

Jan. 4, 1944.

H. B. HULL

2,338,247

THERAPEUTIC DEVICE

Filed Oct. 13, 1941

2 Sheets-Sheet 1

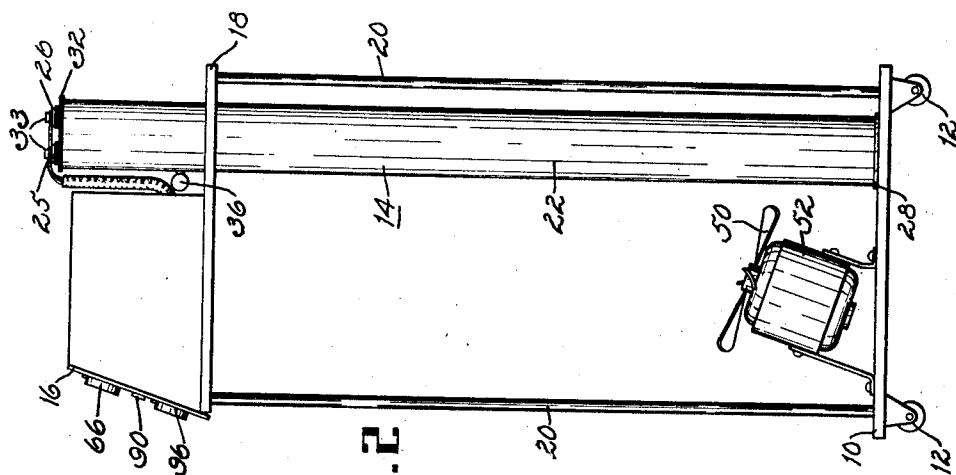


Fig. 2

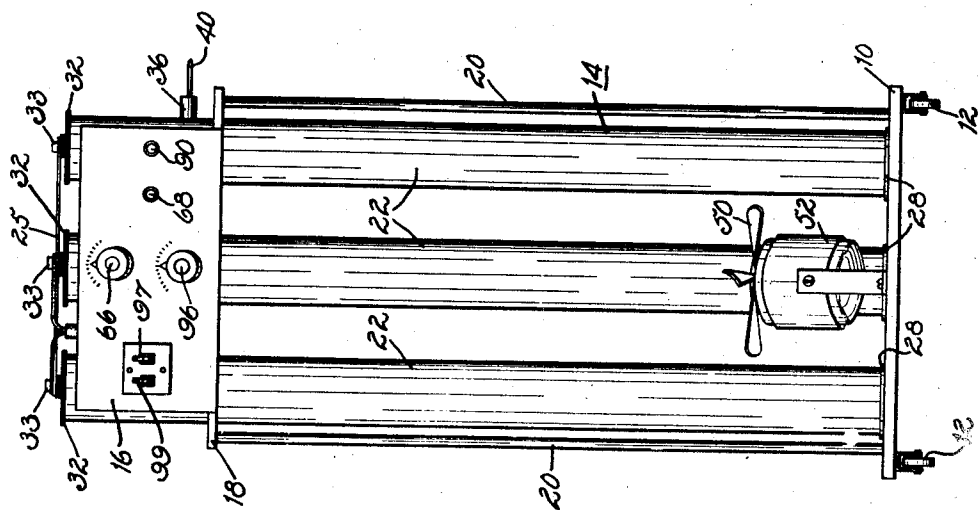


Fig. 1

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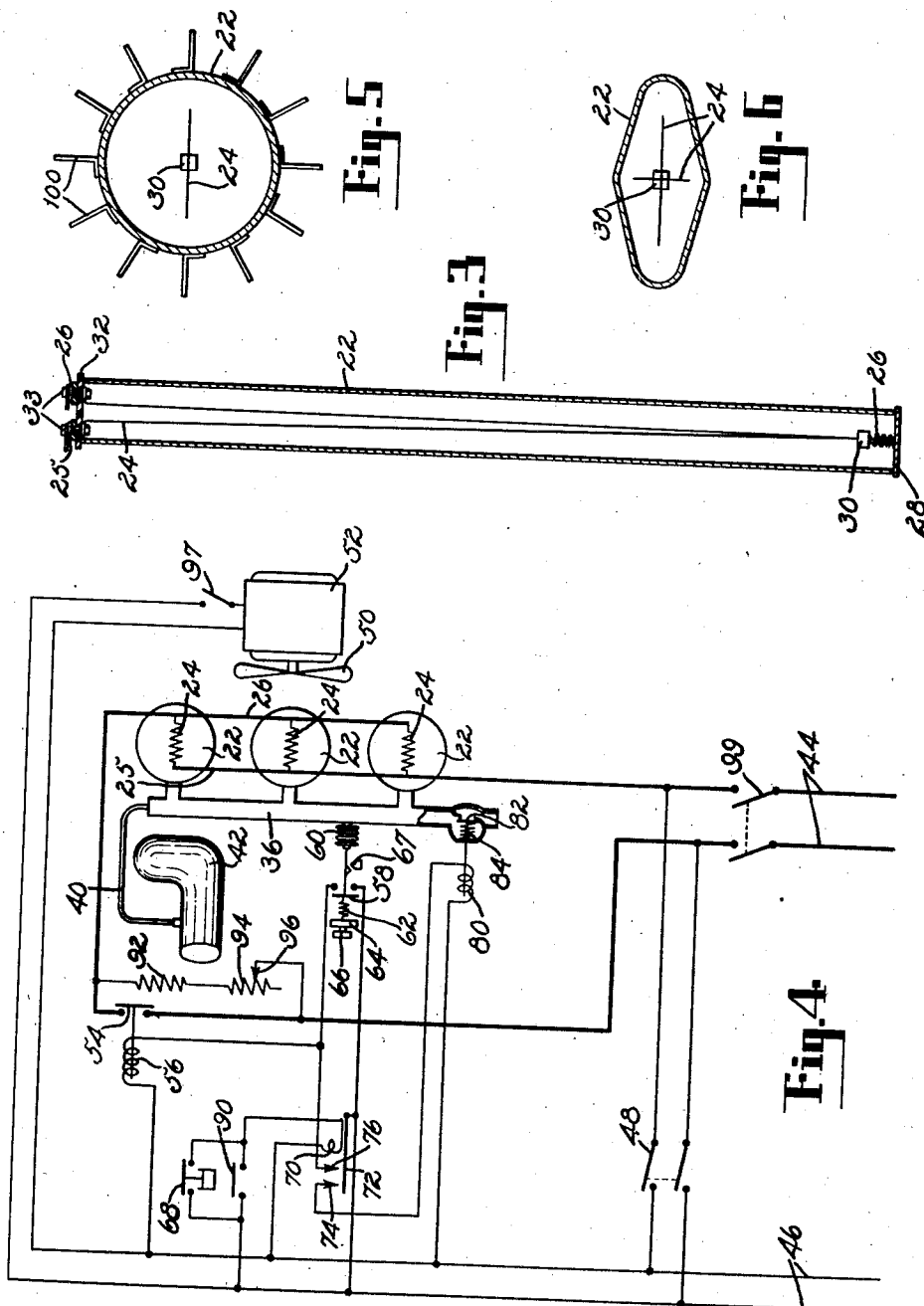
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,338,247

THERAPEUTIC DEVICE

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Application October 13, 1941, Serial No. 414,728

3 Claims. (Cl. 128-299)

This invention relates to a therapeutic device and more particularly to a vascular exerciser.

One object of this invention is to provide a vascular exerciser which is simple and trouble free so that the apparatus may be operated by nurses and doctors.

Another object of this invention is to provide a device which is quiet in operation and in which there are no moving parts.

Since glass boots and similar therapeutic appliances are frequently used in the treatment of infected limbs and since most types of gas-producing bacteria, such as those given off by gangrenous limbs, are very infectious, it is highly important to keep all of the equipment which is exposed to the gas produced by the bacteria properly sterilized and free of oil or grease. It has been found that even the slightest amount of oil serves as an ideal culture medium for the bacteria. Another object of this invention, therefore, is to provide a pump which is self sterilizing and which does not require any oil or grease.

Another object of this invention is to provide a pump for cyclically changing the pressure in such a manner that the changes in pressure follow very nearly a sine wave. It has been found that ordinary pumps in which an abrupt change of pressure takes place are more tiring to the patients and are otherwise unsatisfactory.

A further object of this invention is to provide simple means for controlling the frequency of the pressure pulsations.

Another object of this invention is to provide a pump which supplies relatively dry warm air.

Still another object of this invention is to provide a simple means for varying the pressures at which the vascular exerciser is operated.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a front elevational view of the pump unit;

Fig. 2 is a side elevational view of the pump unit shown in Fig. 1;

Fig. 3 is a vertical sectional view taken through one cylinder of the pump;

Fig. 4 is a diagrammatic view showing the air circuits and the electrical circuits;

Fig. 5 is a horizontal sectional view on an enlarged scale of a modified cylinder construction; and

Fig. 6 is a horizontal sectional view similar to

Fig. 5 showing still another cylinder construction.

Referring now to Fig. 1 in which I have shown an improved type of pump to be used in combination with a glass boot, or the like, reference numeral 10 designates a base member which is provided with casters 12 for portably supporting the pump unit generally designated by the reference numeral 14. For purposes of illustration, I have shown a pump employing three cylinders whereas in actual practice the number of cylinders may be increased or decreased as desired. As shown in Figs. 1 and 2, a control box 16 is supported on the bracket 12 carried by uprights 20 which in turn are carried by the base 10. Each cylinder comprises a metallic casing or shell 22 in which is suitably mounted an electrical heating element 24. The heating elements 24 are connected in parallel by the bus bars 25 and 26. Inasmuch as the heating elements are alternately heated and cooled, it is apparent that each element will expand and contract. In order to allow for expansion and contraction of the heating elements 24, I have resiliently anchored the lower end of each heater element by means of a spring 26 (see Fig. 3) having its one end secured to the lower end wall 28 of the casing 22 and having its other end secured to an insulator 30 to which the heating element 24 is secured. The upper end of the casing 22 is closed by means of an insulating plate 32 which carries a pair of terminals, 33.

As best shown in the diagram of Fig. 4, a manifold 36 joins the three cylinders 22. A pipe line 40 connects the manifold 36 with the glass boot 42. The glass boot 42 is of conventional construction and is adapted to enclose the limb of a patient in accordance with well known practice. By alternately energizing and de-energizing the electric heaters 24, the air within the cylinders 22 will be alternately heated and cooled. The heating and cooling of the air causes expansion and contraction thereof and therefore affords a very convenient means for producing a pumping action in which no abrupt change in pressure takes place. By properly designing the electric heaters and the cylinders in which the heaters are housed, the pressure changes resulting from intermittent energization of the electric heaters follow closely the sine wave. For proper functioning of the glass boot, it is preferable that the apparatus be so designed that the heaters be on in full for approximately one third of the time and off or almost off two thirds of the time.

Referring to Fig. 4, electrical energy is supplied to the heaters 24 from the main power lines 44 through the switch 54. The current supplied by

the power lines 44 may be direct current or it may be alternating current. Since most controls utilize alternating current for their operation, I have provided a second pair of power lines 46 which may be connected to a source of alternating current in the event that the current supply at 44 is direct current. If, however, the current supplied at 44 is alternating current, the controls may be energized directly from the main power lines 44 merely by closing the switch 48. In the event that the main power lines are direct current lines and no alternating current is available, a small motor generator set (not shown) may be provided for generating alternating current which may be supplied to the controls through the lines 46.

Under normal circumstances, it is not necessary to provide any auxiliary means for rapidly cooling the cylinders 22 since the ambient air is sufficiently cool to adequately cool the cylinders. However, under extreme conditions, it may be desirable to provide a fan, such as the fan 50, for producing a circulation of air over the cylinders 22. As shown in the circuit diagram of Fig. 4, the fan 50 is driven by an alternating current motor 52 connected in the circuit as shown.

The current supplied to the electric heaters 24 is controlled by the main circuit breaker 54 which in turn is controlled by the solenoid 56. After the apparatus is once placed in operation, the solenoid 56 is controlled by the pressure operated switch 58. The switch 58 is operated by means of a bellows 60 which is connected to the manifold 36 and which therefore responds to the pressure changes within the pump and within the glass boot 42. In order to adjust the pressure at which the switch is closed, a spring 62 has been provided which has its one end secured to the adjusting member 66 carried by the stationary element 64 and has its other end secured to the switch contact 58. The tension on the spring 62 may be adjusted by rotating the member 66. In order that the switch 58 will open at one pressure and will close at a lower pressure, a spring pressed detent 67 has been provided for biasing the switch 58 into either its open position or its closed position in accordance with well known practice. The switch is preferably set to open the circuit at a pressure of 20 mm. of mercury and to close the circuit at a suction pressure of 60 mm. of mercury. By adjusting the tension on the spring 62, the low pressure value may be varied considerably. The capacity of the pump is preferably such that it will cycle 3 or 4 times per minute.

In order initially to place the apparatus into operation, a manually operated switch 68 is provided which may be of any well-known type which when once manually operated automatically holds the circuit to the solenoid 70 closed for a predetermined time interval and then automatically opens the circuit. Energization of the solenoid 70 causes the armature 72 to engage the contacts 74 and 76. When the armature 72 is in engagement with the contact 76, a circuit is closed through the solenoid 56 and thereby closes the main heater switch 54. Closing of the switch 54 causes the air in the cylinders 22 to be heated. Heating of the air causes expansion thereof. Closing of the circuit from the armature 72 to the contact 74 energizes the solenoid 80 which, when energized, holds the air relief valve 82 open against the tension of the spring 84. So long as the time switch 68 is closed, the armature 72 maintains the solenoids 56 and 80 energized.

After a predetermined interval of time for which the time switch 68 is set, and which in actual practice is approximately one minute, the cylinder walls and the air therein will have been heated sufficiently and a sufficient amount of air will have been exhausted from the system through the valve 82 to place the apparatus in condition for continuous automatic operation. When the switch 68 opens, the solenoids 56 and 80 are immediately de-energized with the result that the air within the cylinders begins to cool. Cooling of the air causes subatmospheric pressures within the cylinders 22. Suitable gaskets (not shown) prevent air entering the glass boot with the result that the pressure within the whole air circuit will drop below atmospheric. Continued drop in the pressure will cause the pressure operated switch 58 to close at the pressure for which the switch 58 is adjusted to operate. Closing of the switch 58 energizes the solenoid 56 and in turn causes the heater switch 54 to energize the electrical heaters 24 so as to start reheating the air in the cylinders of the pump. Heating of the air consequently causes an increase in the pressure within the cylinders and within the boot 42 until the increased pressure opens the pressure operated switch 58.

By virtue of the above described arrangement, the pressure operated switch 58 alternately opens and closes the electrical circuit to the heaters 24 with the result that a pumping action takes place. If for any reason air leaks into the system or if for any reason the amount of air left in the system when the valve 82 is closed is not satisfactory, a manual switch 90 which is arranged in parallel with the switch 68 may be closed during the heating cycle for a length of time sufficient to exhaust an additional amount of air through the valve 82. If the switch 90 is closed when the pressure in the system is below atmospheric pressure, opening of the valve 82 will admit more air into the system.

In order to provide means for varying the frequency of operation of the pump, I have provided means for allowing a predetermined amount of current to flow through the electric heaters 24 when the main heater switch 54 is open. This means includes a fixed resistance 92 and a variable resistance 94 which are arranged in parallel with the switch 54. For normal operation of the pump, the adjustable portion 96 of the variable resistance unit 94 is moved out of contact so as not to allow any current to flow through the resistances. When the circuit is closed through the resistance elements 92 and 94, it takes longer for the air in the cylinders to cool since a small amount of heat is being added to the air therein even though the switch 54 is open. This arrangement, therefore, provides a convenient means for adjusting the frequency of the pumping cycle.

A master control switch 98 turns on and off the entire system whereas switch 97 controls the circuit to the fan motor 52.

While I have shown cylinders having a circular cross-section, it is apparent that other shapes and proportions may be used without departing from the spirit of my invention. In Fig. 5, for example, I have shown a modified cylinder construction in which heat radiating fins 100 have been added to the cylinders for increasing the heat transfer between the air within the cylinder and the ambient air. From the standpoint of strength and economy in materials, a circular cylinder is the most practical, but inasmuch as

a circular cylinder has a minimum amount of exposed surface, it is apparent that a cylinder having a circular cross section is not the most efficient from the standpoint of heat dissipation. In Fig. 6, I have shown a modified cylinder construction in which the shape of the cylinder more nearly corresponds to the most practical shape from the standpoint of heat dissipation.

The air within the cylinders 22 is heated to a temperature in the neighborhood of 400 degrees Fahrenheit with the result that all bacteria which enter the cylinders 22 are killed. The temperature of the heating elements themselves runs much higher than 400 degrees and serves to very effectively assist in killing all bacteria. It is apparent therefore that the pump serves the extra purpose of sterilizing itself.

While I have shown the pump used in combination with a glass boot, it is apparent that the pump is especially suitable for use in combination with respirators and the like. In actual practice, mercury contact switches are used so as to eliminate all noise. Since the pump itself has no moving parts, it is apparent that the entire unit is very quiet in operation.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In combination, a treatment chamber adapted to receive a portion of a human body, a fluid

chamber having means for alternately heating and cooling an expansible fluid so as to cause expansion and contraction of said fluid, means whereby changes in pressure of said expansible fluid produces a substantially corresponding change in pressure in said treatment chamber, and means for controlling the alternate heating and cooling of said expansible fluid.

2. In combination, a treatment chamber adapted to receive a portion of a human body, a fluid chamber having means for alternately heating and cooling an expansible fluid so as to cause expansion and contraction of said fluid, means whereby changes in pressure of said expansible fluid produces a substantially corresponding change in pressure in said treatment chamber, means for controlling the alternate heating and cooling of said expansible fluid, and a vent for said fluid chamber communicating with the outside atmosphere.

3. In combination, a treatment chamber adapted to receive a portion of a human body in isolated relation to atmospheric pressure, a fluid chamber having means for alternately heating and cooling a body of air so as to produce pressure variations in said body of air, means whereby changes in pressure in said expansible fluid produces a substantially corresponding change in pressure in said treatment chamber, and means responsive to changes in pressure in said treatment chamber for controlling the heating of said air.

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