Nov. 17, 1942. P. P. ANDERSON, JR 2,302,091

REFRIGERATION

Filed Jan. 23, 1940 2 Sheets-Sheet 1

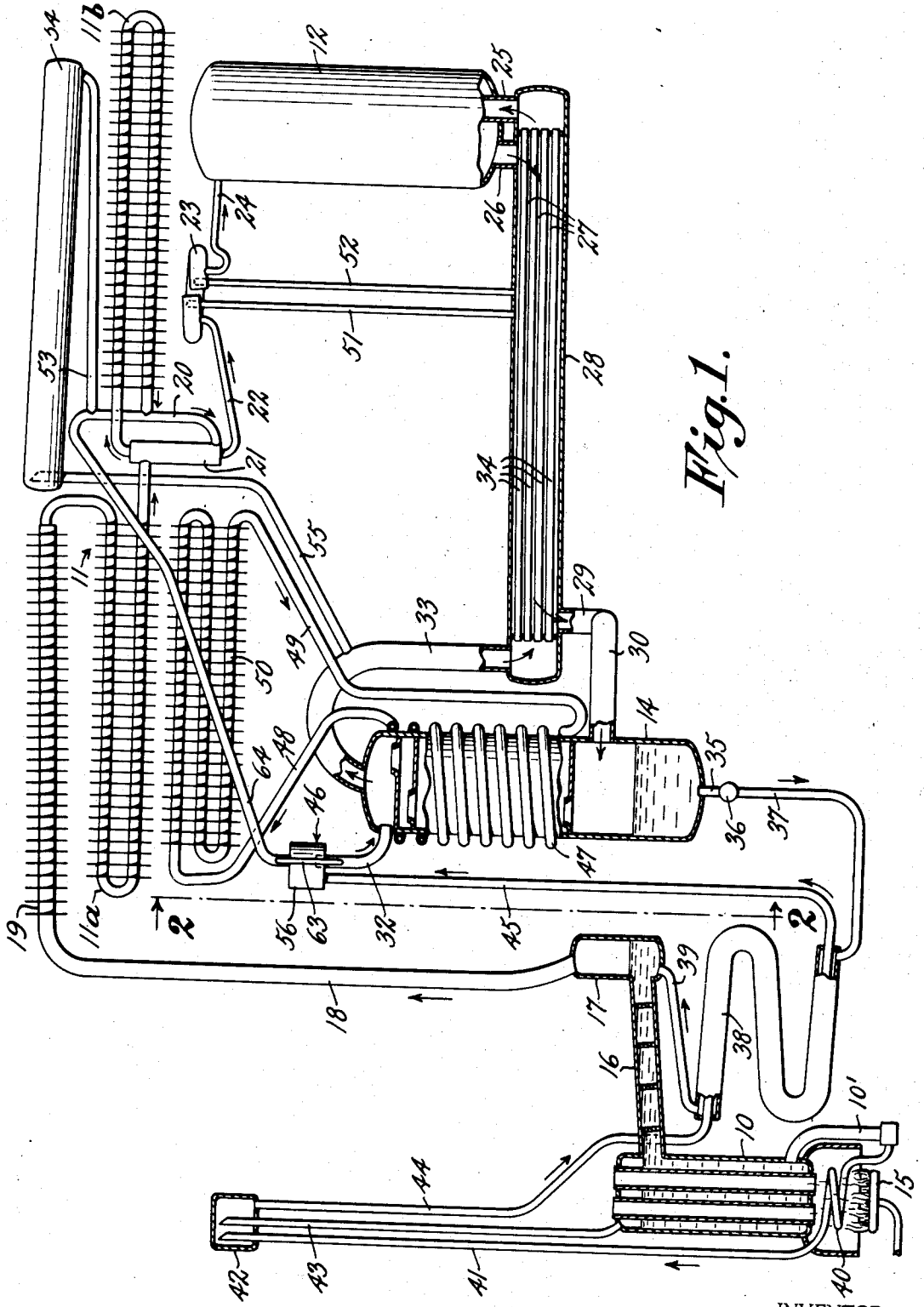


Fig. 1.

INVENTOR.
Philip P. Anderson, Jr.

BY E. A. Fenander
his ATTORNEY.

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Fig. 2.

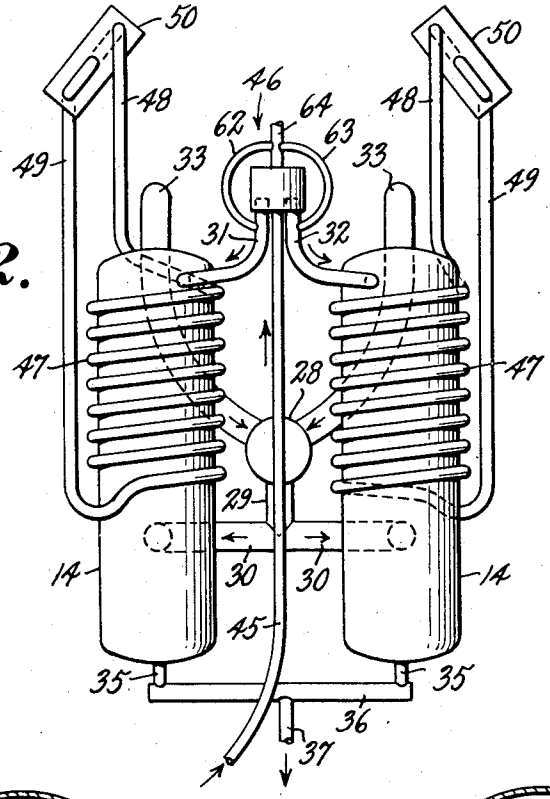


Fig. 3.

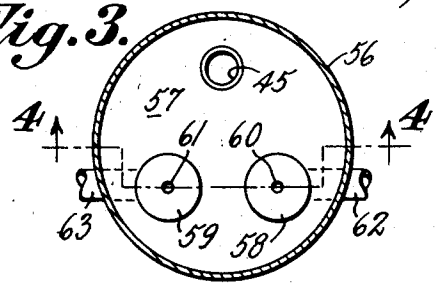


Fig. 5.

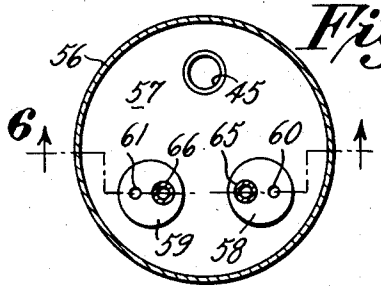


Fig. 4.

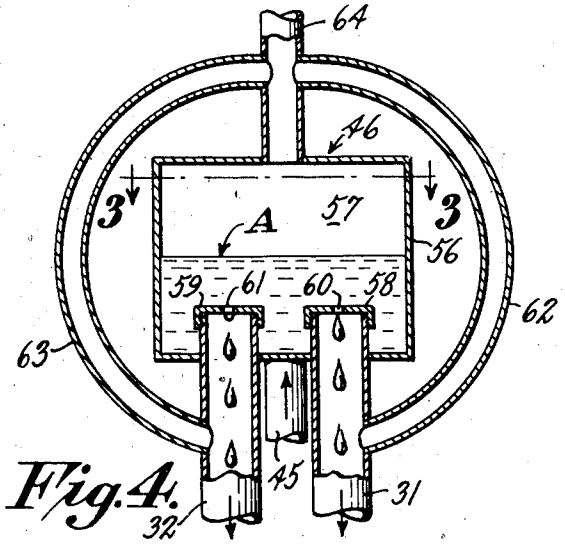
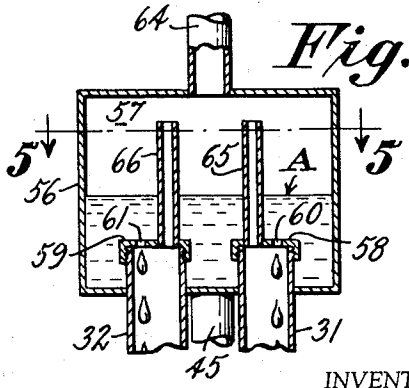


Fig. 6.



INVENTOR.
Philip P. Anderson, Jr.
BY
Ely Fenander his ATTORNEY.

Patented Nov. 17, 1942

2,302,091

UNITED STATES PATENT OFFICE

2,302,091

REFRIGERATION

Philip P. Anderson, Jr., Evansville, Ind., assignor to Servel, Inc., New York, N. Y., a corporation of Delaware

Application January 23, 1940, Serial No. 315,136

2 Claims. (Cl. 62—119.5)

This invention relates to refrigeration, and is particularly concerned with the splitting or dividing of liquid in refrigeration systems into a plurality of paths of flow.

In refrigeration systems it is often desirable to split liquid from a single body into a plurality of quantities or to divide a stream of liquid into a plurality of paths of flow. This is particularly true in absorption refrigeration systems of large size in which consideration must be given to several factors among which may be mentioned the height, capacity and efficiency of the system. By splitting a stream of liquid into several paths of flow, as at an evaporator or absorber or at both of these places, for example, the circulation of liquid in the refrigeration system is such that the capacity and efficiency of the system are improved and advantages may also result in effecting a reduction in the height of the system.

In accordance with the invention, liquid circulating in a refrigeration system is divided into a plurality of paths of flow by producing a body of liquid in a pocket or chamber into which liquid is introduced, and flowing liquid from such body through orifices or restrictions which are below the liquid surface level of the body and at substantially the same height. The orifices or restrictions are of such size that the liquid surface level will stand some distance above the level of the orifices. By making the orifices or restrictions substantially the same in size, equal division or splitting of liquid into a plurality of paths of flow is obtained. By making the orifices of different size, the liquid may be divided to give any definite unequal splitting into several paths of flow. Further, a vent is provided for the several paths of liquid flow and also for the pocket or chamber whereby pressure equalization of these parts is effected and trapping of gas in the pocket is prevented to insure that the liquid divider will function properly.

It is an object of the invention, therefore, to provide an improved liquid divider for refrigeration systems and of the character described above.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the claims. The invention, both as to organization and method, together with the above and other objects and advantages thereof will be better understood as I next describe my improved liquid divider embodied in an absorption refrigeration system like that described in application Serial No. 107,852 of Albert R. Thomas, filed October 27, 1936, which has matured into Patent No. 2,207,838. In the accompanying drawings, which form a part of this specification,

Fig. 1 more or less diagrammatically illustrates a refrigeration system of an absorption type in which is embodied a liquid divider embodying my invention;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1 to illustrate more clearly the manner in which the liquid divider is embodied in the refrigeration system;

Fig. 3 is a horizontal sectional view, taken on line 3—3 of Fig. 4, of the liquid divider shown in Figs. 1 and 2;

Fig. 4 is a vertical sectional view taken on line 4—4 of Fig. 3;

Fig. 5 is a horizontal sectional view similar to Fig. 3, taken on line 5—5 of Fig. 6, illustrating another embodiment of the invention; and

Fig. 6 is a vertical sectional view similar to Fig. 4 and taken on line 6—6 of Fig. 5.

In Figs. 1 and 2 I have shown the present improvement embodied in an absorption refrigeration system of a type containing a pressure equalizing agent and like that described in the aforesaid application of Albert R. Thomas. Such a system includes a generator 10, a condenser 11, an evaporator 12, and a plurality of absorbers 14. The system contains a solution of refrigerant in absorption liquid, such as ammonia in water, for example, and also an auxiliary agent or inert gas, such as hydrogen.

The generator 10 is heated in any suitable manner, as by a gas burner 15, for example, whereby refrigerant vapor is expelled from solution in generator 10. The refrigerant vapor flows through a conduit 16 into a vessel 17 which together constitute a liquid analyzer. From vessel 17 refrigerant vapor flows upward through a conduit 18 and an air-cooled rectifier 19 into a first section 11a of condenser 11 in which vapor is liquefied. Refrigerant vapor not liquefied in condenser section 11a flows into a second condenser section 11b. Refrigerant vapor liquefied in condenser section 11b flows through a conduit 20 into chamber 21 into which liquid also flows from condenser section 11a. From chamber 20 liquid refrigerant flows through a conduit 22, coil 23 and conduit 24 into evaporator 12.

Refrigerant fluid in evaporator 12 evaporates and diffuses into inert gas which enters through a conduit 25. Due to evaporation of refrigerant fluid into inert gas, a refrigerating effect is produced with consequent absorption of heat from the surroundings. The rich gas mixture of refrigerant vapor and inert gas formed in evapora-

tor 12 flows from the lower part thereof through a conduit 26, an outer passage 27 of a gas heat exchanger 28, a conduit 29 and branch conduits 30 into the lower parts of absorbers 14, as shown most clearly in Fig. 2.

In absorbers 14 the rich gas mixture flows countercurrent to downwardly flowing weak absorption liquid which enters through conduits 31 and 32 from a liquid divider 46, as will be described hereinafter. The absorption liquid absorbs refrigerant vapor from the inert gas, and inert gas weak in refrigerant flows from the absorbers 14 through conduits 33, a plurality of tubes 34 forming an inner passage of the gas heat exchanger 28, and conduit 25 into the upper part of evaporator 12.

The circulation of gas in the gas circuit just described is due to the difference in specific weight of the columns of gas rich and weak, respectively, in refrigerant vapor. Since the column of gas rich in refrigerant vapor and flowing from evaporator 12 to absorbers 14 is heavier than the gas weak in refrigerant vapor and flowing from the absorbers 14 to evaporator 12, a force is produced or developed within the system for causing circulation of inert gas in the manner described.

Absorption liquid enriched in refrigerant flows from the lower parts of absorbers 14 through conduits 35, 36 and 37, an outer passage of liquid heat exchanger 38, conduit 39, vessel 17 and conduit 16 into generator 10. Absorption liquid from which refrigerant vapor has been expelled flows from generator 10 through a conduit 10' into a coil 40 which is also heated by the gas burner 15. Absorption liquid is raised in the system by vapor-liquid lift action from coil 40 through a tube 41 into a separating chamber 42. The lifting vapor is separated from the raised liquid and flows from chamber 42 through a conduit 43 into generator 10; and this vapor, together with refrigerant vapor expelled from solution in the generator, flows upwardly into the condenser 11, as explained above.

The raised absorption liquid flows from separating vessel 42 through a conduit 44, an inner passage of liquid heat exchanger 38, and conduit 45 into the liquid divider 46 which will be described presently. This circulation of absorption liquid results from the raising of liquid through tube 41.

Heat liberated with absorption of refrigerant vapor in the absorbers 14 is transferred to a suitable cooling medium which circulates through coils 47 arranged in thermal exchange relation with the absorbers. As shown, the coils 47 are connected by conduits 48 and 49 to air-cooled condensers 50. Each coil 47 and condenser 50 and interconnecting conduits forms a closed circuit which is partly filled with a volatile liquid that vaporizes in the coils 47 and liquefies in the condensers 50. The liquid evaporating in the coils 47 takes up heat from the absorbers 14, and the vapor liquefying in condensers 50 gives up heat to surrounding air.

In coil 23 liquid refrigerant flowing from condenser 11 to evaporator 12 is precooled by evaporation of refrigerant into rich gas which flows from and to the gas heat exchanger 28 through conduits 51 and 52.

The outlet end of second condenser section 11b is connected by conduits 20 and 53, vessel 54, and conduit 55 to the gas circuit, as to one of the conduits 33, for example, so that any inert gas which may pass through the condenser can flow into the gas circuit. Refrigerant vapor not liquefied in condenser 11 flows through conduits 20 and 53 to displace inert gas in vessel 54 and force such gas through conduit 55 into the gas circuit. The effect of forcing gas into the gas circuit in this manner is to increase the total pressure in the system to insure condensation of refrigerant vapor in condenser 11.

As shown most clearly in Figs. 2 to 4 inclusive, the liquid divider 46 includes a vessel 56 forming a chamber 57 into the lower part of which extend the conduits 31 and 32. The upper ends of conduits 31 and 32 are provided with caps 58 and 59 having orifices or flow restricting openings 60 and 61, respectively. The upper ends of conduits 31 and 32 are connected by conduits 62 and 63 to a conduit 64 which is connected at its lower end to the upper part of vessel 56 and at its upper end to the outlet end of condenser 11, as shown in Fig. 1. The conduits 62, 63 and 64 serve as vent conduits for the liquid divider 46 whereby pressure equalization is effected between the upper ends of conduits 31 and 32 and the vapor space of chamber 57 and also to prevent trapping of gas in the latter.

During operation of the refrigeration system, absorption liquid weak in refrigerant flows from generator 10 through conduit 45 into liquid divider 46, as explained above. The force to cause this circulation of absorption liquid is relatively small because the flow of absorption liquid from vessel 42 to liquid divider 46 and thence through the absorbers 14 back to generator 10 takes place by force of gravity. The surface level of the body of liquid formed in chamber or pocket 57 is maintained some distance above the upper ends of conduits 31 and 32, as at the level A in Fig. 4, for example, due to the restriction to flow of liquid through the orifices 60 and 61. The caps 58 and 59 are at exactly the same level, and, when the liquid level in chamber 57 is above the caps, liquid will trickle through the orifices 60 and 61. With this arrangement liquid is effectively split or divided into two paths of flow even though circulation of absorption liquid is effected in the system by the force of gravity. The liquid divided into two paths of flow is conducted by force of gravity through conduits 31 and 32 to the absorbers 14 whereby refrigerant vapor is absorbed out of the inert gas, as explained above.

With the absorbers 14 being the same size, as shown in Fig. 2, it is preferable that the orifices 60 and 61 are the same size so that equal division of liquid into the conduits 31 and 32 is effected. It may be desirable in some instances, as when the absorbers are not the same size, for example, to effect an unequal distribution of liquid. In such case the orifices 60 and 61 are of different size so that the desired unequal splitting or division of liquid is effected.

In Figs. 5 and 6 is illustrated another embodiment of the invention in which the vent conduits 62 and 63 in the embodiment described above are dispensed with and instead vent tubes 65 and 66 are connected to the caps 58 and 59. The vent tubes 65 and 66 establish communication between the upper ends of conduits 31 and 32 and the vapor space in chamber 57. The chamber 57 is connected by the vent conduit 64 to the outlet end of the condenser, as in the embodiment in Figs. 2 to 4 inclusive and shown in Fig. 1, whereby objectionable trapping of gases in the vapor space of chamber 57 is avoided. The upper ends of vent tubes 65 and 66 are near

the upper part of the chamber 57 and above the liquid surface level of the body of liquid maintained in chamber 57.

In view of the foregoing, it will be apparent that I have provided an improved liquid divider for splitting and dividing liquid circulating in a refrigeration system. The liquid divider is relatively simple in nature and yet is extremely efficient in dividing liquid into a plurality of paths of flow even when the force effecting circulation of liquid is relatively small, as in the refrigeration system described above in which force of gravity is utilized to cause circulation of the absorption liquid.

The caps 58 and 59 preferably are formed of relatively thin metal so that no capillary forces are involved in the flow of liquid through the orifices 60 and 61. Consequently, the liquid should flow through the orifices 60 and 61 as soon as the orifices are covered with liquid; and, as the liquid level rises in chamber 57, the rate of flow of liquid increases, the rate of flow being proportional to the square root of the liquid head on the orfices. In refrigeration systems of the type described above and in which the present improvement is embodied, the importance of having the orifices at the same level is due to the low liquid head contemplated above the orifices. If the orifices are not at the same level, a variation in liquid head above the orifices results in considerable change in the rates of flow of liquid through the orifices.

While I have shown and described several embodiments of my invention, it will be apparent to those skilled in the art that modifications and changes may be made without departing from the spirit and scope of the invention. Thus, the liquid divider may be incorporated in other parts of the refrigeration system to divide liquid, such as, for example, to divide liquid refrigerant flowing to a plurality of evaporators. I therefore do not wish to be limited to the embodiments shown in the drawings and described in the specification, and I intend in the following claims to cover all modifications and changes which fall within the true spirit and scope of the invention.

What is claimed is:

1. In an absorption refrigeration system having a generator in which refrigerant vapor is expelled from absorption liquid, a condenser for liquefying the expelled vapor, an evaporator in which the liquid refrigerant is evaporated, means forming a plurality of places of absorption, and members for conducting vapor from said evaporator to said places of absorption, means forming a pocket for liquid, means for conducting weakened absorption liquid to said pocket, means for restricting flow of liquid downward from said pocket forming means at a plurality of places below the liquid surface level therein, and means for conducting liquid entirely below said surface level from each of said last-mentioned places to said places of absorption.

2. In an absorption refrigeration system having a generator in which refrigerant vapor is expelled from absorption liquid, a condenser for liquefying the expelled vapor, an evaporator in which the liquid refrigerant is evaporated, means forming a plurality of places of absorption, and members for conducting vapor from said evaporator to said places of absorption, means forming a pocket for liquid, means for conducting weakened absorption liquid to said pocket, orifices at a plurality of places below the liquid surface level in said pocket for permitting restricted flow of liquid therefrom, conduits for conducting liquid from each of said last-mentioned places to said places of absorption, and means to vent the upper ends of said conduits and the vapor space of said pocket forming means.

PHILIP P. ANDERSON, JR.