April 6, 1943. P. L. GINSBERG 2,315,997

VASCULAR EXERCISER

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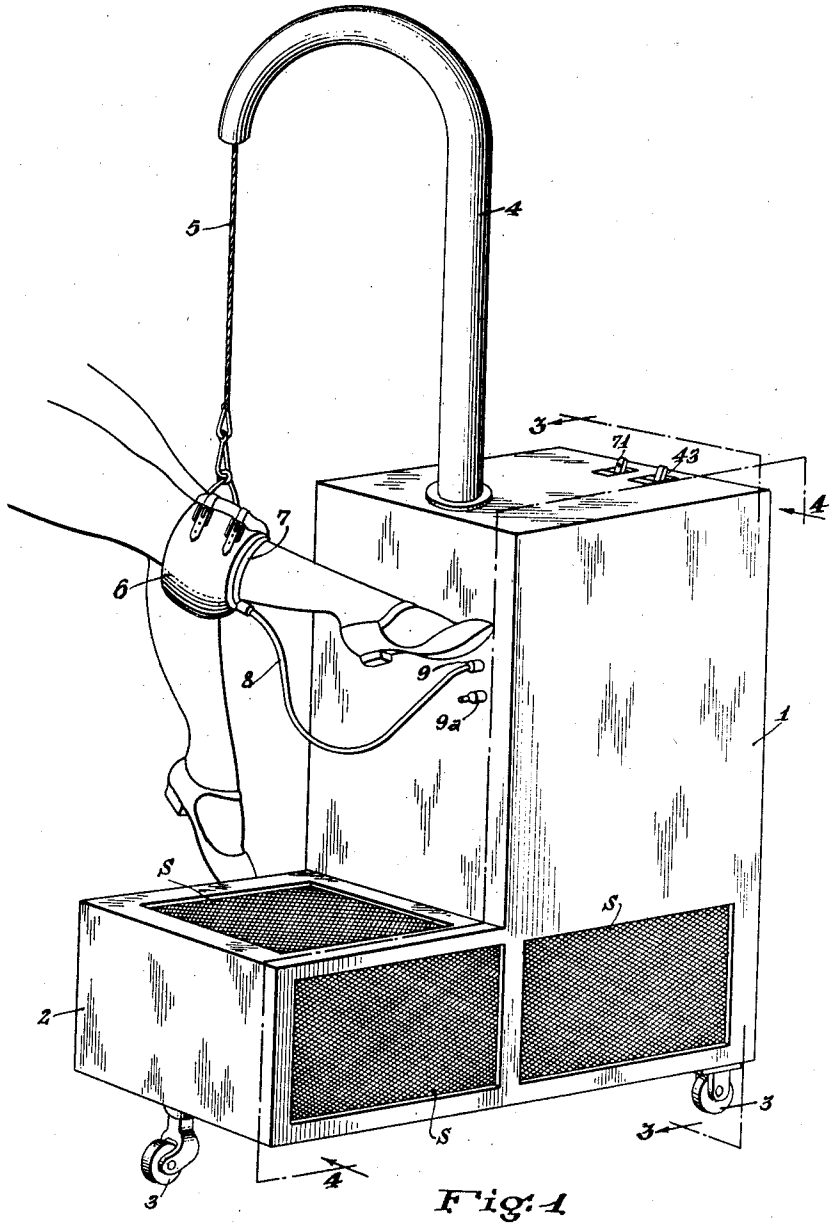


Fig. 1

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VASCULAR EXERCISER

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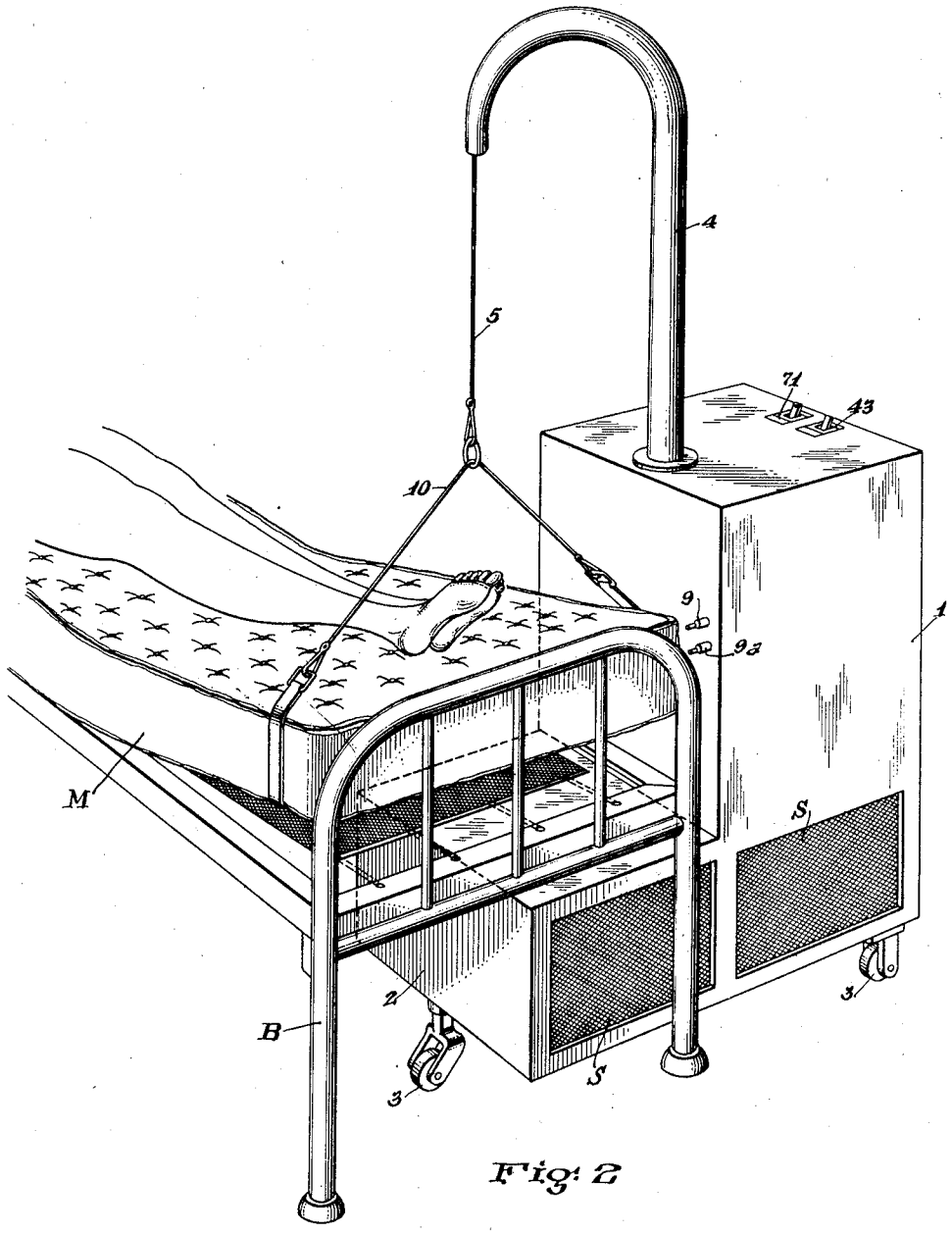


Fig. 2

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VASCULAR EXERCISER

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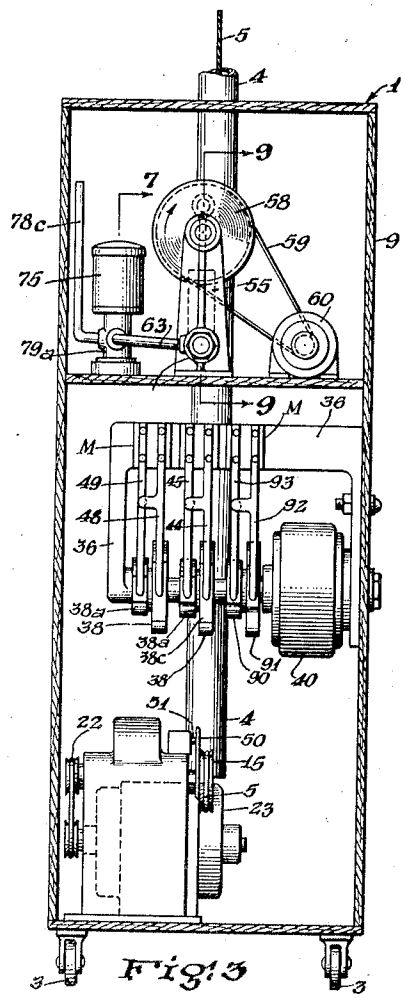


Fig. 3

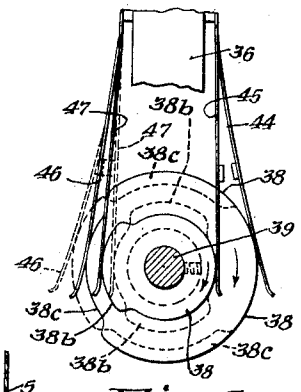


Fig. 5

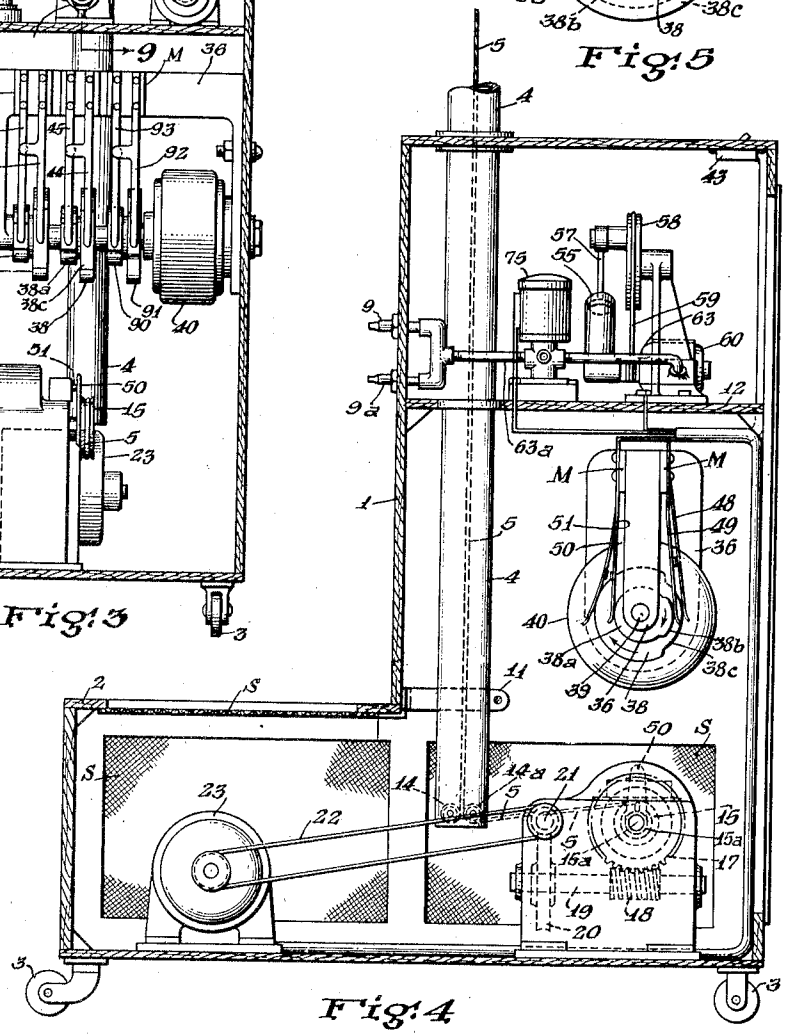


Fig. 4

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VASCULAR EXERCISER

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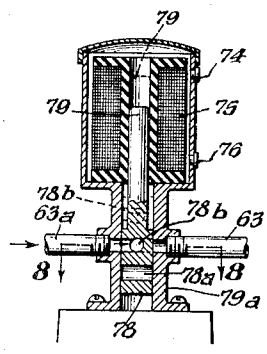


Fig. 7

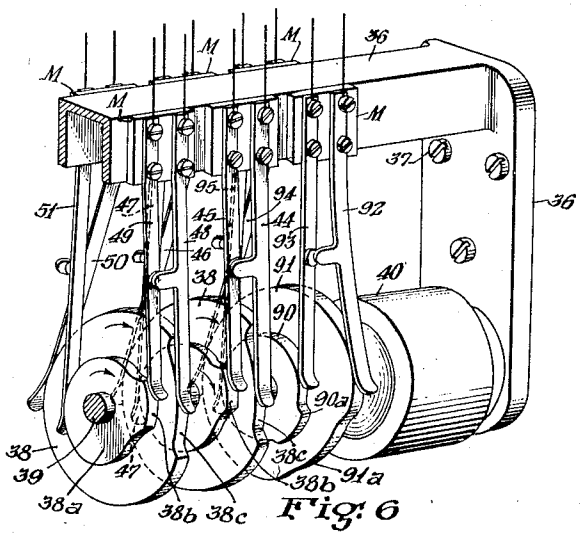


Fig. 6

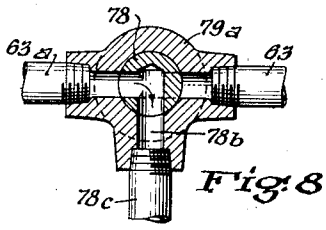


Fig. 8

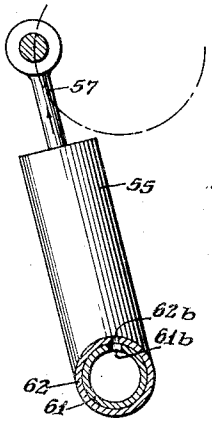


Fig. 11

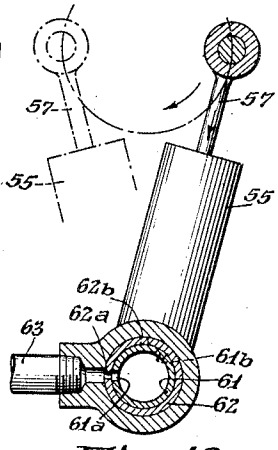


Fig. 10

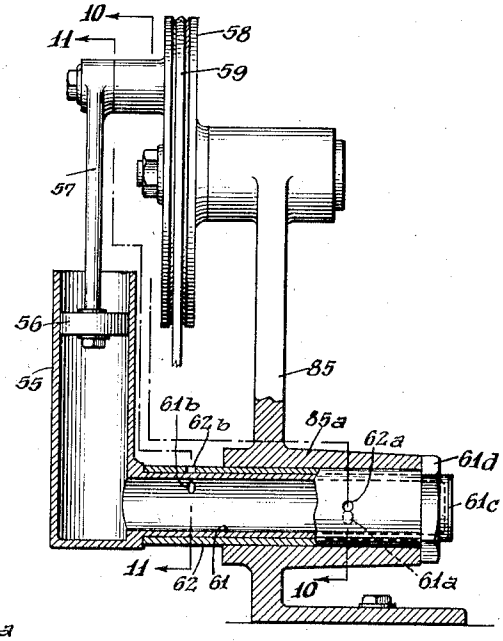


Fig. 9

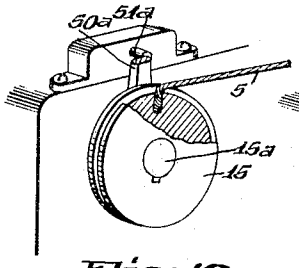


Fig. 12

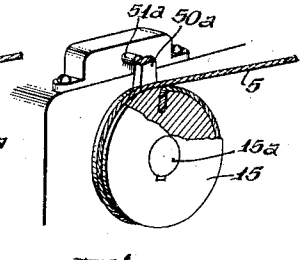


Fig. 13

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VASCULAR EXERCISER

Filed Sept. 26, 1938 5 Sheets-Sheet 5

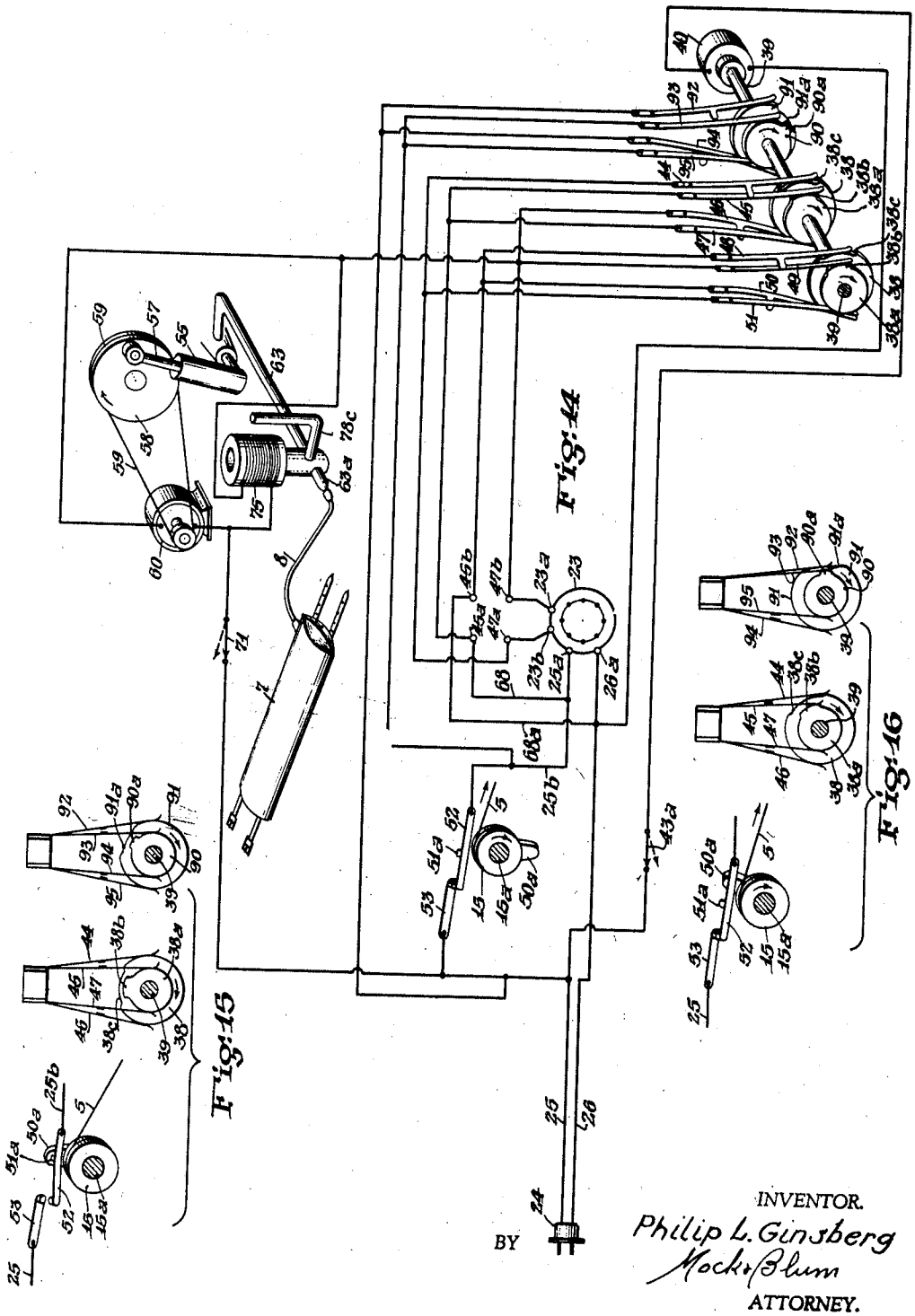


Fig:14

Fig:15

Fig:16

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Patented Apr. 6, 1943 2,315,997

UNITED STATES PATENT OFFICE

2,315,997

VASCULAR EXERCISER

Philip L. Ginsberg, New York, N. Y.

Application September 26, 1938, Serial No. 231,623

6 Claims. (Cl. 128—25)

My invention relates to a new and improved vascular exerciser.

The apparatus is intended to be used in the treatment of circulatory disturbances of the extremities and more particularly of the lower extremities.

The circulatory disturbances above mentioned include thrombo angiitis obliterans, Raynaud's disease, arteriosclerosis affecting the limbs, gangrene due to vascular or thermal disturbances, frost bite, etc.

The apparatus can also be used in treating delayed union of fractures, and it may be used routinely in the course of treatment of fractures. It can be used whenever it is necessary to resort to congestion or exercise of a limb.

Another object of the invention is to provide an improved method for exercising a limb in treating the above mentioned circulatory disturbances, and in all cases whenever the treatment stated herein may be of value.

Other objects of my invention will be set forth in the following description and drawings which illustrate a preferred embodiment thereof, it being understood that the above statement of the objects of my invention is intended generally to explain the same without limiting it in any manner.

Fig. 1 is a perspective view of the apparatus showing it in engagement with a limb.

Fig. 2 is a perspective view showing how the casing of the apparatus may be inserted partially under a bed and showing how a mattress or other support can be actuated, instead of actuating the limb of the patient directly.

Fig. 3 is a sectional view on the line 3—3 of Fig. 1.

Fig. 4 is a sectional view on the line 4—4 of Fig. 1.

Fig. 5 is a detail view showing various positions of the control cams which form a part of the apparatus.

Fig. 6 is a perspective view of the control cams and of their appurtenant parts.

Fig. 7 is a sectional view on the line 7 of Fig. 3.

Fig. 8 is a sectional view on the line 8—8 of Fig. 7.

Fig. 9 is a sectional view on the line 9—9 of Fig. 3.

Figs. 10 and 11 are respectively sections on the lines 10—10 and 11—11 of Fig. 9, showing different positions of the cylinder of the pump which forms a part of the apparatus.

Figs. 12 and 13 respectively show different positions of the drum which actuates the cable which raises or lowers the limb or the mattress, as the case may be. Fig. 12 shows the positions of the pulley and of its control member, when the limb or the mattress is in its bottom position. Fig. 13 shows the positions of these parts, when the limb or mattress is in its top position.

Fig. 14 is a diagrammatic view of the circuit of the apparatus, when the leg or other member is being lowered.

Fig. 15 illustrates certain details of the circuit shown in Fig. 14, when the leg or other element is being maintained stationary in its top position.

Fig. 16 illustrates certain details of the circuit, showing how the circuit of the actuating motor is reestablished after a period of rest.

The apparatus comprises a casing 1 having an extension 2 at the bottom thereof. This casing, including its extension 2, is mounted upon wheels or rollers 3. A curved and hollow standard 4 extends upwardly from the casing 1. A cable 5 extends through this standard, as shown in Fig. 1. The cable 5 is attached to a collar 6, which is provided with an inner inflatable double-walled sleeve 7. This sleeve 7 encircles the limb of the patient. The sleeve 7 can be inflated or deflated by supplying air under pressure to the space between the double walls of said sleeve, or by withdrawing the air from said space, through a pipe 8. Elements 6 and 7 are standard and well known and no particular description thereof is necessary.

The pipe 8 can be made of flexible rubber or the like, and it is connected to a coupling 9. Fig. 1 shows an additional coupling 9*a*, so that more than one patient can be treated by means of the same apparatus. The casing is provided with ventilation screens S, for ventilating the interior thereof. Fig. 2 is identical with Fig. 1, save that in Fig. 2 the cable 5 is connected to a sling 10, which can be placed under and around a mattress or the like, thus making it possible to raise both limbs of the patient. When using the apparatus with the sling illustrated in Fig. 2, the inflatable sleeve 7 need not be utilized, although it may be utilized if desired. Likewise in using the apparatus shown in Fig. 1, the inflatable sleeve 7 may be eliminated and the collar or sling 6 alone may be used for raising and lowering the limb of the patient.

Fig. 2 shows how the extension 2 can be located underneath the bed B, on which the mattress M is located.

As shown in Fig. 4, the standard 4 extends below the top wall of the casing 1. The standard 4 is connected to a wall of the casing 1, by means

of a clamp or bracket 11. As shown in Fig. 4, the casing 1 is provided with a horizontal partition 12, through which the hollow standard 4 extends.

As shown in Fig. 4, the cable 5 passes between a pair of idler guide rolls 14 and 14a which are suitably swivelled to the inner wall of the standard 4. Any suitable numbers of pairs of such idler rolls may be provided at suitable spaced intervals in the hollow standard 4, so as to guide the cable 5 in the curved path which is illustrated. The cable 5 is connected to the drum 15, which is keyed to the shaft 15a. The shaft 15a is provided with a worm wheel 17, which meshes with a worm 18 on the shaft 19. The shaft 15a is provided with suitable bearings (not shown) which are connected to the bottom wall of the casing 1. The shaft 19 is provided with a suitable worm gear 20 which meshes with a worm 21. The shaft of the worm 21 is provided with a pulley, which is driven by means of belt 22, and a pulley on the shaft of the motor 23.

Any conventional reduction gearing may be provided whereby the motor 23, which may be the usual electric motor, can actuate the cable 5 slowly. As later more fully disclosed herein, the shaft 15a is turned back-and-forth intermittently. It is turned a complete revolution, from the position shown in Fig. 12 to the position shown in Fig. 13, in one minute. Therefore the cable 5 and the collar or sling will be raised from its bottom to its top position, through a distance of about one foot, in a period of one minute. The cable 5 will then remain stationary during a period of rest of one minute. The cable will then be lowered to its bottom position during a third period of one minute, and in its bottom position it will have a period of rest of one minute. These periods can be varied as desired.

Therefore, although the shaft 15a turns at the rate of one revolution per minute during the operation thereof, it makes two half-revolutions per two minutes, because of the periods of rest. The shaft 15a is turned in opposite directions during each cycle of four minutes. For this purpose the motor 23 is provided with automatic reversing switch-means as will be later described.

Fig. 14 shows a plug 24 whereby power can be tapped from any suitable power line, which may supply a single-phase alternating current. The invention is not restricted to the type of current or to the type of actuating motor, but for convenience it has been illustrated in connection with the ordinary commercial alternating single-phase current. The motor is the conventional split-phase motor, which has a main stator coil or winding and an auxiliary stator coil or winding.

Wires 25 and 26 are connected to the blades of the plug 24. The wire 26 is connected directly to one of the terminals 26a of the main stator coil of the motor 23. The wire 25 is connected to a switch blade 53 which is associated with another switch blade 52. In Fig. 14 these blades are shown in contact with each other. The switch blade 52 is connected by wire 25b to the other terminal 25a of the main stator coil. The blade 52 is provided with a pin 51a whose function will be later described.

The auxiliary stator coil of the motor 23 has terminals 23a and 23b. The reversing-switch means include stationary switch terminals 45a and 45b, and 47a and 47b. The switch terminals 47a and 47b are respectively connected to the coil-terminals 23b and 23a of the auxiliary stator coil. The switch terminal 45a is connected by wire 68 to wire 25b, and the switch terminal 45b is connected by wire 68a to wire 26 so that the auxiliary stator coil is in shunt with the main stator coil in the well-known manner. The means for automatically reversing the direction of movement of the motor 23 include four pairs of switch blades 44 and 45, 46 and 47, 48 and 49, 50 and 51. The switch blades 45, 47, 49 and 51 are identical, and the blades 44, 46, 48 and 50 are identical. These blades are made of resilient metal. Each of the blades 44, 46, 48 and 50 is provided with an offset whereby said blades can respectively contact with their associated blades 45, 47, 49 and 51. In Fig. 14 the blades 44 and 45 are in contact, the blades 46 and 47 are separated from each other, the blades 48 and 49 are in contact, and the blades 50 and 51 are separated from each other.

As shown in Fig. 6, each said pair of blades is connected by means of a mount M, which is made of insulating material, to a bracket 36 which is suitably connected to one of the walls of the casing by screws 37. The four pairs of blades above mentioned are controlled by cams 38 and 38a which are located upon the cam shaft 39. The two cams 38a are identical, and the two cams 38 are also identical. Each of the cams 38a has a nose or projection 38b and each of the cams 38 has an aligned recess 38c. When the blade 45 (for example) is moved away from its normal position by means of the nose of its associated cam 38a, the companion blade 44 is allowed to move towards its associated blade 45 by the corresponding recess 38c, so that said blade will then contact with the other blade of the respective pair. In Fig. 5, blades 44 and 45 are separated. The full-line positions of blades 46 and 47 show them separated, and the broken-line positions show them in contact. The blade 44 is connected to the switch terminal 47a and the blade 45 is connected to the switch terminal 45a. The blade 46 is connected to the switch terminal 47b and the blade 47 is connected to the blade 45 and the switch terminal 45a. The blade 48 is connected to the switch terminal 45b, and the blade 49 is connected to the switch terminal 47b and to blade 46. The blade 50 is connected to the switch terminal 45b and to blade 48, and the blade 51 is connected to the switch terminal 47a and to blade 44.

When the parts are in the positions shown in Figs. 4 and 14, the circuit of the auxiliary stator coil is closed as follows:

25—53—52—25b—68—45a—45—44—47a—23b through the auxiliary coil to 23a—47b—49—48—45b—68a—26.

The direction of turning of the motor 23 is reversed when the direction of the current through the auxiliary stator coil is reversed. When the parts are in the positions shown in Figs. 4 and 14, the motor 23 is being operated so as to lower the limb. The cam shaft 39 is turned continuously by motor 40 in the same direction when switch 43a is closed, so that said cam shaft 39 makes one revolution in four minutes. During the period of one minute, the switch blades will be maintained in the positions shown in Fig. 14, so that during said period of one minute the motor 23 operates continuously to lower the limb. At the end of said period of one minute, cam shaft 39 has been turned 90° from the position shown in Fig. 4. During the next period of one minute, and while cam shaft 39 is turning 90°, the respective pairs of blades 44 and 45, 46 and 47, 48 and 49, 50 and 51, will

be out of contact with each other. The circuit of the motor **23** will therefore be broken during this period of rest of one minute, so that the limb will remain at rest in its bottom position. During the next period of one minute, the pairs of cams **38** and **38***a* will operate to separate the blades **44** and **45**, to cause the blades **46** and **47** to contact with each other, to separate the blades **48** and **49**, and to cause the blades **50** and **51** to contact with each other. This contacting position of blades **46** and **47** is shown in full lines at the left-hand side of Fig. 5.

The circuit of the auxiliary coil will then be closed as follows:

25—53—52—25*b*—**68—45***a*—**47—46—47***b*—**23***a* through the auxiliary coil to **23***b*, thus reversing the direction of the current through the auxiliary coil—**47***a*—**51—50—45***b*—**68***a*—**26**.

During the last minute of the period of revolution of the shaft **39**, the four pairs of blades will be respectively out of contact with each other, thus breaking the circuit of the motor **23**, and retaining the limb in its top position for a period of one minute.

The blades **52** and **53** provide additional means for controlling the cycle of operation, as for some purposes the control which is provided by the four pairs of switch blades may not be sufficiently delicate.

The drum **15** is provided with a cam projection or nose **50***a*, which strikes the pin **51***a* mounted on blade **52** so as to separate the resilient metal switch blade **52** from its companion resilient metal switch blade **53**, at the completion of each intermittent revolution of the shaft **15***a*.

In Figs. 12 and 13 the cam projection **50** is shown in the position in which the switch blade **52** is separated from the switch blade **53**. Fig. 15 shows the blades **53** and **52** separated from each other and the position of the drum **15** corresponds to the top position of the limb. Therefore, at the completion of each complete revolution of the shaft **15***a* in one direction or in the opposite direction, the circuit of the motor is automatically opened at the switch blades **52** and **53**.

The motor **40** for operating the cam shaft **39** is connected in shunt to the wires **25** and **26**. The only control for the motor **40** is the usual hand switch **43***a*, and when this is closed the motor **40** is turned continuously in the same direction.

The cam shaft **39** has additional cams **90** and **91** for reestablishing the circuit of the motor **23**, after the blades **52** and **53** have been separated from each other and when it is desired to start the apparatus again so as to lower the limb from a top position or to raise the limb from a bottom position. The cam **90** has a nose **90***a* and the cam **91** has an aligned cut-away part or recess **91***a*. These cams **90** and **91** cooperate with pairs of switch blades **92** and **93**, and **94** and **95**. The blades **92** and **94** have offsets which are similar to the offsets of the blades **44**, **45**, etc.

In Fig. 14 the respective pairs of blades **92** and **93**, **94** and **95**, are shown separated from each other. The cams **90** and **91** are located angularly with respect to the cams **38** and **38***a* so that said cams **90** and **91** cause the switch blades **92** and **93** to touch each other, after a period of almost a minute has elapsed subsequent to the separation of the switch blades **52** and **53**. That is, after the blades **52** and **53** have been separated from each other, the blades **92** and **93** will touch each other after an interval of about 57 seconds.

Fig. 15 shows the difference in angular alignment between the nose **38***b* of the cam **38***a*, and the nose **90***a* of the cam **90**. Fig. 15 also shows the difference in angular alignment between the recesses **38***c* of the cams **38** and recess **91***a* of cam **91**. When the blades **92** and **93** touch each other, the circuit of the main stator coil is established as follows:

25—92—93—25*b*—**25***a* through the main stator coil to **26***a*—**26**.

A few seconds after the circuit of the main stator winding is established, as above described, and the motor thereby started, the circuit of the auxiliary stator winding becomes closed, so that the motor continues to run even though the circuit of the main stator winding becomes broken by the operation of the cams **90** and **91**. This is clearly shown in Fig. 16. A second or two after the motor has been started, the nose **50***a* is moved so as to permit the blades **52** and **53** to reestablish contact. The blades **52** and **53** are resilient, and they are biased so as normally to contact. The nose **90***a* is smaller than the nose **38***b* so that the blades **92** and **93** are caused to separate from each other shortly after the current through the auxiliary stator coil has been established, and shortly after the blades **53** and **52** have been moved again into contact with each other.

The blades **94** and **95** operate like the blades **92** and **93**, in order to reestablish the circuit of the motor, after the limb has remained stationary in its bottom position.

The machine has a pump which has a cylinder **55** and a piston **56**. The piston **56** is connected by means of the usual link **57** to a crank disc **58** which is driven by a belt **59** from a third motor **60**. The cylinder **55** is provided with a sleeve **61** which serves as an intake and an outlet under the control of a sleeve-valve **62**. The sleeve-valve **62** is stationary and the sleeve **61** oscillates relative to the sleeve-valve **62**.

As shown in Figs. 9, 10 and 11, the sleeve **61** and sleeve-valve **62** are provided with pairs of cooperating ports **61***a* and **62***a*, and **61***b* and **62***b*. The ports **61***b* and **62***b* are the intake ports, and the ports **61***a* and **62***a* are the outlet ports. The sleeve **61** has a closed outer end which is provided with an external thread **61***c*, and said sleeve **61** is held by the nut **61***d* for free oscillation relative to the sleeve-valve **62**. The sleeve-valve **62** is held stationary in the sleeve **85***a* of a bracket **85**.

When the crank disc **58** turns in the direction of the arrow which is shown in Fig. 14 and also in Fig. 10, the pump cylinder **55** and its integral sleeve **61** are oscillated and piston **56** is reciprocated by means of link **57**. The full line position of the cylinder **55** which is shown in Fig. 10, corresponds to the output stroke in which compressed air is supplied to member **7**, while the limb is being lowered. At the completion of each outlet stroke, the ports **62***a* and **61***a* register so that compressed air is forced out through the pipe **63** which is controlled by a solenoid-controlled valve **78**. The piston **56** reciprocates many times while the limb is being lowered. When this solenoid-controlled valve **78** is in the open position, the compressed air is delivered to the elastic double-walled sleeve **7**. When the cylinder **55** is in the broken line position shown in Fig. 10, which corresponds to the position shown in Fig. 11, the piston **56** is being moved upwardly

on its suction stroke, during which time air enters the cylinder through the registering ports 61*b* and 62*b*.

As shown in Fig. 14, the motor **60**, which operates the pump, has one of its terminals connected through a hand-operated switch **71**, to the wire **25**. The other terminal is connected to the blade **49** so that the circuit of motor **60** is broken during the period in which the blades **48** and **49** are separated from each other. Therefore the motor **60** operates continuously during one-quarter of the revolution of the cam shaft **39** and while the motor **23** is lowering the limb from its top position to its bottom position.

The solenoid **75** has one terminal thereof which can be connected through switch **71** to the wire **25**. The other terminal of said solenoid is connected to the blade **49**. Therefore the solenoid **75** is energized so as to connect the pipe lines **63** and **63***a* to each other, only during the period in which the limb is being lowered from its top position to its bottom position.

As shown in Figs. 7 and 8, the solenoid **75** has a plunger **79** whose top and bottom positions are shown in broken lines and in full lines in Fig. 7. Fig. 7 also shows the buttons **74** and **76** which are connected to the ends of the coil of the solenoid. The valve **78** is integral with or it is suitably connected to the plunger **79** so that said valve **78** slides vertically in the housing **79***a*. Said valve **78** has an angular port **78***b* and an additional port **78***a* which is located below the port **78***b*. The axis of the port **78***a* is a straight line which is parallel to the common axis of the pipe members **63** and **63***a*. When the plunger **79** is in its lower position, the angular port **78***b* is aligned with the pipe member **63***a* and with an exhaust outlet **78***c* which is connected to the valve housing **79***a*. When the plunger **79** is in its upper broken line position, the axis of the port **78***a* is aligned with the common axis of the pipe members **63** and **63***a* so that compressed air can pass through said pipe members to the member **7**.

It is obvious that the device can operate with the use of direct current.

Therefore, while the limb or other part of the human body is being lowered from its top position to its bottom position, the pipe lines **63** and **63***a* are connected to each other and the pump is operated continuously so as to increase the air pressure upon the limb gradually during the lowering thereof.

When the limb has reached its bottom position, the circuit of the motor **60** is opened and the circuit of the solenoid **75** is opened, so that the compressed air is rapidly exhausted from the sleeve **7** and the pressure on the limb is thus reduced to ordinary atmospheric pressure in a very short time. The limb is therefore maintained in its bottom position without any substantial pressure thereon, practically during the entire period of rest of one minute. The limb is then raised from its bottom position to its top position while the circuit of the motor **60** is opened and the limb is then maintained stationary in its top position, without any pressure being exerted thereon, save for normal atmospheric pressure.

It is obvious that numerous changes and omissions could be made from the embodiment illustrated herein without departing from the spirit of the invention, and that the complete embodiment illustrated contains numerous valuable sub-combinations which can be used in other types of machines. Likewise the method stated herein can be practiced by means of mechanisms which differ widely from the complete automatic mechanism illustrated herein.

The switch means illustarted may be made in one or more units and the design can be greatly varied in this respect from the specific design disclosed herein.

Whenever I refer to cams or cam-means in the claims herein I include all mechanisms having an equivalent action. If the source of power is a direct current, the connections to a direct current motor, in order to secure the results stated herein, can be readily made by any skilled person.

Likewise while I have shown a system whereby the operation is secured wholly by regulating a circuit of an electric motor, the invention is not limited to this system because the same results could be secured by using mechanical means such as clutches, reversing-gear means. The invention is therefore not limited to a system which depends wholly upon regulating the circuit of an electric motor.

The action of the control means such as the cams on the shaft **39** and the members **52** and **53**, is to hold the member **5** stationary during a first predetermined period, then to operate said member **5** in a predetermined direction during a second predetermined period, then to hold said member **5** stationary during a third predetermined period, and then to move the member **5** in a direction opposite to said predetermined direction during a fourth predetermined period.

In order to prevent evasion of the principle of the invention, it is stated that if the member **5** is given a relatively slight movement intermediate the main movements thereof instead of holding said member **5** absolutely stationary, such system comes within the scope of the appended claims.

I claim:

1. A method of treating a limb of the human body which consists in raising and lowering the same relative to the body and also maintaining said limbs stationary between consecutive up-and-down movements, while exerting circumferential pressure on said limb substantially only during the lowering of the limb.

2. A method of treating a limb of the human body which consists in raising and lowering the same relative to the body and also maintaining said limb stationary between consecutive up-and-down movements, while exerting circumferential pressure on said limb during the lowering of the same, and gradually increasing said pressure during the lowering movement.

3. A method of treating a limb of the human body which consists in raising and lowering the limb relative to the body and also maintaining said limb stationary between consecutive up-and-down movements, while exerting circumferential pressure on said limb only during the lowering of the same, and releasing the pressure prior to raising the same.

4. A vascular exerciser comprising a motor, first means adapted to raise and to lower a portion of the human body, actuating means connected to said first means, an electric motor connected to said actuating means and adapted to operate the same, the circuit of said motor having switch means constructed to open and to close said circuit and also to reverse said motor, mechanism operated in unison with said motor and constructed to actuate said switch means to hold said circuit open for a first predetermined

period, then to close the circuit of the motor during a second predetermined period, then to open the circuit of the motor for a third predetermined period and then to close the circuit of the motor and to reverse the motor during a fourth predetermined period.

5. A vascular exerciser comprising first means adapted to raise and to lower a portion of the human body, a flexible member connected to said first means, a drum to which said flexible member is connected, said drum being turnable back-and-forth, so as to wind the flexible member thereon and also to unwind the flexible member therefrom, an electric motor connected to said drum and adapted to turn the same, a cam shaft having cam-means thereon, switch blades associated with said cam-means, said cam-means being shaped and located to actuate said switch blades so as to open the circuit of the motor during a first predetermined period, then close the circuit of the motor during a second predetermined period, then open the circuit of the motor during a third predetermined period and then to close the circuit of the motor and to reverse the same during a fourth predetermined period, whereby said drum is alternately turned back-and-forth and said drum is held stationary intermediate the actuations thereof.

6. Mechanism according to claim 5, including an auxiliary switch for the circuit of said electric motor, said drum having a cam member adapted to open said switch shortly before the termination of the second period and of the fourth period.

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