

Nov. 3, 1936.

R. MANN

2,059,803

BLOOD TRANSFUSION APPARATUS AND METHOD

Filed Nov. 13, 1933

3 Sheets-Sheet 1

Fig. 1

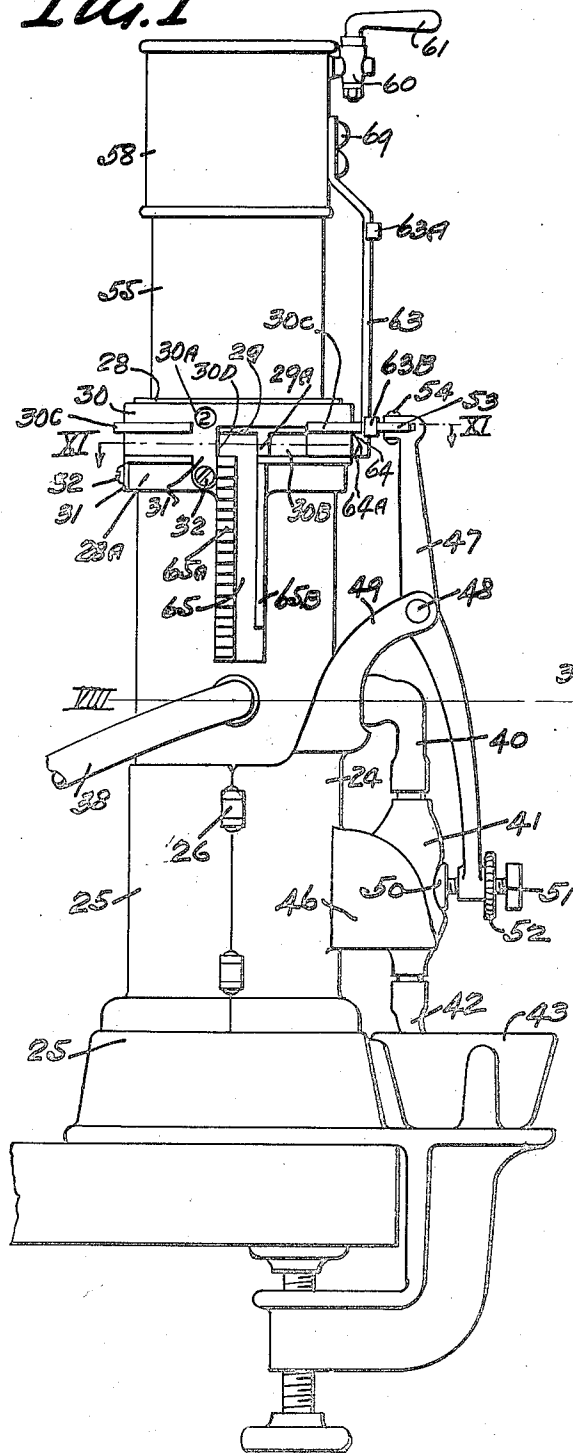
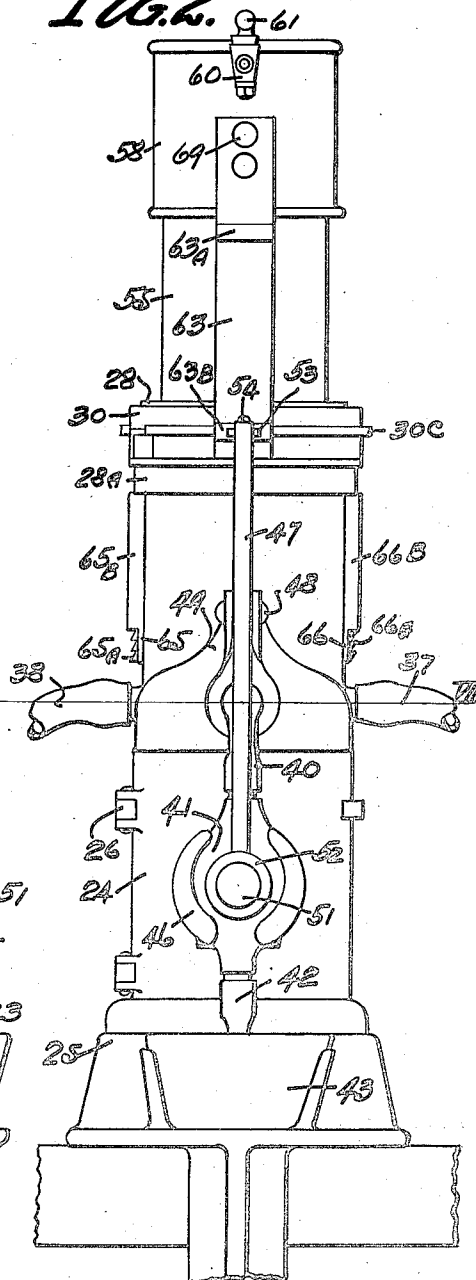


Fig. 2



INVENTOR
ROBERT MANN
By *J. H. Weathersford*
ATTORNEY

Nov. 3, 1936.

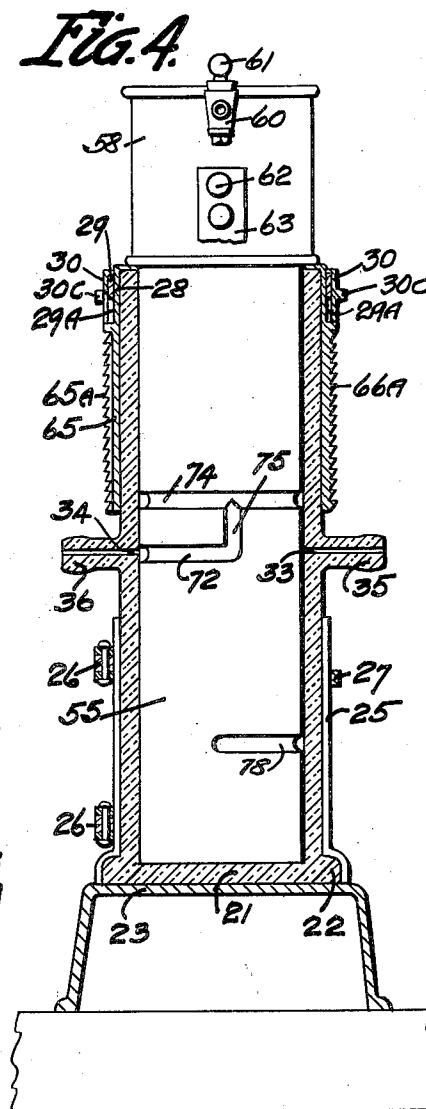
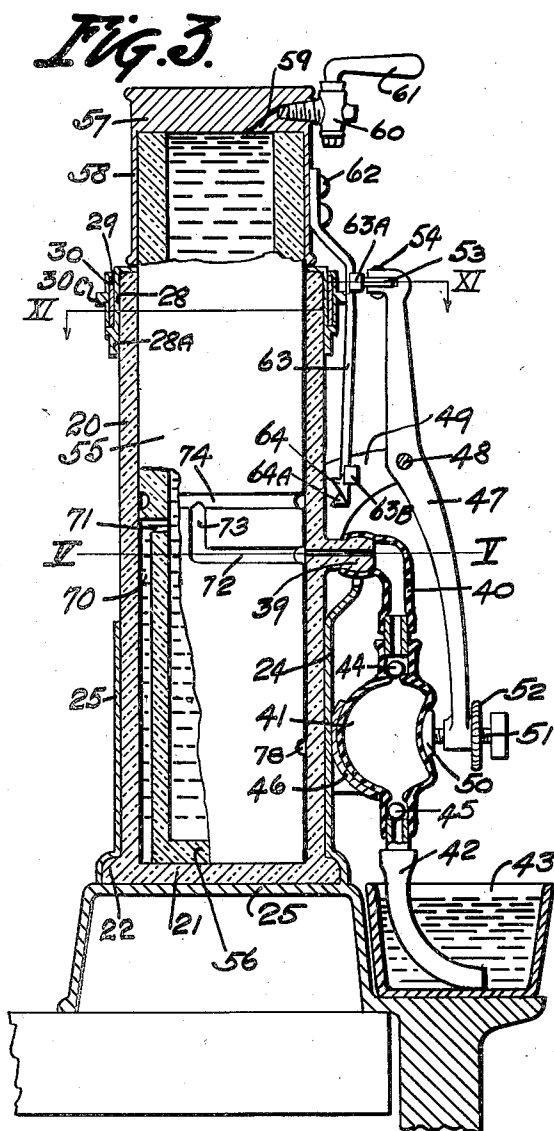
R. MANN

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INVENTOR
ROBERT MANN
by J. H. Weatherford
ATTORNEY

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R. MANN

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3 Sheets-Sheet 3

Fig. 5.

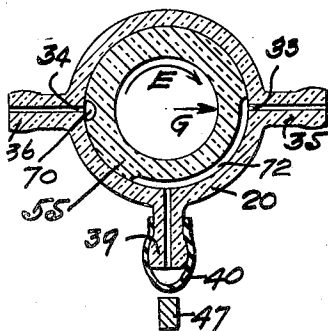


Fig. 6.

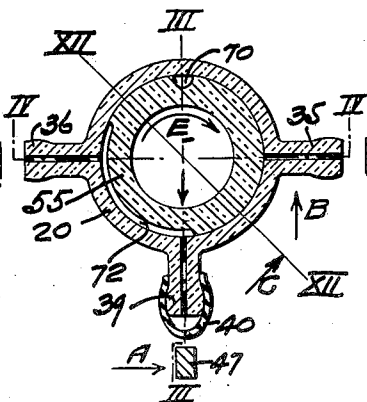


Fig. 7.

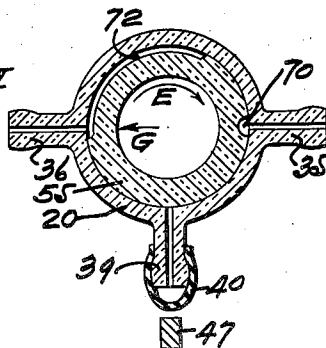


Fig. 10.

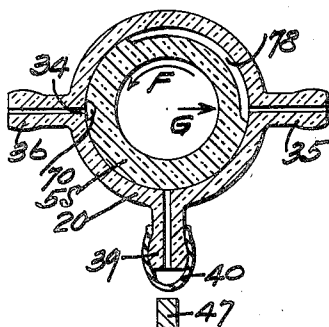


Fig. 9.

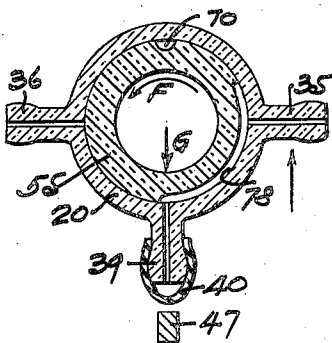


Fig. 8.

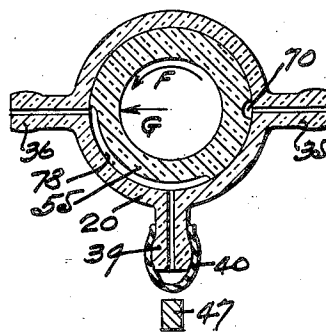


Fig. 11.

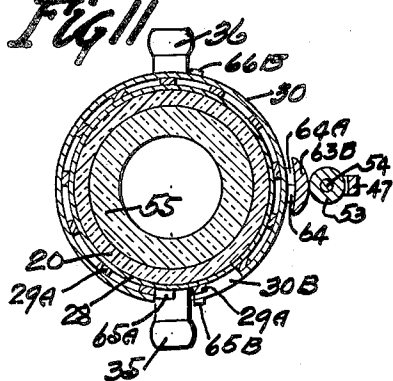


Fig. 12.

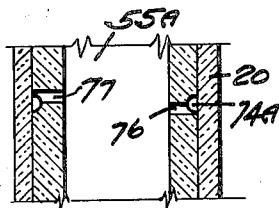
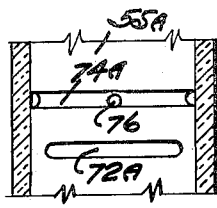


Fig. 13.



INVENTOR
ROBERT MANN
by J. H. Wraetherford
ATTORNEY.

UNITED STATES PATENT OFFICE

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BLOOD TRANSFUSION APPARATUS
AND METHOD

Robert Mann, Memphis, Tenn.

Application November 13, 1933, Serial No. 697,723

20 Claims. (Cl. 128—214)

This invention has general reference to the design and arrangement of the parts, and the method of operation, of syringes especially adapted for medical and/or surgical use; but relates more particularly to such instruments and methods which are intended to be employed in transferring blood from one living human or animal body to another, said operation commonly being termed blood transfusion, and is a continuation in part of my pending application for patent Serial No. 655,325.

Although the importance and efficacy of this operation under various conditions have long been known to and recognized by the medical profession, the dangers, complications and technicalities attendant upon it, limited its use, except in extreme or last-resort cases, until comparatively recent developments and improvements in the means and methods of performing transfusion operations led to their more frequent adoption.

Advancing from direct transfusion by means of cannulae, or with intima in direct contact with intima, with various modifications of the details of such methods, through direct, mediate, or immediate transfusion accompanied by the use of an anticoagulant, such as phosphate or citrate of sodium, the practice has progressed to the point where direct transfusion with syringes is generally regarded as being superior to any other method known heretofore. But there still remain various objections, perhaps the most serious of which is that, without employing an anti-coagulant, no syringe has been devised which provides for avoidance of the dangers and difficulties incident to clotting of the blood during the transfusion operation. By no means the worst, but nevertheless an extremely troublesome, effect of the tendency of blood that has not been defibrinated to thicken and become very adhesive in a comparatively short time after it leaves the body, is the resultant interference with the operation of the piston or plunger of the syringe; and it has been found necessary to meet this condition, either by having the reciprocating part of the syringe wiped occasionally with gauze moistened with ether or the like during the transfusion operation, or to interrupt the operation while the barrel of the instrument is flushed with a saline solution by means of an auxiliary syringe. Such auxiliary flushing operations, or such moistening with a diluent, have the effect of relieving interference with the movement of the piston or plunger, but neither prevents formation of blood

clots in the transmission channels leading to the terminal needles, or in the needles themselves.

One objection to the use of an anticoagulant in connection with indirect transfusion is the amount of such material necessary and the fact that even with the utmost care in straining, it is not possible to remove all of the finer or incipient blood clots, and that these clots even through too fine to directly effect clogging, build up after transfer to the patient and cause trouble. The same conditions are true wherever there is the slightest delay in the application of the anticoagulant as a flushing material in direct transfusion.

Also while it is true that a saline solution may be used in considerable quantity without deleterious effect and cleansing be accomplished, such cleansing is not as effective in accomplishing subsequent opposition to blood clotting as is an anti-coagulant. While the saline solution may be used in considerable quantity, it is now believed to be extremely important that any anti-coagulant be used only in limited quantity and that regulation of the amount used is of very great importance.

The primary object of the instant invention is to improve upon, and overcome the objections to the means and methods employed for blood transfusion, as known heretofore, particularly in the following respects:

By providing a blood-transfusion syringe which shall be adapted to transfer blood directly from the donor to the recipient, while inherently preventing clotting in the intake channel;

By providing such a syringe which shall inherently prevent clotting in the discharge channel;

By providing such a syringe which shall inherently prevent interference with movement of the reciprocable member by coagulated or partially dried blood;

By providing such a syringe in which either a simple diluent or an anti-coagulant solution may serve as the medium for preventing interference with movement of said reciprocable member;

By providing such a syringe in which such a solution is caused to circulate through one of the transfusion channels during shift of the blood groove of the instrument from one of said channels to the other thereof, and through the other of such channels on the reverse shift of such groove;

By providing means cooperating with such a syringe to measure the quantity of solution so transmitted;

By providing means adjusting the amount of solution transmitted;

By providing such a syringe in which either a simple diluent or an anti-coagulant solution may be caused to circulate and wash the barrel or body of the instrument during interruption of the transfusion operation;

By providing such a syringe in which the piston or plunger is manually turnable in the barrel, to bring a groove or opening in such reciprocable part selectively into different positions relative to the inlet and/or discharge parts; and including means for defining such selective positions, and guiding the piston or plunger in its reciprocatory movement in the position selected;

By providing such a syringe in which all parts with which the blood comes in contact may be made of glass;

By providing a method of direct blood transfusion in which each blood transfusion channel is flushed with a diluent or an anti-coagulant solution immediately following transfer of blood therethrough;

By providing means for preventing retrogressive movement of the plunger during the blood-intake stroke;

By providing means for preventing retrogressive movement of the plunger during the blood-discharge stroke;

By providing means for preventing retrogressive movement of the plunger during the blood-intake or the blood-discharge stroke; and

By providing means for indicating the number of blood-discharge strokes.

The means by which the foregoing and other objects are accomplished and the manner of their accomplishment will readily be understood from the following specification by reference to the accompanying drawings, in which:—

Figs. 1 and 2 are side elevations of a preferred form of my improved blood syringe with the plunger at the end of its up stroke, Fig. 2 being taken at 90 degrees to Fig. 1.

Fig. 3 is a sectional elevation of the device taken on the line III—III of Fig. 6 looking in the direction of the arrow A, the plunger being shown in elevation, with a portion in section.

Fig. 4 is a sectional elevation of the device taken on the line IV—IV of Fig. 6 looking in the direction of the arrow B, the plunger being shown in elevation, and in lowered position.

Figs. 5, 6 and 7 are sections taken on the line V—V of Fig. 3 with the plunger at the end of the down stroke, Fig. 5, showing the plunger in the position which it occupies at the completion of blood transfer to the recipient, Fig. 6 the plunger rotated 90 degrees in the direction of the arrow E from the position shown in Fig. 5, and Fig. 7 the plunger further rotated to 180 degrees from the position of Fig. 5.

Figs. 8, 9 and 10 are sections on the line VIII—VIII of Figs. 1 and 2 with the plunger at the end of the up stroke, Fig. 8, showing the plunger in the position which it occupies at the completion of withdrawal of blood from the donor, Fig. 9 the plunger rotated 90 degrees from, and Fig. 10 the plunger further rotated to 180 degrees from, the position shown in Fig. 8, such rotation being in the direction of the arrow F.

Fig. 11 is a section taken as on the line XI—XI of Figs. 1 and 3.

Figs. 12 and 13, show a modification of the lubricating groove on the plunger and the relation of the upper blood-groove thereto; Fig. 12 being a sectional elevation of a fragmentary por-

tion of the plunger and barrel taken on the line XII—XII of Fig. 6; and Fig. 13, a sectional elevation of the same portions of the device, taken at 90 degrees to Fig. 12, the plunger being shown in elevation.

Referring now to the drawings in which the various parts are indicated by numerals, 20 is a hollow, cylindrical barrel, having a smooth and symmetrical inner surface, and having a closed lower end 21, which is extended outwardly to form a concentric flange 22 adapted to serve as a base for the syringe and to cooperate in the retention of the instrument in place on a suitable support 23, as by means of two semi-cylindrical cuffs 24, 25. One cuff 24 is integral with or securely attached to the support 23. The other cuff 25 is movably attached, as by means of hinges 26 and a suitable latch 27, to the cuff 24, the latch 27 being releasable to permit the hinged cuff to be swung open for removal or replacement of the barrel 20, and when secured, clamping the barrel firmly against the other cuff 24. The cuffs 24 and 25, not only secure the barrel 20 to the support 23, but extend longitudinally along somewhat less than half the barrel and thereby brace it against lateral displacement.

The barrel 20 is open at its upper end and is there surrounded by a sleeve 28 securely cemented on, the lower portion 28A of the sleeve being of a greater diameter than the upper portion thereof whereby to form a ledge or shoulder. Loosely surrounding the upper portion of the sleeve 28, is a sleeve 29, having depending rectangular tongues 29A, spaced apart to leave rectangular slots therebetween. The lower ends of the tongues 29A rest on the shoulder of the sleeve 28 and support the sleeve 29. Enclosing but not binding the sleeve 29, is a sleeve 30, having a window 30A therein, through which any one of a series of numbers, on the sleeve 28 may appear, the numeral 2 showing. The sleeve 30 is also provided with a rectangular opening 30B of width equal to the width of the tongue 29A and the two slots adjacent thereto. The sleeve 30 preferably is provided with integral ears 31, which are secured to the lower portion 28A of the sleeve 28 as by screws 32. 30C, is a rib integral with the sleeve 30 and extending therearound, but interrupted by the opening 30B.

At diametrically opposite sides of the barrel, approximately midway of its length, an inlet opening 33, and an outlet opening 34, are provided, each of said openings leading into a channel way extending through a nipple 35, 36, respectively, preferably integral with the barrel and extending sufficiently beyond the outer surface thereof to adapt the nipples to receive suitable lengths of rubber tubing 37, 38, respectively. Positioned at the same level, and half way between these nipples, is a third nipple 39 provided with a similar passageway leading into the barrel, which nipple will be hereinafter designated the flushing nipple. The flushing nipple is connected by a suitable length of tubing 40, with a rubber bulb 41, of usual type, from which a suction tube 42, leads into a suitable vessel 43, for the flushing fluid. The bulb 41 is provided with any suitable type of check valves 44, 45, respectively preventing flow from the tube 40 to the bulb, and from the bulb through the tube 42 to the vessel 43. The bulb 41 is supported and held in position relative to the barrel by a suitable support 46, which is secured as by brazing, or in other desired manner, to the cuff 24. Compression of the bulb 41 preferably is accomplished

through a rocker arm 47 which is fulcrumed on a pin 48. The pin 48 is carried by a pair of arms 49, which preferably are an integral part of the cuff 24, from which cuff they extend upward and outwardly. The lower end of the rocker arm 47, terminates approximately opposite the center of the bulb 41, and carries a button 50, adapted to be pressed against the bulb 41 on inward movement of the lower end of the rocker arm. While the button 50 may be carried directly by the lower end of the arm, it is preferably carried by a screw 51, which passes through and threadedly engages the arm-end, and which may be adjusted inwardly or outwardly, to increase or decrease the action on the bulb as may be found necessary. 52 is a lock nut by which the screw 51 may be locked in any desired position of adjustment. The upper end of the rocker arm 47, preferably carries a roller 53, suitably journaled as on a pin 54.

Disposed within the barrel 20, is a cylindrical plunger 55, which forms an air tight, but reciprocable and turnable, closure for the open end of the barrel. Preferably the plunger 55 is hollow and in such event the lower end thereof is closed, preferably by an integral head 56. The upper end of the hollow plunger is also closed, this closure preferably being accomplished by a metal head 57, which is integral with a cylindrical sleeve 58, adapted to closely fit the exterior of the plunger and extend downward therearound. The head 57, and depending sleeve 58, are secured to the plunger by suitable cementing material. 59 is a passageway extending upwardly, and horizontally outward to one side of the head 57. Secured in this passageway is a pet-cock 60, provided with a suitable handle 61, which may be turned to close or open the passageway 59, as may be desired.

Secured to the upper end of the plunger 58, as by rivets 62, is a cam bar 63 having ratchet dogs 64, 64A, on the lower end thereof. This bar is bent outward so that, with the plunger in down position, it clears the peripheral edge of the sleeve 30, and thence extends downward parallel with the axis of the plunger and barrel. The exterior of the bar 63 is provided with cam portions 63A, 63B, which cooperate with the roller 53, as the plunger is turned, to actuate the ratchet arm 47. Secured to the sleeve 28, at the upper end of the casing 20, or integral therewith, and extending downward therefrom, are rack bars 65, 66, provided with rack teeth 65A, 66A which respectively face downward and upward and with which the oppositely faced ratchet dogs 64, 64A may respectively be engaged by rotative movement of the plunger 55. Such rotative movement is limited by engagement, in the one case, of the side edge of the dog 64A, with the side edges of the rack teeth 65A, and in the other by similar engagement of the dog 64 and rack teeth 66A. The bars 65, 66 are also provided respectively with guide bars 65B, 66B, the lower ends of which terminate short of the lower ends of the bars and above the dogs 64, 64A, when these dogs are at their lowest position. Coaction of the ratchet teeth 65A and dog 64 prevent retrogressive movement on the down stroke, and of the teeth 66A and dog 64A, retrogressive movement on the up-stroke. The teeth 65A and bar 65 provide a channelway for the dog 64A, and the teeth 66A and bar 66B provide a channelway for the dog 64, preventing turning movement of the barrel during such respective strokes. The sleeve portion 28A is channeled correspondingly.

The plunger is provided, in usual manner, with a longitudinal groove 70, herein designated the blood-groove, which extends from the lower end of the plunger upward to the level of the inlet and outlet openings 33, 34, when the plunger is in its down position. If the plunger be hollow, I prefer to extend this groove slightly higher and connect it with the interior of the plunger by an opening 71 through the plunger wall.

72 is a circumferential flushing-groove, slightly in excess of a quadrant in length, cut in the surface of the plunger. In the down position of the plunger, this groove is at the level of the inlet, outlet, and flushing openings. As will be seen by reference to Figs. 5, 6 and 7, one end of this groove is diametrically opposite the blood-groove 70 and substantially in line with the center of the cam bar 63, the position of which center is indicated in these views by the arrow G. From this point the groove extends circumferentially, approximately the width of the cam bar in excess of a quadrant, the groove 72 leading from its starting point toward the flushing-nipple 39, when the blood-groove 70 is aligned with the outlet opening 34. At one end of the groove 72, a vertical groove 73 extends upward to a circumferential lubricating-groove 74, which is above the opening 71, and preferably extends entirely around the plunger. If desired the opposite end of the flushing-groove 70 may be connected to the lubricating-groove by an additional vertical groove 75. Preferably both are used, but if desired either may be omitted.

In Figs. 12 and 13 a modification is shown, in which 74A is a circumferential lubricating-groove extending around the plunger, and 72A, a flushing-groove entirely detached therefrom. In this form the lubricating-groove 74A, is connected by diametrically opposite openings 76, 77, with the interior of the plunger. One of these openings leads from the bottom, and the other thereof from the top, of the groove 74A, into the plunger.

A second flushing-groove 78 of substantially equal length with the groove 72 is cut in the surface of the plunger near the lower end thereof. The vertical positioning of this groove, is determined by withdrawing the plunger to the full length of stroke permitted by engagement of the dog 64, with the rib 30B, and in such position, establishing the groove at the level of the inlet and outlet openings 33, 34. The groove 78 begins diametrically opposite the blood groove 70, and leads away from the flushing-nipple 39, when the plunger is turned to bring the blood groove 70 into alignment with the outlet opening 34, said flushing groove 78 extending circumferentially around the plunger, a distance about the width of the cam bar 63 in excess of a quadrant.

USING OPERATION

Priming

The apparatus, with donor and recipient transfusion tubes 37, 38 and their needles (not shown) attached, is set up and clamped to a table or other suitable support. The receptacle 43 is filled with a flushing fluid, preferably sodium citrate, though if desired some other fluid. The plunger is turned to bring the dog 64A over the rack teeth 66A and the blood groove 70 into alignment with the recipient nipple 36. Should it so happen that the plunger is withdrawn or partially withdrawn, the petcock 60 is opened and the plunger pushed to its lowest position to permit such turning. The recipient needle is placed in the flushing fluid in the receptacle 43, or other

container, the petcock is closed and the plunger withdrawn, engagement of the dog 64 with the rib 30C limiting such withdrawal, and a charge of flushing fluid is drawn from the receptacle through the recipient needle and tube 38, and the blood groove 70, into the barrel below the bottom of the plunger. The plunger is rotated some one-eighth turn, the petcock 60 is opened, and the plunger pushed downward discharging the fluid from the barrel through the blood channel and opening 71 into the hollow plunger, air escaping from the plunger barrel through the petcock. On completion of the down stroke the petcock 60 is closed, the plunger turned back to original position and withdrawn, drawing in an additional charge of flushing fluid, which is discharged into the plunger, and the procedure repeated until the plunger is completely filled. Should filling of the plunger occur before completion of the down stroke such stroke must be completed and the flushing fluid allowed to escape.

During this procedure, with the plunger at the end of one of the up strokes, the plunger is rotated to bring the cam portion 63B of the plunger into engagement with the roller 53 of the rocker arm 47, and is further rotated forward and then backward a number of times, thereby through the rocker arm 47 repeatedly compressing the bulb 41, and through the flushing groove 78, and the inlet opening 33, filling and flushing the donor tube 37 and needle attached.

During filling and flushing of the recipient tube, the lubricating-groove 74 is filled from the flushing groove 72 through the vertical grooves 73 and 75, and such fluid is replenished at each subsequent flushing operation during transfusion.

In the modified form shown in Figs. 12 and 13, the detached lubricating-groove 74A is filled as the plunger is filled, the lower opening 76 allowing the liquid to flow into the groove, and the upper opening 77 allowing air to escape as the groove fills and preventing entrainment of air in such groove.

Transfusion

Priming having been completed the plunger is turned to bring the dog 64A of the cam bar into engagement with the rack teeth 66A, the reversely turned dog 64 limiting such turning movement and the apparatus is ready for the transfusion operation.

The recipient and donor needles are inserted in the veins of the recipient and donor respectively. The plunger is retracted, the dog 64A riding over the rack teeth 66A and being prevented from retrogressive movement by such teeth. Also, the reversely positioned dog 64 lies along and cooperates with the adjacent rack teeth 66A and the guide bar 66B to prevent turning movement of the plunger during such stroke. At the upper end of the rack, the dog 64 rides outward and onto the sleeve 30. The upward stroke is continued until the dog 64 engages the rib 30C and upward movement is thereby stopped.

The plunger is then turned in the direction of the flushing nipple, being the direction shown by the arrows F in Figs. 8, 9 and 10 and toward the opposite rack bar 65. As the cam 63B, in such movement, passes beneath the roller 53, it actuates the rocker arm 47 and compresses the bulb 41, forcing flushing fluid through the groove 78 and through the opening 33 and the donor tube and needle to the donor, thus forcing the blood from the passageway through the nipple 35, the tube 37 and the needle attached thereto and washing such passageways. Further turning

movement causes the dogs 64 and 64A to drop through the opening 30B, and engage the tongue 29A of the sleeve 29, thereafter moving the sleeve, until turning movement is limited by engagement of the dog 64 with the side 30D of the opening 30B. Such engagement positions the dog 64 over the rack teeth 65A, and aligns the blood groove 70 with the opening 34 leading to the recipient tube and needle.

The plunger is forced downward, discharging 10 from the recipient nipple 36 and tube and needle, the flushing fluid contained therein, and thereafter delivering the charge of blood in the barrel to the recipient. In this downward movement, the dog 64 rides over the rack teeth 65A and prevents retrogressive movement thereof. Also the reversely positioned dog 64A, cooperating with the rack teeth 65A and the guide bar 65B, prevents turning movement of the plunger during such downward stroke. At the completion of the 20 down stroke, the plunger is reversely turned, again toward the flushing nipple 39, this being the movement indicated by the arrows E of Figs. 5, 6 and 7. During such movement, the cam 63A passes beneath the roller 63 and, through the 25 rocker arm 47, compresses the bulb 41, to discharge flushing fluid through the nipple 39, the groove 72, and the recipient nipple and tubes attached thereto, forcing the blood remaining therein from the nipple tube and needle and washing out the passageways. Turning movement is continued until the dog 64A is again 30 aligned with the rack teeth 66A, and the operation repeated such number of times as may be necessary to deliver the desired quantity of blood from donor to recipient. The amount of flushing fluid delivered, may be adjusted by advancing or retarding the position of the button 59, the button being locked in such new position by tightening of the locking nut 52. 40

At any time during the operation that it should be deemed necessary an additional flushing charge may be delivered at the end of any up stroke to the donor, by reversely moving the cam 63 beneath the roller 53, and similarly at the end 45 of any down stroke, an additional flushing charge may be delivered to the recipient by reversely turning the cam 63A beneath the roller 53.

Barrel-flushing

At any time during the operation, with the plunger in down position, turning movement may be interrupted, before or after engagement of the cam 63A and the roller 53, and the petcock 60 be opened. The plunger may then be withdrawn, 50 preferably the full limit of its stroke, drawing flushing fluid from the interior of the plunger through the passageway 71 to wash out the blood groove 70 and fill the barrel beneath the plunger with flushing fluid. Depression of the plunger 60 forces this fluid back into the hollow of the plunger, the operation being repeated a sufficient number of times to thoroughly wash the blood groove, the lower end of the plunger, and the lower portion of the barrel free of blood. This 65 flushing operation is completed by pushing the plunger to the down position and closing the petcock 60, again sealing the flushing fluid within the plunger in such position, and transfusion is resumed. 70

Counting

During the first turning movement described above, engagement of the dogs 64, 64A with the tongue 29A and the subsequent movement thereof 75

causes successive numbers, the number 2 being shown, to appear through the opening 30A, and to thus indicate the number of charges of blood withdrawn from the donor and delivered to the recipient. Prior to the beginning of the first turning movement, the sleeve 29 is shifted, by successive movements of the tongues 29A, until the numeral naught is brought into register with the window 30A whereby the first turning movement will display the number 1, and additional movements additional numbers.

Lubrication

Lubrication of the barrel is effected by the liquid contained in the lubrication groove 74, and also by flushing fluid contained in the grooves 72 and 78. If the groove 74 is connected with the flushing groove 72 the fluid in the flushing groove is replenished by each flushing charge delivered, when the plunger is in down position. If the lubricating groove is detached as shown in Figs. 12 and 13 it is replenished through the openings 76 and 77 from the interior of the barrel.

Having described my invention, what I claim is:—

1. Apparatus of the character described, including a hollow barrel having a closed end, and an open end, and a plunger reciprocable and turnable therein, said plunger projecting beyond said barrel, said barrel having an inlet nipple, a diametrically opposite outlet nipple and a flushing nipple substantially midway therebetween, said nipples lying intermediate the ends of the barrel and substantially at a common level; said plunger having a short circumferential surface groove at the level of said nipples when said plunger is at its innermost position, a similar circumferential surface groove at the level of said nipples when the plunger is in retracted position, and a longitudinal surface groove extending from the end of the plunger to the level of the first of said grooves, said circumferential grooves being in excess of a quadrant in length, both beginning substantially diametrically opposite said longitudinal groove, and extending in opposite directions toward said longitudinal groove but terminating short thereof, flushing means secured in fixed relation to said barrel adapted to deliver a charge of flushing fluid through said nipple, actuating means therefor, and means secured to the projecting portion of said plunger opposite said longitudinal groove and depending therefrom along the exterior of said barrel into the path of said actuating means, whereby to actuate said flushing means by turning movement of said plunger.

2. Apparatus of the character described, including a hollow barrel having a closed end, and an open end, and a plunger reciprocable and turnable therein, said plunger projecting beyond said barrel, said barrel having an inlet nipple, a diametrically opposite outlet nipple and a flushing nipple substantially midway therebetween, said nipples lying intermediate the ends of the barrel and substantially at a common level; said plunger having an arcuate circumferential surface groove at the level of said nipples when said plunger is at its innermost position, a similar arcuate circumferential surface groove at the level of said nipples when the plunger is in retracted position, and a longitudinal surface groove extending from the end of the plunger to the level of the first of said grooves, and remote from the ends of both grooves, flushing means secured in fixed relation to said barrel

adapted to deliver a charge of flushing fluid through said nipple, actuating means therefor, and means secured to the projecting portion of said plunger opposite said longitudinal groove and depending therefrom along the exterior of said barrel into the path of said actuating means, whereby to actuate said flushing means by turning movement of said plunger.

3. Apparatus of the character described, including a hollow barrel having a closed end, and an open end, and a plunger reciprocable and turnable therein, said plunger projecting beyond said barrel, said barrel having an inlet nipple, a diametrically opposite outlet nipple and a flushing nipple substantially midway therebetween, said nipples lying intermediate the ends of the barrel and substantially at a common level; said plunger having an arcuate circumferential surface groove at the level of said nipples when said plunger is at its innermost position, a similar circumferential surface groove at the level of said nipples when the plunger is in retracted position, and a longitudinal surface groove extending from the end of the plunger to the level of the first of said grooves, said circumferential grooves being in excess of a quadrant in length, both beginning less than a quadrant from said longitudinal groove, and extending in opposite directions around said barrel toward, but terminating short of said longitudinal groove, flushing means secured in fixed relation to said barrel adapted to deliver a charge of fluid through said flushing nipple, actuating means therefor, and means secured to the projecting portion of said plunger opposite said longitudinal groove and extending therefrom along the exterior of said barrel into the path of said actuating means, whereby to actuate said flushing means by turning movement of said plunger.

4. Apparatus of the character described, including a barrel, a plunger reciprocable and turnable therein, and a support for said barrel, said barrel having a flushing-nipple leading thereinto; and two nipples circumferentially spaced therefrom on opposite sides thereof, said plunger having grooves registerable with said nipples to establish communication from said flushing nipple to said side nipples, means connected to said flushing nipple and actuatable to discharge fluid thereto, means carried by said support, having one end cooperating with said discharge means, and the opposite end extending adjacent the upper end of said barrel, and means carried by said plunger extending exterior to said barrel, movable by turning of said plunger into engagement with said cooperating means, to effect actuation thereof and thereby of said discharge means.

5. Apparatus of the character described, including a hollow barrel having a closed end and an open end; and a hollow plunger, having both ends closed, reciprocable therein; said plunger having an opening through its sidewall intermediate the plunger length and a surface groove leading longitudinally from such opening to the inner end of said plunger, the outer end of said plunger being apertured and being provided with manually operable means for opening and closing said latter aperture, whereby to effect transfer of fluid at option between said barrel beneath said plunger and the interior of said plunger.

6. Apparatus of the character described, including a hollow barrel having a closed end and an open end; and a hollow plunger, having both ends closed, reciprocable therein, said plunger having an opening through its sidewall interme-

diate the plunger length and a surface groove leading longitudinally from such opening to the inner end of said plunger, the outer end of said plunger being apertured and being provided with manually operable means for opening and closing said latter aperture, whereby to effect transfer of fluid at option between said barrel beneath said plunger and the interior of said plunger, and said plunger having a circumferential surface groove disposed outward from said wall opening, and having oppositely disposed wall openings establishing communication between the interior of said plunger and said latter groove, one of said openings lying at the outer edge and the other at the inner edge of said groove.

7. Apparatus of the character described, including a hollow cylindrical barrel having a closed end and an open end, and an elongated hollow plunger reciprocable therein, said plunger forming a reservoir for a fluid, and having a circumferential groove around the exterior surface of the side wall thereof intermediate its length, said plunger having openings extending outward through said side wall connecting said reservoir with said groove, at least one of said openings leading to the upper edge of said groove and an opposite opening to the lower edge of said groove.

8. Apparatus of the character described, including a hollow cylindrical barrel having a closed end and on open end, and an elongated hollow plunger reciprocable therein, said plunger forming a reservoir for a fluid, and having a circumferential groove around the exterior surface of the side wall thereof intermediate its length, said plunger having a pair of oppositely disposed openings extending through said side wall to connect said reservoir with said groove, one of said openings leading to the upper edge of said groove and the opposite opening to the lower edge of said groove.

9. In blood transfusion apparatus, means for withdrawing a charge of blood from a donor and for delivering the blood withdrawn to a recipient, and auxiliary synchronized pumping means connected to said apparatus for measuring charges of flushing fluid and forcing said measured charges of flushing fluid alternately to the said donor, and the said recipient.

10. In blood transfusion apparatus, means for withdrawing a measured charge of blood from a donor, and for delivering the blood so withdrawn to a recipient, additional associated and connected pumping means for measuring charges of flushing fluid, and means actuated by operation of said first means, for actuating said pumping means and forcing said charges of flushing fluid alternately to the said donor and the said recipient.

11. Blood transfusion apparatus, including means for withdrawing a charge of blood from a donor, and for delivering the blood so withdrawn to a recipient, auxiliary pumping means for measuring charges of flushing fluid, and means synchronized with said withdrawing and delivering means for actuating said pumping means to force a said charge of flushing fluid to the said donor after each blood withdrawal, and a similar said charge to the said recipient, after each blood delivery.

12. Blood transfusion apparatus, including means for withdrawing a charge of blood from a donor, and for delivering the blood so withdrawn to a recipient, auxiliary pumping means for

measuring charges of flushing fluid, means for varying the amount of such charges, and means actuated by operation of said first means, for actuating said pumping means and forcing said charges of flushing fluid alternately to the said donor and the said recipient.

13. Blood transfusion apparatus, including means for withdrawing a charge of blood from a donor, and delivering blood so withdrawn to a recipient, and auxiliary pumping means actuated by operation of said first means for measuring charges of flushing fluid and for forcing said measured charges alternately to said donor and to said recipient, said forcing means being synchronized to deliver a said charge to said donor after each blood withdrawal and a said charge to said recipient after each blood delivery.

14. In blood transfusion apparatus, a cylinder having intake and discharge passageways, and a plunger reciprocable and turnable in said cylinder, a supporting frame for said cylinder, auxiliary pumping means carried by said frame, and passageways for effecting connection of said pumping means with said intake and discharge passageways, means for drawing a charge of liquid into said pumping means and discharging same therefrom, and means carried by said plunger for actuating said pumping means.

15. In blood transfusion apparatus, a cylinder, transfusion passageways adapted to lead respectively from a donor to said cylinder and from said cylinder to a recipient, and a plunger in said cylinder adapted to draw blood into said cylinder through said donor passageway and discharge such blood through said recipient passageway, a secondary pumping means, associated with said apparatus and in addition thereto, for transferring a flushing fluid, means carried by said plunger for actuating said pumping means, a passageway connecting said pumping means to said cylinder, and plunger carried means for establishing communication between said latter passageway and either of said transfusion passageways.

16. In blood transfusion apparatus, a cylinder, transfusion passageways adapted to lead respectively from a donor to said cylinder and from said cylinder to a recipient, and a plunger in said cylinder adapted to draw blood into said cylinder through said donor passageway and to discharge such blood through said recipient passageway, plunger-actuated means, associated with said apparatus and in addition thereto, for measuring and transferring a flushing fluid, means connecting said measuring-means to said cylinder, and plunger carried means for establishing communication between said cylinder connecting means and either of said transfusion passageways.

17. In a blood transfusion apparatus, a cylinder, transfusion passageways adapted to lead respectively from a donor to said cylinder and from said cylinder to a recipient, and a plunger in said cylinder adapted to draw blood into said cylinder through said donor-passageway and discharge such blood through said recipient-passageway, pumping means, associated with said apparatus and in addition thereto, for transferring a flushing fluid, means carried by said plunger for actuating said pumping means, and means connecting said transferring means to said cylinder, said plunger being grooved to provide a channel-way registerable with, and establishing communication between, said connecting means and either of said transfusion passageways.

18. Blood transfusion apparatus, including transmission channels respectively adapted to be connected to a donor and a recipient, means for withdrawing blood through said donor channel
5 and for delivering blood so withdrawn through said recipient channel, a source of flushing fluid, auxiliary pumping means connected to said source, means for alternately connecting said auxiliary pumping means respectively to said
10 donor and recipient channels and means operated by actuation of the first said means for actuating said auxiliary pumping means.

19. In apparatus employing a cylinder and a plunger reciprocable and turnable therein, stroke
15 recording means, including a sleeve turnably mounted around said cylinder, means carried by said plunger adapted to engage with said sleeve on outward movement of said plunger, to turn said sleeve on turning movement of said plunger,

and to disengage from said sleeve on inward movement of said plunger, and means shielding said sleeve, said shielding means limiting engagement of said plunger carried means with said sleeve to a predetermined part of such turn-
5 ing movement.

20. Blood transfusion apparatus, including transmission channels respectively adapted to be connected to a donor and a recipient, means for withdrawing blood through said donor channel
10 and for delivering blood so withdrawn through said recipient channel; a source of flushing fluid, auxiliary pumping means connected to said source, means for connecting said auxiliary
15 pumping means to a said channel and means operated by actuation of the first said means for actuating said auxiliary pumping means.

ROBERT MANN.