

May 13, 1941.

M. SHOELD

2,241,620

MEANS FOR PRODUCING PULSATING MOVEMENT

Filed April 10, 1937

2 Sheets-Sheet 1

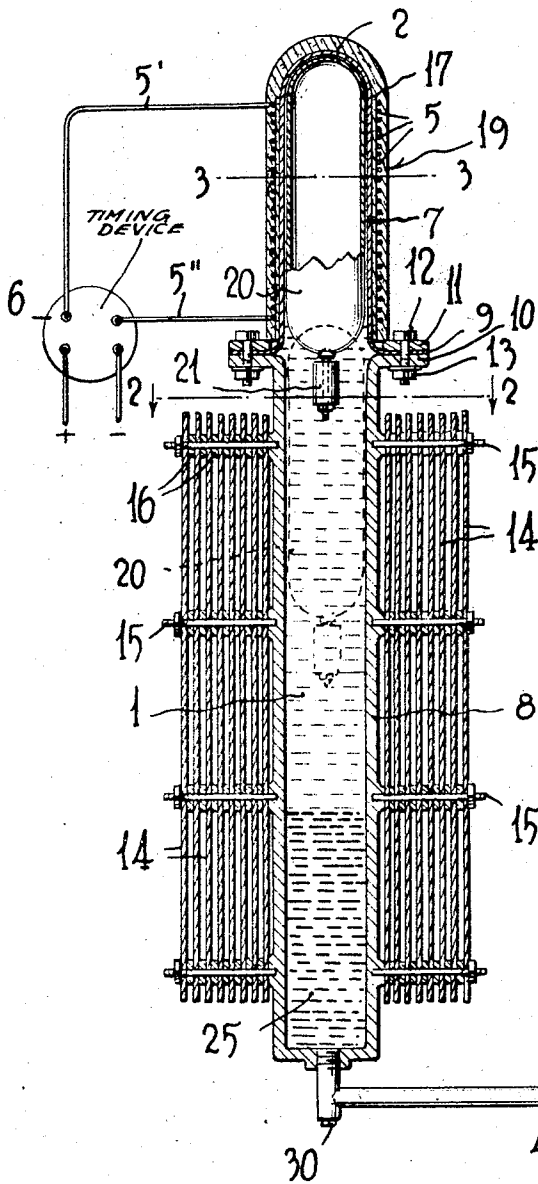


FIG. 1.

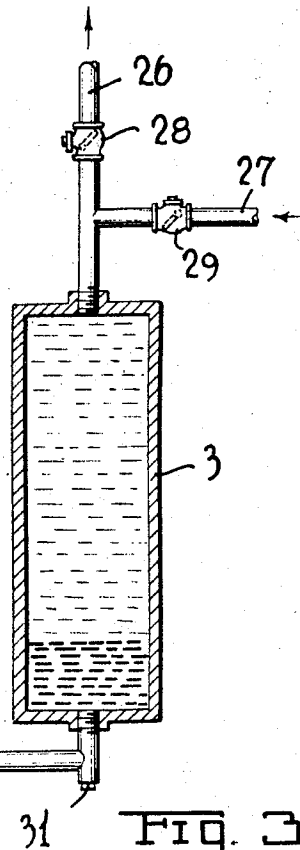


FIG. 3.

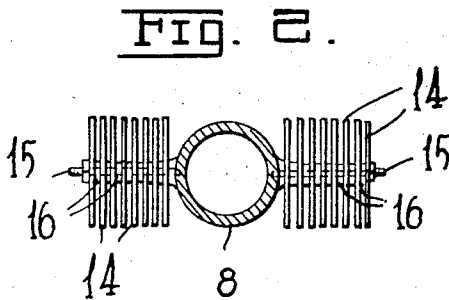
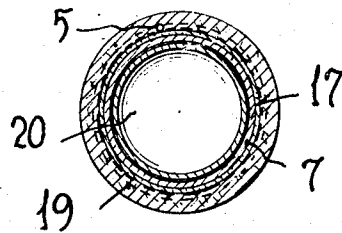


FIG. 2.



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2 Sheets-Sheet 2

FIG. 4.

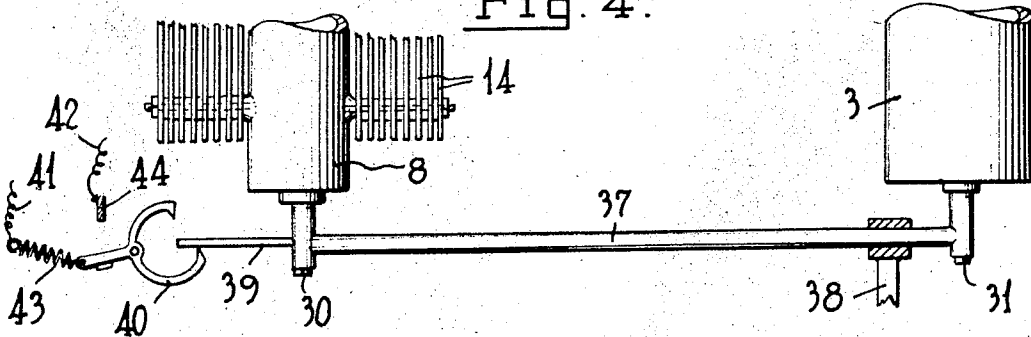


FIG. 5.

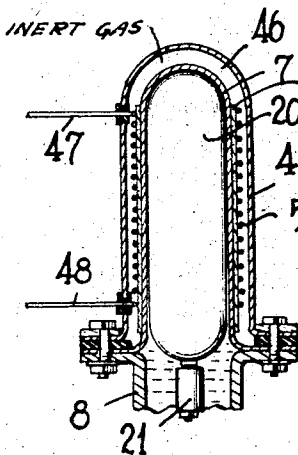


FIG. 6.

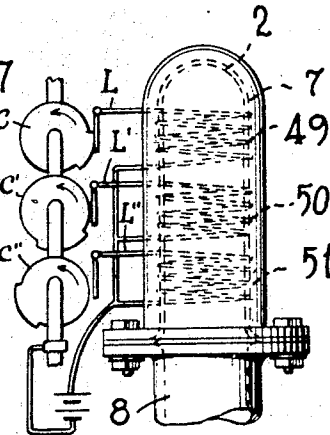


FIG. 7.

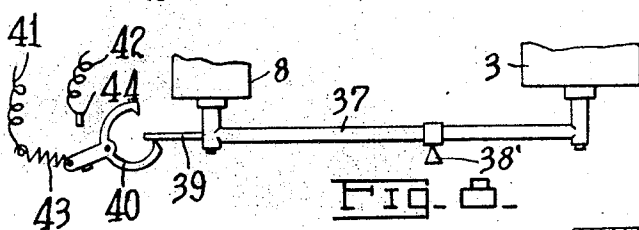
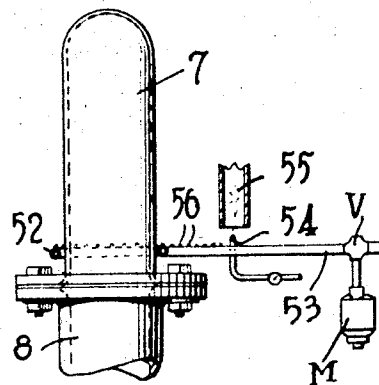


FIG. 8.

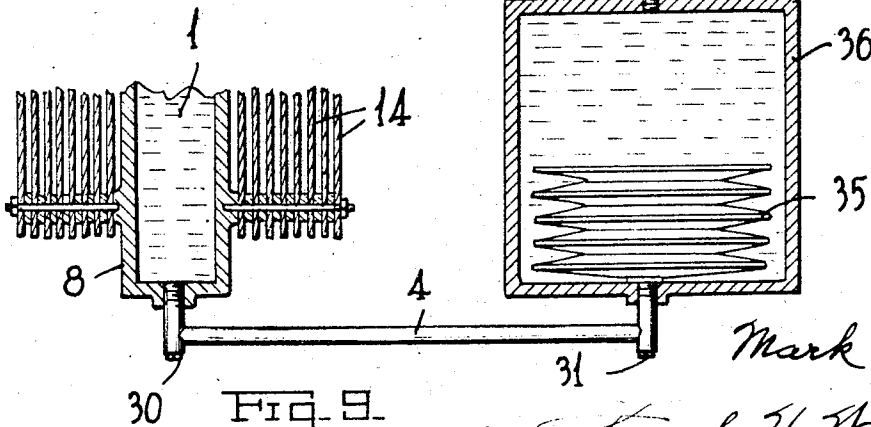


FIG. 9.

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2,241,620

MEANS FOR PRODUCING PULSATING
MOVEMENT

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Application April 10, 1937, Serial No. 136,211

6 Claims. (Cl. 60—25)

This invention relates to means for producing pulsating movement.

The present invention relates more particularly to means for use in transferring liquids in liquid circulating systems or distributing systems. The invention is highly effective, for instance, in the operation of refrigeration machines principally of the domestic type including absorption units.

An object of the present invention is to provide means whereby the transfer of liquids is accomplished in absolute silence by the use of heat.

A further object is to provide means whereby the above is accomplished by a minimum of energy input and hence with economy.

Briefly, the invention comprises means in which a fluid is alternately heated and cooled in an enclosed zone to permit of expansion and contraction thereof, and by such expansion and contraction setting up a reciprocating action which is utilized in effecting the transfer of a liquid. Certain specific characteristics of the apparatus make it possible, where necessary, to provide for rapid heating and cooling of the said zone, resulting in an increased reciprocating action and in turn a greater pumping capacity.

For the purpose of illustrating the invention reference is made to the accompanying drawings in which,

Fig. 1 is a vertical cross section of one form of the apparatus of the present invention;

Fig. 2 is a cross section of Fig. 1 on the line 2—2 in the direction of the arrows;

Fig. 3 is an enlarged cross section of Fig. 1 on the line 3—3;

Fig. 4 is an elevational view of a modified portion of the apparatus;

Fig. 5 is a vertical section of another modified portion of the apparatus;

Figs. 6 and 7 are elevational views of modified portions of the apparatus;

Fig. 8 is a modification of the portion of the apparatus shown in Fig. 4; and

Fig. 9 is a vertical sectional view partly in elevation of a further modification of a portion of the apparatus.

In the various figures similar reference characters are employed to designate similar parts of the apparatus.

Referring to Figs. 1, 2 and 3, the apparatus shown comprises a chamber 1 formed, for instance, by a tubular member having a dead end 2, and a reservoir member 3 connected to the

chamber 1 by a pipe 4. The tubular member forming the chamber 1 is provided with heating means, adjacent the end 2, for heating an end zone in the said chamber 1. Various means for heating may be employed. The heating means shown in Fig. 1 is a heating coil 5 connected in an electric circuit including lead wires 5' and 5'' to a suitable timing device 6 for intermittently supplying current to the coil.

The chamber 1, for convenience, may be formed of two pipe sections 7 and 8. The end section 7 is rendered replaceable by providing a flange connection with the pipe section 8. The end section 7 is made of sheet metal which, including the end 2, is preferably as thin as possible but strong enough to withstand pressures encountered in the chamber 1. Spun copper or other suitable material may be employed.

The dead end 2 is preferably semispherical in shape. The open end of section 7 is provided with a flange 9 which is clamped between a flange 10 on the abutting end of the pipe section 8 and a ring 11, bolts 12 and nuts 13 being used to hold the parts together.

The pipe section 8, the ring 11 and the flange 10 may be made of steel. The internal diameter of pipe 8 is the same as that of the end section 7. The pipe section 8 is preferably provided with cooling fins 14 of any desirable shape and arranged to maintain the section 8 relatively cool as compared with the end section 7 which is intermittently heated. In Figs. 1 and 2 two sets of cooling fins are shown attached on opposite sides of the pipe section 8. The fins are in the form of rectangular metal plates supported on the pipe 8 by metal rods 15 extending diametrically from the pipe 8 and passing perpendicularly through the fins 14. The fins 14 are spaced apart on the rods 15 by metal spacers 16 and are parallel to each other. Although only one form of cooling means is shown, it is understood that other forms may be adopted to provide proper dissipation of heat.

A thin mica sheet 17 is placed between the heating coil 5 and the end section 7 to serve as insulation. The thickness of the mica sheet is exaggerated and for practical purposes is illustrated by a double line. The mica sheet may in fact be considerably thinner, for example, about three or four thousandths of an inch, so that the heating wire is as close as possible to the metal surface. A light asbestos insulating layer 19 may encase the entire end section 7.

A float member 20 is provided in the chamber 1 which is freely movable through the sec-

tions 7 and 8. The member 20 is hollow and is constructed of metal or other suitable heat conducting material. Spun copper of about the same wall thickness as that of the section 7 is found satisfactory for the purpose. The member 20 preferably substantially occupies the entire space in the section 7. The clearance between the member 20 and the side wall of section 7 is preferably relatively small but not so small as to prevent free movement of the member 20 into and out of the section 7. In the drawings, Figs. 1 and 3, for purposes of illustration, the inter space formed between the member 20 and the wall of section 7 is shown to be wider than necessary and could be represented by a single line. An end of the member 20 may be shaped to fit closely against the dead end of section 7 as shown.

A liquid is provided in the chamber 1 in which the member 20 is adapted to float. A weight 21 is attached to maintain the member at least partially submerged but preferably submerged substantially entirely on the liquid side of the liquid-vapor interface under conditions of minimum specific gravity of the liquid corresponding to the maximum temperature to which it may be heated in chamber 1. The weight 21 may be replaceable and may be varied depending on the liquid used in the chamber 1.

A liquid is used in chamber 1 which is readily vaporizable. Water may be used, or a liquid that has a vapor pressure preferably of about one atmosphere at a temperature considerably above atmospheric. Instead of water, benzol, carbon tetrachloride or a petroleum hydrocarbon like octane or decane may be used. An advantage of certain of these latter liquids is that the specific heat per unit volume is quite a little lower than water. The use of a liquid with a lower specific heat results in an increase in efficiency of the apparatus.

Although a mercury seal 25 partly filling chamber 1 and the reservoir 3, may be employed in the pipe 4 to separate the liquid in chamber 1 from the liquid to be pumped, namely, from the liquid in the reservoir 3, it is possible to omit the seal and have the liquid to be pumped fill the apparatus, providing such liquid has suitable characteristics as indicated above. Also, it is possible to omit the mercury seal and to employ a liquid in chamber 1 in contact with the liquid to be pumped, both liquids being immiscible in each other and both liquids having a decided difference in specific gravity. In the latter instance, the liquid-liquid interface may preferably be in the reservoir 3 and if the liquid in chamber 1 is lighter than the liquid to be pumped, the connection 4 may pass from the pipe section 8 to the top of the reservoir 3 instead of to the bottom thereof as shown. The outlet pipe 26 and the inlet pipe 27 for the liquid to be pumped would then be connected to the bottom of the reservoir 3 instead of to the top as shown. The pipe 26 is provided with a check valve 28 that permits passage of liquid out of but prevents return of liquid to the reservoir 3. The pipe 27 is provided with a check valve 29 that permits passage of liquid to but not out of the reservoir 3.

For the purpose of draining liquid out of the apparatus, drain plugs 30 and 31 in connection 4 may be provided.

By way of example, the operation of the above apparatus may be as follows: It may be assumed that the apparatus shown in Fig. 1 is to be em-

ployed in a domestic refrigerating machine of the absorption type, wherein ammonia liquor is used as the refrigerant. By means of the present invention the liquor is transferred from the low pressure side of the refrigerating system to the high pressure side without resorting to the use of pressure equalizing gas such as hydrogen or the like.

The space in the chamber 1 above the mercury seal 25 is initially filled with water or other suitable liquid and the float 20 is in the position shown in Fig. 1. The reservoir 3 is filled above the mercury seal with ammonia liquor to be transferred from the low pressure side of a refrigerating system to the high pressure side. It may be assumed that the pressure on the high pressure side is about 200 pounds per square inch or any desired predetermined pressure and that on the low pressure side is about atmospheric.

The electric timing device 6 may be set to turn the current alternately on and off for the heating element 5 at predetermined intervals. In some cases it may be desirable to have an adjustable timing device by which the frequency of operation may be regulated but ordinarily the frequency is fixed for any given machine. When the current is on, the element 5 heats the section 7 wherein water is vaporized. The pressure developed causes the liquid to move out of the section 7 and the float 20 is moved therewith until it reaches approximately the position shown in dotted lines within the chamber 1. During the movement of the water level and the float 20 out of the section 7, the ammonia liquor in reservoir 3 is forced out through the pipe 26 to the high pressure side.

At the end of the heating interval the current in the element 5 is cut off and the section 7 cools which results in condensation of vapor and hence reduction in pressure until the water level and float 20 assume their original position. During the movement of the water level and float back into section 7, ammonia liquor from the low pressure side enters the reservoir 3 through the pipe 27.

As the above cycle is repeated, a reciprocating motion is set up in the mercury seal which is transmitted to the reservoir 3. Each time the float returns to the end 2, water is confined in the annular space between the float and the wall of section 7. Since the float may be of a size to provide for minimum clearance for free movement, it may apply a relatively thin film of water as it slides along the surface of the wall of the chamber 1.

Various modifications may be employed in which the principle of the present invention is utilized. Several modifications will be described below.

If the section 7 and the float 20 are constructed of stainless steel, there is no theoretical reason why the ammonia liquor in the above example may not fill the entire apparatus. From a practical standpoint, however, the cooling period is likely to be too prolonged. In the above example in which water is employed in chamber 1, it is clear that section 7 would only have to cool to 212° F. to reduce the pressure to atmospheric, whereas in case of ammonia liquor the cooling would have to proceed to almost room temperature. The use of ammonia liquor in chamber 1 results not only in a considerable reduction in the frequency of the cycles, but corollarily in the necessity for a considerable increase in the size of the apparatus. The size

would likely be too large for practical purposes.

It is possible to eliminate the mercury seal 25 by employing a liquid other than ammonia liquor in chamber 1 and having such liquid contact the liquor. The said liquid, such as a hydrocarbon or carbon tetrachloride would have to be insoluble in the liquor and the ammonia insoluble in the liquid.

A mercury seal may likewise be omitted in an arrangement shown in Fig. 8. The liquid in chamber 1 and passing through connection 4 may actuate a bellows 35 provided in a reservoir 36 containing the liquid to be pumped. The bellows 35 may be constructed of material that is not attacked by the liquid to be pumped or by the liquid in chamber 1. In pumping ammonia liquor, the bellows may be made of a ferrous metal like steel or other iron alloy.

Instead of using an electric timing device such as means 6 shown in Fig. 1, the reciprocating motion of the mercury between chamber 1 and reservoir 3 may be taken advantage of, as in the arrangement shown in Fig. 4. A pipe 37 corresponding to the connection 4 in the apparatus shown in Fig. 1, is relatively long and flexible and is mounted on a support 38 positioned near the bottom of the reservoir 3. If desired, instead of depending on the flexibility of a pipe to obtain the necessary motion, the pipe 37 may be a lever or may be pivoted, as shown in the modified apparatus illustrated in Fig. 8 including a supporting fulcrum means 38', to obtain a rocking motion as the mercury reciprocates between the pipe 8 and the reservoir 3. When the mercury is forced over toward the reservoir 3, the end of the pipe 37 that supports the pipe 8 including the chamber containing the float (Fig. 1), will rise. When the mercury flows in the opposite direction, the chamber with the float will fall. To increase the arc travelled by the end of the pipe 37 under the chamber containing the float, an extension 39 may be attached to the said end and in line with the pipe 37. The free end of the extension 39 operates a lost motion device 40. In Fig. 4, as well as in Fig. 8, the circuit for the heating element for the float chamber includes the wires 41 and 42, the spring 43 and the stop 44. Other parts of the circuit include the heating coil 5 shown in Fig. 1 and a source of current. The wire 42 is connected to one end of the coil 5. The wire 41 is connected to the source of current which in turn is connected to the other end of the coil 5. It is evident that from the position of the device shown in both Figures 4 and 8, the heating period has ended, the mercury having been forced to the reservoir 3 and the circuit for the heating element having been opened by the raising of the extension 39. As the float chamber cools, the float 20 therein rises to the top and the mercury passes from the reservoir 3 towards the pipe 8 whereupon the extension 39 falls, thereby causing the lost motion device 40 to close the circuit which feeds current to the heating element 5. As the heating progresses, the mercury is again forced out of the chamber 8 toward the chamber 3 whereupon the arm 39 rises again and opens the heating circuit. The cycle is thereby automatically repeated.

In the modification of the end section of the float chamber shown in Fig. 5, instead of providing an insulation 19 as in Fig. 1, a pressure resisting shell 45 is placed over the end section 7 and spaced therefrom. The hermetically sealed space 46 may be filled with an inert gas under suitable pressure for insulating purposes. Any

insulating material of low heat capacity may be used in the space 46. The lead wires 47 and 48 to the heating element 5 pass through the shell 45 and are properly insulated therefrom. The outside of the shell 45 may be highly polished to reduce energy loss. In this manner it is possible to make the wall thickness of section 7 extremely thin and thereby reduce its heat capacity.

In Fig. 6, a modified arrangement of electrical heating means for the section 7 is illustrated. A plurality of separate heating coils 49, 50 and 51 are provided on contiguous portions of section 7. These coils are connected to an electrical timing device in a well known manner as shown to provide current to the coils, in successive time intervals of predetermined duration by means of cams properly arranged on discs C, C', and C'' which revolve in the direction of the arrows. For instance, assuming that the cycle is to commence or in other words that the float is at the end 2 of section 7, the current will be automatically turned on in the heating coil 49 as the cam on the disc C contacts a lead L of this coil. The temperature is thereby raised to the point where the float will travel a corresponding distance away from the end 2. The current will then be turned off automatically in the heating coil 49 and automatically turned on in the heating coil 50 as the cam on the disc C' contacts a lead L' of this coil. The float will travel another corresponding distance when the current in the heating coil 50 is automatically turned off and then automatically turned on in the heating coil 51 as the cam on the disc C'' contacts a lead L'' of this coil. The float is forced out of section 7 another distance and the current in the heating coil 51 is turned off whereupon the cooling period commences. In fact after the cam on the disc C'' breaks contact with the lead L'', the current remains off in all three coils until the cam on the disc C again reaches the position shown. The float has by then returned to the end 2 and the cycle is repeated.

It is evident in the arrangement shown in Fig. 6 that only the upper third of the float needs to be raised to the maximum temperature. This is also true of the liquid in the annular space between the float and the inner wall of section 7 because the liquid level travels down with the float. The section 7 is the only part of the apparatus that needs to be heated to the maximum temperature in its entirety once during each cycle of operation. This therefore effects considerable heat economy.

It is readily conceivable that instead of turning the current on and off in the coils 49, 50 and 51 at successive intervals, by a proper arrangement of cams the current during the heating period may be turned on in each coil successively and left on as the float proceeds out of section 7. At the end of the heating period the current may be turned off in all of the coils at the same time. This method of operation is not as desirable as the next preceding method described above. The method will depend to some extent on what metal is used in section 7 because the heat conduction of metals varies considerably.

In Fig. 7 an arrangement is shown whereby the section 7 may be heated by gas. A ring burner 52 encircles the lower outer portion of section 7. A pipe 53 connects the burner 52 with a source of gas. Any suitable means such as a valve V revolved by a motor M for automatically turning the gas alternately on and off at predetermined intervals may be provided in the gas

line 53. A pilot 54, provided with a stack 55, is in close proximity to holes 56 in the pipe 53. When the gas in the pipe 53 is turned on, the pilot ignites the gas issuing from the holes 56 and the flame is carried to the burner 52.

In addition to reducing considerably the energy consumption in a pump by the use of a float, the latter has an auxiliary beneficial function, in that, when it travels upwardly during the cooling period, it facilitates cooling and therefore tends to reduce the cooling period.

It may be mentioned here that in the apparatus shown in Fig. 1 for instance, the elimination of heat from section 7 during the cooling period is primarily due to conduction of heat through its walls down through the wall of section 8 and through the float 20. In a device heated by gas (Fig. 7), most of the heat may radiate from the uninsulated shell of section 7 during the cooling period.

It may further be mentioned that during the operation of the apparatus shown in Fig. 1, for instance, the part of the section 8 above the cooling fins 14 as well as the flange 10 and the ring 11 are relatively hot, but the part of section 8 below the cooling fins 14 is always at substantially room temperature or atmospheric temperature. This is advantageous in the use of the device for transferring ammonia liquor in refrigeration units, because the latter must not be heated in the reservoir 3 since this would cause premature evolution of ammonia and thereby defeat the proper operation of the apparatus. Moreover, it is of advantage that the top part of section 8 above the cooling fins be relatively hot during operation so as not to cause undue cooling of section 7 during the heating period.

Reference is made to my Patent No. 2,238,080 dated April 15, 1941, in which there is shown and described a refrigeration unit equipped with the device claimed herein.

Having thus described the invention, those skilled in the art will understand, that the invention is not necessarily restricted by the description given above, since this is subject to more or less radical modification without departure from the substance and essence of the invention as defined by the appended claims and without sacrificing any of its substantial benefits and advantages.

I claim:

1. Apparatus comprising a tubular means constructed of heat-conducting material and having a closed end and an open end, a vaporizable, pressure transmitting liquid in said tubular means, a float member in the liquid within the tubular means movable toward and away from the said closed end by evaporation of part of said liquid and defining with said tubular means an interspace, the said interspace being accessible to and occupied by said liquid in the tubular means, and means for heating at intervals said liquid in said interspace to effect vaporization of part of the liquid during application of heat and to cause movement of the unvaporized liquid and of the said float member away from the closed end, the cessation of heat application causing return of the liquid to the closed end during non-application of heat by condensation of the vaporized liquid.

2. Apparatus comprising a tubular means constructed of heat conducting material and having a closed end and an open end, a vaporizable, pressure transmitting liquid in said tubular means, a float member in the liquid within the

tubular means movable toward and away from the said closed end and defining with said tubular means an interspace, the said interspace being accessible to and occupied by said liquid in the tubular means, and a plurality of heating elements for successively heating and vaporizing the said liquid in the interspace at successive intervals as the float member is forced by said generated vapor away from the said closed end, the cessation of heat application causing return of the liquid to the closed end during non-application of heat by condensation of the vaporized liquid.

3. In apparatus claimed in claim 1, the said float member having means for attaching weights thereto for varying the position of the float member in the liquid.

4. Apparatus comprising an enclosure element comprising an upper zone and a lower zone, a vaporizable, pressure transmitting liquid in said enclosure normally substantially filling the said zones and movable from one zone to the other by vaporization of part of said liquid, the said enclosure having a conduit connection for the passage of liquid in and out of the lower zone, a float member in the liquid in the said enclosure movable from one zone to the other and defining with the wall in the enclosure an interspace, the said interspace being accessible to and occupied by said liquid in the enclosure, means for heating at intervals said liquid in said interspace in said upper zone to effect vaporization of the liquid and to cause movement thereof with said float member into said lower zone, and means for cooling the vapors in said enclosure during non-application of heat to effect condensation of vapors and return of liquid with said float member into the upper zone.

5. Apparatus comprising a tubular means constructed of heat-conducting material and having a closed end and an open end, a vaporizable, pressure transmitting liquid in said tubular means, a float member in the said liquid in said tubular means and movable in and out of the said closed end, the surface of the float member being in close proximity to the wall of the tubular means to form a thin film of the liquid between the surface of the float member and the said wall, and means adjacent the closed end for heating the liquid at intervals in the film in said closed end to cause flashing of part of the liquid into vapor during application of heat and to cause movement of the unvaporized liquid and of the said float away from the closed end, the cessation of heat application causing return of the liquid to the closed end during non-application of heat by condensation of the vaporized liquid.

6. Apparatus comprising a tubular means constructed of heat-conducting material and having a closed end and an open end, a vaporizable, pressure transmitting liquid in said tubular means, a float member in the said liquid in said tubular means and movable in and out of the said closed end, the surface of the float member being in close proximity to the wall of the tubular means to form a thin film of the liquid between the surface of the float member and the said wall, and means adjacent the closed end for heating the liquid at intervals in the film in said closed end to cause flashing of part of the liquid into vapor during application of heat and to cause movement of the unvaporized liquid and of the said float away from the closed end, the cessation of heat application causing return of the

liquid to the closed end during non-application of heat by condensation of the vaporized liquid, the said tubular means and its contents being mounted on a free end of a horizontally supported flexible tube having connection with the said tubular means for free passage of liquid in and out of said tubular means, the said tubular means and the said end of said flexible tube being in a raised position when liquid has been

5 moved out of the tubular means and being in a lowered position when liquid fills the tubular means, and means actuated by raising and lowering of said end of said flexible tube for providing heat in the said heating means when the tubular means is in said lowered position and for cutting off heat when the said tubular means is in said raised position.

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