United States Patent [19]

Wright

[11] **3,901,434**

[45] **Aug. 26, 1975**

[54] **NON-EXTRUDING LID SEAL FOR CENTRIFUGES**

[75] Inventor: **Herschel E. Wright,** Santa Clara, Calif.

[73] Assignee: **Beckman Instruments, Inc.,** Fullerton, Calif.

[22] Filed: **Oct. 10, 1973**

[21] Appl. No.: **405,085**

[52] **U.S. Cl.** **233/27;** 137/525; 277/29

[51] **Int. Cl.** **B04b 1/00**

[58] **Field of Search** ..... 277/29; 251/DIG. 1; 137/525; 233/1 A, 1 B, 20 R, 26, 27

[56] **References Cited**

UNITED STATES PATENTS

3,366,320 1/1968 Cho 233/26

FOREIGN PATENTS OR APPLICATIONS

983,178 2/1965 United Kingdom..... 251/DIG. 1

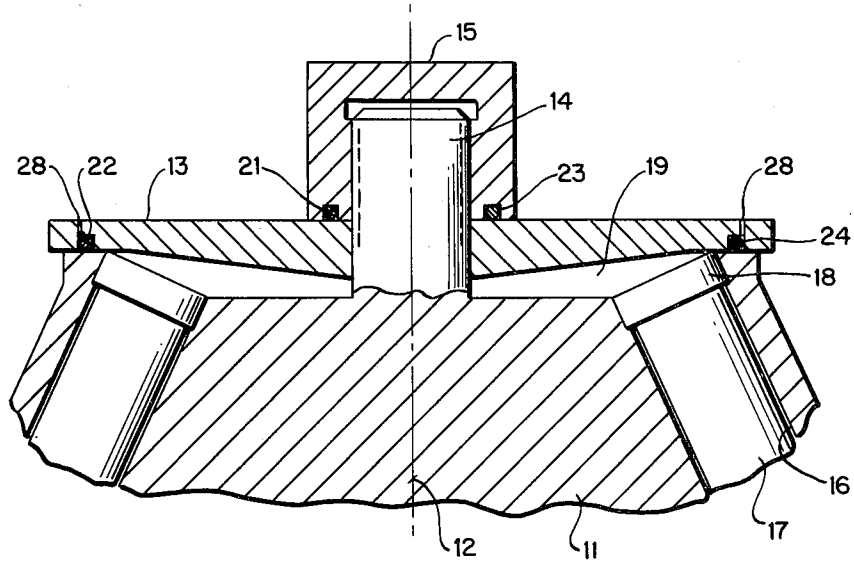
Primary Examiner—Robert I. Smith

Attorney, Agent, or Firm—R. J. Steinmeyer; F. L. Mehlhoff

[57] **ABSTRACT**

A centrifuge rotor having chambers for sample containers and a cover is formed with fluid release openings in the cover to form what amounts to a pressure relief valve. The release openings communicate with a seal-ring groove in the cover. This guards against possible expulsion of the seal ring from the seal-ring groove in the event that one or more of the containers should rupture so that the fluid escaping from the container, producing centrifugal force and fluid pressure acting upon the cover, should bend it up sufficiently to open a gap for expulsion of the sealing ring thereby permitting the fluid to escape. The provision of the fluid release openings communicating between the seal-ring groove and the exterior of the cover permits sufficient fluid to escape through the opening in the event of partial distortion of the sealing ring upon the bending of the cover to allow the cover to return to sealing condition and to retain the remainder of the fluid within the rotor.

6 Claims, 5 Drawing Figures



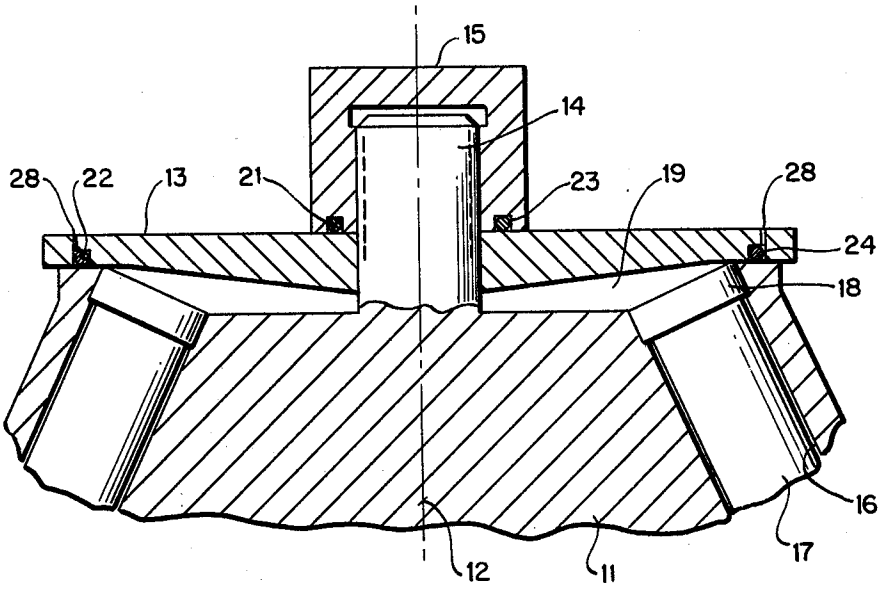


FIG. 1

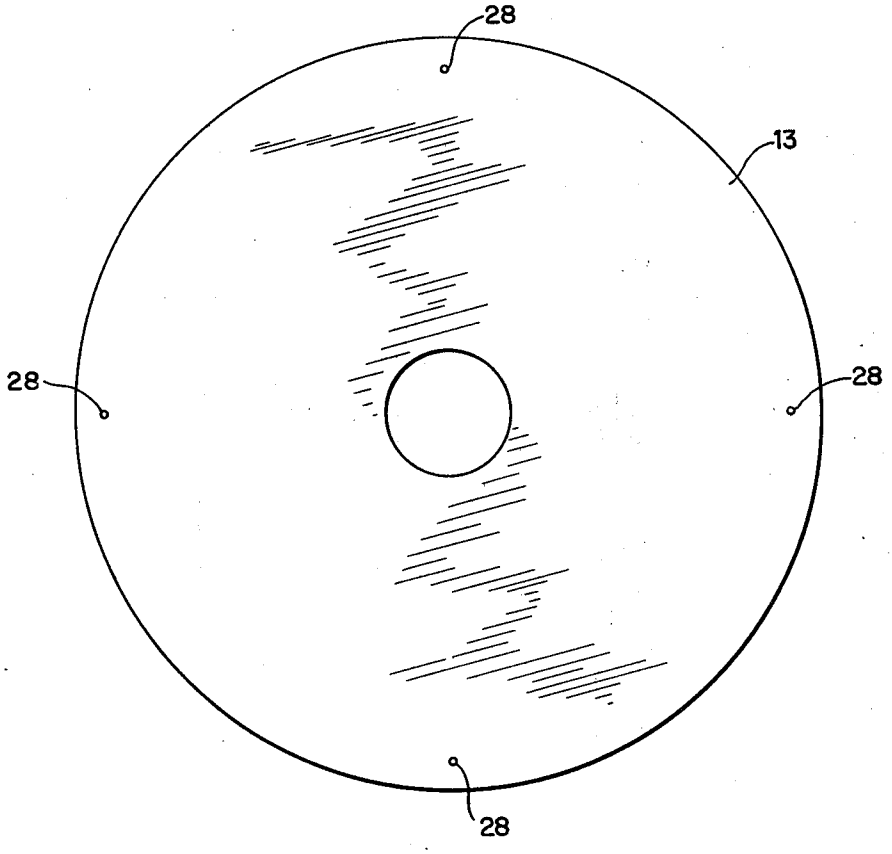


FIG. 2

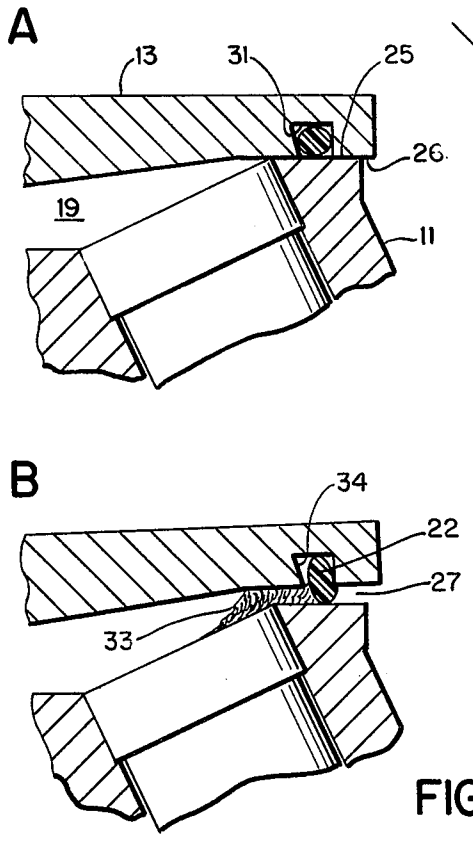


FIG. 3

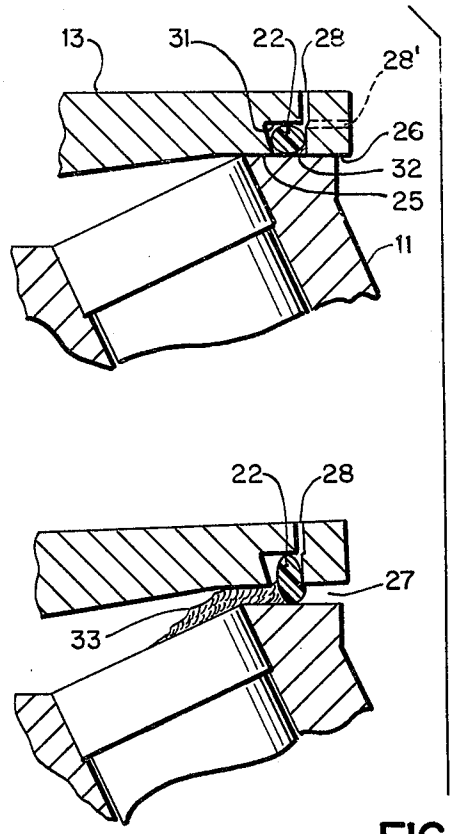
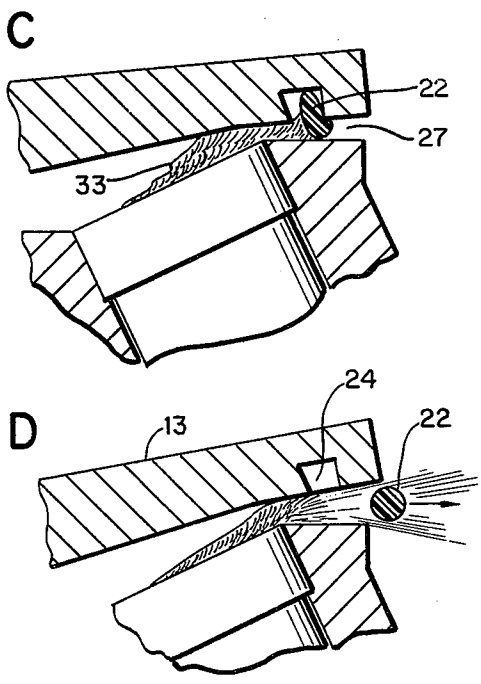
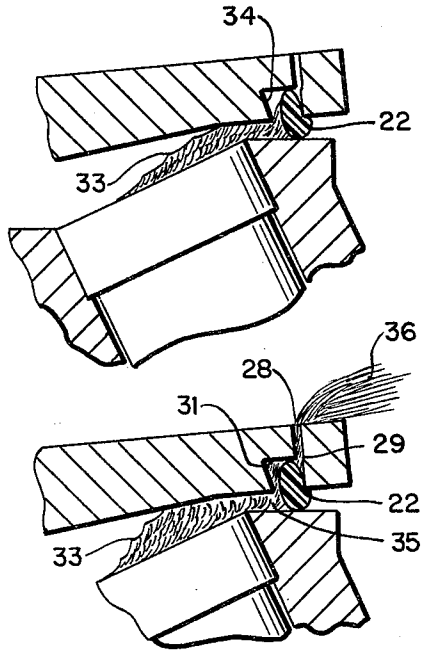


FIG. 4



PRIOR ART



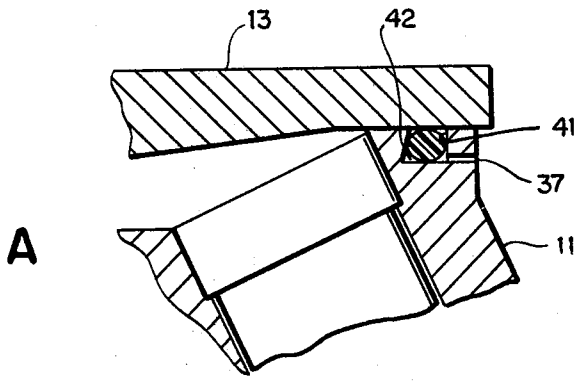
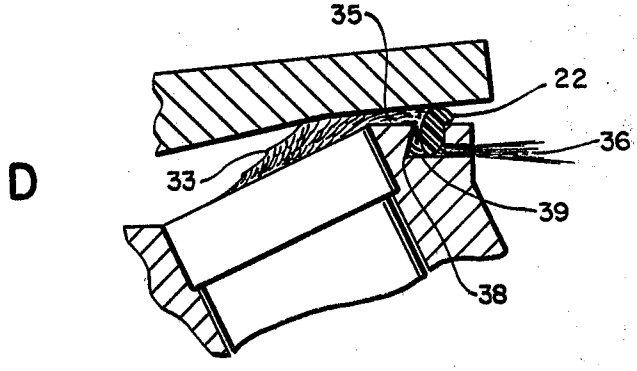


FIG. 5



NON-EXTRUDING LID SEAL FOR CENTRIFUGES

BACKGROUND OF THE INVENTION

Fixed angle centrifuge rotors have been provided with a body having cavities for sealed sample tubes and a lid for the body with a seal to isolate the interior of the rotor from the high vacuum environment of the centrifuge chamber. This isolation is desirable to prevent possible leakage of contents of the centrifuge tubes from contaminating the vacuum system if the contents are corrosive or infectious. Conventional lid seal systems have been satisfactory for preventing minor leakage but difficulties may arise in case of a gross leakage resulting from faulty tubes or improper assembly techniques.

In case of a gross leakage, the rotor lid flexes under the influence of increasing fluid pressure so that the lid may bend far enough away from the rotor body to open a gap large enough to permit the seal ring to be expelled from the rotor. In that event, at least the seal ring must be replaced, and at most it can cause severe rotor imbalance, permanent lid deformation and great difficulty in lid removal.

It is accordingly an object of the invention to overcome the difficulties of existing centrifuge constructions and to make the centrifuge in such a manner as to form a pressure sensitive relief valve which will release only sufficient fluid to permit re-establishment of contact of the seal ring in the seal ring groove after a build up of fluid pressure has caused the rotor lid and the body of the rotor to part somewhat, and to distort the seal ring partially.

Other and further objects, features and advantages of the invention will become apparent as the description proceeds.

SUMMARY OF THE INVENTION

In carrying out the invention in a preferred embodiment of a centrifuge rotor having a vertical axis of rotation, the rotor is generally formed in a conventional manner with a body having an interior adapted to hold, in inclined positions, sealed tubes of samples to be centrifuged and having a cover or lid for the body with a seal between the lid and the rotor body to prevent fluid from escaping from the rotor in case some defect should cause some leakage of fluid from one or more of the sample tubes. In conventional apparatus the seal consists of a deformable sealing ring in an annular sealing groove formed in the cover at the surface thereof which confronts a contiguous surface of the body of the rotor.

However, in accordance with the invention, one or more openings are provided from the intersection of the horizontal and outer vertical walls of the sealing ring groove to release some of the fluid in case of a gross leakage from the tubes permitting fluid to escape from the tubes to the interior of the body of the rotor. Release of some fluid relieves the pressure of fluid which has escaped from the sample tubes sufficiently to permit the gap between the cover and the body of the rotor caused by such fluid pressure to close again and to restore the sealing ring to its normal position in the groove to prevent expulsion of the sealing ring from its groove and to retain the remainder of the fluid in the interior of the rotor.

A better understanding of the invention will be afforded by the following detailed description considered in conjunction with the accompanying drawing.

DRAWINGS

In the drawings:

FIG. **1** is a fragmentary view of a section cut by a plane through the vertical axis of rotation of a fixed angle centrifuge rotor forming an embodiment of the invention;

FIG. **2** is a half, top plan view of the embodiment of FIG. **1**;

FIG. **3** is a series of diagrams fragmentarily illustrating the sealing ring portion of a conventional construction and illustrating the manner in which the sealing ring is expelled and the entire body of fluid in the interior of a centrifuge rotor is permitted to escape in the event that a gross leakage of fluid from a tube in the centrifuge should take place and exert fluid pressure and centrifugal force tending to pry up the cover of the rotor;

FIG. **4** is a series of diagrams corresponding to the diagrams of FIG. **3** illustrating the behavior of a centrifuge rotor constructed in accordance with the invention under the conditions represented in FIG. **3** and illustrating the manner in which pressure is relieved to prevent expulsion of the sealing ring and permit reclosure of the gap between the cover and the rotor body;

FIG. **5** is a pair of diagrams fragmentarily representing the sealing ring portion of the rotor in accordance with a modified embodiment of the invention.

Like reference characters are utilized throughout the drawing to designate like parts.

DETAILED DESCRIPTION

In a typical fixed angle centrifuge rotor, the rotor is formed with a body **11** having a vertical axis of rotation **12** and provided with a cover **13.** The body has an externally threaded stem **14** to receive an internally threaded handle **15** to secure the cover **13** upon the body **11.** The body has inclined chambers **16** for receiving tubes **17** of fluid samples to be centrifuged and the tubes **17** are provided with caps **18** which normally seal in the contents of the tubes **17.** There is some space in the interior of the body **11** above each sample chamber **16** and under the cover **13** to form a cavity **19** into which fluid from the tubes **17** may escape in the event that any of them should be defective or improperly mounted or the caps **18** should have defective seals.

In order to retain such escaping fluid in the interior of the rotor, there are sealing rings **21** and **22,** retained in annular grooves **23** and **24,** respectively.

The sealing rings serve to prevent escape of any fluid in the cavity **19** when there is a minor leakage from one or more of the tubes **17.** However, in the event of a gross leakage, sufficient centrifugal force and fluid pressure may build up under the cover **13** to bend up the outer edges and cause confronting faces **25** and **26** (shown in FIG. **3**) of the body **11** and the cover **13,** respectively, to part and form a gap **27** as shown in FIG. **3B.**

In accordance with the invention, the construction is arranged to provide means for discharging fluid until fluid pressure has been sufficiently relieved. In the embodiment of the invention illustrated in FIGS. **1, 2** and **4,** this is accomplished by providing holes **28** in the cover **13** extending to the exterior from the intersection

of the plane-surfaced wall **31**, perpendicular to the rotor axis of rotation **12**, and the cylindrical-surface outer wall **32** of the annular groove **24** which is concentric with the rotor axis of rotation **12**. This provides a discharge passageway from the peripheral groove **24** to the exterior of the rotor.

PRIOR ART OPERATION

The performance in a typical prior art construction when gross leakage of fluid from sample tubes builds up and a quantity of fluid is present in the cavity **19** is illustrated in FIG. **3**. If there is a sufficient body of fluid **33** which, being subject to centrifugal force, exerts a fluid pressure to pry the circumferential portion of the cover **13** upward, the confronting surfaces **25** and **26** part so that they are no longer contiguous as illustrated in FIG. **3A** and form a gap **27** as illustrated in FIG. **3B**. Fluid pressure acting upon the sealing ring **22** tends to deform it as illustrated in FIG. **3B**, pressing it away from the inside wall **34** of the groove **24**. If the body of fluid **33** builds up as illustrated in FIG. **3C**, there is still greater centrifugal force and fluid pressure so that the gap **27** becomes still greater and there is still further distortion of the shape in cross section of the sealing ring **22**. Then when the bending force upon the cover **13** has become sufficiently great, the surfaces **25** and **26** part to such an extent as to form a gap **27** of sufficient width that the force of the liquid on the sealing ring **22** causes the ring to be expelled instead of merely being partially extruded and the entire body of liquid **33** escapes from the rotor. This has several deleterious effects.

Not only is the body of liquid lost in the vacuum lines and is the centrifuge system subjected to the contamination or corrosion of the entire body of fluid, but the cover **13** may be warped or distorted to such an extent as to be permanently damaged. Moreover, there may be great difficulty in removing the cover **13** and at the very least a new sealing ring **22** must be installed. Still worse, the distortion of the rotor cover **13** may cause such serious imbalance of the rapidly rotating rotor as to damage the mountings or create a safety hazard.

OPERATION IN ACCORDANCE WITH THE INVENTION

The results of the presence of a body of leakage fluid **33** in a rotor having the relief passageway **28** is illustrated in FIG. **4**. Before the leakage of fluid **33** into the cavity **19** takes place, the confronting surfaces **25** and **26** are properly in contact, as illustrated in FIG. **4A**. Then upon the presence of leakage fluid **33**, as illustrated in FIG. **3B**, a parting of confronting surfaces again takes place and the sealing ring **22** is partially extruded into the gap **27** as a result of deformation thereof.

With a still greater mass of fluid **33**, as illustrated in FIG. **4C**, still greater distortion and extrusion of the sealing ring **22** take place. As in the case of FIG. **3C**, the sealing ring **22** is also pressed away from the inner wall **34** of the groove **24** so that sealing no longer takes place at this wall. Moreover, the sealing ring **22** also begins to be pulled away from the upper wall **31** of the groove **24**, thus breaking the seal between the ring **22** and the upper wall **31**. Consequently, as shown in FIG. **4D**, there is an open escape passageway for the body of fluid **33** from the gap **35** between the parted surfaces (but inward from the ring **22** which is still retained in the groove **24** because the confronting surfaces have not sufficiently parted to permit the expulsion of the ring **22**), the space between the ring **22** and the inner wall **34** of the groove **24**, the space between the ring **22** and the upper wall **31** of the groove, and the hole **28**.

Consequently, a small stream **36** of fluid is discharged. However, as soon as this occurs, the mass of fluid **33** is reduced, there is no longer sufficient centrifugal force and fluid pressure to cause the parting of confronting surfaces which resulted in the gap **35** so that the gap recloses and the confronting surfaces **25** and **26** are again in contact as illustrated in FIG. **4A**.

It will be observed that the discharge of fluid from the hole **28** has taken place before the gap **35** has become great enough to permit expulsion of the sealing ring **22**. Consequently, the sealing ring **22** is retained in the annular groove **24**; the seal by the ring **22** between the surface **25** of the body **11** of the rotor and the surfaces of the groove **24**, particularly in the upper wall **31** and the outer wall **32**, is restored so that there is again a complete seal between the cover **13** and the body **11**. Thus, a condition of equilibrium exists in which a maximum amount of fluid is retained in the rotor without the risk of the severe consequences associated with sealing systems not having the pressure relief means described. In this way, the construction described is basically a relief valve which is pressure sensitive. Fluid release may be provided either by the vertical openings **28**, or by radial openings **28'**.

By way of illustration an embodiment of the invention has been illustrated and described in which pressure relief is achieved by means of the holes **28** in the cover **13** extending to the exterior from the intersection of the upper and outer walls of the groove **24**. However, the invention is not limited thereto and does not exclude other means for providing such pressure relief. For example, as illustrated in FIG. **5A** and FIG. **5D**, one or more fluid release openings **37** may be provided in the peripheral walls of the rotor body **11** which extend from the intersection **38** of the lower wall **39**, perpendicular to the rotor axis of rotation, and the outer cylindrical wall **41** of an annular groove **42** formed in the surface **25** of the body **11**.

While certain embodiments of the invention have been fully illustrated and described, it will be obvious to those skilled in the art that various modifications and alterations may be made therein and it is intended to cover all such modifications and alterations as may fall within the spirit and scope of the invention.

What is claimed is:

1. In a rotating receptacle having a chambered rotor and a cover therefor, a fluid pressure and centrifugal force relieving seal comprising:

confronting peripheral portions of the rotor and the cover having confronting, normally contiguous, contacting surfaces, one of the members comprising the rotor and the cover having an annular groove at the confronting surface thereof, said groove having a first wall substantially parallel to the plane of the contacting surfaces and an outer cylindrical wall intersecting the first wall, the grooved member having a pressure-releasing hole extending to the exterior thereof from the intersection of said intersecting walls, and

a resilient deformable sealing ring in said groove of such cross-sectional dimensions as normally to lie tangent to walls of the groove in the grooved mem-

ber and to the confronting surface of the other member for sealing the confronting surfaces, whereby distortion of either of the members by fluid pressure or centrifugal force causing parting of the confronting surfaces of sufficient magnitude to distort the sealing ring out of tangency with either of the said groove walls opens said hole to permit release of sufficient fluid pressure to permit restoration of contact between said contiguous surfaces.

2. The seal defined in claim **1** wherein the pressure releasing hole extends radially.

3. The seal defined in claim **1** wherein the cover is the grooved member.

4. The seal defined in claim **1** wherein the cover is the grooved member and the pressure releasing hole extends parallel to the axis of rotation of the rotor.

5. The seal defined in claim **1** wherein the rotor is the grooved member.

6. The seal defined in claim **5** wherein the pressure releasing hole extends radially.

* * * * *