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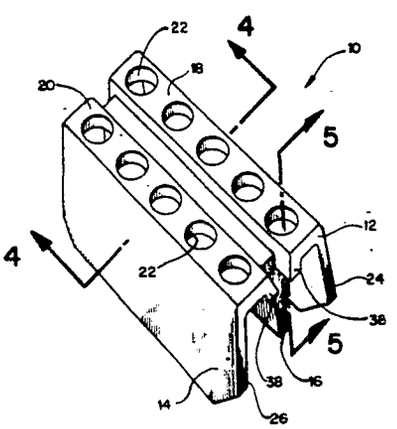
(54) Centrifuge tube holder.

(57) A centrifuge tube holder (10) which not only provides support for the tubes (23) in a vertical orientation when placed on a workbench, but also horizontal and radial support when the tubes are placed in a centrifuge rotor. The tube holder has at least two sections (12, 14) which are pivotally connected to allow for upright or vertical orientation of the tubes when placed on a workbench. The two sections (12, 14) can be pivotally oriented with respect to each other to place the tubes horizontally in a centrifuge rotor at different radial angles with respect to each other with reference to the spin axis of the rotor. The holder (10) also incorporates means (40, 42) for securely holding the tubes within the holder (10) while they are being transported, so that the holder (10) can be inverted without the escape of the tubes (23). On the other hand, the biasing or securing means for the tubes in the holder is eliminated when the holder is at rest on the workbench to permit convenient and easy insertion or removal of the centrifuge tubes. The tube holders (10) act in conjunction with a spacer (70) within the rotor bowl to not only provide the proper placement of the centrifuge tube holders during centrifugation, but also permit extraction of the holders from the rotor bowl to remove essentially all obstructions within the rotor bowl for easier cleaning after a centrifugation run.

An alternate embodiment of the invention holds a plurality of small volume tubes in such a manner that, when the centrifuge rotor is at rest, the tubes will be oriented at an inclined angle, but will assume essentially a horizontal orientation when the centrifuge rotor is operating. The holder (111) provides improved collar (142) support for the centrifuge tube (140) during centrifugation and also provides for the inclusion of a tube pivot point (126) in the plate to enhance the proper movement of the tube from its at-rest position to the correct support position during operational speeds of the centrifuge rotor.



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CENTRIFUGE TUBE HOLDER

Background of the Invention

The present invention is directed to a centrifuge tube holder and, more particularly, is directed to a centrifuge tube holder which provides not only vertical support for the tubes when placed on a workbench, but also horizontal support for the tubes when placed in a centrifuge rotor in such a manner that each of at least two tubes have different radial angles with respect the spin axis of the rotor.

In many cases the racks utilized for holding centrifuge tubes while placed on a table top or workbench have a different configuration than the frame utilized for supporting the centrifuge tubes within the rotor during centrifugation. These different configurations necessitate the physical removal of the tube from the tube rack to the support mechanism in the rotor. The movement of the centrifuge tubes especially after the centrifugation run has been completed is undesirable, because it is preferable to impart the least motion or disturbance to the centrifugated sample as possible. Otherwise, the disturbance to the centrifugated sample may be such that the sample may become remixed, rendering it unusable for the purpose intended.

Some prior art arrangements utilize a tube rack which is capable of placement directly in a centrifuge. However, in such case significant modification is necessary for the rotor structure to accommodate the tube rack. Therefore, the rotor must be specifically adapted to handle the particular tube rack construction.

Also, with the previously used types of centrifuge tube racks or holders that are placed in rotors, a separate rack is required for each row of

centrifuge tubes to provide the necessary radial or angular orientation with respect to the spin axis in the case of a fixed horizontal tube rotor. This results in a limitation in most instances of the number of centrifuge tubes that can be placed in the rotor in the horizontal orientation. Also, the apparatus within the rotor bowl for holding the centrifuge tubes is such that each time the centrifuge tubes are placed as a group in the various locations within the rotor, the rotor must be balanced prior to the centrifugation run. The apparatus within the bowl to support the tubes is typically quite complicated and in some instances is secured in a somewhat permanent basis within the rotor bowl. This causes a disadvantage in attempting to clean the interior of the bowl after centrifugation runs when a sample may possibly leak or spill from the tubes. The irregular shapes of the apparatus used to hold the tubes makes the cleaning of the interior of the bowl inefficient and time consuming.

One distinct disadvantage of most prior art centrifuge tube holders or racks is the tight fit into which the centrifuge tube is placed in the aperture or receptacle portion of the holder. This is required in order to hold the centrifuge tube securely within the rack or holder and prevent the loss of the tube from the rack if the tube holder or the rack is inverted. Therefore, because of this tight fit, the tube is difficult to insert and remove and may cause a jarring or disturbance to the centrifugated sample when trying to remove the tube containing the sample.

Quite often prior centrifuge tube racks or holders are somewhat complicated in design, requiring an expensive overall structure which is neither convenient to use nor economical to manufacture.

The present invention is also directed to a centrifuge tube adapter or holder designed to carry a

plurality of small volume tubes within a centrifuge rotor and designed to permit the tubes to pivot from an inclined angle when the rotor is at rest to a horizontal orientation when the rotor is operational.

In certain clinical tests or experiments, it is desirable to place a large number of separate individual samples in a plurality of very small volume centrifuge tubes for placement in a specific centrifugation run to obtain the desired separation within the sample. Therefore, in order to provide the most efficient use of the centrifuge, it is desirable to place as many of these small volume tubes within a single centrifuge rotor as possible so that each centrifuge run is as efficient as possible. One approach is the placement of a plurality of small volume tubes within the rotor on some type of adapter to hold the tubes in a large rotor for centrifugation.

The problem with previous devices used to handle a plurality of small volume tubes related to the proper orientation of the tubes in the rotor after centrifugation. It is desirable not to have the tubes remain in a horizontal position once the centrifugation has been completed. Some previously designed holders that have been used to support small volume tubes did provide for the desired inclined rest angle, but did not provide the needed support to the upper end or collar of the tube to prevent extrusion of the tube during centrifugation. In other words, it is important that support is provided around as much of the upper end of the tube as possible. Unfortunately, the prior approaches have generally provided support to the collar of the swinging tube on two sides leaving over 180° of the collar portion of the tube unsupported which results in possible deflection or deformity in the tube.

One prior art arrangement incorporates a flat thin plate that has elongated holes into a rotor with a plurality of radially extending sections or arms forming a plurality of yokes. Slots are formed in the opposing arms within a yoke area into which the flat thin plate is positioned. The elongated holes permit pivoting of the tubes, but there is no locating function by the plate of the collar of the tube. Therefore, quite often the collar has significantly less than 180° of support which may cause extrusion of the tube around the collar during high speed centrifugation.

It is also extremely important during the operation of the centrifuge that the tubes be generally free to move between the horizontal and the inclined position depending upon the speed of the centrifuge. Otherwise, the tubes may become askew or caught in the improper position. One reason for problems in this area has been the lack of provision of a proper pivot edge in the holder upon which the tube can rotate or pivot as the centrifuge moves from the rest position to the full operational speed. Similarly, the pivot area is important with respect to the movement of the tube from the operational speed to the rest position.

Summary of the Invention

The present invention comprises two separate centrifuge tube holder sections that are pivotally connected in such a manner that the tubes are vertically supported when the holder is placed on a table top or workbench and horizontally supported when placed in a rotor. When placed in the rotor at least two of the tubes can be oriented at different radial angles with respect to each other in the direction of the spin axis of the rotor. The present holder provides the complete support for the centrifuge tube when placed in a rotor, so that no additional support apparatus is

required for placement within the rotor during centrifugation of the sample carrying tubes.

The present tube holder incorporates a biasing or locking feature which automatically secures the tubes tightly within the holder when the two sections are held in such a manner that they are forced toward each other. When the sections are relaxed and not forced toward each other, the locking feature of the holding device releases its contact on the tubes and permits easier insertion and removal of the tubes from the holder. The apertures or slots within the holder designed to receive the tubes are made of sufficient size to permit the easy entrance and removal of the centrifuge tubes. The unique design of the tube holder is such that a maximum plurality of centrifuge tubes can be placed within a rotor of a given size.

Because of the locking feature in the tube holder, the present invention allows for the decanting of the tubes easily without rehandling them. In other words, it is not necessary to remove the tube for decanting if desirable. Also, in the present design, the two pivotal sections are frame-like members which have their end portions exposed to permit visual observation of the tubes being filled.

The present tube holder provides for at least two rows of centrifuge tubes in one holder which has a pivoting capability so that each row of test tubes is properly aligned with the force field. Other centrifuge tube holders having more than one row of tubes do not have each row properly aligned with the force field.

Once centrifugation is completed, the tube holders can be removed from the bowl rotor and allow for the efficient and easy cleaning of the interior of the bowl. This is very important with respect to the ability to efficiently use the centrifuge rotor which

would require a minimum of time for cleaning between centrifugation runs when necessary.

The present tube holder also has uniquely designed apertures for receipt of a plurality of small volume centrifuge tubes wherein the tubes assume an inclined angle with respect to the horizontal when the centrifuge rotor is at rest, but automatically pivot to the horizontal direction when the centrifuge rotor is at operational speed.

The present invention allows for the free pivoting or movement of the small volume tubes as the rotor is moving from its rest position to full operational speed, as well as when the rotor is moving from its full operational speed to its rest position. An important feature to the present invention to enhance this proper pivotal movement of the tube is the utilization of a built-in pivot edge which acts as a pivot for the tube and operates in conjunction with centrifugal forces to promote the proper movement of the tube to its correct and specific support location.

The support area for the tube when in the aperture of the tube holder is greatly increased over the designs of previous tube holders or adapter plates for small volume centrifuge tubes. Typically, the support area found on the present invention is over 180° of the support collar on the tube. This is extremely important in that it provides more distribution in the support of the tube during centrifugation and tends to prevent any extrusion or deformity in the tube caused by the centrifugal forces during centrifugation.

Brief Description of the Drawings

Figure 1 is a perspective view of the present invention;

Figure 2 is a top end view of the tube holder of the present invention placed in a rotor with the tubes oriented in a horizontal position with different radial angles;

Figure 3 is an end view of the tube holder supporting the tubes in a vertical orientation when placed on a workbench or flat surface;

Figure 4 is a sectional view taken along the lines 4-4 in Figure 1;

Figure 5 is a partial sectional view taken along lines 5-5 in Figure 1;

Figure 6 is a typical bowl type of rotor into which the present invention components are placed;

Figure 7 shows a tube holder in position within the rotor bowl.

Figure 8 is a top perspective view of an alternate embodiment of the present invention;

Figure 9 is a bottom perspective view of an alternate embodiment of the present invention;

Figure 10 is a front elevational view of a second alternate embodiment of the present invention;

Figure 11 is a rear or back elevational view of a second alternate embodiment of the present invention;

Figure 12 is a sectional view taken along the lines 12-12 in Figure 10;

Figure 13 is a partial sectional view of the holder of Figures 10 and 11 showing the centrifuge tube shown in its orientation when the rotor is at operational speed;

Figure 14 is a partial sectional view similar to Figure 13 with the centrifuge tube shown in its orientation when the centrifuge rotor is at rest;

Figure 15 is a schematic sketch of the centrifuge tube collar showing the area supported by prior art holder support mechanisms; and

Figure 16 is a schematic sketch of a tube collar showing the portion which is supported by the tube holder of the present invention.

Detailed Description of the Invention

The holder device 10 is shown in Figure 1 having two pivotal tube support sections 12 and 14 which are mounted on a central support member 16. Each of the pivotal members 12 and 14 have a support surface 18 and 20, respectively, which contain tube holding apertures 22 into which centrifuge tubes 23 are placed, as shown in Figures 2 and 3. Also, the pivotal portions 12 and 14 have respective leg members 24 and 26 which provide support when the tube rack holder is placed on a workbench or placed in a centrifuge rotor.

As shown more clearly in Figure 4, each of the pivoting support or receptacle portions 12 and 14 have slightly inclined bearing surfaces 28 and 30 which are designed to rest on the top curved surface 32 of the center support member 16 when the pivoting members 12 and 14 are pivoted outwardly as shown in Figure 4. Therefore, the surfaces 28 and 30 will bear a significant amount of the forces of the pivot sections 12 and 14 during centrifugation. Consequently, the means for pivotally connecting the pivotal members 12 and 14 to the central support 16 will not have to bear a significant portion of the load during centrifugation.

As shown in Figure 5, one example of pivotally attaching each of the pivotal portions 12 and 14 to the central portion 16 could be the use of the detent arrangement having a spherical protruding portion 34 on the central support member 16 and a recessed mating portion or area 36 on the connecting arms 38 on each of the pivotal members 12 and 14. It should be noted, however, that other means could be utilized to provide the pivoting of the moving sections 12 and 14 to the central portion 16. These means could utilize a continuous bar throughout the length of the central section 16 or the use of pivoting bolts or screws, etc. The desirable use of the detent or snap type relationship

of a spherical projection 34 and recess 36 as shown in Figure 5 is that the holder sections which preferably will be molded out of high strength plastic can be snapped into and out of engagement with the central portion 16 to enable better cleaning of the holder as desired.

As shown in Figure 3, when it is desirable to move the tube holder with tubes therein to a position for decanting, the movement of the support legs 24 and 26 toward each other results in the enlarged locking surfaces 40 and 42 on the central portion 16 contacting the tubes 23 and holding them secure within the holder device. Decanting is done in many instances to remove the unwanted solution and leave the centrifugated pellet in the bottom for analysis. Consequently, it is quite simple and expeditious to remove the solution from a plurality of centrifugated tubes in the tube holder for retaining of the pellet at the bottom of the tubes. The holding of the respective leg portions 24 and 26 of the pivoting sections 12 and 14 automatically will lock or hold the tubes in place when they are inverted because of the bumper or locking surfaces 40 and 42 on the central portion 16.

The unique arrangement of the present invention allows for the dual usage of the device. As shown in Figure 3, the holder device 10 can be placed on a workbench or table top 43 with the support legs or portions 24 and 26 oriented in a somewhat parallel orientation with the central portion 16 to vertically support the centrifuge tubes. However, when it is desirable to centrifugate the centrifuge tubes, the entire device is placed within a centrifuge rotor 44 as shown in Figure 2 wherein the bottom edges 46 and 48 of the support sections 12 and 14 contact the interior side surface 50 of the rotor 44. Also, the bottom edge 52 of the central member 16 is in contact with the

interior side surface 50 of the rotor. Therefore, as shown in Figure 2, the holder device is placed into the rotor on end so that the tubes will maintain or assume a horizontal orientation. During centrifugation all the leg portions 24 and 26 of the pivoting areas or portions 12 and 14 along with the central portion 16 provide support to the tubes during centrifugation.

In order to properly orient the tubes with respect to the spin axis of the rotor, the pivoting portions 12 and 14 are oriented as shown in Figure 2 with a pivot of approximately 15° with respect to the longitudinal center lines 54 of the centrifuge tubes 23. This permits each of the tubes to be properly oriented with the spin axis and force field during centrifugation. As previously discussed with respect to Figure 4, the bearing surfaces 28 and 30 of the support portions 12 and 14 on the central support will assume a significant amount of the load, reducing the forces on the pivotal connections between the pivoting sections 12 and 14 of the support member 16.

The general configuration of the rotor 44 is shown in Figure 7 having essentially a bowl shape or hollow interior into which the holder devices 10 are placed. As previously explained with respect to Figure 2, the bottom edges 46 and 48 of the support sections 12 and 14 contact the interior side surface 50 of the rotor. The interior of the rotor is essentially smooth on its side interior surface 50. At the center of the rotor is a connection post 62 into which a cover, not shown, is secured after the insertion and balancing of the holder members 10 with the centrifuge tubes. This cover is necessary in order to provide a smooth exterior surface to the rotor to eliminate potential air friction which would otherwise occur during the operation of the rotor.

In order to properly position the plurality of tube holders 10 within the rotor 44, a support member or spacer 64 as shown in Figure 6 is mounted on the center post 62 in the interior of the rotor. The spacer 64 has a central ring portion 66 designed to receive the center post 62 of the rotor. Extending from the center ring portion 66 are a plurality of divider members 70 which are designed to position and properly space the tube holders within the bowl rotor 44 of Figure 6.

Reference is made to Figure 7 showing the spacer 64 within the bowl rotor 44 with a single tube holder 10 showing its general orientation with respect to the interior side surface 50 of the rotor 44. For operational purposes a balanced number of tube holders have to be placed within the rotor to provide the proper operation of the rotor. The spacer divider members 70 provide the proper orientation and placement of each of the tube holders in a properly balanced corresponding location around the circumference of the rotor 44.

Once centrifugation has been completed, the entire holder assembly 10 can be removed from the rotor 44 and placed on a workbench 43 shown in Figure 3 wherein the holder acts as a support means for the tubes subsequent to centrifugation. Also, it may be desirable to decant the solution from each of the tubes and to leave the remaining pellet for later analysis. By simply grasping the pivoting sections 12 and 14 and moving them toward each other, the locking or bearing surfaces 40 and 42 on the central portion will hold the tubes secure within the holder and allow for the inversion of the holder to remove the unwanted solution.

After all of the tube holders have been removed from the centrifuge bowl rotor 44, the interior of the bowl rotor is essentially smooth and free of any

projections, except for the spacer so that any necessary cleaning of the interior of the rotor can be accomplished with ease. Typically, it is necessary in the case of any possible leakage of one of the tube samples that the interior be cleansed before the next centrifugation run.

An alternate embodiment 80 of the present invention is shown in Figure 8 having two pivotal tube support sections 82 and 84 which are pivotally connected to each other in a manner which will be described in more detail below. Each of the tube support sections has a plurality of apertures 86 which are designed to receive centrifuge tubes. Each of the support sections 82 and 84 have a support surface 88 and 90 respectively in which are located the apertures 86. Each of the support sections have a support leg 92 and 94 respectively which provide support for the holder device when it is used as a support for test tubes in a vertical orientation on a working table or when placed in a rotor. It should be noted that the holder device 80 operates with respect to support for centrifuge tubes in both the rotor and on a working table in the same manner as described previously with respect to holder device 10.

As shown more clearly in Figure 9, the support section 84 has a plurality of center legs or posts 96, 98 and 100 which are integrally formed with the support section 84. Similarly, support section 82 has the center legs or supports 102, 104 and 106. Consequently, the legs from each of the respective sections are oriented in alternating sequence along the longitudinal length of the holder to form the center support for the holder device 80. When the holder device 80 is placed within the rotor in a manner similar as shown in Figure 2 for the holder device 10, the plurality of center legs or supports 96-106 perform the same func-

tion as the center post 16 in the holder device 10. In other words, when in the rotor, the holder device 80 receives support in its center section from the center legs 96-106. Also, it should be noted that all of the legs 96-106 are lined in side-by-side relation with their surfaces in alignment as shown in Figure 9 when placed within the rotor in an orientation as shown in Figure 2 for the holder device 10.

The support sections 82 and 84 are pivotally connected together by two pivoting pins. One of the pins 108 is connected between the support legs 96 of the section 84 and leg 102 of section 82. Another pin not shown is pivotally connected between the leg 106 of section 82 and leg 100 of section 84. Consequently, as shown in Figure 8, the respective sections 84 and 82 can be pivoted so that, for instance, the legs 96 and 102 are at an angle to each other. When the holder device 80 is used as a support for the tubes in a vertical direction as shown for the holder device 10 in Figure 3, the support legs of the section 82 and the support legs of the section 84 are at an angle to each other in the manner similar shown with respect to legs 96 and 102. The center legs 96-106, as well as the side legs 92 and 94, provide support to the holder device when the holder device 80 is oriented or placed on a table for vertical support of the tubes.

It should be noted that the pivoting support section 82 has a central support surface 110 which is designed to mate with the central support surface 112 of the support section 84. Therefore, when the holder 80 is placed within the centrifuge rotor, the surfaces 110 and 112 are in contact with each other to provide support as shown in Figure 9.

Another alternate embodiment holder device 111 of the present invention shown in Figures 2 and 3 is similar to the arrangement shown in Figure 1. The

two support sections 113 and 114 are pivotally connected to a central support 116. The centrifuge tubes are placed in a plurality of holes 118 in the top portions or panels 120 and 122 of the respective support sections 113 and 114. The combination of the central support 116 and the two support sections 113 and 114 carry and support centrifuge tubes when in the rotor and when on the work table in the manner described above.

The holder 111 in Figure 10 has a plurality of apertures 118, each of which is designed to receive a small volume centrifuge tube designed to hold approximately 1.5 ml. As shown with respect to Figure 12, the holder 111 has a relatively small depth or thickness and is preferably made of hard plastic-type material. A generally semicircular tapered area 124 is formed at the upper end 126 of each of the apertures 118 with respect to Figures 10 and 12. This tapered portion extends from the front surfaces 121 and 123 of the panels 120 and 122, respectively, to the upper edge 126 of each of the apertures. The taper as shown in Figure 12 is approximately 45° with respect to the horizontal reference A.

Also, as shown with respect to Figures 11 and 12, a generally semicircular tapered portion 134 for each of the apertures 118 is located on the back surfaces 130 and 131 of the panels 120 and 122 and extends from the back surface 130 of the holder to the bottom part 138 of each of the apertures 118. The incline with respect to the tapered area 134 on the back surface 130 of the panel 120 is approximately 30° with respect to the horizontal B as shown in Figure 12. Each of the apertures has an upper horizontal area or ledge portion 126 and a lower horizontal area or ledge portion 138.

As shown in Figure 14, a centrifuge tube 140 with its support collar 142 and cap portion 144 is inserted into one of the apertures 118 within the holder 111. When the holder 10 is positioned vertically in a rotor which is stationary, the tube will orient at approximately 30° with respect to the horizontal, since the side surface 146 of the tube 140 will be oriented with the lower tapered portion 134 in the aperture 118. As the centrifuge rotor is moved from the rest position to the operational speed of the centrifuge, the tube 40 will pivot to the horizontal position shown in Figure 13. The upper horizontal surface 126 within each of the apertures 118 will provide a pivot edge around which a tube will pivot to automatically find its proper support orientation for the collar 142 of the tube. It should be noted that the shoulder area 148 of the collar 142 will find support on the front surface 121 and 123 of the respective panels 120 and 122 around the aperture 118.

Because of the unique design of the present invention, the support of the holder for the shoulder 148 of the tube will always be well over 180° around the collar of the tube as shown in the shaded portion of Figure 16. Therefore, the support is distributed around a major portion of the collar of the tube and will prevent any type of extrusion or deformity in the tube when subjected to the high forces induced by centrifugation. Prior approaches for establishing a holder device to carry a plurality of small volume tubes had a significantly smaller area of the collar supported during centrifugation and, therefore, caused the tube to be possibly subjected to deformation because of the high stress exerted at the relatively small support area. This was because in the pivoting of the tube in previous arrangements the tube would randomly find its equilibrium position which resulted in less support to

the tube. Figure 15 shows in shaded areas the much smaller support areas that were established in prior types of adapter devices for the small volume tubes.

The important aspect of the present invention is the location of the pivot edge 126 with respect to the support surface on the front surfaces 121 and 123 of the holder panels 120 and 122, respectively. The pivot edge 126 during centrifugation directs or forces the tube into its proper support location so that the support shown in Figure 16 is achieved around the collar of the tube.

It is envisioned that a similar type of centrifuge tube holder could be made from other various specific configurations while still encompassing the primary concepts of the present invention. Any number of holes or apertures for test tubes could be placed within each of the holders depending upon the size of the holders constructed.

Claims:

1. A centrifuge tube holder (10) for supporting at least one centrifuge tube (23) at a specified orientation within a centrifuge rotor (44) characterized by a first pivotal section (12) and a second pivotal section (14), each of the sections supporting at least one centrifuge tube, the sections being pivotally connected to a central member (16) each of the sections being pivotal independent of each other, the centrifuge tube in the first pivotal secton being oriented at a different radial angle to the spin axis of the rotor than the centrifuge tube in the second pivotal section, the central member with the first and second pivotal sections providing vertical support for the centrifuge tubes when the holder is removed from the rotor and placed on a horizontal surface.

2. A centrifuge tube holder as defined in claim 1, and additionally comprising locking means (40 and 42) on the central portion which contacts the sides of the centrifuge tubes so that the centrifuge tubes are held securely within the holder when the first and second sections are pivoted toward each other.

3. A centrifuge tube holder as defined in claim 1, and additionally comprising a plurality of equally spaced divider members (70) within the rotor for positioning the holder within the rotor in a properly balanced position.

4. A centrifuge rotor tube holder (111) having an elongated panel (120) for placement in a rotor and having at least one aperture (118) through the panel for receipt of a centrifuge tube, the panel

having a front surface (121) and a back surface (130), characterized by a first semicircular tapered portion (124) of the aperture (118) from the front surface (121) toward the back surface (130) and a second semicircular tapered portion (134) of the aperture (118) from the back surface (130) toward the front surface (121), the first and second semicircular tapered portions being on opposite halves of the aperture, the tapered portions facing each other within the aperture so that the tube (140) will assume the tapered orientation when placed in the aperture when the rotor is at rest (Figure A), the tube pivoting within the panel to a position (Figure B) perpendicular to rotor spin axis when the rotor is operating.

5. A centrifuge rotor tube holder as defined in claim 4, and additionally comprising a pivot edge (126) for properly positioning the tube (140) as it pivots from an inclined position (Figure 14) to a horizontal position (Figure 13) so that more than half of the collar (142) of the tube is supported on the front surface (121).

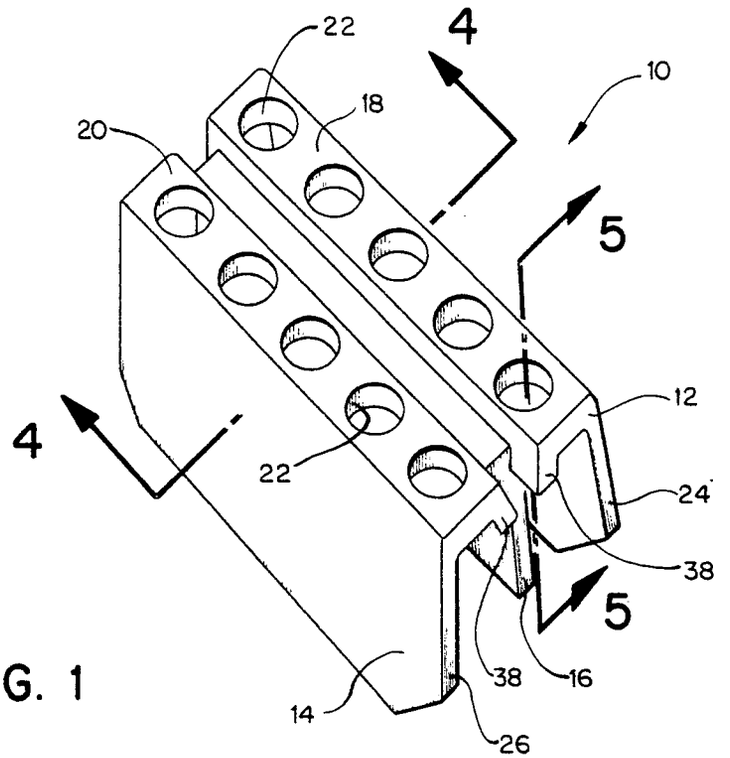

FIG. 1

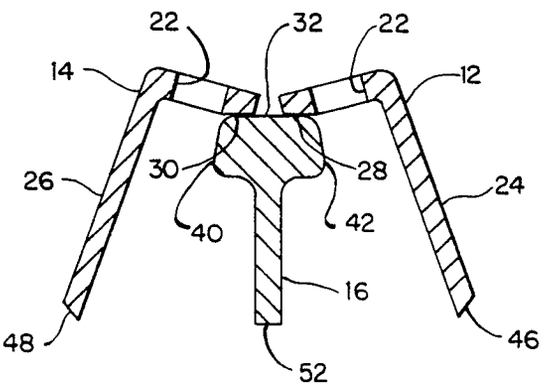

FIG. 4

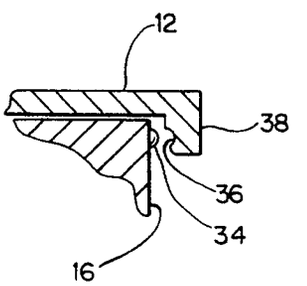

FIG. 5

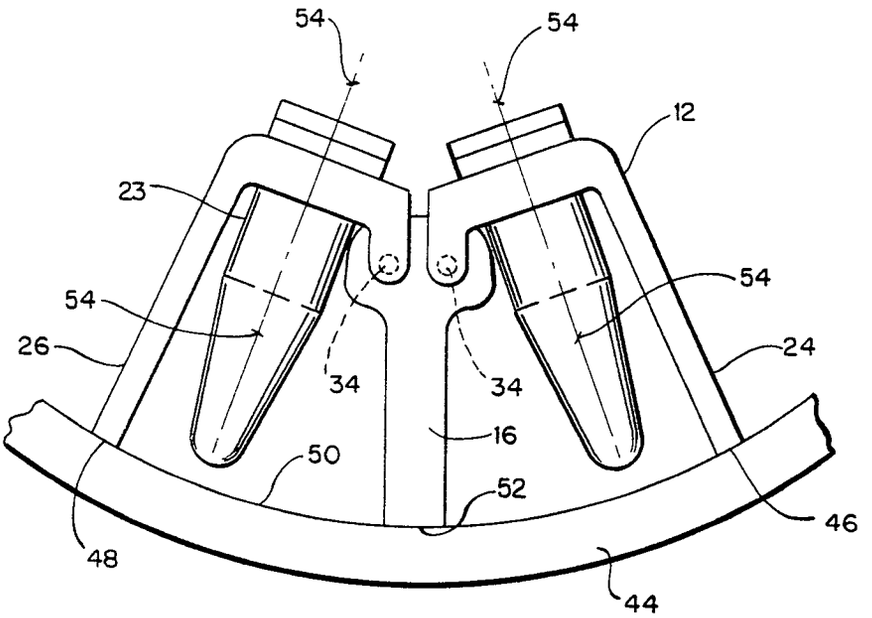
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FIG. 2

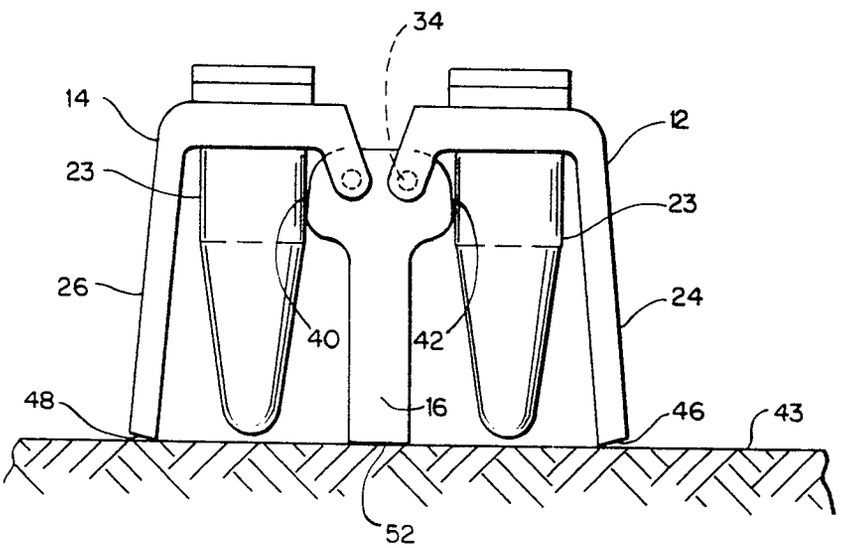
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FIG. 3

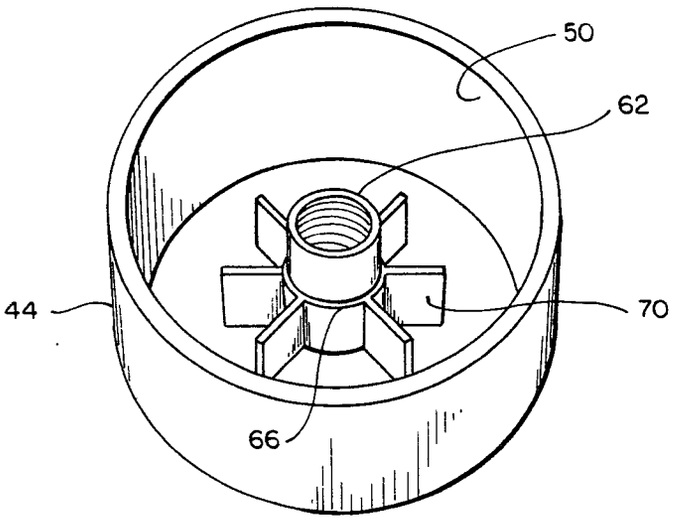

FIG. 6

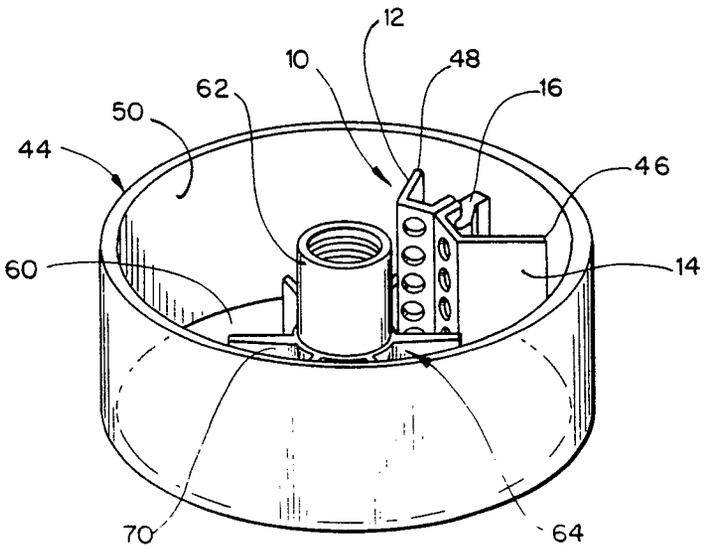

FIG. 7

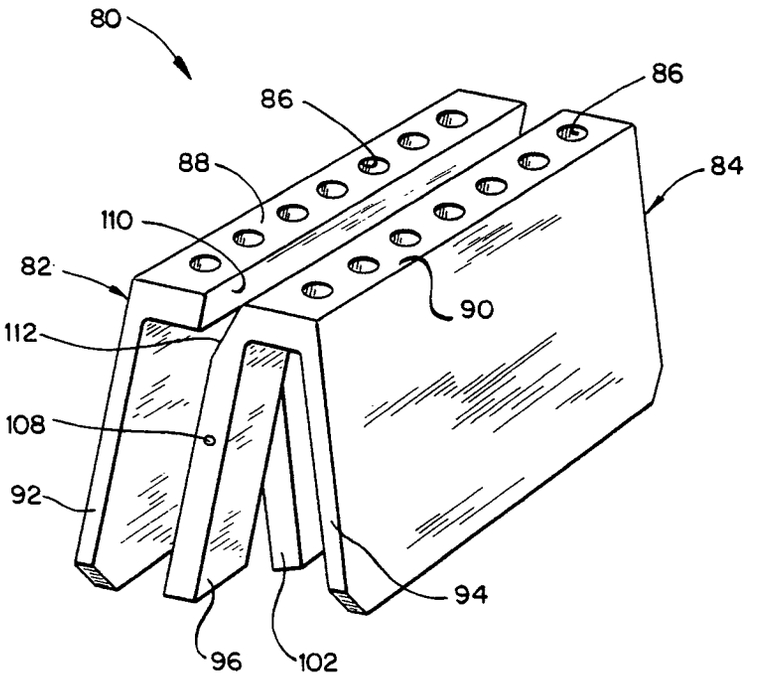
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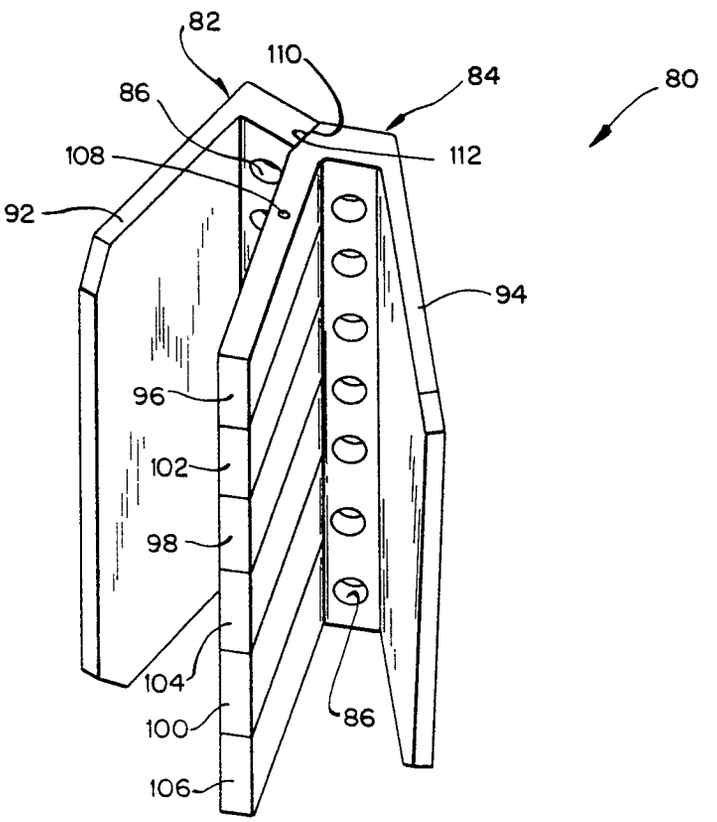
FIG. 8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106

FIG. 9

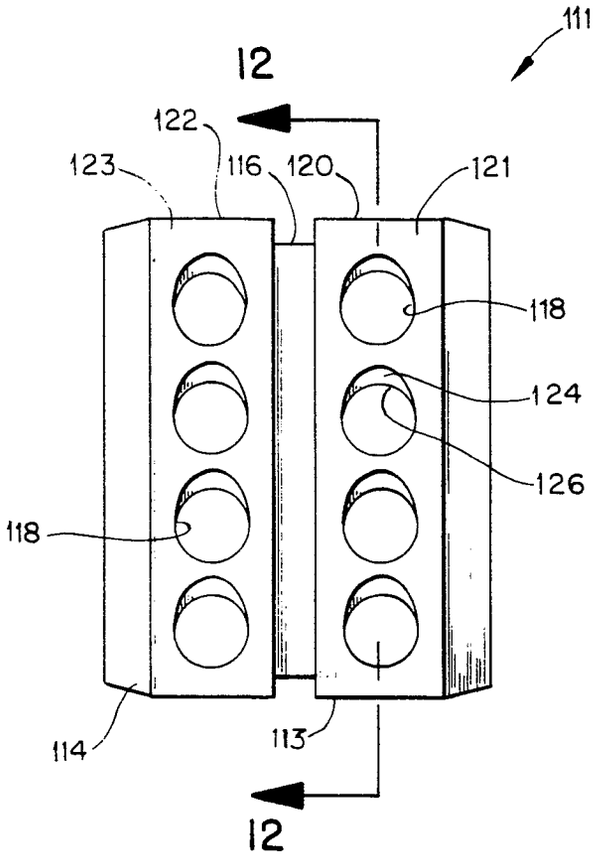
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FIG. 10

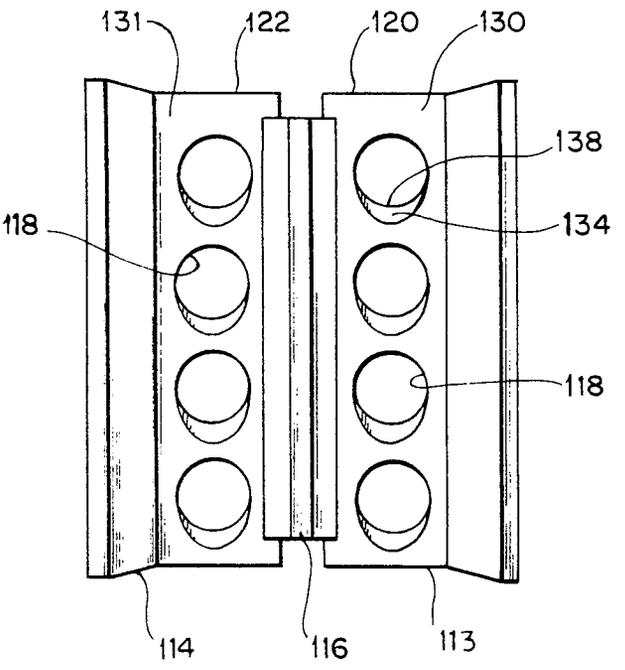
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FIG. 11

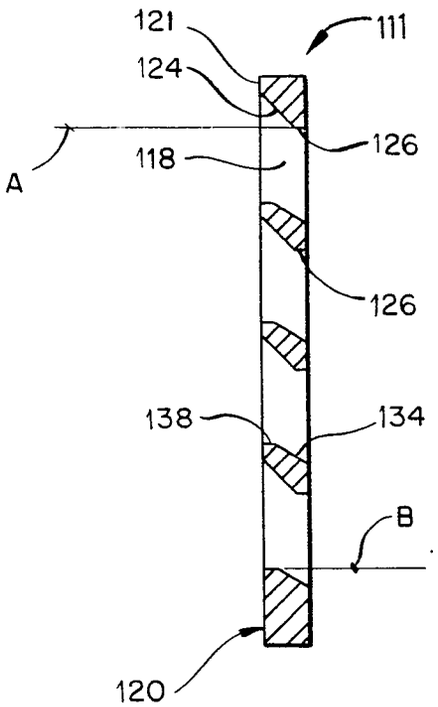

FIG. 12

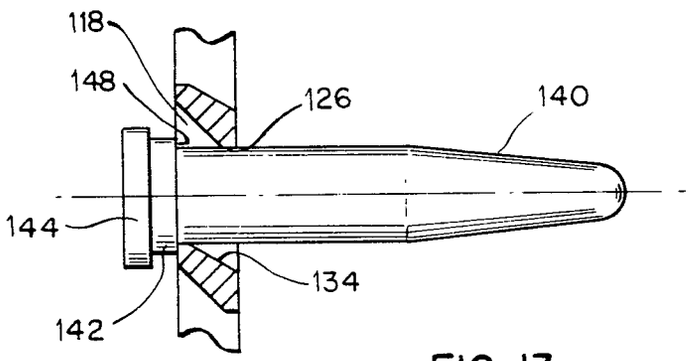

FIG. 13

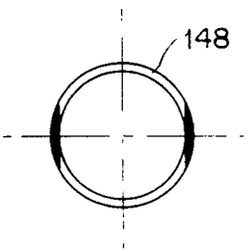

FIG. 15

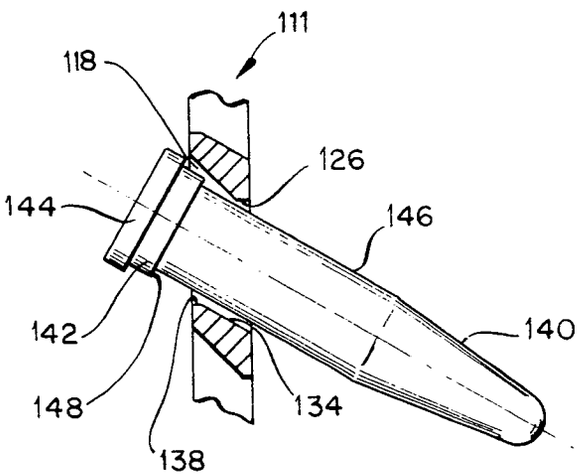

FIG. 14

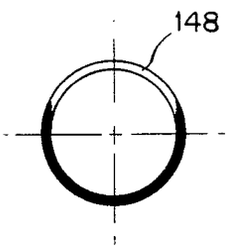

FIG. 16

European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 80 30 3902

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A	FR - A - 993 500 (SUCHESTOW) * Pages 1 and 2 * --	1
A	US - A - 3 891 140 (AYRES) * Column 3, lines 12-16; column 4, lines 35-68 * ----	1

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

B 04 B 5/04

TECHNICAL FIELDS SEARCHED (Int. Cl.³)

B 04 B
B 01 L

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	18-03-1981	VERDONCK

EPO Form 1503.1 06.78