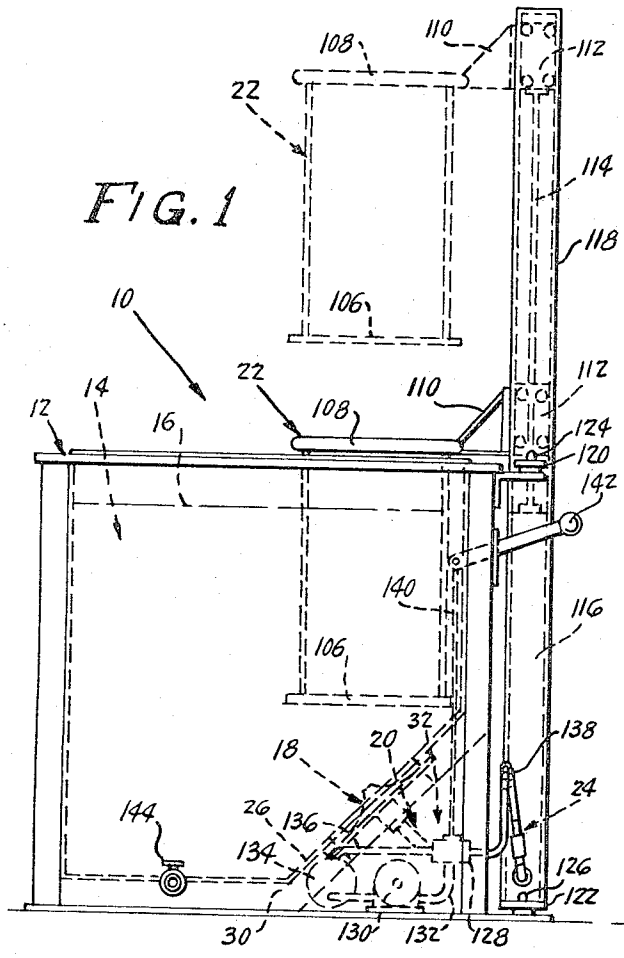
Oct. 17, 1967 A. L. SALSBURY 3,347,225

HYDROTHERAPY BATH WITH WAVE PRODUCING DIAPHRAGM

Filed March 10, 1964 2 Sheets-Sheet 1

FIG. 1



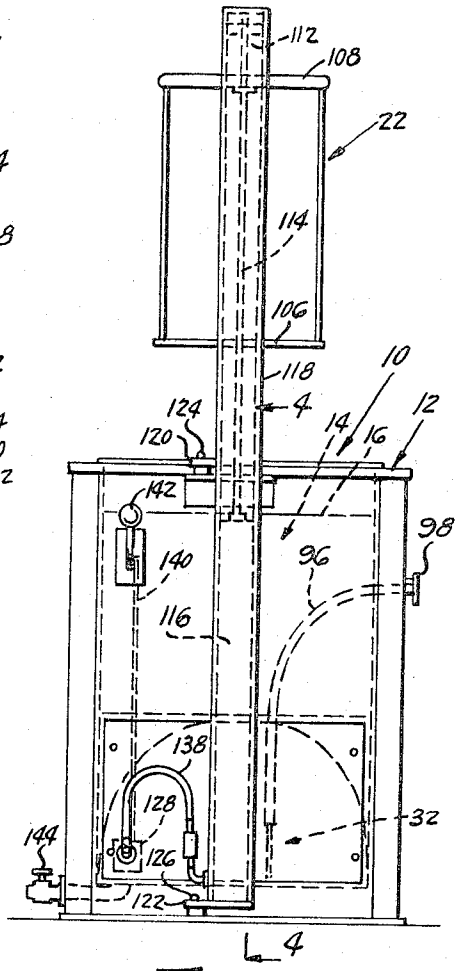


FIG. 2

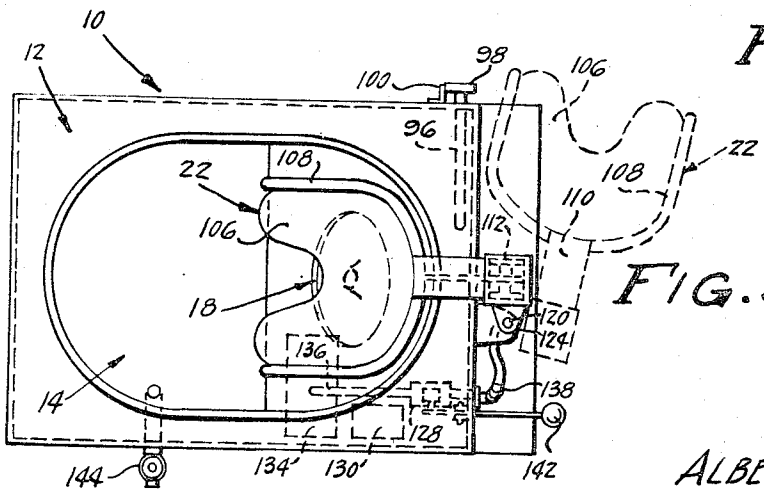


FIG. 3

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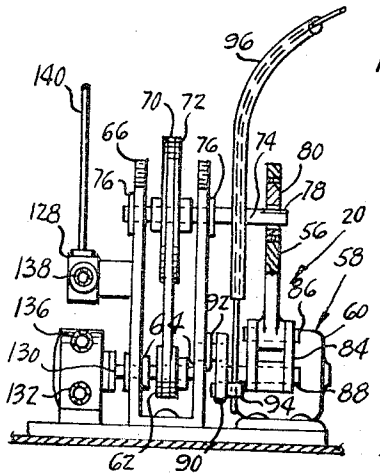


FIG. 5

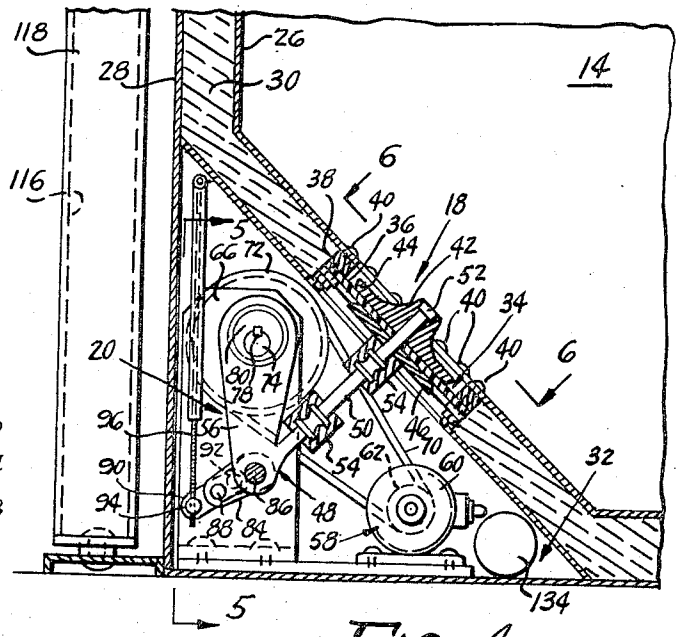


FIG. 4

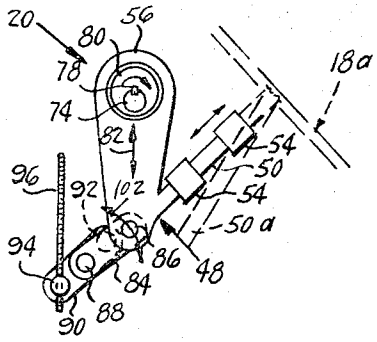


FIG. 7

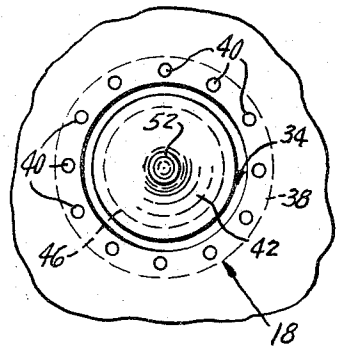


FIG. 6

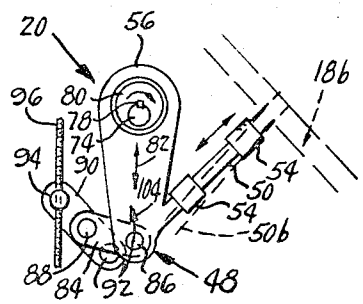


FIG. 8

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HYDROTHERAPY BATH WITH WAVE PRODUCING DIAPHRAGM

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Filed Mar. 10, 1964, Ser. No. 350,785
12 Claims. (Cl. 128—66)

This invention relates to a hydrotherapy bath and relates more particularly to a bath in which at least a portion of an individual to be treated is immersed and including means for subjecting that portion of the individual to pulsating differential pressure shock waves.

Hydrotherapy baths have been utilized heretofore, however, all such devices have relied upon mechanical arrangements designed and timed to impart motion to the liquid material within the bath, the motion of the liquid material over the surface of a body portion immersed therewithin theoretically providing therapeutic and beneficial effects. The device of the instant invention is particularly designed to provide frequent pulsations of relatively small pressure differential or shock waves which, due to the incompressibility of the liquid material within the bath, is equally distributed throughout the bath to be absorbed by a body portion immersed therewithin.

The above-described effect is accomplished by providing a tank means defining a chamber containing a predetermined volume of liquid material having a predetermined head, diaphragm assembly means being carried by the tank means with a front surface in contact with the liquid therewithin, and reciprocating means being operatively connected to diaphragm assembly means to move the front surface toward and away from the liquid material with a predetermined frequency and length of stroke, the dimensions of the diaphragm assembly means and the frequency and length of stroke of the reciprocating means being correlated with the volume and head of liquid material within the chamber to minimize movement of the liquid material and to maximize pulsation of small pressure differentials within the liquid material. As the front surface of the diaphragm assembly means is moved toward the body of the liquid material, a shock or pressure wave is caused to travel forwardly causing a rise in pressure above the ordinary static pressure of the liquid material, such rise in pressure being known as a positive pressure. As the front surface of the diaphragm assembly means is returned or moved away from the body of liquid material, a reversal of the shock or pressure wave is caused reducing the pressure to less than the ordinary static pressure of the liquid material, thereby providing a negative pressure. The variation between the maximum positive pressure and the minimum negative pressure provides a total pressure differential pulsation in the liquid material.

It will be readily seen that the frequency or number of cycles per minute and the length of stroke of the reciprocating means will determine the intensity of the pulsation. These variables produce a particular velocity in the movement of the front surface of the diaphragm assembly means, the increase of which increases the intensity of the shock wave within certain limitations. As the front surface moves toward the body of liquid material, the positive pressure is caused by powered, mechanical action. But as the front surface is retracted by the reciprocating means, no mechanical force is available. This action depends upon the force of gravity and, therefore, limits the speed of operation. Should the frequency be faster than the force of gravity can return the shock wave to its original position, the following forward stroke would have little or no effect. This condition can be called cavitation. If the reciprocatory movement is too slow, the desired intensity will not be realized and the body of

liquid material will be caused to move. This will also be true if the size of the diaphragm assembly means is very large compared to the volume and head of liquid material within the tank. If the frequency and stroke of the reciprocating means are too great, the tendency will be toward cavitation. By adjustment of each of these variables, an optimum relationship can be determined to provide a desired intensity without substantial movement of the liquid material and without cavitation. Such an arrangement can readily be calculated by those with ordinary skill in the art by predetermining one of the variables such as the quantity and head of liquid material within the bath and adjustment of the other variables by trial and error to produce an optimum result.

It will also be seen that in order to provide maximum efficiency of a hydrotherapy bath in accordance with the instant inventive concept, the tank means defining the chamber receiving the liquid material and the diaphragm assembly means should be relatively inelastic to preclude yielding of such elements which would absorb the shock waves and undesirably diminish the pulsations of pressure differentials to be imparted to the body portion immersed in the liquid material.

It is therefore a primary object of the instant invention to provide a hydrotherapy bath which minimizes movement of the liquid material therewithin and maximizes pulsations of small pressure differentials.

Another object of this invention is to provide a means for varying the length of stroke of the reciprocating means whereby the intensity of the pressure differential of each pulsation may be readily adjusted.

A further object of this invention is the provision of a hydrotherapy bath having a substantially rigid walled tank means defining a chamber receiving a volume of liquid material and a substantially inelastic diaphragm assembly means to preclude loss of pressure differential by absorption of either of these elements.

A still further object of the instant invention is to provide a hydrotherapy bath having a diaphragm assembly means carrying a plunger substantially frusto-conical in configuration and including a base portion having outwardly flared peripheral edges to concentrate the pulsations and direct them toward the body portion immersed within the liquid material.

A further object of the instant invention is the provision of a seat means for supporting an individual with at least a portion of his body immersed in the liquid material of the hydrotherapy bath.

Yet another object of this invention is to provide lift means operatively connected to the seat means to lower and raise the same whereby the seat means and the individual supported thereby may be immersed and removed from the liquid material.

A still further object of the instant invention is the provision of a hydraulically operated, pivotally mounted seat means whereby an individual may be lifted from a position exteriorly of the tank means and immersed within the liquid material, and subsequently removed from the liquid material and replaced exteriorly of the tank means.

A further and important object of this invention is the provision of a method of treating a substantial portion of the human body to assist the circulation of body fluids.

An additional important object of this invention is the provision of a method for imparting pressure pulsations into a substantial portion of the human body through a liquid bath which covers a substantial portion of the body and is of sufficient depth to provide a significant pressure head.

The provision of a method for treating the human body by imparting pressure pulses of positive and negative nature relative the static pressure on the body utilizing

a substantial depth of liquid to provide a pressure head is an important additional object of this invention.

Other and further objects reside in the combination of elements, arrangement of parts and features of construction.

Still other objects will in part be obvious and in part be pointed out as the description of the invention proceeds and as shown in the accompanying drawings wherein:

FIGURE 1 is a side elevational view of a hydrotherapy bath in accordance with the instant inventive concept showing a raised position of the seat means in dotted lines, and with various hidden parts being shown in dotted lines;

FIGURE 2 is a rear elevational view of the hydrotherapy bath with the seat means in the raised position;

FIGURE 3 is a top plan view thereof showing a pivoted position of the seat means in dotted lines;

FIGURE 4 is an enlarged fragmentary cross-sectional view taken substantially on line 4—4 of FIGURE 2;

FIGURE 5 is a fragmentary cross-sectional view taken substantially on line 5—5 of FIGURE 4;

FIGURE 6 is a fragmentary plan view taken substantially on line 6—6 of FIGURE 4;

FIGURE 7 is a fragmentary side elevational view diagrammatically showing a relationship of the reciprocating means for minimal movement of the diaphragm assembly means; and

FIGURE 8 is a view similar to FIGURE 7 showing the same elements rearranged to provide a maximum movement of the diaphragm assembly means.

Like reference characters refer to like parts throughout the several views of the drawings.

Referring now to the drawings, a hydrotherapy bath in accordance with the instant inventive concept is designated generally by the reference numeral **10** and comprises basically a tank means **12** defining a chamber **14** therewithin containing a predetermined volume and head of liquid material **16** such as water or the like, a diaphragm assembly means **18** carried by the tank means **12** and having reciprocating means **20** operatively connected thereto, with a seat means **22** being operatively connected to a hydraulic lift means **24** for raising and lowering the same as will be explained in more detail hereinafter.

The tank means **12** includes substantially rigid walls formed by inner and outer shell members **26, 28**, respectively, defining a space therebetween which is filled with a solid insulating material **30** poured thereinto in any conventional manner, the inner shell member **26** defining the chamber **14** and one corner of the walls being angularly offset as shown particularly in FIGURE 4 to define an enclosure **32** receiving the major portion of the reciprocating means **20** and certain of the elements defining the hydraulic lift means **24**.

An opening **34** is defined in the walls of the angularly offset portion of the tank means **12** to receive the diaphragm assembly means **18**. The diaphragm assembly means **18** is comprised basically of a flexible, substantially inelastic diaphragm member **36** secured to an annular flange **38** by a plurality of bolts **40** and carrying on its front surface a substantially frusto-conical plunger **42** having a base portion with upturned peripheral side edges **44**, and on its rear surface a washer member **46**, these latter two elements being rigid and defining a major portion of the front and rear surfaces, respectively, of the diaphragm assembly means **18**. The surfaces of the plunger **42** and washer member **46** in contact with the diaphragm member **36** are arcuately defined adjacent their peripheral edges to preclude cutting of the diaphragm member **36**.

The reciprocating means **20** includes a substantially V-shaped crank means **48** having a first connecting rod **50** with one end **52** secured to the diaphragm assembly means **18** in any conventional manner, the remainder of the first connecting rod **50** extending in substantially right angular relationship to the rear surface of the diaphragm assembly means **18** and including rubber bushings **54** to allow for curvilinear as well as rectilinear motion as will be explained hereinafter, and a second connecting rod **56** with one end operatively connected to a driving means **58** for reciprocatory movement, the other ends of the first and second connecting rods **50, 56**, respectively, being secured to each other to define the apex of the V-shape of the crank means **48**. The driving means **58** includes a motor means **60** with its power take off shaft operatively connected to a small pulley means **62** carried in bearings **64** in a U-shaped support bracket **66**, a belt means **70** drivingly connecting the small pulley means **62** to a large pulley means **72** connected to a shaft **74** supported in bearings **76** in the support bracket **66** and being eccentrically keyed at one end **78** to a disc rotatably carried by the second connecting rod **56** to provide a reciprocatory movement in the direction of the double-headed arrow D. The reciprocating means **20** further includes a link means **84** carrying a first floating pivot means **86** at one end and a second floating pivot means **88** at its other end, the first floating pivot means **86** being operatively secured to the crank means **48** at its apex. An adjustable arm **90** is operatively secured to the second floating pivot means **88** and has one of its ends secured to fixed pivot means **92** carried by the bracket member **66** in spaced relationship to the second floating pivot means **88**. The opposite end of the adjustable arm **90** carries an outstanding lug member **94** threadably receiving a spring covered wire control member **96** extending to a control knob **98** conveniently secured to the tank means **12**, with a spring pressed locking means **100** being provided, if desired, to retain control knob **98** in a preselected position. Rotation of the control knob **98** threadably feeds the wire control member **96** through the lug **94** to raise or lower the adjusting arm **90** as will be seen particularly in FIGURES 7 and 8. By moving the adjustable arm **90** the position of the second floating pivot means **88** and the relationship of the link means **84** to the crank means **48** is varied thereby varying the movement of the first connecting rod **50** on reciprocation of the second connecting rod **56** by the driving means **58** from substantially curvilinear motion as schematically designated in FIGURE 7 by the dashed lines **50***a* and the double-headed arcuate arrow **102** causing minimum length of stroke of the diaphragm assembly means designated schematically by the dotted lines **18***a* in FIGURE 7 and thereby minimum intensity of the pressure differential of the pulsations, to substantially rectilinear motion designated schematically by the dotted lines **50***b* and the double-headed arcuate arrow **104** in FIGURE 8 thereby causing maximum length of stroke of the diaphragm assembly means designated schematically by the dotted lines **18***b* in FIGURE 8 and maximum intensity of the pressure differential of the pulsations.

The seat means **22** includes a seat member **106** of aluminum or other similar material having an upstanding backrest and frame **108** carried by a structural support member **110** secured to a roller guide means **112** on the end of a piston rod **114** of a hydraulic cylinder **116** forming part of a vertical standard member **118** having outstanding lugs **120, 122** pivotally carried by pins **124, 126**, respectively, secured by brackets or the like exteriorly of the tank means **12**. A conventional three-way hydraulic control valve means **128** is operatively connected to a conventional hydraulic pump **130** by conduit means **132**, to a storage tank **134** by conduit means **136** and to the hydraulic cylinder **116** by conduit means **138**. The hydraulic pump **130** is energized by the motor means **60** as will be seen particularly in FIGURE 5 and the hydraulic valve means **128** is actuated in any conventional manner by a flexible member **140** carried by a control level **142** conveniently carried by the tank means **12**.

A drain valve **144** is provided for the tank means **12**.

The use and operation of the hydrotherapy bath of the instant invention will now be apparent. The drain valve **144** is closed and the chamber **14** is filled with water or the like **16** to a desired volume and head. An individual to be treated in the bath **10** sits on the seat means **22** in the dotted position shown in FIGURE 3, lowered adjacent the floor. The control lever **142** is then actuated to open the hydraulic control valve **128** thereby raising the seat means **22** to its uppermost position after which it is rotated about the pivot pins **124, 126** to the position shown in dotted lines in FIGURE 1 and then lowered by reversing the hydraulic control valve **128** until the seat means **22** and the individual supported thereby is immersed in the liquid material **16** to a desired degree. The control knob **98** is then rotated to selectively move the adjustable arm **90** to provide a desired intensity to the pulsations. On energizing the motor means **60** the reciprocating means **20** is actuated to move the diaphragm assembly means **18** back and forth according to a predetermined frequency and length of stroke thereby providing pulsations of pressure differentials communicated through the liquid material **16** to the individual. The intensity of the pulsations may be varied at any time by rotation of the control knob **98**. On completion of the use of the bath **10** the seat means **22** may be raised, rotated and lowered to remove the individual and the liquid material **16** may be drained through the valve **144**, if desired.

As conducive to a better understanding of the instant invention an example of the dimensions of one embodimet of the hydrotherapy bath of the instant invention will be set forth. It will be understood that these dimensions are not to be considered limitative, but merely illustrative of one arrangement providing optimum results. With a chamber **14** having an average total volume of approximately 8100 cubic inches, a maximum stroke of approximately $\frac{7}{32}$ inch has been provided for the diaphragm assembly unit **18**, with the base of the plunger **42** having a diameter of approximately 6 inches and the opening **34** being approximately 7 inches in diameter. Thus, the total surface area of the diaphragm assembly means **18** is approximately 36 square inches and the liquid material displacement will vary from approximately 7.8 cubic inches at the maximum reciprocatory movement of the diaphragm assembly means **18** to 0 cubic inches at the minimum reciprocatory movement, an average setting of approximately 4.5 cubic inches being provided. Thus, it will be seen that the ratio of liquid material displacement to total volume is only approximately 4.5 to 8100 resulting in substantially no liquid material movement. Experimentation has shown the optimum frequency to be approximately 322 cycles per minute resulting in sufficient intensity of pulsations without effecting cavitation.

Although the descriptive matter and drawings have been directed to a substantially oval bath sufficiently large to immerse the major portion of an individual's body, it will be readily seen that smaller baths may be used for receiving only the arm or leg of an individual. Similarly, while specific materials and configurations have been set forth for such elements as the seat means and the plunger, and while specific dimensional and operating values have been provided for an illustrative example, it will now be seen that since many embodiments may be made of the instant inventive concept, and since many modifications may be made of the embodiments hereinbefore shown and described, all matter herein is to be interpreted merely as exemplary and not as limitations on the appended claims.

Thus, there is herein provided an improved hydrotherapy bath which satisfies all of the objectives of the instant invention, and others, including many advantages of great practical utility and commercial importance.

I claim:

1. A hydrotherapy bath comprising a tank means defining a chamber containing a predetermined volume of liquid material having a predetermined head, said chamber being of size and shape to hold an adult human body in a sitting position substantially submersed in the liquid material, diaphragm assembly means carried by said tank means and having a front surface in contact with said liquid material and a rear surface outside of said chamber, and reciprocating means operatively connected to said diaphragm assembly means for moving said front surface toward and away from said liquid material with a predetermined frequency and length of stroke, the dimensions of said diaphragm assembly means and the frequency and length of stroke of said reciprocating means being correlated with the volume and head of said liquid material within said chamber to minimize movement of said liquid material and to maximize pulsations of small pressure differentials within said liquid material.

2. The structure of claim **1** further comprising, in combination, means for varying said length of stroke of said reciprocating means whereby the intensity of the pressure differential of each pulsation may be adjusted.

3. The structure of claim **2** wherein said reciprocating means includes a V-shaped crank means having a first connecting rod with one end secured to said diaphragm assembly means and extending in substantially right angular relationship to said rear surface thereof, and a second connecting rod with one end operatively secured to a driving means for reciprocatory movement, the others ends of said connecting rods being secured to each other to define the apex of the V-shape of said crank means, a link means carrying a first floating pivot means at one end and a second floating pivot means at its other end, said first floating pivot means being operatively secured to said crank means at said apex, an adjustable arm operatively secured to said second floating pivot means, and a fixed pivot means operatively carrying said adjustable arm in spaced relationship to said second floating pivot means, whereby movement of said adjustable arm about said fixed pivot means changes the position of said second floating pivot means and the relationship of said link means to said crank means to vary movement of said first connecting rod on reciprocation of said second connecting rod by said driving means from substantially rectilinear motion causing maximum length of stroke and thereby maximum intensity of the pressure differential of the pulsations, to substantially curvilinear motion causing minimum length of stroke and thereby minimum intensity of the pressure differential of the pulsations.

4. The structure of claim **1** wherein said tank means includes substantially rigid walls defining said chamber and further including a seat in the chamber for supporting the body of an individual while said individual is being treated.

5. The structure of claim **4** wherein said walls include inner and outer shell members defining a space therebetween, and a solid insulating material filling said space.

6. The structure of claim **1** wherein said diaphragm assembly means includes a substantially inelastic, flexible diaphragm member, a rigid plunger member secured to the front of said diaphragm member and defining the major portion of said front surface of said diaphragm assembly means, and a rigid washer member secured to the rear of said diaphragm member and defining the major portion of said rear surface of said diaphragm assembly means and further including a seat in the chamber for supporting the body of an individual while said individual is being treated.

7. The structure of claim **6** wherein said plunger is substantially frusto-conical.

8. The structure of claim **6** wherein said plunger includes a base portion having outwardly flared peripheral edges.

9. The structure of claim **1** further including, in combination, seat means for supporting an individual with

at least a portion of his body immersed in said liquid material.

10. The structure of claim **9** further including, in combination, lift means operatively connected to said seat means to lower and raise the same whereby said seat means and the individual supported thereby may be immersed and removed from said liquid material.

11. The structure of claim **10** wherein said lift means are hydraulically actuated.

12. The structure of claim **10** further including, in combination, pivot means operatively connected to said seat means whereby said seat means may be moved from a first position aligned with said chamber wherein said seat means and the individual supported thereby may be immersed in said liquid material and removed therefrom by said lift means, to a second position remote from said chamber wherein said seat means may be raised and lowered by said lift means for receiving and depositing an individual exteriorly of said tank means.

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