

CENTRIFUGALLY ACTUATED TUBE ROTATOR MECHANISM

FIELD OF THE INVENTION

The present invention relates to an apparatus for producing rotation of a vessel about its longitudinal axis during centrifugation. The apparatus of the present invention comprises: (a) a cup adapted to receive a vessel, (b) a block surrounding the cup in such a manner that the block may move in a direction parallel to the longitudinal axis when acted on by the centrifugal force, (c) a means for retarding this movement, (d) an oscillating means which encircles the cup (thereby providing for movement in a longitudinal and transverse direction), and (e) a pivoting means which connects the oscillating means to the block.

BACKGROUND OF THE INVENTION

Conventional centrifuges typically provide for centrifugation by placing a vessel containing the sample to be subjected to centrifugation in a rotor (or other receiver adapted to contain the vessel) attached to the rotating mechanism. When the centrifuge is started, the force is applied in a direction parallel to the longitudinal axis of the vessel, toward the vessel bottom.

In some instances, it is desirable to provide for simultaneous rotation of the vessel about its longitudinal axis. However, this is extremely difficult to accomplish, due to restrictions on the size of the centrifuge, geometry, etc. This is accomplished by the apparatus of the present invention.

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SUMMARY OF THE INVENTION

The present invention is directed to an apparatus for producing rotation of a vessel about its longitudinal axis during centrifugation. Briefly, the apparatus comprises: a cup adapted to receive a vessel, surrounded by a block in such a manner that the block may move in a direction parallel to the longitudinal axis when acted upon by the centrifugal force, this movement being slowed by a spring or other retarding means, and the cup also contains a cam or other oscillating means which encircles and preferably sinusoidally encircles, the cup, (thereby providing for movement in a longitudinal and transverse direction) and which is connected to the block by a pivoting means such as a cam follower. The entire apparatus is of such a size that it will fit within a centrifuge rotor (or other receiver) without impeding the operation of the apparatus.

In practice, the block will be forced away from the vessel-containing end of the cup upon application of centrifugal force (e.g., by spinning the rotor) until the pivoting means reaches the outer edge of the oscillating means; decreasing the speed of the centrifuge will result in a decrease in centrifugal force, thereby allowing the retarding means to force the block toward the vessel end of the cup until the pivoting means reaches the other edge of the oscillating means, and thereby partially rotating the cup about its longitudinal axis. By varying the centrifuge speed, complete cup rotation about the axis is achieved.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 presents a depiction of one embodiment of an apparatus of the present invention.

Figure 2 presents a detail of a preferred oscillating means of this invention.

Figure 3 presents a depiction of another preferred embodiment of an apparatus of the present invention.

Figure 4 presents an overhead perspective view of the apparatus of the present invention shown in Figure 3.

DETAILED DESCRIPTION OF THE INVENTION

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The present invention is directed to an apparatus for producing rotation of a vessel about its longitudinal axis during centrifugation. This apparatus, adapted for placement in a centrifuge rotor in a centrifuge, comprises:

- 10 (i) a cylindrical cup having an end adapted to receive the vessel when acted on by a centrifugal force generated by spinning the rotor;
- (ii) a block surrounding the cup such that the block may freely move in a direction parallel to the longitudinal axis of the vessel when acted on by the centrifugal force;
- 15 (iii) a pivoting means wherein the pivoting means is attached internally to the block;
- (iv) an oscillating means on the cup and attached to the block by the pivoting means, such that movement of the block in a directional parallel to the longitudinal axis of the vessel will cause the pivoting means to move in the oscillating means; and
- 20 (v) a means for retarding the movement of the block,
the longitudinal rotation being achieved by varying the speed of spinning of the rotor, such that the block is moved bi-directionally, thereby causing rotation of the cup adapted for receiving the vessel.

In one embodiment of the present invention as set forth in Figure 1, the apparatus comprises a cup (2) which has an end adapted to receive the vessel (1). The cup (2) is
25 encircled, and is preferably sinusoidally encircled, by an oscillating means (3) which is connected to the block (4) by a pivoting means (5) inside the block (4). Movement of the block (4) in the direction of the centrifugal force is retarded by the retarding means (6).



The oscillating means (3) is preferably a cam, and the pivoting means (5) is preferably a cam follower. A preferred pattern for the oscillating means (3) is shown in Figure 2. The retarding means (6) in this embodiment is, preferably, at least one spring. In a further preferred embodiment, the vessel (1) is a small diameter tube, such as those
5 used in the QBC™ instruments marketed and sold by Becton Dickinson and Company.

Figure 3 shows another embodiment of the present invention. The apparatus as shown in Figures 1 and 3 illustrates the mechanical processes of the centrifugally actuated tube rotator mechanism of the present invention. The apparatus in each of Figures 1 and 3 uses centrifugal forces to move the associated parts required to achieve rotation of the
10 vessel (1) about the axis of the vessel (1) while the centrifuge rotor is spinning.

In the embodiment of the present invention as shown in Figure 3, the apparatus is comprised of a block (14) having a pivoting means (13) such as, preferably, a cam follower, an oscillating means such as, preferably, a cam or cam groove (not pictured), a retarding means comprising, preferably, at least two springs (15), and a cup (12) for
15 placement of a vessel (1), wherein the vessel (1) is, preferably, a small diameter tube, or more preferably, a QBC™ tube as described above.

As demonstrated in Figure 3, as the centrifuge rotor (10) spins and reaches set rpm, centrifugal force acts upon the block (14) and the attached cam follower (13) to move the apparatus away from the centrifuge rotor center. The cam follower (13) moves along a
20 cam groove (as shown, for example, in Figure 2) on the outer circumference of the cup (12) (the cam groove is not shown in Figure 3) translating the linear movement of the block (14) and the cam follower (13) to a rotational movement of the cup (12). The cup (12) is adapted to accept the vessel (1), therefore the rotational movement of the cup (12) translates directly to the vessel (1). When the centrifuge rotor (10) slows down,
25 decreasing centrifugal force, the springs (15) return the apparatus (including the block (14) and cam follower (13)) back to its static state ready to restart the process. The arrow on the right side of block (14) shows the direction of movement of the block (14) when

acted on by centrifugal force. As shown in the view of the apparatus of Figure 3 as seen in Figure 4, part of the cam follower (13) which is in block (14) can be seen externally, as well as part of the cup (12) and the springs (15).

.. It is apparent that many modifications and variations of this invention as
5 hereinabove set forth may be made without departing from the spirit and scope thereof. The specific embodiments described are given by way of example, only, and is not intended to in any way limit the scope of the present invention.





What is claimed is:

1. An apparatus for producing longitudinal rotation of a vessel having a longitudinal axis, adapted for placement in a centrifuge rotor in a centrifuge, wherein said apparatus comprises:

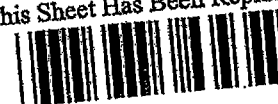
- 5 (i) a cylindrical cup having an end adapted to receive said vessel when acted on by a centrifugal force generated by spinning said rotor;
- (ii) a block surrounding said cup such that the block may freely move in a direction parallel to the longitudinal axis of said vessel when acted on by said centrifugal force;
- 10 (iii) a pivoting means wherein said pivoting means is attached internally to said block;
- (iv) an oscillating means on said cup and attached to said block by said pivoting means, such that movement of the block in a directional parallel to the longitudinal axis of said vessel will cause said pivoting means to move in said
- 15 oscillating means; and
- (v) a means for retarding the movement of said block,
- said longitudinal rotation being achieved by varying the speed of spinning of said rotor, such that the block is moved bi-directionally, thereby causing rotation of said cup adapted for receiving said vessel.

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2. The apparatus of Claim 1 wherein said means for retarding the movement of said block is at least one spring.

3. The apparatus of Claim 1 wherein said oscillating means on said cup is

25 a continuous groove sinusoidally encircling said cup, and said oscillating means provides for movement in both a longitudinal and transverse direction.





4. The apparatus of Claim 4 wherein said oscillating means is a cam or a cam groove.

5. The apparatus of Claim 1 wherein said pivoting means is a cam follower.

6. A method for producing longitudinal rotation of a vessel having a longitudinal axis, in which there is provided an apparatus, adapted for placement in a centrifuge rotor in a centrifuge, said apparatus comprising:

10 (i) a cylindrical cup having an end adapted to receive said vessel when acted on by a centrifugal force generated by spinning said rotor;

(ii) a block surrounding said cup such that the block may freely move in a direction parallel to the longitudinal axis of said vessel when acted on by said centrifugal force;

15 (iii) a pivoting means wherein said pivoting means is attached internally to said block;

(iv) an oscillating means on said cup and attached to said block by said pivoting means, such that movement of the block in a direction parallel to the longitudinal axis of said vessel will cause said pivoting means to move in said
20 oscillating means; and

(v) a means for retarding the movement of said block, wherein said method comprises:

- 25 a) placing said apparatus in said centrifuge rotor;
b) placing a vessel in the cup of said apparatus;
c) beginning the spinning of the rotor of said centrifuge;



d) varying the speed of spinning said rotor such that as the rotor speed is decreased, the block of said apparatus is moved bi-directionally to rotate said cup; and

e) achieving longitudinal rotation of said vessel.

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7. The method of Claim 1 wherein said means for retarding the movement of said block is at least one spring.

8. The method of Claim 1 wherein said oscillating means on said cup is a continuous groove sinusoidally encircling said cup, and said oscillating means provides for movement in both a longitudinal and transverse direction.

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9. The method of Claim 4 wherein said oscillating means is a cam or a cam groove.

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10. The method of Claim 1 wherein said pivoting means is a cam follower.

