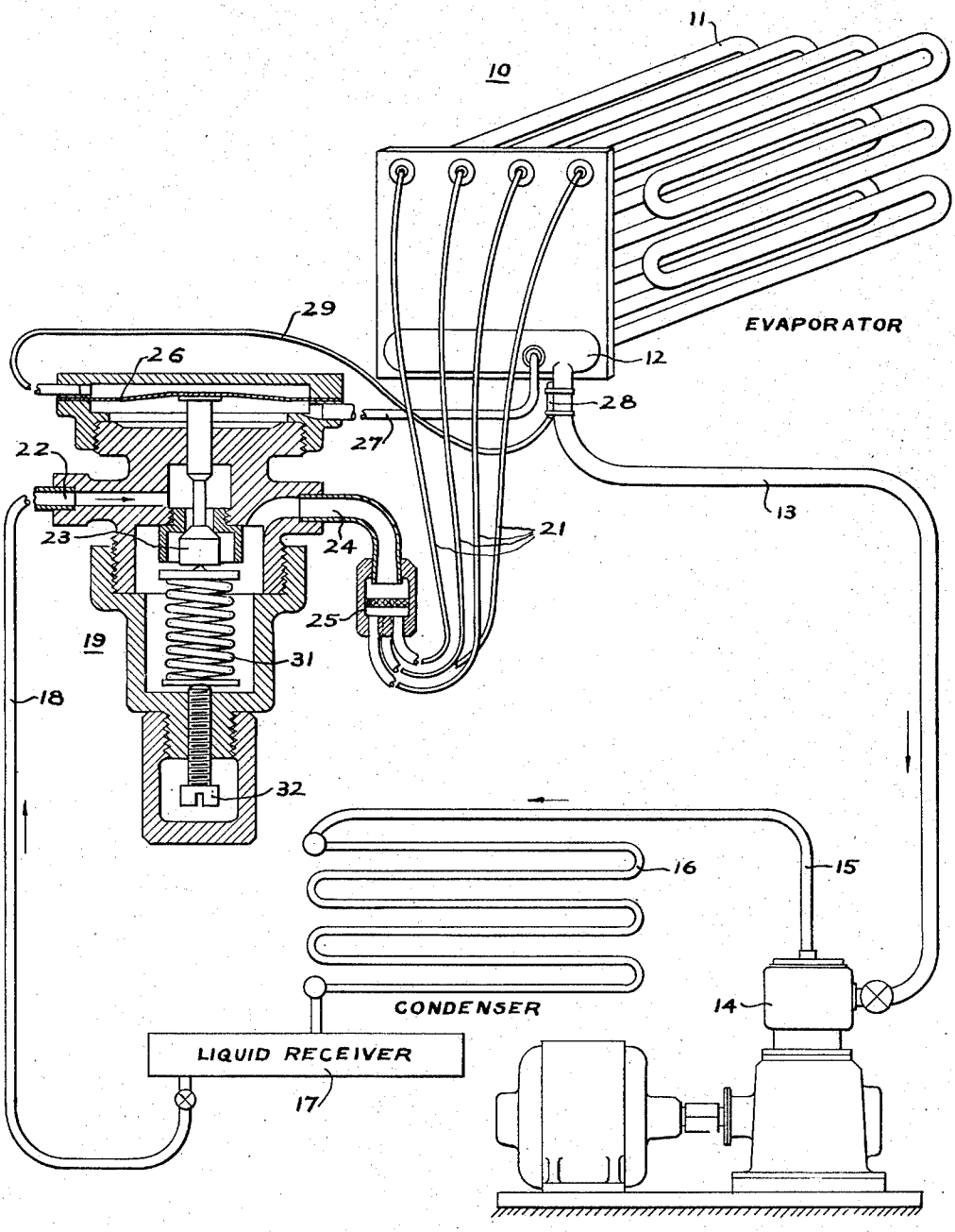
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REFRIGERATING APPARATUS

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WITNESSES:
R. J. Eisinger
James K. Mosser

INVENTORS
JOHN M. LABBERTON, AND
LEWIS R. SMITH.
BY
ATTORNEY

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REFRIGERATING APPARATUS

John M. Labberton, Madison, N. C., and Lewis R. Smith, Pittsburgh, Pa., assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

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14 Claims. (Cl. 62—8)

Our invention relates to refrigerating apparatus, more particularly to the flow-controlling apparatus between the condenser and an evaporator embodying a plurality of passages of the so-called "dry expansion" type, and it has for an object to provide improved apparatus.

A further object is to provide flow-controlling apparatus in which the flow of refrigerant is automatically controlled in accordance with the capacity of the evaporator, as in a conventional thermostatic expansion valve, and in which the refrigerant is distributed among the evaporator passages by flow-resistance passages.

In accordance with our invention, we provide a thermostatic expansion valve, and a plurality of flow resistance passages, such as capillary tubes, arranged in series with the expansion valve. The expansion valve effects the major portion of the expansion or pressure reduction of the refrigerant and also regulates said expansion, while the capillary tubes distribute the refrigerant among the evaporator passages and also effect a minor portion of the expansion. The expansion valve may be biased in closing direction in accordance with the pressure in the evaporator and in opening direction by a pressure varying with the temperature of the vaporous refrigerant leaving the evaporator, whereby the valve is controlled in accordance with the superheat of the vaporous refrigerant leaving the evaporator and regulates the flow of refrigerant to the evaporator in accordance with its capacity to evaporate refrigerant.

The present application is a continuation of our application Serial No. 716,974, filed March 23, 1934.

The above and other objects are effected by our invention as will be apparent from the following description and claims, taken in connection with the accompanying drawing, forming a part of this application, in which:

The single figure is a diagrammatic view of the apparatus with the expansion valve in section.

Referring to the drawing in detail, we show an evaporator 10 comprising a plurality of coils or evaporator passages 11, of the so-called "dry expansion" type. These coils are arranged in parallel with respect to flow of refrigerant and discharge the refrigerant vaporized therein into a common header 12. From the latter, the vaporous refrigerant is drawn through a conduit 13 to a compressor 14. The compressed refrigerant is conveyed from the compressor through a conduit 15 to a condenser 16 in which it is condensed. It then flows into a liquid receiver 17 from which it is delivered to a conduit 18.

To the above described apparatus, which was known prior to our present invention, we provide novel apparatus for controlling the flow of the liquid refrigerant to the evaporator and for distributing refrigerant among the several coils. This apparatus comprises an expansion valve 19 and a plurality of capillary tubes 21, that is, tubes of restricted bore or flow area. The expansion valve 19 may be, and is disclosed as, a conventional thermostatic expansion valve. It has an inlet 22 connected to the conduit 18, a valve member 23 which controls the flow of refrigerant, and an outlet 24 connected through a fitting 25 to the inlet ends of the capillary tubes 21. The outlet ends of the capillary tubes are connected to the inlet ends of the respective coils 11.

The expansion valve further includes a pressure responsive diaphragm 26 connected to the valve member 23. The diaphragm 26 is biased upwardly in valve closing direction by the pressure of refrigerant within the evaporator, which pressure is communicated from the header 12 through a conduit 27 to the lower side of the diaphragm. It is biased downwardly in valve opening direction by the pressure contained in a thermostatic bulb 28, which pressure is communicated through a tube 29 and imposed on the upper side of the diaphragm 26. The thermostatic bulb 28 is clamped to the suction conduit 13 adjacent the header 12, and preferably contains the same fluid as is used for refrigerant in the refrigerating apparatus, so that the pressure provided in the thermostatic bulb 28 is a function of the temperature at which time refrigerant leaves the evaporator. Inasmuch as the pressure within the header 12 is a function of the saturation temperature of the refrigerant, it will be apparent that the difference in pressure imposed on the diaphragm 26 will be a function of the superheat of the refrigerant leaving the evaporator. A spring 31 biases the valve member 23 in opposition to the pressure difference on the diaphragm 26, which tends to open the valve. The setting of the expansion valve may be varied by means of a screw 32 which varies the initial deflection of the spring 31.

The expansion valve and the capillary tubes are so designed that the major portion of the expansion or pressure reduction of the refrigerant from the pressure on the high side to the pressure in the evaporator, is effected in the expansion valve 19, only a small portion of the pressure reduction being effected by the capillary

tubes 21. The capillary tubes necessarily effect some pressure reduction in effecting the distribution of refrigerant to the several evaporator passages.

The operation of the above described apparatus is as follows: Vaporous refrigerant withdrawn from the evaporator through the conduit 13 is compressed by the compressor 14, and conveyed through the conduit 15 to the condenser 16 in which it is condensed. The condensed refrigerant collects in the liquid receiver 17 and flows through the conduit 18 to the expansion valve 19. The latter regulates the flow of refrigerant therethrough in accordance with the superheat of the refrigerant leaving the evaporator, operating to maintain said superheat substantially constant. The expansion valve is set to maintain a relatively small degree of superheat. It will be noted that, by controlling the flow of refrigerant in accordance with the superheat, the evaporator is supplied with such a quantity of refrigerant as can be completely evaporated therein. From the expansion valve 19, the refrigerant flows through the outlet 24 and the fitting 25 into the several capillary tubes 21, by which it is distributed among the several coils 11 of the evaporator. The capillary tubes 21 serve primarily for the purpose of distributing refrigerant to the several capillary tubes, the pressure reduction or expansion effected therein being only such as is necessary to effect proper distribution. As the refrigerant flows through the fitting 25 it encounters sudden change in its flow path, as will be apparent from the drawing, thereby inducing turbulence of the refrigerant. Such turbulence aids in providing a more thorough mixing and uniformity of the liquid and vaporous refrigerant adjacent the inlet ends of the capillary tubes.

From the above description, it will be seen that we have provided flow controlling mechanism comprising an expansion valve and a plurality of flow resistance passages in which the major portion of the pressure reduction or expansion is effected in the expansion valve, in which the supply of refrigerant to the evaporator is controlled by said expansion valve in the same manner as a conventional thermostatic expansion valve commonly used in the art, and in which refrigerant is distributed among the several passages of the evaporator by means of capillary tubes. By providing the expansion valve to effect the major portion of the expansion, the capillary tubes 21 may be made of greater diameter, thereby lessening danger of clogging of said tubes and increasing the reliability of the apparatus.

What we claim is:

1. In refrigerating apparatus, the combination of an evaporator comprising a plurality of evaporator passages, a compressor, a condenser, a valve for regulating the expansion of the liquid refrigerant from the condenser, means responsive to evaporator pressure for biasing said valve in closing direction, means responsive to temperature of vaporous refrigerant leaving the evaporator for biasing the valve in opening direction, and a plurality of capillary tubes for distributing the refrigerant from said valve to the respective evaporator passages, said valve and capillary tubes being of such proportions and dimensions that the major portion of the pressure reduction of the refrigerant is effected in said valve and that the capillary tubes serve primarily for distribution and effect only a small portion of the pressure reduction.

2. In refrigerating apparatus, the combination of an evaporator comprising a plurality of passages; a compressor; a condenser; and means for expanding liquid refrigerant condensed in said condenser, for regulating said expansion, and for distributing the same to the several evaporator passages comprising an expansion valve and a group of capillary tubes, through which valve and tube group the refrigerant flows in series and in each of which it is partially expanded, means responsive to evaporator pressure for biasing said valve in closing direction and means responsive to temperature of vaporous refrigerant leaving the evaporator for biasing said valve in opening direction, whereby said valve and capillary tubes together effect the expansion of the refrigerant, said valve regulates said expansion and said capillary tubes distribute the refrigerant among the evaporator passages.

3. In refrigerating apparatus, the combination of a plurality of evaporator passages, a compressor, a condenser, expansion valve means receiving liquid refrigerant from said condenser and effecting the major portion of the pressure reduction thereof from condenser pressure to evaporator pressure, and a plurality of capillary tubes communicating with said expansion valve means and with the respective evaporator passages for distributing refrigerant from the former to the latter.

4. In refgrigerating apparatus, the combination of a plurality of evaporator elements; a common liquid refrigerant supply conduit therefor; and means for expanding liquid refrigerant supplied from said conduit to said evaporator elements, for regulating said expansion, and for distributing the same to the several evaporator elements comprising an expansion valve and a group of flow-resistance passages, through which valve and group of passages the refrigerant flows in series and in each of which it is partially expanded, means responsive to evaporator pressure for biasing said valve in closing direction and means responsive to temperature of vaporous refrigerant leaving the evaporator elements for biasing said valve in opening direction, whereby said valve and flow-resistance passages together effect expansion of the refrigerant, said valve regulates said expansion and said flow-resistance passages distribute the refrigerant among the evaporator elements.

5. In refrigerating apparatus, the combination of a plurality of evaporator passages, a thermostatic expansion valve for regulating the supply of refrigerant to said passages, said thermostatic expansion valve being operable in response to the superheat of the refrigerant vapor discharged from said evaporator passages to maintain the same substantially constant, and means for distributing refrigerant from said valve to said passages in predetermined proportions and effecting a portion of the expansion thereof.

6. In refrigerating apparatus, the combination of a plurality of evaporator elements, a thermostatic expansion valve regulating the supply of refrigerant to said elements, said thermostatic expansion valve being operable in response to the superheat of the refrigerant vapor discharged from said evaporator elements to maintain the same substantially constant, and a plurality of flow-resistance passages for distributing refrigerant from said valve to said evaporator elements.

7. An expansion mechanism for refrigeration evaporators, comprising an expansion valve, a distributor head, a plurality of outlets in said head leading to a plurality of evaporators, a plu-

rality of orifices connecting with said outlets and with the output side of said valve, a diaphragm, a thermostat exposed to gas from said evaporators, means acting on one side of said diaphragm for moving same proportional to variations in said thermostat, means connecting said diaphragm and valve whereby said valve is moved proportional to the movement of said diaphragm, and means transmitting gas pressure from said evaporators to the other side of said diaphragm.

8. The method of ensuring the supply of uniform mixtures of liquid and vaporous refrigerant at desired rates from a single expansion device to a plurality of evaporators arranged in parallel, which comprises subdividing the stream of refrigerant delivered by said expansion device, determining the proportions of such subdivsion by throttling each off-flow from the point of subdivision; immediately in advance of such subdivision inducing turbulence in such flowing stream of refrigerant; and regulating the rate of delivery of refrigerant by said expansion device, in response to the opposed effects of pressure in said evaporators and the temperature of refrigerant leaving said evaporators.

9. In refrigerating apparatus, the combination of an evaporator comprising a plurality of evaporator passages, means for supplying volatile liquid refrigerant, a valve for regulating the flow of liquid refrigerant from said supply means, means responsive to an operating condition of the evaporator for controlling said valve, and a plurality of flow-resistance passages connecting said valve with the evaporator passages, respectively, said valve and flow-resistance passages being constructed and arranged so that the major portion of the pressure reduction of the refrigerant is effected in said valve and so that said flow resistance passages serve primarily to distribute the refrigerant among the several evaporator passages.

10. In a refrigeration system, an evaporator intercalated between the usual high and low sides of said system, an expansion valve controlling the admission of liquid refrigerant to said evaporator, a diaphragm for operating said valve, a thermostatic bulb positioned adjacent the outlet end of said evaporator for imposing pressure upon said diaphragm in a valve-opening direction, and means communicating with the evaporator adjacent its outlet end, and with the opposite side of said diaphragm for imposing the true suction pressure of said evaporator upon said diaphragm in a valve-closing direction.

11. In a refrigeration system, an evaporator intercalated between the usual high and low sides of said system, an expansion valve controlling the admission of liquid refrigerant to said evaporator, a diaphragm for operating said valve, a thermostatic bulb located at the outlet end of said evaporator, means for transmitting pressure from said bulb to one side of said diaphragm biasing it in a valve-opening direction, and means for imposing a counter-pressure upon the opposite side of said diaphragm derived from a point in said system adjacent the outlet end of said evaporator whereby to decrease the fluctuating of superheat arising during the cycling periods of said system.

12. In refrigerating apparatus, the combination of a plurality of evaporator passages of the dry type, a valve for regulating the flow of liquid refrigerant to said evaporator passages, a plurality of capillary tubes for distributing the refrigerant from said valve to the respective evaporator passages, and means responsive to a condition of the refrigerant leaving the evaporator passages for controlling said valve in such manner that all the refrigerant is vaporized before leaving said evaporator passages, said valve and capillary tubes being of such proportions and dimensions that the major portion of the pressure reduction of the refrigerant is effected in said valve and that the capillary tubes serve primarily for distribution and effect only a small portion of the pressure reduction.

13. An expansion mechanism for a plurality of evaporator elements, comprising an expansion valve, a distributor head communicating with the output side of said valve, the expansion mechanism having a plurality of orifices communicating with said distributor head for distributing refrigerant therefrom to the evaporator elements, a diaphragm connected to said valve, thermostatic means adapted to be subjected to temperature of refrigerant adjacent the outlets of said evaporator elements and imposing on said diaphragm in opening direction a pressure which is variable with said temperature, and means including an external tube for imposing refrigerant pressure in said evaporator elements on said diaphragm in valve closing direction.

14. Expansion mechanism as set forth in claim 13 and further constructed and arranged so that the liquid and vaporous refrigerant leaving said valve remain mixed while flowing through the distributor head and into the orifices.

JOHN M. LABBERTON.
LEWIS R. SMITH.