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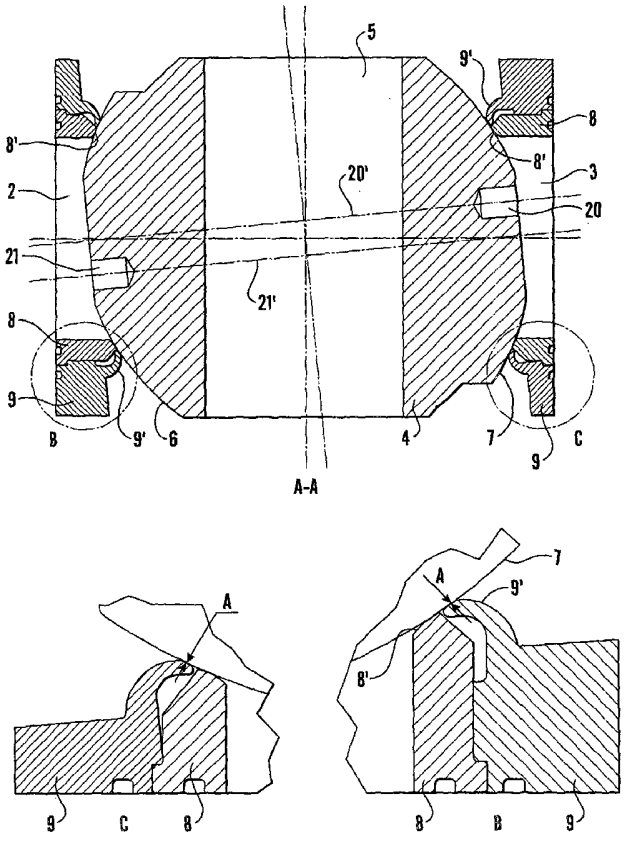
(54) Title: BALL VALVE



(57) Abstract: The present invention relates to a ball valve comprising a valve housing with an inlet and an outlet opening together with a ball-shaped inner valve body which can be rotated in the valve housing between an open and a closed position. In the open position the valve body has a through-going opening connecting the valve housing's inlet and outlet openings. In the closed position the valve body blocks the through-flow.

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Ball valve

The present invention relates to a ball valve comprising a valve housing with an inlet and an outlet opening together with a ball-shaped inner valve body which can be rotated in the valve housing between an open and a closed position. In the open position the valve body has a through-going opening connecting the valve housing's inlet and outlet openings. In the closed position the valve body blocks the through-flow.

Ball valves of the above-mentioned type are used in a great many applications from ordinary piping for drinking water to more sophisticated oil and gas plants, either on land or on offshore installations. Valves of this type are employed for regulating the flow of both gas and liquid.

One of the advantages of the valve is its ease of operation, which is often suitable for operation with a remotely controlled actuator while providing a good seal in a closed position.

With such valves, however, there may be a problem with sealing them in a closed position at high pressure. This applies particularly if a great pressure difference arises over the ball, thus causing it to be displaced by the pressure and thereby deforming any seals or the actual material in the valve housing or the valve body.

In order to remedy sealing problems at high pressure, various improvements and adaptations of known ball valves have been initiated. From the applicant's own patent application WO 91/14891 a method is known involving tilting the seats in the valve housing and the sealing surfaces on the ball-shaped valve body, thus enabling them to meet easily and to achieve a wedge effect when the tilted surfaces meet in the closed position.

From WO 00/50792 it is also known for the seat in the valve housing and in the sealing surface on the ball-shaped valve body to have different curved shapes, thereby sealing with elliptical contact.

However, there are still problems associated with sealing, e.g. with gas at a pressure of 350 bar on one side of the valve. It is therefore an object of the present invention to provide a solution which further tackles the problems of sealing, particularly where there is high pressure on one side of the valve. It is therefore an object to provide a solution where the pressure facilitates the sealing in such a manner that higher pressure provides a better seal as opposed to previously where higher pressure upstream in the fluid flow direction through the valve has increased the chances of leakage. In addition it is desirable to employ the wedge effect mentioned in WO 91/14891 to promote sealing while it is more desirable to employ the

pressure in the surrounding fluid to promote sealing than to employ elliptical contact as in WO 00/50792.

The present invention is therefore produced on the basis of WO 91/14891.

A further object of the present invention is to provide a ball valve with increased resistance to leakage. In previous solutions, a leak in the seal on one side of the valve will result in the valve housing round the valve body being filled with pressurised fluid and if an additional seal breaks down, this makes the whole valve leaky, as for example in WO 00/50792 where a packing is mounted in a groove in the seat ring for sealing on each side of the valve. In order to solve this problem of leakage, according to the present invention several seals (2 on each side in the preferred embodiment) are provided in order to provide a further safeguard against leakage.

For this purpose a ball valve according to the present invention is provided comprising a valve housing with oppositely mounted inlet and outlet openings, each provided with an internal seat, which seats are parallel and tilted relative to the longitudinal axis through the inlet and outlet opening, together with a ball body, which is mounted internally in the valve housing and which is rotatable in the valve housing between an open and a closed position, which ball body has a through-going opening and two opposite, curved sealing surfaces provided in an area of the ball body in such a manner that in the closed position the sealing surfaces are in contact with the seat at the inlet and outlet opening respectively, and where in the open position the ball body's through-going opening is connected with the valve housing's inlet and outlet opening and where in the closed position the ball body's sealing surfaces block the valve housing's inlet and outlet openings. According to the present invention the ball valve is characterised in that the internal seat in the inlet and outlet opening internally in the valve housing consists of an inner seat ring and an outer seat ring respectively, which inner seat ring has a sealing seat surface which in the ball body's closed position is in sealing contact with the ball body's sealing surfaces and the outer sealing ring has a lip which on the outside of the contact surface between the sealing seat surface and the sealing surfaces is curved or tilted against the contact surface between the sealing seat surface and the sealing surfaces and where in an unloaded condition when the ball body is in the open position, the length of the lip on the outer seat ring is such that the lip protrudes for a distance inside the area of the valve housing in which the sealing surfaces are located in the closed position, with the result that during movement from the open to the closed position, the ball body meets the lip on the outer seat rings, bending it so that it assumes a prestressed condition during contact with the sealing surfaces.

In different embodiments, the distance the lip protrudes into the housing inside the ball body's position is adapted in such a manner that bending the lip produces a

level of tension in the material of the lip which does not result in permanent deformation.

The inlet and outlet openings are preferably concentrically arranged along the longitudinal axis through the openings.

The inner seat ring has an external flange. This external flange is located between and in abutment against the outer seat ring and the valve housing, and the inner seat ring is thereby held in position in the axial and radial direction.

Due to its shape the inner seat ring also acts as a stop element for the valve body (the ball body). A wedge effect is obtained between the ball body and the inner seat ring, thus stopping the ball body's progress towards the outer seat ring before the outer seat ring's lip has been permanently deformed.

The inner seat ring acts here as a seal, particularly downstream in the valve housing and, together with the prestressing, uses the load from the system pressure for sealing.

The greatest difference from previously known solutions, however, is to be found in the sealing, which will ensure that no leakages occur upstream, i.e. on the side of the valve housing facing the pressure. When the pressure difference between the upstream side of the valve and the interior of the valve housing exceeds a specific limit, (which varies with the materials and the design of the valve), the valve body (ball body) and the valve housing start to become deformed away from the seal (seat), towards the downstream side. This will also influence the outermost seat ring and it will follow the ball body on account of its shape, which provides pressure internally in the ring over an area that is effective from the contact surface between the sealing surface on the ball body and the outermost seat ring into the packing located behind the same seat ring, preventing leakage to the valve housing via the back of the seat ring. The lip on the outer seat rings will do this on account of their shape (curved or tilted) and their length which provides a prestressing during closing of the valve to the closed position.

Furthermore, each of the sealing surfaces on the ball body has an inclination corresponding to the inclination of the seat in the valve housing. To achieve this, the ball body in the preferred embodiment is provided with a different machining axis for each of the curved sealing surfaces. The machining axes are substantially perpendicular to the parallel planes formed by the seat rings. In addition the machining axes for each of the sides of the ball body are parallel.

This is preferred since, amongst other things, it provides the desired sealing geometry in a ball valve according to the present invention.

An embodiment of the present invention is further illustrated in the attached figures, in which:

fig. 1 illustrates a ball valve assembly according to the present invention;

fig. 2 illustrates the assembly and details of the same ball valve as in fig. 1;

fig. 3 illustrates in cross section, plan view and section the inner seat ring in the ball valve illustrated in figs. 1-2 placed in a JIG (a JIG is an aid to machining/working of seats in valves);

fig. 4 illustrates in cross section, plan view and section the inner seat ring in the ball valve illustrated in figs. 1-2, placed in a JIG;

fig. 5 illustrates in cross section, plan view and section the inner seat ring in the ball valve illustrated in figs. 1-2;

fig. 6 illustrates in cross section, plan view and section the inner seat ring in the ball valve illustrated in figs. 1-2.

Figures 1 and 2 illustrate a ball valve assembly in section from the side, which ball valve consists of a valve housing 1 with an outlet and an inlet opening 2,3, where the valve body (the ball body) 4 is in the closed position in the valve housing 1. According to the invention, in the housing 1 there is mounted a seat consisting of an inner seat ring 8 and an outer seat ring 9. The inner seat ring 8 has a lower flange 12. The lower external flange 12 is located in abutment against the outer seat ring 9. The inner seat ring 8 is thereby held in position axially and radially, the flange 12 and the inner seat ring 8 being pressed against the valve housing by the outer seat ring 9 when it is mounted on the valve housing 1.

The ball body 4 has a through-going opening 5. The ball body also has sealing surfaces 6 and 7 which in the closed position abut against the seat 8,9 on each side of the valve housing, i.e. against each of the openings 2,3 in the housing 1. The sealing surfaces have a curved shape and are provided symmetrically about a machining line 20' and 21'. The machining lines 20' and 21' are located perpendicularly to the inclined plane formed by each of the tilted seats 8,9. In the figures a 5 degree deviation is indicated from the longitudinal axis through the ball body.

The machining axis 20' is the centre axis for the sealing surface 6 on the left side (on the opposite side) of the ball body with the opening 20 for mounting in a rotating machining tool. Similarly the machining axis 21' is the centre axis for the sealing surface 7 on the right side with the opening 21 for mounting in a rotating machining tool.

The result is that the wedge effect desired to be achieved by the solution according to the invention, is achieved.

Furthermore, the inner seat ring 8 with the sealing surface 8' seals against the sealing surfaces 6 and 7 as mentioned above and illustrated in figures 1-6.

In addition, the outer seat ring 9 according to the present invention is illustrated in figures 1-6. The seat ring 9 has a forwardly protruding lip 9', which is illustrated in the embodiment with a curved shape. The length of the lip in an uninfluenced condition (with the ball body in the open position) is such that the lip protrudes a distance A into the part of the valve housing's cavity where the ball body is located in the closed position. When the ball body is then in the closed position, the lip's outermost point is bent down a corresponding distance A and the lip is prestressed according to the invention. This assists substantially in the sealing process. When high pressure upstream of the valve then pushes fluid past the inner seat ring, this fluid will then settle under the lip 9' (which holds the seal longer due to the prestressing) and the pressure will hereby press the lip against the sealing surface 6,7 of the ball body. The pressure against the sealing surface will increase with the pressure.

Figures 1-6 illustrate a practical embodiment but the values are only examples and neither absolute values nor the relationship between different values are decisive for the invention beyond what is stated in the description and claims. The relationship between axes and planes, however, is indicated in greater detail in the figures.

PATENT CLAIMS

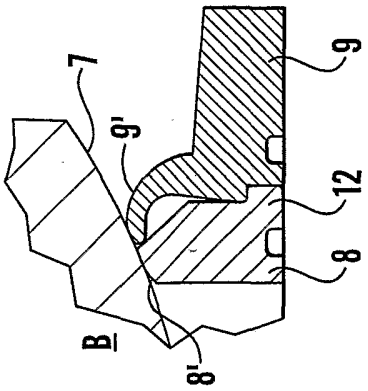
1. A ball valve comprising a valve housing (1) with oppositely mounted inlet and outlet openings (2,3), each of which is provided with an internal seat, which seats are parallel and tilted relative to the longitudinal axis through the inlet and outlet opening, together with a ball body (4), which is mounted internally in the valve housing and which is rotatable in the valve housing (1) between an open and a closed position, which ball body has a through-going opening (5) and two opposite, curved sealing surfaces (6,7) provided in an area of the ball body in such a manner that in the closed position the sealing surfaces (6,7) are in contact with the seat at the inlet and outlet opening respectively, and where in the open position the ball body's (4) through-going opening (5) is connected with the valve housing's (1) inlet and outlet opening and where in the closed position the ball body's (4) sealing surfaces (6,7) block the valve housing's (1) inlet and outlet openings (2.3), characterised in that the internal seat in the inlet and outlet opening internally in the valve housing consists of an inner seat ring (8) and an outer seat ring (9) respectively, which inner seat ring (8) has a sealing seat surface (8') which in the ball body's closed position is in sealing contact with the ball body's sealing surfaces (6,7) and the outer sealing ring (9) has a lip (9') which on the outside of the contact surface between the sealing seat surface (8') and the sealing surfaces (6,7) is curved or tilted against the contact surface between the sealing seat surface (8') and the sealing surfaces (6,7) and where in an unloaded condition when the ball body is in the open position, the length of the lip (9') on the outer seat ring (9) is such that the lip (9') projects for a distance (A) inside the area of the valve housing in which the sealing surfaces (6,7) are located in the closed position, with the result that during movement from the open to the closed position, the ball body meets the lip (9') on the outer seat ring (9), bending it so that it assumes a prestressed condition during contact with the sealing surfaces (6,7).

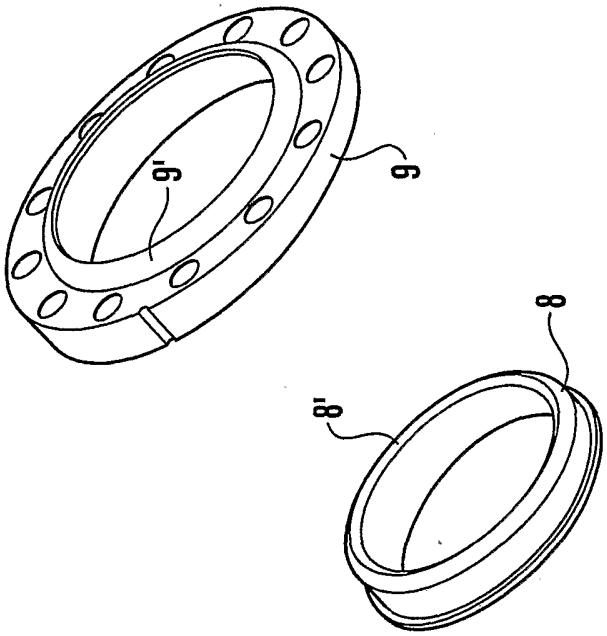
2. A ball valve according to claim 1,
characterised in that the distance (A) is adapted in such a manner that the bending of the lip (9') produces a level of tension in the material of the lip (9') that does not result in permanent deformation.

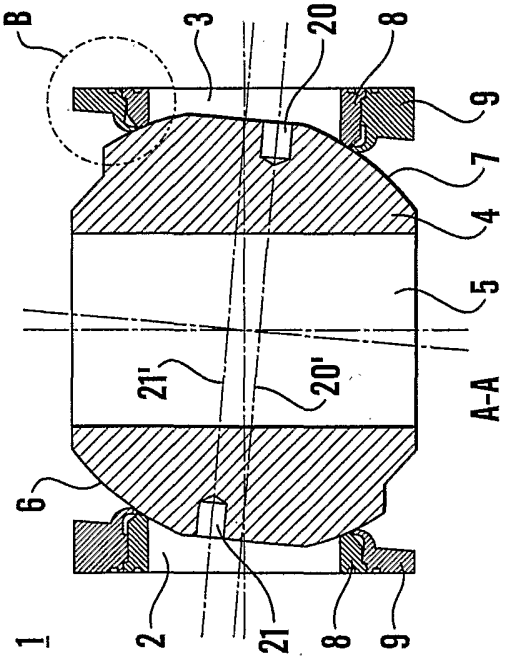
3. A ball valve according to claim 1,
characterised in that the inlet and outlet openings (2,3) are concentrically arranged along the longitudinal axis through the openings (2,3).

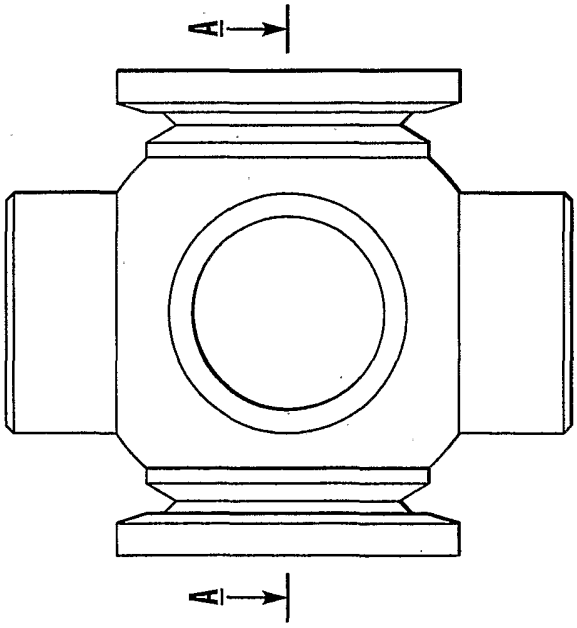
4. A ball valve according to one or more of the preceding claims,
characterised in that the inner seat ring (8) has an external flange (12), one side of which abuts against the outer seat ring (9) and its other side abuts against the valve housing.

Fig. 1









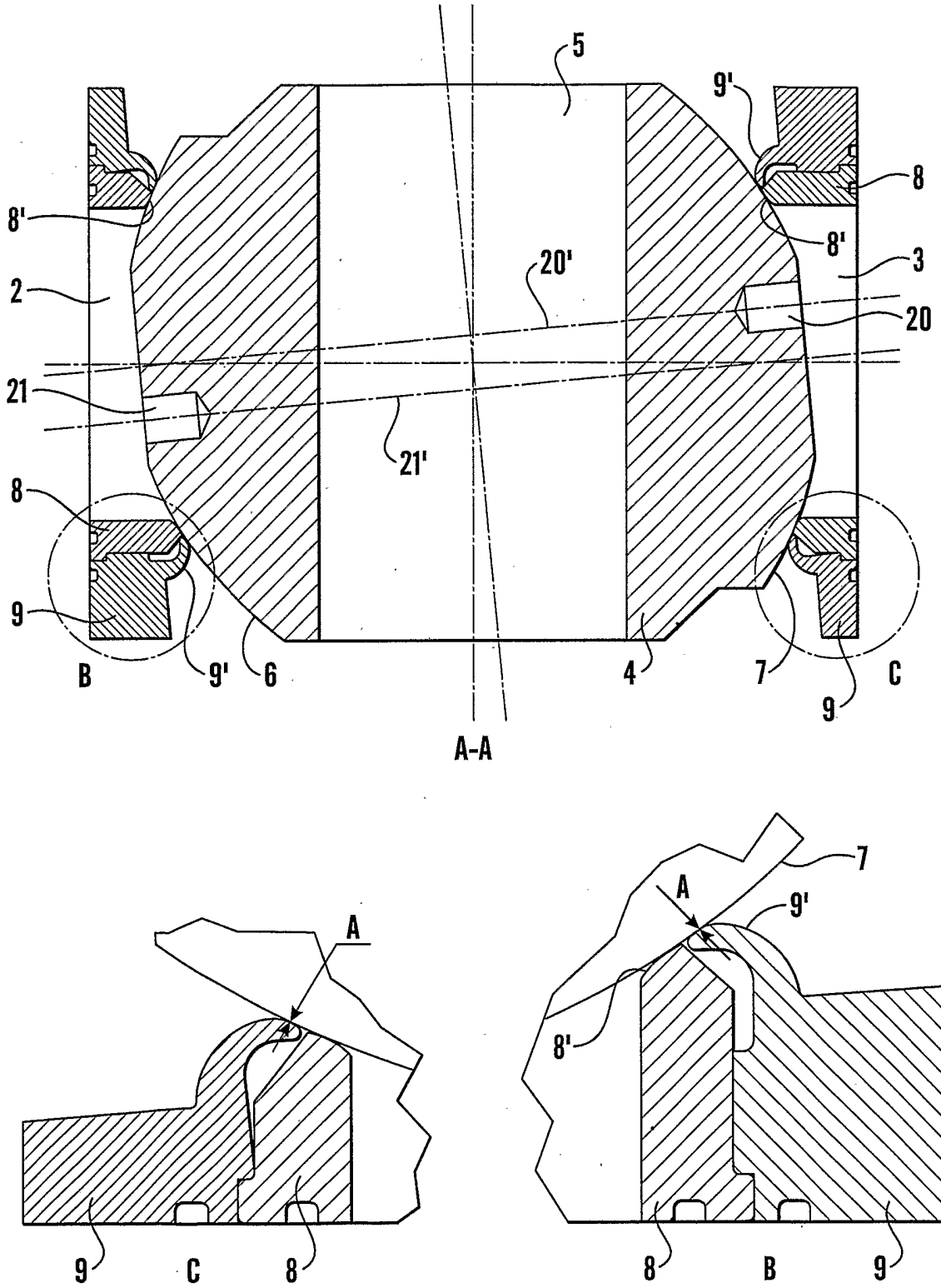


Fig.2

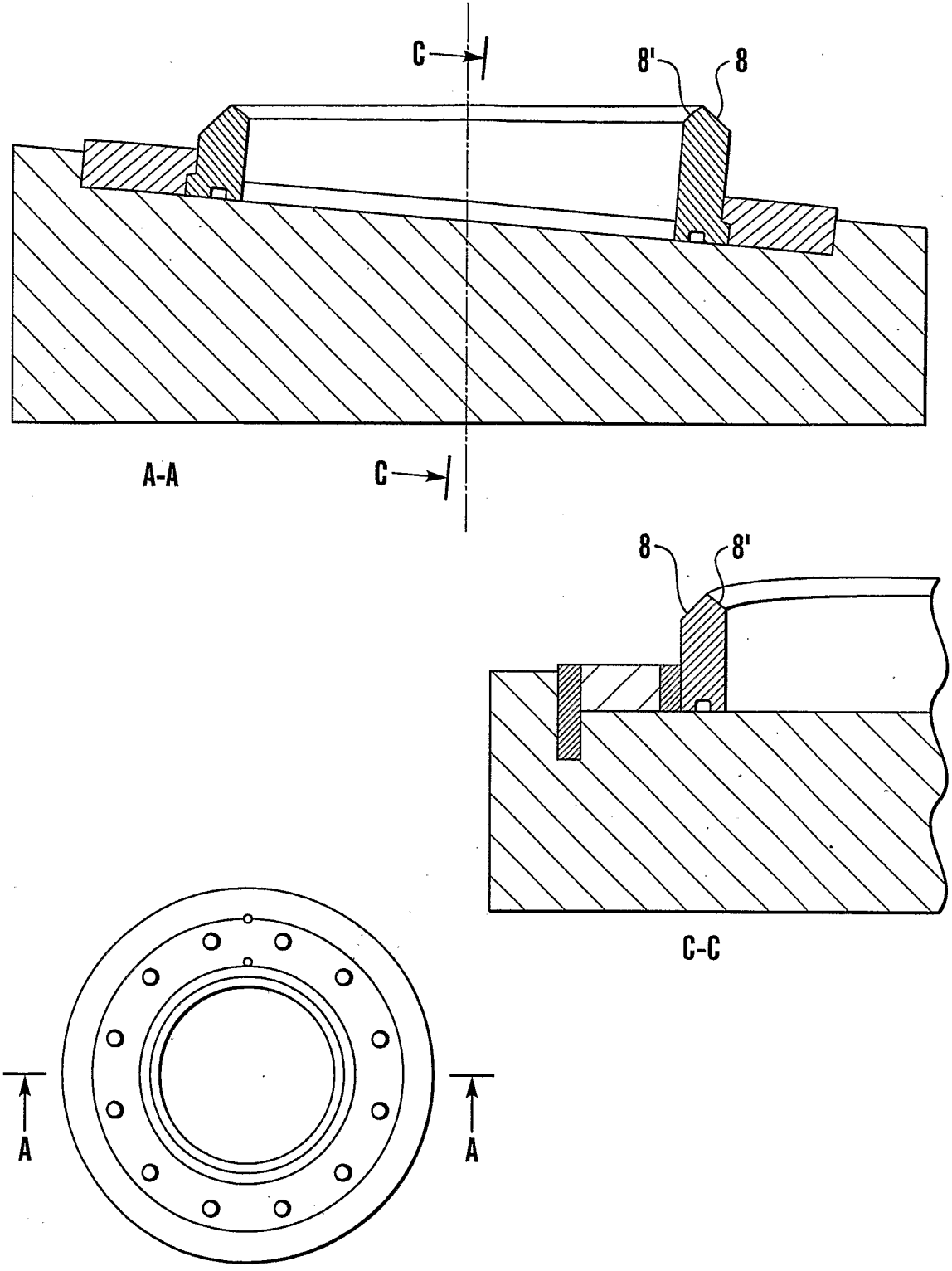
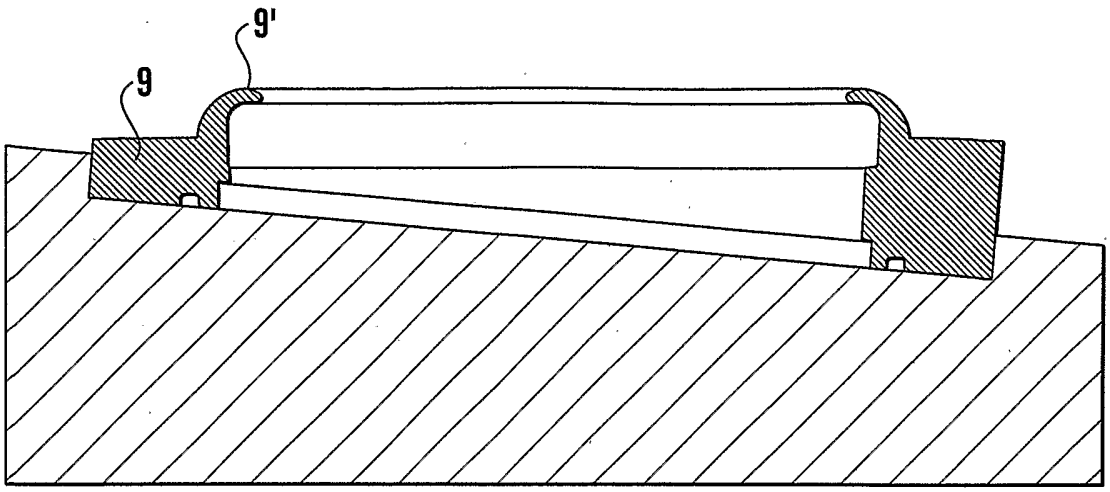


Fig.3



B-B

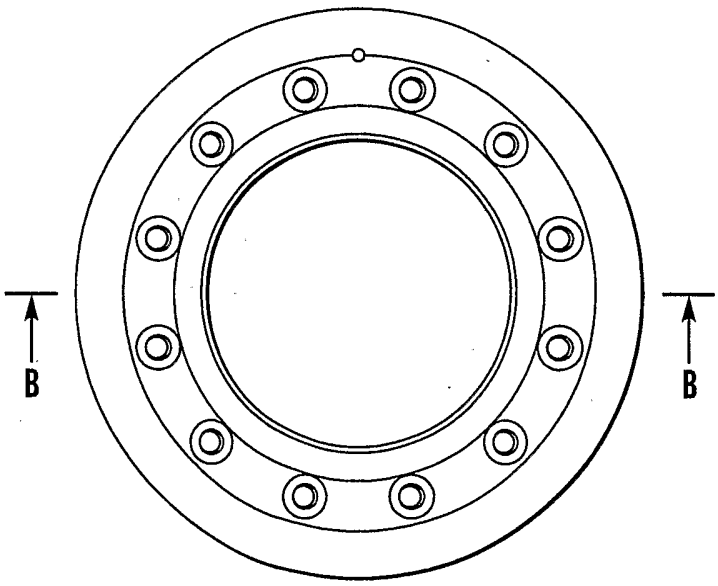


Fig.4

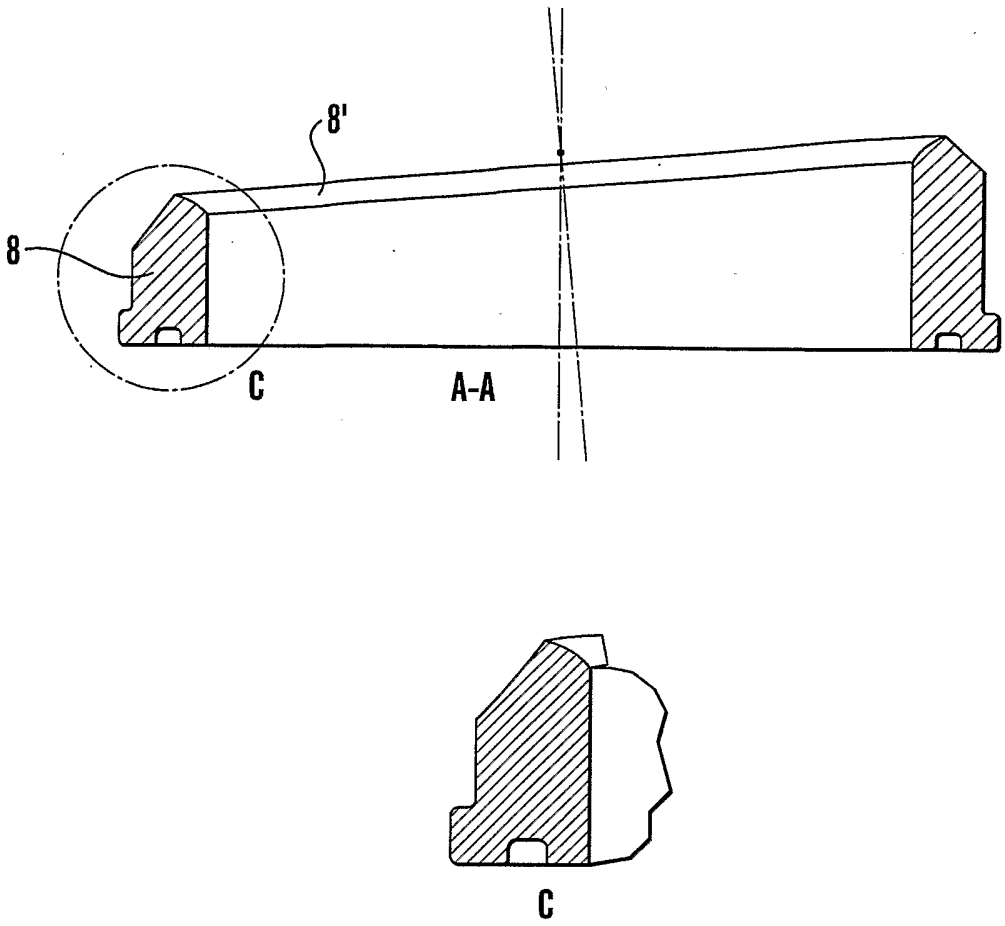
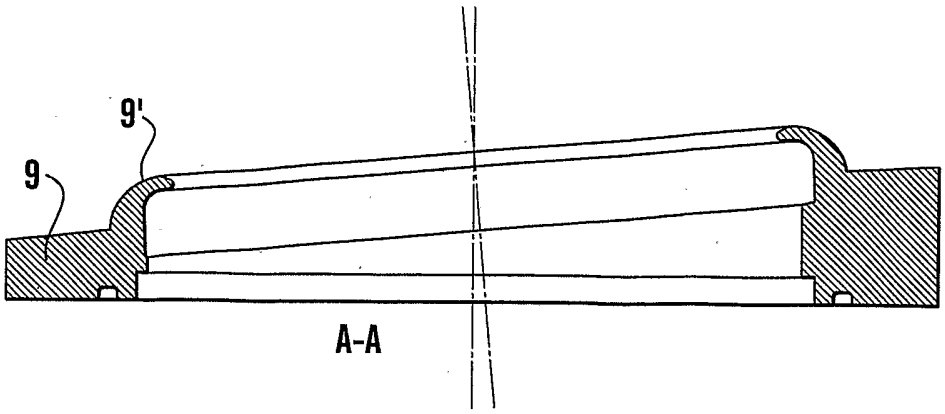
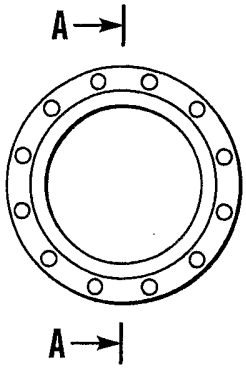
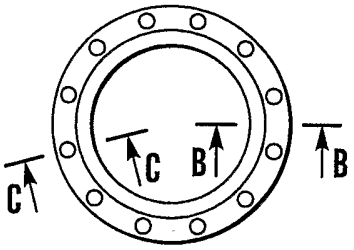
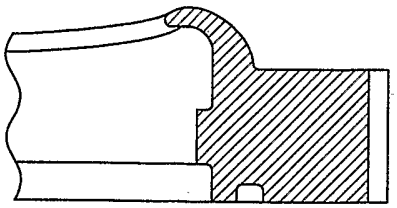


Fig.5









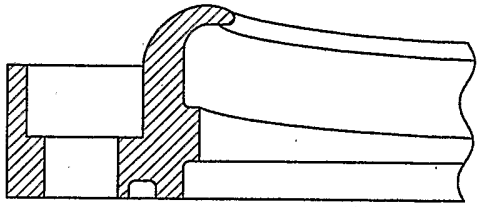


Fig.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 03/00223

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F16K 5/06 // F16K 5/20
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)

IPC7: F16K

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

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9114891 A1 (KLYDE, INGOLF), 3 October 1991 (03.10.91) --	
A	WO 0050792 A1 (KLYDE, INGOLF), 31 August 2000 (31.08.00) --	

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" 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 December 2003	15 -12- 2003
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Sune Söderling / JA A Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

Information on patent family members

31/10/03

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