

[72] Inventor **Gunter Eberle**
Gartenstrasse 100, Postrach 391, 72
Tuttlingen, Germany
 [21] Appl. No. **815,912**
 [22] Filed **Apr. 14, 1969**
 [45] Patented **May 11, 1971**
 [32] Priority **Apr. 13, 1968**
 [33] **Germany**
 [31] **P 17 73 198.5**

2,878,994 3/1959 Anderson 233/26
 3,468,474 9/1969 Shoblom et al. 233/26X

Primary Examiner—Jordan Franklin
Assistant Examiner—George H. Krizmanich
Attorney—Robert I. Pearlman

[54] **RECEPTACLE HOLDER FOR CENTRIFUGES**
5 Claims, 2 Drawing Figs.

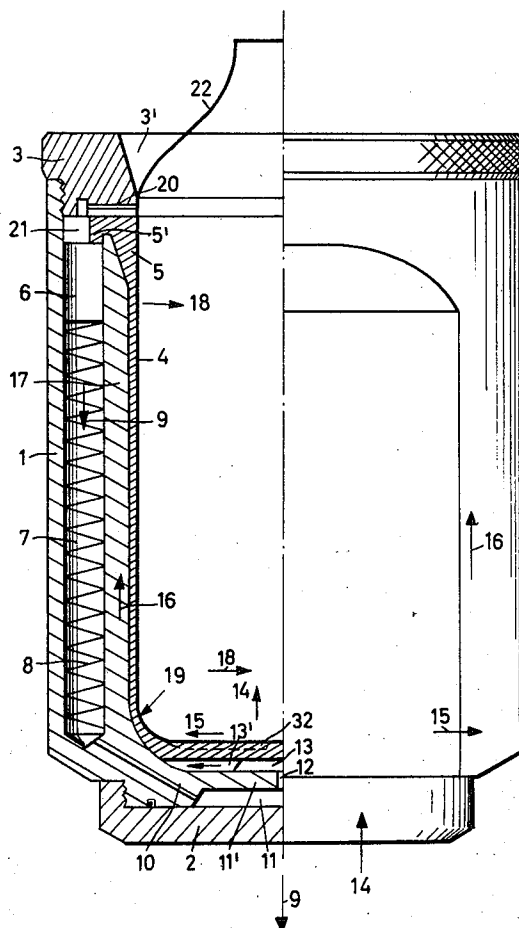
[52] U.S. Cl. 233/26
 [51] Int. Cl. B04b 9/12
 [50] Field of Search 233/26,
 1: 73/535; 164/286

[56] **References Cited**

UNITED STATES PATENTS

2,351,708 6/1944 Rubissow 233/26

ABSTRACT: A holder for a receptacle such as a blood-containing receptacle which is to be centrifuged. The holder includes an outer wall structure which is lined by an inner flexible lining. The outer wall structure is formed with axial bores in which hydraulic pistons are respectively slidable. The outer wall structure and the flexible liner define between themselves a chamber of a predetermined configuration for receiving a compensating hydraulic liquid which is acted upon by the pistons which slide in the bores in response to centrifugal forces which are present during the centrifuging operations. With this construction the configuration of the chamber is such that the hydraulic liquid is displaced by the pistons during centrifuging in such a way that horizontal and radial forces which otherwise would act on the receptacle during centrifuging thereof are eliminated with the compensating hydraulic liquid.



Patented May 11, 1971

3,578,240

2 Sheets-Sheet 1

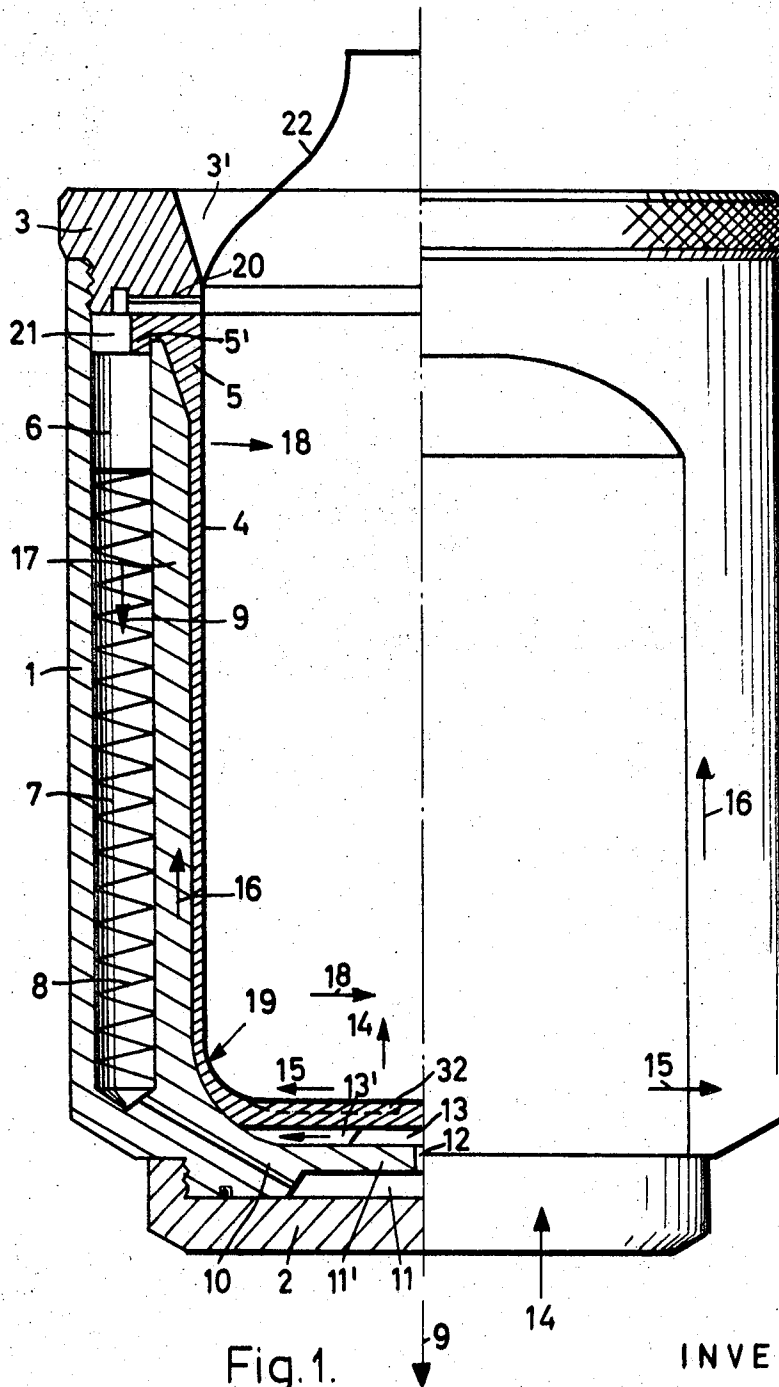


Fig. 1.

INVENTOR:

Qünter Eberle

By Robert J. Sullivan

Attorney

Patented May 11, 1971

3,578,240

2 Sheets-Sheet 2

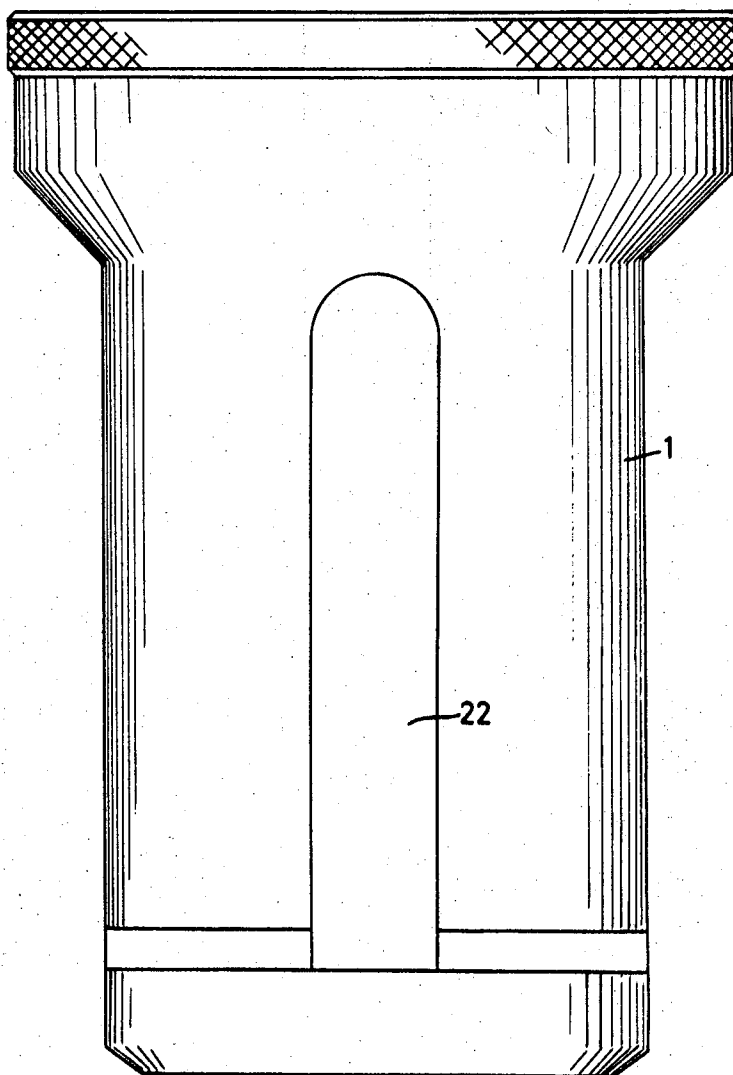


Fig.2.

INVENTOR:

Günter Eberle

By

Robert J. Searles

Attorney

RECEPTACLE HOLDER FOR CENTRIFUGES

BACKGROUND OF THE INVENTION

The present invention relates to the centrifuging of test specimens such as blood specimens located in a suitable receptacle.

In particular, the present invention relates to a construction which enables excessive pressure which otherwise would undesirably act on the receptacle and the contents thereof during centrifuging to be compensated.

It is known to provide for centrifuges receptacle holders which will hold a receptacle in which a blood specimen is located, for example. Such holders are conventionally provided with an inner liner made, for example, of rubber. This rubber liner is surrounded by a substantially rigid holder wall which defines with the rubber liner an annular gap to which liquid is directed from a suitable source so as to attempt with such an arrangement to eliminate the axial and radial forces which act on the test receptacle during centrifuging.

However, experience has shown that with the known constructions designed for these purposes it is not possible to achieve a uniform distribution of the compensating liquid in the annular gap which surrounds the rubber liner and in the end wall of the holder during centrifuging. As a result of the centrifugal action the liquid which is intended to provide the compensating forces instead collects primarily in the region of the end of the holder so that the desired compensating forces cannot be achieved.

In spite of additional inconvenient manipulation which may be carried out in connection with filling the space between the receptacle and holder, the required location of the compensating liquid either is not achieved or the liquid is uncontrollable so that it is only possible to achieve a limited solution to the problem. Thus, for example, with conventional constructions it is only possible to achieve a compensation at the region of the end of the holder where there is some balance between the inner and outer pressures depending upon the specific weight of the receptacle and the contents thereof and depending upon the particular liquid which is used for pressure compensation. However, since the glass receptacles for the blood specimen, for example, are particularly sensitive with respect to inner pressure increases, there are frequent breakages of the test receptacles.

These glass test receptacles used for blood, for example, are manufactured according to pressure-blowing processes resulting in unavoidable variations in the wall thickness of the receptacles. As a result of lack of uniformity in the relieving of loads and as a result of the different degrees of the wall thickness which are encountered in such receptacles, an extremely long centrifuging time under conditions of relatively low gravitational fields are required. It therefore becomes possible to utilize the full rotational speed capacity of a centrifuge, particularly the higher speed ranges thereof.

Moreover, with conventional constructions the compensating liquid after the end of the centrifuging operations, does not automatically flow back to the source or reservoir chamber immediately. Such return flow takes place only after a considerable time delay. As a result considerable difficulties are encountered in removing the test receptacle from the holder. Thus, such receptacles are often removed with conventional constructions under conditions where the compensating forces are still acting on the receptacles, so that as a result the sediment is undesirably set into turbulent motion out of the centrifuged materials, thus placing the results of the test in question.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide a construction which will avoid the above drawbacks.

Thus, it is an object of the invention to provide a construction which will greatly reduce the risk of breakage of delicate test receptacles.

Also, it is an object of the invention to provide a construction which will enable the centrifuging operations to be carried out in an extremely short time.

Moreover, it is an object of the invention to provide a construction which will enable high rotary centrifuging speeds to be used without any danger.

Moreover, it is an object of the present invention to provide a construction which will greatly facilitate removal of the test receptacles after the centrifuging operations are completed.

Thus, it is an object of the invention to provide a construction which will make it possible to achieve a rapid simple testing operation without any danger of breaking the test receptacles as a result of any excessive pressures which are encountered during centrifuging.

According to the invention the holder for the test receptacle has an outer wall means and an inner flexible resilient liner means which lines the interior of the outer wall means. This outer wall means is formed with axial bores in which pistons are respectively slidable, and the outer wall means and liner means define between themselves a chamber for receiving a compensating liquid which is displaced into and out of the chamber of displacement of the pistons within the bores of the outer wall means. These pistons respond to the centrifugal force so as to achieve through the compensating hydraulic liquid forces which will eliminate those forces which act undesirably on the test receptacle during the centrifuging operations.

BRIEF DESCRIPTION OF DRAWINGS

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is an elevation of one possible structure of the invention showing this structure in section at the left half of FIG. 1; and

FIG. 2 is an exterior elevation of the structure showing in particular an arrangement for mounting the holder in a centrifuge.

DESCRIPTION OF A PREFERRED EMBODIMENT

The receptacle holder 1 of the invention includes, as is apparent from FIG. 1, primarily for manufacturing reasons, a lower end or bottom wall member 2 which is threaded onto a substantially cylindrical outer sidewall means of the holder 1 in the manner shown most clearly at the left region of FIG. 1. This outer sidewall means also threadedly carries an upper ring cover 3 which is threaded into the upper portion of the outer sidewall means, as indicated at the upper left portion of FIG. 1.

This holder or outer sidewall means 1 defines an interior cylindrical space the inner surface of which is covered with a soft rubber liner means 4 which simply rests loosely against the inner surface of the outer wall means 1. This liner means 4 is provided at its upper rim with a thickened portion 5 which extends at an outer projection 5' into a cylindrical bore 7 which is formed in the outer wall means and extends parallel to the axis thereof. It is to be understood that the structure is symmetrical with respect to the central axis so that the structure shown in section at the left of FIG. 1 is duplicated at the right of the central line of FIG. 1. The upper end of the outer sidewall means seventeen of the holder 1 is covered by the ring-shaped cover 3 which is formed with a bore 20 communicating through a bore 21 with the interior of the bore 7 so that in this way air can freely flow into and out of the axial bore 7, and of course the same is true of the diametrically opposed axial bore 7 which is not illustrated at the right in FIG. 1. In this way it is possible for air to flow from the space 3' surrounded by the ring 3 into and out of the bore 7.

Within each of the bores 7 is located a pressure piston 6 capable of freely sliding axially along the interior of each bore 7 and urged to the upper rest position shown in FIG. 1 by way of a spring means 8 which is situated within each bore 7. Thus,

each spring means 8 will press the piston 6 against the stop 5' which is formed by the outer projection of the thickened upper portion 5 of the liner means 4.

The lower end of each bore 7 communicates through a passage 10 which is formed in the holder 1 with a chamber 11 defined between the removable cover or bottom wall member 2 and the wall 11'. This wall 11' is in turn formed with a center aperture 12 through which the chamber 11 communicates with a pressure-equalizing or compensating chamber 13 defined between the liner means 4 and the outer wall means 17 at the bottom end portion 11' of the latter. The liner means 4 may be provided with downwardly extending ribs engaging the upper surface of the wall 11' to define radially extending passages 13' which will receive the pressure-compensating liquid, although of course the wall 11' may itself be formed with the upstanding ribs which engage the lower surface of the liner means and define the passages 13'.

FIG. 1 illustrates a receptacle 22 for a blood specimen or the like situated within and surrounded by the liner means 4. The thickened portion 5 of the liner means 4 prevents outward pressing of the receptacle 22 in opposition to the direction 9 of the centrifugal forces.

During the centrifuging operations the pistons 6 are displaced by a centrifugal force in the direction indicated by the arrow 9 for the left piston 6 of FIG. 1, in opposition to the force of the spring means 8. A hydraulic compensating liquid is situated in each bore 7 beneath the piston 6 and in the space defined by the passage 10, the chamber 11, the aperture 12, and the chamber 13 and 13'. Each of the pistons 6 operates in the manner of a piston of a hydraulic pump and displaces liquid out of the cylindrical bore 7 during movement of each piston 6 by the centrifugal force acting in the direction of the arrow 9 toward the lower end of each bore 7. This pressure which is transmitted to the hydraulic liquid spreads itself according to well-known hydraulic principles through the passage 10 and the chamber 11 and bore 12 into the pressure-compensating chamber 13.

The hydraulic piston 6, instead of responding to centrifugal forces, can also be adjusted by hand actuation or electromagnetically. According to the particular cross-sectional relationship between the cylindrical bore 7, the aperture 12, and the pressure-compensating chamber 13, it is possible to achieve a force acting in the direction of the arrow 14 which either is precisely as great as the centrifugal force which acts on the receptacle 22 and its contents or which is greater than this latter force. In the event that the force acting in the direction of the arrow 14 is greater than the centrifugal force, then this pressure spreads itself further in the direction of the arrow 15. Then this hydraulic liquid which is under pressure exerts a force in the direction of the arrow 16 so that the hydraulic liquid which is pressed out of each bore 7 by the piston 6 becomes located between the outer wall means 17 and the elastic rubber liner means 4 and raises the elastic liner means 4 away from the inner surface of the outer wall means 17. In this way the rubber liner means 4 is inwardly bulged uniformly in the inner radial direction 18 and adapts itself to the exterior surface of the receptacle 22 even if the latter has a non-uniform exterior surface.

A relatively large path of movement of the piston 6 in each bore 7 in the direction of the arrow 9 achieves with relatively small movements in the direction of the arrows 14 and 18 a relatively large force which in accordance with the dimensions of the pressure compensating chamber 13 eliminates at this location the centrifugal forces acting on the receptacle 22 and its contents, and achieves gripping forces in the direction of the arrows 18.

Inasmuch as cylindrical bodies may be statically considered as spherical or bodies having convex exterior surfaces which are extremely strong, it is possible to grip the receptacle 22 in the direction of the arrow 18 without any possible damage to the receptacle 22. Even receptacles of extremely small thickness are not placed in any danger of breaking as a result of the uniform inwardly directed radial gripping forces which

act in the direction of the arrow 18. With presently known receptacle holding devices designed for similar purposes large load peaks are encountered at the receptacle walls, these load peaks being situated approximately at the location 19. However, with the present invention such forces are no longer encountered. The air passage 20 within the ring cover 3 communicates through the opening 21 during downward movement of the piston 6 with the interior of the bore 7 above the piston 6 so that there will be no vacuum created within each bore 7 above the piston 6 during displacement thereof in the direction of the arrow 9.

By providing the rubber liner means 4 with portions of different wall thickness, such as with the thicker wall portion at the region 19, it is possible to distribute the counterforces which occur in such a way as to relieve any load from those parts to the receptacle 22 which are particularly subject to breaking. Moreover, the thickened portion 5 of the liner means 4, which is situated at the upper end of the hollow interior of the outer wall means 17 also serves to prevent outward sliding of the receptacle out of the holder in opposition to the centrifugal force.

There is shown in FIG. 2 in a side elevation the holder 1 which is provided at its exterior surface with a pair of diametrically opposed axially extending supporting grooves 22' for receiving pins which engage the upper ends of these grooves, as viewed in FIG. 2. Thus a pair of diametrically opposed pins of the centrifuge will be received in the pair of opposed axially extending grooves 22' to engage the upper ends of these grooves and swingably support each holder 1 with the receptacle 22 therein during the recentrifuging operations. Such pins are carried by the centrifuging head of a conventional centrifuge. As a result it is possible for each holder 1 to swing about the common axis of the supporting pins from a vertical into a horizontal position during centrifuging operations.

Of course, instead of providing grooves 22' for receiving pins it is also possible to provide the holder with a pair of opposed pins projecting radially therefrom and received in corresponding grooves of the centrifuging head of the centrifuge, to achieve the same type of support for the holder during the centrifuging operations.

Thus, it becomes possible with the invention to achieve the counter pressure which is required to prevent breaking of the receptacle 22, this result being achieved by way of the hydraulic principle according to which the counter forces are uniformly distributed over the entire receptacle 22. The glass receptacle is at every point held within the holder with a uniform excess pressure so that the glass walls, particularly at the region of the bottom end of the receptacle, are to a very great extent relieved of any load.

With the structure of the invention the spring means 8 acts to return the piston 6 to its initial position at the end of the centrifuging operation. As a result the receptacle 22 is immediately unloaded from the action of the compensating forces and it is possible for the receptacle 22 to be easily removed without any difficulty from the holder. By way of the openings 21 and 20 it is possible for the air within the bore 7 above each piston 6 to be displaced easily out of the bore 7 during return movement of the piston 6.

Furthermore it is to be noted that the compensating hydraulic liquid is located within a space which is completely closed. This space is formed by the parts of the bores 7 beneath the pistons 6, the passages 10, the chambers 11 and 13, and the opening 12. Thus, it is not possible for any of the hydraulic liquid to escape from this space because of the actions of the pistons 6 on the one hand and the thickened portion 5 of the liner means 4 on the other hand which serves as a stop for the pistons. Therefore, there is no leakage or other loss of liquid used for pressure compensating or equalizing purposes and refilling of the hydraulic passages from time to time is not required.

As was pointed out above it is possible by way of the variable thickness of the liner means 4 to achieve a desirable distribution of the forces acting on the receptacle 22. With the

5

liner means of relatively small wall thickness the compensating forces can act to a great extent on the receptacle. Moreover, by providing thicker portions of the liner means at locations such as, for example, the neck of the holder, at the thickened portion 5, sliding of the receptacle out of the holder in opposition to the centrifugal forces is avoided.

It is furthermore of advantage if it is possible to adjust the compensating pressure. The pistons 6 which slide in the bores 7 act in the manner of the pistons of hydraulic pressure pumps. By changing the volume of the pressure and working chambers it is possible to adjust the pressure which acts on the receptacle 22 in accordance with the particular centrifugal forces so that these forces act on the entire exterior surface of the receptacle which is within the holder 1. Thus, it is possible either to exchange one set of pistons 6 for another set having a different specific weight, so as to achieve a desired change in the compensating forces so that, for example, larger compensating forces can be achieved at the same rotary speeds of the centrifuge. On the other hand, it is also possible to change one outer wall means 17 for another so as to provide bores 7 of different diameters and chambers 11 and 13 of different sizes and configuration so that in this way it is also possible to adjust the compensating forces.

I claim:

1. A holder for a receptacle such as a blood-containing receptacle which is to be centrifuged, comprising outer wall means and inner flexible liner means surrounded by and engaging an inner surface of said outer wall means, said outer wall means being formed with axial bores, a plurality of

6

hydraulic piston means respectively slidable in said axial bores, and said outer wall means and liner means defining between themselves a chamber of a predetermined configuration for receiving hydraulic liquid displaced into said chamber upon centrifugal displacement of said pistons in said bores during centrifuging of a receptacle placed within said liner means, said pistons, outer wall means, and liner means coacting to eliminate axial and radial forces which otherwise would act on the receptacle during centrifuging thereof.

2. The combination of claim 1 and wherein said piston means include spring means situated in each of said bores for displacing the hydraulic piston therein to a given rest position, so as to eliminate axial and radial compensating forces which are applied to the receptacle during centrifuging thereof.

3. The combination of claim 1 and wherein said liner means has a wall provided with different portions which are respectively of different thickness.

4. The combination of claim 1 and wherein the chamber defined between said outer wall means and liner means and the parts of said bores which extend from said chamber up to said pistons all define a closed space for the compensating liquid.

5. The combination of claim 1 and wherein said pistons, outer wall means, and liner means are respectively interchangeable with other pistons, outer wall means, and liner means for changing such features as the volume of said bores, the weights of said pistons, and configuration of said chamber so as to control the compensating forces.

30

35

40

45

50

55

60

65

70

75