Feb. 16, 1932. J. W. CARPENTER 1,845,479

BLOOD TRANSFUSION APPARATUS

Filed July 8, 1929

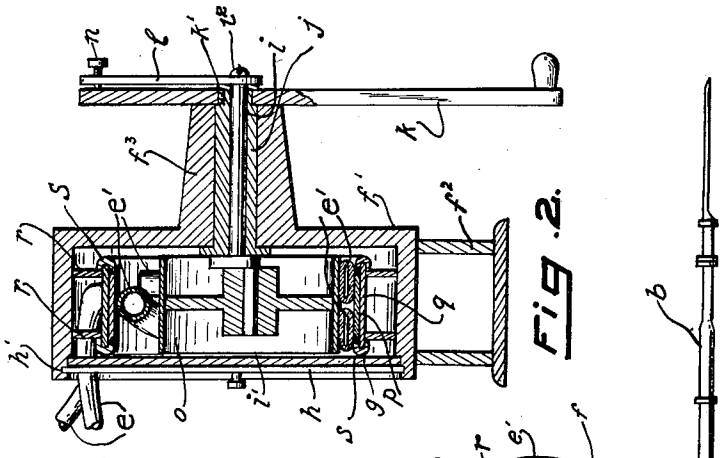


Fig. 2.

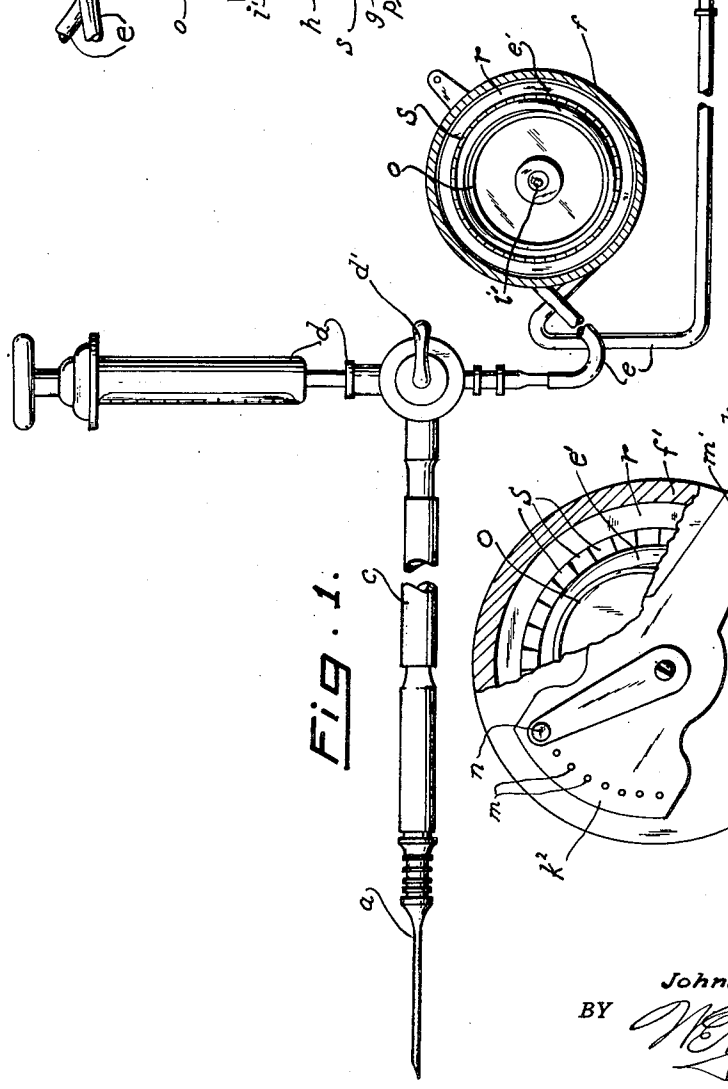


Fig. 1.

Fig. 3.

INVENTOR
John W. Carpenter
BY
ATTORNEY

Patented Feb. 16, 1932 1,845,479

UNITED STATES PATENT OFFICE

JOHN W. CARPENTER, OF EUGENE, OREGON, ASSIGNOR OF ONE-HALF TO W. B. NEAL, OF EUGENE, OREGON

BLOOD TRANSFUSION APPARATUS

Application filed July 8, 1929. Serial No. 376,580.

This invention relates to pumps and fluid propelling devices and especially to that type used in blood transfusion apparatus. In the latter type of apparatus one of the essential features is that there shall be no corners or pockets into which portions of the blood can settle out and form clots or thrombi, which would be introduced into the blood stream of the recipient. It is also essential that no air or foreign bodies be permitted to enter the blood during the pumping operation and further that the blood not be permitted to come into contact with any material which would react with the blood in any manner. Rubber is one of the few materials with which blood does not react.

Rubber tubing is made with a very close-grained structure which presents a smooth surface and is substantially uniform in cross-section and I have utilized all of these features in my present invention. This comprises, in the main, a flat coiled section of rubber tubing and a rotatable pressure producing element arranged upon the interior of such coil and means for giving such pressure producing means an eccentric throw whereby the means is caused to move about such section of tubing and to displace the contents thereof progressively as it passes thereover. Such annular section of tubing is preferably a part of a much longer section the ends of which are adapted to be connected to the veni-puncture needles and in this manner permit blood to be pumped directly from the donor to the recipient without coming into contact with air.

The details of my improved pump and its mode of operation and application are hereinafter described with reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic view of blood transfusion apparatus showing my improved pump element connected therein;

Fig. 2 is a transverse section thru such pump element shown in a larger scale; and

Fig. 3 is an elevation thereof with portions broken away to disclose some of the operating parts which would otherwise be concealed.

Blood transfusion apparatus comprises two veni-puncture needles *a* and *b*, the needle *a* serving as the inlet end of a closed conduit which passes thru the entire transfusion apparatus and the needle *b* is the outlet end thereof, or vice versa.

The butt end of the needle *a* is connected by a piece of tubing *c* to a container *d* for solution, citrate of sodium, or other solution introduced into the blood stream to prevent coagulation, the introduction of solution being common blood transfusion technique. Such container is provided with a valve *d'* to regulate the rate of flow therefrom.

From the outlet end of such container *d* to the butt end of the veni-puncture needle *b*, I preferably arrange a continuous length of tubing *e*, which extends thru my improved pump *f* and lies therein in the form of a flat annular coil, as was previously mentioned. Such section of tubing *e* is of uniform diameter and being continuous eliminates the possibility of foreign bodies entering the blood stream, and also leaky joints thru which air might enter, with its disastrous consequences.

Such force pump *f* comprises a casing *f'*, which casing is substantially cylindrical in form and is provided with a base *f2* adapted to support such cylindrical casing with its ends arranged vertically. Such casing is cup-shaped in section, as shown in Fig. 2, and one end thereof is closed by a removable disk *g* held in place by an easily removable clip *h*. Such clip is made of flexible material, preferably of spring steel, and when flexed may be withdrawn and inserted into place in its groove *h'* arranged upon the inner surface of such casing.

Extending outwardly from the opposite end of such casing *f'* is a lateral journal element *f3* which supports a shaft *i*. Such shaft is provided with an eccentric crank *i'* arranged within the casing *f'*. Such shaft *i* is journalled in an eccentrically bored bushing *j* also carried by such journal element *f3*. Such crank *i'* is offset the same degree as is the bore of the bushing *j* and thus by arranging such offsets in alinement their throws can be neutralized when arranged in one position and supplement each other when rotated relatively. That is, because such throws are

identical, when one opposes the other concentricity occurs, and when such throws are arranged to extend in the same direction the crank element i' traverses a path, which is offset double the degree of eccentricity of each portion.

An operating handle k is fastened to the eccentric journal j by a key k' and the shaft i is connected to such handle k thru an adjustable arm 1. Such handle k is provided with an arcuate portion $k2$ having a series of equally-spaced notches m arranged circularly about the end of the shaft i. Such arm is connected to the shaft i by a screw 12 threaded into the end of such shaft with its head engaging the arm. An adjustable set screw n is carried by the arm l and is adapted to be seated in one of such notches to determine the degree of eccentricity the crank i' should have. A notch m' is arranged 180° opposite from the center of such series of notches and when the arm l is arranged so that the set screw n seats in such latter notch the crank i' assumes a position of concentricity relative to the casing f'.

Carried by such crank i' is a roller o freely journalled on such crank and such roller is disposed within such annular coil e' of rubber tubing. Such roller is designed to have substantially the same external diameter as the internal diameter of the annular coil of tubing, not only to present the largest surface area at the point of contact to the tubing when expressing the contents thereof, but also to produce more positive displacement and to make the angle of flexure more gradual so as to increase the length of life of such tubing under such distorting action.

Such section of tubing is preferably vulcanized to a flat ring of rubber p to make such elements more easily insertable and removable from such force pump. Such rubber ring is fastened to a flat metallic ring q, which is carried by two spaced upstanding annular elements r extending in the general plane of the casing f'. The rubber ring p is fastened to the metallic ring q by opposed clips s, which further locate and hold the assembly upon the annular elements r, as is shown in Fig. 2. The sections of such tubing e adjacent the annular coiled portions e' pass thru holes arranged in one of such annular elements r and lie in the passageway defined by the exterior of the flat metallic ring q, the inner wall of the casing f' and the opposed faces of the spaced elements r.

The mode of operation of my device is as follows: The entire apparatus is first filled with solution from the container d and one of such veni-puncture needles is arranged in the donor and the other in the recipient and the force pump is then operated at a predetermined rate of speed. The valve d' of the container is adjusted to admit a predetermined relative quantity of solution continuously. The arm l is adjusted upon the handle k so that the roller will be given an eccentric throw sufficient to collapse the walls of the tubing, which forms the annular coil e', and to completely displace the contents thereof. The continued rotation of the handle k causes the roller to ride progressively about the annular coil of tubing e' and to displace the contents progressively. The tubing is preferably made of a high-grade rubber having substantial elasticity, which reassumes its circular cross-section after distortion to cause liquid to be drawn in behind the distorted portions and to displace the liquid in advance thereof, thus to produce uniform flow thruout such pumping element.

The flat circular rubber ring p under the annular section of tubing e' serves as a resilient base or cushion, which tends to prevent the distortion by the roller o from cracking the side walls of the tubing, even tho the distorting pressure is unusually severe. The use of clips s permits the entire rubber tubing assembly and its mounting to be removed easily and quickly from the force pump for cleaning and sterilizing, as well as for examination or replacement, as is necessary.

I claim:

1. In a device of the character described, a conduit having walls of collpsible resilient material arranged in the form of an annular coil, and a rotatable roller disposed within such coil and adapted to be moved eccentrically therein to describe a path progressively to engage and collapse the walls of such conduit and express the contents therefrom, two relatively adjustable cam elements engaging such roller to move it along such course.

2. In a device of the character described, a conduit having walls of collapsible resilient material arranged in the form of an annular coil, and a rotatable roller disposed within such coil and adapted to be moved eccentrically therein to describe a path progressively to engage and collapse the walls of such conduit and express the contents therefrom, two relatively adjustable eccentrics mounted one within the other engaging such roller to move it along such course.

3. In a device of the character described, a casing having a circular seat arranged therein having a section of collapsible and resilient tubing arranged in an annular coil mounted thereon, an eccentrically bored bushing mounted concentrically of such seat and a crank element journalled therein, a freely rotatable roller mounted upon such crank and located upon the interior of such coiled section and adapted to be moved eccentrically therein to describe a path progressively to engage and collapse the walls of such coiled section and to express the contents therefrom.

4. In a device of the character described, a casing having a circular seat arranged therein having a section of collapsible and resilient tubing arranged in an annular coil mounted thereon, an eccentrically bored bushing mounted concentrically of such seat and a crank element journalled therein, a freely rotatable roller mounted upon such crank and located upon the interior of such coiled section and adapted to be moved eccentrically therein to describe a path progressively to engage and collapse the walls of such coiled section and to express the contents therefrom, the external diameter of such roller being approximately the same as the internal diameter of such coiled section.

5. In a device of the character described, a casing having a circular seat arranged therein having a section of collapsible and resilient tubing arranged in an annular coil mounted thereon, an eccentrically bored bushing mounted concentrically of such seat and a crank element journalled therein, such crank element being offset to a degree equal to the degree of eccentricity of such bushing thereby adapted in one position to neutralize each other and in another position to supplement each other, a roller mounted upon such crank and located upon the interior of such coiled section and adapted in certain relative adjustments of such crank and bushing to be moved eccentrically therein to describe a path progressively to engage and collapse the walls of such coiled section and to express the contents therefrom.

6. In a device of the character described, a casing having a circular seat arranged therein having a section of collapsible and resilient tubing arranged in an annular coil mounted thereon, such seat being spaced from the inner wall of such casing to define a passageway, such seat being formed to permit the ends of such section to extend therethru and into such passageway, the latter being formed to permit the latter to project exteriorly of such casing, an eccentrically bored bushing mounted concentrically of such seat and a crank element journalled therein, a roller mounted upon such crank and located upon the interior of such coiled section and adapted to be moved eccentrically therein to describe a path progressively to engage and collapse the walls of such coiled section and to express the contents therefrom.

7. In a device of the character described, a casing having a circular seat arranged therein having a section of collapsible and resilient tubing arranged in an annular coil mounted thereon, such seat being provided with a removable covering to which such coiled section is secured and which is secured to such seat by removable clips.

8. In a device of the character described, a casing having a circular seat arranged therein having a section of collapsible and resilient tubing arranged in an annular coil mounted thereon, such seat being provided with a removable rubber covering to which such coiled section is secured.

9. In a device of the character described, a casing having a circular seat arranged therein having a section of collapsible and resilient tubing arranged in an annular coil mounted thereon, an eccentrically bored bushing mounted concentrically of such seat and a crank element journalled therein, devices fastened to such crank and bushing respectively and serving to fasten such devices together.

10. In a device of the character described, a casing having a circular seat arranged therein having a section of collapsible and resilient tubing arranged in an annular coil mounted thereon, an eccentrically bored bushing mounted concentrically of such seat and a crank element journalled therein, such crank element being offset to a degree equal to the degree of eccentricity of such bushing thereby adapted in one position to neutralize each other and in another position to supplement each other, devices fastened to such crank and bushing respectively and serving to fasten such devices together.

In testimony whereof he has affixed his signature.

JOHN W. CARPENTER.