Sept. 25, 1951 A. W. SCHENKER 2,568,934

SYSTEM OF THERAPEUTIC TREATMENT

Filed April 28, 1947

Fig. 1

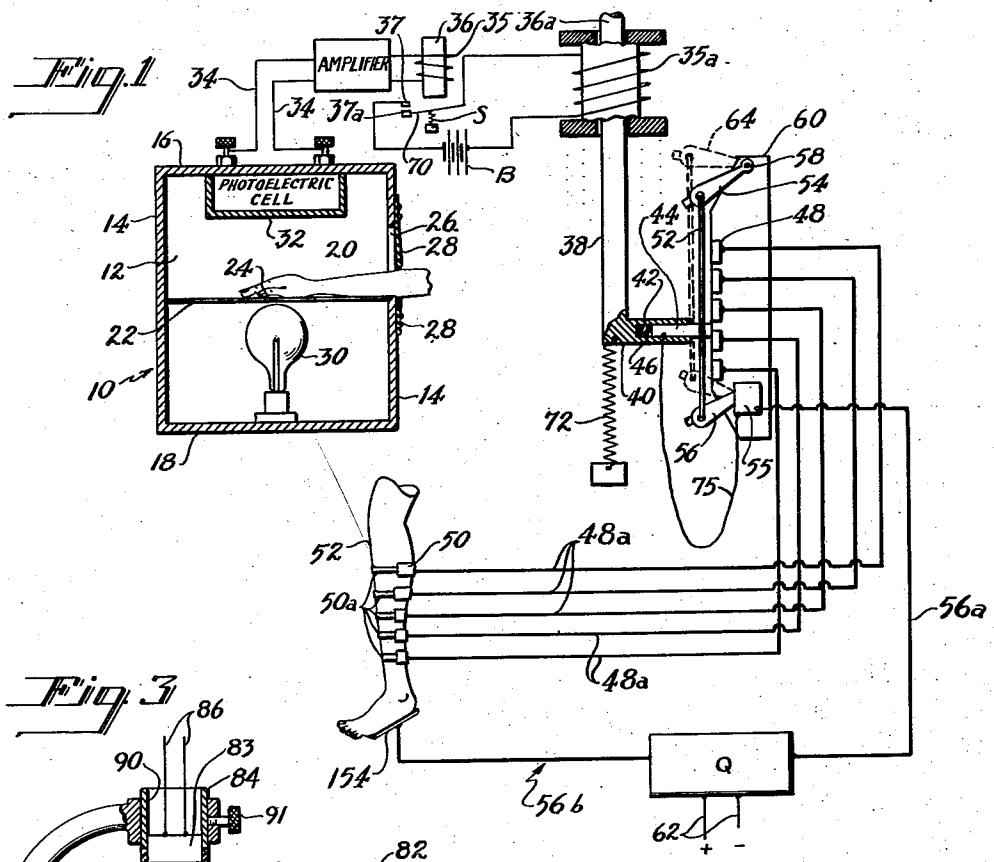


Fig. 3

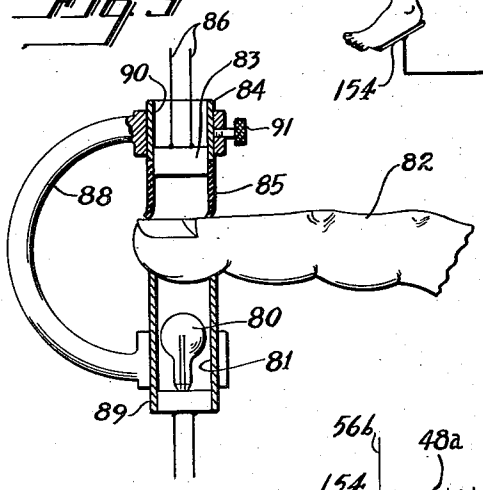
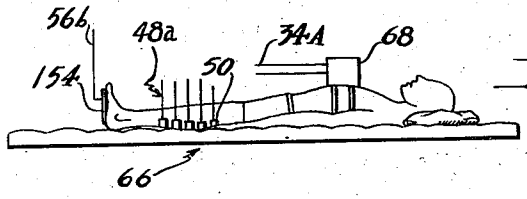


Fig. 2



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SYSTEM OF THERAPEUTIC TREATMENT

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5 Claims. (Cl. 128—404)

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This invention relates to devices for improving the circulation of the blood in the human body.

An object of the invention is to provide a device whereby the skeletal muscles of the body may be rhythmically contracted to improve and maintain the circulaton of the blood.

Another object of the invention is to provide a device for improving the blood circulation of the body, by rhythmically contracting the muscles in the direction of venous flow, the contractions being made to occur in exact synchronism with the arterial pulse rate at all times.

A further object of the invention is to provide a device of the character described, in which the magnitude of the muscle contractions may be varied in accordance with the specific requirements of the individual under treatment.

Still another object of the invention is to provide a source of electric power of a voltage and frequency sufficient, when applied to the body, to bring about a muscular contraction of the underlying muscles, with means for distributing the application of the electric power to a number of locations upon the patient's body, and means for applying the power to said locations successively in synchronism with the pulse rate of the patient.

Another object of the invention is to provide a device of the character described, which is simple in design, relatively inexpensive to manufacture, and which is highly effective for the purpose of maintaning the blood circulation.

Other objects and advantages of the invention will become apparent from the following description of a preferred embodiment thereof as illustrated in the accompanying drawings, and in which,

Fig. 1 is a partly schematic view of my improved device, showing the major elements thereof and the electrical and mechanical connections therebetween,

Fig. 2 is an elevational view of a modified form of the device, and

Fig. 3 is part elevational and part sectional view of a modification of the Fig. 1 form of device.

In order to understand clearly the nature of the invention, and what is sought to be accomplished thereby, it may be helpful to summarize briefly the manner in which the blood circulation in man functions. The heart pumps fresh blood into the arteries which supply every organ of the body. All arteries become progressively smaller in diameter as they lead away from the heart, so that at their termination they are very tiny.

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These terminations are called arterioles because of their small size. The arterioles connect up with a network of extremely fine blood vessels, much smaller in diameter than the arterioles. These are the capillaries. The capillary network extends over every possible tissue of the body. That explains why the slightest pin prick will cause bleeding. Through the walls of these capillaries, there is a constant interchange of food and gases, which keeps the organism alive. After this exchange has occurred, the blood is no longer "fresh" and is ready to return to the lungs for a fresh supply of oxygen, and then to the heart to be pumped away again, in the new cycle.

Each capillary network joins with a tiny vein, called a "venule," which, as it enlarges, becomes a full sized vein. The blood emerging from the capillaries is at a very low pressure, and as it enters the vein on its return to the lungs, it must be aided in its course by additional pressure from other sources, of which the main source resides in the contraction of the skeletal muscles. As a further aid in the passage of blood along the veins to the heart, the walls of the veins are equipped with check-valves so that in its upward course, the blood does not flow back. The fresh blood pumped away from the heart to the tissues is called arterial blood, whereas the blood returning to the heart along the veins is called venous blood.

From the foregoing description, it is seen that the contraction of muscles is one of the most important factors in returning venous blood to the heart. This explains the importance of exercise in keeping well. It also explains why persons with sedentary occupations do not enjoy the same vigorous health that the manual workers or athletes do.

It further explains why people who are bedridden for any length of time become progressively weaker. Convalescense brings about improvement in a person's well-being because of increased physiological activity. In certain diseases, for example, of the heart, physical activity is contra-indicated, yet it is important that the circulation of the blood be maintained, and this can be accomplished mostly by muscle contraction. Many other examples may be cited which would illustrate the importance of maintaining the venous blood return.

From the foregoing, it is seen how vital a part the venous blood return bears in maintenance of health. It is therefore obvious that in any condition in which there is inadequate venous blood return, whether it is by reason of

sedentary occupation or serious vascular disease, it is imperative that an outside means be provided to restore and maintain a constant venous blood return in synchronism with the heart beat or arterial pulse rate. The present invention discloses a device by means of which this may be done.

Referring now to the drawings, it will be seen that there I have shown a housing **10** having front and rear walls **12**, side walls **14**, and top and bottom walls **16** and **18** respectively, defining a dark chamber **20**. A transparent shelf **22** is supported inside the dark chamber as shown, and adapted to provide a support for the hand **24** of the patient. The patient's arm is inserted into the chamber **20** through an opening **26** formed in one of the side walls **14**, entry of light into the chamber being prevented by means of a curtain **28** of felt or other suitable material which bears against the arm surface in such a manner as to block passage of light between the arm surface and the curtain.

A source of light such as an electric light bulb **30**, is disposed in the chamber beneath the transparent shelf **22**, being supplied with electric power from any suitable source such as the electric power lines. A photoelectric cell **32** of standard well known construction is mounted on the underside of the top member **16** so as to be in alignment with the light source **30** and the patient's hand **24**.

The photocell is connected by wires **34** to an amplifier of any well known type. The output from the amplifier leads to a coil of wire **35** surrounding a core **36** to magnetize the same. An independent circuit is provided including a current source, such as for example the battery B, and a solenoid coil **35***a* adapted to be energized by the said battery B when the circuit is closed. A pair of contacts **37** and **37***a* in the said independent circuit are normally held apart by the spring *s* and are made to contactively engage when the coil **35** is energized from the output of the amplifier to attract the arm **70** against the action of the spring *s*.

It is thus seen from the above description that when electric power is generated in the photoelectric cell under the influence of light received from the light source, it will be amplified to close the independent circuit and energize the solenoid **36***a*. The hand, in the path of light from the source **30** will be rendered translucent during the periods between arterial pulsations. These pulsations are noticeably recognized by a rhythmic flicker which occurs with every pulse beat. Every time a flicker occurs, it momentarily interrupts the light beam which passes through the hand to the photoelectric cell. This interruption is made to activate the solenoid **36***a*. When this happens, the solenoid core **38** is pulled upwards against the action of the spring **72**.

At the lower end of the core **38**, is mounted a lateral arm **40** having a recess **42** formed therein for the slidable reception of a metal or carbon brush **44** which is urged outwardly by means of a spring **46** mounted in the recess, so as to cause the brush to bear against a number of electrical contact members **48** insulated from each other and mounted in any suitable manner as in a frame, so as to have their outer surfaces against which the brush **44** bears, all lying in the same vertical plane.

In its upward course, the core **38**, through its spring-backed carbon brush **44**, makes a series of electrical contacts with the contact members **48** as it passes upwardly thereby and in contact therewith.

A toggle switch **55**, mounted on the frame **60**, is provided having a lever **56** in the path of downward movement of the arm **40**. A second pivotally mounted lever **54** is also mounted on the frame **60** in the path of upward movement of the arm **40**. A lever **52** pivotally interconnects the levers **54** and **56** so that the movement of one lever will correspondingly move the other. The levers **54** and **56** as shown in full lines in Fig. 1 represent their positions when the switch **55** is closed.

In Fig. 1, the solenoid plunger arm **40** is shown as having already started its upward travel. However, when the said arm **40** has travelled upwardly high enough, it will strike the upper toggle lever **54**, carrying it upwardly in a clock wise direction about its pivot pin **58**, to the dotted line position shown at **64**.

It will be seen that this upward movement of the lever **54** will necessarily carry the connecting rod **52** upwards as well as the lower toggle switch lever **56**, to its open or dotted line position, to thus break the electrical contact between the brush **44** and the contact members **48**, by opening the switch **55**.

The solenoid plunger **38** being at its uppermost position, as above described, will then commence its downward travel under the influence of the spring **72**, the circuit between the brush **44** and contact members **48** being open during this entire downward travel. However, when the plunger reaches its lowermost position, its arm **40** strikes against the lower toggle switch lever **56**, pushing it downward, to its normal solid line position, again closing the switch **55** and carrying the upper lever **54** also to its lower solid line position. Upon the following upward movement of the brush **44**, under the influence of the next successive pulse beat, the brush **44** again traverses and makes contact with each contact member **48** in turn. The contact members **48** may be suitably insulated from each other and mounted on a frame or panel board **60**.

As shown in Fig. 1, active metal electrodes **50** are placed in successive positions on one of the body extremities, for example, the leg **52**, and one dispersive electrode **54** is placed on or against any other convenient part of the body, such as the sole of the foot. The electrodes **50** are held in place by bands **50***a* and are of the well known type which tighten up when energized by galvanic or faradic current. Wires **56***a* and **56***b* leading from the switch **56** and the passive electrode **54** respectively are connected to a source of low frequency current Q, either galvanic or faradic.

Inasmuch as the unit Q is of a type well known to those skilled in the art, it will not be described in detail, other than to state that its power input is derived through wires **62**. Each of the dispersive electrodes **50** is connected to a corresponding electrical contact member **48** by the wires **48***a*. A slack cable **75** interconnects the toggle switch **55** with the brush **44**.

It will thus be seen that in the upward stroke of the solenoid core **38**, a series of contacts in rapid succession is made between the brush **44** and the members **48**, which causes corresponding successive applications of current from the source Q to pass to the leg **52** and electrode **54** and electrodes **50**, causing corresponding contractions of the muscles of the leg **52** of the patient. It is noted that these successive contractions occur

only in a direction away from the extremity, that is, in a direction toward the heart.

In this manner, venous blood is pumped to the heart, thereby simulating natural muscular contraction which pumps blood upwards along the veins to the heart. On the return or downward stroke of the solenoid core 38, the low frequency current source Q is disconnected as hereinbefore described, so that no current is passed through electrodes 50 and 154, and therefore no contractions occur on the muscles of the limb in a downward direction, that is, away from the heart.

It should be noted that any other suitable means for producing muscular contractions may be substituted for the low frequency currents described. Also, instead of using a galvanic electrical current, compressed air may be used. Thus, instead of electrodes 50 and unit Q, a series of suitably designed inflatable cuffs may be fastened to the leg in the positions shown for electrodes 50. These inflatable cuffs, similar to those of the sphygmomanometer, may be connected to an air compressor, so that instead of a succession of musclar contractions obtained by means of the electrical current, such contractions may be effected by means of compressed air.

Fig. 2 shows another form of the invention, whereby the solenoid 36 may be actuated in synchronism with the heart beat or radial pulse of the patient. As illustrated, there is a table 66 upon which the patient reclines, and strapped to his chest is an electronic pulse microphone pickup 68 which is amplified and adapted to transmit electrical impulses through the wires 34A to the solenoid coil 36. The microphone pickup 68, which is of a design well known to those skilled in the art, acts under the influence of the heart pulsations to actuate the solenoid 36 in the same cyclic manner as do the elements contained in the housing 10 of Fig. 1. All the other elements are the same as already described for Fig. 1, the only difference being that the device 68 takes the place of the housing 10 and its contents.

In Fig. 3, I have shown a modification of the form of my invention shown in Fig. 1 where instead of a hand being placed in the path between the light source 30 and the photoelectric cell 32, only a portion of a finger may be used to effect satisfactory results. As shown, the light source 80 is housed in a tubular casing 81, open at the top and over which the tip of a finger 82 may be placed. A photoelectric cell 83, similar to the cell 32, is mounted directly above and in the path of travel of the light from the source 82, the said cell 83 being suitably housed in a casing 84. A flexible curtain member 85 of lightproof material depends from the housing 84 to prevent loss of light from the source 80 through the finger 82 and to the cell 83. The output of the cell 83 is connected to the amplifier by the wires 86. The housings 81 and 84 may be maintained in desired spaced relationship by a C-clamp member 88 having openings 89 and 90 to accommodate the housings 81 and 84. The housing 81 may be fixed to the support 88 whereas the housing 84 may be slidably adjustable to permit proper insertion of the finger and to regulate the distance of the photocell 83 from the light source 80. A set screw 91 is provided for above mentioned adjustment.

Although I have described my invention in specific terms, it is to be understood that various changes may be made in size, shape, materials and arrangement without departing from the spirit and scope of the invention as claimed.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. A device for aiding and maintaining the circulation of the blood, comprising a plurality of active electrodes adapted to be placed in contact with a portion of the body of a patient, a dispersive electrode adapted to be placed in contact with another portion of the said body, a source of electric current connected to said electrodes, and means for successively energizing said electrodes in synchronism with the arterial pulse, whereby the blood circulation of the body is maintained.

2. A device for aiding and maintaining the circulation of the blood, comprising a dispersive electrode adapted to be placed in contact with a portion of the body of the patient, a plurality of active electrodes adapted to be placed in contact with another portion of the body of the patient and arranged in spaced relationship along the direction toward the patient's heart, a source of electric power of a form which, when acting upon a body muscle causes the contraction thereof, means connecting said source of power to said electrodes, and switch means interposed in said connecting means and operating in synchronism with the patient's arterial pulse, for successively energizing said active electrodes in only one direction whereby the blood circulation of the body is aided and maintained.

3. A device for aiding and maintaining the circulation of the blood, comprising a dispersive electrode adapted to be placed in contact with a portion of the body of the patient, a plurality of active electrodes adapted to be placed in contact with the body of the patient and arranged in a spaced relationship along the direction toward the patient's heart, a source of electric power of a form which, when acting upon a body muscle, causes contraction thereof, means connecting said source of power to said electrodes, and switch means interposed in said connecting means and operating in synchronism with the patient's arterial pulse rate for successively energizing said active electrodes only in a direction toward the heart, said switch means comprising a plurality of electrical contact members connected to said power source and connecting means, a movable brush adapted to successively make electrical connection with said electrical contact members, and means for causing the movement of said brush, said last named being rendered effective in synchronism with the patient's arterial pulse rate.

4. A device for aiding and maintaining the circulation of the blood, comprising a dispersive electrode adapted to be placed in contact with a selected portion of the body of a patient, a plurality of active electrodes adapted to be placed in contact with the body of the patient and arranged in a spaced relationship along the direction toward the patient's heart, a source of electric power of a form which, when acting upon a body muscle, causes contractions thereof, means connecting said source of power with said electrodes, switch means interposed in said connecting means and operating in synchronism with the patient's arterial pulse, for successively energizing said active electrodes in a direction toward the heart, said switch means comprising a plurality of stationary electrical contact members connected to said power source and said connecting means, a movable contact member, means for moving said movable contact member for a predetermined distance in one direction, whereby to

successively engage all of said stationary contact members whereby circuits are closed to successively energize said active electrodes, and means for restoring said movable contact member by moving the same in the opposite direction to initial position, and means whereby said means for moving said movable contact member is synchronized with the heart beat of the patient.

5. The construction according to claim 4 in which means are provided for disconnecting said stationary contact members from said power source at the end of the said predetermined period of movement of said movable contact member.

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