

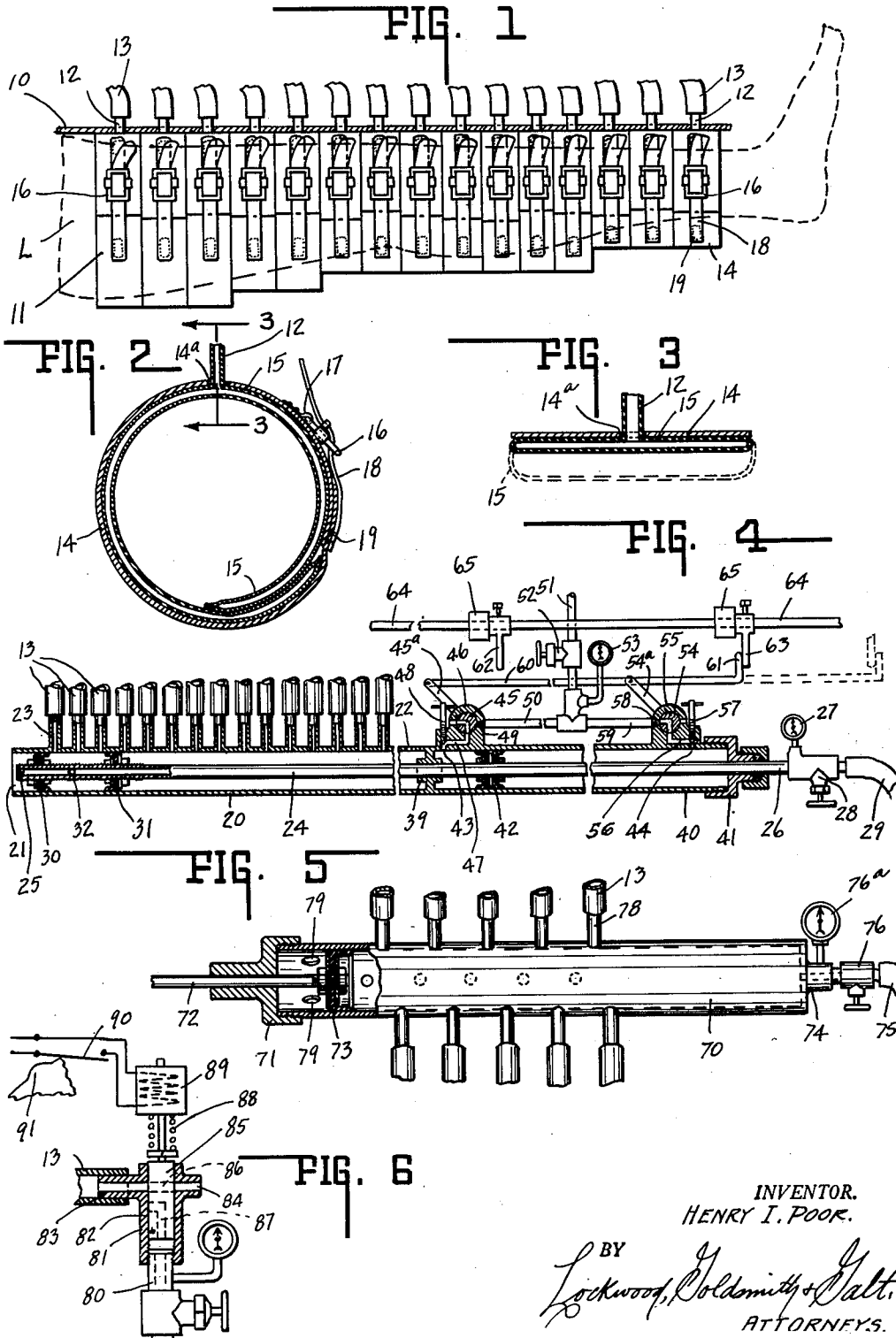
Nov. 7, 1950

H. I. POOR
APPARATUS FOR THE TREATMENT OF
INTERMITTENT CLAUDICATION

2,528,843

Filed Dec. 5, 1945

2 Sheets-Sheet 1



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FIG. 7

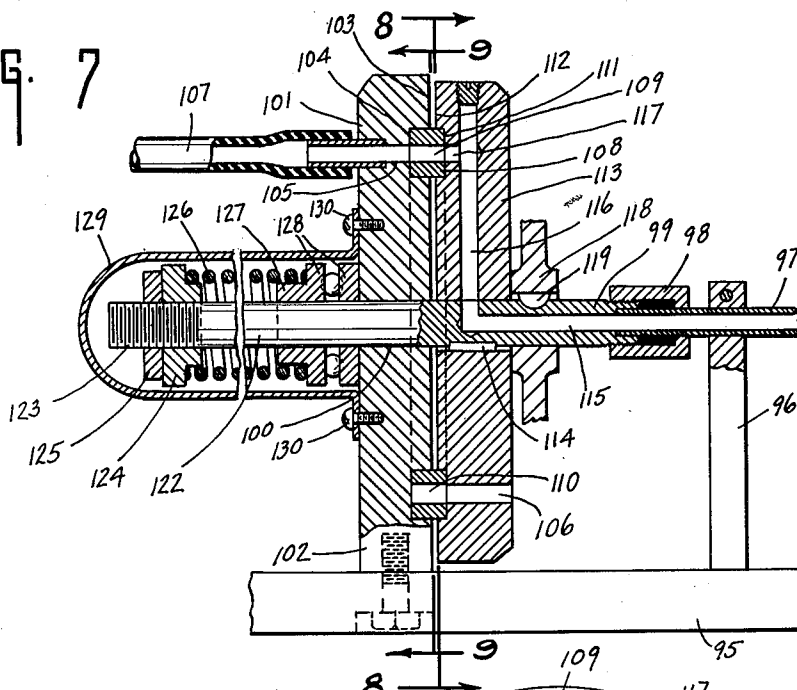


FIG. 8

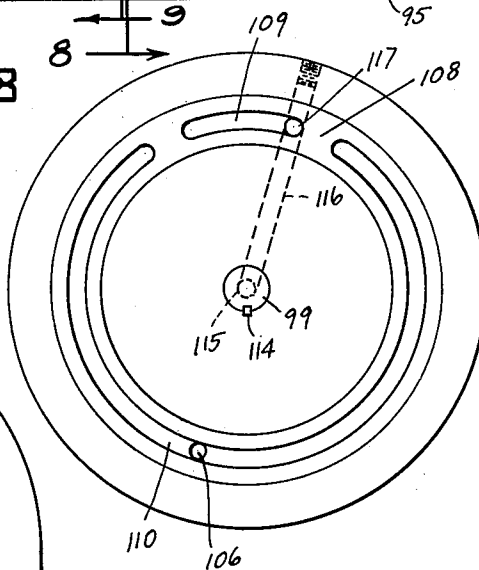
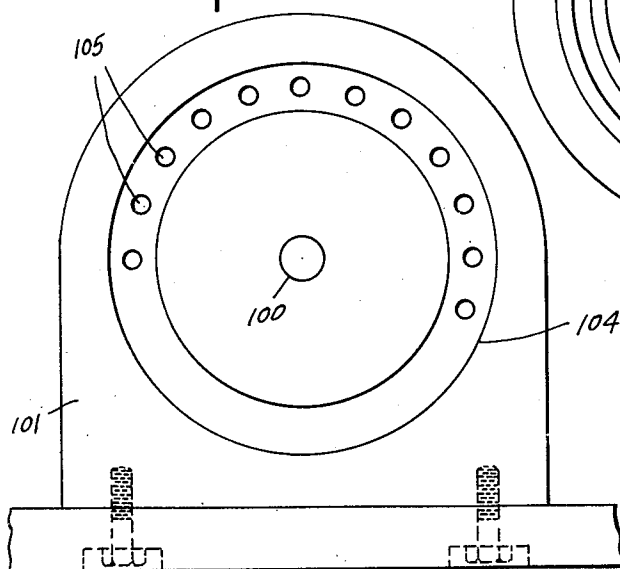


FIG. 9



INVENTOR.
HENRY I. POOR.

BY

Lockwood, Greenleaf & Co.
ATTORNEYS.

UNITED STATES PATENT OFFICE

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APPARATUS FOR THE TREATMENT OF
INTERMITTENT CLAUDICATION

Henry I. Poor, La Fayette, Ind., assignor of one-fourth to J. Philip Sampson, Santa Monica, Calif.

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12 Claims. (Cl. 128—24)

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This invention relates generally to means for the treatment of certain vascular diseases in which there exists deficient or impaired circulation, and particularly by increasing the immediate flow by forcing blood flow through established vessels and by stimulating collateral circulation in certain cases. While particularly beneficial in the treatment of the circulatory system of a limb of the human body, the invention is also of value for the treatment of certain muscular conditions.

Having the foregoing in mind, an object of this invention is to repetitiously apply to a limb or selected portion thereof to be treated, predetermined pressure in an intermittent and generally in a progressive manner, in accordance with the specific directions of the attending physician.

An important feature of this invention resides in a sectionalized, limb-enveloping means and applying selected pressure thereto and releasing the pressure therefrom, all in timed relation and cyclically, as hereinafter described.

Other objects and features of this invention will be set forth more fully hereinafter.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

In the drawings Fig. 1 is a side elevation of the limb-enveloping applicator unit of the apparatus of sectional character and adjustable to limb conformance, the limb (a leg) being shown dotted.

Fig. 2 is a transverse cross-sectional view of one of the limb-enveloping sections.

Fig. 3 is a sectional view thereof taken at right angles to Fig. 2, on line 3—3 thereof and in the direction of the arrows, full lines indicating the normal position and dotted lines indicating the inflated or pressure applying position.

Fig. 4 is a longitudinal and generally sectional view of an automatic control mechanism of the type operable by fluid pressure and adapted for control of the device illustrated in Fig. 1.

Fig. 5 is an elevational view of a modified and simplified form of control capable of manual or power operation, portions being broken away to show the details of certain parts and their operative relation.

Fig. 6 is a diagram of an electric control.

Fig. 7 is a vertical sectional view through a control mechanism of still different construction, which may be utilized according to the present invention.

Fig. 8 is a transverse sectional view looking toward the valve ring, taken upon the broken line

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3—8 of Fig. 7 and in the direction of the arrows.

Fig. 9 is a transverse sectional view looking toward the base structure, taken upon the broken line 9—9 of Fig. 7 and in the direction of the arrows.

Reference will now be had to Figs. 1 to 3 inclusive, wherein the limb-enveloping applicator unit is illustrated in detail. This is an exemplary form only, for obviously it may take other shapes.

In these figures, 10 indicates a common connector to which is suitably secured (detachably, if desired) the required number of pressure inflatable sections 11, each of the desired circumferential size and each having a common inlet 15 and outlet 12, connectible by conduit or flexible tube 13 to a source of regulated pressure.

Each section, see more particularly Figs. 2 and 3, includes a somewhat flexible base 14, such as 4 oz. canvas, which fits the leg and has suitably secured thereto an inflatable portion 15 of closed character having free communication with the combination inlet and outlet 12, the latter passing through the base 14 as at 14a.

Associated with this elongated structure is a suitable connector in the form of a buckle or the like 16 secured as at 17 and the cooperating strap 18, also secured oppositely as at 19.

The entire applicator unit is applied to the limb L, see Fig. 1, and the several sections thereof are adjusted thereto, in deflated condition, by lapping the buckle supporting end of each with its strap supporting end, associating the buckle and strap together and tightening up the section to the desired degree upon the limb, so that unit conformance to the limb is obtained.

Such a unit obviously can be used interchangeably on different length, girth and shaped limbs. Obviously, also, the inflating pressure can be adjusted. When each section is inflated it assumes or rather tends to assume a position as shown by dotted lines in Fig. 3, that is, expands radially inward. Thus, constricting pressure may be selectively applied by the several sections along the entire length of the limb enveloped by the applicator unit, the points of pressure application and progressive movement thereof being determined by the control mechanism, as will hereafter be described more fully.

Reference will now be had to Fig. 4, wherein one form of adjustable, automatic control mechanism of the type operable by fluid pressure is illustrated. As there shown, 20 indicates a common supply and exhaust header or cylinder which may have open end 21, exhaust port 22 and

take-off tubes 23, each of which connects to a tube 13.

Slidably mounted in a bearing 39 near the exhaust port 22 is a reciprocable tube 24 closed as at 25 at one end and connected at its opposite end 26 to a gauge 27 and pressure regulating valve 28 in turn suitably connected by a supply tube 29 to a source of fluid pressure (not shown).

Adjustably mounted on the opposite end of tube 24 in the take-off portion of cylinder 20 is a pair of spaced pistons 30 and 31, which act as valves, the tube 24 therebetween being suitably ported as at 32. The pistons herein are illustrated in the positions shown as having an effective spacing sufficient to connect this space with three of the tubes 23.

From the foregoing, it will be observed that regulated pressure from tube 29, as shown in Fig. 4, will be supplied to the three left end tubes 13, while all other tubes 13 are free to vent to atmosphere. Moreover, as the tube 24 is reciprocated in opposite directions, tubes 13 will be successively and progressively connected in the direction of movement of the pistons and successively and progressively disconnected in the opposite direction with respect to the space between the pistons. It will be noted that at least one tube remains connected and inflated at all times, so as to apply a holding pressure as the tubes on one side are progressively connected and the tubes on the other side thereof progressively disconnected. With this action, a continuously applied pressure wave may be progressively translated along the connected sections of the applicator unit in one direction or the other depending upon the order in which the sections are connected to the take-off tubes 23. The unconnected tubes 13 on the right side of piston 31 are free to vent to atmosphere by way of cylinder 20 and exhaust port 22, and since cylinder 20 is open at the left hand end, of course, all tubes 13 then to the left of piston 30 also vent to the atmosphere.

Reference will now be had to the right hand portion of Fig. 4. Herein cylinder 20 is extended beyond bearing 39 and the latter serves as a cylinder head. This extension 40 is closed at the other end as 41, which also serves as a cylinder head and a bearing for tube 24. Said tube serves as a piston rod for pistons 42 in cylinder 40.

Supply and exhaust ports 43 and 44 are provided to cylinder 40 adjacent the ends thereof. Each port is controlled by a three-way valve. Herein port 43 is controlled by valve member 45 in housing 46 having a port 47, needle valve or like controlled at 48. The housing has supply port 49 connected to line 50 supplied by line 51 and controlled by valve 52. Gauge 53 indicates the fluid supply pressure.

In like manner port 44 is controlled by valve member 54 in housing 55 having exhaust port 52 controlled by needle valve 57. The housing has supply port 58 connected by line 59 to line 51. The two valve members 45 and 54 have arms 45a and 54a respectively connected by link 60.

Link 60 carries stop or arm means 61 that is alternately engaged by arms 62 and 63 carried by travel limit reciprocable arm 64 slidably supported in bearings at 65 and suitably connected directly or indirectly to tube 24 for movement in timed relation therewith.

Thus, when piston 42 has completely moved to left, the fluid ahead of same discharging at 47-48 as regulated, valve 45 is actuated to supply

pressure to ports 49 and 43 and simultaneously cut off pressure at port 58. The fluid to the right of piston 42 then wastes through port 56 controlled by valve 57. When the travel is completed pressure supply at the left end is cut off, that end connected to vent and the pressure supply is connected to the right end of cylinder 40.

In this manner the tube 24 is reciprocated to and fro automatically and the duration is determined by the adjusted pressure supply and valve controlled wastes or vents. As stated, travel limit member 64 or link 60 may actuate an on-off valve in line 26-29 so that pressure is applied to the sections for one travel direction only. In this event the vent valve for the reverse travel control would be omitted so that quick return, as it were, could occur.

Reference will now be had to Fig. 5. Herein there is illustrated a header and cylinder 70 having a head 71 at one end supporting rod 72 mounting piston 73 within said cylinder.

The other end of said cylinder 70 is connected at 74 to a supply line 75 by regulating valve 76. Gauge 76a may also be included. Cylinder 70 has exhaust ports 79 near the end opposite the pressure supply end, and take-off tubes 78 respectively connected to tubes 13.

Piston rod 72 may be cyclically controlled automatically or manually and, if automatically, by any suitable fluid pressure, mechanical or electrical means.

In this embodiment of the invention pressure is held from the right end in Fig. 5 to the left end and progressively released as piston 73 is moved to the right.

It is to be understood that it is preferred in this form to apply, see Fig. 1, pressure closest to the trunk and gradually apply pressure toward the extremity and then proceed in reverse direction to withdraw the pressure, as described.

Obviously, other forms of control may be utilized as desired or required as, for example, in Fig. 6 there is illustrated an adjusted fluid pressure supply 80 feeding to header 81 having as many bores 82 therein as there are sections in the applicator unit. For each bore there is a take-off tube 83 and an atmospheric vent 84.

In each bore is a valve member 85 having a cross-passage 86 adapted to interconnect tube 83 with port 84. Valve member 85 includes angle passage 87 having one end constantly exposed to the regulated pressure. The other end, when venting passage 86, is in non-registering position and connects supply 80 to tube 83.

Valve 85 is normally biased to venting position by spring 88 and is electrically actuated in opposition thereto by solenoid 89 having in its circuit a normally open switch 90. A rotative cam 91 closes said switch and during the switch closed duration pressure fluid is supplied to tube 83 and the section connected thereto and such pressure is maintained until the cam closed switch opens, whereupon pressure fluid is cut off and vented at 84.

Various other electrical controls may be employed. In the form illustrated a single rotative cam can successively close peripherally arranged switches, the length of the cam portion determining whether 1, 2 or 3 sections are simultaneously being inflated and repetitiously.

In Figs. 7 to 9 inclusive, there is illustrated a further modification of the invention in which the control is arranged for rotative cyclic operation. Therein 95 indicates a base provided with

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bracket bearing 96 which supports a pressure supply line 97, which is leak-proof, connected as at 98 to conduit 99 which is rotatably supported at 100 in the main stationary element 101 supported by base 95 at 102.

This element 101 has formed in one face 103 a circular channel 104. Herein in said channel are provided twelve ports 105 (same may be fifteen if desired). Each of ports 105 communicates by flexible conduit 107 with one of the inflatable sections of the applicator unit shown in Fig. 1 and connects to the inlet and outlet 12 shown therein.

Rotatable in said channel 104 is a hard rubber valve ring 108 having an arcuate channel or slot 109 therethrough equal to the spacing between three ports 105. It also is provided with an arcuate slot or channel 110. The ring 108 may be press fitted or otherwise suitably secured in seat 111 in the element confronting face 112 of confronting element 113 keyed as at 114 to rotatable conduit 99. Element 113 has discharge port 106 therein communicating with channel 110.

Said conduit has bore 115 that is in free communication with radial bore 116 in element 113, the latter having bore 117 that registers with arcuate slot 109 at all times. A gear 118 is keyed as at 119 to conduit 99 or otherwise secured to element 113. Motor rotation of gear 118 therefore rotates element 113 and ring 108 so that three of the ports 105 are successively and progressively connected and disconnected with respect to the fluid pressure supply in the manner previously described. Since discharge port 106 in element 113 registers with arcuate slot or channel 110 and this with selected ports 105, the latter when so registering vent to the atmosphere.

Conduit 99 projects beyond element 102 and is appreciably extended as at 122, the free end being threaded as at 123 to take a spring seat member 124 and lock nut 125 for securing predetermined pressure from spring 126, the latter at its opposite end bearing on seat member 127, in turn bearing on thrust bearing 128 bearing upon element 102. Thus element 113 with its ring 108 is always drawn by spring 126 into facial engagement with element 102. A protective cap 129, secured as at 130 to element 102, may be provided if desired.

While the invention has been illustrated and described in great detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character.

The several modifications described herein, as well as others which will readily suggest themselves to persons skilled in this art, all are considered to be within the broad scope of the invention, reference being had to the appended claims.

The invention claimed is:

1. A selective pressure supply control device including in combination a cylinder having a piston rod therein, a plurality of take-off tubes in free communication with the cylinder and arranged longitudinally thereof, said cylinder having a vent therefrom, and piston means positioned in the cylinder carried by said rod, said means having spaced ends, and a pressure supply connection between said spaced ends connectable with said tubes during actuation of said piston means, whereby selective pressure supply to certain of the tubes and the venting of other tubes is determined.

2. A selective pressure supply control device

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including in combination a cylinder having a piston rod therein, a plurality of take-off tubes in free communication with the cylinder and arranged longitudinally thereof, said cylinder having a vent therefrom, and piston means positioned in the cylinder carried by said rod, said means having spaced ends supported for adjustment towards and away from each other, and a pressure supply connection between said ends, connectable with said tubes during actuation of said piston means, whereby selective pressure supply to certain of the tubes and the venting of other tubes is determined.

3. A control device as defined by claim 1 wherein the pressure supply connection includes a piston rod which is tubular and in constant communication with the pressure supply.

4. In therapeutic apparatus including a plurality of inflatable and deflatable applicator sections adapted to be applied in side-by-side relation along a portion of a limb to be treated, a source of fluid pressure, and control means comprising valve parts arranged to connect a plurality of adjacently disposed sections to said fluid pressure for simultaneous inflation as a group, and means for actuating said valve parts to successively connect additional sections for inflation at one side of said group and at the same time successively disconnect and deflate inflated sections at the other side of the group, whereby translation of the group along the limb in one direction is secured, said group containing at least one inflated section other than those being connected and disconnected, which is retained in connection with said source of fluid pressure.

5. In therapeutic apparatus, a selective fluid pressure distribution and control device comprising a fluid pressure inlet, a plurality of spaced fluid pressure outlets, valve means arranged to simultaneously connect as a group a plurality of adjacently disposed outlets to the inlet, and means for actuating said valve means to successively connect additional outlets at one side of the group to the inlet and disconnect outlets at the other side of the group with respect to the inlet, said group containing at least one outlet, between the outlets being connected and disconnected, which is connected to the inlet.

6. In therapeutic apparatus, a selective fluid pressure distribution and control device comprising a fluid pressure inlet, a plurality of spaced fluid pressure outlets, valve means arranged to simultaneously connect as a group a plurality of adjacently disposed outlets to the inlet, means for actuating said valve means to successively connect additional outlets at one side of the group and disconnect outlets at the other side of the group, said group containing at least one outlet connected to the inlet other than the one being disconnected, and means venting to atmosphere the outlets which are not connected to the inlet.

7. In therapeutic apparatus, a selective fluid pressure distribution and control device comprising a fluid pressure inlet, a plurality of spaced fluid pressure outlets, valve means arranged to simultaneously connect as a group a plurality of adjacently disposed outlets to the inlet to apply positive pressure to said outlets, and means for actuating said valve means to successively disconnect the outlets at one side of the group with respect to the inlet pressure and vent all the disconnected outlets to atmosphere.

8. Apparatus for treatment of vascular diseases, comprising: a fluid pressure inlet, a plural-

ity of spaced fluid pressure outlets adapted for connection with the respective sections of a pressure applicator, valve means arranged to simultaneously connect as a group a plurality of adjacently disposed outlets to the inlet, means for actuating said valve means to successively connect additional outlets at one side of the group and disconnect outlets at the other side of the group, said group containing at least one outlet connected to the inlet other than the one being disconnected, and means venting to atmosphere the outlets positioned on both sides of the group connected outlets.

9. Apparatus for treatment of vascular diseases, comprising: a fluid pressure inlet, a plurality of spaced fluid pressure outlets adapted for connection with the respective sections of a pressure applicator, continuously rotatable valve means cyclically operable to simultaneously connect as a group a plurality of adjacently disposed outlets to the inlets, and means for actuating said valve means to successively connect additional outlets at one side of the group and disconnect outlets at the other side of the group, said group containing at least one outlet connected to the inlet other than the one being disconnected.

10. Apparatus for treatment of vascular diseases, comprising: a cylinder having a piston rod therein, a plurality of take-off tubes in free communication with the cylinder adapted for connection with the respective sections of a pressure applicator, said cylinder communicating at its ends with atmosphere, piston means positioned in the cylinder carried by said rod, said means having ends separated sufficiently to provide a space adapted to simultaneously connect with a plurality of said take-off tubes, and a pressure supply connection with the space between said ends, whereby selective pressure supply to the tubes connected with said space and the venting to atmosphere of the other tubes is determined.

11. Therapeutic apparatus, comprising: a plurality of successively arranged limb-developing and compressing units, each of said units being pressure expansible inwardly toward the limb to apply a constrictive pressure; supply and exhaust

means for each of said units; a common pressure supply; and repetitiously operable valve control means including a pressure supply port and an atmosphere exhaust port successively connectible with said supply and exhaust means of the units, said pressure supply port being of such extent as to simultaneously supply pressure to a plurality of said units as a group, whereby at least one unit of the group will remain connected to the pressure supply to form a holding pressure as other units are added and removed from the group.

12. Therapeutic apparatus, comprising: a plurality of limb-developing and compressing units, successively arranged and pressure expansible inwardly toward the limb for compression thereof, supply and exhaust means for each of said units, a common pressure supply, and repetitious cyclically operable valve control means including a continuously rotatable valve member having a pressure supply port and an atmosphere exhaust port, successively connectible with said supply and exhaust means of the units, the pressure supply port being arranged to simultaneously maintain at least two of the units connected with said common pressure supply while being disconnected with respect to other of the units, and the exhaust port being arranged for connection with the supply and exhaust means of the units as they are disconnected with respect to the pressure supply port.

HENRY I. POOR.

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Certificate of Correction

Patent No. 2,528,843

November 7, 1950

HENRY I. POOR

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 7, line 44, and column 8, line 14, respectively, for the word "limb-developing" read *limb-enveloping*;

and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of February, A. D. 1951.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.