July 31, 1956 L. M. A. RIEUTORD ET AL 2,757,375

APPARATUS FOR AGITATING LIQUIDS, PARTICULARLY SUITABLE IN BLOOD TRANSFUSION OPERATIONS

Filed Oct. 6, 1953

2 Sheets-Sheet 1

Fig. 1

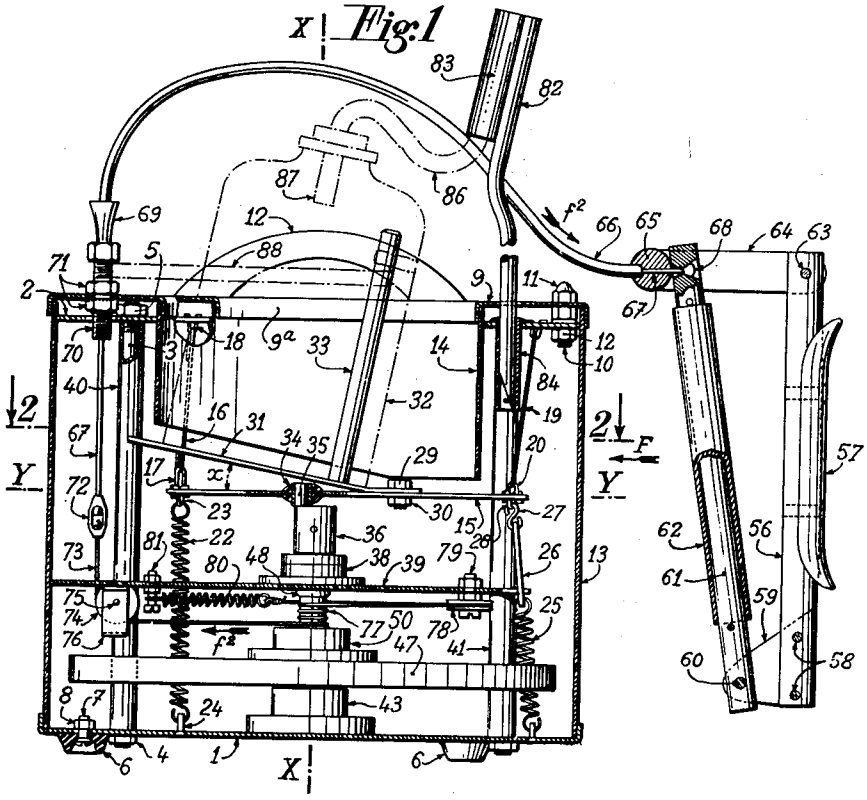
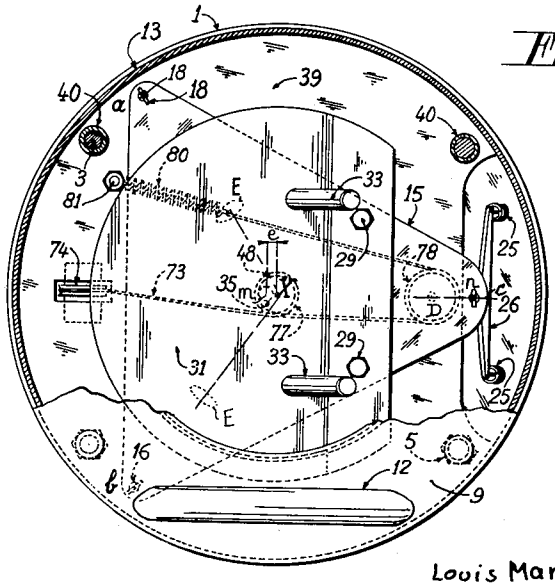


Fig. 2



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Filed Oct. 6, 1953 2 Sheets-Sheet 2

Fig. 3

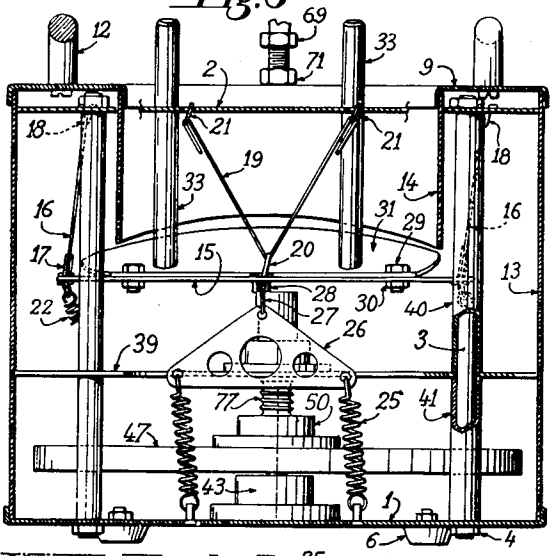


Fig. 5

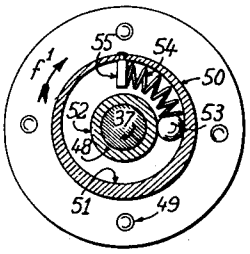


Fig. 6

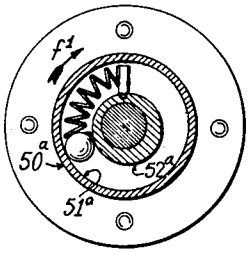


Fig. 4

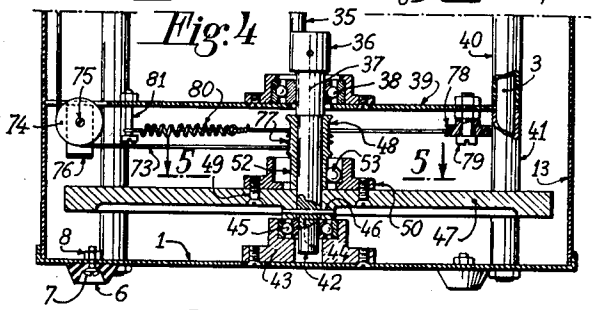
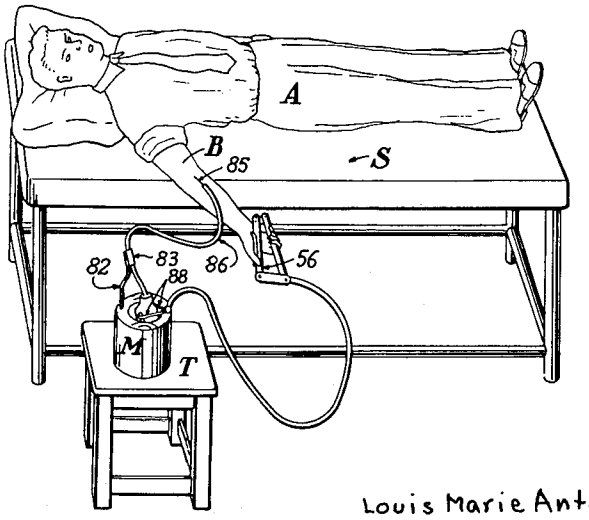


Fig. 7



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United States Patent Office 2,757,375 Patented July 31, 1956

2,757,375

APPARATUS FOR AGITATING LIQUIDS PARTICULARLY SUITABLE IN BLOOD TRANSFUSION OPERATIONS

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Application October 6, 1953, Serial No. 384,464

Claims priority, application France October 11, 1952

5 Claims. (Cl. 259—56)

The invention relates to apparatuses for agitating liquids with which it is possible to obtain homogeneous mixtures from several liquids; it relates more particularly to an apparatus with which it is possible during a blood transfusion to obtain an intimate mixture of the blood with an anti-coagulant liquid in which the blood is received.

It is known that when the agitation is imperfect, clots appear which, even if they are very small and even microscopic, render the blood useless, whence an important loss of a substance of considerable value.

The manual agitation by the nurse assisting at the blood transfusion cannot give sufficient guarantee of a perfect agitation and numerous agitating apparatuses have been proposed for use in particular in blood transfusions. These agitators are generally of the type in which a movement is given to the bottle containing the anti-coagulant liquid in which the blood is received during the transfusion. These apparatuses are actuated by an electric motor which generally ensures that the bottle is agitated, this bottle being maintained in a vertical position on a movable plate. These apparatuses present various disadvantages:

a. The agitation is often imperfect owing to the fact that a simple movement of revolution about a vertical axis is given to the contents.

b. These apparatuses necessitate the presence of electric supply in the neighbourhood of the blood transfusion operation. This is not always possible and, indeed, blood transfusions are often performed by mobile units distant from the normal blood transfusion centres. In this case, the power is generally supplied by long cables which considerably interfere with the operation of the unit.

c. The noise emitted by the driving mechanisms is troublesome, the more so as often several apparatuses operate simultaneously side by side.

d. Frequent breakdowns often occur due to the lack of electric power or due to the mechanism itself, which is relatively complicated.

The invention has for its object to provide an apparatus for agitating liquids which is simple in construction, very convenient to use, and which avoids all the aforementioned disadvantages. It comprises in combination: a plate reciprocative substantially in its own plane, an operating device adapted to be held in the hand by the blood donor, and connecting means between this device and said plate, by means of which the donor, in giving successive movements to this control device, is able to give a reciprocative movement to said plate.

Owing to this feature the apparatus no longer includes an electric motor and is therefore not subject to the breakdowns inherent in this kind of drive. On the contrary, use is made of the reciprocative movement obtained by the donor opening and closing his hand, which latter movement the donor is obliged to perform in order to quicken the blood circulation and thus increase the blood flow.

Furthermore, the fact that the blood donor is employed

to operate the agitating apparatus until the end of the blood transfusion counters the tendency of the blood donor to stop his movements after a certain lapse of time. Moreover, the mind of the blood donor is occupied during the blood transfusion, and this is psychologically advantageous. Experience has shown that, under these conditions, fainting or fainting fits are much less frequent.

Other features and advantages of the invention will appear from the ensuing description.

In the accompanying drawings, given solely by way of example:

Fig. 1 is a vertical longitudinal sectional view of an apparatus according to the invention.

Fig. 2 is a plan view thereof.

Fig. 3 is a side elevational and partly sectional view in the direction of arrow *f* of Fig. 1.

Fig. 4 is a sectional view thereof.

Fig. 5 is a view partially in section and on a larger scale along line 5—5 of Fig. 4.

Fig. 6 is a similar sectional view of a modification, and

Fig. 7 is a diagrammatic view in perspective showing the apparatus in use.

According to the illustrated embodiment, the apparatus comprises a support in the form of a cage which includes a lower plate **1** and an upper ring **2** connected by bars **3** screw-threaded at their ends and carrying nuts **4** and **5**.

The lower plate **1** is provided on its under face with supporting studs **6** of rubber or other resilient material, fixed by means of screws **7** and nuts **8** and arranged in such manner that when the apparatus is supported by these studs on a horizontal plane, the longitudinal axis XX thereof is vertical. The cage is preferably provided on the upper part thereof with a second finishing ring **9**. This ring is fixed to the ring **2**, for example by two small rods **10** and nuts **11** and **12** (see Fig. 1 in the upper left hand corner). Two diametrically opposed handles **12** are secured to this finishing ring **9** and enable the apparatus to be moved or transported.

The support unit is completed by a cylindrical case **13** disposed between the lower plate **1** and the ring **9** and encompassing the ring **2**, and a cylindrical skirt **14** concentric with the case **13** and fixed in the central opening of the ring **2** by welding or other means. The finishing ring **9** includes a flange **9a** which covers the upper edge of the skirt **14**.

In the cage is disposed, perpendicular to the axis XX, a plate **15** which is substantially triangular in shape. This plate is suspended, for example, in the following manner. Adjacent each of the points *a* and *b* (Fig. 2), the plate is connected to the upper ring **2** by two rigid rods **16** pivoted by universal joints or like means to the plate **15** and the ring **2**. These rods are, for example as illustrated, engaged by their hooked ends in anchor members **17** and **18** which are passed through holes provided in the plate **15** and the ring **9** and held to the latter by their formed over ends. The third point *c* is connected to the upper ring **2** by a metal wire **19** formed into a V-shape. This wire freely passes, at the apex of the V-shape, through an eye member **20** carried by the plate **15**, and its ends, which are formed into hooks, are engaged in eye members **21** fixed to the ring **2**. These eye members **21** are so disposed that the V-shaped wire lies in a plane perpendicular to the radial plane containing the apex of the V and the axis XX and which therefore coincides with plane of Figure 1.

At each of its points the triangular plate **15** is yieldingly connected by devices adapted to take up play, to the lower plate **1**. These devices, which are resilient, comprise, in respect of each point *a* and *b*, a spring **22** engaged in eye members **23** and **24** integral with the plates **15** and **11** respectively, and, with respect to the point *c*, two springs **25** (Figs. 1 and 2) connecting the

lower plate 1 to the two ends of a triangular plate 26 whose apex is connected by an S-shaped member 27 or the like to an eye member 28 fixed to the plate 15.

To this plate 15 is fixed, for example by means of bolts 29 and nuts 30, an inclined plate 31 which forms with the plane YY an angle x, preferably of the order of 15 degrees. A bottle 32 containing the anti-coagulant liquid is supported on this inclined plate 31. For purposes of maintaining this bottle 32 in place on the plate 31, the latter is preferably provided with two parallel rods 33 perpendicular to this plate.

For the purpose of imparting to the plate 15 a reciprocative movement substantially in its own plane YY, said plate is mounted, preferably through the medium of a resilient bushing 34 (Fig. 1), on an eccentric journal 35 integral with a boss 36 (Figs. 1 and 4). This boss is keyed to the upper end of a shaft 37 which is journaled in an anti-friction bearing 38 fixed to a horizontal plate 39. This plate is itself supported by the bars 3 which pass therethrough. It is held in position on these bars by spacer members 40 and 41 disposed on either side of the plate.

The shaft 37 is centred at its lower end 42 which is journaled in a pedestal 43 fixed to the lower plate 1. This shaft comprises, above the journal 42, a shoulder 44 by means of which it is supported on the inner ball race of a ball bearing 45 housed in the pedestal 43.

Disposed above this pedestal and keyed at 46 to the shaft 37, is a flywheel. This flywheel is connected by a free wheel device to a sleeve 48 mounted on the shaft 37 above the flywheel. The free wheel device is so adapted that a rotation of the sleeve 48 in the direction of arrow f^1 (Fig. 5) rotates the flywheel 47 and the shaft in the same direction. The rotation of the sleeve in the opposite direction has no action on the flywheel or the shaft. A rotation in the direction of f^1 of this flywheel and this shaft relative to the sleeve has, furthermore, no action on the latter. The free wheel device may be constituted for example as illustrated in Fig. 5 or Fig. 6.

With reference to Fig. 5, there is fixed on the flywheel 47, for example by means of rivets 49, a cup 50 the inner face 51 of which is eccentric relative to the vertical axis XX to which the smooth surface 52 of the sleeve 48 is concentric so that there is formed between these two surfaces 51 and 52 an annular space the radial width of which is variable. In this space is housed a ball or roller 53 which a spring 54, bearing against an abutment 55 integral with the cup 50, urges in the direction of arrow f^1 and wedges between said surfaces 51 and 52. As will be readily understood, when the sleeve 48 is driven in the direction of arrow f^1, the spring-loaded ball 53 wedges between the two aforementioned surfaces and the flywheel 47 is rotated. A rotation in the direction opposite to that of arrow f^1 of the sleeve 48 relative to the flywheel causes the release of the ball 53.

Referring now to the embodiment shown in Fig. 6, the cup 50^a comprises an inner surface 51^a concentric with the axis XX. In this example it is the sleeve 48 which includes a smooth eccentric surface 52^a. The operation is identical to that of the preceding example.

The apparatus is completed by means making it possible for the blood donor to rotate the sleeve 48 in the direction of arrow f^1 and thus rotate the flywheel 47 and the shaft 37 and maintain these members in rotation. To this end, the apparatus comprises a control device in the form of a hand grip (see Figs. 1 and 7) comprising for example a first member 56 preferably tubular and to which is attached a member 57 adapted to bear against the palm of the hand between the palm and the thumb. At one of the ends of the member 56 is secured, by rivets 58 or otherwise, a pivot member 59 on which is pivoted about a pivot pin 60 a second member comprising a tube 61 preferably provided with a sheath or barrel 62.

At the other end of the tube 56, there are pivoted about a pivot pin 63 two parallel arms 64 connected at their other ends by a spacer block 65. This spacer block serves as a support for the end of a cable sheath 66. A cable 67 movable in this sheath emerges from the latter and passes freely through the block 65 and is fixed at 68 to the end of the second member 62 of the hand grip. Hence by urging together the members 56 and 62 of the hand grip, the cable 67 is drawn in the direction of arrow f^2 (Fig. 1). The other end of the sheath 66 is engaged in a sleeve 69 extended by a screw-threaded end 70 which is passed through the rings 2 and 9 and is adjustable in height by means of nuts 71.

The cable 67 is prolonged beyond the tubular piece 69—70 and the end thereof is secured at 72 to a cord or the like 73. This cord is passed around a pulley 74 freely rotative about a pin carried by a bracket 76 fixed to the plate 39 and is then freely wound several times round the sleeve 48; after the latter the cord passes around another pulley 78 freely rotative on a vertical pin 79 carried by the plate 39 and is finally fixed at its other end to one of the ends of a spring 80 the other end of which is fixed to a pin 81 also carried by the plate 39.

The apparatus is completed by a rod 82 (Figs. 1 and 7) at the upper end of which is attached a support clip 83. The other end of this rod 82 is engaged in a socket 84 carried by the upper ring 2, the finishing ring 9 being provided with a clearance hole in line with the socket.

The apparatus is operated and functions in the following manner:

Let it be assumed that a blood transfusion is to be performed on a blood donor A. The latter is in a prone position on a table, bed or any other support S, he extends his arm B from which the blood is to be taken. The apparatus according to the invention is placed at the side of the blood donor on a stool T. The blood transfusion needle 85 is prolonged by a flexible tube 86 of rubber or other material which is engaged in the support clip 83 carried by the rod 82, and the lower end 87 (Fig. 1) of this tube is inserted in the bottle 32. The latter is placed on the inclined plate 31 and is maintained thereon by the two rods 33 and a number of elastic bands 88 stretched between these rods and the tubular piece 70.

As soon as the blood transfusion has started, the blood donor takes in his hand the hand grip as shown in Fig. 7, the member 56 of this hand grip is placed against his palm between the latter and the thumb, whereas his fingers pass around the barrel 62 of the tube 61. While the blood is passing through the tube 86 into the bottle 32, the blood donor successively opens and closes his hand and thus each time he closes his hand brings together the two members of the hand grip and draws the cable 67 in the direction of the arrow f^2 (Fig. 1). The cable draws the cord 73 in the direction of arrow f^2 (Fig. 1). Owing to the fact that the cord is wound at 77 around the sleeve 48 it causes the latter to rotate in the direction of arrow f^1 (Figs. 5 or 6) and this sleeve, through the medium of the above mentioned free wheel device, rotates in the direction of arrow f^1 the flywheel 47 and the shaft 37 connected thereto. As soon as the blood donor opens his hand, the action of the spring 80 causes the cord 73 to return to its initial position and draw back the cable 67 which spreads apart the members 56 and 61 of the hand grip. Meanwhile, the sleeve 48 rotates in the direction opposite to that of arrow f^1 about the axis XX, but this time without rotating the flywheel 47, which continues its rotation in the direction of arrow f^1 owing to its inertia.

The blood donor continues the operation, each closure of the hand grip corresponding to a new impulse communicated to the flywheel 47 which soon rotates at a substantially constant speed about the axis XX in the direction of arrow f^1. The successive impulses given to this flywheel compensate any loss of speed due to the various frictions which are, however, very slight, and above all compensate the resistance due to the actuation of the plate 15, the plate 31, the bottle and the mixture

of blood and anti-coagulant liquid contained therein. When the shaft **37** rotates, the journal **35** of the boss **36** communicates to the plate **15** in the plane YY a reciprocative movement which is the resultant of the following components:

a. The point *m*, which coincides with the axis of the journal **35** fixed to the shaft **37**, describes a small circle (Fig. 2) whose radius is equal to the off-set *e* of this journal.

b. The point *n*, at which the plate is connected to the apex of the V-shaped metal wire **19**, describes an arc having a centre located on the horizontal pivot axis through the connection of said wire **19** to the eye members **21**; this arc is projected on the plan view of Fig. 2 along the straight line D which, if prolonged, intersects the axis XX.

c. The abovementioned paths of movement, which are characteristic of the construction, are such that any point of the plate **15** describes a closed curve E which is very similar to an ellipse whose minor axis substantially intersects the axis XX.

As has been hereinbefore explained, owing to the fact that the bottle **32** is inclined relative to the axis XX to the extent of the angle *x* which the plate **31** makes with the plate **15**, the movement of this plate **15** does not result in a mere rotation of the liquid in the bottle **32** which would take on the form of a paraboloid of revolution. In the present apparatus this liquid is thrown against the walls of the bottle with a force sufficient to break up any tendency of the mixture to take on a regular movement of rotation and sufficiently small to avoid any deterioration of the blood. The agitation continues during the blood transfusion, since the blood donor continually actuates the hand grip with a regular motion. As has been explained, the work carried out by the blood donor, which is moreover not at all tiring, keeps the mind of the patient occupied while maintaining the arm B in the required condition for a good blood transfusion.

It should be noted, lastly, that the apparatus is very silent owing to the fact that the plate is suspended.

Although constructional details of the embodiments have been herein described, it is to be understood that many changes and modifications may be made therein without departing from the spirit of the invention or the scope of the appended claims.

For example, it is obvious that the free wheel device may be constructed in any way other than that described. The hand grip, instead of consisting of two members pivoted together in the form of a V, may comprise two members to which are imparted relative movements of translation which actuate the flywheel drive mechanism for example by means of a rack and pinion. The control device may be in fact of any type, for example a rubber bulb acting through the medium of a fluid on any member such as for example a piston which operates in turn a free wheel or the like by means of a rack and pinion or otherwise. The to and fro movement of the movable member of the hand grip relative to the body of the latter may be transformed into a movement of rotation of the flywheel **47** by means other than those described and illustrated. It will be clear, furthermore, that the apparatus although of particular use in blood transfusions, may be utilized for any other agitating operation, and in particular any time a thorough mixture of two or more liquids is required. This apparatus has, therefore, a special place in chemistry laboratories. Inasmuch as it is manually operated, the apparatus is extremely advantageous even in these latter applications for it is possible to carry it about the laboratory or workshop.

Having now described our invention what we claim as new and desire to secure by Letters Patent is:

1. Apparatus for agitating liquids and in particular a mixture of blood and an anti-coagulant product in the course of a blood transfusion, said apparatus comprising

in combination: a support constructed and arranged in the form of a vertical cage having an upper and a lower portion, a horizontal plate, suspension devices connecting said plate to said upper portion, resilient means connecting said plate to said lower portion, said resilient means being adapted to put under tension any play the plate may have relative to said support, said plate being free to move substantially in its own plane, a bottle for receiving the liquid to be agitated which is supported by said plate, means for securing the bottle to said plate, a control device adapted to be manually operated by the operator of the apparatus, and a connection mechanism which connects this control device to said plate and enables the operator to impart a movement to said plate substantially in the plane of the latter by means of successive actions on the control device.

2. Apparatus for agitating liquids and in particular a mixture of blood and an anti-coagulant product in the course of a blood transfusion, said apparatus comprising in combination: a support, constructed and arranged in the form of a vertical cage having an upper and a lower portion, a horizontal plate, suspension devices connecting said plate to said upper portion, resilient means connecting said plate to said lower portion, said resilient means being adapted to put under tension any play the plate may have relative to said support, said plate being free to move substantially in its own plane and including a support face which is inclined relative to said plate, a bottle for receiving the liquid to be agitated which is supported by said inclined support face and is therefore inclined relative to said plane, means for securing the bottle to said inclined support face, a control device adapted to be manually operated by the operator of the apparatus, and a connection mechanism which connects this control device to said plate and enables the operator to impart a movement to said plate substantially in the plane of the latter by means of successive actions on the control device.

3. Apparatus for agitating liquids and in particular a mixture of blood and an anti-coagulant product in the course of a blood transfusion, said apparatus comprising in combination: a support, a plate suspended on the latter in such manner as to be capable of moving substantially in its own plane, a bottle for receiving the liquid to be agitated which is supported by said plate, a shaft rotatively mounted in said support and disposed substantially perpendicular to said plane, an eccentric member which is eccentrically disposed relative to the axis of rotation of said shaft and is integral with the latter, said member being operatively connected to said plate, a free wheel device mounted on said shaft, a control device adapted to be manually operated by the operator of the apparatus and comprising two members capable of moving relative to each other, and a connection mechanism operatively connecting one of said members to said shaft, said connection mechanism comprising a cable in a flexible sheath, a cord, a sleeve connected to said free wheel device, said cord being connected at one of its ends to said cable and at its other end to a tension spring and being wound round said sleeve, the other end of said cable being connected to said one of said members of the control device, whereby when the latter moves the cable in its sheath this cable causes the sleeve to rotate which in turn through the medium of the free wheel device rotates said shaft controlling the movement of said plate.

4. Apparatus as claimed in claim 3, wherein suspension devices are provided for suspending said plate at three points situated at the points of a triangle having substantially as centre the point at which said eccentric member is operatively connected to the plate, two of said suspension devices comprising rods pivoted by means of universal joints to the plate and to the support, whereas the third suspension device is so arranged that the corresponding point of the plate is constrained to describe a small arc which lies in a plane which is perpen-

dicular to the plate and substantially contains said centre, said third suspension device comprising a V-shaped rod, an eye member pivotally connected to the plate so as to pivot about an axis lying substantially in the plane containing said arc, the part of said V-shaped rod at which the limbs of the V meet being loosely connected to said eye member, and said V-shaped rod lying a a plane perpendicular to the plane containing said arc.

5. Apparatus for agitating liquids, and in particular a mixture of blood and an anti-coagulant product in the course of a blood transfusion, said apparatus comprising in combination: a support having an upper portion and a lower portion; a plate provided with a support face inclined relative to the horizontal; a bottle for receiving the fluid to be agitated supported on said support face; three suspension devices connecting said plate at three different points thereon that are substantially symmetrically equispaced about a centre, to said upper portion, two of said suspension devices each comprising a rod and universal joints at each end of this rod for its connection to the plate and the upper portion, and the third suspension device comprising a rod formed into a V-shape, the base of which is disposed adjacent said plate, connection means connecting the ends of the V-shaped rod to said upper portion and the base of the V-shaped rod to said plate, this V-shaped rod lying substantially in a vertical plane which is perpendicular to a vertical plane containing said centre and the base of the V-shaped rod, and said connection means being so constructed and arranged as to allow said plate to move a limited amount in any direction substantially in a horizontal plane; resilient means yieldingly connecting said plate to said lower portion; plate shifting means comprising a vertical shaft rotatively mounted on said support and substantially concentric with said centre, a journal integral with said shaft

and eccentrically disposed relative to the axis of the latter, a resilient bushing connecting this journal to said plate substantially at said centre, a sleeve rotatively mounted on said shaft, a flywheel concentric with and fixed to the latter, a free wheel device operatively connecting said sleeve to said flywheel in such manner that the latter is free to rotate in one direction relative to said sleeve and drives the latter in rotation when it rotates in the opposite direction, a cord wound round said sleeve and connected at one end thereof by a spring to said support, a control device comprising two assembled members capable of relative movement; connection means operatively connecting said control device to said cord, said connection means comprising a cable, a flexible sheath for the latter, said cable being connected at one end thereof to one of said members and at the other end to said cord at the end of the latter remote from said spring, and said flexible sheath being connected at one end thereof to said other member and at the other end to said support, whereby when said members are moved in one direction relative to one another said cord is displaced with respect to said flexible sheath and causes said shaft to rotate and agitate the contents of said bottle.

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