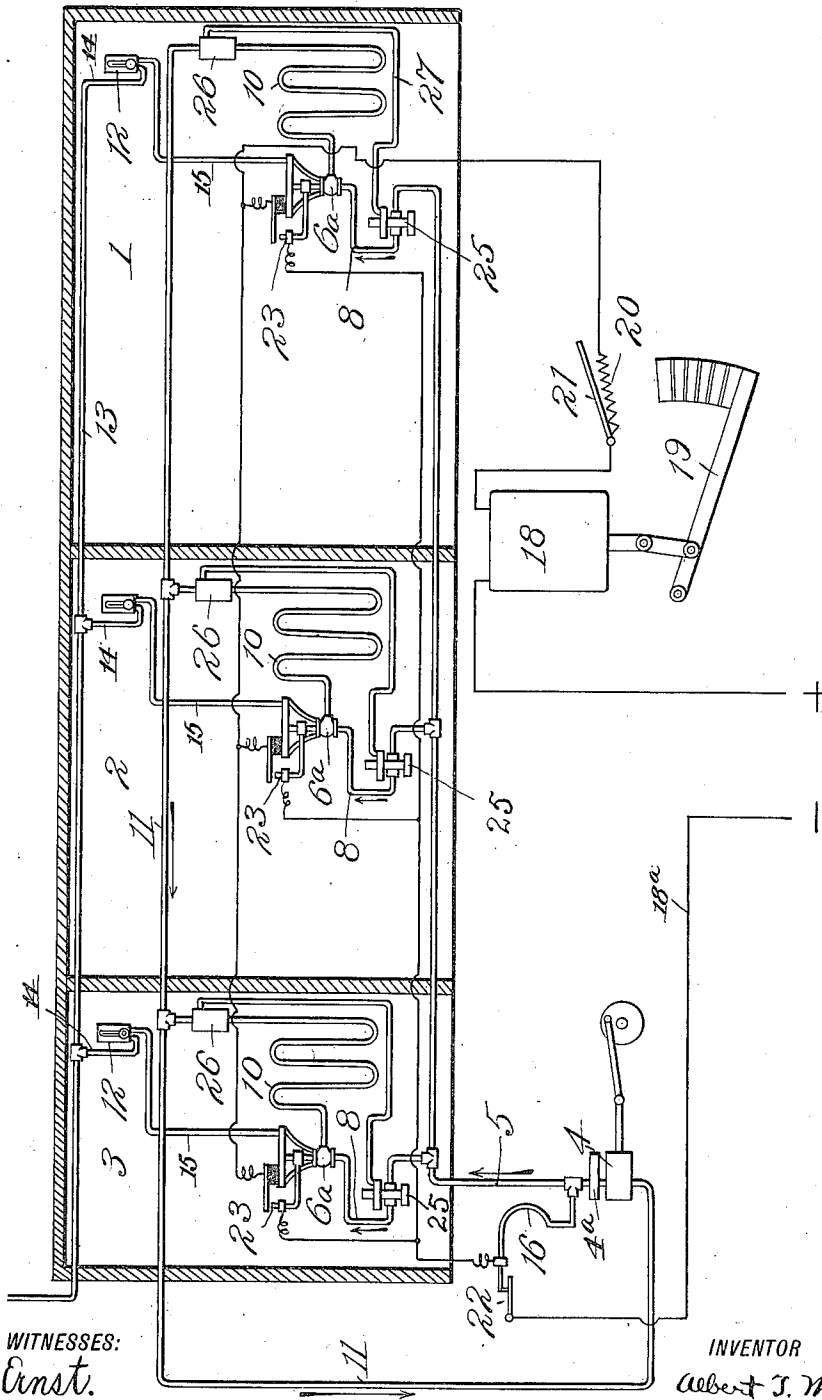


A. T. MARSHALL.
REFRIGERATING SYSTEM.
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WITNESSES:

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REFRIGERATING SYSTEM.

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To all whom it may concern:

Be it known that I, ALBERT T. MARSHALL, a citizen of the United States, and a resident of Hartford, Hartford county, State of Connecticut, have invented certain new and useful Improvements in Refrigerating Systems, of which the following is a full, clear, and exact description.

My invention relates to refrigerating systems in which a fluid, such as, for instance, ammonia, is used as a refrigerant by first compressing and then expanding it.

In particular, my invention relates, in such plants, to the manner in which the refrigerant is distributed to the several distributing chambers so that these chambers may be cooled as required, independent of each other.

In automatic refrigerating systems hitherto known, the several refrigerating chambers have been arranged in series regarding the refrigerant supply; that is to say, the coils in the different chambers containing the refrigerant in expanded and semi-expanded condition are in series with each other. This arrangement has the great disadvantage that the chamber, through the coils of which the refrigerant passes first, will be cooled faster than the chamber through the coils of which the refrigerant passes last, owing to the greater resistance offered by the long pipe to this latter chamber. Consequently, the devices cutting off the refrigerant after the proper low temperature is reached must be placed so that the refrigerant is cut off only after the proper temperature has been reached in the last chamber, thus causing the other chambers to assume too low a temperature, or, in case of the cut-off device operating at the proper temperature of one of the first chambers, to leave the last chamber without the proper refrigeration. Furthermore, in case the different chambers should require a different temperature, it is impossible, in the arrangement above referred to, to obtain a certain temperature in one of these chambers without disturbing the refrigeration of the other chambers. In my novel arrangement, all these difficulties and disadvantages are overcome, and each chamber may be cooled to the temperature desired whereafter the refrigerant is cut off from this chamber without disturbing the refrigeration

of the other chambers which may still require further supply of refrigerant.

Another particular feature of my system is, that the compressor, supplying the refrigerant to the system is automatically stopped only after every chamber has reached its proper temperature and also automatically started again whenever any of the chambers should require further refrigeration.

I provide suitable means for each chamber controlled by the means for cutting off the refrigerating supply for this chamber, which means tend to stop the operation of the compressor and which are arranged so as to operate in parallel to each other, so that the compressor will be stopped after the last chamber has been cut off, and so that the compressor will be started again whenever the rising temperature in one of the chambers should call for a supply of refrigerant. Also, safety means may be provided in the high pressure side of the system for stopping the compressor irrespective of the temperature in any of the chambers in case the pressure should unduly rise. I also provide means by which the admission of refrigerant to the coil is controlled so that always the maximum amount of refrigerant is admitted to the coil, which the latter can evaporate according to its temperature, so that at no time any appreciable amount of liquid refrigerant can reach the low pressure side of the system.

In the drawing I have illustrated diagrammatically how my invention may be reduced to practice, all detail construction, however, of the different devices required therein being omitted as they are well known to the art.

In the drawings, 1, 2 and 3 are different refrigerating chambers.

4 is a compressor with the usual condenser and receiver (which I have for the sake of simplicity merely indicated by a rectangular element 4^a), the compressor supplying refrigerant of high pressure to pipe 5.

25 are expansion valves which may be of any suitable kind known in the art. From the valves 25 the refrigerant is discharged into pipes 8, to each of which is connected a stop valve 6^a which controls the supply to the expansion system, consisting, as shown, of coils 10 in each chamber. A pipe 11, run-

ning through all chambers, connects the other ends of coils 10 in parallel, thus leading the refrigerant back to the compressor 4 on the low pressure side of the system.

5 In each of chambers 1, 2 and 3 is provided a thermostat 12 which controls its stop valve 6^a by means of pressure fluid of any kind, such as for instance air or water, in any well known manner, the controlling
10 fluid for the thermostat being supplied through pipe 13, so that the thermostat 12 for each chamber is connected by a pipe 14 in parallel to pipe 13. From thermostats 12 the fluid, controlling valves 6^a, is con-
15 ducted to said valves by pipes 15.

The stop valve 6^a may in some cases be constructed as an expansion valve, thereby omitting expansion valve 25, but preferably this usual expansion valve 25 is employed
20 in addition.

In the high pressure main 5, preferably shortly after leaving the receiver 4^a, is inserted a pressure gage 16 responsive to high pressure, which may, through its action,
25 open or close by means of circuit breaker 22 an electric controlling circuit operating a solenoid 18, which in turn operates the motor starter 19 for the motor (not shown), driving the compressor 4. If a high tension
30 circuit should be used for operating the solenoid, a resistance 20 may be provided in this circuit in order not to overload the coil, which resistance may be shunted by switch 21 so long as solenoid 18 is disengaged, the
35 switch being opened by suitable means after the solenoid has thrown in the motor starter 19. To the pressure system, operating stop valve 6^a, is further connected a circuit breaker 23 which may be operated in any
40 suitable manner by the pressure fluid controlled by the thermostat, so that when stop valve 6^a is closed by the action of the thermostat, circuit breaker 23 will open at the
45 same time. Such a connection is shown for instance in the drawing, in which circuit breaker 23 is connected with any suitable moving part of valve 6^a, which connection is, however, only advisable in case the surroundings of the valve can be kept suffi-
50 ciently dry, so as not to disturb the insulation.

The solenoid circuit is as follows: Leaving the plus pole the current flows through solenoid 18, resistance 20 (or switch 21 as
55 may be the case), thence through the circuit breaker 23 of any of the stop valves 6^a, which are all in parallel to the line, thence through a circuit breaker 22 of pressure gage 16 and back to the minus poles. It is obvious that circuit breaker 23 may also control small relays which in turn control the motor starter. These forms of control being, however, so well known in the art, their description and illustration have been
65 omitted in the present application.

The expansion valve 25, previously referred to, is preferably of special construction so that its operation may be controlled by the temperature of the expanded gases when leaving the expansion coils 10, so that
70 at any time the maximum amount of refrigerant is supplied by the valve 25 to its coil which the coil can evaporate. For this purpose I provide a thermostatic chamber 26 at the end of the coil system 10, through
75 which chamber the end of coil 10 passes before joining the return main 11. Chamber 26 contains a suitable charge of fluid, highly responsive to expansion and contraction by the increase or decrease in tempera-
80 ture, preferably ammonia, so that this fluid is acted upon by the temperature of the gas in the refrigerating coil. Chamber 26 is connected by pipe 29 with a suitable element of expansion valve 25, so as to cause the am-
85 monia charge contained in chamber 26 to throttle the feed of valve 25 as it cools. The construction of these so called thermostatic expansion valves, such as is indicated at 25, being well known in the art, a detail de-
90 scription and illustration is omitted, and the expansion valve and thermostatic chamber are merely indicated in their relative position to each other, so as to show how these elements may be disposed in my novel re-
95 frigerating system. The particular advantage of employing this kind of expansion valve and fluid thermostat in each chamber is that these valves keep the refrigerating coils which they control frosted throughout
100 their whole length by supplying, as pointed out above, all of the refrigerant which the coils can evaporate instead of supplying it at a fixed back pressure with a part of the coil not frosted as would be the case if for in-
105 stance one expansion valve common to all chambers were used. The individual expansion valve 26 will keep the coil in each chamber frosted until the temperature of the chamber is reduced sufficiently for the
110 chamber thermostat 12 to act and close the special stop valve 6^a, shutting off entirely all further refrigeration of these chambers, and breaking at the same time the circuit at 23, as described, until the temperature of
115 the chamber has risen sufficiently to again operate the stop valve 6^a to turn on the refrigeration. The fact that expansion valve 26 keeps the whole length of its coil frosted throughout the whole period during which
120 the chamber requires refrigeration, does not necessarily mean that this valve 25 remains full open; but the coil being first warm, and thus able to evaporate probably the maximum amount of refrigerant which the ex-
125 pansion valve 25 can furnish, will soon cool, so that also the refrigerant therein cools. Coil 10 thus losing a part of its evaporating capacity is unable to take care of the full amount of liquid refrigerant, supplied by
130

valve 25. The now cooler refrigerant reaching thermostatic chamber 26 affects the charge contained therein, which in turn in the manner described above throttles the refrigerant supply 25, the two elements being adjusted relatively to each other and to the size of the coil that by such throttling always the maximum amount of refrigerant is supplied which the coil can evaporate at a prevailing temperature of the coil.

The operation of the whole system is as follows: Assuming each of the chambers should require refrigeration, the thermostat 12 of each chamber will cause its stop valve to open, which will at the same time cause circuit breaker 23 to close. At this time circuit breaker 22 of pressure gage 16 will also be closed, so that the solenoid circuit is completed and solenoid 18 throws the motor operated compressor 4 into operation. Coils 10 being then comparatively warm and also the thermostatic fluid in chamber 26 being warm, expansion valves 25 are wide open. The refrigeration now takes place in each chamber in the manner previously described. If now, for instance, chamber 2 should be sufficiently cooled, its thermostat 12, which is very accurately responsive to the temperature in the chamber, causes stop valve 6^a to close and thus to shut off entirely the refrigerant supply to coil system 10 of this chamber. The closing of stop valve 6^a, as also previously stated, at the same time causes circuit breaker 23 to open. The opening of circuit breaker 23 in chamber 2, however, will not cause the compressor 4 to stop, since the circuit breakers 23 in the other chambers are still closed. Only after the refrigerant in all chambers has been shut off from their respective coils is the solenoid circuit completely interrupted and by these means the compressor is stopped.

It may happen that the high pressure side of the system assumes, through any cause, an undue and dangerously high pressure. In this case pressure gage 16 comes into action and causes its circuit breaker 22 to open and to interrupt the solenoid circuit, thus stopping the operation of the compressor. This action takes place independently of the refrigeration of the different chambers, that is to say, no matter whether they are properly cooled at the time or not, because circuit breaker 22 is in series with circuit breakers 23 of all chambers. The compressor 4 now remains at rest until normal pressure is restored in the system which permits circuit breaker 22 to close, and thus return the control of the starting or stopping of the motor to the individual thermostats 12 of each chamber.

It will be clearly seen that in my novel refrigerating system each chamber may receive the refrigeration desired independently of the temperature conditions of the other

chambers, and the refrigeration may be cut off or turned on in each chamber without disturbing the refrigeration of the other chambers; furthermore it will be seen that in case none of the chambers should require refrigeration, the operation of the compressor will be stopped automatically and thrown in automatically if any of the chambers should require refrigeration. It is also obvious that by always supplying all the amount of refrigerant which the coil can evaporate, the coils are always used to their best efficiency. It will also be noted that while the presence of a thermostatic chamber 26, as the only thermostat in the chamber, may act as a means for keeping the temperature of such chamber within certain desired limits, and while it is admitted that such thermostats have been used heretofore in the art as a sole control of refrigerating chambers, still such regulation is possible only within very wide limits, which for modern requirements of refrigeration would be totally insufficient. The reason for this deficiency is obvious because the thermostatic charge is solely affected by the temperature of the refrigerant and therefore in case of comparatively large chambers it can not respond to the temperature conditions in such chambers, particularly not at places remote from the coil. On the other hand thermostats of the character such as thermostat 12, which may be placed in any suitable place in the chamber can be made, as is well known in the art, to respond within very narrow limits to temperature changes. Thus by the combination of the two thermostatic devices I maintain at any time the exact temperature of the chamber desired, and also the maximum efficiency of the coil at any given temperature.

While I have shown in the drawing a specific arrangement of the different auxiliary devices comprising the refrigerating system, I do not wish to limit myself to any particular form of device such as stop valves, expansion valves, thermostats and the like, which, as has been previously stated are well known in the art in themselves, the novelty of my invention consisting in the individual and independent cooling of the different chambers as required and in individually regulating the temperature of each chamber without disturbing the refrigerant of the other chambers, and in maintaining not only the exact temperature in each chamber but in also maintaining the maximum efficiency of the coil at a given temperature.

What I claim is:

1. In a refrigerating plant having a plurality of refrigerating chambers, the combination with expansion coils in said chambers, a compressor supplying the refrigerant to said coils in parallel, means for each chamber, controlled by the temperature of

the refrigerant when leaving said coils, for supplying the maximum amount of refrigerant which the coils can evaporate according to their temperature, and thermostats in said chamber; of valves directly controlled by said thermostats for regulating the refrigerant supply to each chamber to maintain the predetermined temperature of each chamber, and means for automatically stopping the operation of said compressor, when all of said chambers have assumed their desired temperature.

2. In a refrigerating plant having a plurality of refrigerating chambers, the combination with expansion coils in said chambers, a compressor supplying the refrigerant to said coils in parallel, means for each chamber, controlled by the temperature of the refrigerant when leaving said coils, for supplying the maximum amount of refrigerant which the coils can evaporate according to their temperature, and thermostats in said chamber; of valves directly controlled by said thermostats for regulating the refrigerant supply to each chamber to maintain the predetermined temperature of each chamber, and means for automatically starting the operation of said compressor, when any of said chambers require refrigeration.

3. In a refrigerating plant having a plurality of refrigerating chambers, the combination with expansion coils in said chambers, a compressor supplying the refrigerant to said coils in parallel, expansion valves for each chamber controlled by the temperature of the refrigerant when leaving said coils for supplying the maximum amount of refrigerant which the coils can evaporate according to their temperature, and thermostats in said chambers; of valves directly controlled by said thermostats for regulating the refrigerant supply to each chamber to maintain the predetermined temperature of each chamber, and means for automatically stopping the operation of said compressor, when all of said chambers have assumed the desired temperature.

4. In a refrigerating plant having a plurality of refrigerating chambers, the combination with expansion coils in said chambers, a compressor supplying the refrigerant to said coils in parallel, expansion valves for each chamber controlled by the temperature of the refrigerant when leaving said coils for supplying the maximum amount of refrigerant which the coils can evaporate according to their temperature, and thermostats in said chambers; of valves directly controlled by said thermostats for regulating the refrigerant supply to each chamber to maintain the predetermined temperature of each chamber, and means for automatically starting the operation of said compressor, when any of said chambers require refrigeration.

5. In a refrigerating plant having a plurality of refrigerating chambers, the combination with expansion coils in said chambers, a compressor supplying the refrigerant to said coils in parallel, means for each chamber controlled by the temperature of the refrigerant when leaving said coils for supplying the maximum amount of refrigerant which the coils can evaporate according to their temperature, and thermostats in said chambers; of valves directly controlled by said thermostats for regulating the refrigerant supply to each chamber to maintain the predetermined temperature of each chamber, and means controlled by said thermostats for stopping the operation of said compressor, when all of said chambers have assumed their desired temperature.

6. In a refrigerating plant having a plurality of refrigerating chambers, the combination with expansion coils in said chambers, a compressor supplying the refrigerant to said coils in parallel, means for each chamber controlled by the temperature of the refrigerant when leaving said coils for supplying the maximum amount of refrigerant which the coils can evaporate according to their temperature, and thermostats in said chambers; of valves directly controlled by said thermostats for regulating the refrigerant supply to each chamber to maintain the predetermined temperature of each chamber, and means controlled by said thermostats for starting the operation of said compressor, when any of said chambers require refrigeration.

7. In a refrigerating plant having a plurality of refrigerating chambers, the combination with expansion coils in said chambers, a compressor supplying the refrigerant to said coils in parallel, an expansion valve for each chamber controlled by the temperature of the refrigerant when leaving said coils for supplying the maximum amount of refrigerant which the coils can evaporate according to their temperature, and thermostats in said chambers; of valves directly controlled by said thermostats for regulating the refrigerant supply to each chamber to maintain the predetermined temperature of each chamber, and means controlled by said thermostats for stopping the operation of said compressor, when all of said chambers have assumed their desired temperature.

8. In a refrigerating plant having a plurality of refrigerating chambers, the combination with expansion coils in said chambers, a compressor supplying the refrigerant to said coils in parallel, an expansion valve for each chamber controlled by the temperature of the refrigerant when leaving said coils for supplying the maximum amount of refrigerant which the coils can evaporate according to their temperature, and thermostats in said

chambers; of valves directly controlled by said thermostats for regulating the refrigerant supply to each chamber to maintain the predetermined temperature of each chamber, and means controlled by said thermostats for starting the operation of said compressor, when any of said chambers require refrigeration.

9. In a refrigerating plant having a plurality of refrigerating chambers, the combination with expansion coils in said chambers, a compressor supplying the refrigerant to said coils in parallel, an expansion valve for each chamber and a thermostatic chamber surrounding the expansion coils in each chamber at the point where the refrigerant leaves said coil and adapted to contain temperature responsive fluid and suitably connected with said expansion valve, to permit said fluid to act upon said expansion valve to supply the maximum amount of refrigerant which the coils can evaporate according to their temperature, and thermostats in said chambers; of stop valves directly controlled by said thermostats for regulating the refrigerant supply to each chamber to maintain the predetermined temperature of each chamber and means controlled by said thermostats for stopping the operation of said compressor, when all of said chambers have assumed their desired temperature.

10. In a refrigerating plant having a plurality of refrigerating chambers, the combination with expansion coils in said chambers, a compressor supplying the refrigerant to said coils in parallel, an expansion valve for each chamber and a thermostatic chamber surrounding the expansion coils in each chamber at the point where the refrigerant leaves said coil and adapted to contain temperature responsive fluid and suitably connected with said expansion valve, to permit said fluid to act upon said expansion valve to supply the maximum amount of refrigerant which the coils can evaporate according to their temperature, and thermostats in said chambers; of stop valves directly controlled by said thermostats for regulating the refrigerant supply to each chamber to maintain the predetermined temperature of each chamber and means controlled by said thermostats for starting the operation of said compressor, when any of said chambers require refrigeration.

11. In apparatus of the character described, the combination of a refrigerating chamber, fluid expansion system, means for

supplying refrigerating fluid thereto, a valve controlling the supply of fluid to said system, means responsive to the temperature at the delivery end of said system for controlling said valve to supply the maximum amount of refrigerant which can be evaporated in the system, a second valve controlling the supply of fluid to said system, and means responsive to the temperature in the refrigerating chamber for controlling said second valve.

12. In apparatus of the character described, the combination of a refrigerating chamber, fluid expansion system, means for supplying refrigerating fluid thereto, a valve controlling the supply of fluid to said system, means responsive to the temperature at the delivery end of said system for controlling said valve to supply the maximum amount of refrigerant which can be evaporated in the system, a second valve controlling the supply of fluid to said system in series with the first valve, and means responsive to the temperature in the refrigerating chamber for controlling said second valve.

13. In apparatus of the character described, the combination of a refrigerating chamber, fluid expansion system, a pump for supplying refrigerating fluid thereto, a valve controlling the supply of fluid to said system, means responsive to the temperature at the delivery end of said system for controlling said valve to supply the maximum amount of refrigerant which can be evaporated in the system, a second valve controlling the supply of fluid to said system, and means responsive to the temperature in the refrigerating chamber for controlling said second valve, and stopping the pump.

14. In apparatus of the character described, the combination of a refrigerating chamber, fluid expansion system, a pump for supplying refrigerating fluid thereto, a valve controlling the supply of fluid to said system, means responsive to the temperature at the delivery end of said system for controlling said valve to supply the maximum amount of refrigerant which can be evaporated in the system, a second valve controlling the supply of fluid to said system, and means responsive to the temperature in the refrigerating chamber for controlling said second valve and starting the pump.

ALBERT T. MARSHALL.

Witnesses:

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