

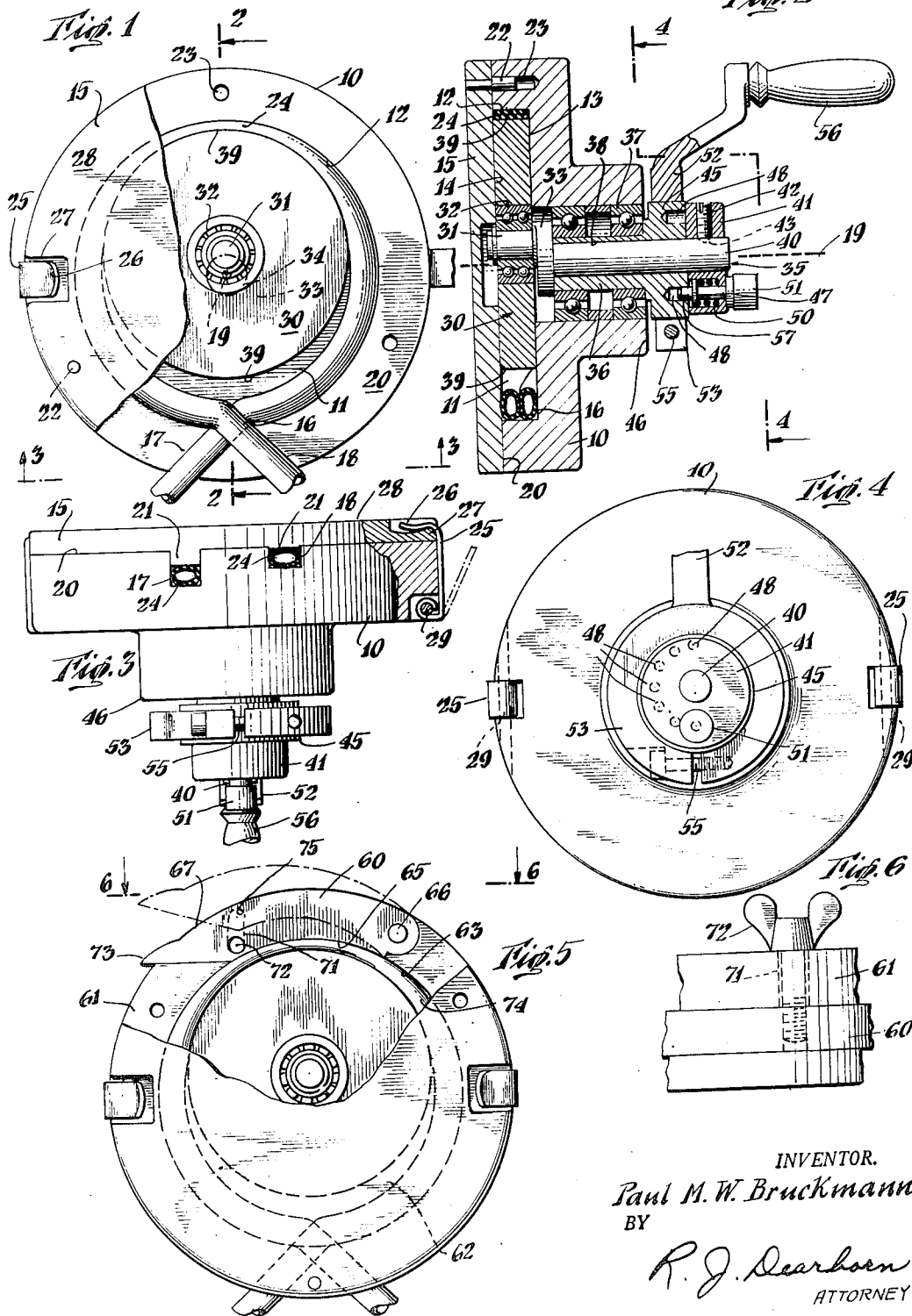
June 1, 1954

P. M. W. BRUCKMANN

2,679,807

PUMPING DEVICE

Filed June 1, 1951



INVENTOR.
Paul M. W. Bruckmann.
 BY
R. J. Dearborn
 ATTORNEY

UNITED STATES PATENT OFFICE

2,679,807

PUMPING DEVICE

Paul M. W. Bruckmann, Alpine, N. J., assignor to
The De Florez Company, Inc., New York, N. Y.,
a corporation of Delaware

Application June 1, 1951, Serial No. 229,373

2 Claims. (Cl. 103-149)

1

This invention relates to pumping apparatus and is particularly concerned with an improvement in apparatus of the type for moving fluid through a flexible tube having resilient walls, the apparatus being adapted to be readily disposed between the ends of the flexible tube to pump fluid in either direction through the tube and also to permit the fluid to move freely through the tube without disengaging it from the pump.

The apparatus is constructed so that it may be operatively connected or disconnected without the necessity of disturbing either end of the tube. The pumping devices in which this invention is particularly useful are those of the type described in my copending application Serial No. 210,403 filed February 10, 1951, now Patent No. 2,651,264, in which a loop of tube is disposed in a cylindrical chamber and the pumping action is obtained by compressing successive contiguous areas of the tube between a rotating member and the wall of the chamber.

As noted in the above referred to patent application, the tube which is disposed in the chamber has a tendency to creep during the operation of the pump and, to counteract this creeping action, certain prior devices have sought to anchor the tube against the cylindrical wall of the chamber. To achieve the desired anchoring effect, special tubes have been used which were provided with flanges or projections adapted to be received in suitable recesses in the cylindrical wall of the housing.

In the applicant's copending application, means are described and claimed for substantially eliminating the creeping action of the tube during operation by providing constrictive passageways into the chamber of the pumping device to hold the ends of the tube against the creeping. In order to remove the tube from the prior devices, it was generally necessary to disconnect one of the ends of the tube from its receiving or delivery vessel so that the ends could be threaded through the entrance and exist holes provided in the wall of the chamber.

The copending application describes and claims suitable means for positioning the tube in the pumping device while both of the ends are suitably connected to their receiving and delivery vessels. The copending application also discloses and claims means for compensating for irregularities in the wall thickness of the tube and also means for receiving tubes of slightly different diameters.

The invention described herein relates to an improvement in pumping devices whereby the

2

compressive means, for pumping the fluid through the tube by compressing successive contiguous areas of the tube in a cyclical operation, can be released to permit the fluid to flow freely through the tube by gravity or by other means outside the pump without removing the tube from the pump.

An important object of the present invention therefore is to provide a device in which a standard flexible tube may be used in a pumping device and may have fluid pumped through the tube or be free to allow fluid to run freely through the tube without the action of the pumping device but while the tube is in position in the pumping device.

Another object of the invention is to provide a device which can be connected to and disconnected from the tube without disturbing the ends of the tube or contaminating the inside of said tube and also to provide a device which will selectively permit fluid to be pumped through the tube or to flow freely therethrough.

A still further object of the invention is to provide a means whereby tubes of substantially different diameter may be used in the pumping device and various sized tubes may be prevented from creeping during the operation of the pump.

A still further object is to provide a means whereby the pumping member or a portion of the chamber wall may be moved out of compressive position with respect to the other to permit the tube to be positioned or removed easily from its looped arrangement adjacent the chamber wall.

The invention includes a pumping device for moving fluid through a flexible tube by compressing successive contiguous areas along a length of said tube during each pumping cycle. The device comprises a chamber having a cylindrical wall, a floor portion, and an open end. A cover is adapted to be removably positioned on said open end. The cylindrical wall may be formed with at least one opening therein. The chamber is adapted to receive a loop of tube positioned adjacent the chamber wall, the ends of the tube extending out through the opening. The wall of the chamber is of sufficient axial length to accommodate the tube when in compressed condition. A cylindrical pumping member having a diameter smaller than the cylindrical wall of the chamber is rotatably mounted in the chamber on means for moving the pumping member in a path about the axis of the cylindrical wall so that successive areas of the periphery of the pumping member compress successive contiguous areas along the length of the tube, against the

cylindrical wall, during each cycle of the pumping member in the path about the axis of the cylindrical wall.

The device includes means for moving either the pumping member or at least one portion of the chamber wall out of compressive relation to each other, with respect to the tube disposed between the periphery of the pumping member and the wall. The device also includes means for constrictively engaging the portions of the tube passing through the opening in the chamber wall when the removable cover for the chamber is in position on the chamber.

A more complete description of the invention is given below with reference to the attached drawings in which:

Fig. 1 is a plan view of one form of apparatus embodying the invention;

Fig. 2 is a cross-sectional view taken along the line 2—2 in Fig. 1;

Fig. 3 is a side view of the apparatus taken along the line 3—3 in Fig. 1;

Fig. 4 is a top view of the apparatus as viewed along the line 4—4 in Fig. 2;

Fig. 5 is a plan view of an alternate form of the invention; and

Fig. 6 is a fragmentary view of the alternate form taken along the line 6—6 in Fig. 5.

The pumping apparatus includes a housing 10 which has a chamber 11 defined by the cylindrical wall 12, a floor 13, and the inside face 14 of the removably positioned cover 15. The wall 12 is formed to define at least one opening 16 in its cylindrical surface. The chamber 11 is adapted to receive a loop of tube 24 which is positioned adjacent the cylindrical wall 12 with two portions of the tube extending through the opening 16. The opening may branch into diverging channels 17 and 18. The opening 16 extends substantially from the floor 13 of the housing 10 to the face 20 of the housing. The channels 17 and 18 also extend to the face 20 of the housing, the channels being at respectively different levels as best shown in Fig. 3 to permit the portions of the tube 24 to cross each other as they pass through the opening 16 in the manner shown in Fig. 2. The channels 17 and 18 may be arranged to extend in diverging directions away from the opening at angles substantially tangent to the cylindrical wall so that the tube is not bent sharply as it passes out of the chamber 11.

To prevent the tube from creeping during the operation of the pump, the channels 17 and 18 may be of a diameter slightly smaller than the diameter of the tube, in accordance with the disclosure of my copending application, Serial No. 210,403 filed February 10, 1951, now Patent No. 2,651,264.

Another suitable means for holding the tube 24 in position in the channels is illustrated in the apparatus shown in Figs. 1 and 3 wherein the channels 17 and 18 are of substantially the same or even of greater diameter than the diameter of the tube to be received in the channels. Projections 21 are provided on the cover 15 which extend into the channels 17 and 18 and constrictively engage the tube disposed in said channels.

The cover 15 may be provided with any suitable means for removably securing it on the face 20 of the chamber 10 to close the cylindrical chamber 11. In the forms shown in the drawings, the cover is provided with dowel pins 22 to prevent the rotation of the cover with respect to the housing and to correctly position the projections 21 with respect to the channel openings 17

and 18. Holes 23 are formed in the face 20 of the housing 10 to receive the dowel pins in the desired position. The cover 15 may be maintained on the face 20 by suitable means such as spring clips 25 which may be pivotally mounted at 29 to the housing 10 so that they may be moved up to engage the cover 15 as best shown in Fig. 3. The outer end 26 of each spring clip 25 is formed to cam over the shoulders 27 which are provided in the outer surface 28 of the cover 15 to lock the cover in position when the spring clips 25 are in the position shown in Figs. 1 and 3.

In order to remove the cover, the ends 26 of the spring clips 25 are pressed upwardly and outwardly so that the ends of each pass over the respective shoulders 27 with which they are engaged. The cover 15 may then be lifted off the housing 10.

A cylindrical pumping or compressing member 30 may be mounted in the chamber 11 for rotation about its axis on the shaft 31, suitable bearing means 32 being interposed between the shaft and the cylindrical pump member 30. The pumping member may be maintained on the shaft 31 by suitable means.

The shaft 31 is eccentrically fixed with respect to the axis of the crank shaft 35 on the disc 33. The disc 33 is fixed on the crank shaft 35 as best shown in Fig. 2. A bushing 36 is rotatably and concentrically mounted with respect to the axis 19 of the cylindrical wall 12 in bearing housing 37. The bushing 36 is formed with a bore 38 which is eccentric with respect to the axis 19 of the cylindrical wall. The bore is of a size to receive the crank shaft 35 in rotatable position therein. The end 40 of the crank shaft 35, extending beyond the housing, is provided with a collar 41 which is fixed on the shaft 35 by means of the set screw 42 engaging in a recess 43 formed in the crank shaft. The bushing 36 is provided with an enlarged portion 45 which may be integral with the bushing and is interposed between the collar 41 and the outer end 46 of the housing. A locking pin 47 extends through the collar 41 and is adapted to engage in holes 48 tapped in the enlarged portion 45 of the bushing 36. A spring 50 may be provided to urge the locking pin into position in one of the holes 48 and a knob 51 may be provided at the end of the locking pin to facilitate grasping of the pin when it is desired to move it out of its position in one of the holes 48. Suitable means for rotating the bushing may be provided, such as the crank 52 which is releasably fixed on the portion 45 of the bushing by means of the expanding collar 53 which is locked in place by the screw 55. A handle 56 may be provided on the arm of the crank 52.

When the locking pin 47 is in the position shown in Fig. 2, in which the end 57 of the pin is seated in one of the holes 48 of the enlarged portion 45 of the bushing 36, the crank shaft and the bushing are locked together and consequently the crank shaft 35 is rotated when the bushing 36 is rotated.

By moving the locking pin out of the hole 48, shown in Fig. 2, the crank shaft 35 can be rotated with respect to the bushing 36 so that the relative eccentricity of the crank 31 may be changed with respect to the axis 19 of the cylindrical wall.

In the position shown in Fig. 2, wherein the crank shaft 35 is eccentrically offset from the axis 19 of the cylindrical wall in the same direction as the offset of the shaft 31 from the shaft 35, the periphery 39 of the pumping member com-

presses the tube 24 against the cylindrical wall 12.

If the locking pin is released and the crank shaft 35 is rotated 180° with respect to the bushing 36, the crank shaft will be eccentrically offset with respect to the axis 19 of the cylindrical wall in a direction opposite to that of the offset of the shaft 31 with respect to the crank shaft 35, the effect of the two oppositely disposed offsets being to substantially equalize each other and cause the shaft 31 to be moved toward the axis of the cylindrical wall 12. In such position, the periphery of the pumping member will not compress the tube 24 against the cylindrical wall 12.

In operation, with the tube looped in the chamber as shown in figures, and the cover 15 fixed in position on the housing in the manner described and, with the pumping member in the position to compressively engage the tube against the cylindrical wall, the bushing 36 and the crank shaft 35 locked with the bushing 36 may be rotated by turning the crank 52 by means of the handle 56. The pump may be operated in either direction to effect the pumping action which is obtained by milking the tube, i. e. compressing successive contiguous areas thereof. The rotation of the bushing 36 with the crank shaft 35 locked therein causes the shaft 31 to move in a circular path 34 indicated in dotted lines in Fig. 1 about the axis 19 of the cylindrical wall 12.

As the pumping member 30 is caused to move in the circular path 34, successive areas of the periphery 39 of the member 30 compress successive areas of the tube 24, the member 30 rotating about its own axis 31, while the axis 31 moves in the circular path 34 about the axis 19. As the successive compressions are exerted on the tube 24 by the member 30, fluid in the tube 24, ahead of the point of compression, is forced through the tube in a direction in which the member 30 is moving in the path 34. If liquid is not in the loop of the tube 24 contained in the pump chamber 11 at the beginning of the pumping operation, the movement of the pumping member 30 around the cylindrical wall successively compressing areas of the tube 24, causes the air to be pushed from the tube in front of the liquid to be pumped through the tube so that the liquid is drawn into and through the pump by syphoning action. The recovery characteristics of the tube after compression creates sufficient vacuum to refill the loop so that a steady flow may be maintained by continuously rotating the member 30. The direction of flow of the liquid through the pump may be changed by changing the rotational direction of the bushing 36 and the crank shaft 35 locked therein.

The improvement of providing a means for releasing the pumping member 30 from compressive engagement with the tube 24 against the cylindrical wall 12 is of considerable advantage because initially, when the tube is to be placed in the pumping chamber 11, the pumping member can be moved out of the compressive position and the tube may be seated readily in the chamber about the cylindrical wall. Thereafter, the crank shaft 35 may be rotated 180° with respect to the bushing 36 and be locked in the position shown in Fig. 2 so that the periphery 19 compressively engages the tube 24 as shown in Figs. 1 and 2.

Furthermore, during the pumping operation, it may be desired to release the tube from compressive engagement with the pumping member 30 to permit free flow of the fluid through the tube.

This can be readily achieved by removing the end 57 of the locking pin from the hole 48 shown in Fig. 2 and rotating the crank shaft 180° with respect to the bushing 36. It has been found in the utilization of the pumping device in blood transfusions that it is frequently desired to stop the pumping action and to permit the blood to flow by gravity. By the arrangement described, it is thus possible to accomplish this result easily and rapidly without removing the tube from the pump.

Fig. 4 illustrates several intermediate holes 48 tapped in the member 45 in which the locking pin may be positioned. These intermediate positions may be utilized in an instance where it is desired to have an imperfect vacuum on the tube in order to increase the gravity flow of the fluid through the pump but without obtaining complete pumping action. The additional intermediate positions may also be used where the wall thickness of the tube or the diameter of the tube is such that the compressive engagement is achieved at some point intermediate the two extremes of the eccentric offsets of the shaft 31 and the shaft 35.

Fig. 5 illustrates an alternative means by which the compressive engagement of the pumping member may be relieved. In that form of the invention, a portion 60 of the housing 61 is adapted to be displaced outwardly from the chamber 62 defined by the cylindrical wall 63. The portion 60 has an inner arcuate face 55 which, in the closed position shown in Fig. 5, completes the cylindrical wall 63 of the chamber 62. The portion 60 is pivotally mounted at 66 to permit the outward movement of the end 67 of said portion 60. A slot 71 is formed in the housing beneath the portion 60 and a lock screw, such as the wing head screw 72, is positioned in the slot and tapped into the lower side of the portion 60 as best shown in Fig. 6. By releasing the lock screw 72 and grasping the extension 73 of the end 67, the portion 60 may be pivoted outwardly about the pivot 66, until the lock screw reaches the end 75 of the slot 71 which is the position indicated by dash lines in Fig. 5. With the pumping member in the position shown in solid line in Fig. 5, and the portion 60 in the dash line position, the compressive pressure on the tube 74 is released to permit the removal or positioning of the tube in the pump or to permit free fluid flow through the tube. It will be appreciated that, in the form of the invention shown in Fig. 5, it is not necessary to provide the eccentrically bored bushing or other means for changing the offset of the pumping member with respect to the axis of the cylindrical wall for the compression on the tube between the cylindrical wall and the pumping member is relieved by the portion 60 of the wall being displaced outwardly.

It will also be noted that, in displacing the wall portion 60 outwardly, while the tube is in the chamber, it is generally only necessary to release the lock screw 72 and rotate the pumping member to the position shown in Fig. 5. The wall portion 60 will move outwardly under the pressure of the pumping member against the tube. Therefore, it may be found that the extension 73 is not necessary to displace the portion 60 in most cases.

The provision of the wing type head on the lock screw 72 is of convenience for the rapid manual release of the screw to relieve compression on the tube.

The pumping member and the housing may be constructed of any suitable material, such as

metal or plastic, and the tube may be of any standard type having sufficient resiliency to recover its shape between successive cyclic operations.

It will be appreciated that the pump may be used effectively and will fulfill all the objects of the invention in many applications. However, it may be of interest to note that the pump has been found of particular use for the pumping of blood, especially in blood transfusions. The action of the pump does not result in any measurable amount of hemolysis, i. e. a destruction of the blood cells. A pump embodying the invention has been used for regular transfusions as well as for intra-arterial transfusions. Present transfusion techniques require that some means be available in the operating room by which blood can be transfused rapidly into the patient. None of the various methods previously available had the same degree of simplicity and safety as this new pump which may be operated without priming, which may use standard tubing, and which does not require sterilizing before using because the blood being pumped through the tube does not at any time come in contact with the pump. Furthermore the tube may be placed in the pump without disturbing the ends of the tube and the compressive pumping action of the pumping member may be relieved to permit free flow of the fluid through the pump without the inconvenience of removing the tube from the pump or providing complicated valves and additional tubing for by-passing the pump.

In accordance with the provisions of the patent statutes, I have herein described the principles of the operation of the invention, together with the elements which I now consider the best embodiments thereof, but I desire to have it understood that the structure disclosed is only illustrative and the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combinations and relations described, some of these may be altered and modified without interfering with the more general results outlined.

Having thus described my invention, I claim:

1. In a pumping device for moving fluid through a flexible tube having resilient walls, by compressing successive contiguous areas along a length of said tube during each pumping cycle, the combination, comprising, a chamber having a cylindrical wall, a floor portion and an open end, a cover adapted to be removably fixed on the open end, said chamber being formed to define at least one opening in the cylindrical wall and having at least two channels extending from said opening in the wall to the outside of the chamber, a flexible tube, said chamber being adapted to receive a loop of tube adjacent the cylindrical wall and with the ends of the tube extending outwardly through the opening in said wall, said opening and said channels extending upwardly to the open end of the chamber to permit the placing of the tube in the opening and the channels by passing it in from the open end, the wall of the chamber being of sufficient axial

length to accommodate the tube when in compressed condition, a cylindrical member having a diameter smaller than the diameter of the cylindrical wall of the chamber, means for rotatably mounting the member for rotation about its axis and means for moving the axis of the member in a path about the axis of the cylindrical wall so that successive areas of the periphery of the member compress successive contiguous areas along the length of the loop of tube against the cylindrical wall during each cycle of the member in the path about the axis of the cylindrical wall, the tube being substantially continuous around the wall of the chamber so that the member commences a new cycle upon the completion of the preceding cycle an outwardly displaceable portion of the cylindrical wall and means for displacing said portion of the cylindrical wall outwardly for relieving the compressive pressure on the tube when the periphery of the member is moved into compressive position at that portion of the cylindrical wall.

2. In a pumping device for moving fluid through a flexible tube having resilient walls for compressing successive contiguous areas along a length of said tube during each pumping cycle, the combination comprising a chamber having a cylindrical wall, a floor portion and an open end, a cover adapted to be removably positioned on said open end, a flexible tube, the cylindrical wall of the chamber being formed to define at least one opening therein providing an exit to the outside of the chamber, said chamber being adapted to receive a loop of tube so that it lies adjacent the cylindrical wall with the portions of the tube beyond the loop extending outwardly through the opening in the wall, the wall also being formed to define at least one channel extending from said opening in the wall to the open end of the wall, the wall of the chamber being of sufficient axial length between the floor and the open end to accommodate a tube when it is in compressed condition, a cylindrical member having a diameter somewhat smaller than the cylindrical wall of the chamber, means for mounting the member for rotation about its axis and means for moving the axis of the member in a circular path about the axis of the cylindrical wall so that the successive areas of the periphery of the member compress successive contiguous areas along the length of tube against the cylindrical wall during each cycle of the member in a path about the axis of the cylindrical wall, said cover being provided with at least one projection to extend into the channel formed in the cylindrical wall to restrictively hold the tube in place.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,845,479	Carpenter	Feb. 16, 1932
2,035,159	Henry	Mar. 24, 1936
2,102,523	Ferrara	Dec. 14, 1937
2,123,781	Huber	July 12, 1938
2,231,579	Huber	Feb. 11, 1941