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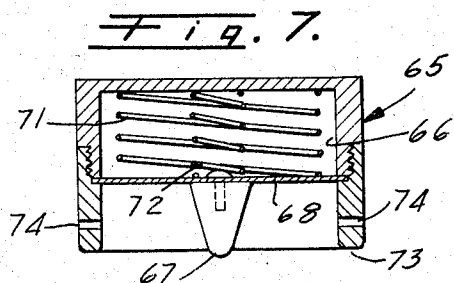
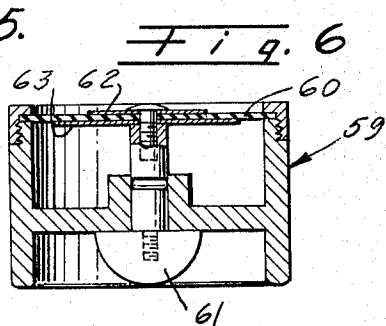
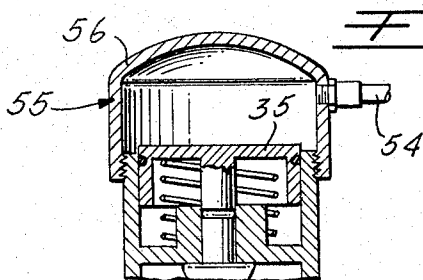
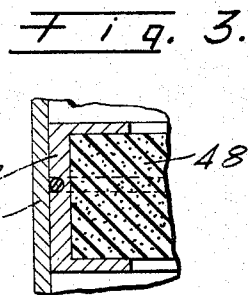
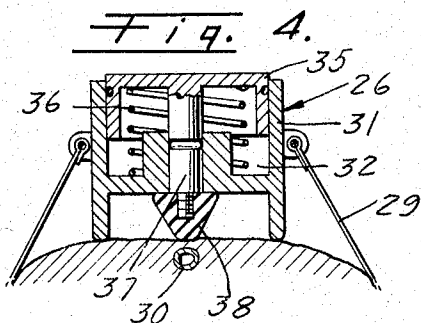
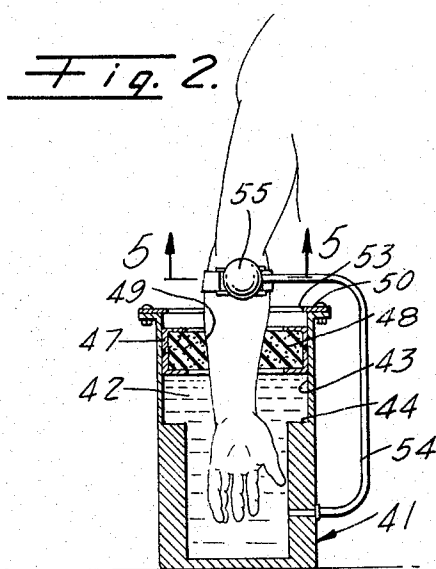
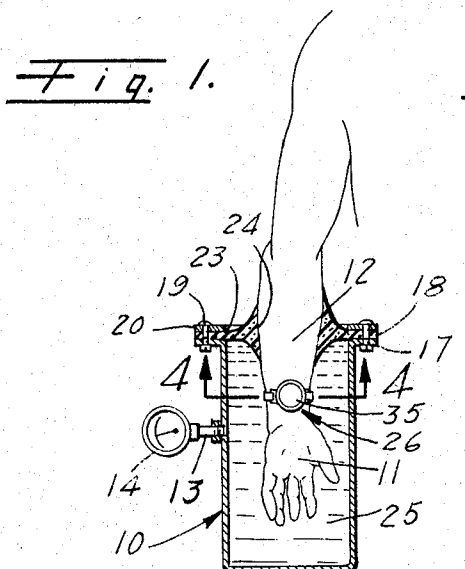
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3,286,711

MEANS AND METHOD FOR SELF-PRESSURE CYCLING OF LIMBS

TO IMPROVE BLOOD CIRCULATION

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3,286,711

## MEANS AND METHOD FOR SELF-PRESSURE CYCLING OF LIMBS TO IMPROVE BLOOD CIRCULATION

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7 Claims. (Cl. 128-40)

This invention relates to a method and apparatus for improving the circulation of fluids within the limbs of the human body, and more particularly, relates to a method and apparatus for self-pressure cycling of limbs to improve the blood circulation therein.

In my U.S. Letters Patent No. 3,094,983 for "Blood Circulation Device and Methods", there is shown that mechanical means can be used to produce a rapid series of pressure fluctuations as applied to a limb that was contained in a liquid-filled chamber. Such apparatus and method, as disclosed in the foregoing patent, allow a great amount of work to be done in a short time and the metabolic processes and blood and lymph circulation are benefited thereby.

Further, as described in my co-pending application, entitled "Means and Method for Controlled Pulsatory Flow of Blood to Improve Circulation", Serial No. 289,653, filed June 21, 1963, much greater stimulation of blood circulation is possible when the arterial surge towards the heart, on application of a positive pressure, is reduced or stopped entirely. That is, when there is a localized pressure applied at the well-known arterial pressure points, a which pressure can be applied from the skin surface, the arterial flow is greatly reduced or even entirely stopped downstream of the localized pressure points in the direction away from the heart.

The apparatus disclosed in the foregoing patent and application is relatively expensive and requires treatment at frequent intervals, preferably under a physician's supervision. According to the present invention, there has been developed a small, inexpensive and simple apparatus and method to produce pressure changes in limbs, whereby pressure is changed in a sealed chamber by reciprocal movement of a limb within the sealed chamber. This apparatus is particularly adaptable for arthritic hands and feet. The present invention further includes simple means for occluding the arteries and veins during the pressure changes produced within the sealed chamber.

The present method and apparatus can be used for the arms, foot or leg and the entire lower trunk could be treated under the same principles whereby the hands or legs could be used to raise and lower the body in the chamber.

It is an object of the present invention to provide an improved method and apparatus for improving the blood circulation whereby the person being treated creates pressure changes in a limb by self-cycling by reciprocation of the limb in a sealed chamber.

It is another object of the present invention to provide a method and means to provide positive pressure pulses to a limb by the movement thereof to increase the pressure on the limb within a sealed chamber while an artery or arteries of the limb are occluded.

It is still another object of the present invention to provide means and a method for applying negative pressures to a limb by the movement thereof within a sealed chamber while a major vein or veins are occluded to assist the check valves in the veins.

Further objects and advantages of the invention may be brought out in the following part of the specification wherein small details have been described for the compe-

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tence of disclosure, without intending to limit the invention which is set forth in the appended claims.

Referring to the accompanying drawings which are for illustrative purposes:

FIG. 1 is a side elevational view, partially in cross section, of an apparatus according to the present invention;

FIG. 2 is a view, similar to that shown in FIG. 1, of another embodiment of the invention;

FIG. 3 is a fragmentary, cross sectional view of the sealing means shown in FIG. 2;

FIG. 4 is a cross sectional view, taken as indicated by the line 4-4 in FIG. 1;

FIG. 5 is a cross sectional view, taken as indicated by the line 5-5 in FIG. 2;

FIG. 6 is a fragmentary, cross sectional view of a positive pressure occlusion device, similar to that shown in FIG. 4; and

FIG. 7 is a fragmentary view of a negative pressure occluding device for use on a vein.

Referring again to the drawings, in FIG. 1 there is an elongated chamber 10, of a size to receive a human hand 11, and a substantial part of a forearm 12. Threadedly engaged in an opening of a wall of the chamber is a tube 13 to which is attached a pressure gauge 14, the gauge being adapted to show any pressure variations within the chamber 10.

Extending horizontally outwardly from the upper part of the chamber is a peripheral flange 17. Secured to the flange 17 is a flexible gasket 18. The gasket is held in place by bolts 19 which extend through a peripheral holding member 20, having a central opening 23, and the lower surface of the flange 17. The gasket may be of elastomeric or other suitable flexible material and is formed with an opening 24, outwardly of which the gasket is elongated so as to form a suitable seal on the forearm. When the forearm is tightly placed within opening 24 and the hand is within the chamber, the latter is sealed.

Prior to the time that the hand is inserted into the chamber for treatment, the chamber is substantially filled with warm or hot water so that the hand will receive the benefit of the heat. The arm and hand is then inserted into the gasket, which is secured to the chamber so as to seal it. At the time that the hand is placed within the chamber and water, the chamber should be filled so that the water makes contact with the inner surfaces of the gasket 18. An excess of water, which may become evident as the hand is inserted into the chamber, can be drained off over the top or removed through a valve which may be attached to the chamber. Further, additional water, if necessary, could be added through the same valve.

In operation, when the arm is moved downwardly and upwardly within the chamber, the pressure varies within the chamber from the positive to the negative. Variation of plus and minus 3 pounds per square inch can be readily produced by vigorous arm movement. Since the chamber is filled completely with liquid, any, even a very slight, movement of the gasket 18 varies the pressure of all the liquid in the chamber, and a change in pressure in the chamber liquid causes the same variation in pressure in the liquids within the limb within the chamber. This is particularly true of the blood within the arteries and veins and the change of the pressure of the blood therein causes increased circulation.

In the arteries, applications of positive and negative pressure pulses tend to cause surging of the blood toward and away from the heart. When there is a localized pressure applied at the well-known arterial pressure points, at which pressure can be applied from the skin surface, the

arterial flow downstream of the pressure point during the positive pressure pulse is directed toward the veins by way of the capillaries and thence back to the heart, resulting in enhanced blood flow in the limb.

An occlusion device 26 for the wrist artery or arteries is shown in FIGS. 1 and 4. By means of this device, when a positive pressure pulse is exerted within the chamber, a localized pressure is exerted at the appropriate wrist arterial pressure point, the latter pressure being maintained during the period of the positive pressure pulse within the chamber. This prevents the flow of blood back toward the heart in the artery in question and forces the flow away from the part in the chamber into the capillaries and veins and then back to the heart.

The occlusion device 26 is shown fastened to the wrist by straps 29 in position to occlude one of the wrist arteries. It is comprised of an outer cylindrical member 31, having an air chamber 32 in which is slidably and sealingly engaged a piston 35. The piston is held in a neutral or non-occluding position by means of a coil spring 36. Secured to the piston is a stem 37, slidably and sealingly engaged in an opening in the base closure of the chamber 32. At the end of the stem 37 is a plunger 38, positioned to occlude the artery when pressure is applied to the outer face of the piston.

The artery is thus occluded when a positive pulse is applied to the liquid by the downward movement of the arm and the gasket 18. That is, when the pressure is increased within the chamber, it acts upon the outer face of the piston 35 to move it toward the arm against the force of the spring 36 so as to occlude the artery 30. The result of this is that when the water pressure acts upon the artery in the hand, the blood is forced into the vein and is not permitted to flow backwardly in the artery toward the heart.

When the negative pulse is applied to the chamber by means of moving the arm outwardly, the piston 35 is permitted to move to its neutral position by the action of the spring 36 and is otherwise not affected by the negative pressure.

In FIGS. 2 and 3 another embodiment of the invention is shown in which a chamber 41 is shown filled with water 42. The chamber 41 has an enlarged diameter cylindrical portion 43 which terminates at its lower end at a shoulder 44. Slidably and sealingly engaged in the cylindrical portion 43 is an annular channel shaped member 47, forming a piston along with an elastomeric sealing member 48, having an inner opening 49 in which the arm is sealingly fitted. An annular flange 50 having an opening 53 is secured to the top of the chamber and limits the upward movement of the piston and the elastomeric member 48.

As shown in FIGS. 2 and 5, there is connected to the interior of the chamber 41, a tube 54 which has its upper end connected to an occlusion device 55, shown on the arm in position to occlude an artery. The device 55 is substantially identical with the occlusion device 26 except that it has a cap 56 over the piston 35 whereby pressure is transmitted from the chamber to the face of the piston. The device 55 operates in the same way as the device 26 except that by means of the tube 54 it is permitted to be applied to an artery higher on the arm. When the chamber 41 is filled, the tube 54 must also be filled so that any increase in pressure, resulting from the downward movement of the arm within the channel 47 and the seal 48, is applied to the face of the piston 35 to occlude the artery.

Another type of occluding device 59 is shown in FIG. 6 and this may be substituted for either the device 26 or the device 55. Instead of a piston, here there is a flexible and resilient diaphragm 60, supported by metal plates 62 and 63. The diaphragm is shown in its neutral position, and when pressure is applied to the outer surface of the diaphragm and to the plate 62, the plunger is moved toward the artery. When the pressure is re-

duced or removed, the diaphragm returns to its neutral position.

In FIG. 7 there is shown a vein occluding device 65 having a generally cylindrical configuration and having a sealed air chamber, 66 formed at its lower end by a flexible, resilient diaphragm 68. In the neutral position shown, the plunger 67 is held, so as to occlude a vein, by a coil spring 72 and is also somewhat assisted in the same direction by the diaphragm 68, held in the neutral position by a coil spring 71. A lower cylindrical edge 73 is adapted to make contact with the limb and passages 74 are provided so that the same liquid pressure that exists outwardly of the edge 73 will also exist inwardly thereof.

When a negative pressure is applied, as in the chambers 10 or 41, the plunger remains in its occluding position on a vein so that if the vein check valves do not function properly blood will not be drawn in the wrong direction away from the heart and towards the capillaries. When a positive pressure is applied within the chamber, as 10 or 41, it acts upon the diaphragm 68 so as to move it upwardly against the force of the springs and so as to thereby move the plunger 67 to open the vein and to permit the blood to flow in the proper direction towards the heart. The vein occluding device 65 is generally for use on the limb of an elderly person whose vein check valves are not operating properly and is used in conjunction with an artery occluding device, such as that shown in FIGS. 4 and 5. As indicated, the vein and artery occluding devices both are operated by positive pressure, in the former the vein being opened and in the latter the artery being closed.

It will be appreciated that muscular movement by a person will not give the very prolonged or rapid movement which is possible with mechanically activated pressure varying devices, as described in my U.S. Patent No. 3,094,983. Nevertheless, the use of a liquid filled chamber is very effective since the pressure variation is produced with a minimum movement of the limb and therefore the pressure can be varied quite rapidly by short rapid limb movements.

The invention and its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the form, construction and arrangement of the parts of the invention without departing from the spirit and scope thereof or sacrificing its material advantages, the arrangement hereinbefore described being merely by way of example. I do not wish to be restricted to the specific form shown or uses mentioned, except as defined in the accompanying claims, wherein various portions have been separated for clarity of reading and not for emphasis.

I claim:

1. A method for self-pressure cycling of limbs to improve blood circulation, comprising:

- (a) placing a part of a limb to be treated in a chamber;
- (b) filling said chamber with a liquid;
- (c) sealing said limb part within said chamber; and
- (d) applying pressure pulses to all of said liquid by reciprocal movements of said limb in said chamber and within said seal.

2. A method for self-pressure cycling of limbs to improve blood circulation, comprising:

- (a) placing a part of a limb to be treated in a chamber;
- (b) filling said chamber with a liquid;
- (c) sealing said limb part within said chamber;
- (d) applying pressure pulses to all of said liquid by reciprocal movements of said limb in said chamber and within said seal; and
- (e) applying localized pressure on a part of the limb by said movements of the limb to inhibit arterial flow upstream toward the heart.

3. A method for self-pressure cycling of limbs to improve blood circulation, comprising:

- (a) placing a part of a limb to be treated in a chamber;
- (b) filling said chamber with a liquid;

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- (c) sealing said limb part within said chamber;  
 (d) applying pressure pulses to all of said liquid by reciprocal movements of said limb in said chamber and within said seal;  
 (e) applying localized pressure on a part of the limb by said movements of the limb to inhibit arterial flow upstream toward the heart; and  
 (f) applying localized pressure on a near-surface vein by movements of said limb in the direction away from said chamber to assist the action of the vein check valves.
4. A method for self-pressure cycling of limbs to improve blood circulation, comprising:  
 (a) placing a part of a limb to be treated in a chamber;  
 (b) filling said chamber with liquid;  
 (c) sealing said limb within said chamber;  
 (d) applying alternate positive and negative pressure pulses to all of said liquid and to said seal by reciprocal movement of said limb;  
 (e) applying localized pressure on a part of said limb by said movement of the limb during said positive pressure pulses to inhibit arterial flow from said part toward the heart; and  
 (f) applying localized pressure to a vein in said limb by said movement of the limb during said negative pressure pulses to assist the action of the vein check valves.
5. A method for self-pressure cycling of limbs to improve blood circulation, comprising:  
 (a) placing a part of a limb to be treated in a chamber;  
 (b) filling said chamber with liquid;  
 (c) sealing said limb within said chamber;  
 (d) applying alternate positive and negative pressure pulses to all of said liquid and to said seal by reciprocal movement of said limb; and  
 (e) applying localized pressure on a part of said limb during said positive pressure pulses to inhibit arterial flow from said part toward the heart.

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6. A method for self-pressure cycling of limbs to improve blood circulation, comprising:  
 (a) placing a part of a limb to be treated in a chamber;  
 (b) filling said chamber with liquid;  
 (c) sealing said limb within said chamber;  
 (d) applying alternate positive and negative pressure pulses to all of said liquid and to said seal by reciprocal movement of said limb; and  
 (e) applying localized pressure to a vein in said limb during said negative pressure pulses to assist the action of the vein check valves.
7. A self-pressure cycling chamber for limbs to improve blood circulation, comprising:  
 (a) a chamber for containing liquid under pressure,  
 (b) said chamber having an opening adapted to receive a limb; and  
 (c) a piston slidably and sealingly engaged in said chamber opening,  
 (d) said piston having an opening adapted to receive said limb therethrough for extending into said chamber and being flexible around its opening to fit snugly on the limb to form a seal therearound,  
 (e) said piston being slidably movable relative to said chamber and said liquid by the force of reciprocal movement of said limb thereon toward and away from said chamber to vary the pressure of all the liquid in said chamber when it is filled and sealed.

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