

May 22, 1962

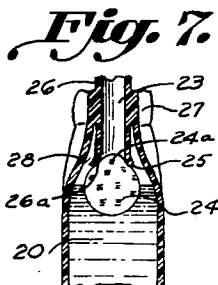
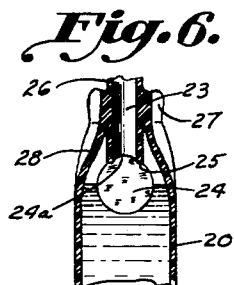
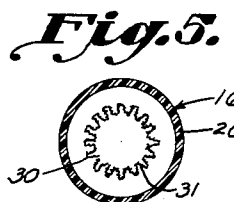
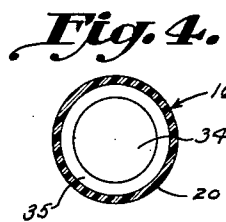
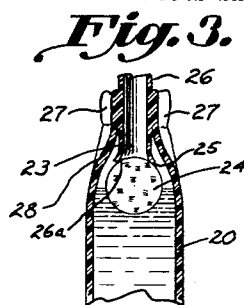
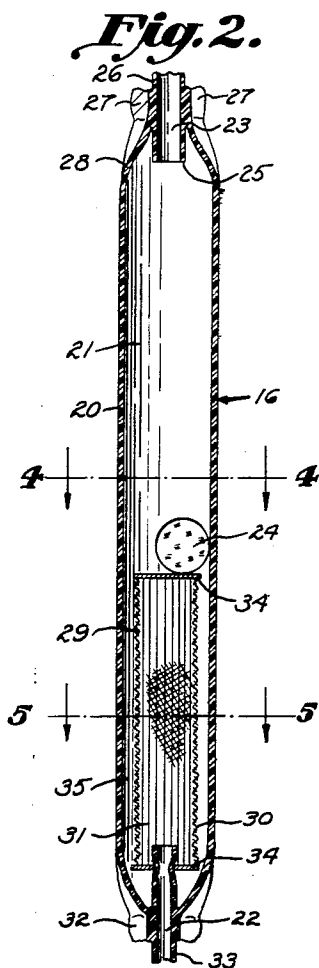
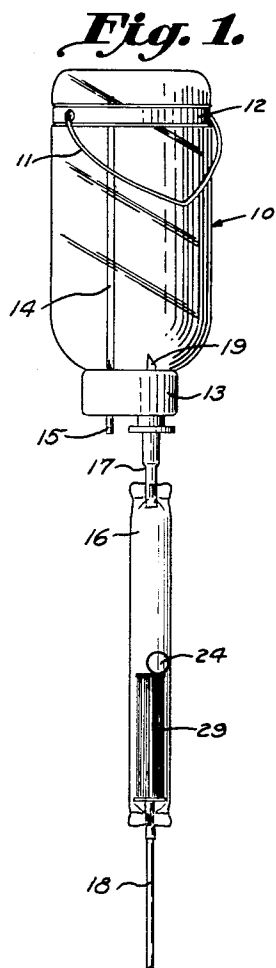
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3,035,575

MANUALLY-OPERABLE BLOOD PUMP

Filed May 10, 1954

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 8.

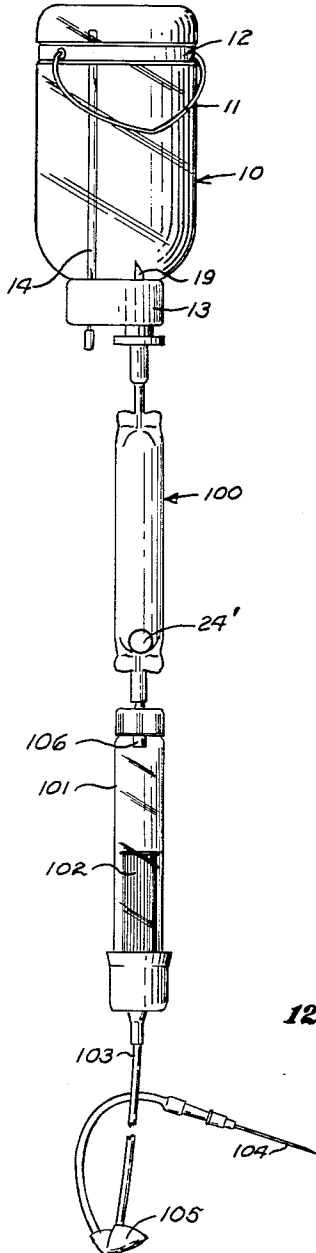


Fig. 9.

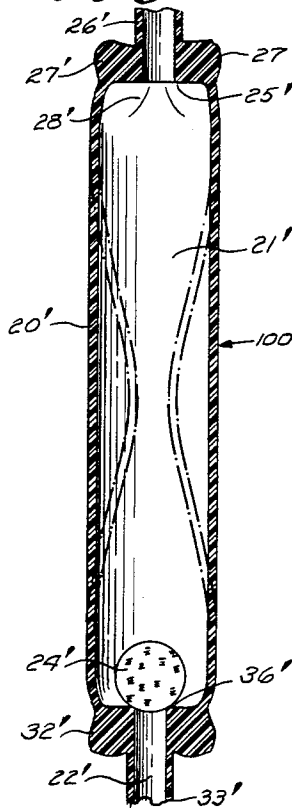


Fig. 10.

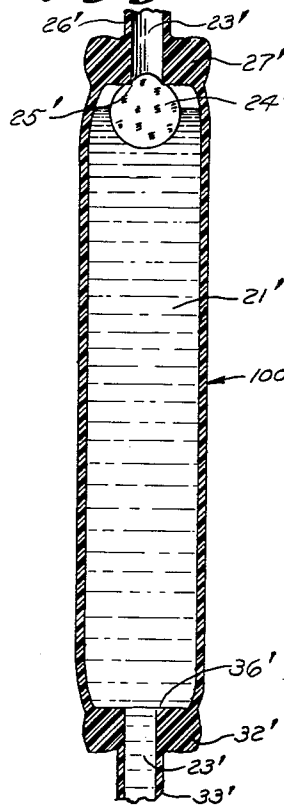


Fig. 11.

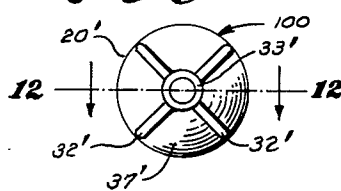
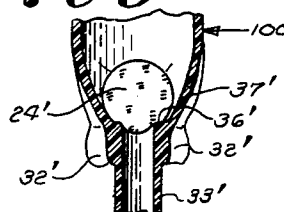


Fig. 12.



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3,035,575

MANUALLY-OPERABLE BLOOD PUMP

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15 Claims. (Cl. 128-214)

This invention relates to a manually-operable blood pump for pressure transfusions adapted to be interposed in the conduit extending downwardly from a blood supply container to the point of administration of the blood. The term "blood" as used herein is intended to include not only whole blood but plasma or other equivalents of blood for certain purposes. Further, the pump structure of this invention can also be used, if desired, for the parenteral administration of other liquids.

This application is a continuation-in-part of my co-pending application Serial No. 392,236, filed November 16, 1953, now abandoned.

It is a general object of this invention to provide a simple, compact, and easily operated pump structure for the parenteral administration, under pressure, of blood or other intravenous liquid, which apparatus is sufficiently inexpensive to permit it to be discarded after a single use. More particularly, it is an object to provide a pump structure of the character indicated which is manually operable and can be interposed in the passage extending downwardly from the blood supply container to the point of administration of the blood, said pump also being capable of mechanical actuation if desired. A more specific object is to provide a pump adapted to be interposed in the supply conduit means of a gravity flow administration apparatus to provide additional pressure when needed without interfering with the gravity flow. Further objects and advantages will appear as the specification proceeds.

This invention is shown in illustrative embodiments in the accompanying drawings, in which—

FIG. 1 is an elevational view showing a blood pump constructed in accordance with this invention as it would appear in use when connected to the blood supply container, said blood pump also containing a filter unit; FIG. 2, a vertical sectional view of the blood pump of FIG. 1; FIG. 3, a detail sectional view of the inlet valve structure of the blood pump showing the floating ball valve in contact with the valve seat; FIG. 4, a sectional view of the blood pump taken on line 4-4 of FIG. 2; FIG. 5, another sectional view of the same blood pump taken on line 5-5 of FIG. 2; FIG. 6, a view similar to FIG. 3, showing a modified inlet check valve construction; FIG. 7, a view similar to FIGS. 3 and 6, showing still another modification of inlet check valve construction; FIG. 8, a view similar to FIG. 1, showing a modified blood pump construction with the blood pump shown as part of a complete apparatus for parenteral administration of a liquid under pressure; FIG. 9, a vertical sectional view of the modified blood pump of FIG. 8, showing the floating ball valve closing the outlet passage; FIG. 10, a view similar to FIG. 9, showing the floating ball valve closing the inlet passage; FIG. 11, a view of the bottom end of the pump, showing the radiating ribs; and FIG. 12, a partial vertical sectional view taken on line 12-12 of FIG. 11, showing the inwardly-curved walls of the tube just above the radiating ribs.

Looking first at FIG. 1, there is shown a conventional container 10 for the administration of whole blood or plasma, having a support ball 11 pivotally connected to recess ring 12. Container 10 is also provided with a closure or cap 13 which is provided with an opening connected to an air tube 14. The purpose of air tube 14, as is well known in the art, is to permit the air

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space above the liquid in container 10 to be connected to the atmosphere during the dispensing operation. In the illustration given, closure 13 includes a soft rubber plug constructed so that the opening aligned with air tube 14 is normally closed, but can be forced open by the introduction of a hollow needle, such as needle 15.

This invention is concerned primarily with the pump structure designated generally as 16. The purpose of pump structure 16 is to provide a means by which pressure can be created on the blood as it flows through the conduit provided by tube sections 17 and 18, and tube section 19 being connected to a container plug-in extension 19. Pump unit 16 provides a flexible pumping chamber, which permits the movement of the liquid to be accelerated at spaced intervals by the manual flexing of the pumping chamber, or alternatively, the pumping chamber can be flexed mechanically. Preferably, as illustrated, pump unit 16 also provides a filter element, thus rendering the use of a separate filter unit unnecessary.

The construction of pump unit 16 is shown more clearly in FIG. 2. There is provided an elongated, vertically-extending tube 20 composed of transparent material which provides a pumping chamber 21 therein of variable volume by flexing the walls of the tube. Tube 20 can be constructed of various plastic materials, but is preferably constructed of a thermoplastic material, such as polyvinyl chloride, polyethylene, etc.

Tube 20 has an outlet 22 at its lower end and an inlet 23 at its upper end communicating with pumping chamber 21. A floating ball valve 24 is provided within pumping chamber 21 and a valve seat 25 for ball valve 24 is provided about inlet 23. Ball valve 24 can be composed of cork, balsa wood, etc., or any other suitable material which is of substantially lower specific gravity than the liquid which is dispensed; or alternatively, ball valve 24 can be made hollow so that as a whole it will be of lighter specific gravity and will thereby float. A specific, hollow form of ball valve 24 can be constructed of a flexible, plastic material, as by molding. Molding techniques for achieving such a ball or bubble (hollow or otherwise) are well known to the art and are not part of this invention as such. A plastic ball valve of this nature has the additional advantage of being able to conform to any irregularities in the valve seat, whereby a tight seating of the valve will be achieved.

Preferably, valve seat 25 is provided by the lower end of an inlet tube 26, which is of considerably smaller diameter than tube 20 but is also preferably formed of a thermoplastic material so that it can be heat sealed to the upper end of tube 20. As illustrated in FIGS. 1, 3, 6 and 7, the upper end portion of tube 20 has sector portions about inlet tube 26 brought together and fused to form at least 3 centering fins 27, or preferably 4 fins 27, as illustrated. It will be noted that fins 27 support inlet tube 26 in centered relation within the upper end of tube 20, and that fins 27, as shown more clearly in FIG. 2, are constructed so that the walls of tube 20 therebetween curve inwardly at 28 about valve seat 25 provided by the lower end of inlet tube 26. This construction cooperates with the action of ball valve 24, the inwardly-curving walls 28 serving to direct the ball valve upon valve seat 25, which is held in correctly centered relation for receiving the ball valve by ribs 27.

Referring to FIG. 3, it is to be noted that the lower portion of drip tube 26 is shown in a distended form as at 26a so as to accomplish a tight seating with an irregularly surfaced ball 24. The thermoplastic material used to construct inlet tube 26 can be made flexible by the addition of various solvents or plasticizers known to the art. It is important that a relatively tight closure be achieved by the cooperation of ball valve element 24 and

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valve seat element 25 during the pumping operation because the pumping operation is generally only resorted to at times when the patient is in a critical condition and desperately in need of blood. A faulty check valving arrangement in the blood pump would, therefore, defeat its primary purpose. However, it is also desirable to make use of relatively inexpensive elements to construct the blood pump, since the pump is to be of an expendable nature. FIG. 6 is similar to FIG. 3 with the exception that ball 24 is adapted to conform to stiff inlet tube 26 as at 24a. FIG. 7 is similar to both FIGS. 3 and 6 and shows both inlet tube 26 distended as at 26a and ball valve 24 distended to conform to the seat, as at 24a.

In the illustration given in FIGS. 1 to 7, pump unit 16 also includes a filter element designated generally as 29, thus providing a combination blood pump and blood filter. Filter element 29 is mounted in the lower portion of tube 20 between pumping chamber 21 and outlet 22. Preferably, as shown, filter element 29 is spaced from the walls of tube 20 to permit the walls of the tube to be flexed inwardly thereabout.

In the illustration given, filter element 29 consists of a generally cylindrical shell 30 formed of a plastic-impregnated cloth having a fine pore structure arranged in a series of vertically-extending pleats or folds 31. Filter element 29 is equipped with upper and lower end pieces 34. The lower end piece is provided with an opening which permits filter element 29 to be mounted on outlet tube 33 as by a press fit. As is pointed out above with respect to inlet tube 26, which is heat sealed to the upper portion of tube 20, outlet tube 33 is heat sealed to the lower portion of tube 20 by fusing sector portions to form centering fins 32.

Filter element 29 is of slightly smaller outside diameter than the inside diameter of tube 20, thereby permitting easy access of blood or other material to the filter surface. However, space 35, between filter element 29 and tube 20, is small enough to prevent ball 24 from moving into it. In the preferred embodiment the upper end piece 34 is of a slightly larger diameter than filter element 29 so as to prevent ball 24 from becoming wedged between filter element 29 and tube 20.

If desired, the blood pump of this invention can be constructed for use with a separate filter unit, and this may be desirable for some purposes. Such a modification is illustrated in FIGS. 8 to 12 of the drawings, FIG. 8 showing the modified pump structure 100 incorporated in a complete apparatus for the administration of blood. The container structure of FIG. 8 is the same as that of FIG. 1 and therefore the parts have been given corresponding numbers. In addition to this structure, there is shown a conventional filter unit 101 having a filter element 102 therein being connected to a downwardly-extending conduit 103 which has an administration needle 194 on the end thereof and is provided intermediately with a control clamp 105, all in accordance with well known practice.

The modified pump structure 100 is shown more clearly in FIGS. 9 and 10. It will be noted that pump unit 100 is the same as the pump unit 16 previously described except that no filter unit is present in the lower portion of the tube, and that outlet tube 33' provides on its inner end a valve seat 36' for receiving the floating ball valve 24' when pumping chamber 21' provided by tube 20' is empty. Also, inlet tube 26' is retracted as compared with inlet tube 26, while continuing to provide a valve seat 25' on its inner end.

As indicated above, inlet tube 26' is generally retracted because there is no need for an extended portion to provide a drip tube of the nature shown in FIGS. 3, 6 and 7. In the event a retracted form of inlet tube is used, it is preferred to incorporate a plastic form of ball valve element 24' in order to achieve tight seating, as shown in FIG. 10.

Inlet tube 26' is heat sealed to tube 20' in the manner described in connection with the previously discussed em-

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bodiment and is held in centered relation in the upper portion of tube 20' by ribs 27', while the inwardly-curved walls 28' between ribs 27' serve to direct ball valve 24' onto valve seat 25'. Similarly, outlet tube 33' is mounted in the lower end of tube 20' by the fusion of the lower end of tube 20' to form 4 radiating ribs 32', as illustrated more clearly in FIG. 11. Also, between ribs 32' and extending thereabout at 37', tube 21' has inwardly-curving walls which tend to direct ball valve 24' onto valve seat 36'.

Operation

In the operation of this invention with either of the embodiments previously described, the blood pump is connected or interposed in the conduit leading from the blood supply container, as illustrated in FIGS. 1 and 8. At the start of the administration the blood within container 10 will flow downwardly under the force of gravity through the blood pump. Ball valve 24' in the embodiment illustrated in FIGS. 8 to 12 will not interfere with this flow, since as soon as pumping chamber 21 begins to fill with blood, the ball valve will float off of valve seat 36' and allow the blood to flow downwardly out of the pumping chamber. In the embodiment illustrated in FIGS. 1 to 7, the blood will be filtered as it leaves pumping chamber 21, while in the embodiments shown in FIGS. 8 to 12 the blood will be filtered in a separate filter unit 101.

For gravity or slow administration of blood or other intravenous fluid, it is desired to observe the rate of administration by counting drops of the fluid. For this purpose, in the embodiment of FIGS. 1 to 7, inlet tube 26 has a lower extension projecting into pumping chamber 21 from which the drops can fall, pumping chamber 21 thus acting as a drip chamber for gravity administration with blood pump unit 16 in the administration line. Similarly, filter unit 101, in the embodiment of FIGS. 8 to 12, provides a drip tube extension 106, as seen in FIG. 8.

When it is desired to accelerate the blood flow, this can readily be accomplished by manually flexing the walls of tubes 20 or 20' about pumping chambers 21 and 21' respectively. When the walls of pumping chambers 21 and 21' are squeezed and released, the pumping chambers will tend to fill with blood, thus causing ball valves 24 and 24' to rise to the top of the pumping chambers, as illustrated more clearly in FIGS. 3, 6, 7 and 10. In this position the ball valve will engage the valve seat provided by the lower end of the inlet tube, and thus act as an inlet check valve to prevent the blood from returning up into the bottle while the pump is squeezed. When the pump is released, the floating ball valve will move away from the valve seat and this will permit blood to flow into the pumping chamber. Thus, repeated squeezing and releasing of the pump unit will provide a pumping action which will force blood into the veins of the patient.

The construction illustrated in FIGS. 8 to 12 has the further advantage of tending to prevent any pumping of air, which might be dangerous if introduced into the veins of the patient. As shown in FIG. 9, ball valve 24' will seat on valve seat 36' provided by outlet tube 33' when the pumping chamber 21 is empty. In other words, when the liquid level within the pumping chamber falls to the level of outlet 22', ball valve 24' will seal the outlet to prevent air from being forced into the outlet even though the squeezing of the walls of the pumping chamber is continued. By way of comparison it can be seen, as previously indicated, that when the liquid level within the pumping chamber approaches that of inlet 23', ball valve 24' will seal the inlet.

Both of the embodiments illustrated in the drawings provide another safety factor action which tends to prevent pumping of air. This is due to the fact that when the blood or liquid supply is exhausted, the floating ball valve drops away from the inlet valve seat. Thus, any

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further flow is stopped and no air will be pumped even if the pump action is inadvertently continued.

While in the foregoing specification this invention has been described in relation to specific embodiments thereof for purposes of illustration, it will be apparent to those skilled in the art that this invention is susceptible to other embodiments and that many of the details set forth herein can be varied widely without departing from the basic concepts of the invention.

I claim:

1. A manually-operable blood pump for pressure transfusions adapted to be interposed in the conduit extending downwardly from a blood supply container to the point of administration of the blood, comprising an elongated, vertically-extending tube having flexible resilient walls composed of transparent material, said tube providing a pumping chamber therein of variable volume by flexing the walls of said tube, said tube having an outlet at its lower end and an inlet at its upper end communicating with said pumping chamber, a floating valve element within said pumping chamber, and a seat for said valve element about said inlet, said valve element floating into seating engagement with said valve seat when the blood within said tube rises to the level of said inlet, said inlet including an inlet tube of smaller diameter than said pumping chamber-providing tube, said inlet tube serving as a drip meter whenever said valve element is not seated thereagainst.

2. A manually-operable blood pump for pressure transfusions adapted to be interposed in the conduit extending downwardly from a blood supply container to the point of administration of the blood, comprising an elongated, vertically-extending tube having flexible resilient walls composed of transparent material, said tube providing a pumping chamber therein of variable volume by flexing the walls of said tube, said tube having an outlet at its lower end and an inlet at its upper end communicating with said pumping chamber, a floating ball valve element within said pumping chamber, and a valve seat element for said ball valve element about said inlet where at least one of said elements constructed of a flexible plastic material, the said valve seat element being a flexible plastic tube adapted to conform to an irregularly surfaced ball valve element, the said ball valve element floating into tight seating engagement with said valve seat when the blood within said tube rises to the level of said inlet.

3. A manually-operable blood pump for pressure transfusions adapted to be interposed in the conduit extending downwardly from a blood supply container to the point of administration of the blood, comprising an elongated, vertically-extending tube having flexible, resilient walls composed of transparent material, said tube providing a pumping chamber therein of variable volume by flexing the walls of said tube, said tube having an outlet at its lower end, and an inlet at its upper end communicating with said pumping chamber, a floating ball valve within said pumping chamber, and a seat for said valve about said inlet, said ball valve floating into seating engagement with said valve seat when the blood within said tube rises to the level of said inlet and being pressed thereagainst by pressure imparted to blood within said tube by flexing of the walls thereof.

4. A manually-operable blood pump for pressure transfusions adapted to be interposed in the conduit extending downwardly from a blood supply container to the point of administration of the blood, comprising an elongated, vertically-extending tube having flexible, resilient walls composed of transparent material, said tube providing a pumping chamber therein of variable volume by flexing the walls of said tube, said tube having an outlet at its lower end, and an inlet at its upper end communicating with said pumping chamber, a floating ball valve within said pumping chamber, a seat for said valve about said inlet, said ball valve floating in the seating

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engagement with said valve seat when the blood within said tube rises to the level of said inlet, a filter element mounted in the lower portion of said tube between said pumping chamber and said outlet, said filter element being spaced from the walls of said tube to permit the walls of said tube to be flexed inwardly thereabouts, and a retainer means mounted on the upper end of said filter element for preventing said ball valve from moving into the space between said filter element and the walls of said tube and to keep said ball valve freely movable within said pumping chamber.

5. A manually-operable blood pump for pressure transfusions adapted to be interposed in the conduit extending downwardly from a blood supply container to the point of administration of the blood, comprising an elongated, vertically-extending tube having flexible, resilient walls composed of transparent material, said tube providing a pumping chamber therein of variable volume by flexing the walls of said tube, said tube having an outlet at its lower end, and an inlet at its upper end communicating with said pumping chamber, a floating ball valve within said pumping chamber, a seat for said valve about said inlet, the walls of said tube curving inwardly towards said inlet whereby said ball valve is directed toward said seat, said ball valve floating in the seating engagement with said valve seat when the blood within said tube rises to the level of said inlet, a filter element mounted in the lower portion of said tube between said pumping chamber and said outlet, said filter element being spaced from the walls of said tube to permit the walls of said tube to be flexed inwardly thereabout, and a retainer means mounted on the upper end of said filter element for preventing said ball valve from moving into the space between said filter element and the walls of said tube and to keep said ball valve freely movable within said pumping chamber.

6. A manually-operable blood pump for pressure transfusions adapted to be interposed in the conduit extending downwardly from a blood supply container to the point of administration of the blood, comprising an elongated, vertically-extending tube having flexible, resilient walls composed of transparent material, said tube providing a pumping chamber therein of variable volume by flexing the walls of said tube, said tube having an outlet at its lower end, and an inlet at its upper end communicating with said pumping chamber, a floating ball valve within said pumping chamber, said inlet including an inlet tube of somewhat smaller diameter than said pumping-providing tube mounted in the upper end of said inlet tube providing a valve seat, the walls of said tube curving inwardly toward said inlet whereby said ball valve is directed toward said seat, said ball valve floating in the seating engagement with said valve seat when the blood within the said tube rises to the level of said inlet, said outlet including an outlet tube of somewhat smaller diameter than said pumping chamber-providing tube, whereby said valve is pressed against said seat by flexing of the walls of said pumping chamber-providing tube when the level of blood therein is sufficient to raise said valve in the seating engagement with said seat.

7. A manually-operable blood pump for pressure transfusions adapted to be interposed in the conduit extending downwardly from a blood supply container to the point of administration of the blood, comprising an elongated, vertically-extending tube having flexible, resilient walls composed of transparent material, said tube providing a pumping chamber therein of variable volume by flexing the walls of said tube, said tube having an outlet at its lower end, and an inlet at its upper end communicating with said pumping chamber, a floating ball valve within said pumping chamber, said inlet including an inlet tube of somewhat smaller diameter than said pumping chamber-providing tube mounted in the upper end of said pumping chamber-providing tube, the lower end of said

inlet tube providing a valve seat, the walls of said tube curving inwardly toward said inlet whereby said ball valve is directed toward said seat, said ball valve floating in the seating engagement with said valve seat when the blood within said tube rises to the level of said inlet, a filter element mounted in the lower portion of said tube between said pumping chamber and said outlet, said filter element being spaced from the walls of said tube to permit the walls of said tube to be flexed inwardly thereabout, and retainer means mounted on the upper end of said filter element for preventing said ball valve from moving in the space between said filter element and the walls of said tube and to keep said ball valve freely movable within said pumping chamber.

8. A manually-operable blood pump for pressure transfusions adapted to be interposed in the conduit extending downwardly from a blood supply container to the point of administration of the blood, comprising an elongated, vertically-extending tube having flexible, resilient walls composed of transparent material, said tube providing a pumping chamber therein of variable volume by flexing the walls of said tube, said tube having an outlet at its lower end, and an inlet at its upper end communicating with said pumping chamber, a floating ball valve within said pumping chamber, said inlet including an inlet tube of somewhat smaller diameter than said pumping chamber-providing tube mounted in the upper end of said pumping chamber-providing tube, the lower end of said inlet tube providing a valve seat, the said pumping chamber-providing tube having sector portions about said inlet tube brought together and fused to form at least three centering fins affording said inlet tube in centered relation within said pumping chamber-providing tube, the walls of said pumping chamber-providing tube curving inwardly between said fins about the valve seat provided by the lower end of said inlet tube for directing said ball valve onto said valve seat, a filter element mounted in the lower portion of said tube between said pumping chamber and said outlet, said filter element being spaced from the walls of said tube to permit the walls of said tube to be flexed inwardly thereabout, and retainer means mounted on the upper end of said filter element for preventing said ball valve from moving into the space between said filter element and the walls of said tube and to keep said ball valve freely movable within said pumping chamber.

9. A manually-operable blood pump for pressure transfusions adapted to be interposed in the conduit extending downwardly from a blood supply container to the point of administration of the blood, comprising an elongated, vertically-extending tube having flexible, resilient walls composed of transparent material, said tube providing a pumping chamber therein of variable volume by flexing the walls of said tube, said tube having an outlet at its lower end and an inlet at its upper end communicating with said pumping chamber, a floating valve element within said pumping chamber, and a seat for said valve element about said inlet, said valve element floating into seating engagement with said valve seat when the blood within said tube rises to the level of said inlet, the said outlet including a tube of smaller bore than said elongated tube whereby flexing of said walls forces said valve element in the tight seating engagement with said valve seat.

10. In a device for the administration of blood, a length of relatively small bore tubing adapted to connect a blood supply container with the point of administration of the blood and with said container elevated relative to said point, a drip-counting device adjacent the upper end of said tubing and providing a blood conduit therewith, said drip-counting device comprising an air-confining chamber having an inlet tube projecting thereinto at the upper end thereof, said chamber being laterally enlarged relative to said tubing about said inlet tube to entrap air between columns of blood in said inlet tubing and the lower portion of said air-confining chamber, and a pump-

ing chamber in said conduit below said air-confining chamber, said pumping chamber also being laterally enlarged relative to said tubing and having flexible, resilient walls, and valve means in said pumping chamber for preventing upward flow of blood when the walls of said pumping chamber are flexed whereby said device when blood-filled except for said air-confining chamber necessarily prevents pumping of air toward said point of administration.

11. In combination, a blood supply container supported above the point of administration for gravity flow of blood therebetween, an administration set attached at its upper end to said container and communicating therewith, said set comprising in sequential, communicating relation a plug-in extension at the upper end thereof, an air-confining drip chamber, a pump and check valve system operative to force blood toward said point of administration at a rate faster than that induced by gravity, and a length of flexible tubing whereby operation of said pump and check valve system necessarily forces only the blood and not the air toward said point of administration.

12. In combination, a length of relatively small bore flexible, transparent tubing, a plug-in extension at one end thereof adapted to be inserted into a blood supply container, a drop-counting device adjacent said extension and having an enlarged tube closed at its upper end except for a relatively small bore inlet tube extending into said enlarged tube, said inlet tube communicating with said plug-in extension, and a pump and check valve adjacent to and communicating with the lower portion of said drop-counting device and communicating at its lower end with said tubing, said check valve being operative to prevent flow of blood from said pump toward said plug-in extension when the walls of said pump are flexed inwardly.

13. A blood administration set comprising a length of flexible tubing adapted to communicate a blood supply container with a point of administration, said tubing being laterally enlarged adjacent its upper end to provide communicating drip-counting chamber means and pumping chamber means below the drip-counting chamber means, the upper end of said tubing being equipped with a plug-in extension for communicating said set with said container, said pumping chamber means being equipped with transparent, resilient flexible walls and with check valve means for preventing upward flow of blood into said extension when said pumping chamber means is blood-filled, said pumping chamber means being connected to said tubing at its lower end and to said drip-counting chamber means at its upper end.

14. Venoclysis equipment of transparent plastic material and adapted normally to provide a continuous channel for injection fluid flowing from a source of supply to a hypodermic cannula, said equipment comprising, in combination, a drip-tube, a housing for the drip tube, and a length of tubing of relatively small cross-section adapted to receive the cannula at one end thereof, and including, disposed along its length, between the housing for the drip tube and the end of the tubing of relatively small cross-section removed from the cannula-receiving end, and as, at least in effect, an integral part of the equipment, a pump and check valve system, the pump being tubular, compressible transversely of the axis of the equipment and readily returnable to normal expanded condition on release of the compressing force.

15. Venoclysis equipment formed of plastic material substantially all of which is transparent and adapted normally to provide a continuous channel for injecting a fluid flowing from a source of supply to a hypodermic cannula, said equipment comprising in combination a drip tube, a housing for the drip tube, and a length of tubing of relatively small cross section adapted to receive the cannula at one end thereof and including disposed along its length below the drip tube and above the

end of the tubing of relatively small cross section removed from the cannula receiving end, and as, at least in effect, an integral part of the equipment, a tubular pump compressible transversely of the axis of the equipment and readily returnable to normally expanded condition 5 on release of the compressing force, said equipment including a valve element and a valve seat element for said valve element operable to close the inlet into the pump when the pump is compressed.

References Cited in the file of this patent

UNITED STATES PATENTS

926,197	Kim -----	June 29, 1909
1,215,475	Brokaw -----	Feb. 13, 1917
2,664,085	Ryan -----	Dec. 29, 1953
2,672,051	Butler -----	Mar. 16, 1954
2,681,654	Ryan et al. -----	June 22, 1954
2,701,565	Gewecke -----	Feb. 8, 1955