March 24, 1936. L. E. V. J. HENRY 2,035,159

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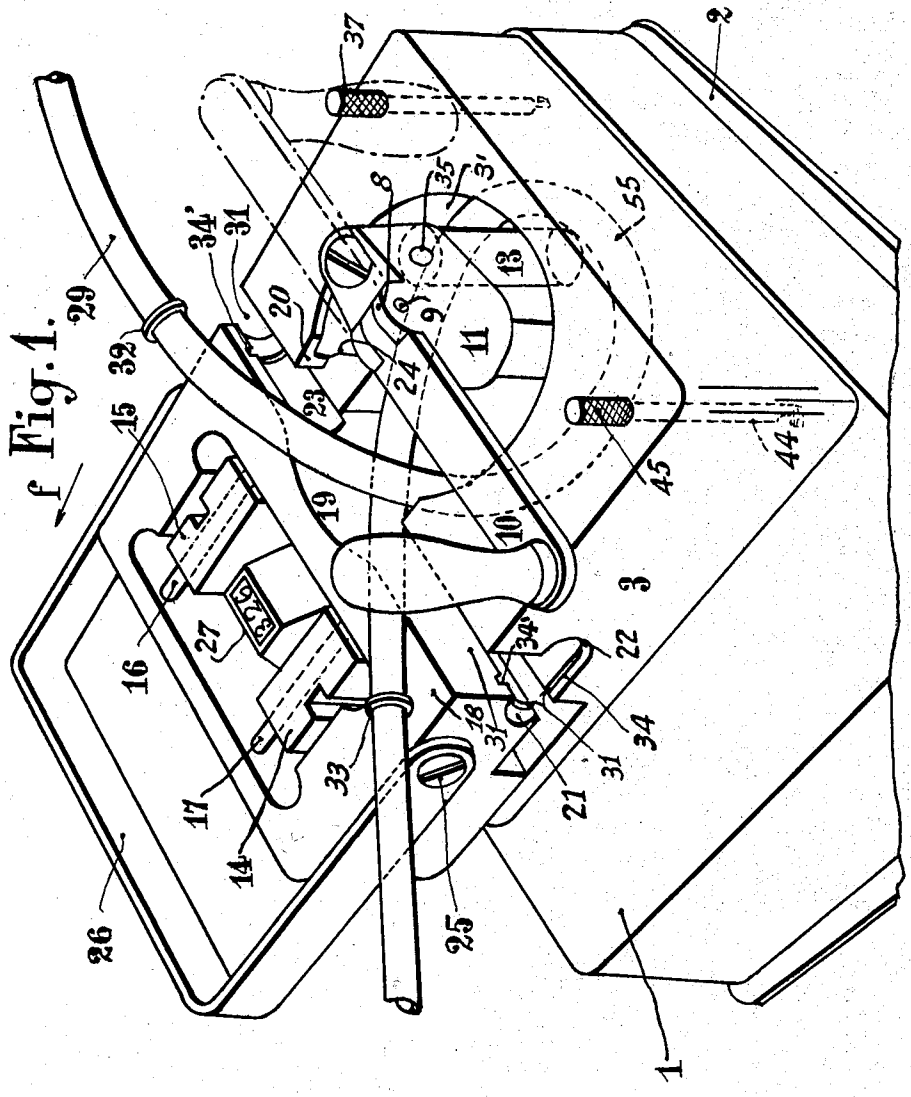
Fig. 1.



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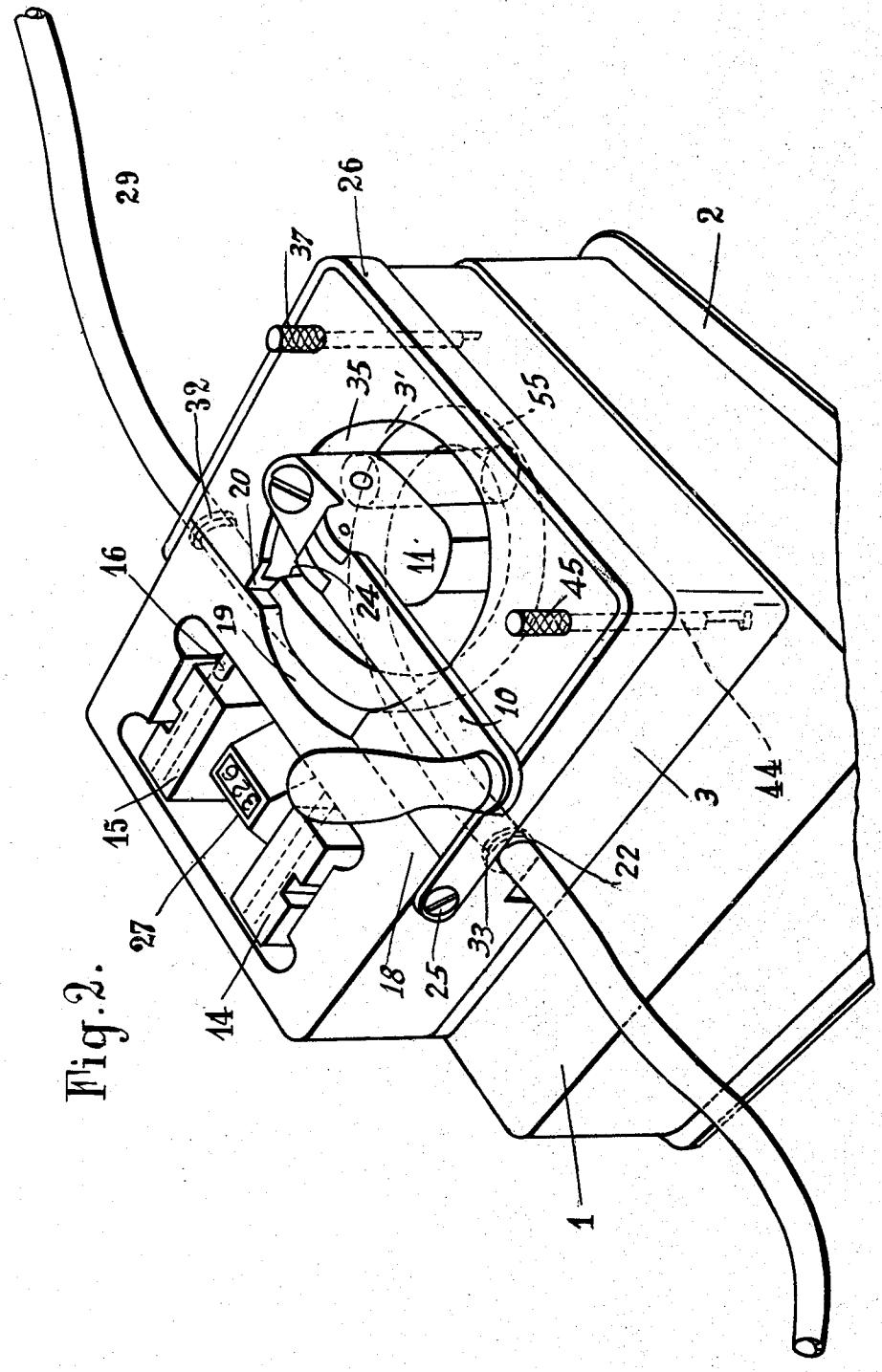

Fig. 2.

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Fig. 4.

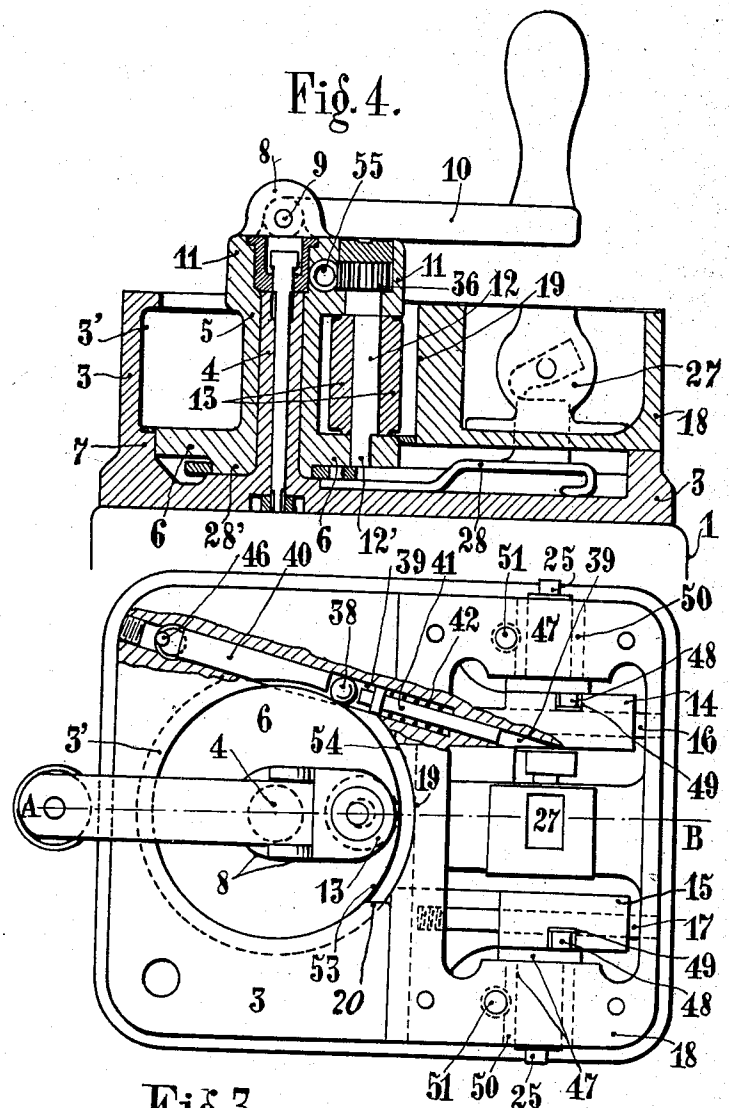

Fig. 3.

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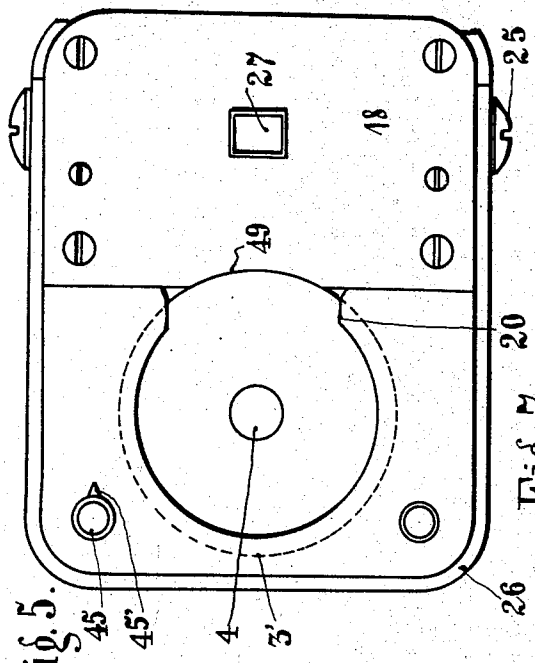

Fig. 5.

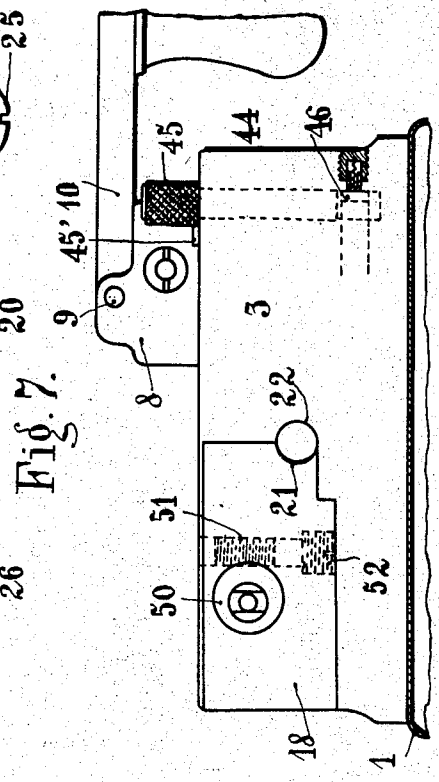

Fig. 7.

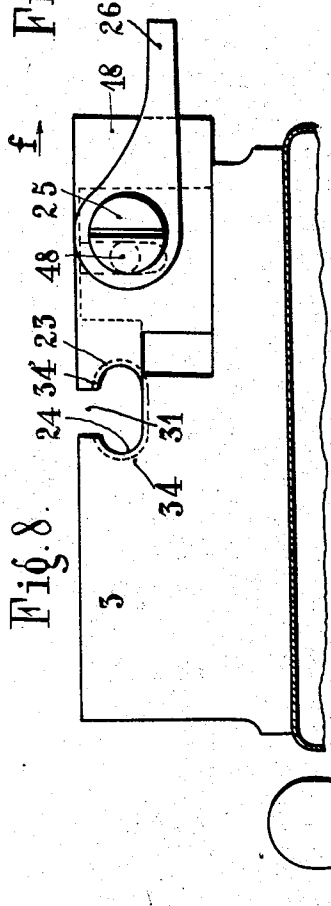

Fig. 8.

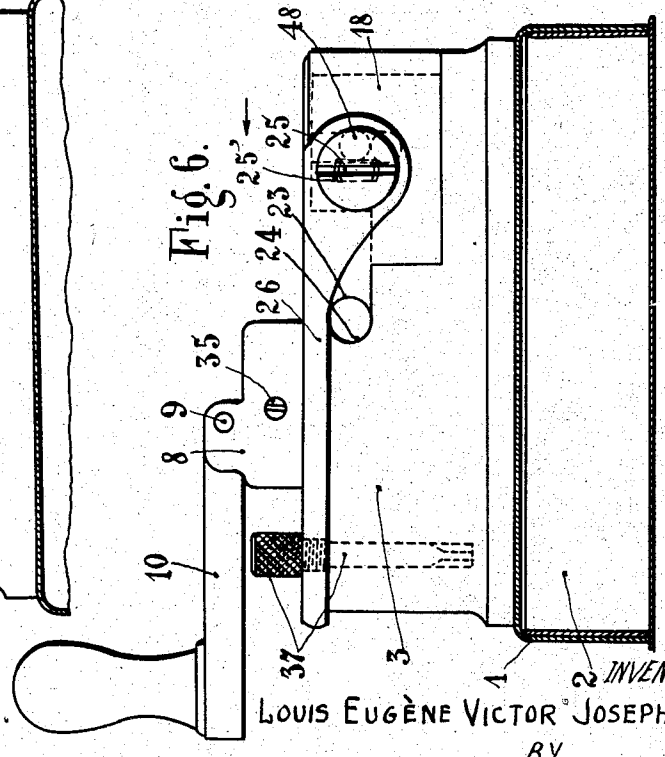

Fig. 6.

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Patented Mar. 24, 1936 2,035,159

UNITED STATES PATENT OFFICE

2,035,159

PUMP

Louis Eugène Victor Joseph Henry,
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Application September 20, 1934, Serial No. 744,843
In Luxemburg September 25, 1933

3 Claims. (Cl. 103—149)

The present invention relates in general to a device for pumping fluids, semi-fluids, and syrupy, pulverous or other substances, and more particularly has reference to a pumping device including a tube made of elastic material which is successively deformed under the action of a suitable member and allowed to return to its original form as a result of its elasticity.

In a preferred form of the present invention, more particularly adapted to the transfusion of blood or other medical or surgical operations, the pumping mechanism is mounted upon a base forming a casing provided with a removable bottom, intended to contain the accessories utilized in the operation of the device, so that they will be always within reach of the operator.

Another characteristic of the device consists in the use of a single wide roller of large diameter, which acts upon a loop of the tube, positioned in a suitable casing. The free ends of the said tube, are connected to suction and compression conduits, respectively.

Due to this particular arrangement, a chamber of large volume is obtained, and all churning of the blood or of other substance passing through the tube is avoided, the deformation of the tube being produced progressively over a long section thereof.

A third characteristic of this device resides in the control of the single roller mentioned above, by means of a crank or other suitable member for revolving it indifferently in both directions, or in one direction only, this latter possibility preventing all false movements, which is extremely important in the case of blood transfusion.

The said control member is, besides, combined with a hodometer to measure the output of the pump in direct relation to the number of revolutions of the rotor which supports the roller.

The device also includes means associated with the single roller mentioned above to vary the spacing of the roller from the side of the casing which serves as a bearing surface for the deformation of the tube, so as to permit the use of tubes of various sections.

Another feature of the present invention resides in the fact that the casing containing the mechanism has a movable part, combined with a play compensating device, which permits, when it is separated and drawn apart from the fixed part, the tube to be easily placed in position without having to touch its ends, or to bring them into contact with any part of the apparatus. As a consequence these ends are not exposed to the risk of being soiled or contaminated and the apparatus may be utilized without any previous aseptic treatment.

The accompanying drawings illustrate, by way of example, one form of the invention.

Figure 1 is a perspective view of the apparatus, the cover being removed and the parts of the apparatus being separated to permit placing the elastic tube in position.

Figure 2 is a view corresponding to Figure 1, but with the tube shown in its working position and the device ready to operate.

Figure 3 is a plan view seen from above the apparatus, with a part torn away, to show the device which ensures the irreversibility of the control member.

Figure 4 is a sectional view along line A—B of Figure 3.

Figure 5 is a plan view seen from above the apparatus, the mechanism acting on the tube being removed.

Figure 6 is a side elevation showing the apparatus in working position.

Figure 7 is a view corresponding to Figure 6, but with the hand crank turned upside down.

Figure 8 is a detailed view showing the parts of the casing, separated to permit placing the elastic tube in position.

The apparatus of the present invention is mounted on a hollow base 1 provided with a removable bottom 2 which serves as a receptacle for the accessories required for use of the apparatus.

Mounted on base 1 is a block 3 provided with a cylindrical chamber 3' which serves as the casing of the pumping mechanism. It will be noted that an opening 20 is formed in one side of block 3 providing access to the chamber 3' and that this same side of the block 3 is provided with grooves 22 and 24 and two small furrows 34. The purpose of the opening 20 and grooves will be described hereinafter.

As shown in Fig. 4, a shaft 4 is supported by block 3 coaxially of the chamber 3'. A hub 5 is freely rotatably mounted on shaft 4 and is integral with a plate 6 which revolves in the circular space confined by the shoulder 7 formed in the lower portion of the chamber 3'. The upper portion of hub 5 is formed to provide a boss 11. A pair of spaced lugs 8 are formed on the upper surface of boss 11 and carry a pin 9 on which one end of crank arm 10 is pivoted.

As shown in Fig. 4, boss 11 extends to one side and cooperates with plate 6 to support axle 12 parallel to shaft 4. The portion of axle 12, extending between plate 6 and boss 11 about which

roller 13 revolves, is eccentric relative to the portions extending through plate 6 and boss 11. With this construction, the distance between the axis of roller 13 and the cylindrical wall of chamber 3' can be varied by rotating axle 12. For this purpose a pinion 36 is affixed on the upper end of axle 12 and is rotated to desired positions by a cooperating worm 35 mounted in boss 11.

Block 3 is provided with two bosses 14 and 15 (Figs. 1, 2 and 3), having longitudinal holes for receiving two rods 16 and 17 carried by a sliding block 18. The latter is hollowed out to receive bosses 14 and 15 and a hodometer 27. One side of block 18 is recessed in the form of a portion of a cylinder 19 adapted, as shall be explained further on, to close opening 20. Block 18 is provided with two grooves 21 and 23, as well as two furrows 34', corresponding respectively to half grooves 22 and 24, and to furrows 34 already mentioned above.

Sliding block 18 may be drawn close to, or pulled away from, block 3, its guiding being ensured by rods 16 and 17, which slide in bosses 14 and 15. Displacements of block 18 are obtained by means of a double lever 26, mounted to pivot in 25, on block 18.

As shown in Fig. 3, each of the extremities of the double lever 26 is secured to a stub shaft 47 by means of screw 25. Each shaft 47 has an eccentric pin 48 on the free end thereof loosely positioned in a groove 49, provided in the bosses 14 and 15 of block 3. It can be conceived, therefore, that when double lever 26 is swung from the closed position as shown in Figures 2 and 6, to its opened position as shown in Figures 1 and 8, pins 48 cause sliding block 18 to slide in the direction of arrow *f*.

By reversing the movement of double lever 26, sliding block 18 is drawn close to block 3 until part 19, mentioned above, adapts itself to opening 20 and thus completes the periphery of casing 3' which, thence, has the shape of a complete cylinder. In this position, grooves 21—22, and 23—24, are brought against each other thus forming two cylindrical channels intended to receive the elastic tube (Figures 2, 6 and 7). It is to be noted that these channels are located at two different levels.

It may be noted, also, that in order to permit the setting in height of the double lever 26, so that it may not project above the upper plane of blocks 3 and 18, shafts 47, upon which the ends of this double lever are clamped, are engaged in long holes provided for them in the ends of the said double lever.

Under these conditions, after blocks 3 and 18 have been adjusted, the double lever is clamped fast in its correct position by means of screws 25 which are screwed in shafts 47. On the other hand, in order that, when the double lever 26 is in its closed position, sliding block 18, may be exactly applied without any play against block 3, an adjusting device has been provided to take up the play that may result from wear of shaft 47 and pin 48 or of their bearing points. This device comprises a bearing 50 (Figures 3 and 7) mounted to fit easily in a recess provided in block 18 and having a hole to receive axle 25, eccentrically provided therein as shown in Fig. 7. The outside of the bearing is provided with teeth which mesh with a worm 51, which can be controlled from outside and which cooperates with a thrust block 52. By acting upon worms 51, it is possible to displace the shafts 47 and pins 48 in such a way as to permit an accurate adjustment of block 18 against block 3.

The apparatus above described is utilized in the following manner:

To put in place the elastic tube 29, which is provided with circular rings 32 and 33, double lever 26 is swung backward to the position indicated on Figure 1. The swinging of the lever causes the sliding of block 18 in the direction of arrow *f*, and the spacing apart of blocks 3 and 18, thus creating between them a gap 31. To put tube 29 in place, roller 13 is brought in front of opening 20 above mentioned, by means of crank 10, so as to occupy the position shown in Figure 3. In this position, there exist, on either side of the said roller, entirely free passages 53 and 54. Tube 29 is placed in empty space 31, with its ring 33 set in furrow 34 and after having been passed through passage 53, it is formed into a loop 55 (Figure 1) of the same diameter as casing 3' which contains it. It is then made to pass through passage 54, and led out of the apparatus through the free part of empty space 31, ring 32 being at the same time engaged in the corresponding furrow 34'. Double lever 26 is then swung forward to its closed position thus drawing together blocks 18 and 3, and enclosing parts of tube 29 in the channels formed by grooves 21 and 22, and 23—24 (Figures 2, 6 and 7).

By acting upon crank 10, roller 13 is displaced along the length of loop 55 which it deforms against the sides of casing 3'. This deformation produces compression of the fluid in the portion of the tube toward which the roller advances, and the tendency of the tube to assume its original form creates a suction in the portion thereof over which the roller has passed.

As shown in Fig. 4, the lower portion of plate 6 carries an eccentric 28' which has a connecting rod 28 associated therewith for actuating the hodometer 27. At each revolution of crank 10, the hodometer receives an impulse through connection 28—28' and, as explained above, provides means to compute the output of the pump in terms of the number of revolutions of the crank.

Well known and conventional means are provided to release the hodometer when sliding block 18 is drawn apart from block 3.

The present invention embodies mechanism for compensating for the variation in wall thickness of tubes. This mechanism includes the worm 35, described hereinbefore, for adjusting the spacing of roller 13 from the wall of chamber 3'. A screw driver 37 for making the adjustment may be received in a suitable socket, as indicated in the drawings.

As described so far, the apparatus is reversible and in order to make it irreversible, a blocking system, such as that shown in detail in Figure 3, is preferably utilized. This device consists essentially of a ball 38, lodged in a channel 39, in which an opening is provided laterally to allow ball 38 to come into contact with the periphery of plate 6. This ball 38 is placed between two pistons 40 and 41, piston 41 being subjected to the action of a spring 42. In normal operation of the apparatus ball 38 is kept out of contact with the periphery of plate 6, and this plate may be made to revolve freely in either direction (left or right), no braking action being exercised upon it. To permit rotation in a single direction only, for example from left to right, it is necessary to bring ball 38 into contact with plate 6. For this purpose, the back of piston 40 is acted upon by means of a cam

46, controlled from the outside by means of a knob 45.

In Figure 3, the ball is shown in braking position on plate 6, cam 46 being without action on piston 40. To bring the said ball into neutral position, it is sufficient to make the cam revolve by means of milled knob 45, so that this cam pushes piston 40 and, consequently, ball 38 which ceases to be in contact with plate 6. Cam 46 is combined with a device which ensures its locking in its two extreme positions. An index 45' rigid with knob 45, indicates these two positions.

I claim as my invention:—

1. A pump of the character described, comprising a block having a cylindrical chamber formed therein and a lateral opening in one wall providing access to said chamber, a second block mounted for sliding movement toward and away from the side of said first-mentioned block provided with an opening, a resilient tube having a loop, the cooperating sides of said blocks having grooves formed therein operable when said blocks abut each other for supporting the loop of the resilient tube in said chamber with the tube against the inner wall thereof and the free ends of the tube projecting through said lateral opening, means in said chamber for pressing the resilient tube against the wall of the chamber, and means for moving the pressing means along the wall and tube to create a flow through said tube.

2. An apparatus for transfusion of blood, comprising an elastic tube, a fixed casing and a part removable from the fixed part for positioning the elastic tube therebetween and in said casing, means for taking up the play between the movable and fixed parts of said casing, a roller for deforming the tube, and means for moving said roller along the tube positioned in said casing to create a flow through the tube.

3. An apparatus for transfusion of blood, comprising an elastic tube, a fixed casing and a part removable from the fixed part for positioning the elastic tube therebetween and in said casing, means for taking up the play between the movable and fixed parts of said casing, a roller for deforming the tube, means for moving said roller along the tube positioned in said casing to create a flow through the tube, means for preventing reversal of the roller moving means consisting of a conduit provided in said casing, two pistons arranged in said conduit and a ball positioned in said conduit between said pistons, a disc associated with the means for moving the roller and projecting into said conduit, a spring engaging one piston to urge the ball to a wedging position between the wall of the conduit and the periphery of the disc to prevent rotation of the disc in one direction, and cam means for actuating the other piston to shift the ball against the action of the spring away from the wedging position.

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