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[56]

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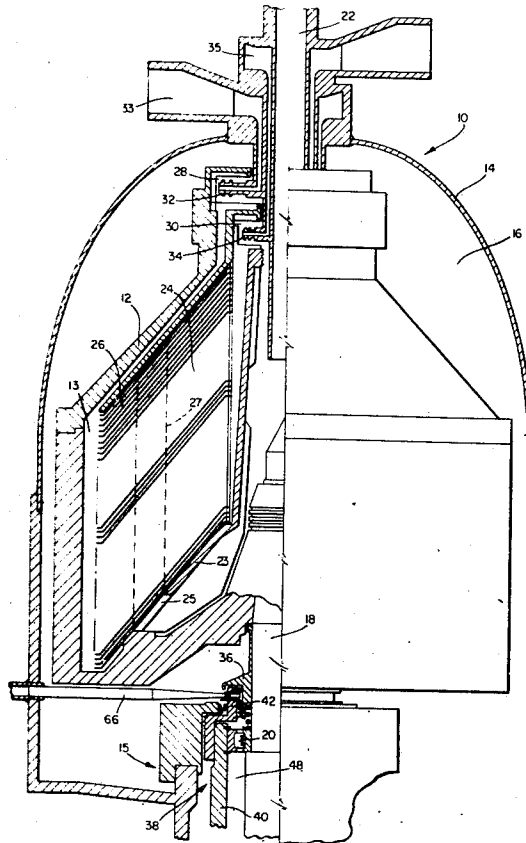
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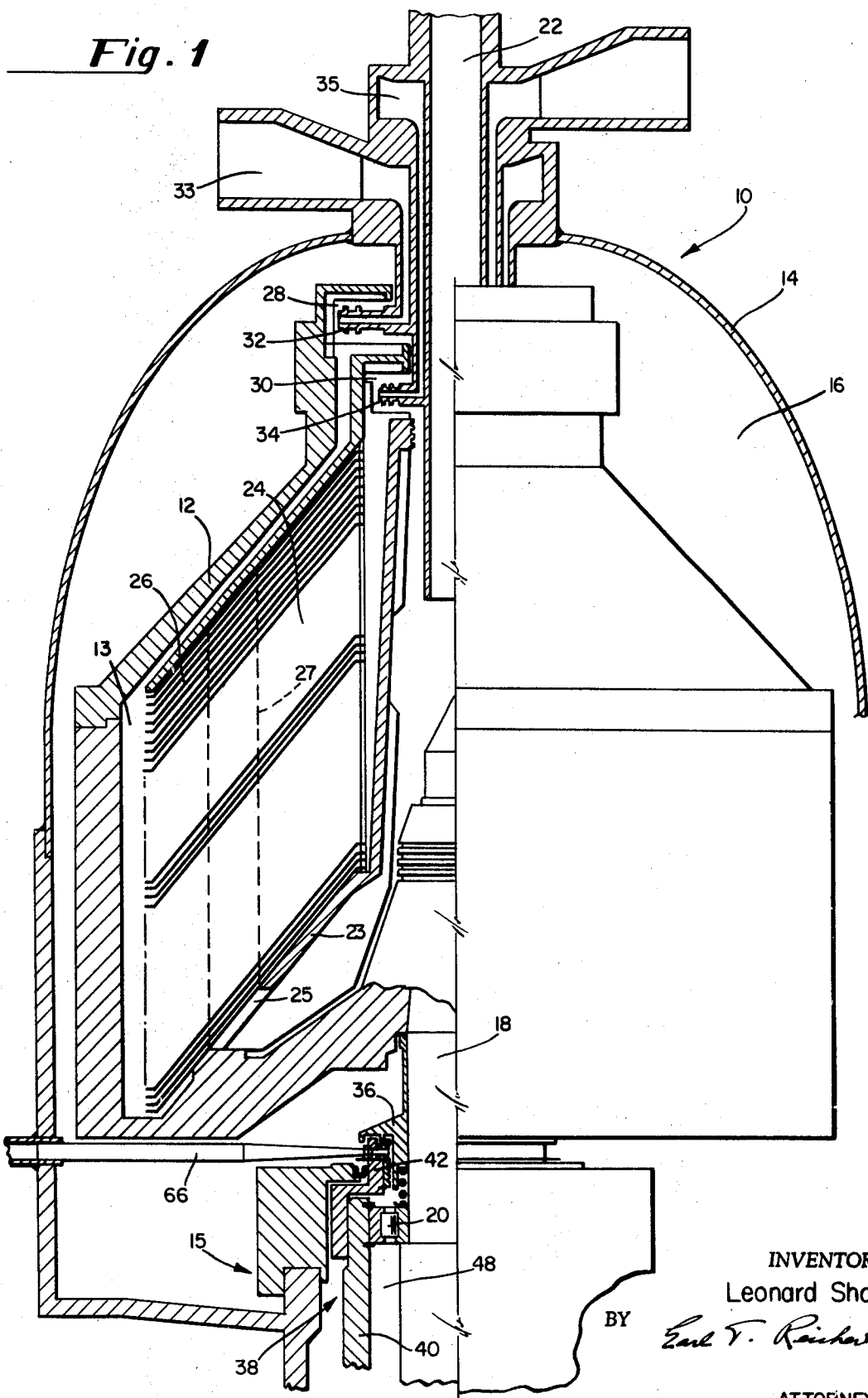
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[54] **CENTRIFUGE WITH SPINDLE-SEALING MEANS**
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ABSTRACT: A sealing structure is provided between a centrifuge bowl and its surrounding cover to prevent process fluids existing between the centrifuge bowl and the cover from vibrating lubricant surrounding the bearings for the main spindle.





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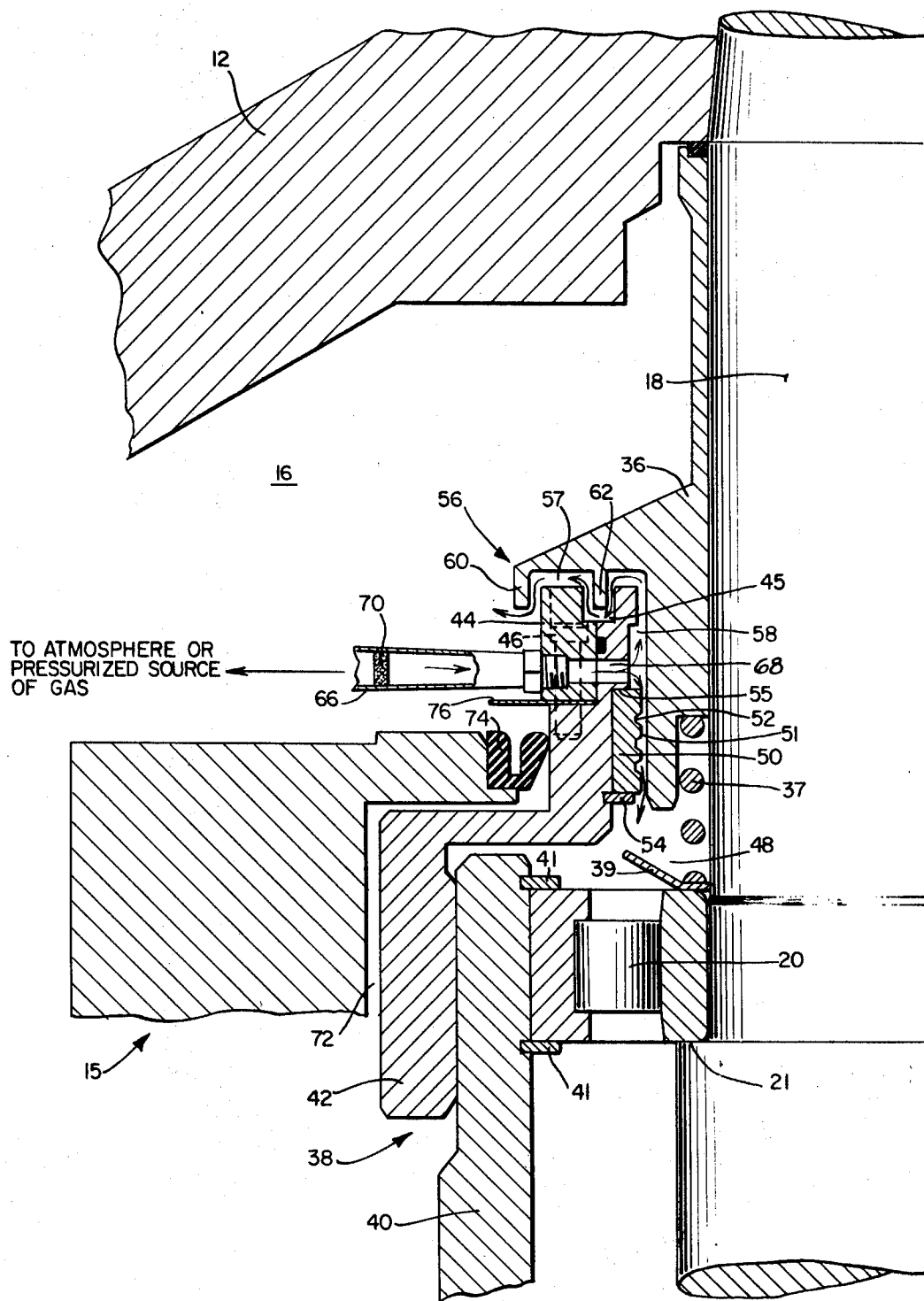


Fig. 2

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CENTRIFUGE WITH SPINDLE-SEALING MEANS

This invention relates in general to centrifuge apparatus. More particularly, the invention relates to spindle-sealing means for a centrifuge having a centrifuge bowl disposed within a cover, the bowl being rigidly connected to a spindle, which spindle is rotatably supported on spindle bearings contained with a spindle housing.

In the centrifuge art, feed is introduced via an inlet into a rotating bowl for separation; the centrifuge bowl generally contains multiple outlets for discharge of the separated materials. The separated materials are sometimes discharged into the space between the centrifuge bowl and the cover, from which space they are recovered by appropriate means. At other times, the separated materials are recovered from the centrifuge bowl by skimmer passages which either extend into the interior of the bowl, or into a channel disposed on the bowl.

One of the problems with such centrifuges is the prevention of interchange between process liquids and vapors existing between the bowl and cover, and the lubricating oil surrounding the spindle bearings contained within the spindle housing. Mechanical rubbing seals, clipper seals, and labyrinth seals are used with various degrees of success. Rubbing seals are expensive and are generally successful for a period of time, but after some wear, oil contaminates the process, or the process contaminates the oil, resulting in mechanical or process failure. Labyrinth and clearance seals are used, but it is extremely difficult to design these seals to effect positive separation between process components and the lubricating oil.

Accordingly, one of the primary objects of the present invention is to provide a centrifuge spindle seal which maintains positive separation between process components and the lubricating oil surrounding the spindle bearings.

Another object of the present invention is to provide a centrifuge spindle seal which minimizes the problem of wear.

Another object of the present invention is to provide a centrifuge spindle seal which is relatively inexpensive and of relatively simple design.

Another object of the present invention is to design a centrifuge spindle seal which returns to the spindle-bearing chamber any lubricating oil tending to escape therefrom.

Another object of the present invention is to provide a centrifuge spindle seal which prevents leakage from a space by pumping into said space.

Another object of the present invention is to provide a centrifuge spindle seal which prevents communication between a first space and a second space by providing a third space therebetween, with means on each side of the third space for pumping therefrom into the first space and the second space.

Another object of the present invention is to provide a centrifuge spindle seal which prevents communication between a first space and a second space by providing a third space therebetween, the pressure within the third space being higher than that in either the first or the second space.

Accordingly, the present invention seeks to accomplish the above objects by providing a centrifuge spindle seal which isolates the space between the centrifuge bowl and the cover from the space within the spindle bearing chamber, by providing a first seal adjacent to the spindle bearing chamber which returns to the bearing chamber any lubricating oil tending to escape therefrom, a second seal adjacent to the space between the centrifuge bowl and the cover, the second seal tending to pump into the space between the bowl and the cover, and a vented equalizing chamber between the two seals.

The various objects, features and advantages of the invention will appear more fully from the detailed description which follows, taken in connection with the accompanying drawings in which:

FIG. 1 is a view, partly in section, of a disc-type centrifuge embodying the present invention;

FIG. 2 is a longitudinal sectional view on an enlarged scale showing an embodiment of the invention in detail.

Referring to FIG. 1 of the drawings, it can be seen that the present invention is illustrated as being embodied in a disc-type centrifuge. This disc-type centrifuge is designated generally by the numeral 10, and includes a centrifuge bowl 12 disposed within a cover 14, the bowl 12 and cover 14 defining a space 16 therebetween. The cover 14 is supported on housing structure designated generally by the numeral 15. The bowl 12 is rigidly connected to a spindle 18 adapted to rotate about a vertical axis, the spindle 18 being rotatably supported at its lower end by spindle bearings 20. Extending into the upper end of the centrifuge bowl 12 is an axially extending feed passage 22. This feed passage 22 is utilized for introducing the liquid mixture to be separated into a separation chamber 13 within bowl 12.

Disposed in the lower portion of the bowl 12, and extending outwardly away from the axis of rotation, is a feed distribution skirt 23 having feed openings 25 disposed therein. Surrounding the feed passage 22, and disposed above the skirt 23, is a stack 24 of conical discs 26. The stacked discs 26 are spaced in vertical relation to each other, and are arranged so that the feed openings 27 in each disc are vertically aligned with the feed openings 25 of the skirt 23.

Disposed at the upper end of the centrifuge bowl 12 are two annular channels 28 and 30. Extending into the annular channels 28 and 30 are two stationary skimmer discharge passages 32 and 34. These skimmer discharge passages 32 and 34 receive each of the separated liquids confined within the channels 28 and 30 for delivery to outlet passages 33 and 35 respectively.

The theory of operation of a disc-type centrifuge is well known in the art, and forms no part of the present invention. The operation, briefly described, is as follows: The process feed stream, or liquid mixture to be separated, is introduced into the rotating centrifuge bowl 12 through the feed passage 22, and enters the feed openings 27 as indicated by the arrow in FIG. 1. The mixture passes upwardly through the discs 26 via the openings 27. Through the openings 27, the mixture is introduced successively into the separating spaces between adjacent discs. The action of the centrifugal force effected by the rotation of the bowl 12 separates the liquid mixture into a light liquid phase and a heavy liquid phase. The light liquid phase passes inwardly toward the axis of rotation along the upper surface of each disc until it reaches the inner edge of the disc from where it is directed upwardly into the annular channel 30. The heavy liquid phase passes outwardly away from the axis of rotation along the underside of each disc until it reaches the outer edge of each disc where it is directed upwardly into the annular channel 28. The dynamic pressure of the rotating liquid within each of the channels 28 and 30 promotes the flow of the separated liquids within the channels through the skimmer discharge passages 32 and 34, and into the discharge outlets 33 and 35 respectively.

As stated above, one of the problems with these centrifuges is the prevention of interchange between process liquids and vapors which may exist within the space 16, and the lubricating oil which surrounds the spindle bearings 20. The present invention provides means for maintaining positive separation between the lubricating oil surrounding the spindle bearings 20, and the process components within the space 16.

Referring to FIG. 2, it can be seen that a sleeve member 36 is disposed adjacent to the underside of the bowl 12, the sleeve member surrounding the spindle 18 and mounted to rotate therewith. The sleeve member 36 is biased toward the bowl 12 by a spring 37, the spring 37 abutting an annular spring retainer 39. The spring 37 also serves to bias the spindle bearings 20 toward the shoulder 21 of the spindle 18. Supported by the housing structure 15 is a spindle housing designated generally by the numeral 38. The spindle housing 38 is comprised of three annular members 40, 42, and 44. It is noted that the annular member 44 is secured to member 42 by means of bolts 46, the members 42 and 44 together defining an annular channel 45. Annular member 40 has annular retaining rings 41 disposed therein for confining the spindle bearings 20 therebetween. It can be seen that the spindle

housing 38, together with spindle 18 and the sleeve member 36, defines generally a bearing chamber 48, which bearing chamber contains the lubricating oil for the bearings 20.

Mounted between the sleeve member 36 and member 42 is a seal, or annular sealing member 50, having spiral grooves 52 machined therein. It is noted that the sealing member 50 is securely locked in place on the member 42 between a retaining ring 54, and the shoulder 55 of the annular member 42. The seal 50 is mounted so that there will be no relative motion with respect to the member 42 of the spindle housing 38. Thus, during operation of the centrifuge, the spindle 18 is rotating at a high relative speed with respect to both the entire spindle housing 38 and the sealing member 50. A seal, such as indicated at 50, having spiral grooves 52 machined therein, is sometimes referred to as a visco seal, and is capable of sealing against relatively high pressures. Due to the high relative rotational speed between the sleeve member 36 and the seal 50, any oil trapped in the radial clearance 51 between the seal 50 and the sleeve member 36 is driven back into the bearing chamber 48.

A visco seal such as seal 50 tends to pump into the spindle housing or bearing chamber 48 any vapor or fluid that enters on its opposite side. For this reason a labyrinth seal or pumping means, designated generally by the numeral 56, is disposed between the space 16 and the seal 50, thus defining an annular chamber 58 between the labyrinth seal 56 and the seal 50. The labyrinth seal 56 is comprised of two annular axially extending flanges 60 and 62 which cooperate with the spindle housing 38 and the annular groove 45 to define a labyrinth 57 therebetween. The purpose of the labyrinth seal is to create a slight vacuum in the chamber 58 to compensate for the tendency of the seal 50 to pump from the chamber 58. This vacuum is effected by the relative rotation between the sleeve member 36 and the spindle housing 38.

In order to keep this vacuum from being too high, a closed line 66 connects the chamber 58 to the atmosphere via a passage 68 within the spindle housing 38. This closed line 66 is connected between the chamber 58 and the outside of the centrifuge cover 14 (see FIG. 1). The gas that is pumped into the chamber 58, and ultimately into bearing chamber 48 and space 16, is from the outside of the centrifuge, and is therefore free from contaminants. A filter 70 can also be provided within the line 66 to prevent airborne solids or liquids from being brought in from the outside atmosphere. Thus, clean gas is pumped into the space 16 between the bowl 12 and the centrifuge cover 14 by the labyrinth seal 56, and is pumped into the bearing chamber 48 by the seal 50, and therefore causes no damage within the centrifuge 10. An alternative to this system is to connect the closed line 66 to a pressurized source of filtered gas or air. This permits the presence of even a positive pressure in the space 16 and still prevents liquids or vapors from reaching the lubricating oil in the bearing chamber 48. The radial clearance 51, and the clearance within the labyrinth 57 are each very slight (exaggerated in the drawings), but are such that a gas encounters more resistance in flowing through the clearance 51 than through the labyrinth 57.

During the operation of the centrifuge 10, there is no relative rotation between the housing structure 15 and the spindle housing 38. However, radial motion does occur and in order to prevent process liquids and vapors existing within the space 16 from reaching the space 72, between the housing structure 15 and the spindle housing 38, a clipper seal 74 is disposed therebetween. This clipper seal 74 is made of an elastomeric material which expands and contracts with the radial motion between the housing structure 15 and the spindle housing 38, thus preventing any liquids or vapors existing within the space 16 from reaching the radial clearance 72. Disposed adjacent to the clipper seal 74 and secured between members 44 and 42 is a splash guard 76. This splash guard 76 serves to prevent process components within the space 16 from directly contacting the clipper seal 74 by diverting it away from the same.

Thus, it can be seen that the above arrangement maintains a positive separation between process liquids and vapors existing within the space 16 and the lubricating oil in the bearing chamber 48. Seal 50 and labyrinth seal 56 each pump away from the chamber 58, thus completely isolating space 16 from the bearing chamber 48. Only atmospheric air or positively pumped gas entering through the closed line 66 will enter space 16 or bearing chamber 48. This being either filtered gas or clean air from the outside of the centrifuge, it will have no harmful effects on either the separation process in operation, or upon the lubricating oil in the bearing chamber 48. The problem of wear between the seal 50 and the sleeve member 36 is minimized because any oil tending to get into the radial clearance between the two is returned to the spindle bearing chamber 48 due to the pumping action effected by the spiral grooves 52 and the relative rotation between the seal 50 and the sleeve member 36.

Although I have described my invention with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example, and that numerous changes in the details and construction, and combination and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed. For example, although the invention is disclosed as embodied in a disc-type centrifuge, it is equally applicable in any centrifuge where a potential problem exists concerning interchange between the process components existing between the centrifuge bowl and the cover and the lubricating oil surrounding the spindle bearings.

What is claimed is:

1. In a centrifuge:
 - a. a cover;
 - b. a centrifuge bowl having a separation chamber disposed therein, said centrifuge bowl having inlet and outlet means adapted to admit a feed mixture into said separation chamber and discharge a separated material therefrom, said centrifuge bowl being disposed within said cover and defining a first annular space between adjacent surfaces of said cover and said bowl;
 - c. spindle means connected to said centrifuge bowl, said spindle means being adapted to rotate about its longitudinal axis;
 - d. a spindle housing surrounding a portion of said spindle means and defining a second annular space between adjacent surfaces of said spindle means and said spindle housing;
 - e. sealing structure comprising an annular sealing member disposed between said spindle means and said spindle housing whereby said second annular space is divided into a first annular zone and a second annular zone, and means disposed between said second annular zone and said first annular space for pumping from said second annular zone into said first annular space.
2. The combination claimed in claim 1, including passage means for admitting gas into said second annular zone.
3. The combination claimed in claim 1, in which said means for pumping from said second annular zone into said first annular space comprises an annular flange and a cooperating annular groove adapted to rotate with respect to each other, said annular flange and said annular groove being disposed on said spindle means and said spindle housing.
4. The combination claimed in claim 3, in which said sealing member has spiral grooves disposed therein for pumping from said second annular zone into said first annular zone.
5. The combination claimed in claim 4, including passage means for admitting gas into said second zone.
6. The combination claimed in claim 5, including filter means disposed within said passage means for filtering said gas.
7. The combination claimed in claim 6, in which said annular flange is projected from said spindle means in a direction parallel to said longitudinal axis.

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8. The combination claimed in claim 7, wherein said spindle means comprises a spindle and a sleeve member surrounding said spindle, said annular flange being disposed on said sleeve member, and said annular sealing member is disposed between said spindle housing and said sleeve member.

9. The combination claimed in claim 8, including housing structure, said spindle housing being disposed adjacent to said housing structure, and defining a third annular space between adjacent surfaces of said spindle housing and said housing

structure, a clipper seal disposed between said spindle housing and said housing structure for sealing said first annular space from said third annular space.

10. The combination claimed in claim 1, in which said annular sealing member has spiral grooves disposed therein for pumping from said second annular zone into said first annular zone.

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