May 24, 1938. C. E. MEYERHOEFER 2,118,263

HEAT TRANSFER APPARATUS

Filed Feb. 16, 1938 2 Sheets-Sheet 1

Fig. 1

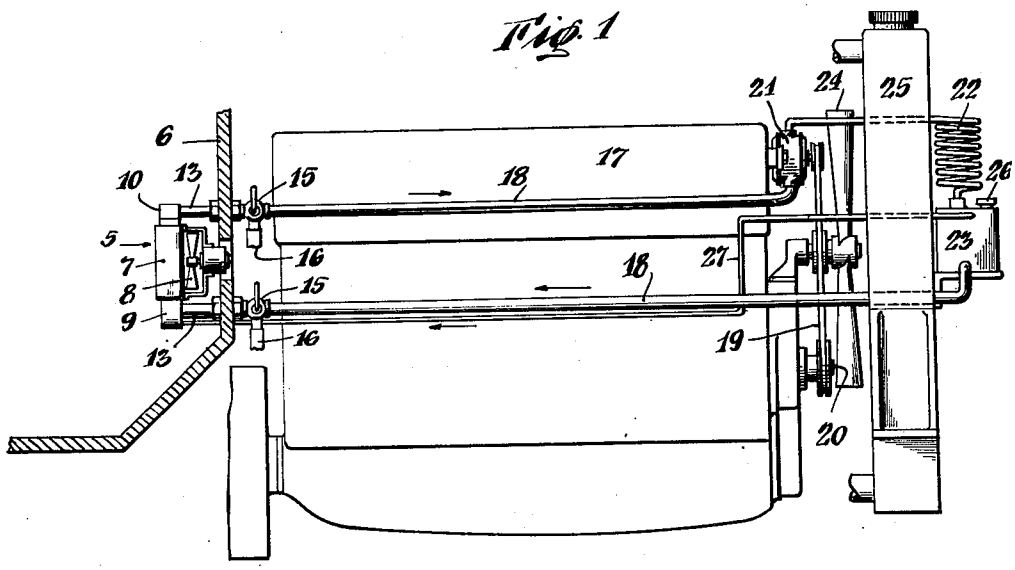


Fig. 2

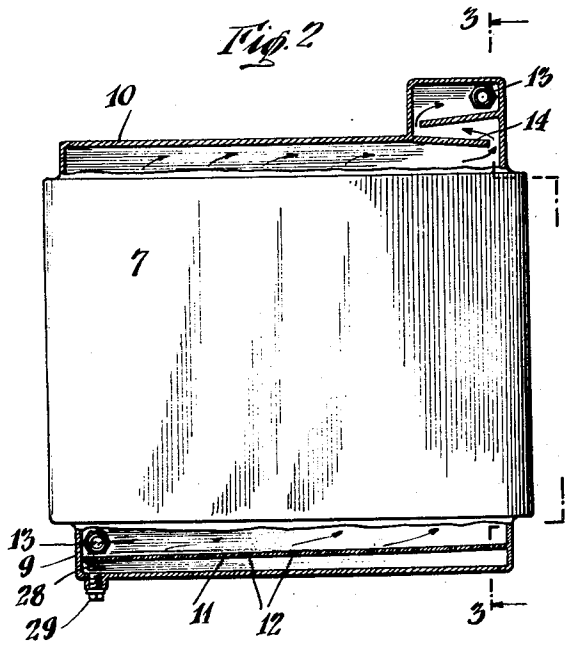
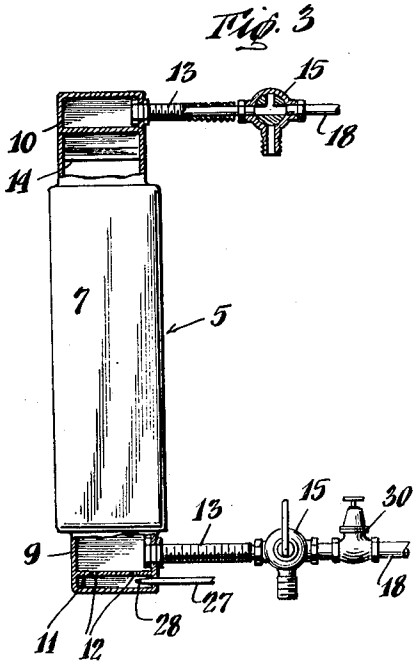


Fig. 3



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Filed Feb. 16, 1938 2 Sheets-Sheet 2

Fig. 4

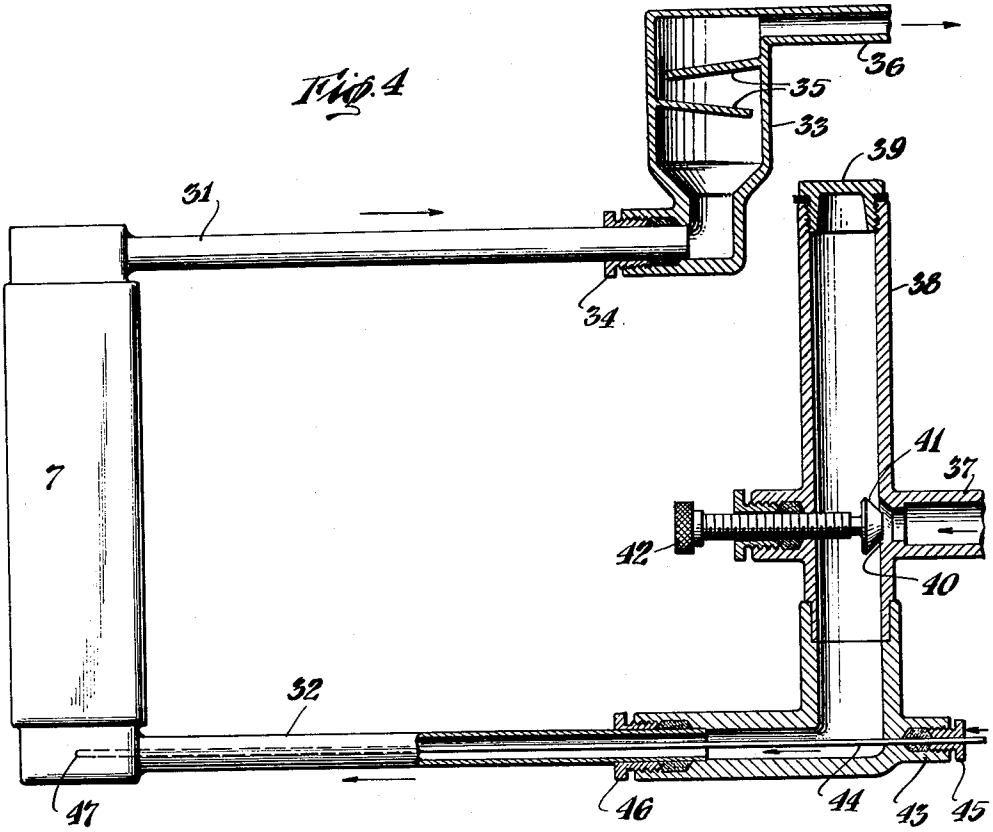
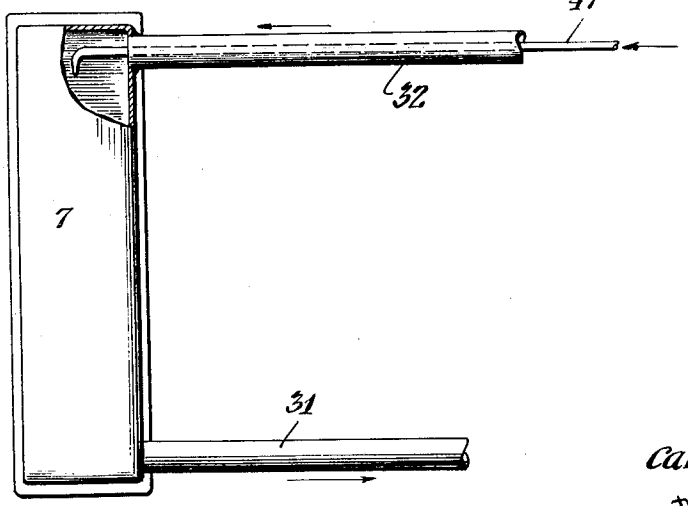


Fig. 5



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2,118,263

UNITED STATES PATENT OFFICE

2,118,263

HEAT TRANSFER APPARATUS

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Application February 16, 1938, Serial No. 190,732

16 Claims. (Cl. 62—117)

This invention relates to a structurally and functionally improved heat transfer apparatus, capable of use in numerous different associations, but primarily intended for employment with motor driven vehicles such as automobiles.

It is an object of the invention to provide a unit of this character which, under cold weather operating conditions, will serve to raise the dry bulb temperature of an enclosure such as the body of a vehicle, and which under high temperature conditions will function to lower the temperature of such enclosure.

Thus, by means of a unit which, to all intents and purposes, will, from the user's standpoint, be nothing more than the conventional automobile heater, it will be possible to provide not alone for winter operating conditions, but the comfort of the user may be catered to under all summer operating conditions.

A further object of the invention is that of furnishing a system as part of an apparatus and by means of which operating expense will be reduced to a negligible factor. Additionally, the layout of the system and the materials preferably employed will be such that even if leakages occur, the user will not be subjected to any dangerous conditions in that the invention contemplates a system in which no noxious or other fumes detrimental to health will be generated, nor will there be any fire hazard present. In addition, no caustic or acid materials will be employed so that objections in this connection will also be avoided.

A still further object is that of furnishing a layout of apparatus which will function in an automatic manner such that extreme and objectionable conditions will at no time be encountered.

Another object is that of providing a heat exchange apparatus which may, with facility, be converted to function as desired under winter and summer operating conditions. This transfer or adjustment may, moreover, be effected by relatively unskilled persons and at minimum expense.

An additional object is that of teaching a method of operating a heat transfer system such that under no circumstances can dangerous operating conditions come into being, such method being capable of being practiced by virtue of the structure embodied in the present apparatus.

Still another object is that of manufacturing mechanism of this type which contains relatively few parts each individually simple and rugged in construction and capable of manufacture at nominal expense; the mechanism operating over long periods of time with freedom from all difficulties.

With these and other objects in mind, reference is had to the attached sheets of drawings illustrating practical embodiments of the invention and in which:

Fig. 1 is a diagrammatic representation of the forward section of a motor vehicle and showing a layout of apparatus in association therewith;

Fig. 2 is a fragmentary face view of the heat exchange unit which may be employed;

Fig. 3 is taken along the lines 3—3 and in the direction of the arrows of Fig. 2;

Fig. 4 shows an alternative form of apparatus, and

Fig. 5 is a plan view of a unit thereof.

As before brought out, the invention is not necessarily limited or confined to use in connection with motor vehicles, although in certain respects this is a preferred embodiment thereof. As will be hereinafter apparent, the teachings of the present invention could be advantageously utilized in numerous different associations where it is desired to effect a lowering of the dry bulb temperature. The invention has been illustrated and hereinafter described in its preferred embodiment. It is to be distinctly understood, however, that this is to be regarded as illustrative rather than in a limiting sense, except where otherwise indicated in the appended claims.

Thus, in these several views no attempt has been made to show in detail the apparatus involved. Suffice it to say that if the apparatus (as shown) is employed in association with a motor vehicle, such as an automobile, the heat transfer unit 5 is located on the passenger side of the dash 6 and may generally embrace a structure such as has been shown in my prior Patent 2,087,160 of July 13, 1937. Such a unit includes, of course, a core 7 of any desirable construction and which presents interstices or passages for the flow of air as induced by a motor driven air impeller 8. This core has disposed adjacent its lower edge a head 9 and along its upper edge a head 10. Partially or wholly dividing the lower head is a plate 11 formed with a series of perforations 12. Fluid is conducted through tubes 13 conveniently located adjacent opposite corners of the apparatus.

At this time also it will be observed, as in Figs. 1 to 3, that the head 10 may conveniently include a trap structure embracing as shown a pair of baffles 14 arranged to capture or divert any large particles of liquid entrained within the fluid flowing to the upper pipe or tube. Also, it will be observed that the lower tube 13 preferably

communicates with header 9 at a point above plate 11.

Tubes 13 may be coupled by means of three-way valves 15 to hose or tube sections 16 connected in any desired number of ways with the cooling system of a motor 17. Under these circumstances it will be understood that water will be diverted from such cooling system, pass through the unit 5, and return to the cooling system. Consequently, with the air impeller 8 operating, the air within the compartment beyond dash 6 will be warmed in the usual and well known manner.

However, valves 15 may be adjusted so that the fluid circulating through the unit 5 will flow through tubes 18 which may be in the form of hose sections. Suitably driven as for example by a belt 19 extending from a power driven shaft 20 projecting beyond the motor is a centrifugal blower or compressor 21. This element discharges into a condenser 22 associated with, or in turn coupled to, a tank 23. Both the condenser and the tank may be located in line with the fan 24 which cools radiator 25, but such location should preferably be in advance of the cooling radiator. In this connection it will be understood that most modern automobiles provide ample space between the protective grille (not shown) and the cooling radiator 25 to accommodate units of this nature. Consequently neither the condenser nor the tank 23 will be affected by the heat transferred from radiator 25.

Of course, the condenser and tank may conveniently be located or associated with portions of the fuel or carbureter system (again not shown), so that they will be subjected to the lowest possible dry bulb temperature. In any event, however, tank 23 may conveniently be provided with a filler plug 26 and the level of the tank should be such that with the installation extending in a normal horizontal plane, the upper edge of such tank—or in any event the location of the filler opening—should be in the same plane as the upper edge of the core 7 or within the area of the upper header 10. Accordingly, an operator, in charging the system by pouring liquid into the tank 23 until, for example, the liquid is level with the opening, will know that the system has been charged to a proper extent, and thereupon plug 26 may be re-applied.

Conveniently extending from the condenser-tank assembly and connected thereto is a tube 27. The entrance to this tube may be guarded in any desirable manner (not shown) to prevent the flow of liquid therethrough. As illustrated, the tube extends through to the lower end of head 9 and below plate 11 and may have a nozzle-shaped end, as indicated at 28.

Now it has heretofore been noted how the system functions in a conventional manner if it is desired to discharge heated air through unit 5. It has also been noted that when summer operating conditions are encountered and it is desired to discharge cooled air through the unit, valves 15 are either closed or the hose sections 16, or their equivalents, are uncoupled from the unit and tubes or hose sections 18 are coupled to the same. It is, of course to be understood that at that time unit 5 is drained by, for example, removing plug 29 and flushing the unit until all liquid is discharged therefrom. Thereupon, plug 29 or its equivalent is caused to seal the unit and the operator proceeds to charge the system in the manner before described through, for example, tank 23, so that the desired results are achieved.

Numerous liquids may be employed in effecting such charging. It is preferred, however, that a refrigerant be utilized of the chloro hydro-carbon group. Specifically the liquid which has in most respects been found to be satisfactory is methylene chloride which is commonly marketed under the trade-mark "Carrene" and involves CH_2CL_2. Under atmospheric pressure this liquid has a boiling point of 103.46° F. and possesses the virtue of being non-inflammable and non-caustic or otherwise injurious in addition to the fact that even if vaporized and breathed into the lungs it will cause no injurious effects unless it is in a highly concentrated form. At the same time it possesses a characteristic odor, so that if by any possible chance a leak should occur, the occupant of the vehicle would quickly become aware of such leakage and could immediately take steps to remedy the condition.

It is finally to be observed that tube 27 should present an effective cross-sectional area such that it is more than the equivalent area of the aggregate perforations 12, so that pressure may be built up below the plate 11; the perforations thus acting as an expansion valve between the upper and lower sections of head 9. Specifically, it has been found that if tube 27 has an effective area of ¼ inch the perforations may conveniently be 1/100 of this area and in aggregate present a passage which will be $\frac{3}{16}$ of an inch. Again, in connection with tube 18 there should be provided a constricted portion such that an expansion valve effect is produced. Instead of simply constricting the tube it may be most desirable to associate therewith a valve 30 which is adjusted to furnish the expansion effect. Of course, where the perforated plate, having perforations as before taught, is imployed, it is not necessary to embody in the tube 27 or its nozzle an expansion valve structure or function, in that this will be provided for as the air passes through the perforations 12.

In any event, it will be remembered that with the system charged as before described, the level of the methylene chloride will be substantially adjacent the base of the head 10. With the motor 17 operating, the centrifugal compressor 21 will function to cause, for example, a vacuum of five inches within tube 18 and head 10. Incident to the provision of the expansion valve effect in head 9 and the constricted portion or expansion valve 30, it will be found that a pressure exists within the condenser-tank assembly of, for example, two pounds, or higher; this being largely dependent upon the temperature of the air or other cooling medium in contact with the condenser 22. From this assembly air will flow through tube 27 and the condensed liquid will return to unit 5 through tube 18. Air discharged by tube 27 will flow through nozzle 28 (if the latter is provided) and upwardly through perforations 12, through the body of the liquid within the core. Having in mind that the core and the upper head thereof are subjected to a vacuum, the liquid will "boil" or evaporate and the temperature of unit 5 will quickly drop. Thereupon the vapor will flow through the trap structure indicated at 14 and, as before brought out, any large particles of liquid will be diverted back to the core. The vapor will flow through upper tube 18, again through the centrifugal blower pump, and thence to the condenser 22, and so to tank 23, repeating the cycle indefinitely.

It has been found that, under ordinary conditions and with the air impeller 8 operating, the

temperature of the core will be reduced to approximately 40° F. and that such temperature will be maintained. However, and under certain weather conditions, it might be that the occupant of the car will not have the impeller 8 operating. Thus substantially no heat transfer would be occurring in connection with unit 5. Thus, the system will continue to function and the temperature of the boiling liquid will quickly become lowered and this condition, if permitted to continue, might lead to damage to the parts, but in any event would certainly result in an objectionable building up of frost on the unit 5 which inevitably would drip from the unit with consequent complaint on the part of the user. This frost would, of course, build up in proportion to the humidity content of the air, but except in very dry climatic conditions would be objectionable in that the temperature of the core would rapidly fall below the freezing point.

With a view to overcoming these objections I have employed a relatively constricted tube 27 or else have used care to see that the nozzle or discharge end 28 of the same be constricted to, for example, the size indicated (¼ inch). It is apparent that at the time of filling the system, a certain amount of air will enter the same and this air naturally will have some moisture content. Additionally, under ordinary conditions, a minute but appreciable quantity of water will be found within the system. This amount, while small, will still be adequate to safeguard and control the operation of the system because it is found that with the impeller 8 inoperative and as soon as the temperature of the unit 5 drops to approximately 16° F. the end of tube 27 will gradually have built up within it a minute ice plug which will constantly reduce the effective area of the tube until finally air ceases to be discharged from tube 27. Thereupon the temperature of the core 5 will rapidly rise and usually, when such temperature has reached 35° F., the small ice plug will melt or become freed, whereupon air will again be discharged through tube 27 and the temperature of unit 5 will again drop, resulting in a repetition of the cycle. Thus, the temperature range of unit 5 without the impeller operating will vary for example between 16° and 35° F. Under ordinary conditions, however, and as before brought out, with the impeller functioning the unit 5 will remain at a temperature of approximately 40° F.

Of course, under certain circumstances the question of the lowering of the temperature of unit 5 to the minimum level and the formation of frost may be of no consequence, or may, in fact, be desired. If such is the case, it is obvious that either by proportioning the parts so that it is difficult, if not impossible, for an effective plug to be built up within the tube 27, or else by taking care that all water within the system is discharged, the formation of the ice plug may be prevented.

In conclusion it will, of course, be appreciated that as before brought out, in lieu of employing an expansion valve such as 30, tubes 18 or 13, or a continuation thereof, may simply be formed to produce this effect. Likewise, while in most respects it is preferred that a plate 11 be employed, a substitute structure might be utilized. Thus, it is apparent that if the plate is provided, it should preferably be inclined upwardly and away from the discharge end 28 of the tube 27 so as to assure an even distribution of air throughout the entire length of the core. However, a more or less satisfactory effect can be achieved by simply constricting the tube 27 preferably adjacent its discharge end so as to duplicate the function of an expansion valve. It will, of course, be understood that with the unit operating to heat the air, the tube 27 is—in any suitable manner—rendered inoperative to pass air through to the core.

Now referring to Figs. 4 and 5 it will be noted that there has been shown an apparatus embodying the present invention but the structure of which has been modified so that the invention may be applied to heat exchange units as heretofore constructed for use in automobiles. With this thought in mind, the numeral 7 indicates the core as heretofore identified and from which tubes 31 and 32 extend.

However, instead of building the trap structure as part of the unit, this structure is embraced within a casing 33 coupled to tube 31 by any suitable type of packing 34. This casing has within it any proper baffling structure 35 and from the same there extends a tube 36 connected to the vacuum pump or unit as heretofore described. Also, as heretofore described, there will be situated beyond the vacuum pump or its equivalent a condenser-tank assembly and the latter will be connected by a tube 37 to, for example, a unit 38 having a plug or cap 39 extending into a proper horizontal plane. As afore brought out, this plane should be substantially the same as that into which the upper head of the heat transfer unit 7 extends, so that by removing the plug 39 the entire system may be filled with refrigerant to a proper level. Tube 37 may have a constricted portion as afore brought out, which will function as an expansion valve. However under ordinary conditions it is preferred to provide a suitable valve seat 40 adjacent the end of tube 37 and with which there may cooperate a valve body 41 shifted by a control 42. Casing 38 is extended and coupled to tube 32 as, for example, by means of a packing assembly 46. The member 38 is also provided with an extension 43 through which a tube 44 extends into the tube 32. Again, at this point packing 45 may be employed.

Suffice it to say, however, that while tube 44 preferably terminates in a nozzle portion 47, the length of the latter and the diameter of the tube are less than the internal diameter of tube 32. As a consequence the air pipe 44 may without difficulty be inserted into the tube 32 to occupy a position such that the nozzle will lie within the lower head of the unit 7.

Thus it is obvious that the present invention may be adapted to units as heretofore in existence without the necessity of the purchaser having to replace these units. This will effect a considerable saving and it will be an easy matter for a mechanic or owner to simply strip off the conventional hose fittings, couple the hose up to the cooling system of the car, and to apply packings 34 and 46, together with the mechanism positioned beyond them.

In both of the apparatus assemblies heretofore described, it will be obvious that the system functions as follows: air saturated with refrigerant vapor is compressed and passed through the condenser in which most of the refrigerant vapors are deposited to flow into the tank, the air of course still being saturated with vapor consistent with its particular pressure and temperature. This saturated compressed air is per-

mitted to expand incident to the expansion valve, constricted nozzle, perforations of the plate 11, or any equivalent structure, and against the resistance of the liquid refrigerant within the evaporator. Incident to this step the air becomes cold. Since expansion has taken place, this air is no longer saturated at its new pressure and can therefore absorb considerably more vapor in its path through the liquid. This in turn causes the liquid refrigerant to evaporate rapidly, thereby absorbing heat from the surrounding space; the vapor mixture now under sub-atmospheric pressure passing along to the compressor and the cycle is repeated.

From the foregoing it will be understood that in certain respects the system embodied within the present invention may be likened to a "dense air" refrigerating system. Viewed from other aspects it might be likened to a compression-refrigeration system while in other respects it follows the teachings of the so-called vacuum type refrigeration principle and/or a combination of any or all of these systems. Thus, the compression cycle will be perfectly obvious when one considers the differentials of pressure, the cooling, and the expansion valve effect achieved by the present structures. The vacuum effect is likewise obvious when one considers the vacuum to which the body of liquid is subjected and the fact that air is permitted to expand upwardly throughout the liquid body and to cause evaporation of the latter. Finally, with respect to the air refrigeration (dense-air cycle) it is believed that it will be likewise obvious when one considers that the air is compressed, cooled, and expanded, and while being expanded performs the actual physical work of displacing or lifting a column or columns of liquid (the refrigerant within the evaporator). The analogy between thus lifting liquid as against expanding a metallic piston, appears to be obvious.

It will be apparent that in a specific system such as is proposed, it would be difficult to evacuate the air. Thus, not alone is this difficulty avoided and evacuation rendered unnecessary, but in fact the air within the system, instead of being a detriment, is actually put to work to reduce the temperature.

It is obvious that numerous changes in construction and rearrangement of the parts might be resorted to without departing from the spirit of the invention as defined by the claims.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A heat transfer unit including a core, a head disposed below said core and in fluid communication therewith, a tube through which liquid may flow to said head and core, a further tube associated with said head and providing an air passage for the discharge of air into the body of said liquid and upwardly through said core, and a perforated plate interposed between said tubes and extending longitudinally of said head, said air tube being located below said plate.

2. A heat transfer unit including a core, a head disposed below said core and in fluid communication therewith, a tube through which liquid may flow to said head and core, a further tube associated with said head and providing an air passage for the discharge of air into the body of said liquid and upwardly through said core, and a perforated plate interposed between said tubes and extending longitudinally of said head, said air tube being located below said plate, the aggregate area of the perforations of said plate being less than the effective cross-sectional area of said air conducting tube.

3. A heat exchange unit including a core, a head disposed below said core, a liquid conducting tube connected to said head, an air tube also connected to said head and of restricted area in comparison with the effective area of said liquid conducting tube, a further head connected to the upper end of said core, a vapor conducting tube coupled to said latter head adjacent its upper end, a perforated plate disposed within the lower head and between the air and liquid conducting tubes, the former being disposed below said plate, and means associated with said upper head to prevent particles of liquid entrained within the vapor from passing through to the tube connected to said upper head.

4. A heat exchange system for use in connection with automobile and similar installations, said system including a heat transfer unit for placement within a space, the air of which is to be conditioned, air impelling means associated with said unit to cause air to move in heat exchange relationship therewith, tubes extending from and connected to the upper and lower portions of said unit, vacuum creating means coupled to the upper of said tubes, a condenser receiving vapor from said vacuum creating means, a tank to receive condensate from said condenser, means coupling said tank to the lower tube of said unit to cause liquid to flow towards the same, means for conducting air to the lower end of said unit from said tank, and means associated with said last named means and said liquid conducting tube and functioning in each instance as an expansion valve for fluid flowing through said unit.

5. A heat exchange system for use in connection with automobile and similar installations, said system including a heat transfer unit for placement within a space, the air of which is to be conditioned, air impelling means associated with said unit to cause air to move in heat exchange relationship therewith, tubes extending from and connected to the upper and lower portions of said unit, vacuum creating means coupled to the upper of said tubes, a condenser receiving vapor from said vacuum creating means, a tank to receive condensate from said condenser, a tube coupling said tank to the lower tube of said unit to cause liquid to flow towards the same, a further tube connected to said condenser and tank and to the lower end of said unit whereby air may flow from the former to the lower end of the latter, and means associated with said further tube and said liquid tube and functioning as expansion valves.

6. A method of operating a heat transfer unit to cool a given space and which includes evaporating a refrigerant within said unit and under conditions of vacuum by passing through the refrigerant within said unit a stream of air bubbles, removing the mixture of air and resultant vapor from said unit and condensing the resultant vapor, returning the condensate towards said unit under conditions of pressure, also returning the air after such condensation to said unit to again pass through the body of liquid within said unit, releasing the pressure to which said air and returning liquid are subjected, in passing such returned air through an orifice sufficiently small to permit of the latter becoming plugged with ice as said refrigerant decreases its temperature below a predetermined point whereby to interrupt the passage of air through said refrigerant, and

thereby permitting said refrigerant to increase its temperature above the melting point of ice resulting in an unplugging of said tube and a further flow of air through said refrigerant.

7. An apparatus of the character described including, in combination, means producing a vacuum, a condenser-tank assembly, a tube extending from such assembly and providing a passage for the flow of liquid, said vacuum producing means and tube being adapted for coupling to the outlet and intake tubes of a heat exchange unit, such as is employed in a motor vehicle, an air tube having one of its ends connected to said condenser-tank assembly and of a diameter such that it may be introduced into the intake tube of said unit, and means associated with said air tube and the liquid conducting tube extending from said assembly and functioning as expansion valves.

8. An apparatus of the character described including, in combination, means producing a vacuum, a condenser-tank assembly, a tube extending from such assembly and providing a passage for the flow of liquid, said vacuum producing means and tube being adapted for coupling to the outlet and intake tubes of a heat exchange unit such as is employed in a motor vehicle, an air tube having one of its ends connected to said condenser-tank assembly and of a diameter such that it may be introduced into the intake tube of said unit, and means functioning as an expansion valve and associated with said air tube.

9. An apparatus of the character described including a trap member for preventing the flow through its body of liquid particles entrained within vapor, vacuum producing means connected to said trap member, a condenser-tank assembly receiving the vapor from said trapping member, a tube extending from said assembly to conduct liquid therefrom, an air tube also connected to said assembly, said latter tubes being adapted for coupling with the lower tube of a heat exchange unit such as is associated with a motor vehicle, and said trapping member being adapted for coupling to the upper tube of such unit.

10. A heat exchange system including a heat transfer unit for placement within a space, the air of which is to be conditioned, said unit being formed with passages through its body and through which air to be conditioned is to pass, inlet and outlet tubes connected to said unit, means associated with the outlet tube for preventing a flow of liquid through the same, means connected to said latter tube for creating in said tube and said unit an absolute pressure of predetermined value and less than atmospheric, a condenser-tank assembly disposed beyond said means and within which an absolute pressure of higher value than that within said unit is to be established by said means, means for conducting condensed liquid from said tank assembly to said inlet tube, separate means for conducting air vapor from said tank assembly to the lowermost portion of said unit, and means associated with both said air conducting means and said inlet tube and having the functions of expansion valves for both said air and returned liquid.

11. A heat exchange system including a heat transfer unit for placement within a space, the air of which is to be conditioned, said unit being formed with passages through its body and through which air to be conditioned is to pass, said body in section presenting substantial width and depth inlet and outlet tubes connected to said unit, means associated with the outlet tube for preventing a flow of liquid through the same, means connected to said latter tube for creating in said tube and said unit an absolute pressure of predetermined value and less than atmospheric, a condenser-tank assembly disposed beyond said means and within which an absolute pressure of higher value than that within said unit is to be established by said means, means for conducting condensed liquid from said tank assembly to said inlet tube, separate means for conducting air vapor from said tank assembly to the lowermost portion of said unit, means associated with both said air conducting means and said inlet tube and having the functions of expansion valves for both said air and returned liquid, and means forming a part of said system and assuring a contact of the air injected into the unit throughout substantially all portions of the liquid contained within the same.

12. A method of operating a heat transfer unit to cool a given space and which method includes evaporating a refrigerant within said unit, passing an inert gas through said refrigerant while maintaining said refrigerant and gas under an absolute pressure less than atmospheric, withdrawing the resultant fluid from said unit and compressing the same to have an absolute pressure greater than that to which it is subjected within said unit, condensing the liquid within said fluid, returning all of such condensed liquid towards said unit and under the aforesaid conditions of higher absolute pressure, causing all of the gas within said fluid and separate from said liquid to likewise flow towards said unit under such conditions of higher absolute pressure, subjecting both the gas and liquid flowing towards said unit to a reduction in pressure, releasing the gas into said fluid and within said unit under the initially stated and reduced absolute pressure conditions, and in causing air within the space within which said unit is disposed to flow in heat exchange relationship with the surfaces of said unit.

13. An attachment to be coupled to the intake and outlet tubes of a heat exchange unit such as is employed in a motor vehicle, said attachment comprising a vacuum producing pump, a condenser-tank assembly coupled to and receiving the discharge from said pump, a tube extending from said tank to conduct liquid therefrom, a pipe having one of its ends coupled to the condenser-tank assembly for conducting vapor therefrom, means for detachably coupling said liquid conducting tube to the inlet tube of said unit and the end of said pipe being of a size such that it may extend into said inlet tube, further means for detachably coupling the intake of said pump with the outlet tube of said unit, and means associated with said air pipe and having the function of an expansion valve.

14. An attachment to be coupled to the intake and outlet tubes of a heat exchange unit such as is employed in a motor vehicle, said attachment comprising a vacuum producing pump, a condenser-tank assembly coupled to and receiving the discharge from said pump, a tube extending from said tank to conduct liquid therefrom, a pipe having one of its ends coupled to the condenser-tank assembly for conducting vapor therefrom, means for detachably coupling said liquid conducting tube to the inlet tube of said unit and the end of said pipe being of a size such that it may extend into said inlet tube, further means for detachably coupling the intake of said pump

with the outlet tube of said unit, a nozzle portion forming a part of said pipe and within said unit, and means whereby said pump may be detachably connected with a prime mover to be operated thereby.

15. An attachment to be coupled to the intake and outlet tubes of a heat exchange unit such as is employed in a motor vehicle, said attachment comprising a vacuum producing pump, a condenser-tank assembly coupled to and receiving the discharge from said pump, a tube extending from said tank to conduct liquid therefrom, a pipe having one of its ends coupled to the condenser-tank assembly for conducting vapor therefrom, means for detachably coupling said liquid conducting tube to the inlet tube of said unit and the end of said pipe being of a size such that it may extend into said inlet tube, further means for detachably coupling the intake of said pump with the outlet tube of said unit, means associated with said air pipe and having the function of an expansion valve, and a trap member interposed between the outlet of said unit and said pump for preventing particles of liquid from flowing from said unit into said pump.

16. A method of operating a heat transfer unit to cool a given space and which includes evaporating a refrigerant within said unit and under conditions of vacuum by passing through the refrigerant within said unit a stream of air bubbles, removing the mixture of air and resultant vapor from said unit and condensing the resultant vapor, returning the condensate towards said unit under conditions of pressure, also returning the air after such condensation to said unit to again pass through the body of liquid within said unit, releasing the pressure to which said air and returning liquid are subjected, in interrupting such air flow through the body of liquid upon the refrigerant reaching a temperature below a predetermined point, thereby permitting said refrigerant to raise its temperature, and to thereupon re-establish a further flow of air through said refrigerant.

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