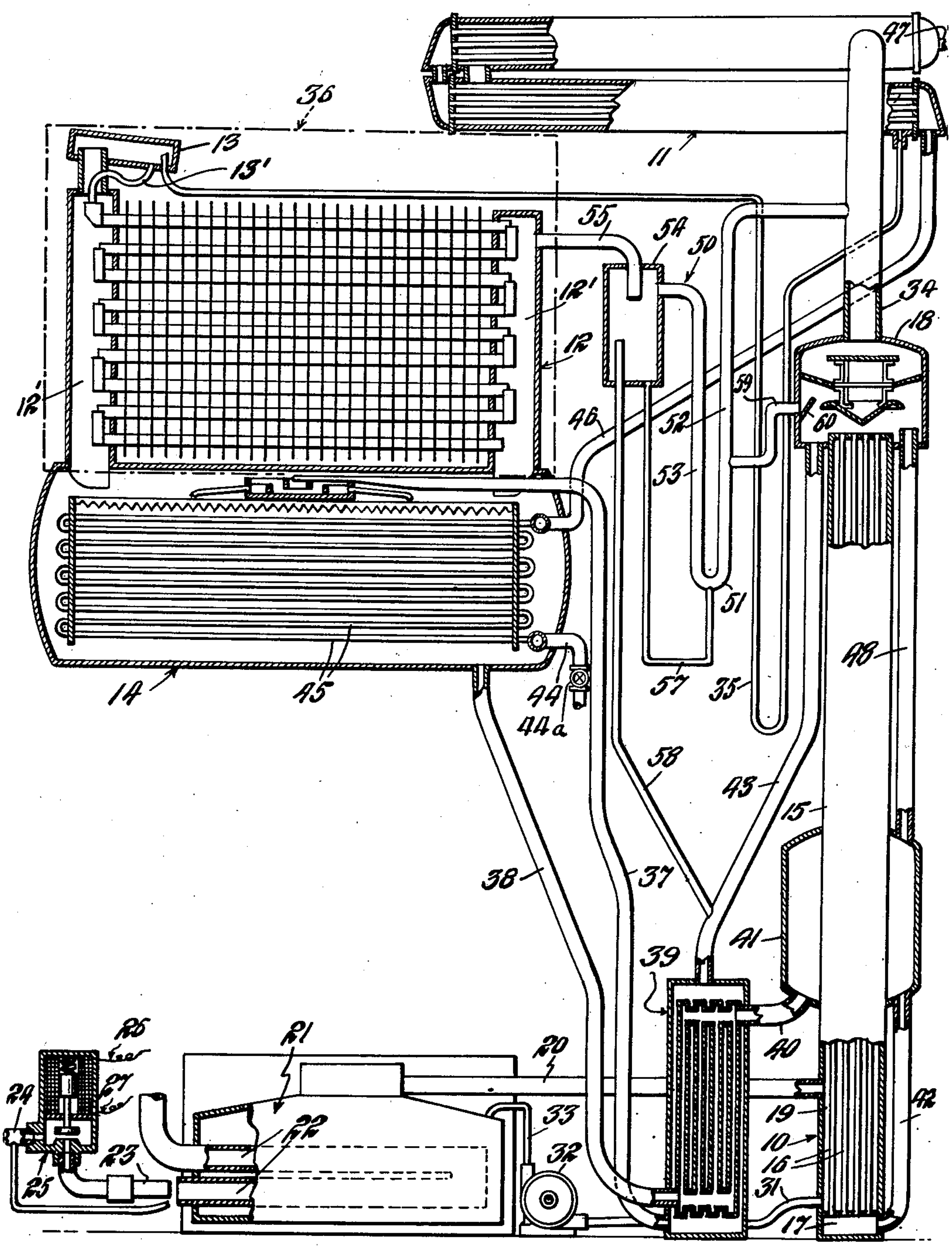
June 19, 1951 T. K. SHERWOOD 2,557,573

AIR CONDITIONING

Filed Aug. 27, 1946



INVENTOR
Thomas K. Sherwood
BY
J. L. Kelly
ATTORNEY

Patented June 19, 1951

2,557,573

UNITED STATES PATENT OFFICE

2,557,573

AIR CONDITIONING

Thomas K. Sherwood, Wellesley Hills, Mass., assignor to Servel, Inc., New York, N. Y., a corporation of Delaware

Application August 27, 1946, Serial No. 693,317

1 Claim. (Cl. 257—9)

1

This invention is a method of and an apparatus for both heating and cooling. Hot vapor is utilized as the heating medium and liquid refrigerant formed from the same vapor does the cooling, one or the other as may be desired being supplied to a heat exchanger. The novelty resides in the changing back and forth between hot vapor and liquid refrigerant and making available in the heat exchanger the necessary quantities of one or the other to do a good job of both heating and cooling without having to depend upon valves or other mechanical contrivances in the fluid circuits of the apparatus.

Since low pressures and harmless fluids are much to be desired in apparatus in our homes, I prefer to utilize a vacuum type apparatus which provides water for cooling and water vapor at sub-atmospheric pressure for heating. Accordingly, one way to enjoy the invention is to take an absorption type water refrigerating apparatus, for instance, like that described in Patent No. 2,282,503 of A. R. Thomas and P. P. Anderson, Jr., and make some connections which permit flow of a lot of hot water vapor from the boiler to the evaporator for making the latter a good heater, but which connections are sealed when water is supplied to the evaporator for its usual cooling function.

The invention, together with its objects and advantages, is set forth in more technical detail in the following description and the accompanying drawing in which the single figure shows more or less diagrammatically a dual function apparatus of this invention.

Referring to the drawing, the apparatus shown comprises basically a two pressure water absorption type refrigerating unit generally as described in said Patent No. 2,282,503. An apparatus of this type operates below atmospheric pressure and includes a generator 10, a condenser 11, an evaporator 12 and an absorber 14 which are interconnected in such a manner that, when operating as a cooling unit, flow of fluid between the high and low sides of the apparatus is regulated by liquid columns. By "condenser" as applied to the element 11 is meant the refrigerant liquifier for cooling operations. By "evaporator" as applied to element 12 is meant the heat exchanger or air contact coil which functions as an evaporator or cooling element during cooling periods of operation, and as a condenser or heat radiator during heating periods of operation.

The generator 10 includes an outer shell 15 within which are disposed a plurality of vertical riser tubes 16 having the lower ends thereof communicating with an inlet chamber 17 and the upper ends thereof extending into and above the bottom of a separating vessel 18. A space 19 within shell 15 and about the tubes 16 forms a steam chamber to which steam is supplied through a conduit 20 from a steam boiler 21. The boiler 21 is provided with fire or heating tubes 22 which are adapted to be heated by the products of combustion from a gas burner 23. A combustible gas is delivered to burner 23 from a source of supply through a conduit 24 in which is provided an electro-magnetically-operated valve 25 connected by conductors 26 and 27 to a suitable source of electrical energy. The water in boiler 21 is heated by the hot gases passing through the heating tubes 22, thereby producing steam which flows through conduit 20 to generator 10. The steam is produced at suitable pressures, so that the apparatus may operate as a heating unit as well as a cooling unit. Condensate formed in steam chamber 19 is returned to boiler 21 through a conduit 31, a condensate return pump 32 and a conduit 33.

2

The system contains a water solution of refrigerant in absorbent liquid such as, for example, a water solution of lithium chloride or lithium bromide or a mixture of the two. With steam supplied through conduit 20 to space 19, heat is applied to tubes 16 whereby water vapor is expelled from solution. The residue absorption solution is raised by gas or vapor-lift action with the expelled water vapor forming a small core within an upwardly rising annulus of the solution. The expelled water vapor rises more rapidly than the solution with the solution flowing along the inside walls of the tubes 16.

The water vapor flows upwardly through the tubes or risers 16 into vessel 18 which serves as a vapor separator. Due to baffling in vessel 18, water vapor is separated from raised absorption solution and flows through conduit 34 into condenser 11. The liquid refrigerant formed in condenser 11 flows through a pressure-balancing U-tube 35 into a flash chamber 13 and from there the liquid refrigerant flows through a conduit 13' into the upper part of evaporator 12. U-tube 35 has an internal cross-sectional area so small as to present sufficient resistance to limit vapor flow therethrough when no liquid is contained therein and thus produce sufficient pressure in the condenser that condensation of vapor is effected during cooling periods of operation. The small cross-sectional area of U-tube 35, on the other hand, presents substantially no resistance to flow of liquid therethrough. The refrigerant evaporates in evaporator 12 with consequent absorption of heat to produce a refrigerating effect which is utilized to cool an air stream flowing through a duct 36, which duct is indicated in dotted lines in the drawing.

The refrigerant vapor formed in evaporator 12 flows into headers 12' at each end of the evaporator and from there to the absorber 14 in which the vapor is absorbed by the absorption solution which enters the upper part of the absorber through a conduit 37. The absorption solution enriched in refrigerant is conducted from absorber 14 through a conduit 38, an inner passage in a liquid heat exchanger 39, a conduit 40, a stabilizing vessel 41, and a conduit 42 into chamber 17 of generator 10. Refrigerant vapor is expelled out of solution in generator 10 by heating, and the solution is raised by gas or vapor-lift action in riser tubes 16, as explained above.

The absorption solution weak in refrigerant which has been lifted in the riser tubes 16 into vessel 18 flows therefrom through a conduit 43, an outer passage in liquid heat exchanger 39, and conduit 37 into the upper part of absorber 14. This circulation of absorption solution results from the rising of solution in riser tubes 16, whereby such solution can flow to the absorber and return from the latter to the generator by force of gravity. The upper part of vessel 41 and vessel 18 are connected by a vent conduit 48

When the apparatus is operating as a cooling unit, the absorber 14 and condenser 11 constitute heat rejecting parts of the refrigeration apparatus and are cooled by a suitable cooling medium such as water, for example, which is conducted from a suitable source of supply through a conduit 44 to a bank of tubes 45 within the absorber, whereby heat of absorption is given up to the cooling water. The cooling water is conducted from the absorber through a conduit 46 to condenser 11 in which heat of condensation is given up to the cooling water. The cooling water leaves the condenser through a conduit 47. Conduit 44 is provided with a suitable valve 44*a*, for cutting off the supply of cooling water to the absorber and condenser during heating periods of operation.

In accordance with this invention a vapor by-pass, designated generally by numeral 50, is connected between vapor conduit 34 and the evaporator 12 for flow of hot water vapor from generator 10 to the evaporator. The by-pass includes a liquid trap 51 comprising a downleg 52 connected to conduit 34 and an upleg 53 connected to a reservoir or separating vessel 54, which vessel is connected by a conduit 55 to one of the vapor manifolds 12' of the evaporator. A second liquid trap 57 is connected between the bottom of trap 51 and the bottom of vessel 54. An overflow conduit 58 connects vessel 54 with the conduit 43 which conveys absorption solution from the separating vessel 18 to the liquid heat exchanger 39. A conduit 59 connects separating vessel 18 to the downleg of trap 51. A baffle or lip 60 is provided in separating vessel 18 at the entrance of conduit 59 for trapping absorption solution and leading it into this conduit. It is to be noted that absorption liquid enters vessel 18 from riser tubes 16 with sufficient velocity that it rises an appreciable distance in this vessel and due to the baffle arrangement in the vessel a small amount of solution is continuously trapped and led into conduit 59.

On cooling cycles of operation the hydrostatic

head from the bottom of trap 51 to the level of the bottom of vessel 54 when filled with absorption solution must be at least as great as the maximum pressure differential encountered on cooling cycles of operation. Assuming that the trap 51 is filled with solution, the level of solution in downleg 52 will depress when a cooling cycle is commenced, and the level of solution in the uplegs of traps 51 and 57 will rise as the pressure rises in the generator 10 and condenser 11. When the pressure in the condenser reaches condensing pressure for the cooling water temperature the vapor will begin to condense and no further depression of liquid level will take place in downleg 52. The condensed refrigerant passes through the U-trap 35 into the evaporator 12. If a previous shut-down followed a cooling cycle of operation there will be sufficient absorption solution in trap 51 to fill vessel 54 up to the top of overflow conduit 58 almost immediately and then any additional absorption solution flowing from the separating vessel 18 through conduit 59 into trap 51 will flow through trap 57 into vessel 54 from whence it overflows into conduit 58. The diameter of the conduit which forms liquid trap 51 should be of such size that absorption solution which backs out of vessel 54 through trap 57 into trap 51 on shut-down periods will not rise in conduit 52 to the point that it overflows through conduit 59 into vessel 18 and robs the trap of solution. Otherwise it would be necessary to establish trap 51 at the beginning of each cycle of operation.

At the beginning of a heating cycle of operation, as the pressure rises in the generator 10 and condenser 11, the pressure in the evaporator 12 will not continue to rise as the pressure there is set by the condensing pressure for water vapor at the temperature of air passing over the evaporator to be heated. The liquid level in downleg 52 will then depress and the level will rise in upleg 53 of trap 51 and in the upleg of trap 57. Since the cooling water to the condenser has been cut off, the pressure in the generator will continue to rise and the level of solution in downleg 52 will fall until it reaches the bottom of trap 51. This will allow vapor to begin to flow from conduit 34 through downleg 52 into upleg 53 and the solution in upleg 53 will either be pumped into separating vessel 54 or it will fall back to the bottom of trap 51 and be forced from there through trap 57 into vessel 54. So long as the resistance to vapor flow from the bottom of trap 51 to separating vessel 54 through conduit 53 is not greater than that corresponding to the hydrostatic head between the bottom of trap 57 and the level of solution in vessel 54 the vapor will all pass into vessel 54 through conduit 53. The vapor flows from vessel 54 through conduit 55 into the evaporator heater 12' and from there into the evaporator tubes wherein the vapor is condensed giving up its heat of condensation to the air flowing over the tubes thereby heating the air. The condensate formed in the evaporator flows into the absorber and from there it is returned to the generator, or, if preferred, the condensate may be returned to the bottom of the generator by a separate conduit, not shown.

During heating cycles of operation most of the solution will separate from the vapor at the bottom of trap 51 and flow through trap 57 into vessel 54 and from there through overflow conduit 58 into conduit 43. If the resistance to vapor flow through upleg 53 is not great enough to correspond to the hydrostatic head of trap 57 some solution would stand in upleg 53 and be carried along with the vapor through this conduit into vessel 54 sufficient to raise the resistance to the above mentioned value. If this requires more solution than is delivered from the separating vessel 18 through conduit 59, the additional solution will fall back from vessel 54 through trap 57 into the bottom of trap 51. The volume of liquid in the vessel 54 up to the top of the overflow conduit 58 should be such that on shut-down this liquid will be sufficient to fill trap 51 with that required to fill upleg 53 from the bottom of trap 51 to the level of the bottom of vessel 54 and also to fill trap 57.

Upon a sudden switch from a cooling cycle to a heating cycle the pressure in the condenser rises until vapor starts passing through the upleg 53 and the operation will continue as explained above. A sudden switch from a heating cycle to a cooling cycle will result in a decreased pressure differential across trap 51 below that corresponding to the hydrostatic head from the bottom of trap 51 to the solution level in vessel 54. Solution will then back out of vessel 54 through trap 57 and into the bottom of trap 51 and at first some solution may be pumped through upleg 53 into vessel 54 allowing some passage of vapor to the evaporator. However, this solution will return constantly through trap 57 into the bottom of trap 51 and the resistance to flow of vapor caused by this solution will soon be high enough to cause condensation of vapor in the condenser 11. Vapor flow through trap 51 will them cease and the condensate formed in the condenser will flow through the U-trap 35 into the evaporator, as previously explained. The trap 57 should be of sufficient cross sectional area that resistance to flow of liquid back and forth therethrough is not appreciable so that liquid may flow quickly from vessel 54 through this trap to fill trap 51.

While a single embodiment of the invention has been illustrated and described, it will be apparent that modifications and changes may be made without departing from the spirit and scope of the invention as pointed out in the claim.

What is claimed is:

In an air conditioning system of the type described, an absorption refrigerating apparatus of the two pressure type comprising a generator, a condenser, a heat exchanger, an absorber and conduits interconnecting said elements for flow of a refrigerating medium and an absorption solution and for regulating the flow of fluid between the high and low pressure sides of the apparatus, a by-pass connection between the generator and the heat exchanger for flow of hot refrigerant vapor to the heat exchanger, liquid column forming means in said by-pass for establishing a barrier between the generator and heat exchanger, means for cooling the condenser, whereby refrigerant vapor supplied thereto is liquefied and flows to the heat exchanger wherein the liquid is vaporized to produce a desired cooling effect, and means for discontinuing the cooling of the condenser whereby the pressure in the generator is increased to the extent that the barrier in the by-pass is removed and hot refrigerant vapor flows from the generator to the heat exchanger wherein the vapor is condensed to produce a desired heating effect.

THOMAS K. SHERWOOD.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,019,290	Brace	Oct. 29, 1935
2,064,040	Smith	Dec. 15, 1936
2,365,797	Bichowsky	Dec. 26, 1944
2,402,416	Kogel	June 18, 1946
2,468,104	Phillips	Apr. 26, 1949