

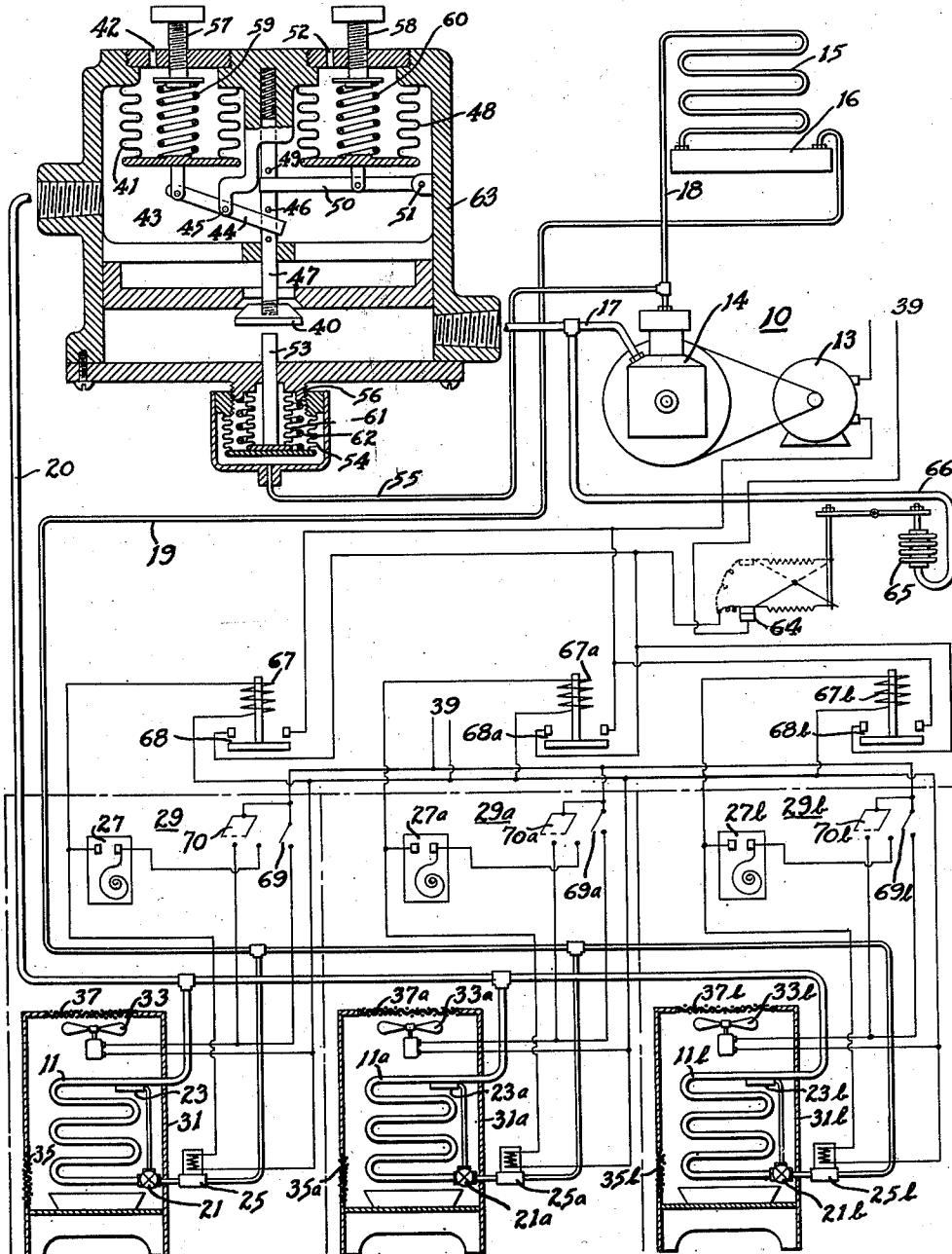
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REFRIGERATING APPARATUS

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REFRIGERATING APPARATUS

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This invention relates to refrigeration and more particularly to the automatic control of refrigerating apparatus.

It is among the objects of this invention to provide controls for refrigerating apparatus of such a character that the unbalanced capacity of the various elements of the refrigerating apparatus are controlled to provide satisfactory operation.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred form of the present invention is clearly shown.

In the drawing:

The figure represents diagrammatically an apparatus embodying features of my invention.

In practicing my invention, a refrigerant liquefying unit 10 is connected with a plurality of evaporators 11, 11a and 11b in refrigerant-flow relationship. The evaporators 11, 11a and 11b are so constructed that they are likely to impose varying refrigeration loads on the refrigerant liquefying unit 10.

The unit 10, which is operated by a motor 13, tends to have a relatively constant refrigerating capacity while the evaporators 11, 11a and 11b may be connected to the unit 10 simultaneously or in time staggered relationship. This tends to create an unbalanced condition between the capacity of the unit 10 and the evaporators 11, 11a and 11b. Controls are provided for balancing these capacities.

The refrigerant liquefying unit has a refrigerant low pressure side and a refrigerant high pressure side. Thus it may include a compressor 14 and a condenser 15 which is provided with a refrigerant receiver 16. The compressor 14 is provided with an evaporated refrigerant inlet 17 which forms part of the refrigerant low pressure side, and is connected by a discharge conduit 18 with the condenser 15 which forms a part of the high pressure side.

The high pressure side is connected by a liquid refrigerant line 19 with the evaporators 11, 11a and 11b which latter are provided with valve means at their inlets to control the flow of liquid refrigerant into the evaporators. The evaporators are also connected by an evaporated refrigerant line 20 with the liquefying unit 10 thus forming the low pressure side of the system.

The valve means for the evaporators 11, 11a and 11b may include automatic expansion valves 21, 21a and 21b which are of the character which automatically introduced refrigerant into the evaporators when the pressure therein is reduced

below a predetermined limit. These expansion valves preferably are also provided with thermostatic bulbs 23, 23a and 23b which automatically throttle the flow of liquid refrigerant into the evaporators in accordance with temperature conditions in a portion of the evaporators preferably located at the outlet of the evaporators. The construction and operation of these valves therefore is such that when the pressure in the evaporators is reduced below a predetermined limit they introduce liquid refrigerant into the evaporators until the refrigerating effect thereof reaches the bulbs 23, 23a and 23b, after which the valves throttle the flow of refrigerant into the evaporators to prevent the waste of refrigeration beyond the outlet of the evaporators.

In addition, the valve means for the evaporators may include electro-magnetic valves 25, 25a and 25b which are actuated in accordance with conditions produced by the evaporators. Thus the thermostats 27, 27a and 27b, placed in the rooms 29, 29a and 29b, respectively, in which the evaporators are placed, open and shut the valves 25, 25a and 25b in accordance with air temperature conditions in the rooms 29, 29a and 29b.

The evaporators 11, 11a and 11b may be of any suitable construction; but in the preferred form, they form parts of air conditioning for cooling equipment. Thus they may be placed in casings 31, 31a and 31b through which a circulation of air is forced by means of motor-driven fans 33, 33a and 33b, the air currents entering by the inlets 35, 35a and 35b and leaving at the outlets 37, 37a, 37b. The fans 33, 33a and 33b are energized by the operation of the thermostats 27, 27a and 27b along with the electro-magnetic valves 25, 25a and 25b, the current coming from the electrical source 39.

When a refrigerant liquefying unit is connected with a plurality of evaporators, particularly for air conditioning, it frequently occurs that one or more of the evaporators are temporarily made inoperative, such as by the electro-magnetic valves 25, 25a and 25b. Under such conditions, the amount of refrigeration required by the remaining evaporator or evaporators is materially reduced, while the capacity of the unit 10 tends to remain constant. Under such conditions the unit 10 would tend to reduce the refrigerant temperature in the remaining active evaporator or evaporators below the acceptable temperature. In the use of refrigerant evaporators for air conditioning, it is desirable to maintain the cooling surfaces of the evaporators above the freezing temperature of water, so that the cooling surfaces

do not accumulate frost but merely condense the moisture from the air and permit it to flow away. When the capacity balance of the system is thrown off by the inactivity of one or more of the
 5 evaporators, the excess capacity of the unit 10 tends to reduce the temperature of the active evaporators to too low a temperature. This invention prevents this undesirable result.

Accordingly, means are provided for throttling
 10 the flow of refrigerant into the liquefying unit 10 when the pressure of the refrigerant from the evaporators falls below a predetermined or desirable limit and thus the temperature of the evaporators is prevented from falling below a
 15 selected limit, such as 32° F. This means takes the form of an automatically actuated valve means 40 which is actuated by pressure responsive means or bellows 41 in accordance with the temperature-pressure conditions in the evaporated
 20 refrigerant line 20. As the pressure in line 20 falls to a temperature-pressure condition near the freezing point of water, the bellows 41 expands by the action of atmospheric pressure through the opening 42 on one side and the refrigerant
 25 pressure in the chamber 43. The expansion of the bellows 41 raises the valve rod 47 through the medium of the lever 44, which is pivoted at 45 and engages the pin 46 of the rod 47. When the valve
 30 40 is thus raised, the flow of refrigerant in the low pressure side of the apparatus is throttled to prevent a drop in temperature of the active evaporators below the freezing point of water. The temperature-pressure limit at which the valve 40
 35 closes in response to the action of the bellows 41 is chosen to be below the pressure-temperature conditions at which the valves 21, 21a and 21b open.

In the manufacture of refrigerating apparatus for air conditioning, it is quite usual to assemble
 40 the refrigerant liquefying unit as one piece of mechanism, and each of the evaporators 11, 11a and 11b, etc., together with their casings, fans, valves, etc., as other pieces of mechanism. These factory assembled pieces of mechanism are
 45 shipped to the place where they are to be installed and there they are assembled for operation. It frequently happens that the wrong number of evaporators are connected to a refrigerant liquefying unit. Sometimes the number actually
 50 installed is less than the proper amount for correct refrigeration balance and at other times the number of evaporators is more than the proper amount for correct balance. When less than the proper amount are installed, the valve 40 when
 55 actuated by the bellows 41 will prevent the unit 10 from producing too low temperatures in the evaporators installed, and this invention is therefore applicable also to installations where the wrong number of evaporators are installed even
 60 when the evaporators are not independently cut out.

In order to take care of the condition when too many evaporators are installed, means are provided to throttle the low pressure side when the
 65 pressure-temperature conditions in the evaporators rise above a predetermined limit due to the presence of an excess number of evaporators. Either an additional valve, or the same valve 40 may be used for this purpose. If the valve 40 is
 70 used, a pressure responsive means in the form of bellows 48 is connected to the valve 40 through the medium of rod 47, pin 49 and lever 50 pivoted at 51. When the pressure-temperature conditions in the line 20 and chamber 43 rise above a
 75 predetermined limit, the bellows 48 tends to col-

lapse because of the increased pressure differential between the chamber 43 and the atmospheric pressure in bellows 48 entering through the opening 52. When the bellows 48 thus collapses the
 5 valve 40 rises and throttles the flow of refrigerant to the unit 10 and thus prevents it from being overloaded.

It sometimes occurs that the refrigerant pressure on the high side becomes excessive, for instance when the flow of cooling medium to the
 10 condenser 15 is accidentally prevented. Means are provided for reducing the capacity of the unit 10 under these conditions and this may be accomplished by providing means for throttling the flow of refrigerant from the low pressure side to
 15 the unit 10 when these conditions occur. This may be accomplished either by an additional valve or by the same valve 40. Thus a rod 53 may be actuated by the bellows 54 which is connected on one side by the pipe 55 with the high pressure
 20 side and with the atmosphere through the opening 56 on the other side. When the pressure becomes excessive on the high pressure side the rod 53 rises and throttles the valve 40.

It is to be understood that the bellows 41, 48
 25 and 54 may be each independently connected to an individual valve rather than all be connected to a single valve. Adjusting screws 57 and 58 may be provided to vary the tension of the springs
 30 59 and 60 respectively so that the pressure conditions at which the bellows 41 and 48 operate may be adjusted. A small bellows 61 may be provided to prevent the escape of refrigerant through the opening 56, and spring means 62 may be provided to properly calibrate the action of the
 35 bellows 54.

If the refrigerant liquefying unit is manufactured as an entity at the factory it is often desirable to assemble the valve structure contained
 40 in the casing 63 with the refrigerant liquefying unit, thus insuring satisfactory operation of the unit 10 even if the same should be assembled with the wrong number of evaporators.

An automatic control may be provided for the unit 10. This may take the form of a snap
 45 switch 64, operated by a bellows 65 in response to conditions of the apparatus, such as in response to the refrigerant pressure at the intake 17 transmitted through the pipe 66 to the bellows 65 thus
 50 starting and stopping the unit 10 as refrigerant conditions require.

Means are provided for permitting the fans 33, 33a and 33b to be operated when refrigeration is not desired and for insuring the operation of these fans when there is a refrigeration demand
 55 upon their respective evaporators. These means are preferably coordinated with the thermostats 27, 27a and 27b and with the switch 64 to insure that the unit 10 shall not operate for appreciable periods of time when all of the evaporators are
 60 rendered inactive but shall operate in response to pressure conditions when any one of the evaporators is rendered active.

Thus hand switches 69, 69a and 69b are provided which may cause the operation of the
 65 respective fans 33, 33a and 33b when air circulation is desired even when refrigeration is not desired. The closing of these switches energize the respective fan motors from source 39. Hand switches 70, 70a and 70b are also provided for
 70 rendering the refrigerant control thermostats 27, 27a and 27b effective. When any of the switches 70, 70a or 70b are manually closed the corresponding thermostat is rendered capable of energizing its corresponding relay 67, 67a or 67b. 75

The energizing of any of the relays 67, 67a or 67b in turn closes its corresponding switch 68, 68a or 68b which in turn energizes and opens its corresponding solenoid valve 25, 25a or 25b.

5 The above electrical controls therefore cause the unit 10 to maintain the refrigerant pressure in suction line 20 between the lowest pressure limit for which bellows 41 is calibrated and the highest pressure limit for which switch 64 is cali-
10 brated. The low pressure limit of the switch 64 is made lower than the low pressure limit of the bellows 41 so that when the bellows 41 throttles the valve 40 a certain amount the bellows 65 closes the switch 64. The unit 10 therefore main-
15 tains the suction line 20 in readiness to evaporate refrigerant in any one of the evaporators 11, 11a or 11b whenever the corresponding valve 25, 25a or 25b is opened. When any one or more of the switches 70, 70a or 70b are closed then the cor-
20 responding thermostat 27, 27a or 27b feeds refrigerant into its corresponding evaporator 11, 11a or 11b in response to the temperature in its corresponding room. This provides the necessary refrigeration for each room as it is required.
25 At the same time the proper evaporator temperatures are maintained so that no deleterious frosting thereon occurs.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form,
30 it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. Refrigerating apparatus comprising a re-
35 frigerant liquefying unit having a refrigerant low pressure side and a high pressure side, a plurality of evaporators having refrigerant inlets connected to said high pressure side and re-
40 frigerant outlets connected to said low pressure side, throttling means on said low pressure side effective to throttle the flow of refrigerant into said liquefying unit when the pressure of the refrigerant from said evaporators falls below a
45 predetermined limit and when it rises above a predetermined limit.

2. Refrigerating apparatus comprising a re-
frigerant liquefying unit having a refrigerant low pressure side and a high pressure side, a plurality of evaporators having refrigerant inlets
50 connected to said high pressure side and refrigerant outlets connected to said low pressure side, throttling means on said low pressure side effective to throttle the flow of refrigerant into said liquefying unit when the pressure of the
55 refrigerant from said evaporators falls below a predetermined limit and when the refrigerant pressure in said high pressure side rises above a predetermined limit.

3. Refrigerating apparatus comprising a refrigerant liquefying unit having a refrigerant low
60 pressure side and a high pressure side, a plurality of evaporators having refrigerant inlets connected to said high pressure side and refrigerant outlets connected to said low pressure side, throttling means on said low pressure side effective to
65 throttle the flow of refrigerant into said liquefying unit when the pressure of the refrigerant from said evaporators rises above a predetermined limit and when the refrigerant pressure in said high
70 pressure side rises above a predetermined limit.

4. Refrigerating apparatus comprising a refrigerant liquefying unit having a refrigerant low
75 pressure side and a high pressure side, a plurality of evaporators having refrigerant inlets connected to said high pressure side and refrigerant outlets

connected to said low pressure side, automatic expansion valves at said inlets, throttling means on said low pressure side effective to throttle the flow of refrigerant into said liquefying unit when the
5 pressure of the refrigerant from said evaporators falls below a predetermined limit and when it rises above a predetermined limit.

5. Refrigerating apparatus comprising a refrigerant liquefying unit having a refrigerant low pressure side and a high pressure side, a plural-
10 ity of evaporators having refrigerant inlets connected to said high pressure side and refrigerant outlets connected to said low pressure side, expansion valves at said inlets having means for automatically introducing refrigerant into said evapo-
15 rators when the pressure in said evaporators is reduced below a predetermined limit, throttling means on said low pressure side effective to throttle the flow of refrigerant into said liquefying unit when the pressure of the refrigerant from said
20 evaporators falls below a predetermined limit and when it rises above a predetermined limit.

6. Refrigerating apparatus comprising a refrigerant liquefying unit having a refrigerant low pressure side and a high pressure side, a plurality
25 of evaporators having refrigerant inlets connected to said high pressure side and refrigerant outlets connected to said low pressure side, expansion valves at said inlets having means for automatically introducing refrigerant into said evaporators
30 when the pressure in said evaporators is reduced below a predetermined limit, and having means for throttling the flow of refrigerant into said evaporators in accordance with temperature conditions in a portion of said evaporators, throt-
35 tling means on said low pressure side effective to throttle the flow of refrigerant into said liquefying unit when the pressure of the refrigerant from said evaporators falls below a predetermined limit and when it rises above a predetermined limit.
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7. Refrigerating apparatus comprising a refrigerant liquefying unit having a refrigerant low pressure side and a high pressure side, a plurality of evaporators having refrigerant inlets connected
45 to said high pressure side and refrigerant outlets connected to said low pressure side, valves at the inlets of said evaporators responsive to temperature conditions of air cooled by said evaporators, throttling means on said low pressure side effective
50 to throttle the flow of refrigerant into said liquefying unit when the pressure of the refrigerant from said evaporators falls below a predetermined limit and when it rises above a predetermined limit.

8. Refrigerating apparatus comprising a refrigerant liquefying unit having a refrigerant low
55 pressure side and a high pressure side, a plurality of evaporators having refrigerant inlets connected to said high pressure side and refrigerant outlets connected to said low pressure side, electro-magnetic valves for said evaporators having means for
60 electrical energization in accordance with conditions produced by said evaporators, throttling means on said low pressure side effective to throttle the flow of refrigerant into said liquefying unit
65 when the pressure of the refrigerant from said evaporators falls below a predetermined limit and when it rises above a predetermined limit.

9. Refrigerating apparatus comprising a compressor, condenser and refrigerant evaporating
70 means, an evaporated refrigerant line connecting said evaporating means and the intake of said compressor, a liquid refrigerant line connecting said condenser and said evaporating means, throttling means in said evaporated refrigerant line
75

effective to throttle the flow of refrigerant into said compressor when the refrigerant pressure in said evaporated refrigerant line falls below a predetermined limit and when it rises above a predetermined limit.

10. Refrigerating apparatus comprising a compressor, condenser and refrigerant evaporating means, an evaporated refrigerant line connecting said evaporating means and the intake of said compressor, a liquid refrigerant line connecting said condenser and said evaporating means, a single valve in said evaporated refrigerant line effective to throttle the flow of refrigerant into said compressor when the refrigerant pressure in said evaporated refrigerant line falls below a predetermined limit and when the refrigerant pressure in said condenser rises above a predetermined limit.

11. Refrigerating apparatus comprising a compressor, condenser and refrigerant evaporating means, an evaporated refrigerant line connecting said evaporating means and the inlet of said compressor, a liquid refrigerant line connecting said condenser and said evaporating means, throttling means in said evaporated refrigerant line effective to throttle the flow of refrigerant into said compressor when the refrigerant pressure in said evaporated refrigerant line rises above a predetermined limit and when the refrigerant pressure in said condenser rises above a predetermined limit.

12. Refrigerating apparatus comprising a refrigerant liquefying unit having a refrigerant low pressure side and a high pressure side, a plurality of evaporators having refrigerant inlets connected to said high pressure side and refrigerant outlets connected to said low pressure side, automatic expansion valves at said inlets, throttling means on said low pressure side effective to throttle the flow of refrigerant into said liquefying unit when the pressure of the refrigerant from said evaporators falls below a predetermined limit and when the refrigerant pressure in said high pressure side rises above a predetermined limit.

13. Refrigerating apparatus comprising a refrigerant liquefying unit having a refrigerant low pressure side and a high pressure side, a plurality of evaporators having refrigerant inlets connected to said high pressure side and refrigerant outlets connected to said low pressure side, expansion valves at said inlets having means for automatically introducing refrigerant into said evaporators when the pressure in said evaporators is reduced below a predetermined limit, throttling means on said low pressure side effective to throttle the flow of refrigerant into said liquefying unit when the pressure of the refrigerant from said evaporators falls below a predetermined limit, and when the refrigerant pressure in said high pressure side rises above a predetermined limit.

14. Refrigerating apparatus comprising a refrigerant liquefying unit having a refrigerant low pressure side and a high pressure side, a plurality of evaporators having refrigerant inlets connected to said high pressure side and refrigerant outlets connected to said low pressure side, expansion valves at said inlets having means for automatically introducing refrigerant into said evaporators when the pressure in said evaporators is reduced below a predetermined limit, and having means for throttling the flow of refrigerant into said evaporators in accordance with tem-

perature conditions in a portion of said evaporators, throttling means on said low pressure side effective to throttle the flow of refrigerant into said liquefying unit when the pressure of the refrigerant from said evaporators falls below a predetermined limit and when the refrigerant pressure in said high pressure side rises above a predetermined limit.

15. Refrigerating apparatus comprising a refrigerant liquefying unit having a refrigerant low pressure side and a high pressure side, a plurality of evaporators having refrigerant inlets connected to said high pressure side and refrigerant outlets connected to said low pressure side, valves at the inlets of said evaporators responsive to temperature conditions of air cooled by said evaporators, throttling means on said low pressure side effective to throttle the flow of refrigerant into said liquefying unit when the pressure of the refrigerant from said evaporators falls below a predetermined limit, and when the refrigerant pressure in said high pressure side rises above a predetermined limit.

16. Refrigerating apparatus comprising a refrigerant liquefying unit having a refrigerant low pressure side and a high pressure side, a plurality of evaporators having refrigerant inlets connected to said high pressure side and refrigerant outlets connected to said low pressure side, electro-magnetic valves for said evaporators having means for electrical energization in accordance with conditions produced by said evaporators, throttling means on said low pressure side effective to throttle the flow of refrigerant into said liquefying unit when the pressure of the refrigerant from said evaporators falls below a predetermined limit, and when the refrigerant pressure in said high pressure side rises above a predetermined limit.

17. Refrigerating apparatus comprising a refrigerant liquefying unit having a refrigerant low pressure side and a high pressure side, a plurality of evaporators having refrigerant inlets connected to said high pressure side and refrigerant outlets connected to said low pressure side, automatic expansion valves at said inlets, throttling means on said low pressure side effective to throttle the flow of refrigerant into said liquefying unit when the pressure of the refrigerant from said evaporators rises above a predetermined limit and when the refrigerant pressure in said high pressure side rises above a predetermined limit.

18. The method of operating a refrigeration system which comprises circulating a volatile refrigerant from a refrigerant liquefying zone through a liquid refrigerant conveying zone, through a plurality of evaporating zones in parallel into a common vapor conveying zone and to the refrigerant liquefying zone for recirculation, maintaining the liquefying capacity of said liquefying zone sufficient for the demands of all of said evaporating zones, periodically stopping the flow of refrigerant through one or more of said evaporating zones, automatically throttling said vapor conveying zone to maintain the refrigerant pressure in said conveying zone adjacent said evaporating zones above the vapor pressure corresponding to 32° F., and automatically throttling said refrigerant conveying zone when its pressure rises above a predetermined limit.

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