

Dec. 12, 1950

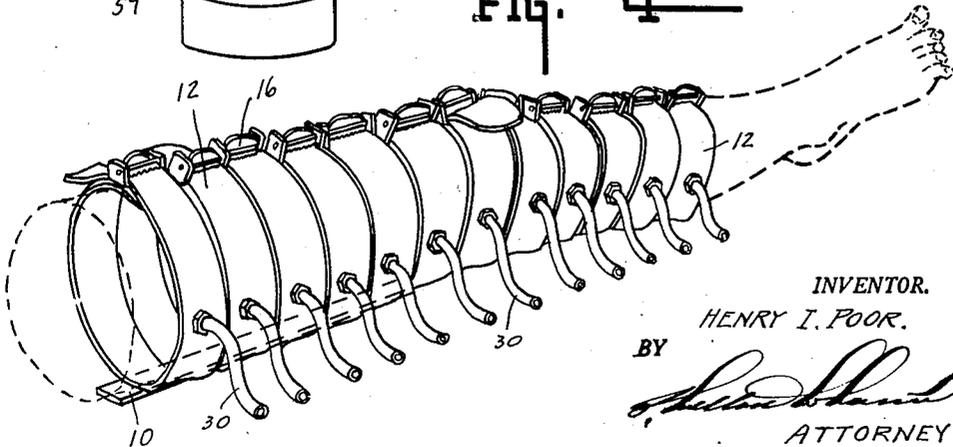
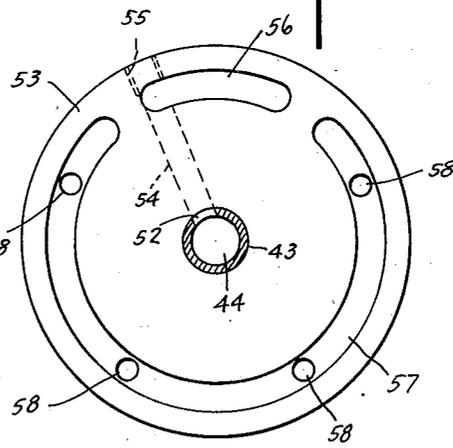
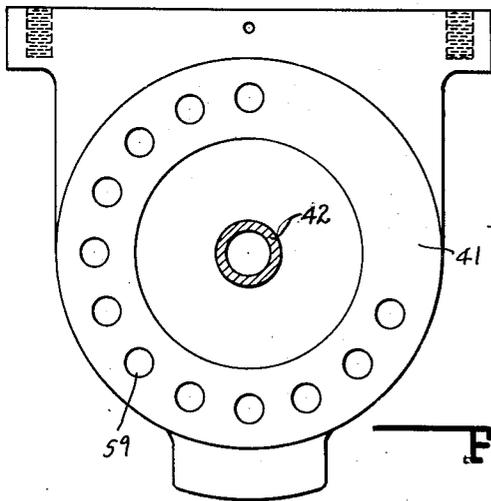
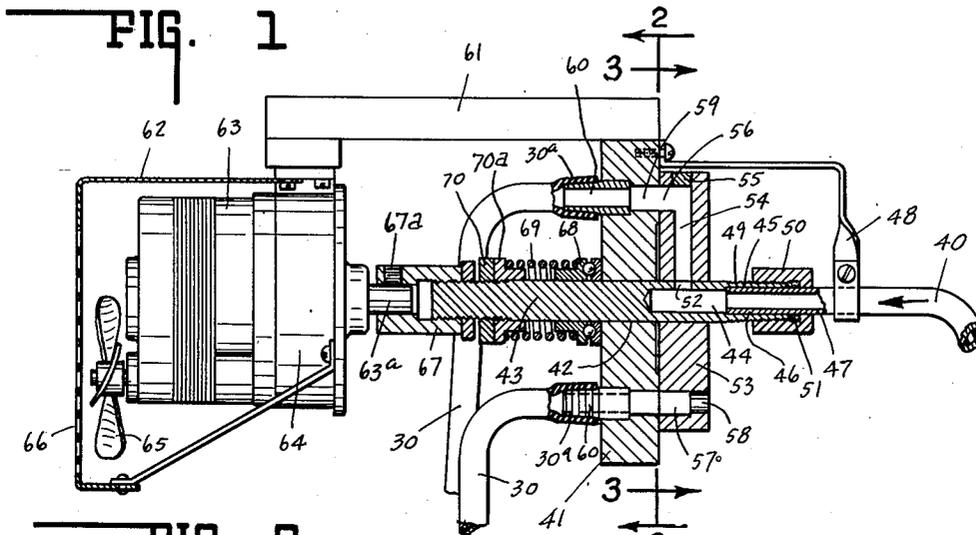
H. I. POOR

2,533,504

THERAPEUTIC APPARATUS

Filed April 19, 1948

3 Sheets-Sheet 1



INVENTOR.  
HENRY I. POOR.  
BY *[Signature]*  
ATTORNEY

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H. I. POOR  
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3 Sheets-Sheet 2

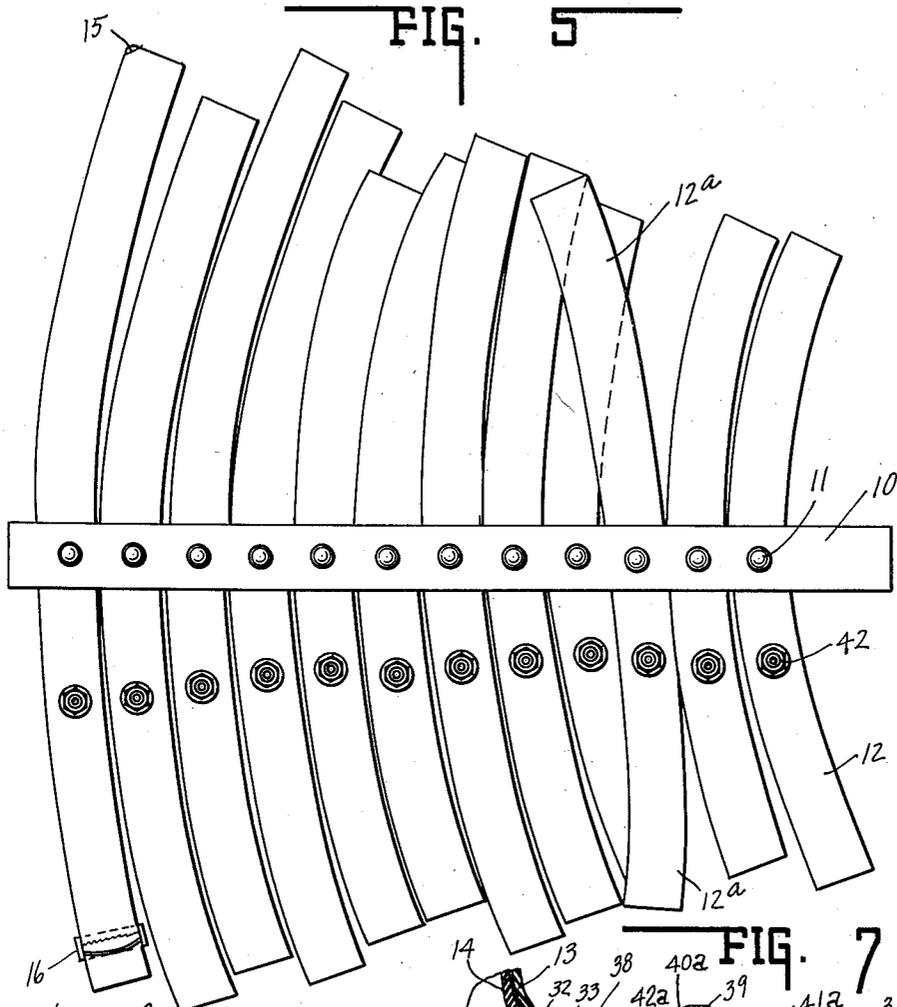


FIG. 6

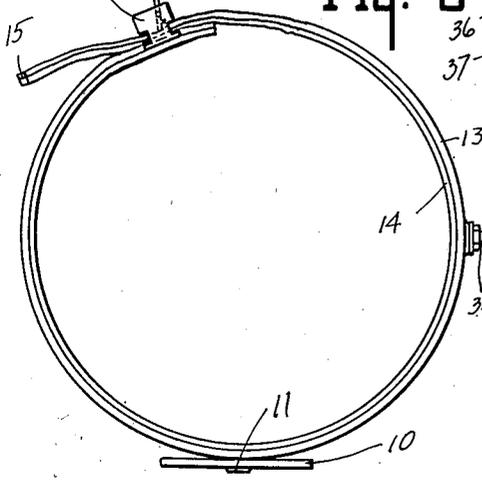


FIG. 7

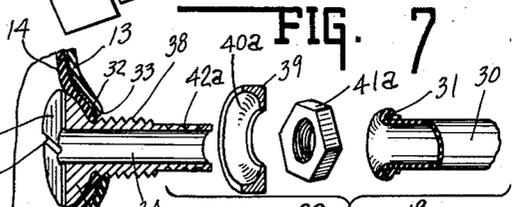
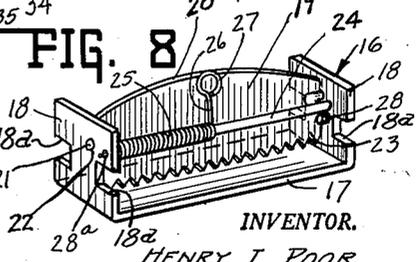


FIG. 8



INVENTOR.  
HENRY I. POOR.  
BY *[Signature]*  
ATTORNEY.

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H. I. POOR

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FIG. 9

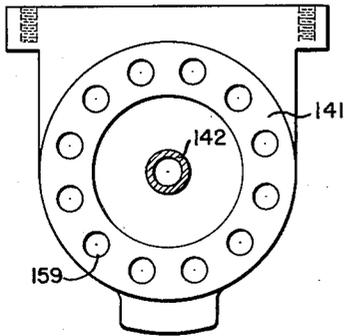


FIG. 10

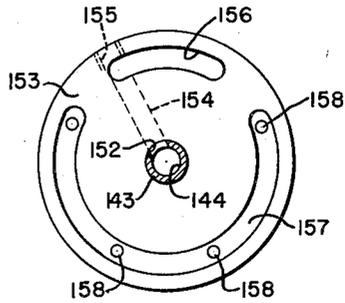


FIG. 12

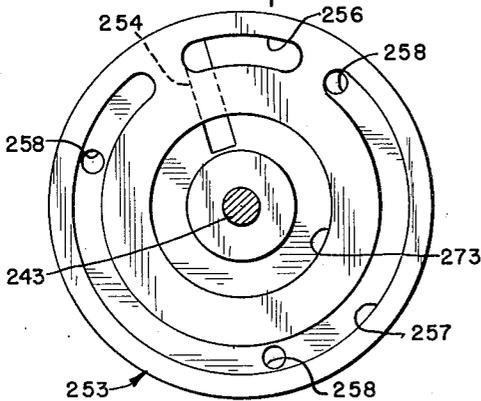
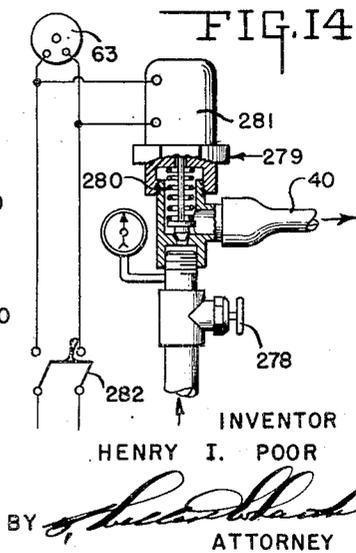
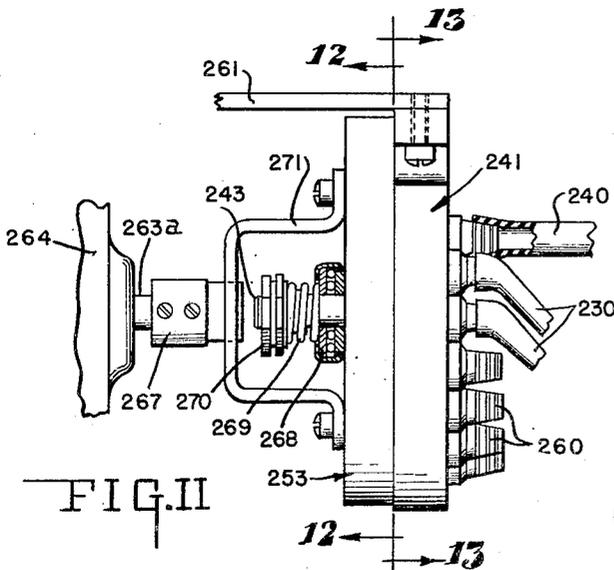
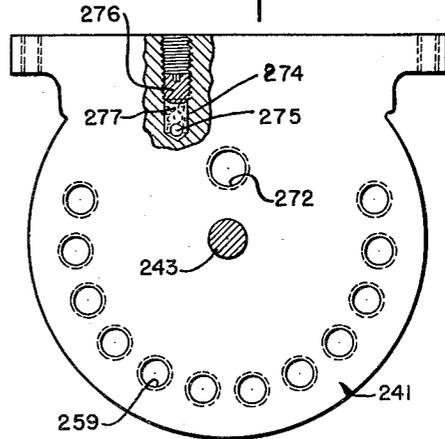


FIG. 13



INVENTOR  
HENRY I. POOR

BY *[Signature]*  
ATTORNEY

# UNITED STATES PATENT OFFICE

2,533,504

## THERAPEUTIC APPARATUS

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

Application April 19, 1948, Serial No. 21,769

7 Claims. (Cl. 128—24)

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The present invention relates generally to therapeutic apparatus 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.

The present application constitutes a continuation-in-part of my application entitled "Apparatus for the Treatment of Intermittent Claudication," Serial No. 632,907, filed December 5, 1945, and now Patent No. 2,528,843, issued November 7, 1950.

It is one object of the present invention to provide improved therapeutic apparatus for carrying out the method disclosed in my aforementioned copending application, namely, the application of a peripherally extending band of constrictive pressure to a portion of the limb to be treated, this band of pressure being translated along the limb by advancing the zone of pressure application, while maintaining and at no time releasing the constrictive pressure during such translation until the end of the treated portion of the limb is reached. At such time, all pressure may be released, and after lapse of a predetermined time interval, another band of constrictive pressure may be applied and translated along the limb portion to repeat the cycle.

A further object of the invention is to provide in therapeutic apparatus of the character described herein, a sectionalized applicator unit of improved construction, which may be applied to the limb portion to be treated, the sections being so formed that they may be quickly and easily varied as to effective length, and are so constructed as to conform to different portions of the limb in such a way as to prevent tendency to crawl or creep along the limb as a result of inflation and deflation during operation.

A still further object of the invention is to provide in connection with therapeutic apparatus, improved control and distribution means of simplified construction for utilization with the applicator unit, and by means of which the inflation of its sections may be accomplished in accordance with the previously mentioned method in a cyclic manner.

Further objects of the invention will be brought out in the following part of the specification, wherein detailed description is for the

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purpose of fully disclosing preferred embodiments of the invention without placing limitations on the scope of the invention defined in the appended claims.

Referring to the drawings, which are for illustrative purposes only:

Fig. 1 is a longitudinal axial sectional view of the fluid pressure control and distribution unit of the present invention;

Figs. 2 and 3 are transverse sectional views through the same, taken substantially on lines 2—2 and 3—3, respectively, of Fig. 1;

Fig. 4 is a perspective view of the applicator unit of the invention, illustrating the manner in which the applicator sections are secured in limb enveloping positions on the limb to be treated, the limb being shown in dotted lines;

Fig. 5 is a plan view of the applicator unit as it appears when detached from the limb being treated, the applicator sections being longitudinally extended;

Fig. 6 is an end elevational view of one of the applicator sections with its ends overlapping and secured by clamping means;

Fig. 7 is an exploded view of the parts constituting the fluid supply connection to an applicator section, certain of the parts being shown in section to disclose pertinent details of construction;

Fig. 8 is a perspective view of a clamp such as used for securing the ends of each applicator section in overlapping relation;

Figs. 9 and 10 are views similar to Figs. 2 and 3, showing in reduced scale a modified arrangement;

Fig. 11 is a side elevational view of a fluid pressure control and distribution unit of modified construction embodying the features of the present invention;

Figs. 12 and 13 are transverse sectional views through the same, taken substantially on lines 12—12 and 13—13 respectively; and

Fig. 14 is a view schematically illustrating the safety cut-off and control for the fluid pressure supply source.

The therapeutic apparatus of the present invention consists primarily of two cooperatively associated units, namely, a fluid pressure control and distribution unit as exemplified by the illustration in Fig. 1 of the drawings, and an applicator unit such as exemplified by the illustration in Fig. 4 of the drawings.

It is believed that the invention will be more clearly understood if the applicator unit is first considered. As generally illustrated in Figs. 4 to

8 inclusive, the applicator unit as shown in Fig. 4 is illustrated as enveloping a portion of a human limb, in this case, a leg, which is to be treated, the limb being shown in dotted lines.

Structurally, the applicator unit includes an elongate base member 19 of suitable material and length, depending upon the limb to be treated. This base member forms a unitary or common support to which there is secured by means of complementary snap connectors 11 a plurality of inflatable and deflatable sections 12. As thus supported, these sections extend transversely of the base member and are disposed in side-by-side relationship.

As shown in Fig. 5, the sections when extended from the base member as shown are laterally curved lengthwise between their ends, and one or more of the sections as illustrated by section 12a may be disposed in a reversed curved relation to the other sections. By constructing the sections with a curvature as described, these sections, when secured around a limb having a generally tapering exterior, will more properly conform to the outer surface thereof and will be prevented from crawling or creeping along the limb upon being inflated and deflated during treating of the limb. Moreover, the sections may be made of any desired length, and the number may be increased or decreased as found necessary to adapt it for treatment of a specific limb.

Each of the inflatable sections of the applicator unit includes a base strip 13 of somewhat rigid, but flexible material, upon which there is secured along one surface thereof, as by vulcanization or the like, an elongate tube 14 of suitable expansible material. This tube is closed at one end and open at its other. If desired, the tube may be closed at both ends and a corner of one closed end severed or cut to provide an opening 15 as shown in Figs. 5 and 6, which will connect the interior of the tube with atmosphere.

In order to provide for adjustment of each section so as to fit the adjacent portion of the limb which is being treated, a clamp 15 is provided for clampingly securing the ends of the respective sections in overlapping engagement, as shown in Fig. 6. As shown in Fig. 8, the clamp is shown as comprising a U-shaped base member having a portion 17 which interconnects in spaced relation deflected parallel end portions 18—18. The portion 17, as shown in Fig. 6, is anchored at one end of a section 12 by securing it between the base strip 13 and tube 14 with the end portions 18—18 respectively extending along the side edges of the base strip.

A clamping member 19 in the form of a plate is shaped to provide an arched edge 20 along one side and is provided with oppositely projecting aligned end pin portions 21 adapted to extend into openings 22 in the end portions 18—18 and form a pivotal support for the clamping member. The edge opposite the arched edge 20 of the plate is serrated, this edge being provided with a plurality of teeth 23.

With the clamping member supported as described above, it may be pivotally rotated so as to move the serrated edge toward and away from the portion 17 of the base or into clamped and unclamped relation therewith. Provision is made for normally actuating the clamping member 19 to a clamped position by supporting a member 24 at its ends in the end portions 18—18 so as to extend transversely therebetween in parallel relation to the pivotal axis of the clamping member. A spring 25 is coiled about one end of the

member 24, one end of this spring being anchored to an adjacent end portion 16, as indicated at 29a, and the other end of the spring being formed as an extension 26 which is terminated as an end loop 27 adapted to bear against the clamping member adjacent its arched edge 20.

The action of the spring 25 is such that it will bias the clamping member 19 toward clamped position. Movement of the clamping member toward clamped position is limited by a stop pin 28 supported on an adjacent end portion 16. When the free end or open end of an associated section is passed between the clamping member 19 and the portion of the section overlying the portion 17, the base strip 13 of the free end will be engaged by the teeth 23 along the serrated edge so that the material of the expansible tube 14 will be protected and prevented from becoming worn or torn by the teeth of the clamping member.

By utilizing a clamp as heretofore described, the effective lengths of the various sections 12 may be readily adjusted by simply applying pressure on the arched edge 20 of the clamping member so as to tilt it toward unclamped position against the bias of the spring 25. The physician may therefore readily and rapidly adjust the length of each section to the adjacent portion of the limb to be treated. Moreover, by providing edge notches 18a—18a in each end portion of the U-shaped base, adapted to receive the edge margins of an inserted end section, such section may be angularly shifted under the clamping member in such a manner as to permit limited tightening or loosening adjustment of the opposite edges of the sections with respect to the enveloped adjacent limb portion.

Each section of the applicator unit is provided with a fluid connection means for supplying a fluid under pressure to the section, such connection means serving as both inlet and outlet for its associated section during use or treatment. As clearly illustrated in Fig. 7, each section means comprises a tubular stem 34 which is positioned in apertures 32 and 33 of the tube 14 and base strip 13, the tubular stem having a convex shaped head portion 35 positioned within the tube 14. The opposite side of the head portion is formed with a flat face 36 containing one or more grooves 37 communicating at its innermost end with the interior of the stem. The purpose of these grooves is to form a connection with the interior of the tube, even though the opposite wall of the tube may be pressed against the surface 36 of the head. From the head portion, the stem is partially threaded as shown at 38 to a point inwardly spaced from the end of the stem. A concave faced clamp washer 39 is arranged to fit over the stem and is provided with a complementary surface 40a adapted to bear on the outer surface of the base strip 13 and coact with the head portion 35 to clamp the adjacent base strip and tube portion therebetween. A nut 41a is provided for engaging the threaded portion 38 of the stem for effecting the clamping operation. The tip end of the stem is provided with peripheral grooves 42a which are adapted to seatingly receive a ring shaped member 31 surrounding the end portion of a connectible supply tube 36, by means of which fluid supply is carried to the stem.

The fluid pressure control and distribution unit which is utilized for determining the inflation and deflation of the respective sections of the applicator unit and their cyclic operation during treatment will now be described. The inven-

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tion contemplates several arrangements, for accomplishing varied cyclic operations. One embodiment is illustrated in Figs. 1 to 3. In practice, it is contemplated that this unit will be supported upon a portable standard (not shown), and that a fluid pressure of air or other suitable fluid will be conducted to the control and distribution unit from a suitable supply source. For purposes of illustration, a supply line 40 for the regulated fluid pressure is shown in Fig. 1.

In this construction, there is a base plate 41 having a central aperture 42 in which there is rotatably mounted a shaft 43. This shaft at one end is centrally bored as indicated at 44, and has its adjacent end portion provided with an enlarged bore, as indicated at 45, for receiving therein an end portion 46 of a connection fitting 47 of tubular construction adapted to be connected to the supply line 40. This fitting is non-rotatably supported in a bracket 48 mounted on the base plate 41.

The shaft at this end is provided with threads 49 for operative association with a gland nut 50 which contains a ring seal 51. Adjacent its innermost end, the bore 44 is provided with an outlet 52 which is in communication with a radially extending bore passage 54 in a control plate 53 carried by the shaft. At the periphery of the control plate, the radial bore portion is closed by a plug 55.

As shown in Figs. 2 and 3, the base plate 41 and the control plate 53 have confronting faces in intimate contact and are supported for relative rotational movement. As more clearly shown in Fig. 3, the face of the control plate is provided with a plurality of arcuate slots in end-to-end relation, one of these slots, 56, being of relatively short length, and the other slot, 57, being of relatively greater length. It will be noted that the radial bore passage 54 communicates with slot 56 and slot 57 communicates with a plurality of port openings 58, by means of which the slot 57 is connected with atmosphere. As shown in Fig. 2, the base plate 41 has a plurality of passages 59 opening into its confronting face, these passages corresponding in number to the number of sections 12 of the applicator unit, and being circumferentially spaced equidistant from each other on the same radial axis as the slot 56 and the slot 57.

With the foregoing arrangement, rotation of the shaft 43 will successively move the slots 56 and 57 over the passages 59, fluid pressure being supplied to the passages 59 which are in connection or communication with slot 57, and those passages 59 which are in communication with slot 56 being vented to atmosphere.

It will be observed that the length of slot 57 is such as to be capable of simultaneous communication with a plurality of passages 59, and in the arrangement illustrated in Figs. 2 and 3, the slot 57 is of sufficient length to extend over these passages 59. Each passage 59 communicates with a connection nipple 60, whereby each passage 59 may be connected through an individual supply tube 30 with one of the sections 12 of the applicator unit.

With the arrangement shown in Fig. 2, the passages 59 are discontinued for a portion of their mounting circle, so that there will be a considerable interval between two of the passages in which there will be no passage communicating with slot 56 during rotation of control plate 53. Thus, it will be apparent that as the slot 56 is moved from this interval, the first three passages

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59 will be successively connected to the fluid pressure, all three being simultaneously connected to the fluid pressure supply. Consequently, the first three sections of the applicator unit will be inflated.

As relative rotation is continued between the control plate and base plate, passages 59 will be successively connected with the slot 56 in the direction of rotation and successively disconnected in the opposite direction, but at least one tube will remain connected and inflated at all times, so as to apply a holding pressure. This holding pressure is constantly maintained, but is translated or advanced along the sections of the applicator and the limb being treated.

This continues until the slot 56 starts moving into the space interval, at which time the last passages 59 will be successively disconnected from communication with the slot 56. Movement of the slot 56 over the space interval will form a dwell period, during which there will be no fluid pressure supplied to the sections of the applicator unit. At the end of this dwell period, the cycle will be repeated. The passages 59 which are not in communication with slot 56 will be in communication with slot 57, and thus vented to atmosphere, so that these sections will be deflated.

In certain cases of treatment, it may be desirable to utilize a cyclic translation of constrictive pressure from one end of the limb being treated to the other, the cycle being immediately commenced upon completion without an inactive or dwell period between each cycle as previously explained. In such cases, the fluid pressure control and distribution unit may be modified as shown in Figs. 9 and 10, wherein similar parts are designated by similar numerals of the 100 series. In this arrangement, the space interval has been eliminated and the passages 159 are shown as being circumferentially spaced at equal distance throughout their mounting circle. The slot 156 is therefore extended in length and slot 157 shortened accordingly.

As further shown in Fig. 1, the plate 41 is connected with a bracket member 61 which forms a support from which a casing 62 and motor 63 connected to a reduction drive 64 are supported in outboard relation to the plate 41. A fan 65 driven by the motor provides a circulation of cooling air, the casing 62 being provided with apertures 66 for the passage of air.

The reduction drive operates through a slot speed shaft 63a which is connected with a coupling 67 by means of a set screw 67a. This coupling is connected in any suitable manner to the shaft 43.

Provision is made for maintaining the confronting faces of base plate 41 and control plate 53 in pressure engagement. This is accomplished by means of a thrust bearing 68 which is biased by an expansion coiled spring 69 in a direction toward the base plate 41. The effective force of the spring 69 is adjustable through a nut 70 having threaded connection with the shaft 43 and bearing against a collar 70a interposed between the nut and adjacent end of the spring 69.

A fluid pressure control and distribution unit of different modified structure is disclosed in Figs. 11, 12 and 13, similar parts being designated by similar numerals in the 200 series. In this arrangement, it will be noted that the base plate 241 and control plate 253 are reversed with respect to the motor 263. This places all the connections for the supply tube 240 and connection tubes 230 on the same side and supported from

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the same plate, in this case, base plate 241, which is stationary. The control plate 253 in this case is rotatably mounted on the shaft 243, which is stationary, and anchored in the base plate 241. Connection of the control plate to the driving shaft 263a is accomplished through a U-shaped bracket 271 having its leg ends connected to the control plate and its bridging portion connected to a coupling 267.

Referring to Figs. 12 and 13, the pressure supply tube 249 communicates with a passage 272 in the confronting face of the base plate 241. This passage in turn communicates with an annular continuous slot 273 opening into the confronting face of the control plate 253, and this slot is connected through a radial bore passage 254 with the slot 256.

As further shown in Fig. 13, provision is made for introducing a lubricant to the confronting faces of the base plate and control plate. For such purpose, a lubricant well 274 is drilled or otherwise formed in the base plate 241. This well at its inner end has an opening 275 into the adjacent face of the plate. The outermost end of the well is internally threaded for receiving a plug 276 which may be screwed into the well and utilized to retain a lubricant containing packing 277 therein from which lubricant will seep between the confronting faces of the relatively rotatable base plate and control plate to keep these surfaces lubricated.

As an example of the speed of operation and cycle time for the equipment described herein, it may be stated that a time cycle has been used which required two seconds from the time of initial inflation of the first section of the applicator until the inflation of the last section, the total cycle requiring a time of three seconds to complete. As a general rule, the speed of rotation of the control plate will be slower when a rest period is included between the cycles than when the treatment is given without a rest period. In the first case, a speed of 20 R. P. M. has been used and in the latter, a speed of 30 R. P. M. This difference in speed may be obtained in any suitable way.

As schematically illustrated in Fig. 14, safety cut-off and control is contemplated for the fluid pressure connected to the supply line 40.

More specifically, a suitable fluid source is connected through a manually operable valve 278 with the inlet of a normally closed electrically actuated valve 279. This valve is normally biased to closed position by a spring 280, and has its outlet connected with supply line 40. The electrically energizable means 281, which may be a solenoid or other suitable means, is adapted, upon energization, to open the valve and hold it in open position. This means is electrically connected to the energizing circuit of the motor 63 of the control and distribution unit, so that, upon disconnection of the motor by means of control switch 282, the valve will automatically close and cut off the line 40 from the fluid pressure supply source.

I claim as my invention:

1. An inflatable applicator structure adapted to envelop a body portion to be treated, comprising: a flexible strap-like base member; an inflatable tube secured to the base member so as to extend along one surface thereof, said tube being closed at one end and open at the other; means for clampingly securing the ends in overlapped relation; fluid connection means to said tube including a tubular stem extending through the base

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member and having a head portion disposed in the tube, said head portion having a clamping surface on the stem side thereof and a lateral channel on the opposite side connecting with the stem interior; a clamping washer carried by the stem exteriorly of the base member; and a washer engaging nut threaded upon the stem to actuate the washer into clamped cooperation with the head portion.

2. An inflatable applicator structure adapted to envelop a body portion to be treated, comprising: a flexible strap-like base member; an inflatable tube secured to the base member so as to extend along one surface thereof, said tube being closed at one end and open at the other; a U-shaped member secured adjacent the closed end of the tube; a tube clamping member pivoted between the end portions of the U-shaped member, said end portion being so arranged as to permit angular shifting of the inserted open end of the tube under the tube clamping member; and fluid connection means to said tube extending through said base member.

3. An inflatable applicator structure adapted to envelop a body portion to be treated, comprising: a flexible strap-like base member; an inflatable tube secured to the base member so as to extend along one surface thereof, said tube being closed at one end and open at the other; clamping means secured adjacent the closed end of the tube including a pivotally mounted clamping member; means normally biasing the clamping member toward clamped position; and fluid connection means to said tube extending through said base member.

4. An applicator unit adapted to envelop a body portion to be treated, comprising: an elongate base member; a plurality of laterally curved inflatable sections carried by said member extending substantially transversely thereof in side-by-side relation, each of said sections having a closed end and an open end and at least one of said sections being disposed with its curvature in reversed relation to the other sections; clamping means carried by each section adjacent its closed end adapted to adjustably receive and close the open end of the section, whereby its inflatable length may be varied; and means for independently connecting each section with a fluid pressure source.

5. An applicator unit adapted to envelop a body portion to be treated, comprising: an elongate base member; a plurality of inflatable sections carried by said member extending substantially transversely thereof in side-by-side relation, each of said sections having a closed end and an open end and being laterally curved lengthwise between said ends; clamping means carried by each section adjacent its closed end adapted to adjustably receive and close the open end of the section, whereby its inflatable length may be varied; and means for independently connecting each section with a fluid pressure source.

6. An applicator unit adapted to envelop a body portion to be treated, comprising: a flexible strap forming an elongate base; a plurality of inflatable sections respectively closed at one end and open at the other; complementary snap fastener means detachably connecting the sections to the strap in transversely extending side-by-side relation; clamping means carried by each section adjacent its closed end adapted to adjustably receive and close the open end of the section, whereby its inflatable length may be varied; and means for in-

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dependently connecting each section with a fluid pressure source.

7. An applicator unit adapted to envelop a body portion to be treated, comprising: an elongate base member; a plurality of inflatable sections carried by said member extending substantially transversely thereof in side-by-side relation, each of said sections having a closed end and an open end; clamping means carried by each section adjacent its closed end adapted to adjustably receive and close the open end of the section, where- by its inflatable length may be varied; and means for independently connecting each section with a fluid pressure source.

HENRY I. POOR. 15

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