

L. A. EDBLOM ET AL

MEANS FOR TREATING BLOOD STREAM INFECTIONS

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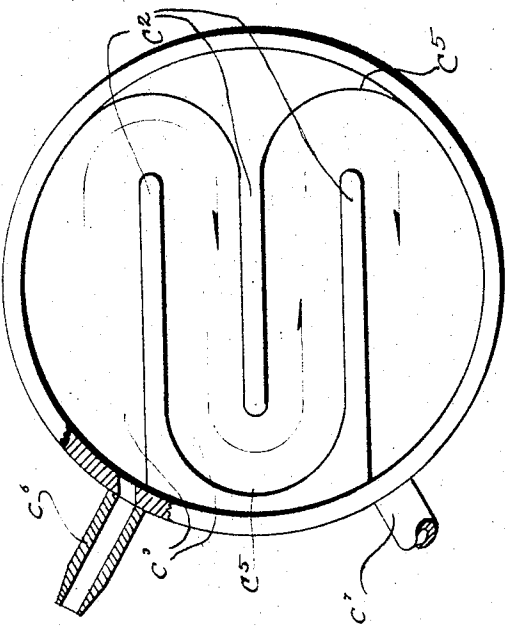


FIG. 1.

FIG. 2.

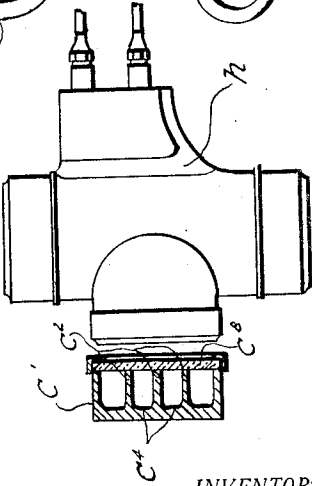
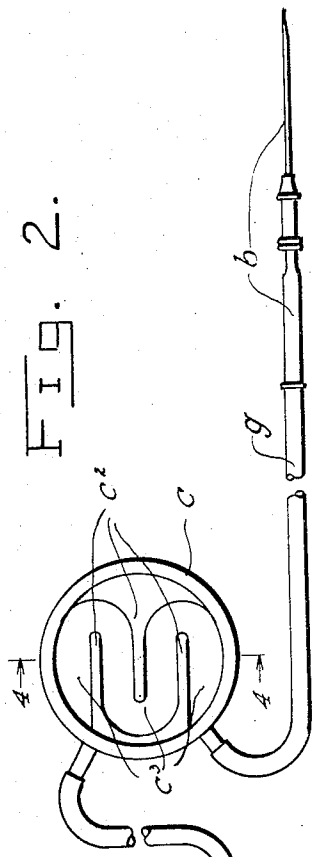


FIG. 3.

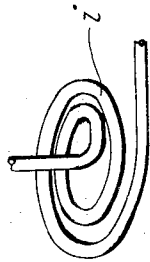


FIG. 4.

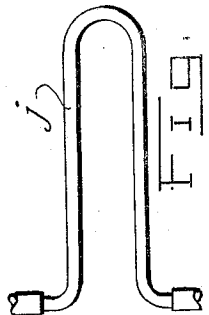


FIG. 5.

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MEANS FOR TREATING BLOOD-STREAM INFECTIONS.

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Our invention relates to the art of surgery and medicine and has for its object the provision of a novel method and means for treating blood stream infections and other pathologic blood conditions, and to this end is effective to destroy infectious bacteria, to stimulate normal blood cells and to inactivate toxic serum, by the use of ultra violet rays.

These phenomena of ultra violet radiation are generally known and are utilized in the treatment of external infections, and one of the principal objects of our invention therefore, is to use effectively these phenomena in the treatment of blood stream infections. We have discovered further that all toxins in the blood stream that we have exposed to ultra violet radiation, have been inactivated.

The treatment of blood in the circulatory system is rendered difficult because all of the blood vessels are encased in a layer of tissue constituting the walls of the vessel, and such layer of tissue is not permeable to the range of ultra violet radiation having bactericidal properties. When bacteria have thus entered the blood stream or become otherwise lodged under even the thinnest layer of tissue, they are protected against the bactericidal effect of radiation and can be destroyed only by the indirect manner of stimulating normal cells to combat such infectious organisms by their increased activity.

Clinical experiments have further determined that beneficial energy is stored up in the rayed blood temporarily, and if such blood can be returned to the blood stream immediately after it has been rayed, it will throw off secondary radiations which will stimulate and energize the patient.

We attain our object in a practical manner by tapping one of the patient's blood vessels, removing a small portion of blood in a closed air-tight conduit having one section permeable to the ultra violet rays possessing bactericidal power, and by forcing such blood thru such section while it is exposed to ultra violet radiation of the lengths mentioned, then returning the rayed blood immediately to another vessel in the body. This process is preferably carried on continuously over a period of time so that a predetermined portion of blood is rayed and rendered bacteri-free, and in this manner a large amount of blood can be withdrawn and rayed without lowering the patient's vitality to a very great degree. The portion rayed at one operation is determined by the patient's vitality, his

power to throw off the organisms thus killed and remaining as foreign proteins in the blood stream, and by the condition to be corrected. The operation is repeated at intervals until a sufficient number of the infectious bacteria have been killed, sufficient normal cells have been stimulated, and/or a sufficient amount of toxic serum has been inactivated, to permit the normal bodily functions to take care of the pathological condition without further external aid.

The preferred apparatus for utilizing this method comprises a veni-puncture needle which is inserted into a vein, the butt end of the needle being attached to a piece of tubing of required length into which a container of citrate or oxylate solution is connected. The other end of such tubing is attached to a transfusion pump, which is connected at its outlet side to an exposure chamber covered by a quartz lens or other substance permeable to ultra violet rays. A generator of rays between 1800-4000 A. U. is arranged to direct such rays thru such quartz lens upon the blood stream. Such exposure chamber is constructed to produce turbulence to prevent setting out of the constituent parts of the blood, and the uniform and thorough raying thereof.

The outlet end of such chamber is connected by tubing to another veni-puncture needle which is inserted into another vessel of the same patient. If the method is used in blood transfusion to insure the purity of the blood, the second veni-puncture needle would, of course, be inserted into the patient to whom the blood was being given. The operation is performed in a room in which the temperature is maintained at such heat as to prevent a change in temperature of the blood being rayed, the apparatus is thoroughly sterilized, and great care is taken to prevent any air from entering the closed circuit.

The different bacteria to be destroyed contain various amounts of the photo-sensitive amino acids mentioned, and it is desirable to force the blood being treated thru the exposure chamber in the shortest possible time and thus each blood stream infection has its optimum exposure period. During this period the infectious bacteria are coagulated by the chemical action of the ultra violet rays and normal cells are stimulated by the longer length rays to better perform their functions. Over-stimulation of such cells causes their ultimate destruction but happily, observation

has proven, there is a wide gap between the time of chemical destruction of foreign bacteria and the impairment or physical breakdown of normal cells due to over stimulation, somewhat in the relation of five seconds to two hundred and forty-five seconds.

The details of our improved method and the means in which it is embodied and efficiently performed, are hereinafter described in greater detail with reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic representation of the mechanism used, such devices comprising the latter being shown connected together;

Fig. 2 is a larger scaled plan view of the exposure chamber with the quartz lens removed;

Fig. 3 is a cross-section of such exposure chamber, and shown in relation to a quartz lamp; and

Figs. 4 and 5 are alternative forms of exposure chambers which might be used but are not considered as desirable as the one shown in the other figures.

The devices used are two veni-puncture needles *a* and *b*, the needle *a* serving as the inlet end of the closed conduit and the needle *b* as the outlet end. The butt end of the needle *a* is connected to the exposure chamber *c* by a piece of tubing *d*, preferably rubber, to provide the desired flexibility. Connected into such tubing is a container *e* for solution, citrate or oxylate, which solution is introduced into the blood stream to prevent coagulation and is a common expedient in blood transfusion technique. A second piece of tubing *g* connects the outlet end of the exposure chamber *c* to the needle *b*.

A force pump *f*, of the type used in blood transfusion also is connected in such tubing *d* so as to move such blood thru the exposure at a predetermined rate of flow.

The exposure chamber *c* comprises a cup-shaped body *c'* having a plurality of laterally extending, substantially parallel baffle walls *c''* defining a tortuous passageway of uniform cross-section from the inlet *c''* to the outlet *c''* of such exposure chamber. Such exposure chamber *c* preferably is set up on its edge with the baffle walls extending in a horizontal plane. The walls are spaced alternately from the opposite sides of the body, and thus when blood is forced thru such body, it is required to flow over the ends of such baffles and to be agitated thereby. Inasmuch as the walls are thus arranged in a vertical stack the blood flows in a continuous descending path and thus the cells are not permitted to settle out and to form thrombi. As is shown in Fig. 3, the connection between the walls and the bottom of the cup-shaped body is filleted, as at *c''*, to eliminate a sharp corner in which particles might become lodged, and subsequently become loosened and carried along by the blood stream. The ends of the

baffle walls *c''* are connected by rounded portions *c''* also to eliminate this possibility of thrombi formation, and also to eliminate a sudden corner around which the force of the flow might whip out the solid particles carried by the stream, and thus destroy the nice uniform mixture of the latter.

The entire chamber, or at least the portions thereof in contact with the blood stream, is made of a material with which the blood will not react chemically, such for example as silver or glass. The passageway also is of uniform depth which depth is less than the depth of effective radiation and preferably is approximately one centimeter.

The tortuous passageway *c''* causes the blood to be gently agitated so that the turbulence thus created turns all of the particles carried in suspension to the ultra violet rays so that the latter will be enabled to effect its beneficial influence on all of the blood cells and its lethal influence upon infectious bacteria carried by such stream.

A lens of quartz *c''*, or of other material permeable to ultra violet radiation, is fitted air-tight upon the open top *c''* of the exposure chamber and thru the lens the ultra violet rays are directed by a generator, preferably of the water-cooled type capable of delivering rays between 1800-3000 A. U. and having a large proportion of such rays in the region of 2540 A. U.

There may be one or more of such exposure chambers *c* and generators *h* connected in series or in parallel, to produce the ideal condition to the blood leaving the circulatory system and being returned thereto bacteria-free, stimulated and with no active toxins present but physically unchanged except diluted slightly, and to effect this result in the shortest possible time and with the least amount of blood withdrawn from the circulatory system at one time.

It is to be understood also that altho the particular form of exposure chamber is preferable, it is not essential. A straight or flat spiral, or a reversed tube, as shown as *i* and *j*, respectively, in Figs. 4 and 5, can be used altho they are not believed to be as practical as the one shown in Figs. 1 to 3, because of their increased cost and frailty, and difficulty of manufacture and because of a less efficient mixture of the blood stream attained, while the latter is passing under the influence of the beneficial ray. It is believed essential in every exposure chamber that the bore be smooth but that means be provided for causing the cells to be agitated gently so that all cells and bacteria be exposed to the ultra violet radiation.

In our experimentations we have used an exposure chamber of the type shown in Figs. 1 to 3, inclusive, in which the passageway is approximately 1 square centimeter in cross-sectional area, and about 1 centimeter deep,

and a flat quartz lens approximately one-quarter centimeter thick was sealed tightly over the chamber. A water cooled type Uviarc quartz tube, located as close as possible, was used as the generator of the ultra violet radiation, the generator being operated at 60 volts, and approximately 4 amperes, and the room temperature was maintained at about 90 degrees F.

Under such conditions, small quantities of human blood in which cultures of Staph. aureus were mixed, were rayed for the following exposures: 0—5—10—15—20—30—35—45—60—70—80—90—100—120—140—160—180—220—260—280 seconds. Cultures obtained, taken after each exposure showed growth only on the first three exposures, and no growth after 10 seconds exposure.

There was no change in the forms of the blood cells up to 70 seconds exposure, then slight poikilocytosis noted which condition disappeared after 80 seconds. The cells were normal and no change was noted until 280 seconds then disintegration of a mild degree was noted. Achromogenises also noted at 280 seconds.

We claim:

1. Apparatus of the character described for treating blood stream infections, comprising in combination with a generator of ultra violet radiation between 1800-4000 A. U., an airtight conduit having veni-puncture needles at the ends thereof, an exposure chamber connected in said conduit, intermediate such ends, a pump element connected to said conduit and adapted to cause flow therethrough at a predetermined rate, such exposure chamber having a portion permeable to ultra violet radiation, and such portion being arranged relatively to such generator as to permit the rays directed from the latter to pass therethrough.

2. Apparatus of the character described for treating blood stream infections, comprising in combination with a generator of ultra violet radiation between 1800-4000 A. U., an airtight conduit having veni-puncture needles at the ends thereof, an exposure chamber connected in said conduit, intermediate such ends, a pump element connected to said conduit and adapted to cause flow therethrough at a predetermined rate, such exposure chamber having a portion permeable to ultra violet radiation, and such portion being arranged relatively to such generator as to permit the rays directed from the latter to pass therethrough, and provided with means for producing turbulence in the blood passing by such permeable portion, for the purpose specified.

3. Apparatus of the character described for treating blood stream infections, comprising in combination with a generator of ultra violet radiation between 1800-4000 A. U., an airtight conduit having veni-puncture needles

at the ends thereof, an exposure chamber connected in said conduit, intermediate such ends, a pump element connected to said conduit and adapted to cause flow therethrough at a predetermined rate, such exposure chamber having a portion permeable to ultra violet radiation, and such portion being arranged relatively to such generator as to permit the rays directed from the latter to pass therethrough, and the portions of the conduit in the exposure chamber being formed to produce turbulence in the blood passing by such permeable portion, for the purpose specified.

4. Apparatus of the character described for treating blood stream infections, comprising in combination with a generator of ultra violet radiation between 1800-4000 A. U., an airtight conduit having veni-puncture needles at the ends thereof, an exposure chamber connected in said conduit, intermediate such ends, means for supplying a diluting medium into such conduit arranged adjacent said exposure chamber, a pump element connected to said conduit and adapted to cause flow therethrough at a predetermined rate, such exposure chamber having a portion permeable to ultra violet radiation, and such portion being arranged relatively to such generator as to permit the rays directed from the latter to pass therethrough and provided with means for producing turbulence in the blood passing by such permeable portion, for the purpose specified.

5. Apparatus of the character described for treating blood stream infections, comprising in combination with a generator of ultra violet radiation between 1800-4000 A. U., an airtight conduit having veni-puncture needles at the ends thereof, an exposure chamber connected in said conduit, intermediate such ends, a container of diluting material connected into such conduit adjacent said exposure chamber, a pump element connected to said conduit and adapted to cause flow therethrough at a predetermined rate, such exposure chamber having a portion permeable to ultra violet radiation, and such portion being arranged relatively to such generator as to permit the rays directed from the latter to pass therethrough, and provided with side walls formed to produce turbulence in the blood passing by such permeable portion, for the purpose specified.

6. An exposure chamber of the character described, comprising a body defining a tortuous passageway of substantially uniform cross-section, one portion of said body separating the passageway from the exterior thereof being made of a material permeable to ultra violet radiation of 1800-4000 A. U.

7. An exposure chamber of the character described, comprising a body defining a tortuous smooth-bored passageway of substantially uniform cross-section, and descending progressively in a vertical plane, one portion

of said body separating the passageway from the exterior thereof being made of a material permeable to ultra violet radiation of 1800-4000 A. U.

5 8. An exposure chamber of the character described, comprising a body defining a tortuous passageway of substantially uniform cross-section, one portion of said body separating the passageway from the exterior
10 thereof being made of quartz permeable to ultra violet radiation of 1800-4000 A. U.

9. An exposure chamber of the character described, comprising a body defining a tortuous smooth-bored passageway descending
15 progressively in a vertical plane, one portion of the latter separating the passageway from the exterior thereof being made of a material permeable to ultra violet radiation of 1800-4000 A. U.

10. In apparatus for treating blood stream infections, in combination with devices adapted to be connected with a blood vessel of a patient to be treated including a tubular conduit having a section permeable to ultra violet radiation, means for pumping blood at
25 a predetermined rate from said vessel thru such section, and means for directing ultra violet radiation of 1800-4000 A. U. upon the blood passing thru such section.

11. In apparatus for treating blood stream infections, airtight withdrawing and containing devices adapted to remove from the circulatory system a predetermined quantity
30 of blood, means for exposing the same to radiation of 1800-4000 A. U. and returning
35 such rayed blood to the circulatory system.

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