F. A. BUTLER.

TRANSFUSION APPARATUS.

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1,170,958.

Patented Feb. 8, 1916.

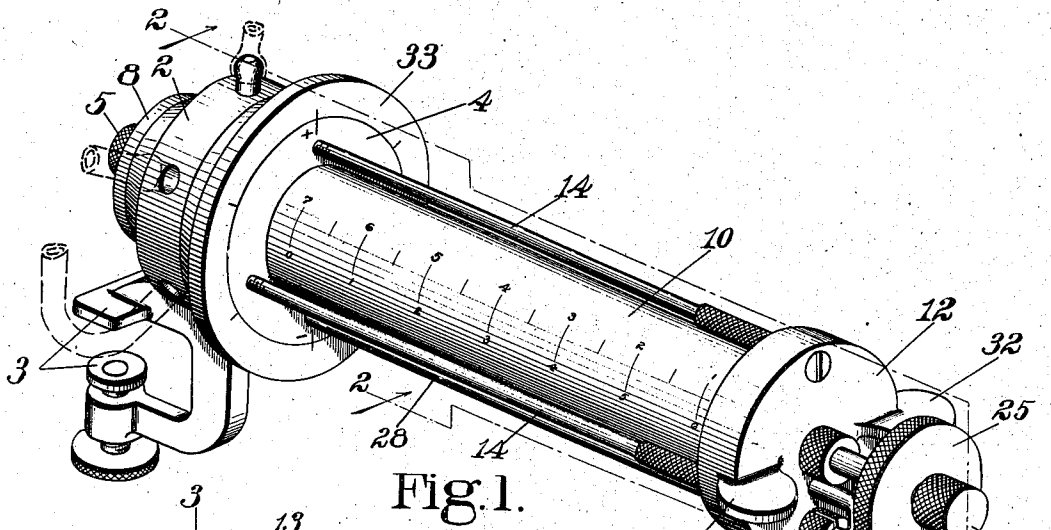


Fig. 1.

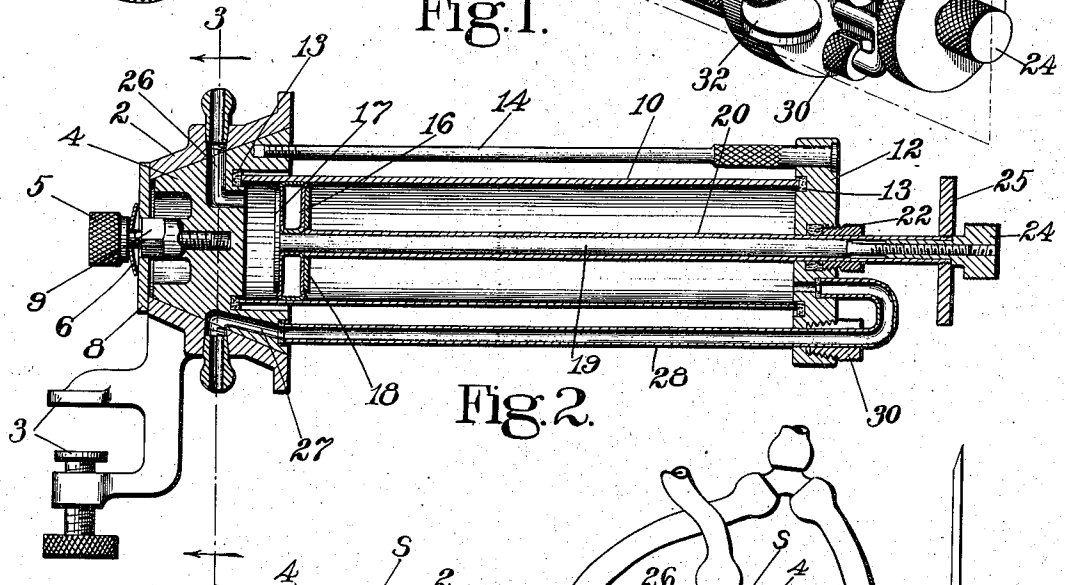


Fig. 2.

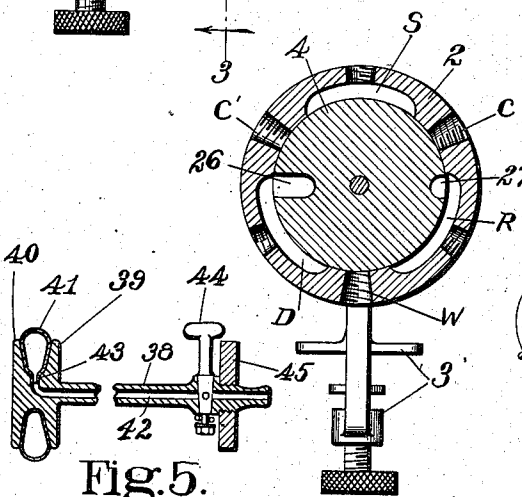


Fig. 5.

Fig. 3.

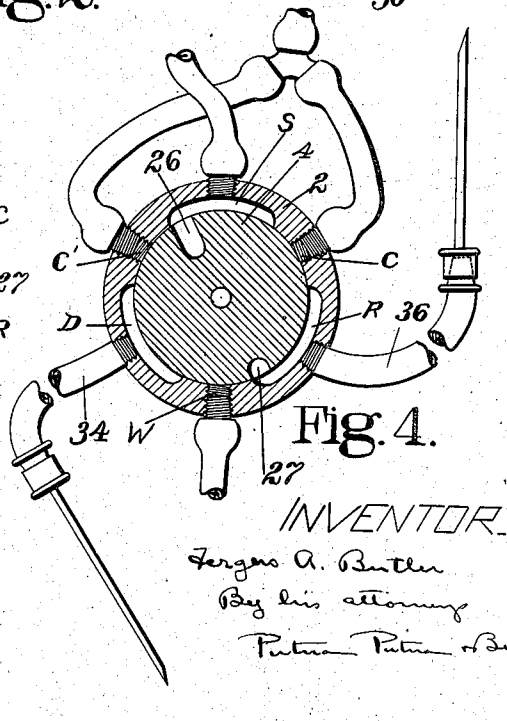


Fig. 4.

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TRANSFUSION APPARATUS.

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To all whom it may concern:

Be it known that I, FERGUS A. BUTLER, a citizen of the United States, residing at Danvers, in the county of Essex and State of Massachusetts, have invented certain Improvements in Transfusion Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like reference characters on the drawings indicating like parts in the several figures.

This invention relates to appliances of the character used in the practice of medicine and surgery for the purpose of introducing fluids into or aspirating fluids from the body, and will be herein disclosed as embodied in an apparatus designed especially to meet the requirements of the operation of transfusing blood.

As this operation is now usually performed, the blood is transferred by filling a syringe with blood from the donor and then injecting this blood intravenously into the recipient, repeating this process until the required quantity of blood has been transferred. This method, however, requires the use of a large number of syringes and necessitates the attendance of two physicians and a nurse, one physician filling the syringes from the donor, the other injecting the blood into the recipient, and the nurse sterilizing the syringes. This method not only is very slow but also is open to the objection that there is danger of a clot forming in the blood vessel where the needle or tube is inserted in either the donor or the recipient.

The present invention provides an apparatus with which this operation can be performed more expeditiously and with greater safety than with the appliances now in use. This apparatus, however, is not limited in use to this particular operation but has many other uses, as for instance, in the intravenous injection of medication in fluid form or for the aspiration of pathological fluids from the pleural, abdominal or other cavities of the body.

The invention will be readily understood from the following description, reference being made to the accompanying drawings, in which—

Figure 1 is an angular view of an apparatus constructed in accordance with the invention; Fig. 2 is a longitudinal, sectional view on the plane indicated by the line 2—2, Fig. 1; Fig. 3 is a vertical, sectional view on the line 3—3, Fig. 2; Fig. 4 is a sectional view similar to Fig. 3 but showing certain of the connections leading from the apparatus; and Fig. 5 is a sectional view of a modified form of plunger or piston for the apparatus.

The apparatus shown comprises a distributing valve consisting of a valve casing 2, provided with a clamp 3 by which it may be secured to a table or similar support, and a valve plug 4 rotatably mounted in the casing 2. Preferably the casing 2 has a tapered seat and the plug 4 is correspondingly tapered to fit snugly within this seat. The plug normally is held in its operative position by a thumb screw 5 which is threaded into the plug 4, the head of this screw bearing on a spring washer 6 that holds a larger washer 8 yieldingly against the end of the casing 2. A squared hub 9 on the valve plug 4 projects through a square hole in the washer 8 and thus forces the washer and plug to rotate together.

The valve has a syringe directly connected to it. This syringe comprises a barrel or cylinder 10 which is mounted between the valve plug 4 and a cylinder head 12, both the plug and the head being recessed to receive the opposite ends of the cylinder and washers 13 made of some yielding material, such for instance, as rubber, preferably being interposed between the ends of the cylinder and the parts 4 and 12. Several rods 14, threaded into the valve plug 4 and having heads bearing against the outer end of the cylinder head 12, clamp the cylinder 10 firmly between the parts 4 and 12.

The piston for the syringe in the construction shown in Fig. 2 consists of a pneumatic, annular rubber member 16 clamped between two washers or heads 17 and 18, respectively, the head 17 having fast to it a stem 19 that telescopes within a tubular stem 20 fast on the head 18. Both of these stems extend through a stuffing box 22 formed in the cylinder head 12 and a thumb screw 24 is threaded on to the stem 19 and bears against the end of the tube 20, thus acting to compress the two heads or washers 17 and 18 against the pneumatic member 16 and expanding it sufficiently to cause it to bear firmly but yieldingly against the inner wall of the cylinder 10. The part 16 is larger in diameter than the washers 17 and 18 so that it fits the bore of the cylinder

tightly and conforms to the small variations which frequently are present in the cylinders used for syringes, particularly where such cylinders are not ground. Any other suitable construction of syringe may, however, be substituted for that shown. A handle 25 is provided on the outer end of the tube 20 and affords a convenient means for operating the piston.

The syringe used preferably is of the double action type; that is, it is arranged to draw liquid into one end and simultaneously expel liquid from the other end on each stroke. In the construction shown this result is accomplished by providing the plug 4 with a passage or port 26 that communicates with the end of the cylinder 10 adjacent to the member 4 and also providing this plug with another port 27 which communicates with a side tube or by-pass 28 that leads to the end of the cylinder back of the piston, that is, the end adjacent to the cylinder head 12. The two ends of the tube 28 are received in sockets formed, respectively, in the plug 4 and cylinder head 12, and the tube is clamped in its operative position by a split nut 30 which is threaded into the part 12 where the tube extends through it, and contracts and grips the tube when threaded into its seat. Small yielding washers preferably are interposed between the ends of the tube and their respective seats in the parts 4 and 12.

The valve casing 2 is provided with a series of ports to each of which a tube may be connected, suitable nipples or other connectors being provided for this purpose. The ports in the plug 4 are so spaced that different pairs of the ports in the casing may be placed in communication with the opposite ends of the syringe simply by turning the valve plug until the ports 26 and 27 are made to register with the desired ports in the casing. This rotative movement, of course, rotates the syringe also since it is supported by the plug 4, and the cylinder head 12 is provided with thumb pieces or wings 32, as best shown in Fig. 1, for the purpose of facilitating this turning movement. The forward face 33 of the valve casing 2 also is graduated or has marks formed on it at points opposite the ports in the casing to coöperate with similar marks formed on the front face of the plug 4 opposite the ports in the plug, thus indicating to the operator which of the ports in the casing are in communication with the ports of the plug at any instant.

As above stated, the apparatus shown is designed particularly to meet the requirements of those cases in which it is desired to transfer blood from one person to another. Accordingly, the casing has connected thereto a tube 34 leading from the port D in the valve casing to an intravenous needle which, in this apparatus, is intended to be inserted in a vein of the person from whom the blood is to be taken. A similar tube 36 leads from the port R in the casing to another intravenous needle designed to be inserted in a vein of the recipient. It is desirable to use certain medications in fluid form in performing this operation, such for instance as a saline solution which is employed partly for its stimulating properties but more particularly for the purpose of replacing a part of the fluid medium that is removed from the donor. A solution of sodium citrate also is usually employed in this operation to prevent the clotting of the blood. These solutions may be introduced into the upper ports in the casing 2 by means of tubes leading from suitable sources of supply, the saline solution being brought into the port S and the solution of sodium citrate into the ports C and C′. The lowermost port W is, in this apparatus, designed to be used for a waste or drain port. It will be noted that the ports C, C′ and W are spaced substantially uniformly about the plug 4 and are of about the same width as the ports 26 and 27 in the plug, while the ports S, D and R are very much wider and alternate with the narrow ports. Accordingly, the plug 4 can be adjusted so that either port 26 or 27 will register with the port R while the opposite port registers with any one of the ports D, C′ or S; or either port 26 or 27 can be brought into register with the port D while the opposite port registers with any one of the ports R, C or S.

In using this apparatus for the purpose of transfusing blood the appliance preferably is secured to a table or other stationary support by means of the clamp 3, leaving the syringe projecting away from the table within convenient reach of the physician or surgeon. The tubes leading from the ports C, C′ and S are then connected to containers holding the desired solutions. By manipulating the apparatus in a manner that now will be entirely obvious the syringe and the tubes 34 and 36 can be filled with saline solution. The needle attached to the tube 34 next is inserted in a vein of the donor and the needle attached to the tube 36 is inserted in a vein of the recipient. Assuming that the piston now is positioned at the inner limit of its stroke, the syringe and the valve plug 4 are turned by pressing on the thumb pieces 32 to bring the port 26 into communication with the port C′ and the port 27 into communication with the port R. By now pulling out the handle 25 a short distance a small quantity of the citrate solution can be drawn into one end of the syringe, at the same time injecting into the recipient a small quantity of saline from the chamber behind the piston. As soon as the desired quantity of citrate has been drawn into the

cylinder 10, the syringe is turned to bring the plug 4 into the position in which it is shown in Fig. 3 and the handle 15 is then pulled out to the outer limit of its stroke, thus filling the syringe with blood and emtying the saline solution into the recipient. The syringe is next turned to bring the port 26 into register with the port R and the port 27 into communication with the port C'. By pushing the piston inwardly while the valve plug is in this position the mixture of blood and citrate in the syringe is injected into the recipient and citrate solution is taken in the syringe through the port 27 and the tube 28. As soon as the desired quantity of citrate is taken in, the syringe is turned into a position diametrically opposite to that in which it is shown in Fig. 3 and the plunger then is pushed to the inner limit of its stroke, thus filling the chamber behind the piston with a mixture of citrate and blood and injecting into the recipient the mixture of citrate and blood which the syringe previously contained. Substantially this cycle of operations is continued, with such variations as the attending physician finds advisable, until the desired quantity of blood has been transferred. This quantity can be determined with sufficient accuracy for all ordinary purposes by counting the strokes of the piston and knowing the capacity of the cylinder 10. When the desired transfer of blood has been effected the physician can then use the apparatus to inject any desired quantity of saline solution into the donor.

It is obvious that, by using this apparatus, no change in the mechanical connections between the donor, the recipient and the containers from which the solutions are supplied, is required during the entire operation. The liability of forming a clot, due to movement of the tubes or needles in the blood vessels of the donor or recipient when the operation is performed according to the present methods, is substantially eliminated. Furthermore, the time required to perform the operation is reduced and the operation is rendered practically continuous. With the aid of this apparatus the physician can, at any stage in the operation, inject into either the donor or recipient any of the solutions ordinarily employed in this operation without any change in the mechanical connections. The apparatus also enables one physician to perform this operation unaided.

It is obvious that this apparatus can be used for the injection of any medication in fluid form into the body or for the aspiration of fluids from various cavities in the body. The provision of the waste port W is of advantage in using the apparatus for the latter purpose and also in permitting the attendant to wash out the apparatus with saline or other liquid at any stage of the operation. If, at any point, it should be desired to replace one source of fluid with another, this result can be readily accomplished by removing one tube from the casing and substituting the new one and such a substitution would not interfere in any manner with the other connections leading from the apparatus.

In Fig. 5 a modified construction of piston is shown. In this arrangement the piston stem 38 is provided with two flanges 39 and 40, respectively, between which a hollow rubber ring 41, of larger diameter than the flanges, is mounted. The stem has a passage 42 extending longitudinally therethrough and opening into the space between the collars 39 and 40. A nipple 43, formed in the ring 41, fits snugly into the end of this passage, as shown in Fig. 5, and has an opening formed therethrough to communicate with the passage 42. When the ring is placed in position on the piston head the nipple 43 is inserted in the opening at the end of the passage 42 and jammed tightly into place so that it will not leak. This collar is then inflated by forcing air through the passage 42 in the stem 38 and, when blown up to the required pressure, the passage is closed by a cock 44 or in any other convenient manner. This stem, of course, is provided with a handle 45 corresponding to the handle 25 of the piston stem 20, as shown in Fig. 2.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In an apparatus of the character described, the combination with a distributing valve having a plurality of ports, of a double acting syringe connected to said valve, said valve being constructed and arranged to control the communication between said ports and said syringe.

2. In an apparatus of the character described, the combination of a double acting syringe, a valve controlling the flow of liquid to and from said syringe, and a series of tubes leading from said valve, said valve being constructed to place different pairs of said tubes in communication with opposite ends of the syringe to enable the syringe to draw liquid through one tube and simultaneously discharge liquid through another tube.

3. In a transfusion apparatus, the combination of a double acting syringe, a valve controlling the flow of liquid to and from said syringe, and two tubes arranged to lead, respectively, to the recipient and donor from said valve, said valve being constructed to control the communication between said tubes and the syringe.

4. In an apparatus of the character described, the combination of a valve casing having a series of ports, a double acting syr-

inge, and a valve plug movable in said casing and in communication with the opposite ends of said syringe, said plug being constructed to control the communication between said syringe and said ports.

5. In an apparatus of the character described, the combination of a stationary valve casing, a rotatable valve plug mounted in said casing, and a double acting syringe mounted on said plug, said casing having a plurality of ports and said plug being constructed to control the communication between said syringe and said ports.

6. In an apparatus of the character described, the combination of a stationary valve casing having a plurality of ports, a rotatable plug mounted therein and a double acting syringe mounted on said plug to rotate therewith, said plug having ports leading to the opposite ends of said syringe and adapted to register with different ports of said casing.

7. In a transfusion apparatus, the combination of a syringe, a distributing valve controlling the flow of liquid to and from said syringe, two tubes arranged to lead, respectively, from said valve to the recipient and donor, and a plurality of additional tubes leading from said valve, said valve being constructed and arranged to control the communication between said syringe and said tubes.

8. In an apparatus of the character described, the combination of a double acting syringe, a valve casing, and a valve plug movable in said casing and carrying said syringe, said casing having three narrow ports spaced substantially equally about the plug and three wide ports spaced alternately with said narrow ports, said plug having two diametrically opposed ports communicating, respectively, with the opposite ends of the syringe and arranged to register with different ports in said casing.

9. In an apparatus of the character described, the combination with a distributing valve including a casing constructed to be secured to a stationary support, of a double acting syringe supported by said valve, said valve having a plurality of ports and being constructed and arranged to control the communication between said ports and said syringe.

10. In an apparatus of the character described, a syringe piston comprising a tubular piston stem, a pair of spaced flanges fast on said stem, the bore of said stem opening into the space between said flanges, a pneumatic collar mounted between said flanges but of larger diameter than the flanges, said collar having an inlet fitting said opening, and means to open or close the passage through said stem.

11. In an apparatus of the character described, a syringe piston comprising a tubular piston stem, a pair of spaced flanges fast on said stem, the bore of said stem opening into the space between said flanges, a pneumatic collar mounted between said flanges but of larger diameter than the flanges, said collar having a hollow nipple fitting in said opening and affording communication between the bore of said stem and the interior of the collar, and means for opening or closing the passage through said stem.

In testimony whereof I have signed my name to this specification.

FERGUS A. BUTLER.