seal between the flanges is completed by the inclusion of two 'O' rings 94, 96, one on each side of the gasket 88 of elastomeric material, each of which lies between the gasket and one of the flanges. When the flanges are tightened together to form the join, the gasket and flanges impact on the O-rings 94, 96 to compress the same and hence create the required seal.

The current invention, and the embodiments thereof, provide a means and arrangement whereby polymer and elastomeric materials can be used to provide advantageous sealing means while at the same time ensuring that the sealing means use is not detrimental when they are used in a high vacuum system and can be baked when in a closed position. The seals obtained are improved over all metal seals and the problems of compression set and outgassing previously encountered are minimised. Furthermore the seals can be obtained with a reduced application of force applied to the components in comparison with all metal seals and therefore the sealing means of the invention can be actuated by automated actuation means.

CLAIMS

1. A sealing means, which is bakeable, for use in a high vacuum environment for effecting a gas tight seal, said sealing means including at least two components, at least one of which is movable between a seal open position and a seal closed position and including at least a first sealing element attached to a component and a second sealing element having at least an outer surface formed of an elastomeric material and wherein the first sealing element has at least a seal forming face formed of polymeric material arranged to contact with the second sealing element in a seal closed position.

2. A sealing means according to Claim 1 wherein the first sealing element is formed as an integral part of the component.

3. A sealing means according to Claim 1 wherein the first sealing element is in the form of a pad of polymeric material applied to the component.

4. A sealing means according to Claim 3 wherein the pad includes at least one aperture to allow the release of any contaminants during the baking and vacuum of the surrounding enivornment without affecting the integrity of the seal.

5. A sealing means according to Claim 1 wherein the first sealingg element is in the form of a gasket.

6. A sealing element according to Claim 5 wherein the first sealing element is adapted to be located between two components in the form of matching flanges which are brought together into a seal closed position.

7. A sealing means according to any of the preceding claims wherein the sealing means is provided in a valve which has a first component in the form of a valve head and a second component in the form of a valve seat and the sealing means is provided between these two components.

8. A sealing means according to Claim 7 wherein a first sealing element is located in either of the valve seat and/or the valve head and the second sealing element is located in the other of the valve head or valve seat.

9. A sealing means according to any of the preceding claims wherein the second component has at least the second sealing element located thereon in the form of an O-ring.

10. A sealing means according to any of the preceding claims wherein the first sealing element includes location means formed therein which match with location means formed in the component to locate the said sealing element in engagement with the component.

11. A sealing means according to Claim 10 wherein the mechanical location means in the component is a threaded aperture and the first sealing element is provided with a matching threaded shaft.

12. A sealing means according to Claim 11 wherein the threaded shaft is provided as an integral part of the first sealing element.

13. A sealing means according to Claim 10 wherein the location means in the component and/or first sealing element includes at least one vent to allow gas created during the baking of the components to escape from the vicinity of the sealing element.

14. A sealing means according to any of the preceding claims wherein a plurality of the second sealing elements are provided with at least one element provided to contact each sealing surface of the first sealing element.

15. A sealing means according to any of the preceding claims wherein the second sealing element is an O-ring.

16. A sealing means according to Claim 15 wherein the O-ring is formed of any of VITON, a fluoroelastomer; silicone, or material known under the registered trade marks KALREZ or CHEMRAZ.

17. A sealing means according to any of the preceding claims wherein the polymeric material used for the first sealing element is any of PTFE, fluorocarbon polymer, polymide material.

18. A sealing means according to any of the preceding claims wherein the sealing means can be baked at temperatures of over 250 degrees Celsius with the sealing means in the seal closed position.

19. A sealing means according to Claim 18 wherein the valve is used as part of an Ultra High Vacuum (UHV) apparatus.

20. A valve for use in Ultra High Vacuum apparatus, said valve comprising a sealing means formed between a valve seat and a valve head and wherein the valve and sealing means is movable between a valve open position and a valve closed position and wherein the sealing means includes mutually contacting surfaces when in the closed position and wherein at least one of said surfaces is formed of a polymeric material such as PTFE.

21. A valve according to Claim 20 wherein the polymeric material is provided in the form of a pad of solid material which is mechanically located to a support plate as part of the valve seat or valve head.

22. A valve according to any of the Claims 20 and 21 wherein the valve head includes a first sealing element attached thereto which is formed at least partially from polymeric material and the valve seat includes a second sealing element of elastomeric material located thereon.

23. A valve according to any of the preceding Claims 20-22 wherein the valve includes means for urging the sealing means into a closed, sealed position.

24. A valve according to Claim 23 wherein the valve components are moved between the open and closed positions by any of automation, pneumatic, hydraulic or electromagnetic control means.

25. A valve according to Claim 23 wherein the valve components are moved between the open and closed positions by manual actuation including means to give mechanical advantage in the manual movement of the same.

26. A valve according to any of Claims 20-25 wherein the valve is a gate valve.

27. Apparatus for operation with an Ultra High Vacuum, said apparatus baked to a temperature of at least 250 degrees Celsius prior to use to remove contaminants from interior surfaces and wherein at least one article is included therein incorporating a sealing means and the sealing means of the at least one article includes at least a first sealing element

formed from a polymeric material and a second sealing element formed substantially of elastomeric material so that during baking the at least one article can be maintained in a closed, sealed position.

28. Apparatus according to Claim 27 wherein the at least one article is provided so that when the same is in a sealed, closed position the apparatus to be subjected to baking is isolated from the surrounding environment.

29. Apparatus according to Claim 28 wherein the article is fitted to a port into a chamber which is to be baked and said article consists of a first component surrounding the port entrance or exit and a second component which is movable between an open position, and a closed position, when at least a portion of an outer surface of the second component contacts the first component to form a seal and wherein at least the portion of the surface of the second component which contacts the first component is formed of a polymeric material and there is provided a second sealing element formed from elastomeric material.

30. Apparatus according to Claim 29 wherein the first component has located thereon an O-ring formed of elastomeric material and the second component, when in the closed position contacts with the O-ring to form the seal.

31. Apparatus according to Claim 28 wherein the article is a valve which in a closed position serves to provide a gas tight seal between, on one side a combustible fluid, and on the other side the apparatus to be subjected to baking thereby allowing the apparatus to be subjected to baking with the combustible material isolated.

32. Apparatus according to any of Claims 27-31 wherein the

apparatus further includes means for baking a chamber and components connected to said chamber.

33. A sealing means and apparatus as hereinbefore described with a reference to the accompanying drawings.

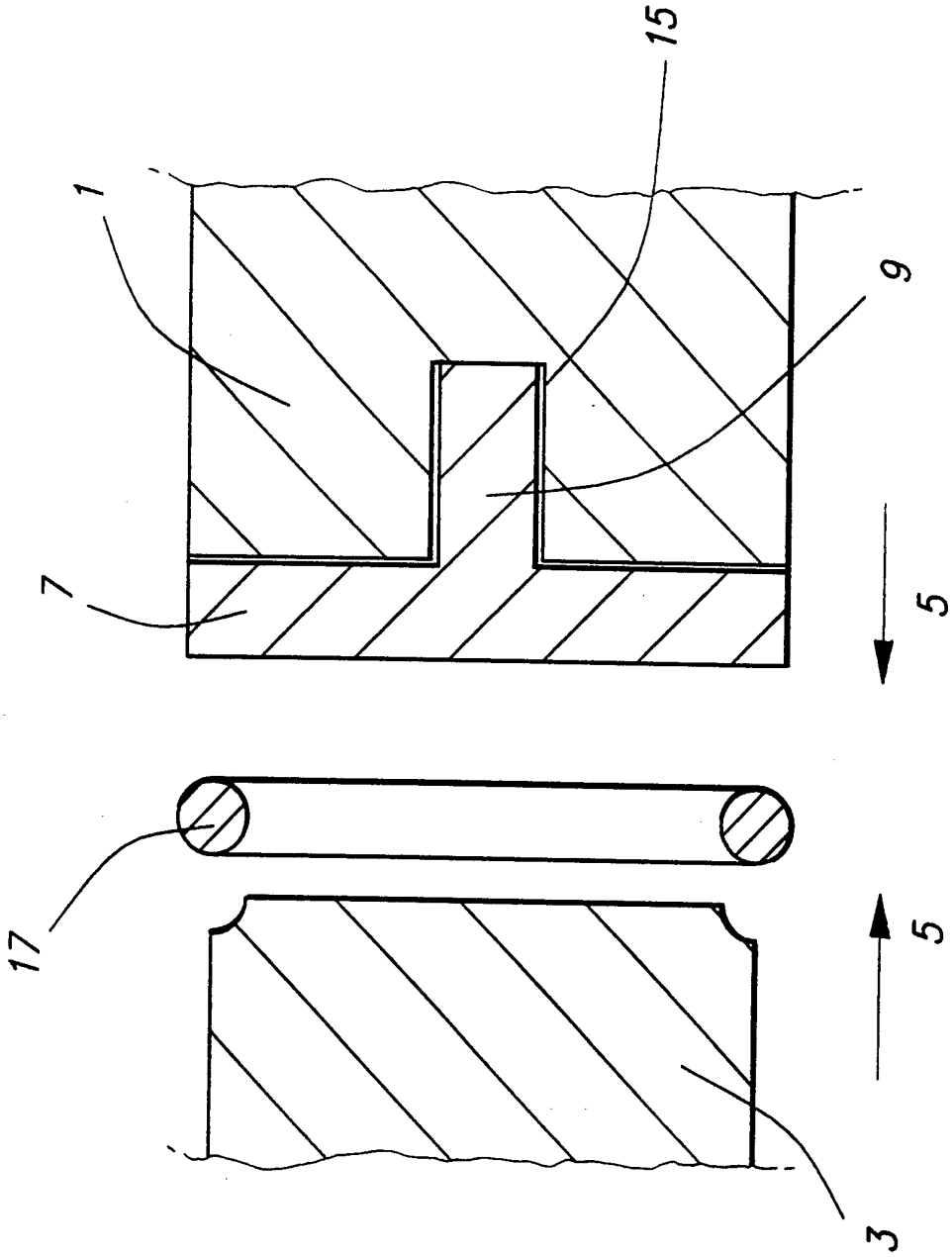

FIG.1

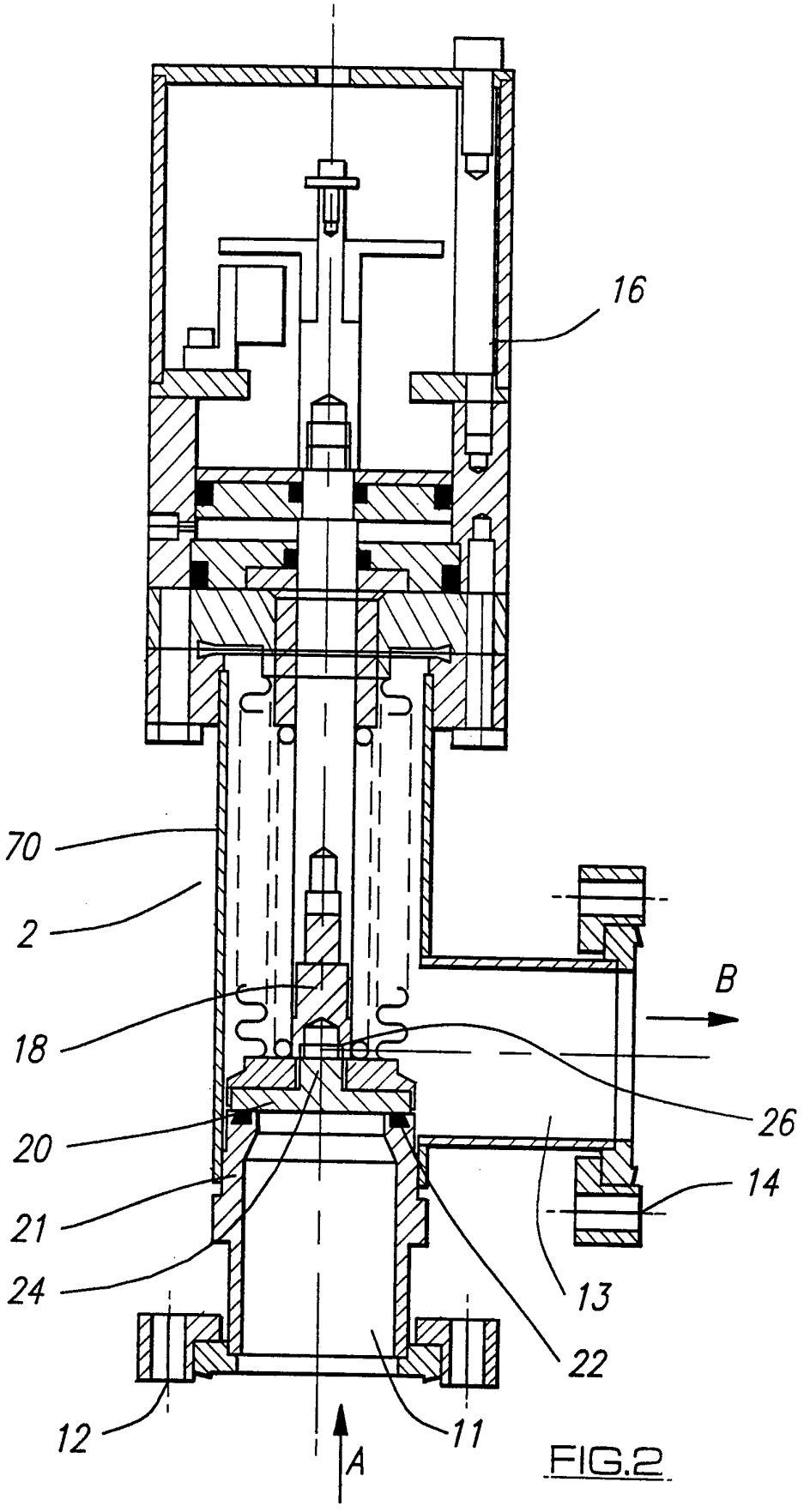

FIG.2

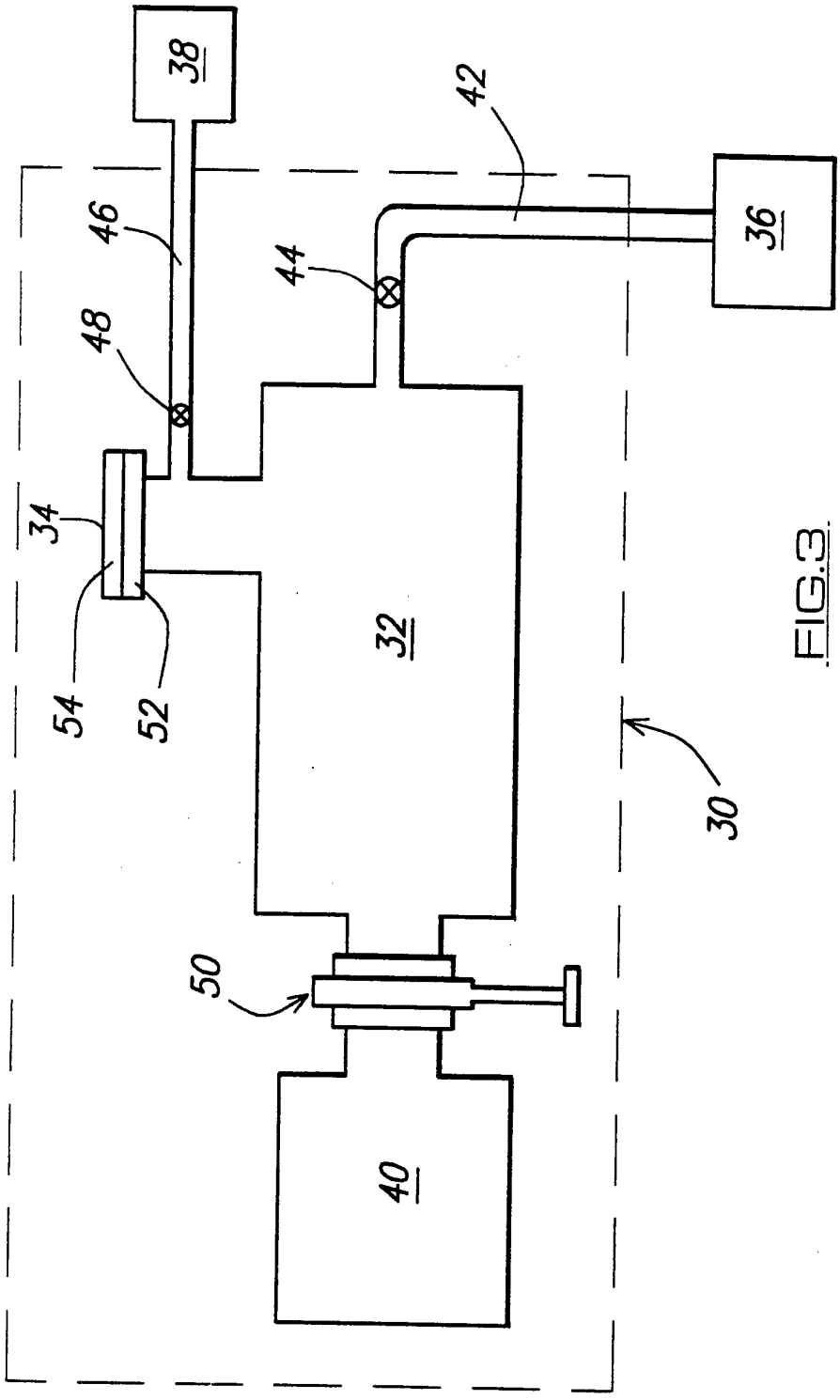

FIG.3

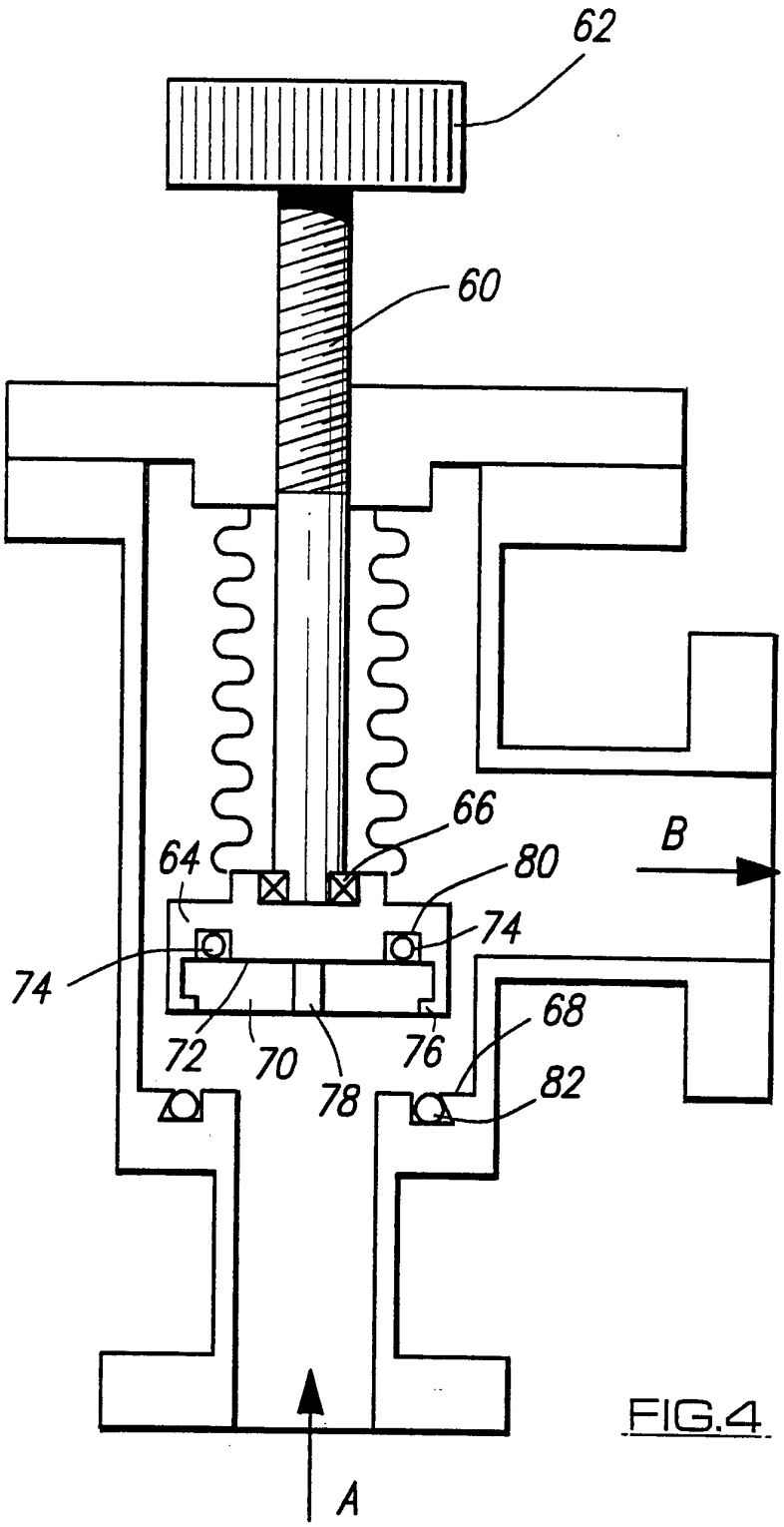

FIG.4

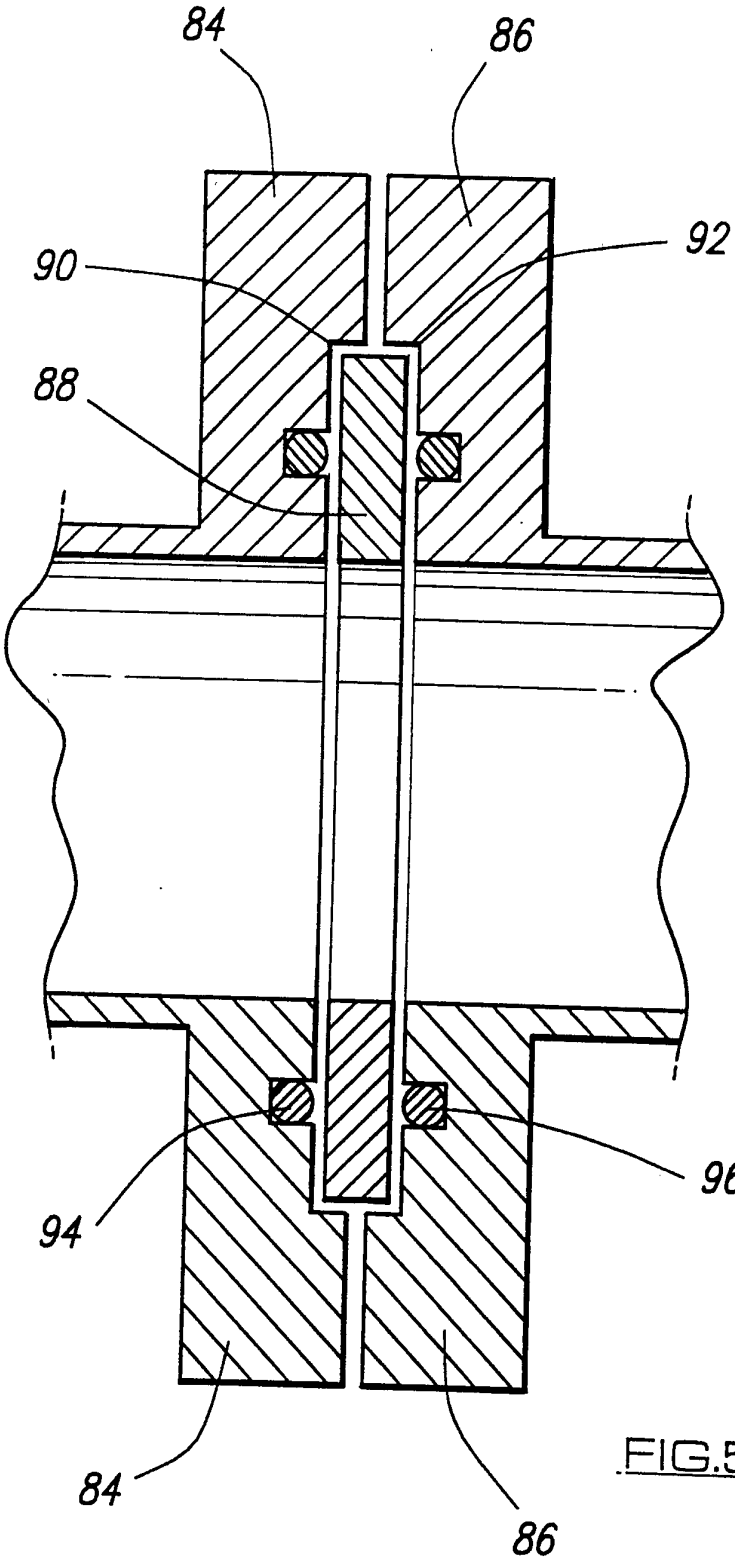

FIG.5

INTERNATIONAL SEARCH REPORT

Interi. .nal Application No
PCT/GB 95/01492

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F16J15/10

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)
IPC 6 F16J

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 294 224 (VG INSTRUMENTS) 7 December 1988 see the whole document -----	1-3,5-9, 14-28

☐ Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
21 September 1995	02. 10. 95

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter. nal Application No
PCT/GB 95/01492

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