

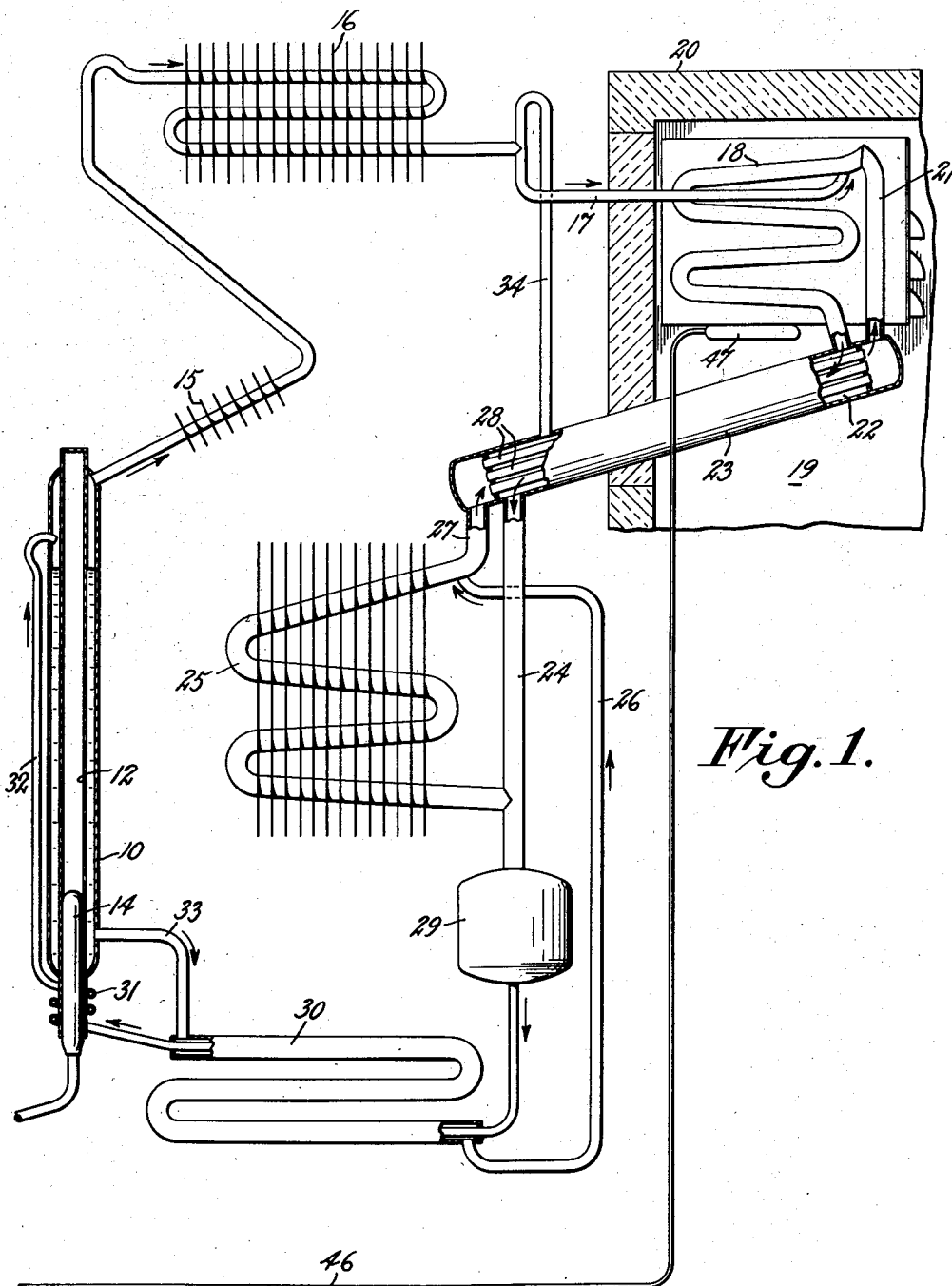
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G. GRUBB ET AL
HEAT TRANSFER SYSTEM

Filed March 20, 1937

2,269,101

4 Sheets-Sheet 1



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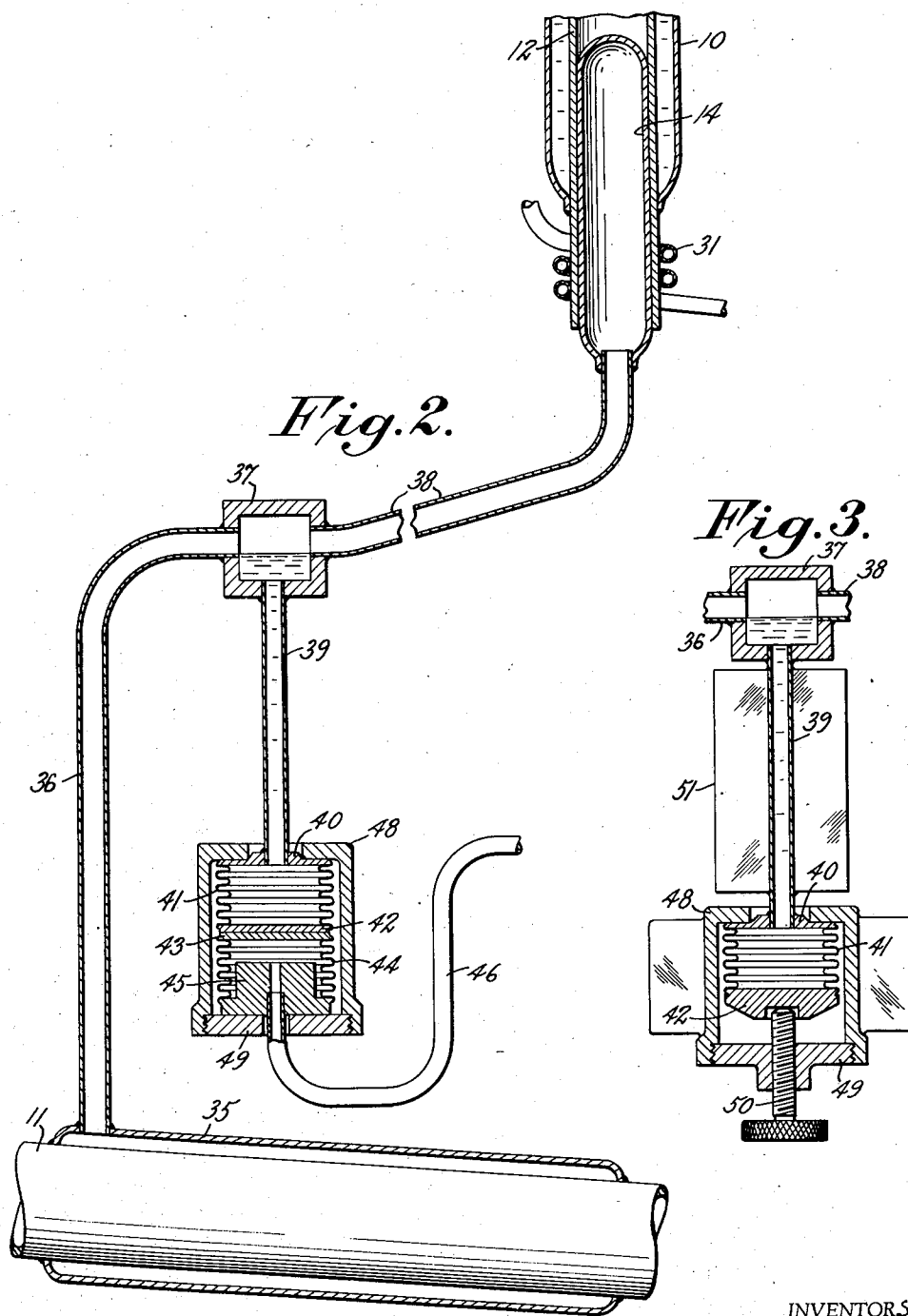
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4 Sheets-Sheet 2



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HEAT TRANSFER SYSTEM

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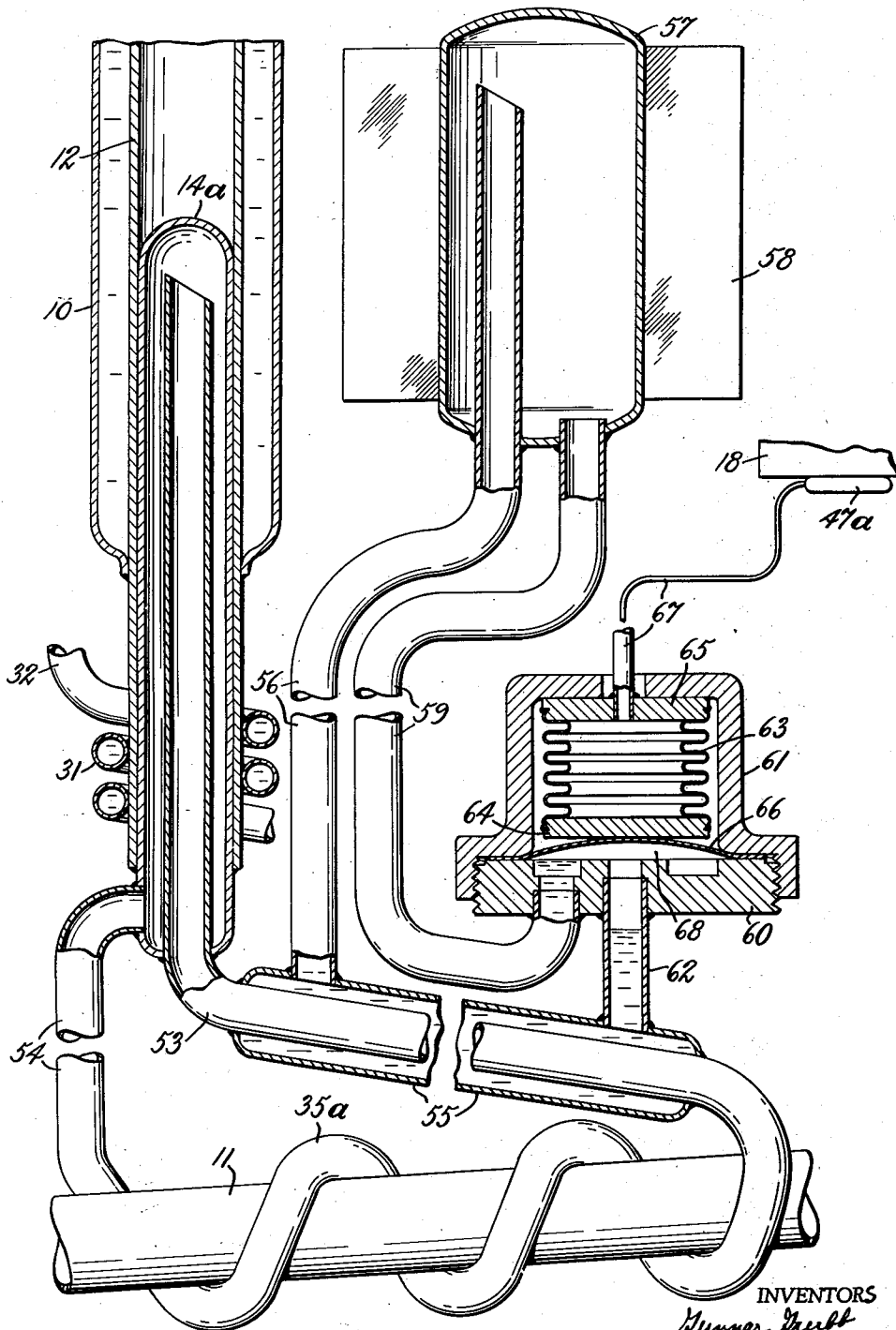


Fig. 4.

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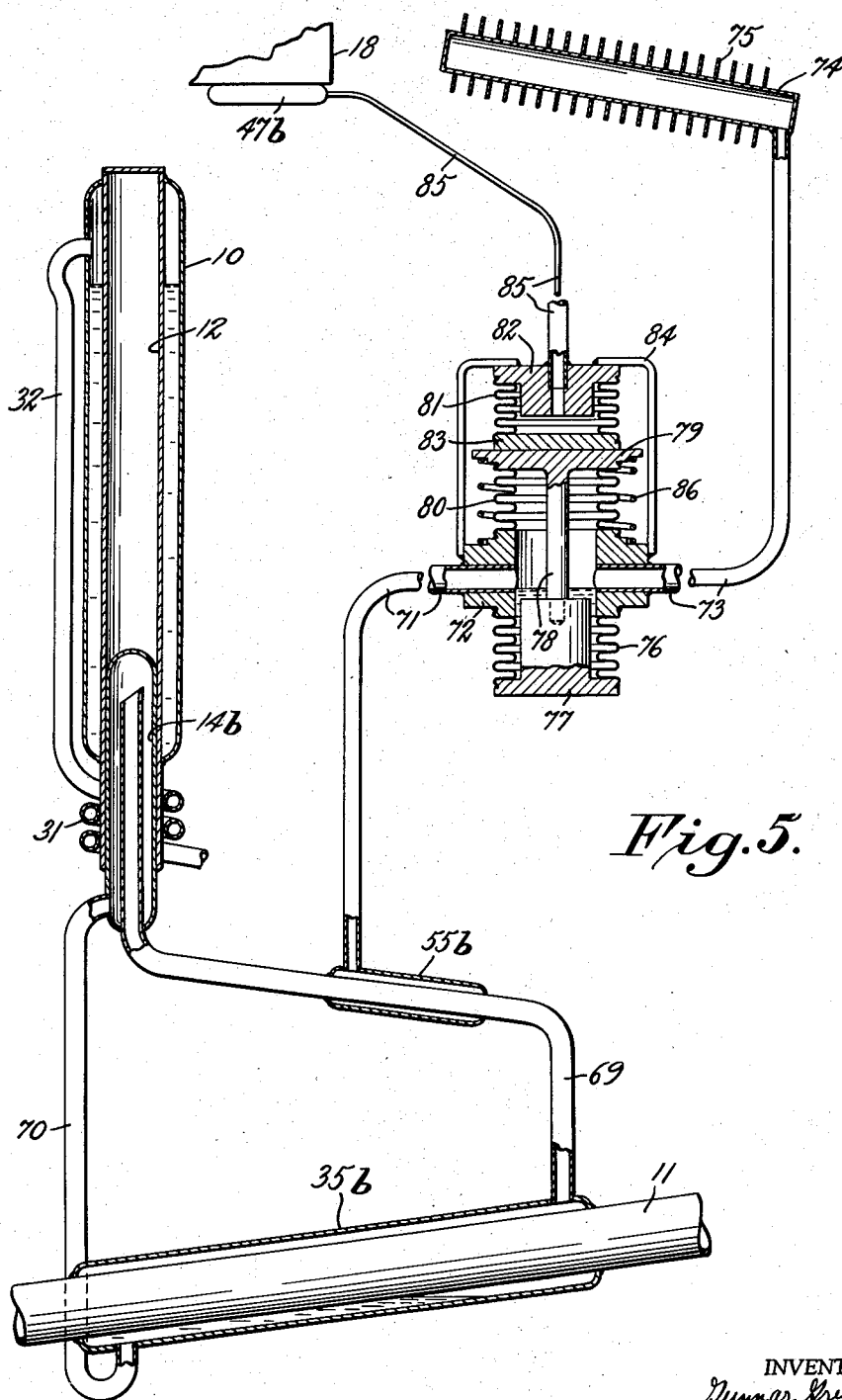


Fig. 5.

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UNITED STATES PATENT OFFICE

2,269,101

HEAT TRANSFER SYSTEM

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Application March 20, 1937, Serial No. 132,016
In Germany March 28, 1936

12 Claims. (Cl. 62—5)

This invention relates to heat transfer systems, and more particularly to the art of transferring heat from an available heat source to a place of heating where it may be effectively utilized.

It is an object of this invention to provide an improvement in heat transfer systems whereby the transfer of heat from a suitable source to a place of heating may be reliably and safely controlled independently of the source of heating. We accomplish this by providing an improved heat transfer system, containing a fluid for transferring heat from an available source to a place of heating, which is so constructed and arranged that a portion thereof effective to control the rate of heat transfer is maintained at a lower temperature or both at a lower temperature and pressure than the portion thereof in which the fluid normally circulates to transfer heat.

The above and other objects and advantages of our invention will become apparent from the following description, taken in conjunction with the accompanying drawings forming a part of this specification, and of which Figs. 1 and 2 taken together diagrammatically illustrate an embodiment of our invention for automatically controlling the transfer of heat from a suitable heat source to refrigeration apparatus operated by heat; Fig. 3 is a fragmentary view diagrammatically illustrating a modification of the embodiment shown in Figs. 1 and 2 for manually controlling the transfer of heat; and Figs. 4 and 5 are fragmentary views diagrammatically illustrating modifications of the embodiments shown in Figs. 1 and 2.

Referring to Figs. 1 and 2, we have shown our invention in connection with absorption refrigeration apparatus to the generator 10 of which heat is transferred from a source of heat 11. The heat source 11 is indicated as a pipe which may be connected to an internal combustion engine (not shown) and through which the hot exhaust gases from the latter are discharged. Instead of utilizing the exhaust gases of an internal combustion engine as the primary source of heat, the waste heat from any other available or primary heat source may be used, such as, for example, the waste heat of gases of furnaces, stoves, or heating plants. The refrigeration apparatus we have shown is of a uniform pressure absorption type, generally as described in Patent 1,609,334 to von Platen and Munters, in which an auxiliary pressure equalizing gas is employed. It is to be understood, however, that

our invention can be employed to transfer heat to other apparatus, such as hot water heaters and the like, for example, as well as other types of refrigeration apparatus operated by heat.

The refrigeration apparatus shown includes the generator 10 containing a refrigerant, such as ammonia, in a body of absorption liquid, such as water. The generator 10 is provided with an annular sleeve 12 which is closed at its upper end and within the lower end of which is arranged a heating element 14 forming part of my heat transfer system, hereinafter to be described.

The heat applied to the generator 10 and its contents expels the ammonia out of solution, and the ammonia vapor flows upward through an air cooled rectifier 15 in which accompanying water vapor is condensed and drains back to the generator 10. The expelled ammonia vapor is liquefied in an air cooled condenser 16, and flows therefrom through a conduit 17 into the upper end of an evaporator or cooling element 18. The evaporator 18 is disposed in an enclosed space 19 which may form a food storage compartment of a thermally insulated refrigerator cabinet 20.

An auxiliary agent or inert gas, such as hydrogen, enters the upper end of the evaporator 18 through a conduit 21. Liquid ammonia evaporates and diffuses into the hydrogen with consequent absorption of heat from the surroundings of the evaporator 18. The resulting rich gas mixture of ammonia and hydrogen flows from the evaporator 18 through an outer passage 22 of a gas heat exchanger 23 and vertical conduit 24 into the lower end of an air-cooled absorber 25. Ammonia is absorbed out of enriched gas mixture into weak absorption liquid which enters the upper part of the absorber 25 from conduit 26. The hydrogen, which is practically insoluble and weak in ammonia, passes upward from the absorber 25 through a conduit 27, a plurality of parallel tubes 28 which form the inner passage of the gas heat exchanger 23, and conduit 21 into the upper end of the evaporator 18.

Absorption liquid in the absorber 25 becomes enriched in ammonia and passes through the lower end of conduit 24 into an accumulation vessel 29. From the vessel 29 the enriched absorption liquid flows through the inner passage of a liquid heat exchanger 30 to a coil 31, and is raised by vapor-lift action through conduit 32 into the upper part of the generator 10. Absorption liquid weak in ammonia flows from the

lower part of the generator through a conduit 33, outer passage of the liquid heat exchanger 30, and conduit 26 into the upper end of absorber 25.

The lower end of the condenser 16 is connected by a conduit 34 to the gas circuit, as at the gas heat exchanger 23, for example, so that any non-condensable gas which may pass into the condenser can flow to the gas circuit and not be trapped in the condenser.

In accordance with our invention, the heat transfer system for transferring heat of the gases passing through the pipe 11 to the refrigeration apparatus includes an evaporation member 35 which is in the form of a jacket surrounding the pipe 11. The evaporation member 35 is closed at one end and connected at its other end by a vertical conduit 36, vessel 37, and conduit 38 to the condenser member 14 which serves as the heating element of the generator.

The vessel 37 is connected to the horizontally disposed ends of the conduits 36 and 38, and to the lower part thereof is connected a downward extending vertical conduit 39. The lower end of conduit 39 is connected to the upper end plate 40 of an expansible bellows 41. The lower end plate 42 of the expansible bellows 41 bears against the upper end plate 43 of a second expansible bellows 44. To the lower end plate 45 of the bellows 44 is connected one end of a tube 46 which is connected at its other end to a bulb 47 secured to and in thermal exchange relation with the cooling element 18, as shown in Fig. 1. The expansible bellows 41 and 44 may be maintained in abutting relation within a shell 48 having a removable cover 49. The evaporation member 35, vessel 37, condenser member 14, and connecting conduits 36, 38 and 39 form a hermetically sealed circuit adapted to contain a suitable volatile fluid for transferring heat from the pipe 11 to the generator 10; and the bellows 44, tube 46, and bulb 47 constitute an expansible fluid thermostat which is filled with a suitable vapor or liquid for controlling the transfer of heat responsive to the temperature of the cooling element or evaporator 18.

When the apparatus associated with the pipe 11 is being operated, the liquid in jacket 35 is evaporated due to the high temperature of the gases discharged through the pipe 11. The vapor passes upward through conduit 36, vessel 37, conduit 38 and into the member 14 in which it is condensed. The vapor condensed in the member 14 flows downward through conduit 42 and back to the jacket 35 and is again evaporated. It will therefore be understood that an evaporation-condensation circuit has been provided in which the fluid serves as a heat transfer agent which circulates naturally in a closed system. The evaporation of the liquid in the member 35 takes up heat from the hot gases discharged through the pipe 11, and the condensation of the vapor in the member 14 gives up heat to the generator 10 and its contents to expel refrigerant out of solution from the absorption liquid, whereby refrigeration is produced in the storage compartment 19 to maintain the latter at a desired low temperature.

The temperature at which the generator 10 is maintained is dependent upon the amount of liquid in the evaporation-condensation circuit. When all of the liquid in member 35 has evaporated due to the high temperature of the gases passing through pipe 11, the density of the vapor in the circuit has attained its maximum value

and no further heat transfer can momentarily take place due to evaporation of liquid. The quantity of heat transferred from the pipe 11 to the generator 10, and hence the temperature of the latter, therefore, is governed by the amount of liquid in the active portion of the system in which circulation takes place. The maximum temperature at which generator 10 can be maintained is determined by the instant when the density of vapor is at its maximum value and no evaporation of liquid takes place in member 35. With complete evaporation of liquid in member 35, heat momentarily is not transferred to the generator 10, and the transfer of heat is again resumed when liquid returns to evaporation member 35.

By providing the vessel 37, downward extending conduit 39, and expansible bellows 41, the amount of liquid in the active portion of the system can be regulated to control the quantity of heat transferred from the pipe 11 to the generator 10 and hence the temperature at which the latter is maintained. In order to control automatically the quantity of liquid in the active portion of the heat transfer system, movement of the expansible bellows 41 is effected by the expansible fluid thermostat including the bellows 44, tube 46 and thermal bulb 47.

When the cooling element 18 tends to decrease below a desired low temperature, the vapor or liquid in the bulb 47, tube 46, and bellows 44 becomes reduced in volume, whereby the bellows 44 contracts and permits the expansible bellows 41 to expand. This lowers the level of liquid in vessel 37 from that shown in Fig. 2, and liquid condensate formed in the condensation member 14 and flowing toward member 35 is trapped in the vessel 37 to increase the quantity of liquid which is held in the stagnant portion of the system. This prevents liquid from returning to the evaporation member 35 until the liquid in vessel 37 has risen to such a level that it will again overflow into conduit 36 and flow back to the evaporation member 35. Since a part of the liquid previously in the active portion of the system is trapped in vessel 37 and less liquid can return to the member 35, the maximum temperature at which the generator 10 can be maintained is decreased. This maximum temperature, as explained above, is dependent upon the maximum vapor pressure that can be attained by the liquid remaining in the system when all of the liquid in the evaporation member 35 has evaporated. With less heat transferred to generator 10 from the pipe 11, less refrigerant is expelled out of absorption liquid, and the refrigerating effect produced by the cooling element 18 is reduced.

When the temperature of the cooling element 18 tends to increase above the desired low value, the vapor or liquid in the expansible fluid thermostat increases in volume and causes the expansible bellows 44 to expand. Expansion of the bellows 44 causes the bellows 41 to contract whereby liquid is caused to overflow from vessel 37 into conduit 36. This increases the amount of liquid in the active portion of the heat transfer system and permits a higher temperature to be maintained at the generator 10. With more heat applied to generator 10, an increased quantity of refrigerant is expelled out of absorption liquid, and the refrigerating effect produced by the cooling element 18 is increased.

The temperature at which generator 10 is maintained may be controlled manually instead of automatically by an expansible fluid thermo-

stat, as just described. Such a modification is shown in Fig. 3 wherein only the expansible bellows 41 is arranged within the casing 48. The length of the expansible bellows 41, and hence the quantity of liquid in the active portion of the evaporation-condensation circuit, is controlled by a screw 50 which extends upward through the removable cover 49 and bears against the lower end plate 42 of the bellows 41.

Although evaporation takes place at the surface of the liquid in vessel 37, this does not affect the operation and control of the evaporation-condensation circuit inasmuch as liquid and vapor in vessel 37 are in thermal equilibrium, and an equal amount of vapor is condensed at the surface of the liquid. The amount of liquid used in the active portion of the system is considerably less than the volumetric capacity of the circuit, and, when using water, for example, it is preferably about one-third of the volumetric capacity. In such case a temperature as high as 200° C. and 250° C. is readily maintained in the condenser 14 to heat the generator 10 and its contents. It should be understood, however, that other fluids may be used in the heat transfer system, such as toluene, for example, having critical pressures and other physical characteristics which are capable of maintaining the condenser member in the desired temperature range for any particular installation. When heat is to be transferred to a hot water heater, a suitable volatile fluid is used to maintain a temperature in the range of 95° C. at the place of heating.

Since the liquid in conduit 39 and expansible bellows 41 is out of direct contact with vapor flowing from evaporation member 35 to condensation member 14, the greater portion of stagnant liquid not in the active portion of the system is at a considerably lower temperature than the temperatures existing in members 35 and 14. In order to maintain the expansible bellows 41 at as low a temperature as possible, conduit 39 may be formed of material having low heat conductivity, such as, for example, German silver or other suitable alloys. If desired, conduit 39 and casing 48 may be provided with fins or cooling elements 51 and 52, respectively, as shown in Fig. 3, to increase the heat dissipating surface of these parts of the heat transfer system. It will now be understood that the portion of the heat transfer system effective to control the transfer of heat to the place of heating is maintained at a lower temperature than the active portion of the system in which the volatile fluid normally circulates. Thus undesirable overheating of the part of the system effecting control of heat transfer is avoided, whereby the rate of heat transfer may be reliably and safely controlled.

In Fig. 4 we have shown a modification which differs from the embodiment just described in that the active portion of the heat transfer system and the portion of the system for controlling the rate of heat transfer do not form a single hermetically closed circuit. With this arrangement the portion of the system for controlling the rate of heat transfer can be maintained at a lower pressure, as well as at a lower temperature, than the pressure and temperature existing in the main or active portion of the system. Only a fragmentary view of the generator 10 of the refrigeration apparatus is shown in Fig. 4 with parts similar to those shown

in Figs. 1 and 2 referred to by the same reference numerals.

The main or active portion of the heat transfer system shown in Fig. 4 includes a member 35a in the form of a helical coil which is in heat exchange relation with pipe 11 through which pass the high temperature gases utilized as the source of heat. The upper end of member 35a is connected to a conduit 53 which extends into the upper part of a member 14a which is similar to the condenser member 14 in Fig. 2. To the lower part of member 14a is connected a downward extending conduit 54 which is connected at its lower end to one end of member 35a.

The portion of the system provided for controlling the quantity of heat transferred from the heat source to the place of heating includes an evaporation member 55 in the form of a jacket disposed about a part of conduit 53. A conduit 56 connected to the upper part of jacket 55 extends upward into the upper part of a vessel 57 which is provided with cooling fins 58. To the lower part of vessel 57 is connected one end of a conduit 59 which is connected at its lower end to an opening in the removable cover 60 of a casing 61. A second conduit 62 connected to an opening in the cover 60 extends downward and communicates at its lower end with an end of the jacket 55.

Within the casing 61 is arranged an expansible bellows 63 having end plates 64 and 65, respectively. The lower end plate 64 is adapted to bear against a flexible diaphragm 66 which is secured to the open end of the casing 61 by the removable cover 60. The diaphragm 66 is normally bowed or arched upward, as shown in Fig. 4, whereby it will normally tend to flex to this position. The upper end plate 65 of bellows 63 is connected to one end of a tube 67 which is connected at its other end to a bulb 47a secured to and in thermal contact with the cooling element 18, in the same manner as the bulb 47 in Fig. 1. The bulb 47a, tube 67, and bellows 63 contain a vapor or liquid which increases and decreases in volume with corresponding changes of temperature.

The main portion of the system including the member 35a, member 14a and connecting conduits 53 and 54 is partly filled with a suitable liquid, as in the embodiment shown in Fig. 2. When high temperature gases pass through pipe 11, liquid in coil 35a is evaporated. The vapor passes upward through conduit 53 and into the upper part of the member 14a in which it is condensed. The vapor condensed in member 14a flows downward from the lower part thereof through conduit 54 and back to coil 35a in which it is again evaporated. The separate closed circuit including the jacket 55, vessel 57, chamber 68 formed by the diaphragm 66 and cover 60, and connecting conduits 56, 59 and 62 contain a suitable fluid which evaporates in the jacket 55. The vapor formed in jacket 55 passes upward through conduit 56 into the vessel 57 in which it is condensed. When the diaphragm 66 is in the flexed position shown in Fig. 4, condensed vapor flows from vessel 57 through conduit 59, chamber 68, and conduit 62 into jacket 55 in which it is again evaporated.

When a heat transfer system of the character just described is utilized to transfer heat to absorption refrigeration apparatus, it is necessary to maintain the condenser member 14a at a temperature as high as 200° C. and 250° C. The pressure in the main system at this tempera-

ture is relatively high, such as, for example, above 20 atmospheres. In this modification a liquid is employed in the separate hermetically closed circuit which, at 100° C., for example, has a pressure of one or two atmospheres. The maximum temperature and pressure in the separate closed circuit can be controlled by the quantity of liquid introduced in this circuit.

When the cooling element 18 is at the desired low temperature the vapor or liquid in the expansible fluid thermostat is of such volume that the expansible bellows 63 is effective to maintain the diaphragm 66 in its lower position to shut off flow of liquid from conduit 59 to conduit 62. Under these conditions whatever liquid there is in jacket 55 is evaporated and the vapor thus formed flows upward into vessel 57. The vapor in vessel 57 is condensed, and, since the lower end of conduit 59 is closed by the diaphragm 66, liquid will collect in conduit 59. With no liquid in jacket 55 all of the heat supplied to liquid in coil 35a to effect evaporation thereof is transferred to the condenser member 14a. In such case the separate closed circuit including the jacket 55 has practically no influence on the quantity of heat transferred in the primary system from pipe 11 to generator 10.

When the cooling element 18 tends to fall below the desired low temperature, the vapor or liquid in the expansible fluid thermostat becomes reduced in volume, whereby the expansible bellows 63 contracts. This permits the flexible diaphragm 66 to move upward to its normal position shown in Fig. 4, whereby liquid in conduit 59 flows through chamber 68 and conduit 62 into jacket 55. The evaporation of liquid in jacket 55 takes up heat from vapor flowing through conduit 53 from coil 35a to member 14a, thereby lowering the temperature of the vapor in the main part of the system. The separate closed circuit including the jacket 55 may be arranged either to effect partial or complete condensation of vapor flowing through conduit 53 due to the heat taken up by evaporation of liquid in jacket 55. By permitting liquid to enter jacket 55 and causing condensation of vapor in conduit 53, the temperature of the condenser member 14a is reduced. With less heat transferred to generator 10 from pipe 11 less refrigerant is expelled out of absorption liquid, and the refrigerating effect produced by the cooling element 18 is reduced.

When the cooling element 18 is again at the desired low temperature, the expansible bellows 63 of the fluid thermostat expands to cause the diaphragm 66 to flex downward and shut off flow of liquid from conduit 59 to conduit 62. Evaporation of liquid continues in jacket 55 until the latter is depleted of liquid, and the vapor condensed in vessel 57 collects in conduit 59.

In some instances it may be desirable to withdraw all of the heat from the primary system at the jacket 55, and to give up such heat at the vessel or condenser 57 to the surrounding cooler air. This is particularly true when a heat transfer system of the type just described is employed with intermittent absorption refrigeration apparatus which operates with alternate periods of absorption of refrigerant and expulsion of refrigerant vapor. A refrigerating system of this type is generally described in Thomas application Serial No. 110,195, filed November 11, 1936. When it is desired to instigate an absorption period and stop the transfer of heat from a heat source to the generator-absorber of the

refrigerating system, the diaphragm 66 may be permitted to flex upward, either manually or by suitable automatic control, whereby circulation of fluid can take place in the separate closed circuit to cause condensation of vapor in conduit 53 at the jacket 55. The quantity of heat withdrawn from the primary or main portion of the system at the jacket 55 may be such that no heat is transferred to the condenser member 14a, thereby permitting cooling of the generator of the intermittent system. With cooling of the generator, refrigerant is absorbed therein and flows from the evaporator into the generator absorber. When it is desired to cause complete condensation of vapor in the primary portion of the system at the jacket 55, the separate closed circuit must be properly dimensioned to insure complete withdrawal of heat that is normally transferred from the heat source to the condenser member. Instead of controlling the separate circuit automatically, as just described, a manually operable valve may be connected in the conduits 59 and 62 to regulate the flow of liquid in the control portion of the system.

The modification shown in Fig. 5 is similar to that illustrated in Fig. 4 and differs therefrom only in the regulating means provided to control the circulation of fluid in the separate control circuit which is preferably maintained at a lower temperature and pressure than the temperature and pressure in the main portion of the system. The main or active portion of the heat transfer system is partly filled with a suitable liquid and includes the jacket 35b, conduit 69, member 14b, and conduit 70.

The separate control circuit is somewhat similar to the primary system shown in Fig. 2 and includes jacket 55b in heat exchange relation with conduit 69 of the primary circuit, conduit 71, vessel or housing 72, conduit 73 and condenser 74 which is provided with cooling fins 75. To the lower part of the housing 72 is secured an expansible bellows 76 having a lower end plate with which is integrally formed a piston 77. When the piston 77 is moved upward or downward due to contraction or expansion of bellows 76, the level of liquid in the lower part of housing 72 and bellows 76 is varied to control the amount of liquid that can flow through conduit 71 into the jacket 55b, in the same manner as the system shown in Fig. 2.

A pin 78 extending upward from the piston 77 is secured to an upper end plate 79 of a second expansible bellows 80. The bellows 80 is secured to the upper part of housing 72, and, together with the bellows 76 forms a chamber which is a part of the separate hermetically closed circuit. A third expansible bellows 81 having upper and lower end plates 82 and 83, respectively, is disposed above the bellows 80. The bellows 80 and 81 are arranged in abutting relation within a casing 84 which may be secured to the housing 72.

To an opening in the upper end plate 82 of bellows 81 is connected one end of a tube 85 which is connected at its other end to a bulb 47b secured to and in thermal contact with the cooling element 18. The bulb 47b, tube 85, and bellows 81 constitute an expansible fluid thermostat similar to the thermostat shown in Fig. 4. A coil spring 86 is disposed about the bellows 80 with the ends thereof secured to the housing 72 and upper end plate 79. The spring 86 is provided to counter-balance the weight of the bellows 80 and 76 and urge the end plate 79 upward when the vapor or liquid in the expansible

fluid thermostat becomes reduced in volume and the bellows 81 is capable of contracting.

By providing the two bellows 76 and 80 and the spring 86, the weight of the regulating means is equalized and the pressure in the separate closed circuit will not affect the operation of the expansible fluid thermostat. Since the bellows 76 and 80 are connected by the pin 78, the volume of the chamber formed by the two bellows 76 and 80 will always be constant irrespective of any variation in length of the bellows.

In this modification, when the cooling element 18 tends to decrease below a desired low temperature, the bellows 81 of the expansible fluid thermostat contracts and permits bellows 80 to expand. This moves the piston 77 upward whereby liquid is caused to overflow from housing 72 into conduit 71 and flow into jacket 55b. The evaporation of liquid in jacket 55b takes up heat from vapor flowing through conduit 69 from member 35b to member 14b, thereby lowering the temperature of the vapor in the same manner as in the modification described above and illustrated in Fig. 4. The vapor formed in jacket 55b flows upward through conduit 71, housing 72 and conduit 73 into condenser 74. The vapor is condensed in condenser 74, thereby giving up and rejecting heat to the surrounding cooler air. Liquid formed in condenser 74 flows downward through conduit 73 and back to the evaporation member or jacket 55b.

When the cooling element 18 is at the desired low temperature, the bellows 81 of the expansible fluid thermostat is effective to contract the bellows 80 and cause piston 77 to move downward. Under these conditions liquid continues to evaporate in jacket 55b until the latter is depleted of liquid. The vapor now condensed in member 74 is trapped in housing 72 and bellows 76, and cannot flow back to the evaporation member 55b. Since liquid cannot return to the member 55b all of the heat supplied to liquid in coil 35b is transferred to the condenser member 14b, and the separate closed circuit has practically no influence on the quantity of heat transferred in the primary system from pipe 11 to generator 10.

In the modifications shown in Figs. 4 and 5 and described above, a safe and reliable regulating means is provided to control the quantity of heat transferred from a heat source to a place of heating. By providing the regulating means in a hermetically closed circuit separate from the main heat transfer circuit, the control portion of the system is not subjected to the high pressures in the main system, and, in addition, is maintained at a considerably lower temperature. In the embodiment shown in Figs. 1 and 2, as well as the modifications of Figs. 4 and 5, the heat transfer systems permit accurate regulation of the quantity of heat transferred to the place of heating even when the primary heat source is of such a character that it is difficult to regulate, such as, for example, the exhaust gases discharged from an internal combustion engine.

In view of the foregoing it will now be understood that we have provided an improved heat transfer system which permits accurate regulation of temperature at the place of heating. Although we have shown several embodiments of our improved heat transfer system, we do not wish to be limited to the particular arrangements set forth, and we intend in the following claims to cover all modifications which do not depart from the spirit and scope of our invention.

What is claimed is:

1. In a method of heating with a source of heat by the aid of a system including two portions in which fluid within one portion of said system is normally caused to circulate to transfer heat from said source to a place of heating, that improvement which consists in utilizing fluid in said one portion to heat fluid within said other portion and external to the path of flow of fluid in said one portion to regulate and vary the quantity of heat reaching the place of heating from said source.

2. A method of transferring heat which consists in evaporating fluid at a place of evaporation associated with a source of heat, flowing vapor from the place of evaporation to a place where heat is rejected, condensing the vapor at the place where heat is rejected, flowing the condensed fluid from the place where heat is rejected to the place of evaporation, flowing fluid external to the path of flow of said vapor and in heat exchange relation therewith at a region between the place of evaporation and the place where heat is rejected, and controlling the flow of said last-mentioned fluid to said region to regulate the quantity of heat reaching the place where heat is rejected from the place of evaporation.

3. A refrigeration system operated by heat and including a cooling element and a heat receiving part, a vaporization member adapted to be heated by a source of heat and a condenser member in thermal exchange relation with said heat receiving part, conduit means connecting said members to form a closed circuit containing a volatile fluid, structure in said circuit from which liquid is adapted to flow to said vaporization member, said structure being constructed and arranged to control flow of liquid to said vaporization member without blocking flow of vaporized fluid from said vaporization member to said condenser member, and means responsive to a temperature condition affected by said cooling element for operating said structure.

4. The combination defined in claim 3 in which said conduit means provides a single path of flow between said vaporization and condenser members whereby vaporized fluid and condensed fluid flow in opposite directions in the presence of each other.

5. A heat transfer system including a vaporization portion and a condenser portion, conduit means connecting said portions to form a circuit for circulation of a volatile fluid, said circuit including a trap adapted to collect condensate flowing from said condenser portion and from which condensate flows to said vaporization portion, said trap having a flexible wall portion, fluid pressure means responsive to temperature for moving said flexible wall portion to control flow of condensate from said trap to said vaporization portion, and means whereby the pressure existing in said circuit will not affect operation of said fluid pressure means.

6. In a system for transferring heat from a source of heat to a heat absorbing element, the combination of a first circuit adapted to contain a fluid and having a part associated with the source of heat and another part associated with said element, said fluid being adapted to circulate in said first circuit to transfer heat from the source of heat to said element, a second circuit containing a fluid and having a heat rejecting part and a part in heat exchange relation with a portion of said first circuit other than

said part associated with said source of heat and said element, the fluid in said second circuit being adapted to circulate therein to transfer heat from said first circuit to a medium in thermal relation with said heat rejecting part, and means for controlling the circulation of fluid in said second circuit to regulate the transfer of heat from the source of heat to said heat absorbing element.

7. A refrigerating apparatus including a part adapted to be heated at a high temperature, a part adapted to absorb heat at a low temperature, a part adapted to give off heat at an intermediate temperature, fluid conveying conduits for connecting said parts together, means for heating the first mentioned part, a closed system having a member arranged to be heated by heat normally utilized by said part adapted to absorb heat at a high temperature, a condenser located at a higher level than said member, conduit means for conducting fluid from said member to said condenser and for conducting fluid from said condenser to said member, said system containing a vaporizable liquid, and means for varying the ratio between the volume of the system and the volume of the liquid therein.

8. A refrigerating apparatus including a part adapted to be heated at a high temperature, a part adapted to absorb heat at a low temperature, a part adapted to give off heat at an intermediate temperature, fluid conveying conduits for connecting said parts together, means for heating the first mentioned part, a closed system having a member arranged to be heated by heat normally utilized by said part adapted to absorb heat at a high temperature, a condenser located at a higher level than said member, conduit means for conducting fluid from said member to said condenser and for conducting fluid from said condenser to said member, said system containing a vaporizable fluid having a large coefficient of expansion, and a hollow member connected to said system and in heat exchange relation with said part adapted to absorb heat at a low temperature, whereby a reduction in temperature of the last mentioned part causes the fluid in said hollow member to contract and thus vary the ratio between the volume of said system and the volume of the liquid therein.

9. A refrigerating apparatus including a part adapted to be heated at a high temperature, a part adapted to absorb heat at a low temperature, a part adapted to give off heat at an intermediate temperature, fluid conveying conduits for connecting said parts together, means for heating the first mentioned part, a closed system having a member arranged to be heated by heat normally utilized by said part adapted to absorb heat at a high temperature, a condenser located at a higher level than said member, conduit means for conducting fluid from said member to said condenser and for conducting fluid from said condenser to said member, said system containing a vaporizable liquid, means for varying the ratio between the volume of the system and the volume of the liquid therein, and means for operating said ratio varying means.

10. In a system for transferring heat from a source of heat to a place of heating, the combination of a first circuit adapted to contain a fluid and having a member associated with the source of heat and another member associated with the place of heating, said fluid being adapted to circulate in said first circuit to transfer heat from the source of heat to the place of heating, a sec-

ond circuit adapted to contain a fluid and having a first part in heat exchange relation with a portion of said first circuit and a second heat rejecting part, the fluid in said second circuit being adapted to circulate therein to transfer heat from said first circuit to a medium in thermal relation with said second heat rejecting part, said second circuit being constructed and arranged to hold at a place removed from said first part fluid in a liquid state returning thereto from said second part, means for controlling the liquid flowing from said holding place to said first part to regulate the quantity of heat transferred from said first circuit to said heat rejecting part, said holding place for liquid including an expansible and contractable element, and said means for controlling the liquid flowing from said holding place including a member operative to regulate said last mentioned element to vary the quantity of liquid capable of being retained in said holding place.

11. In a system for transferring heat from a source of heat to a place of heating, the combination of a first circuit adapted to contain a fluid and having a member associated with the source of heat and another member associated with the place of heating, said fluid being adapted to circulate in said first circuit to transfer heat from the source of heat to the place of heating, a second circuit adapted to contain a fluid and having a first part in heat exchange relation with a portion of said first circuit and a second heat rejecting part, the fluid in said second circuit being adapted to circulate therein to transfer heat from said first circuit to a medium in thermal relation with said second heat rejecting part, said second circuit being constructed and arranged to hold at a place removed from said first part fluid in a liquid state returning thereto from said second part, means for controlling the liquid flowing from said holding place to said first part to regulate the quantity of heat transferred from said first circuit to said heat rejecting part, said holding place for liquid comprising a pair of aligned expansible bellows of which one is disposed below and the other above the liquid level in said holding place, means connecting said bellows whereby the volume of said holding place remains substantially constant irrespective of the lengths of said bellows.

12. In a system for transferring heat from a source of heat to a place of heating, the combination of a first circuit adapted to contain a fluid and having a member associated with the source of heat and another member associated with the place of heating, said fluid being adapted to circulate in said first circuit to transfer heat from the source of heat to the place of heating, a second circuit adapted to contain a fluid and having a first part in heat exchange relation with a portion of said first circuit and a second heat rejecting part, the fluid in said second circuit being adapted to circulate therein to transfer heat from said first circuit to a medium in thermal relation with said second heat rejecting part, said second circuit being constructed and arranged to hold at a place removed from said first part fluid in a liquid state returning thereto from said second part, means for controlling the liquid flowing from said holding place to said first part to regulate the quantity of heat transferred from said first circuit to said heat rejecting part, said holding place comprising a pair of aligned expansible bellows of which one is

disposed below and the other above the liquid level in said holding place, means connecting said bellows whereby the volume of said holding place remains substantially constant irrespective of the lengths of said bellows, resilient means associated with said upper bellows tending to contract said lower bellows, and said means for con-

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trolling liquid flowing from said holding place including a member adapted to act against said resilient means associated with said upper bellows.

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