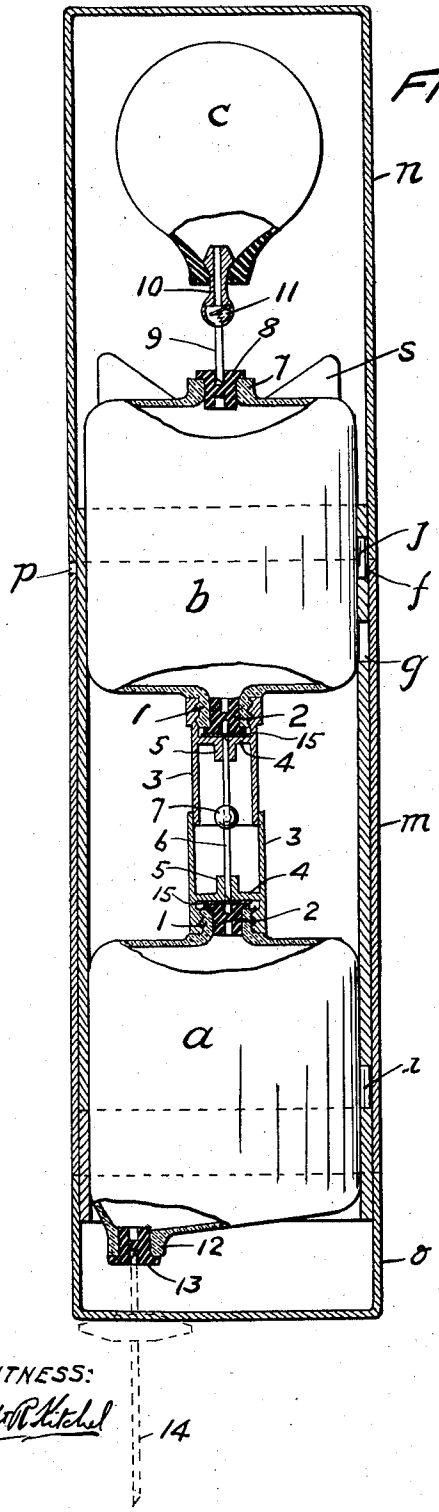
Nov. 7, 1944. A. W. PRICE 2,362,025

APPARATUS FOR ADMINISTERING BLOOD PLASMA

Filed Jan. 26, 1943

FIG. 1.



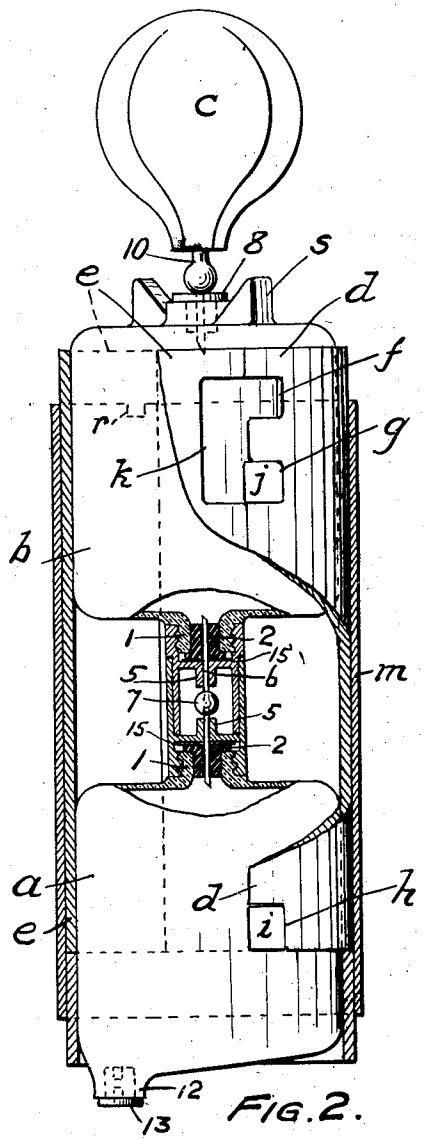


FIG. 2.

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Patented Nov. 7, 1944 2,362,025

UNITED STATES PATENT OFFICE

2,362,025

APPARATUS FOR ADMINISTERING BLOOD PLASMA

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Application January 26, 1943, Serial No. 473,584

7 Claims. (Cl. 128—214)

The present forms of apparatus for administering plasma are heavy, expensive, bulky to transport, complicated to set up, require a standard or upright, and the overall time of administration is long.

Under conditions of warfare, with the ever present menace of casualties among combatants and the civilian population, there is need for a small, compact, lightweight, durable, refillable unit by which plasma can be administered rapidly under adverse conditions.

Plasma administering units now in use are not designed or adapted for the emergency administration of plasma to those patients whose circulatory depression is so marked that it is difficult or impossible to introduce anything into their circulation by the venous route. It is at this time that fluids are most urgently needed and the intra-osseous route should be used.

The object of my invention is to provide an apparatus for administering plasma that is comparatively light in weight, comparatively inexpensive, safe to transport, simple to set up, requiring no supplemental equipment, such as a supporting standard or upright, permitting a short overall time of administration, and adapted equally for intra-venous injection and intra-osseous injection.

One preferred embodiment of my invention, which accomplishes all of the specified objects, and which exhibits other advantages which the following description will disclose, is shown in the accompanying drawing, in which—

Fig. 1 is a longitudinal sectional view of the apparatus before use and Fig. 2 a similar view showing the changed relative positions of the parts during administration of plasma.

The main elements of a structure embodying my invention in its preferred embodiment are: a glass vessel *a* containing dried blood plasma and from which most of the air has been evacuated; a glass vessel *b*, containing distilled water, which, before operation, is held in non-communicating relation with the vessel *a* but which is movable toward the vessel *a* to open communication between them; a rubber air-filled bulb *c* mounted on, and communicable with, the vessel *b*; an inner shell *d*, *e* within which the vessels *a* and *b* are normally held in noncommunicating relation but which permits the vessel *b* to be manually turnable therein and then to be moved to open communication, as above specified, between the vessels; and an outer container enclosing the elements above described and comprising a body portion *m*, a cover *n* and a cap *o*.

The inner shell is made in two semi-cylindrical parts. One half shell, *d*, near its upper end, is cut away along one edge to form two spaced-apart recesses *f* and *g*, and, near its lower edge, is cut away to form a recess *h*. The other half shell *e* is cut away, near its upper end, to form a recess or slot *k* extending from the upper edge of recess *f* to the lower edge of recess *g*. Vessel *a* is provided with a projection *i* and vessel *b* with a projection *j*. To assemble the vessels *a* and *b* within the inner shell, the vessels are so laid in the half shell *d* that projection *i* of vessel *a* engages recess *h* and projection *j* of vessel *b* engages recess *f*. The other half shell *e* is then applied to the half shell *d*. The vessels *a* and *b* now occupy the position, relative to their enclosing shell or casing *d*, *e*, shown in Fig. 1.

The inner shell *d*, *e*, carrying the vessels *a* and *b* is now slipped into the outer shell *m*, and the cover *n* and cap *o* applied to the shell *m*, this completely enclosing the operative elements. The upper edge of the outer shell *m* is provided with a recess *r* and the cover *n* is so applied to the shell *m* that a projection *p* on the lower edge thereof engages the recess *r*, thereby holding the cover from turning on the shell.

The unit is now assembled for storage and transportation.

It should be understood that the description, so far as it has proceeded, is directed mainly to the means for holding the parts of the injector unit in inoperative position and for protecting the unit from injury before use. The inner holding shell and the outer cover are, however, not essential to the broad embodiment of the invention, which comprises features that will now be described.

The top of vessel *a* and the bottom of vessel *b* are provided each with a neck **1**, in which is tightly inserted a rubber stopper **2**. Each stopper is preferably provided with a central orifice closed between its ends by a readily puncturable web. Threaded on each neck **1** is a guide sleeve **3**, the two sleeves being in telescopic relation. Extending across the interior of each sleeve **3** is a disc **4** having a central boss **5**, the boss and disc having a central orifice aligning with the central orifice in the adjacent stopper and with the central orifices in the stopper, disc and boss of the other vessel.

Extending centrally through the two sleeves and through the orifices in both discs, is a hollow needle **6** (the bosses **5** being long enough to act as a guide for the needle) having bevelled ends which extend into the central orifices in

the two stoppers and terminate short of the puncturable webs in said stoppers. Between its ends, the needle is provided with an enlargement, preferably a ball 7 secured to and surrounding the center of the needle. The drawing may also be assumed to illustrate two aligning needles mounted on a central hollow ball, although this equivalent construction is less desirable.

The bottom of vessel *a* is provided with a neck 12, in which is inserted a rubber stopper 13 similar to the stoppers 2.

The upper end of the vessel *b* is provided with a neck 7 having a stopper 8 which may be similar in construction to stoppers 2. Positioned on the stopper 8 is a hollow needle 9, which connects with a channeled member 10 the upper end of which is enclosed within the mouth of the compressible rubber bulb *c*. The lower end of the channel in member 10 may be enlarged to contain a spring actuated check valve 11.

In order to move the vessel *b* toward the vessel *a*, the cover *n* must first be removed. By means of the wings *s* on the top of vessel *b*, the latter is turned to move the projection *j* out of recess *f* into slot *k*. This permits vessel *b* to be pushed toward vessel *a*, projection *j* sliding in slot *k* until the projection arcuately aligns with recess *g*, whereupon vessel *b* may be turned in the direction opposite to that in which it was first turned, thereby moving the projection into recess *g* and locking the vessel *b* in its advanced position.

In the forward longitudinal movement of vessel *b* toward vessel *a*, needle 6 first penetrates the stopper 2 of vessel *b* and then the stopper 2 of vessel *a*, thereby establishing fluid communication between the two vessels.

It may be helpful to now explain with more particularity the procedure for intra-venous administration of plasma.

The cover or end section *n* of the outer container is removed. By means of the winged arms *s* of the protruding upper end of the bottle *b*, the latter is turned clockwise, pushed longitudinally within the inner shell and then turned counter-clockwise to lock the bottle in its advanced position. The container is held upright. The bulb *c* is now pushed home, causing needle 9 to penetrate the stopper 8. The described advancement of bottle *b* causes the needle 6 to penetrate the stoppers of both bottles *a* and *b* and establish fluid communication between them. It is preferred to insert a thin aluminum puncturable disc 15 between each disc 4 and its corresponding stopper 2 to insure against possible penetration, during transportation, or as a result of careless handling, of either rubber stopper by the needle 6. As hereinbefore described the bottle *a* contains dry plasma, and being under high vacuum, the distilled water filling bottle *b* is drawn into bottle *a*, the space in bottle *b* left by the outflowing water being filled with air entering from bulb *c*. When all the water has entered bottle *a* the device is agitated for about one minute or less in order to restore the plasma to a fluid state.

A sterile needle is now inserted into the vein. This needle, into which a stylet (not shown) is inserted, may be conveniently carried in the cover *n* of the container *m*, the stylet being inserted with the needle and then removed. The needle 14 (as well as the stylet) being of conventional design, and forming no part of my invention, is shown only in dotted lines in Fig. 1. After insertion of the needle in the vein, the lower cover or cap *o* of the outer container is removed. The rubber stopper 13 of vessel *a* is now punctured.

The patient's arm is elevated distally so that the container is as near upright as possible and then, by intermittent compression of the bulb *c*, the plasma is forced into the vein. When the fluid level reaches a marked line on the vessel *a*, compression of the bulb *c* is stopped and the needle 14 removed.

It should be borne in mind that the described operation is practicable even if there is no inner shell or outer container. In other words, the unit which comprises only the two glass vessels *a* and *b*, the bulb *c* and the described connections between them, is operative with skillful handling. However, the described enclosure for this unit is obviously an important adjunct, since it not only guards said operative unit from injury after manufacture and before use, but it facilitates the plasma-injecting operation.

The procedure for intra-osseous administration of plasma is the same as that described for intra-venous administration except that the needle 14, with stylet enclosed, is inserted into the bone.

The technique for introducing the needle into the marrow may now be described.

The site of choice for the injection in patients over 5 years of age is the manubrium, 1 cm. above the angle of Louis, or the body of the sternum, at the third interspace in the midline. After preliminary local anesthesia with procaine (when possible or necessary) the needle 14 with its stylet is inserted vertically with the bevel towards the head of the patient. The periosteum is penetrated gently with a semi-circular burrowing motion until a firm hold is obtained. The needle is then tilted, its tip pointed toward the neck of the patient and with the same burrowing motion, the anterior plate of the sternum is penetrated. The needle should not be "jabbed in" or pushed in with force. When the marrow cavity is penetrated, diminution in the resistance to the progress of the needle is felt, amounting sometimes to a trap-door effect. In the hands of the inexperienced there is less danger of injury if the needle is inserted in the upper end of the tibia, than in the sternum. The needle being properly fixed in the bone, the stylet is removed. A small syringe is then attached and a few drops of bone marrow aspirated to insure that the needle is properly placed in the marrow cavity. The syringe is then removed.

The operation then proceeds as in the case of an intravenous injection, the plasma being forced through the needle into the marrow and, ultimately, into the circulation of the recipient. After the injection is completed, the needle is withdrawn with the same type of twisting motion employed in driving it in.

The invention does not depend for its successful operation upon size, dimensions or weight of the elements described or of the unit as a whole. In order, however, to give the full information required to enable the unit to be made precisely in the form in which I have constructed and successfully operated it, the following specific data is submitted.

The unit, filled and packed for transit, weighs 680 gm. (1½ pounds). The complete apparatus measures 22.5 cm. (8¾ inches) in length and 6 cm. (2 5/8 inches) in diameter, and can be packed in a metal can under vacuum. The diameter of the container is comparable with the average water glass and is easily held in the hand.

The syringe, as well as the needle 14, with its inserted stylet, may be removably mounted in the upper cover *n*. Each of the vessels *a* and *b* is a 120 cc. Pyrex glass bottle. Movable bottle *b* contains 100 cc. of sterile pyrogen-free water with 0.1% sodium chloride. Fixed bottle *a* contains 16.5 grams of desiccated human plasma representing 250 cc. of original liquid-cooled plasma. The dried plasma is packed under a vacuum of about 29 inches mercury. The enclosing inner shell *d*, *e* and outer container *m*, *n*, *o* may be of metal, fibre or transparent plastic. The clearance between the Pyrex bottles *a* and *b* and the shell *d*, *e*, may be 1/64 of an inch; this prevents damage to the contained bottles if dropped or jarred. The double pointed needle 6 is of gauge #18. The needle 14 is of #16 gauge, is made of stainless steel and has a 3 mm. bevel. The needle does not clamp on the glass neck or lip of the bottle *a* but rides in the rubber stopper, allowing some free play, thus preventing breakage of the glass lip that might otherwise occur from motion of the operator's hand transmitted to the rigid needle fixed in the bone.

From the foregoing description it will be apparent that the apparatus embodies the features which attain all the objects of the invention. The apparatus is light in weight, occupies a small space during transportation, and is protected from injury during transportation or even from rather rough handling. In use, no part of the apparatus need be laid aside. It can be operated without any accessory equipment or aid. The entire amount of fluid may be given without danger of administering air, as the lower end of the bottle *a* is tapered and if, as preferred, the shell and outer container are transparent, the plasma level is visible during the entire administration. For injecting plasma rapidly into an acutely disabled patient, it is possible to give 16 to 20 grams of plasma (dry weight) intravenously or intra-osseously within five minutes after beginning operation. The average time is four minutes.

The simplicity of the mechanism, its light weight, small size, rapid utilization, and choice of two routes of administration, enable these units to be used with advantage by mobile groups or isolated personnel; thus making possible the benefits of plasma to individuals at critical times under adverse conditions.

The used bottles may be taken apart, sterilized, refilled, and placed back in active service. This salvage reduces the overall cost of a primarily inexpensive method.

What I claim and desire to protect by Letters Patent is:

1. An apparatus for administering blood plasma which comprises two vessels one adapted to contain dried plasma and adapted to be put into fluid connection with the body of the recipient, the other vessel being adapted to contain a suitable liquid, the opposing ends of said vessels having openings, puncturable stoppers sealing said openings, a shell enclosing said vessels, means to hold one of said vessels in fixed relation to the shell, mutually engaging means carried by the other vessel and the shell adapted to allow longitudinal movement of the last named vessel within the shell and hold it in either longitudinal position, and a hollow needle extending between said stoppers and of such length as to clear both stoppers when the movable vessel is at its greater distance from the fixed vessel but penetrate both stoppers in the movement of the movable vessel toward the fixed vessel.

2. An apparatus for administering blood plasma which comprises two vessels one adapted to contain dried plasma and adapted to be put into fluid connection with the body of the recipient, the other vessel being adapted to contain a suitable liquid, the opposing ends of said vessels having openings, puncturable stoppers sealing said openings, a shell enclosing said vessels, means to hold one of said vessels in fixed relation to the shell, said shell having a longitudinally extending slot having offset recesses at its opposite ends, a projection on the other vessel adapted to engage either recess, the last named vessel adapted to be arcuately turnable to move said projection out of such recess into said slot, movable longitudinally to slide said projection in said slot and arcuately turnable in a direction opposite to that first specified to move said projection into the other recess, a hollow needle, guides holding said needle in such position that it extends longitudinally in alignment with said stoppers but allowing said needle to slide therein when the movable vessel is moved toward the fixed vessel, said needle being of such length as to puncture both stoppers in the last named movement of the movable vessel.

3. An apparatus as defined in claim 1 comprising also a compressible bulb beyond the movable vessel and means adapted to connect it with the interior of the movable vessel, and a container enclosing the two vessels, the surrounding shell and the bulb; said container comprising a main body, a removable lower end cap and an upper removable cover.

4. An apparatus for administering blood plasma which comprises two vessels, one adapted to contain dried plasma and adapted to be put into fluid connection with the body of the patient, the other vessel being adapted to contain a suitable liquid, said vessels having opposed openings, one of said vessels being movable toward the other, a shell enclosing said vessels, means to hold one of said vessels in fixed relation to the shell, mutually engaging means carried by the other vessel and the shell adapted to allow longitudinal movement of the last named vessel within the shell and hold it in either longitudinal position, means adapted to supply air to the liquid-holding vessel and means operable in the specified movement of one vessel toward the other to establish fluid connection between the two vessels, thereby enabling the air supplied to the liquid-holding vessel to cause the liquid therein to flow into the plasma-holding vessel.

5. An apparatus for administering blood plasma which comprises two vessels, one adapted to contain dried plasma and adapted to be put into fluid connection with the body of the patient, the other vessel being adapted to contain a suitable liquid, said vessels having opposed openings, one of said vessels being movable toward the other, a shell enclosing said vessels, mutually engaging means carried by the shell and one of said vessels operable to allow a relative movement, longitudinally within the shell, of one vessel toward the other, means adapted to supply air to the liquid-holding vessel, and means operable in the specified relative movement of one vessel toward the other to establish fluid connection between the two vessels, thereby enabling air supplied to the liquid-holding vessel to expel liquid therefrom into the plasma-holding vessel.

6. An apparatus for administering blood plasma which comprises two vessels, one adapted to be placed under vacuum and to contain dried plasma and having an outlet opening at one end by means of which it may be put into fluid connection with the body of the patient and having an inlet opening at the other end through which a suitable liquid may be admitted, the other vessel being adapted to contain a suitable liquid and having at one end an outlet opening in opposed relation to the inlet opening to the plasma-containing vessel and having at the other end an air admission opening, puncturable stoppers sealing all four openings, said vessels being slidably connected one with the other, a hollow needle located between and aligning with said opposed puncturable stoppers and carried by both vessels and adapted, in the movement of said vessels one toward the other, to puncture the stoppers sealing said opposed openings, an air-containing bulb, a hollow needle carried by said bulb and engaging the stopper sealing the air-admission opening to the liquid-containing vessel and slidable relatively to such stopper to effect puncturing of the same; whereby when said opposed stoppers and the stopper at the air-admission end of the liquid-containing vessel are punctured as specified, air pressure within the liquid containing vessel will force liquid therefrom through the first named hollow needle into the plasma-containing vessel while air flows from the bulb to fill the space left by outflowing liquid.

7. An apparatus for administering blood plasma which comprises two vessels one adapted to contain dried plasma and adapted to be put into fluid connection with the body of the recipient, the other vessel being adapted to contain a suitable liquid, the opposing ends of said vessels having necks, rubber stoppers one inserted in each neck, each stopper having a central orifice and a puncturable web extending across the orifice, sleeves extending from the necks and in telescopic engagement with each other, needle guiding members extending across the interior of the respective sleeves adjacent said stoppers having central orifices aligning with the central orifices in the stoppers, and a hollow needle the ends of which extend into said guiding members of such length that in the relative movement of the two vessels and the consequent telescoping of the two sleeves, said needle will penetrate the webs spanning the orifices in said stoppers, thereby allowing flow of liquid from the liquid holding vessel to the plasma-containing vessel.

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