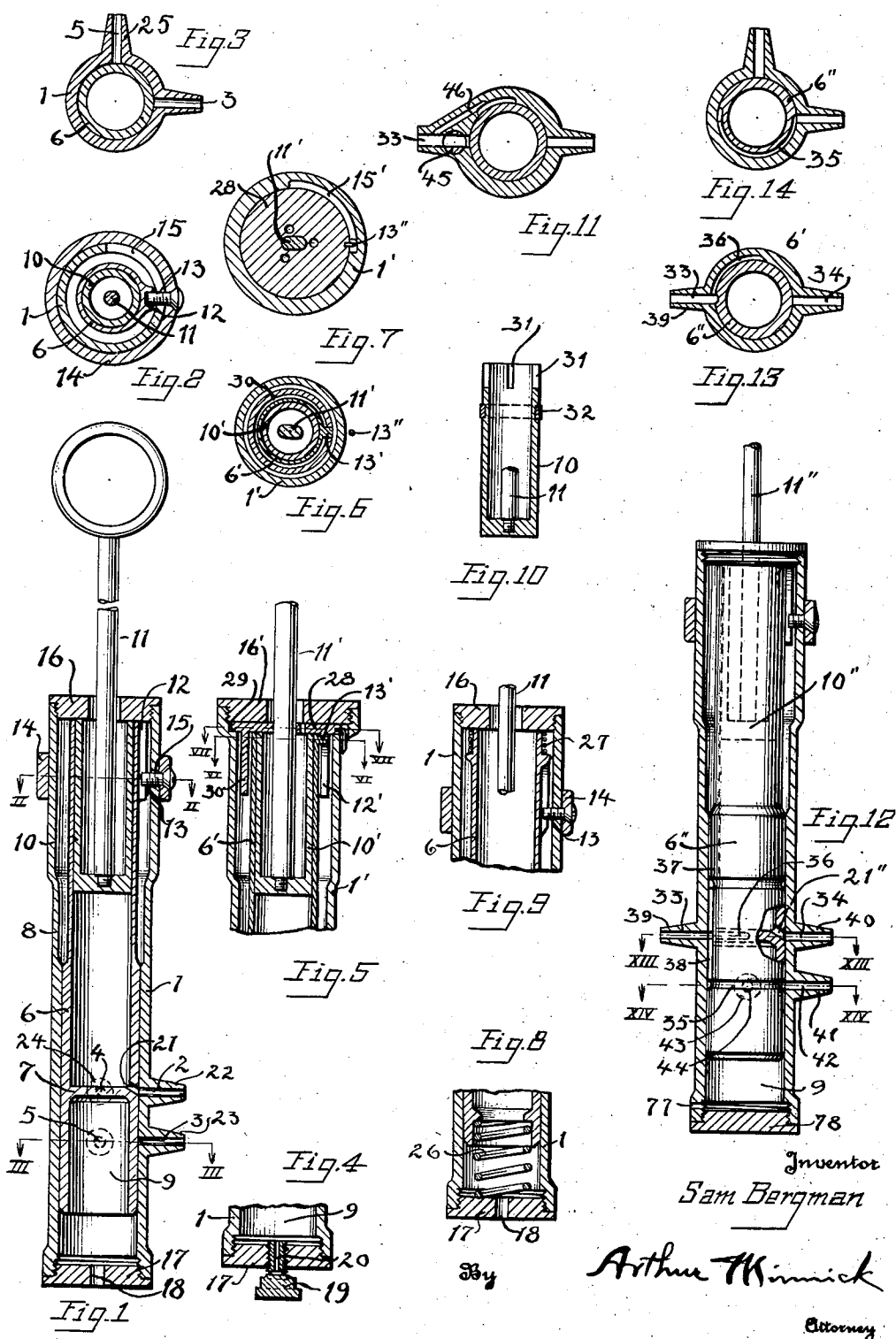


2,062,285

SYRINGE

Filed May 2, 1934

2 Sheets-Sheet 1



Dec. 1, 1936.

S. BERGMAN

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SYRINGE

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2 Sheets-Sheet 2

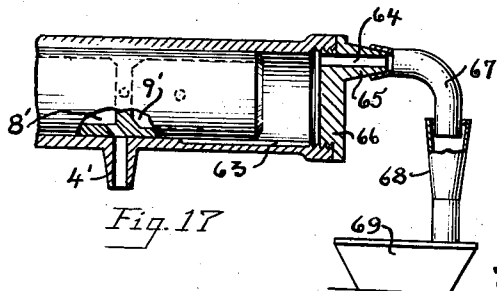


Fig. 17

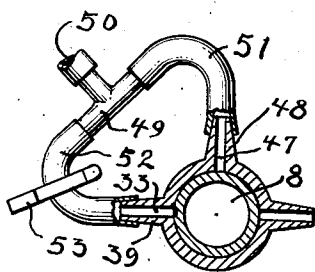


Fig. 16

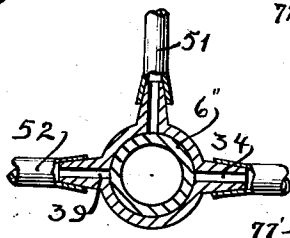


Fig. 20

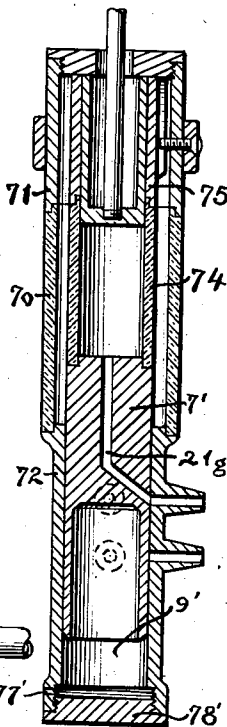


Fig. 22

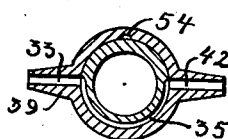


Fig. 19

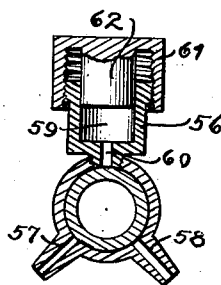


Fig. 21

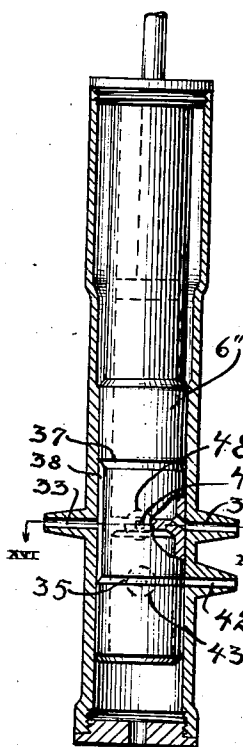


Fig. 15

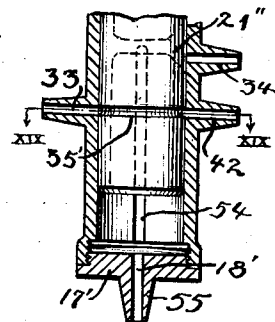


Fig. 18

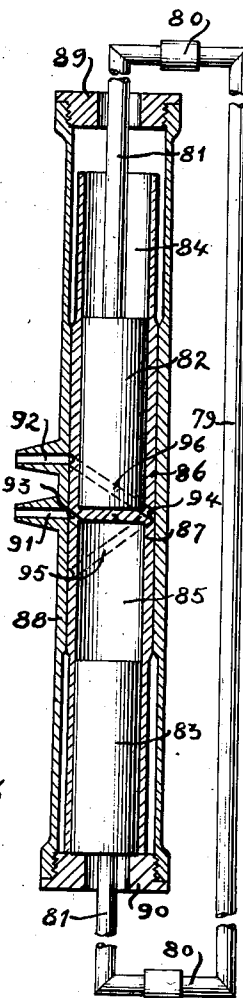


Fig. 23

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2,062,285

SYRINGE

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Application May 2, 1934; Serial No. 723,437

15 Claims. (Cl. 128—214)

This invention relates to syringes particularly adapted for use in blood transfusion though capable of use for many other purposes, and it has for its objects the control of the flow of blood from donor to syringe and then out of the syringe into the recipient entirely automatically, yet with the certainty offered by a positively actuated valve; the elimination of the possibility and danger of injection of blood into the donor and aspiration of blood from the recipient; the utilization of citrate solution as an anti-coagulant within the valve joint space to prevent clotting of blood there with the consequent gumming up of the valve action while not permitting the citrate solution to mix with the blood transfused; the elimination of broken, jointed or uneven surfaces between the syringe and the donor and recipient tubes, preventing stagnation areas so that there is no intermixing of blood fresh from the donor with residual blood before injection into the recipient; the provision for washing out the syringe with saline or other solution in such manner that the washings are not thrown back into the container for the solution but clean solution only to be drawn into the syringe; and the achievement of these desirable results with simplicity of construction and a minimum number of parts.

In general, the invention provides a pump system in which an accurately fitting piston slides within a chamber formed in a cylindrical sleeve valve which in turn is accurately fitted to slide and to rotate through a limited range of angular movement within a cylindrical barrel provided with a plurality of inlet and outlet ports with which a port in the wall of the chamber of the sleeve valve may be made to register at the limits of the sliding and angular movements of the valve.

In the drawings, Figure 1 is a longitudinal section showing one embodiment of the invention; Fig. 2 is a transverse section on the line II—II of Fig. 1; Fig. 3 is a transverse section on the line III—III of Fig. 1; Fig. 4 is a fragmentary longitudinal section of the outer end of a modified form showing a detail of an air valve; Fig. 5 is a fragmentary longitudinal section of an inner end of a modification; Fig. 6 is a transverse section on the line VI—VI of Fig. 5; Fig. 7 is a transverse section on the line VII—VII of Fig. 5; Fig. 8 is a fragmentary longitudinal section of a centering spring within the outer end of a modification; Fig. 9 is a fragmentary longitudinal sectional detail of a centering spring within the inner end of a modification; Fig. 10 is a longitudinal sec-

tion through a piston provided with friction devices; Fig. 11 is a transverse section through a valve controlled port; Fig. 12 is a longitudinal section through a modification providing additional channels for saline solution; Fig. 13 is a transverse section on the line XIII—XIII of Fig. 12; Fig. 14 is a transverse section on the line XIV—XIV of Fig. 12; Fig. 15 is a longitudinal section of a modification showing a different channel arrangement from that of Fig. 12; Fig. 16 is a transverse section on the line XVI—XVI of Fig. 15; Fig. 17 is a fragmentary longitudinal section of a modification providing an outlet port at the outer end of the pump; Fig. 18 is a fragmentary longitudinal section of a modification in which the outer end is provided with an outlet and inlet port; Fig. 19 is a transverse section on the line XIX—XIX of Fig. 18; Fig. 20 is a view similar to Fig. 16 but having a different arrangement of tubes connected with the nipples; Fig. 21 is a diagrammatic transverse section of a modification having a chamber for an anti-coagulant solution; Fig. 22 is a longitudinal section through a modification providing transparent portions in the valve and cylinder; and Fig. 23 is a longitudinal section of a modification having two pistons operating in a double-ended valve.

In the embodiment of the invention illustrated in Fig. 1, the outer barrel or cylinder is provided with ports 2 and 3 in the same longitudinal plane, and with ports 4 and 5 in a longitudinal plane substantially at right angles to that of the ports 2 and 3, though it will be understood that the angle between the planes is a matter of choice. Slidably and rotatably mounted within the cylinder 1 is a sleeve valve 6 formed as a cylinder open at both ends and separated by a partition 7 into two chambers 8 and 9. A cylindrical piston 10 is slidably fitted within the chamber 8 and provided with a handle 11. The outer surface of the sleeve 6 has formed therein a groove or channel 12 for the reception of a stud 13 carried by a ring 14 which is mounted on the outer surface of the cylinder 1, the stud extending through a slot 15 in the cylinder. This slot is of a length which permits the ring to be turned through substantially ninety degrees, the angle between the planes of the ports, the ends of the slot acting as stops to engage the stud 13 and thereby accurately position the sleeve valve in its angular relations in the cylinder, while the channel 12 allows longitudinal sliding movement of the valve and is of a length such that the stud 13 will remain in the channel through the

entire travel of the valve. The outer periphery of the sleeve valve for at least a substantial portion of its length is formed to engage the inner periphery of the cylinder with a ground and liquid-tight joint, and the piston 10 engages within the cylindrical inner periphery of the sleeve valve 6 with a similar joint. To lessen friction, the inner end of the sleeve may be out of contact with the inside of the cylinder at a distance from the ports.

A plug or cap 16, shown as in screw-threaded engagement with the end of the cylinder 1 and as centrally perforated for the passage of the handle 11, acts as a stop to limit the inward sliding movement of the piston and of the valve, and a plug or cap 17 at the other end of the cylinder acts as a stop to limit the outward sliding movement of the valve. This plug 17 is provided with an opening 18 for which an air valve 19 having an air passage 20 may furnish a convenient means for closing the chamber between the plug 17 and the partition 7. At the bottom of the chamber 8, adjacent to the partition 7, a passage 21 extends through the wall of the sleeve valve 6, the length of the valve being such that when it is at the inner end of its movement with its inner end in contact with the plug 16, the outer end of the passage 21 will be in the same transverse plane as the ports 2 and 4, and when the sleeve is at the outer end of its longitudinal movement, the outer end of the channel 21 will be in the same transverse plane as the ports 3 and 5.

Starting in the position of parts shown in Fig. 1, and assuming that a liquid is in the chamber 8 between the piston 10 and the partition 7, pressure applied to the handle tending to force the piston into the chamber 8 will be transmitted to the partition 7 and will cause the valve to slide within the cylinder. The area of the partition 7 is so much greater than the area of the passage 21 that the pressure on the partition will be sufficient to overcome any friction between the valve and the cylinder, especially in view of the fact that there is always a film of liquid in the joint between the valve and the cylinder, and a very short movement of the valve will carry the end of the passage 21 out of registry with the port 2. Continued pressure will cause the sleeve to move until its outer end comes into contact with the plug 17, at which position of the valve, the passage 21 will be in registry with the port 3. Further movement of the piston toward the partition 7 will force liquid in the chamber 8 out through the port 3, the partition acting as a stop to limit the outward movement of the piston.

It will be obvious that the movement of the piston can be controlled by the operator to give a full stroke or to pause at any point in the outward movement. When the piston has been brought to a stop, force applied to the handle to move the piston in a reverse or inward direction will cause the valve 6 to slide inward carrying the passage 21 out of registration with the port 3. The sleeve 6 is made to slide at least as freely within the cylinder as the piston slides within the sleeve, and as subsequently explained, there will usually be a greater friction between the piston and the sleeve than between the sleeve and the cylinder. Thus a pull exerted on the handle of the piston will, because of this friction, tend to slide the sleeve in the cylinder and the friction between the sleeve and the cylinder will not be enough to overcome this tendency. Also, movement of the piston out of the sleeve will

act to create a partial vacuum within the chamber 8, whereupon air pressure on the outer surface of the partition 7 will act to push the sleeve after the piston until the inner end of the sleeve comes into contact with the plug 16, the passage 21 then being in registration with the inlet port 2. Further inward movement of the piston will tend to create a vacuum within the chamber 8 and this will cause inward suction at the port 2. At the ports 2, 3, 4, and 5 are nipples 22, 23, 24, and 25 respectively to which rubber tubing may be attached as is familiar in the art, such tubing being indicated in Figs. 16, 17, and 20.

At any point in the range of longitudinal travel of the valve, the ring 14 may be turned to slide the stud 13 along the slot 15, and when the stud engages the end of the slot, the valve will be in the exact angular adjustment to cause the valve passage 21 to register with the plane in which lie an inlet and an outlet port. Longitudinal movement of the piston and of the valve without change of angular adjustment will act to cause inward suction at port 2 and expulsion at port 3 when the stud is at one end of the slot, and inward suction at port 4 and expulsion at port 5 when the stud is at the other end of the slot. However it is clear that after inward suction at port 2 or port 4, the valve may be turned to discharge at the outlet port in the other plane. Thus the same piston may be made to draw a liquid from either of two sources and may discharge it at either of two outlets in accordance with the adjustment of the ring 14.

The device illustrated in Fig. 1 is especially adapted for blood transfusion, a tube leading from the nipple 22 being provided with a hypodermic needle inserted within the vein of a donor of blood, and a tube leading from nipple 23 being provided with a hypodermic needle inserted within the vein of a recipient of the blood. With the valve properly positioned, simple reciprocation of the piston will obviously withdraw blood from the donor through the port 2 and will inject it into the vein of the recipient through the port 3. This operation does not require more technical skill or knowledge than is required for a venipuncture and operation of the ordinary hypodermic syringe, and during its use, the surgeon's attention is not required for the operation of valves, while he has the assurance that blood can be aspirated only from the donor and injected only into the recipient.

Whenever the operator desires to cleanse the pump without disturbing the connections from donor to recipient, he may rotate the sleeve by turning the ring 14 to the other limit of its angular adjustment, and reciprocation of the piston will then act to draw in a saline or citrate washing solution through a tube connected to the nipple of the port 4 and to discharge it through the port 5 from which a tube may lead to any receptacle for the washings.

As a further precaution against clotting of the blood, before beginning transfusion, a solution of citrate of sodium or of potassium will be drawn into the chamber 9 whence it may penetrate by capillary action into the joint between the cylinder and the sleeve, thus preventing the intrusion of blood in the space, or, if any should penetrate into the space, mixing with it to prevent its coagulation. After pumping a sufficient quantity of the washing solution into the valve chamber until the washing liquid shows clear, the sleeve will be rotated back to the original

angular setting to permit the transfusion to be continued.

In Fig. 4, the opening 18 in the plug 17 is shown as screw-threaded to receive a threaded valve member 19 having a transverse passage communicating with a central passage 20. When the sleeve is at its inner position against the plug 16, the valve member 19 is screwed into the opening 18 to close the air passage thus confining the air between the partition 7 and the cap or plug 17 from escape through the opening 18. When the sleeve is forced against the plug 17 by the outward stroke of the piston, the air in the chamber 9 will be compressed and as soon as the handle 11 is released, the expansion of the air will slide the sleeve back to cause automatic closing of the port 3 or 5. If the valve 19 is closed when the sleeve is at the outer position against the plug 17, inward sliding of the valve 6 will cause a partial vacuum in the chamber 9, and release of the handle 11 will allow the sleeve to slide outward, automatically closing the port 2 or 4. If the sleeve is slid to a mid position with the valve member 19 open and the passage 20 is then closed, the pressure in the chamber 9 on the outward stroke and the partial vacuum on the inward stroke will be sufficient in either case to cause the sleeve to recede from its extreme positions to a central position in which both inlet and outlet ports will be closed.

In Fig. 8, a spring 26 is shown as seated within a recess in the end of the valve 6, or the spring may be on the outside of the sleeve as shown at 27 in Fig. 9, the function in each case being to press the sleeve away from contact with the end member engaged by the spring, and thus to slide the sleeve valve port out of registration with the inlet or outlet ports. Such springs may be used in cases where it is not desirable to have the chamber 9 closed by a member 19.

Another embodiment of the invention is illustrated in Figs. 5, 6, and 7, in which the piston 10' has a non-circular handle 11' slidable through an aperture of similar cross section in a disc 28 mounted for rotation on a shoulder 29 formed in the enlarged inner end of the cylinder 1', the disc being held in place by a plug 16' having an aperture permitting the rotation of the handle 11'. The disc 28 has a guide portion 30 provided with a groove or channel 12' parallel with the axis of the cylinder. A sleeve valve 6' has a projection 13' extending into the channel 12' which is of a length to be engaged by the projection 13' during the entire travel of the sleeve valve. Rotation of the handle 11' will cause rotation of the disc 28 and hence of the channel and the sleeve valve, wherever the valve may be in its longitudinal movement. The shoulder 29 is provided with a slot 15' through which extends a pointer 13'', the ends of the slot 15' acting as stops to engage the pointer to determine the limiting positions of the sleeve valve in the same manner as the corresponding slot 15 in Fig. 2 and for the same purpose. This disc 28, inside the cylinder and rotated by the handle, takes the place and has the function of the ring 14 of Figs. 1 and 2. It is more easily removed than the ring and there is nothing on the outside of the cylinder to render cleaning or sterilization more difficult. The pointer 13'' adjacent to the outer surface of the cylinder at its expanded end may serve to indicate to the operator the angular position occupied by the valve.

With this arrangement, the operator controls the position of the piston and of the valve by

merely sliding and rotating the handle and has no need to let go of the handle to manipulate a ring.

Since the longitudinal movement of the valve is necessary to cause registration of the passage 21 first with port 2 or 4 at the intake end of the stroke and then with port 3 or 5 at the outlet end of the stroke, the friction between the piston and the sleeve may be made greater than the friction between the sleeve and the cylinder by forming slits or slots 31 in the open inner end of the piston as is shown in Fig. 10, to permit the metal portions between them to be expanded slightly to act as spring fingers. A piston ring 32 set within a groove in the piston wall will not only act to increase friction but will tend to prevent the ingress of blood between the piston and the valve wall.

In giving a transfusion of blood, it may be desirable to give the donor an infusion of saline solution, and it may also be deemed desirable to supplement the transfusion of blood by giving the recipient an infusion of saline solution. For the facile accomplishment of this purpose, a modification of the construction of Fig. 1 is shown in Figs. 12, 13, and 14, in which the inlet opening 33 for the saline solution is substantially opposite the inlet opening 34 for blood; in which the sleeve valve is provided with channels 35, 37, and 38 in its periphery for passage of the saline solution; and in which the cylinder has a channel 36 formed in its inner periphery. The channel 35 is shown in Figs. 12 and 14 as extending around the outer periphery of the sleeve valve 6'' for a little more than 180° and the channel 37, separated from the channel 35 by a distance longitudinally twice that travelled by the sleeve, lies on the same side of the sleeve and has the same length. These two transverse or semicircumferential channels are connected at one end by a longitudinal channel 38, shown in Figs. 12 and 13 as in registration with the inlet port 33 for saline solution. In the same transverse plane as the port 33 is the channel 36, shown in Figs. 12 and 13 as extending through a little more than 90° around the inner periphery of the cylinder on the side opposite the channels 35 and 37, and having one end communicating with the port 33. The inlet port 33 has a nipple 39 which will be connected by a tube with any suitable source of saline solution under pressure, and since this source forms no part of the pump apparatus of the present invention it has not been illustrated. Those familiar with the art will recognize as suitable sources such familiar equivalent devices as a suspended container, a hand operated piston, or a closed tank charged with compressed air and the solution.

Nipples will be provided at each port for the usual tubing. Nipple 40 at port 34 will be connected by a tube with the vein of the donor. Nipple 41 at port 42 will be connected by a tube with the vein of the recipient. Nipple 43 at outlet port 44 will be connected with a receptacle for washings. The piston 10'' is shown in Fig. 12 at the inner end of its stroke with the passage 21'' opposite the port 34 as it would be just after drawing in blood from the donor. Pressure on the handle 11'' will cause the valve 6'' to slide longitudinally until the passage 21'' registers with the port 42 and the channel 37 will then form a communicating passage between the port 33 and the port 34. While the piston is forcing blood out at the port 42, saline solution may be passed through the channel 37 to the vein of the donor.

to prevent stasis of blood in the connecting tube, thus preventing coagulation of blood in the tube. On the intake stroke, the sleeve slides to the position shown in Fig. 12 and the channel 35 and half of the channel 38 form a passage for the saline solution from the inlet port 33 to the port 42 permitting an infusion of saline solution into the vein of the recipient supplementary to the transfusion of blood from the vein of the donor.

10 This infusion may be continued at will as long as the piston is held at the inner end of its stroke, the pressure on the saline solution being made sufficient to provide a continuous flow.

Rotation of the sleeve valve through 90° counterclockwise in Figs. 13 and 14 will bring the passage 21'' in the same longitudinal plane with the end of the channel 36 and the outlet port 44, whereupon reciprocation of the piston will draw saline solution into the valve chamber through the channel 36 from the port 33 and will force it out at the port 44 into the receptacle for waste. After washing out the valve by this operation, a charge of saline solution, if desired, may be drawn into the valve and after rotating it ninety degrees, the charge may be sent into the vein of the recipient. Thus it will be seen that saline solution may be given both to the donor and to the recipient of blood during a transfusion. The channel 38 registers with the port 33 during the entire reciprocation of the piston in the normal angular setting and the pressure on the saline solution aids in causing the liquid to interpose itself between the valve and the cylinder.

By the provision of a valve 45 in the inlet port 33 as shown in Fig. 11, the flow of saline solution may be made greater or less or may be entirely cut off from either the donor or the recipient or both, while an independent passage 46 without a valve may be used instead of the channel 36 to permit a free flow of the solution for washing.

The modification shown in Figs. 15 and 16 is substantially the same as the structure just described with the addition of an inlet port 47 and nipple 48 and the omission of the channel 36, which enables the operator to use a T 49 connected by tube 50 to a source of saline solution, connected by tube 51 with the nipple 48 and connected by tube 52 with the nipple 39. An adjustable clamp 53 regulates the pressure of solution entering the port 33 for passage either to the donor or to the recipient while the open tube 51 permits the unobstructed flow at full pressure of solution into the port 47 for use in washing out the valve chamber.

This construction also permits the two tubes 51 and 52 to be used independently as indicated in Fig. 20, in which the tube 52 may be used for connection with a source of saline solution and the tube 51 may be used to connect the apparatus with a source of citrate solution for washing out the chamber when an anti-coagulant is desired.

A still further modification is illustrated in Figs. 18 and 19 in which the nipples 43 and 48 of Fig. 15 have been omitted and a longitudinal channel 54 has been formed in the wall of the cylinder to register with the passage 21'' when it has been turned ninety degrees away from registration with the ports 34 and 42. The cap 17' may have a nipple 55 at the opening 18' through which a saline or citrate washing solution may be drawn and discharged.

It will be seen that with this arrangement, the recipient of blood may still receive an infusion of saline solution through the channel 35' though no provision is made for giving the donor an

infusion. It will be noted that the channel 54 for the washing solution does not communicate with the channel 35', which however will be kept free from blood during the intake stroke of the piston by the saline solution entering at port 33.

The use of a solution of citrate of soda or citrate of potassium to prevent coagulation of blood in the joints between the sleeve valve and the cylinder is so desirable that a pressure cup 56, (shown in Fig. 21 as attached to the cylinder on the side opposite the ports 57 and 58, which may correspond with any of the ports 2, 3, 4, 5, 33, 34, or 42), can be provided as an addition to any of the modifications already described. The cup 56 has a chamber 59 formed with an outlet passage 60 and has a cap 61 in screw-threaded engagement with the outer periphery of the upper end of the cup, the cap being formed with a piston portion 62 sliding with a ground and liquid-tight joint in the cylindrical interior of the cup. Before use of the device, the cap is removed, a quantity of citrate solution is poured into the chamber 59, and the cap is replaced, the piston portion 62 acting to force some of the solution through the passage 60 into the space between the valve and the cylinder. At intervals during the process of transfusion, the cap 61 may be turned enough to force additional citrate solution into the valve joint, the surplus escaping at some of the ports and leaving the joint filled with clean solution.

A modification shown in Fig. 17 provides an inlet port 4' for saline washing solution and a channel 63 in line with the port 4' to discharge washings from the chamber 8' into the chamber 9' from which they escape through a port 64 in a nipple 65 on the end plug, this nipple being held while in use at the top of the plug 66 and being connected by a tube 67 with an open-mouthed funnel 68 leading to a receptacle 69 for washings. This does not permit return of the washings from the receptacle 69 back to the chamber 9'.

The devices described thus far may be made of any suitable material, a non-corrosive, non-rusting metal being entirely satisfactory for most purposes, but since many operators desire visibility of the blood chamber, glass may be used for the center of the device as illustrated in Fig. 22. The central part 70 of the cylinder is indicated as a glass tube attached at its ends to metal portions 71 and 72, and the central portion 74 of the valve is indicated as a glass tube attached at its ends to metal portions 75 and 76. It will be evident that the contents of the valve element 74 will be visible throughout the entire range of its movement within the cylinder element 70. With this arrangement in which the intake and outlet nipples are not in the glass portion but within a metal portion, the length of the channel 21g is necessarily greater than that of the channel 21 of Fig. 1 and the partition 7' will be of greater thickness than that of partition 7.

In Figs. 12 and 22, the chambers 9 and 9' respectively are shown as having an inlet port 77 or 77' formed in the wall of the cylinder while the end plug 78 or 78' is imperforate. With the valve in its outermost position, the end of the cylinder may be immersed beneath the surface of a citrate solution and some of the liquid may be drawn into the chamber by sliding the valve inward as a means by which a limited amount of the solution will be available to penetrate into the valve joint by capillarity. The port 77 or 77' will be carried on the upper surface of the cylinder as it is held in place for use so that the liquid cannot escape.

The modification shown in Fig. 23 is a double-acting pump having a handle 79 connected at its ends by cross arms 80 to the shafts 81 of the pistons 82 and 83 sliding within chambers 84 and 85 of a valve member 86 consisting of a cylindrical sleeve having a partition 87 separating the chambers 84 and 85. The sleeve valve is limited in its longitudinal sliding movements by the end caps 89 and 90 of the cylinder 88 and there is an intake port 91 and a discharge port 92 separated from each other by a distance equal to the amount of sliding movement of the sleeve in the cylinder. The chamber 85 has a passage 93 adjacent to the partition 87, the outer end of this passage being in registration with the intake port 91 at one end of its stroke and in registration with the discharge port 92 at the other end of its stroke. The chamber 84 has a passage 94 adjacent to the partition 87, the outer end of the passage communicating with two channels formed within the outer periphery of the sleeve valve, of which one channel is designated as 95 and this is in registration with the intake port 91 when the passage 93 is in registration with the discharge port 92, and the other channel, designated as 96, is in registration with the discharge port 92 when the passage 93 is in registration with the intake port 91.

Starting with the parts in the position shown in Fig. 23, with the piston 82 in contact with the partition 87 and the piston 83 in contact with the plug 90, longitudinal movement of the handle 79 will cause the valve 86 to slide along the interior of the cylinder 88 until the plug 89 stops its further sliding movement with the passage 93 in registration with the port 92. Continued movement of the handle will cause both pistons to slide in the sleeve valve, piston 83 forcing any contents of the chamber 85 out through the passage 93 and port 92 while piston 82 creates a suction to draw liquid into chamber 84 through the passage 95 and port 91. It will be obvious that a reverse movement will act to slide the valve to the plug 90 followed by expulsion of liquid from chamber 84 through passage 94 and channel 96 to the outlet port 92, and simultaneous inward suction into chamber 85 through port 91 and passage 93.

It will be evident that the invention is not limited to the exact details of construction of the specific elements chosen for illustration as preferred embodiments of the device since obviously many changes in formation and arrangement of parts may be made without departure from the essential mode of operation and without loss of its many advantages, while it is also clear that such a pump assembly is adapted for many other uses than those set forth.

I claim:

1. A pump assembly comprising a cylinder having two inlet ports in the same transverse plane and having two outlet ports in a transverse plane different from that of the inlet ports, each outlet port being in a longitudinal plane with an inlet port, a cylindrical sleeve valve within the cylinder, said sleeve having a transverse partition and being provided with a port formed in the wall of the sleeve adjacent to the partition, a piston slidable within the sleeve, and guiding means comprising elements on the cylinder and on the sleeve adapted for rotation whereby the port of the sleeve valve may be brought into alinement selectively with either of the longitudinal planes having an inlet and outlet port.

2. A structure as in claim 1 in which the guiding means on the cylinder and on the sleeve are

interengaged during the entire longitudinal movement of the valve.

3. A pump assembly comprising a barrel having inlet and outlet ports, a sleeve valve having a port registrable with the inlet or the outlet port selectively, a piston slidable in the sleeve valve, and a port angularly spaced from the inlet port, the sleeve valve being provided with a channel arranged to connect the said angularly spaced port with the inlet port of the barrel when the valve port is in registration with the outlet port of the barrel.

4. A pump assembly comprising a barrel having inlet and outlet ports, a sleeve valve within the barrel and having a port registrable with the inlet or the outlet port selectively, a piston slidable in the valve, the barrel being formed with separate inlet and outlet ports for a washing liquid, and means for rotating the sleeve valve and for limiting its rotative movement to positions in which the port in the valve registers with either of the inlet ports at one end of its longitudinal movement and with either of the outlet ports at the other end of its longitudinal movement.

5. A pump assembly comprising a barrel having inlet and outlet ports formed therein for one fluid, and having a separate port formed therein for another fluid, a sleeve valve slidable within the barrel and provided with a port formed within its wall for registration with the inlet or the outlet port of the barrel selectively, a piston slidable within the valve, and the sleeve valve being provided with a channel arranged to connect the said separate port for fluid with the outlet port of the barrel when the valve port is in registration with the inlet port of the barrel.

6. A structure as in claim 5 in which the sleeve valve is provided with a channel arranged to connect the said separate port for fluid with the inlet port of the barrel when the valve port is in registration with the outlet port of the barrel.

7. A pump assembly comprising a barrel having inlet and outlet ports, a sleeve valve slidable within the barrel and having a passage formed in its wall for registration with the ports of the barrel, a piston in the sleeve, and a pressure cup secured to the barrel and communicating with the space between the barrel and the sleeve valve, whereby a liquid in the cup may be forced under pressure into said space.

8. A pump assembly comprising a barrel having spaced ports for use as inlet and outlet ports, a sleeve valve slidable longitudinally within the barrel and having a transverse partition and a port formed within the wall of the valve adjacent to the partition for registration with the ports in the barrel, and a piston slidable within the sleeve valve and conforming to its interior dimensions whereby to expel substantially all fluid from the valve as the piston reaches the partition.

9. A pump assembly comprising a cylinder having two inlet ports and two outlet ports, a cylindrical hollow sleeve valve slidable longitudinally and rotatable within the cylinder, said sleeve valve being provided with a port formed in the wall of the sleeve, a piston operatively connected with the interior of the sleeve valve, and guiding means comprising elements on the cylinder and on the sleeve adapted for rotation whereby the port of the sleeve valve may be brought into alinement selectively with either inlet port or either outlet port.

10. A pump assembly comprising a barrel having inlet and outlet ports, a sliding hollow valve having a port registrable with the inlet or the out-

let port selectively and having a piston operatively connected with the hollow interior of the valve, the barrel having a port angularly spaced from the inlet port, and the sliding valve being
5 provided with a channel arranged to connect the said angularly spaced port with the inlet port of the barrel when the valve port is in registration with the outlet port of the barrel.

11. A pump assembly comprising a barrel having inlet and outlet ports, a sleeve valve within
10 the barrel and having a port registering selectively with either the inlet or the outlet port, a piston operatively connected with the interior of the sleeve valve, the barrel being formed with
15 separate inlet and outlet ports for a washing liquid, and means for rotating the valve and for limiting the rotative movement to positions in which the port in the valve registers with either
20 of the inlet ports at one end of its longitudinal movement and with either of the outlet ports at the other end of its longitudinal movement.

12. A pump assembly comprising a barrel having inlet and outlet ports formed therein for one fluid, and having a separate port formed therein
25 for another fluid, a sleeve valve slidable within the barrel and provided with a port formed within its wall for registration with inlet or the outlet port of the barrel selectively, a piston operatively connected with the interior of the sleeve valve, and
30 the sleeve valve being provided with a channel arranged to connect the said separate port for fluid with the outlet port of the barrel when the

valve port is in registration with the inlet port of the barrel.

13. A structure as in claim 12 in which the sleeve valve is provided with a channel adapted to connect the said separate port for fluid with
5 the inlet port of the barrel when the valve port is in registration with the outlet port of the barrel.

14. A pump assembly comprising a barrel having inlet and outlet ports, a sleeve valve slidable
10 within the barrel and having a passage formed in its wall for registration with the ports of the barrel, a piston operatively connected with the interior of the sleeve valve, the barrel having a port communicating with the space between the
15 barrel and the sleeve valve, a container for a fluid, and means connecting said container with the said port to permit liquid from the container to come in contact with the space between the
20 barrel and the sleeve valve.

15. A pump assembly comprising a barrel having inlet and outlet ports, a sleeve valve slidable
longitudinally within the barrel and having a transverse partition and a port formed in the wall
25 of the valve adjacent to the partition for registration with the ports in the barrel, a piston slidable within the valve between one end of the valve and the partition, and a closure for the end of the barrel remote from the piston to provide a liquid chamber within the barrel between
30 said closure and the partition in said valve.

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