

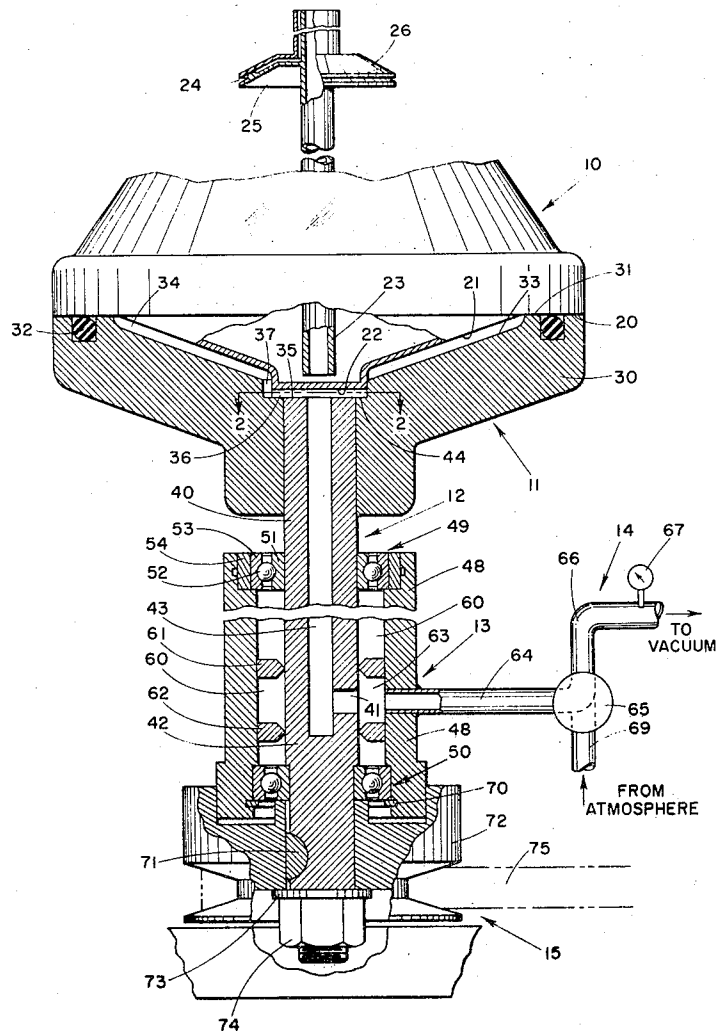
- [58] **Field of Search**233/1 B, 1 R, 1 A, 1 C, 23 A,
233/23, 24, 21, 11, 26; 279/3

- Attorney—Bessie A. Lepper*

A chuck suitable for holding a centrifuge rotor during centrifuging and requiring only minimum skill to place in position. The rotor is held by atmospheric pressure by creating a vacuum under the rotor base. Evacuation is by way of a fluid flow path extending through a portion of the spindle on which the chuck is mounted. Means responsive to the pressure in the system may be used to control the operation of the motor driving the spindle and rotor to ensure locking of the rotor prior to startup.

3,581,981	6/1971	Latham	233/21
-----------	--------	--------------	--------

10 Claims, 4 Drawing Figures



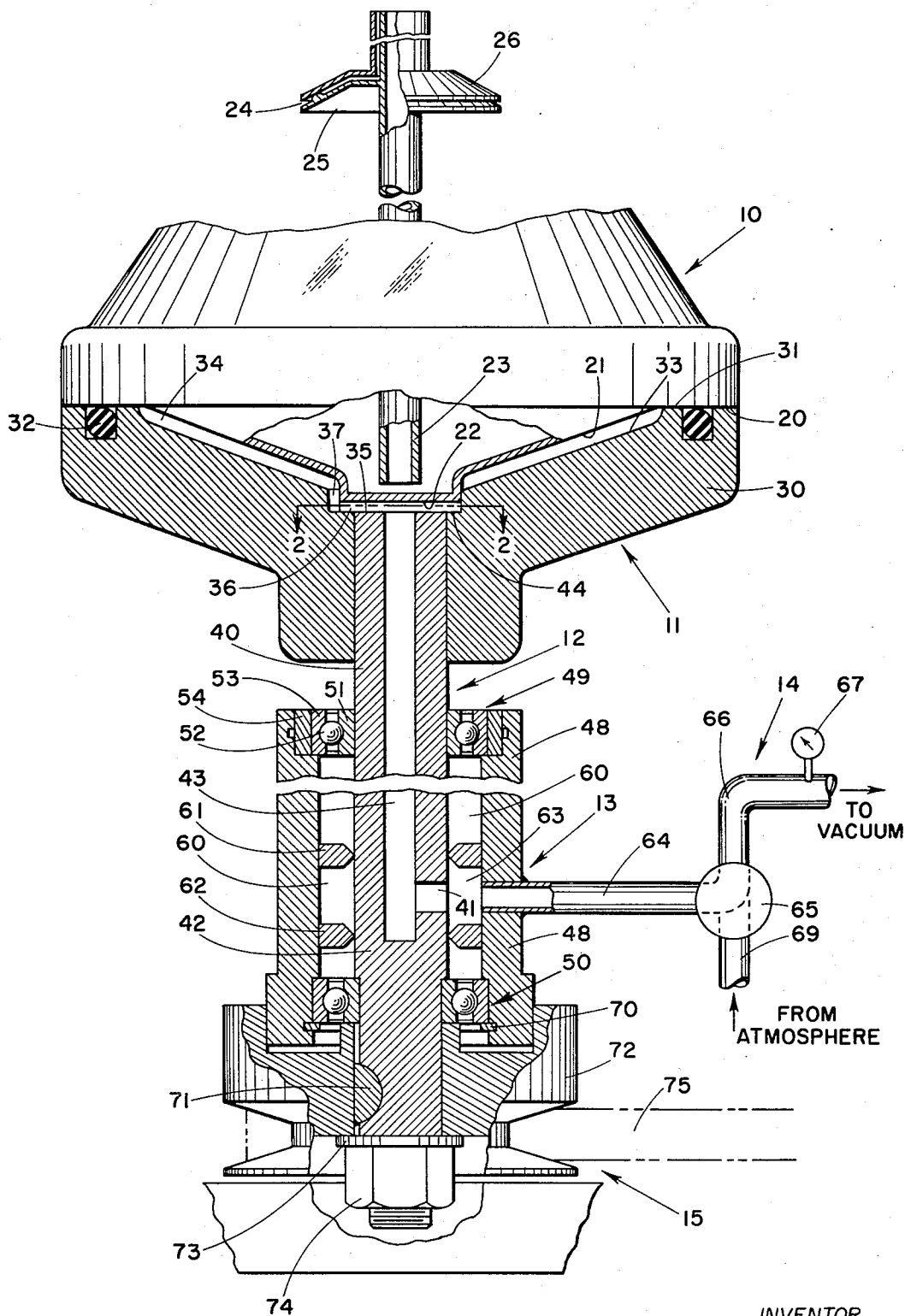


Fig. 1

INVENTOR
Allen Latham, Jr.

BY *Bernie A. Leppner*
Attorney

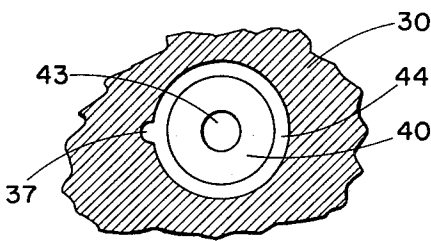


Fig. 2

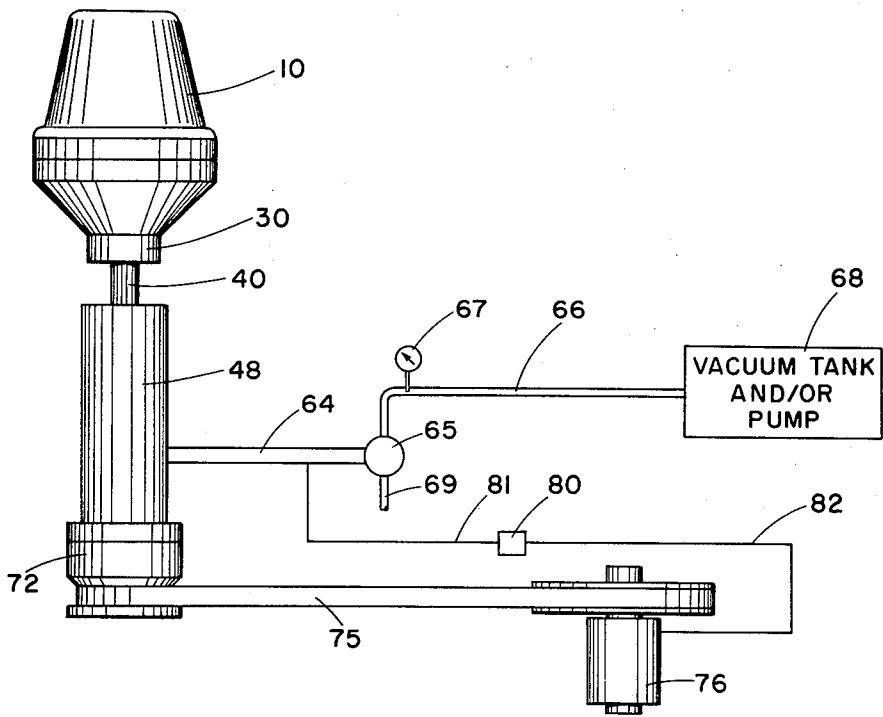


Fig. 3

INVENTOR.
Allen Latham, Jr.
BY *Bennie A. Lygner*
Attorney

PRESSURE-ACTUATED CENTRIFUGE CHUCK AND CENTRIFUGE INCORPORATING THE SAME

This invention relates to chucks, and more particularly to chucks mounted for rotation and to centrifuges embodying such chucks.

In centrifuging liquids such as blood, there is a need for a simple chuck which can hold the centrifuge rotor in proper alignment and which provides rapid and reliable engagement and disengagement with the rotor. In processing blood, the technician who performs the processing steps should be as free as possible from engineering details. This, in turn, means that he should be able to place a centrifuge rotor in a chuck to attain automatic registry both with respect to axial alignment and perpendicular alignment and to effect the locking of the rotor in the chuck with the minimum number of motions, preferably only one.

It is therefore a primary object of this invention to provide a simple, easily used chuck for holding centrifuge rotors during operation. It is another object of the invention to provide a chuck of the character described which is particularly useful in centrifuges used to process blood and which requires but a single operation to lock or unlock the centrifuge rotor into the chuck. It is yet another object to provide such a chuck which incorporates safeguard means for its use. Other objects of the invention will in part be obvious and will in part be apparent hereinafter.

In the chuck of this invention, atmospheric pressure is employed to hold the centrifuge rotor securely to the chuck by providing a vacuum under most of the area under the base of the rotor. Axial and perpendicular of is attained by registration surfaces. Provision is made to evacuate the area under the rotor base through a hollow spindle. Means may also be provided to ensure that the evacuation has been attained prior to startup.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a vertical cross section of the chuck and one embodiment of its associated spindle of this invention;

FIG. 2 is a cross section through a portion of the chuck body taken along plane 2—2 of FIG. 1;

FIG. 3 is a somewhat simplified side elevation of the entire equipment including safeguard means associated with centrifuge startup; and

FIG. 4 is a vertical cross section of the chuck and another embodiment of its associated spindle.

As will be seen in FIG. 1, the centrifuge rotor 10 is mounted on a chuck 11 which in turn is affixed to a partially hollow spindle 12 having associated therewith fluid communication means 13 which provide alternative connections, through fluid flow control means 14, with a vacuum pump (or reservoir) or the atmosphere. The spindle is rotated by a suitable driving means 15.

The centrifuge rotor 10 is typically formed of a suitable plastic material shaped on its base to have a flat peripheral surface 20, a downwardly inclined surface 21 forming a major portion of the base and a central

circular alignment surface 22. Blood to be processed is introduced through a stationary inlet line 23 while the low-density fractions separated from the blood are forced outwardly through passage 24 defined between stationary walls 25 and the wall 26. The actual internal design of the rotor is not part of the invention; and only a portion of it is illustrated by way of explanation.

The chuck 11 is formed of a chuck body 30, the upper surface of which is contoured to provide a flat peripheral surface 31 adapted to engage the corresponding flat peripheral surface 20 of the rotor and through a sealing ring 32 to provide a fluid-tight seal. The sealing ring 32 is preferably a large O-ring soft enough to allow contact between these perpendicularity registration surfaces 20 and 31. The chuck body also has a downwardly inclined surface 33 essentially corresponding in surface area to the inclined surface 21 of the rotor, but spaced therefrom to define an evacuable spacing 34 between the rotor base and the chuck body. The chuck body has a shallow central well 35 sized to correspond in diameter to the diameter of the circular alignment surface 22 of the rotor. The depth of the well 35 is such that a fluid passage 36 is defined below the rotor alignment disk 22. This fluid passage 36 is in communication with space 34 through a vent notch 37.

The chuck body 30 is mounted for rotation on spindle 12 which comprises a hollow section 40 extending to at least that level where it has a port 41 providing a fluid connection with fluid communication means 13. The bottom solid section 42 of the spindle is adapted for attachment to driving means 15 as explained below.

The fluid passage 43 within the spindle opens out into fluid passage 36. The outside diameter of the spindle is somewhat less than the diameter of well 35 thus providing an annular shoulder 44 around the top edge of spindle 40. The spindle, below the chuck 11, is encased in a heavy walled tubing 48 which serves as a support for an upper bearing means 49 and a lower bearing means 50. Typically, as shown in the case of upper bearing means 49, these components are comprised of a rotating inner spindle bearing 51, a ball bearing 52, an outer stationary bearing ring 53 and an annular ring 54 formed of an elastomeric material serving as a spindle bearing flexible mount to permit flexible accommodation to any unbalance of the rotating parts and to reduce the load on the bearing means 49.

Within spacing 60 defined between the inner surface of heavy-walled tubing 48 and the outer surface of hollow spindle section 40, there are positioned an upper annular rotary seal 61 above port 41 and a lower annular rotary seal 62 below port 41 thereby defining an annular fluid-tight spacing 63 open to the passage 43 within the spindle. A fluid conduit 64 extends through the heavy-walled tubing 48 and it is welded thereto to form a fluid-tight seal. The fluid conduit 64 terminates within the fluid flow control means 14 which is shown in FIG. 1 to be a three-way valve 65 connected by way of line 66, having a vacuum gage 67, to a vacuum tank and/or vacuum pump 68 (FIG. 3) and by way of line 69 to the atmosphere. In its third alternative position the valve 65 is closed to both lines 66 and 69 thus providing a closed vacuum system within the spindle and chuck.

The lower bearing means 50, which does not require an annular elastomeric ring comparable to 54 of the

upper bearing means, is held in place by a retainer ring 70. In the embodiment of FIG. 1, a key 71 is provided to effect the mechanical linkage of the pulley 72 to the spindle. A pulley clamp washer 73 and nut 74 complete the pulley-spindle assembly. The pulley is driven by belt 75 which in turn is driven by any suitable means such as an electric motor 76 (FIG. 3).

In the operation of the chuck of this invention, the centrifuge rotor is placed on the chuck body, axial registration being attained by fitting the circular alignment surface 22 of the rotor into chuck body well 35, and perpendicular registration by matching annular surface 20 of the rotor with annular surface 31 of the chuck body. After the rotor is placed in position, the three-way valve 65 is turned to open the vacuum system of the chuck and spindle to either a vacuum tank and/or vacuum pump. The vacuum system comprises the spacing 34, vent notch 37, spacing 36, spindle passage 43, port 41, spacing 63 and conduit 64. When vacuum gage 67 indicates that a sufficient vacuum (typically about 25 inches Hg) has been established within the system the centrifuge may be started. The valve 65 may be turned to completely isolate the vacuum system or it may be left in a position to provide continuous fluid communication between the chuck-spindle vacuum system and the vacuum tank and/or pump. By creating a pressure differential across the rotor 10 from top to base, it is possible to use the atmospheric pressure as a force to hold the rotor in the chuck during centrifuging. After the motor has been stopped and the centrifuge rotor comes to rest, the valve 65 is turned to open the vacuum system to the atmosphere by way of line 68, thus destroying this pressure differential and making it possible to lift the rotor from the chuck. Thus it will be seen that once the rotor is placed on the chuck, it requires but one operation, i.e., turning valve 65, to engage the rotor to the chuck; and one operation to disengage it.

FIG. 3 illustrates an embodiment of the apparatus of this invention which provides a safeguard against starting the centrifuge when the vacuum in the chuck-spindle vacuum system is insufficient to hold the centrifuge rotor. In FIG. 3 the same reference numerals are used to identify identical components as in FIG. 1. A vacuum actuated switch 80, such as a microswitch actuated by a flexible metal bellows connected to the vacuum line, is connected by conduit 81 to conduit 64 and through suitable lead lines 82 to motor 76. The vacuum switch 80 is preset to be actuated at pressures equivalent to or below the pressure required in the vacuum system for holding the rotor. Through lines 82 the switch in turn permits the motor 76 to be started such as by closing a circuit between a power supply and the motor. Thus if, and only if, there is a sufficient vacuum attained in the system the centrifuge may be started. If a leak occurs in the vacuum system, then the vacuum switch 80 will serve to stop the motor.

The apparatus illustrated in FIG. 4 embodies a modification in the spindle and in the spindle drive, and it incorporates means to cool the drive motor, the shaft and the heavy casing surrounding the centrifuge. In FIG. 4, like reference numerals are used to identify like components in FIG. 1. The spindle 12 of FIG. 4 is a shaft 85 which is hollow throughout its length thus defining a fluid passage 86 which terminates in a fluid

chamber 87 defined within a housing 88 which provides a support for the lower bearing means 50. Fluid conduit 64 extends through the bottom wall of housing 88 and it is welded thereto to form a fluid-tight seal. A single rotary seal 89 provides the necessary seal around the shaft 85. The fluid communication between the vacuum source and the evacuable spacing 34 therefor comprises fluid conduit 64, fluid chamber 87, and passages 86, 36 and 37.

The spindle shaft 85 is driven by motor 95 by being connected directly thereto. A fan 96, two blades of which are shown, is also mounted on shaft 85 by suitable means such as by press fitting. A heavy casing 97, affixed to the upper end of housing 88, surrounds the motor and at least a portion of the centrifuge rotor 10. This casing comprises a lower, smaller-diameter section 98 and an upper, larger-diameter section 99 joined and made integral with the lower section through an annular section 100. The upper section 99 of the casing is divided into a chuck/rotor chamber section 101 and a fan chamber section 102 by means of a horizontal, heavy-walled divider 103, which may be integral with the wall of section 99 and which provides the necessary support for upper bearing means 49. The lower casing 98 defines a motor cooling chamber 104 which opens into the fan chamber section 102. A plurality of air inlet ports 105 are spaced around the lower end of casing section 98 and a plurality of air discharge ports 106 are located in the wall of the upper casing section 99 providing for the discharge of air from the fan chamber section 102. When the spindle rotates, the fan is also rotated and cooling air is drawn in through inlet ports 105 to sweep around the motor, the spindle and the bearing means. The casing 97 is also cooled which means that the environment about the centrifuge chuck and rotor is also controlled.

The operation of the embodiment of FIG. 4 is essentially the same as that for the apparatus of FIG. 1 and the safeguard mechanism shown in FIG. 3 is applicable to the apparatus of FIG. 4.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A centrifuge in which a rotor is held in a chuck for spinning, comprising in combination

- a. a rotor, the base of which is contoured to have a flat peripheral rotor registration surface, a downwardly inclined surface and a central circular alignment surface;
- b. a chuck, the upper surface of which is contoured to have a flat peripheral chuck registration surface substantially corresponding in size to said rotor registration surface, a downwardly inclined surface substantially corresponding in size and area to said downwardly inclined surface of said rotor base and defining therewith an evacuable space, and a shallow central well corresponding in diameter to said central circular alignment surface of said rotor;

- c. sealing means adapted to form a fluid tight seal between the peripheral registration surfaces of said rotor and said chuck;
 - d. a rotatable spindle adapted to support and rotate said chuck;
 - e. driving means adapted to rotate said spindle;
 - f. evacuating means; and
 - g. fluid communication means connecting said evacuating means and said evacuable space defined between said rotor base and said chuck surface.
2. A centrifuge in accordance with claim 1 wherein said sealing means is a relatively large soft elastomeric ring.
3. A centrifuge in accordance with claim 1 wherein said fluid communication means comprises a fluid passage within said spindle, means to define a fluid passage around a portion of said spindle, port means connecting said fluid passage in said spindle with said fluid passage around said spindle, and means to connect said fluid passage with said evacuating means.
4. A centrifuge in accordance with claim 1 wherein said evacuating means is a vacuum tank.
5. A centrifuge in accordance with claim 1 wherein said evacuating means is a vacuum pump.
6. A centrifuge in accordance with claim 1 including switch means responsive to pressures within said fluid communication means, said switch means being adapted to control the operation of said driving means.
7. A centrifuge in which a rotor is held in a chuck for spinning, comprising in combination
- a. a rotor, the base of which is contoured to have a flat peripheral rotor registration surface, a downwardly inclined surface and a central circular alignment surface;
 - b. a chuck, the upper surface of which is contoured to have a flat peripheral chuck registration surface substantially corresponding in size to said rotor registration surface, a downwardly inclined surface substantially corresponding in size and area to said downwardly inclined surface of said rotor base and defining therewith an evacuable space, and a shallow central well corresponding in diameter to said central circular alignment surface of said rotor and defining with said alignment surface an auxiliary evacuable spacing in fluid communication with said evacuable spacing;
 - c. sealing means adapted to form a fluid tight seal between the peripheral registration surfaces of said rotor and said chuck;
 - d. a rotatable spindle adapted to support and rotate said chuck and defining through at least a portion of its length an internal fluid passage opening at its top end into said auxiliary evacuable spacing;
 - e. heavy-walled tubing means surrounding said spindle below said chuck and defining around said spindle an annular spacing;
 - f. rotary seal means within said annular passage and defining a fluid-tight annular passage around said spindle;
 - g. a port in the wall of said spindle providing fluid communication between said internal fluid passage in said spindle and said fluid tight annular passage;
 - h. evacuating means;
 - i. fluid communication means connecting said annular passage with said evacuating means and with the atmosphere;
 - j. fluid flow control means in said fluid communication means and being adapted to connect said evacuable space through said auxiliary evacuable space, said internal fluid passage in said spindle, said annular fluid passage and said fluid communication means with either said evacuating means or the atmosphere; and
 - k. driving means adapted to rotate said spindle.
8. A centrifuge in accordance with claim 7 including switch means responsive to pressures within said fluid communication means, said switch means being adapted to control the operation of said driving means whereby said driving means may be actuated only if the pressure in said evacuable spacing is below a predetermined level.
9. A centrifuge in which a rotor is held in a chuck for spinning, comprising in combination
- a. a rotor, the base of which is contoured to have a flat peripheral rotor registration surface, a downwardly inclined surface and a central circular alignment surface;
 - b. a chuck, the upper surface of which is contoured to have a flat peripheral chuck registration surface substantially corresponding in size to said rotor registration surface, a downwardly inclined surface substantially corresponding in size and area to said downwardly inclined surface of said rotor base and defining therewith an evacuable space, and a shallow central well corresponding in diameter to said central circular alignment surface of said rotor and defining with said disk an auxiliary evacuable spacing in fluid communication with said evacuable spacing;
 - c. sealing means adapted to form a fluid tight seal between the peripheral registration surfaces of said rotor and said chuck;
 - d. a rotatable spindle adapted to support and rotate said chuck and defining through its length an internal fluid passage opening at its top end into said auxiliary evacuable spacing;
 - e. housing means defining a fluid chamber around the bottom end of said spindle, in fluid communication with said internal fluid passage of said spindle and providing lower spindle bearing support means;
 - f. rotary seal means within said fluid chamber;
 - g. fluid communication means connecting said fluid chamber with said evacuating means and with the atmosphere;
 - h. fluid flow control means in said fluid communication means and being adapted to connect said evacuable space through said auxiliary evacuable space, said internal fluid passage in said spindle, said fluid chamber and said fluid communication means with either said evacuating means or the atmosphere;
 - i. motor means directly connected to said spindle and mounted thereon adapted to rotate said spindle;
 - j. fan means mounted on said spindle above said motor means; and
 - k. heavy-walled casing means defining motor/fan chamber means around said motor means and said

7

fan means and chuck/rotor chamber means around said chuck and at least a portion of said rotor, said motor/fan and said chuck/rotor chamber means being separated by divider means serving as a support for upper spindle bearing means; said motor/fan chamber means having fluid inlet and fluid discharge ports.

10. A centrifuge in accordance with claim 9 includ-

8

ing switch means responsive to pressures within said communication means, said switch means being adapted to control the operation of said motor means whereby said motor means may be actuated only if the pressure in said evacuable spacing is below a predetermined level.

* * * * *

10

15

20

25

30

35

40

45

50

55

60

65