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Gulley

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[54] **CENTRIFUGE**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **233/28,** 233/1 A

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

[58] **Field of Search** ..... 233/46, 1 A, 12, 233/14 R, 14 A, 21, 22, 27, 28, 3, 16

[56] **References Cited**

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[57] **ABSTRACT**

A fluid feed head for supplying fluid to and removing fluid from a rotating centrifuge rotor, comprising two coaxial rotating feed tubes one of which is subjected to the axial sealing forces of the head whilst being substantially isolated from the torsional forces between the rotor and head and the other of which tubes is mounted so as to be held against rotation with respect to the rotor and the rotary portion of the head whilst being movable axially.

7 Claims, 4 Drawing Figures

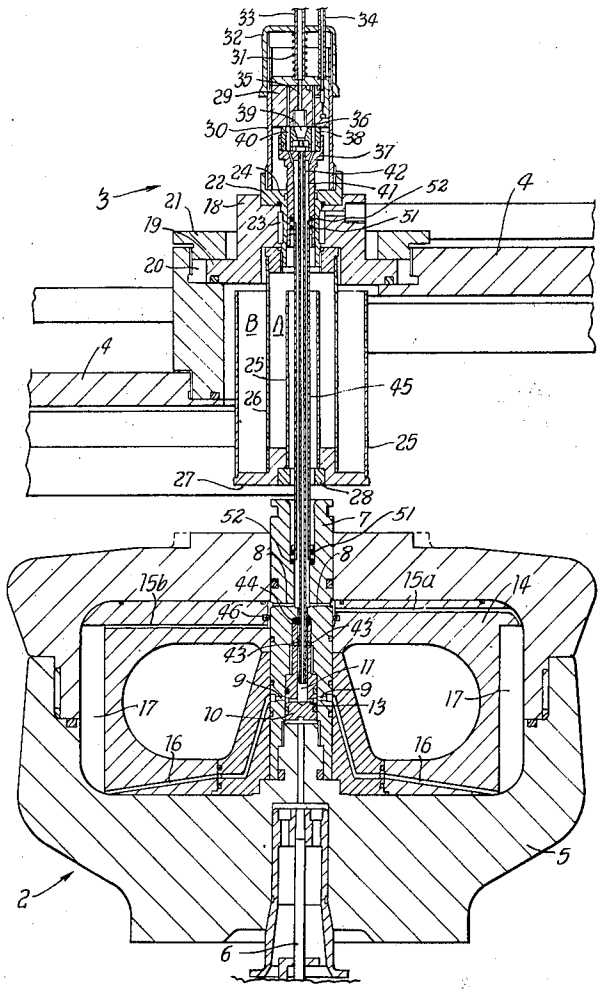


FIG.1

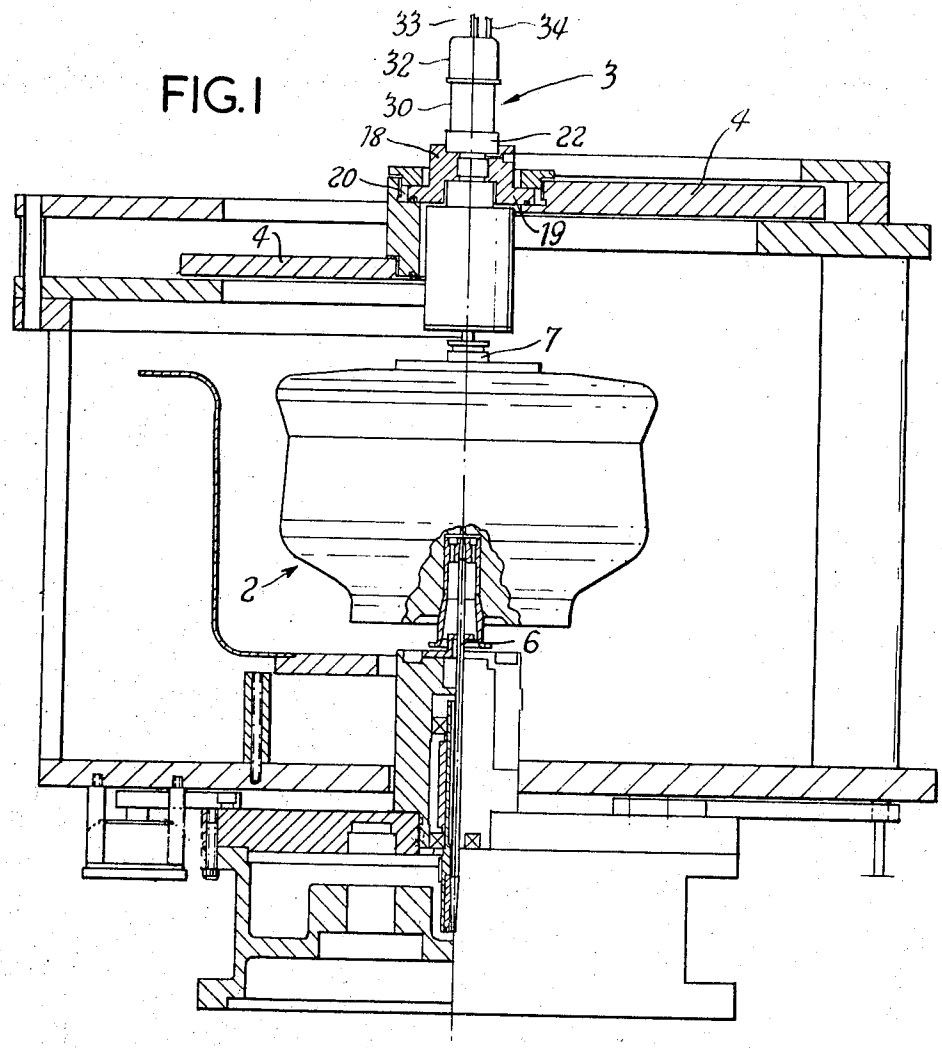


FIG.3

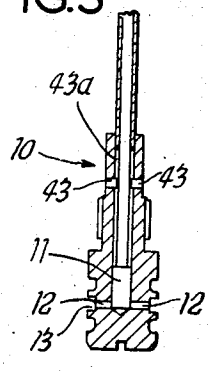


FIG.4

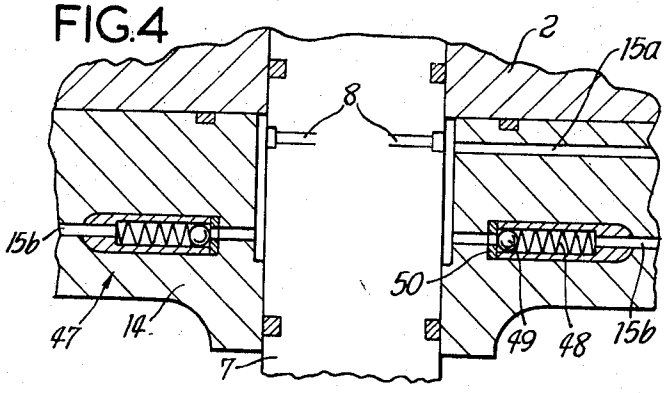
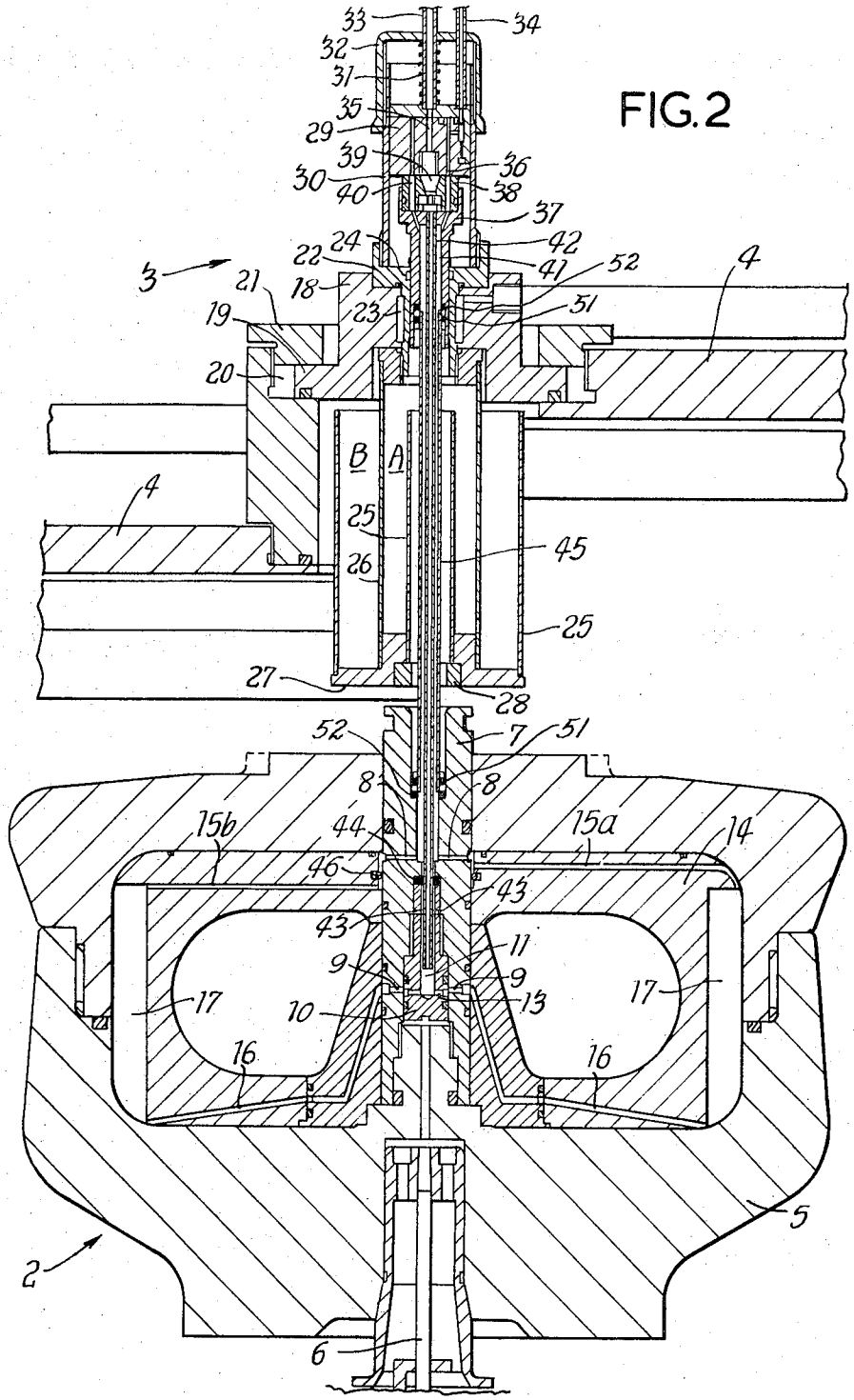


FIG.2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CENTRIFUGE

BACKGROUND TO THE INVENTION

This invention relates to fluid feed heads for supplying fluid to and removing fluid from rotating centrifuge rotors, and is particularly applicable to such heads for zonal centrifugation and centrifugation under a vacuum.

A conventional zonal centrifuge head is designed to feed fluid to and from a centrifuge zonal rotor during rotation and incorporates various seals including a rotating seal to maintain sealing between the stationary and rotating parts of the head. The rotating parts are fixed relative to each other and to the rotor and cooperate with a stationary part by the rotary, face-to-face, seal. By virtue of this construction, vibrations set up during operation are transmitted to the seals and impair their performance.

It is an object of the present invention to reduce the effect of vibrations.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a fluid head for supplying fluid to and removing fluid from rotating centrifuge rotors, the head comprising two relatively rotatable and sealable portions, one being intended to be held stationary and the other being intended to rotate with a rotor, and said other, rotatable, portion carrying two feed tubes for feeding material to and from a centrifuge rotor, characterised in that one of said tubes is axially clampable, so as to be subjected to the axial sealing forces between said head portions whilst being rotatable relative to at least one of the rotor and said rotatable portion, and in that the other tube has coupling means so that it will rotate with, and be movable axially relative to at least one of, the rotor and said rotatable portion so as to transmit torsion forces between the rotor and the head.

In a preferred embodiment, for operation under a vacuum, said one tube coaxially surrounds the other.

Said other tube may be formed for splined or equivalent coupling, such as by a pin and slot coupling, with the rotor and/or the head. Thus, the region of said other tube to engage a rotor may be formed with a slot or pin as the case may be and the rotor, or a coupling member secured to the rotor, may be formed with a corresponding pin or slot.

Advantageously such a coupling member, when provided, will be formed with passages to transfer fluid between the tubes and the interior of the rotor.

Said one tube will advantageously have a friction coupling with a rotor and/or the head to relieve that tube of substantially all torsional stress should the rotor and head momentarily undergo a relative angular movement. The friction coupling may be provided by seals positioned to seal the joints made between that tube and the rotor and the rotatable head portion.

DESCRIPTION OF THE FIGURES

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawing in which:

FIG. 1 is a cross-section of a centrifuge having a continuous flow head;

FIG. 2 is a cross-section of the head and rotor shown in FIG. 1;

FIG. 3 is a cross-section of a fluid transfer plug of the head of FIG. 2; and

FIG. 4 shows a modification of the head of FIG. 1.

FIGS. 1 and 2 are cross-sectional views of a centrifuge and its flow head respectively, showing at the left hand side one form of centrifuge and head and at the right hand side a modified form illustrating the change necessary to allow for differing distances between top of rotor and underside of lid. The following description applies to both forms.

The illustrated centrifuge comprises a vacuum enclosure **1** containing a rotor **2** coupled to a continuous flow head **3** mounted on the movable cover **4** of the enclosure **1.**

The rotor comprises a main body **5** releasably supported on a motor driven shaft **6.** A rotor core member **7** is supported axially by the body **5** and contains feed passages **8** and **9.** The member **7** contains a fluid transfer plug **10** illustrated in cross-section in FIG. **3.** The plug **10** has an axial feed passage **11** communicating by radial passages **12** with a fluid transfer annulus **13** into which the passages **9** open. O-rings are placed at each side of the annulus to form a seal with the core member **7.** The member **7** is surrounded by a hollow member **14** containing feed passages **15***a* and **15***b* communicating with the passages **8** and feed passages **16** communicating with the passages **9.** A centrifuge chamber **17** is defined between body **5** and the member **14.** The passages **15***a* open at the upper outer region of the chamber **17,** the passages **15***b* open at the upper inner region of the chamber **17** and the passages **16** open at the lower inner region of the chamber. The chamber **17** contains septa dividing it into segments.

The head **3** comprises a rotatable portion and a static portion, the static portion defining first feed passages **36** and a second passage **35.**

The static portion comprises a flanged cylinder **18** mounted in a recess **20** formed in the cover **4** or a member secured thereto, the cylinder **18** being held in the recess by an annular member **21.** The lower flange **19** of the cylinder **18** is movable in the recess **20** during assembly to allow the head to be aligned with the rotor **2.** A static bearing sleeve **22** is fitted in the cylinder **18** and contains a water cooling annulus **23** and an oil lubrication annulus **24.** To the bottom of sleeve **22** is fitted an oil drain reservoir comprising concentric tubes **25,** separated by a supporting tube **26,** and a bottom plug **27.** The tube **26** has apertures for oil drainage from volume A to volume B. The plug **27** contains a plastics ring **28.**

The static portion also comprises a sealing pressure member **29** contained in a retaining tube **30** screwed to the static bearing member **22.** The sealing pressure member **29** is held under pressure against the rotatable portion of the head by a spring **31** retained and controlled by a cap **32** screw-threaded to the tube **30.** The sealing pressure member **29** carries feed tubes **33** and **34,** the tube **33** opening into said axial feed passage **35** in the member **29** and the tube **34** communicating with an annular array of said passages **36** in the member **29.**

The rotatable portion of the head comprises a rotatable bearing member **37** rotatably mounted in member **22** with cylindrical bearing surfaces of the members **22** and **37** engaging one another. The member **37** supports a rotating seal **38** formed, for example, of a plastics material, such as Rulon. The seal **38** contains an axial passage **39** communicating at one end with passage **35** and

passages 40 communicating at one end with the passages 36, the passages 39 and 40 opening at their other ends into the rotatable bearing member 37.

A tube 42 is fixedly secured coaxially within member 37 at its upper end to define through the member 37 a first passage communicating with tube 33 and a second passage 41 coaxially surrounding the tube 42 and communicating with the tube 34. The tube 42 extends into the transfer plug 10 and its lower end is formed with slots 43*a* engaged by inwardly extending pins 43 (FIG. 3) of the plug 10. Thus, torque can be transmitted by the tube 42 from the rotor to the bearing member 37, whilst longitudinal stress on the tube 42 is negligible as the tube 42 is axially movable relative to the rotor. An O-ring seal 44 seals the tube 42 relative to the core member 7.

The annular passage surrounding tube 42 in the bearing member 37 is connected to the rotor by a tube 45, the ends of which are formed with annular projections each containing an annular recess housing a sealing means in the form of an O-ring 51 which, together with further sealing means in the form of compressed O-rings 52 abutting the annular projections, seal the passage defined by the tube 45 from the space within the vacuum enclosure. It will be apparent that this tube 45 is subjected compressively to the axial sealing forces of the head whilst at the same time being relieved substantially entirely of torsion stress, which is taken up by the tube 42. By virtue of the frictional engagement between the tube 45 and the core 7 and bearing member 37, the tube 45 can rotate relative to the core 7 and bearing member 37 if the tube 42 is torsionally deformed.

The construction illustrated is assembled and operated as follows.

Firstly, the rotor is put in position on the shaft 6 and the cover 4 is slid to its final position. The cylinder 18, with bearing member 22, is then placed in the illustrated position and annular member 21 is screwed into the recess 20 to retain the flange 19. When it is seen that the bearing member 22 is aligned coaxially with the rotor, the annular member is tightened up to clamp the flange 19.

The rotatable bearing member 37 with the tubes 42 and 45 attached thereto is then positioned in member 22, causing tube 42 to pass through O-ring 44 and engage the pins 43. At this stage, the tube 45 will be held by O-rings at its ends, the O-rings at the upper end being a tighter fit than those at the lower end so that tube 45 will be released with the bearing member 37 when the latter is removed.

The seal 38 is then positioned on the rotatable bearing member 37 and the pressure member 29 is placed on the bearing member 37. The retaining tube 30 is screwed into position and the spring 31 and cap 32 added to complete the head. The cap 32 is screwed down to apply the desired sealing pressure, which compressively stresses the tube 45 but not the tube 42.

In operation, a vacuum is produced in the enclosure 1 and the rotor is run up to a relatively low speed. Liquid, such as water, is then pumped through tube 33 and fills the rotor chamber 17, displacing air through passages 15*a*, passages 15*b* being blocked at this speed from passages 8 by an O-ring valve 46.

The rotor speed is then increased to open valve 46 centrifugally, displacing air trapped in passages 15*b*.

The speed is then reduced to close valve 46 and a liquid having a density gradient of predetermined volume is fed light end first through passage 34 to chamber 17 via passages 15*a*, this liquid displacing water from chamber 17 through passages 16 to tube 33.

The rotor speed is then increased to open valve 46 centrifugally and a sample in a carrier is fed through tube 33. The carrier flows from passages 16 along the surface of the rotor member 14 and through passages 15*b* to the tube 34. The sample particles migrate radially across the chamber according to their densities. The sample particles may be removed by slowing the rotor to close valve 46 and by passing a dense solution along tube 34 via passages 15*a*, displacing sample via passages 16 and out of tube 33.

With a modified rotor construction, a sample may be continuously fed into and out of the rotor at high speed and under vacuum.

FIG. 4 shows a valve arrangement 47 which may be found to be preferable to O-ring valve 46. The valve arrangement comprises a ball 49 urged by a spring 48 onto a seating 50. When the centrifugal force has reached a certain design level, balls 49 are lifted off their seatings 50 to interconnect passages 8 and 15*b*.

I claim:

1. A centrifuge arrangement having a rotor and a fluid feed head for supplying fluid to and removing fluid from said rotor whilst the rotor rotates, the head comprising:

a first, stationary, portion defining first and second passages; a second portion rotatable with said rotor;

sealing means for effecting a rotary seal between said first and second portions;

a first tube providing a feed path between said first passage and said rotor and being axially clamped so as to be subjected to the axial sealing forces of said sealing means whilst being rotatable relative to at least one of said rotor and said second portion;

a second tube providing a feed path between said second passage and said rotor; and

mounting means of said second tube holding said second tube against rotation relative to said rotor and said second portion whilst permitting axial movement of said second tube relative to one of said rotor and said second portion.

2. An arrangement as claimed in claim 1, wherein said second tube extends within said first tube.

3. An arrangement as claimed in claim 2, wherein said mounting means comprises a pin and slot coupling.

4. An arrangement as claimed in claim 1, and comprising a fluid transfer member attached to said rotor for transferring fluid between said rotor and said tubes.

5. An arrangement as claimed in claim 3, and comprising a fluid transfer member attached to said rotor for transferring fluid between said rotor and said tubes, said pin and slot coupling acting between said fluid transfer member and said second tube.

6. An arrangement as claimed in claim 2, and comprising sealing means sealing said first tube relative to said rotor and said second portion and permitting rotation of said first tube relative to at least one of said rotor and said second portion.

7. An arrangement as claimed in claim 1, and comprising cylindrical bearing surfaces by which said second portion is rotatably mounted relative to said first portion.

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