Feb. 26, 1952 H. C. MILLER 2,587,363

CONTROLLING DEVICE FOR REFRIGERATOR SYSTEMS

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Fig. 1.

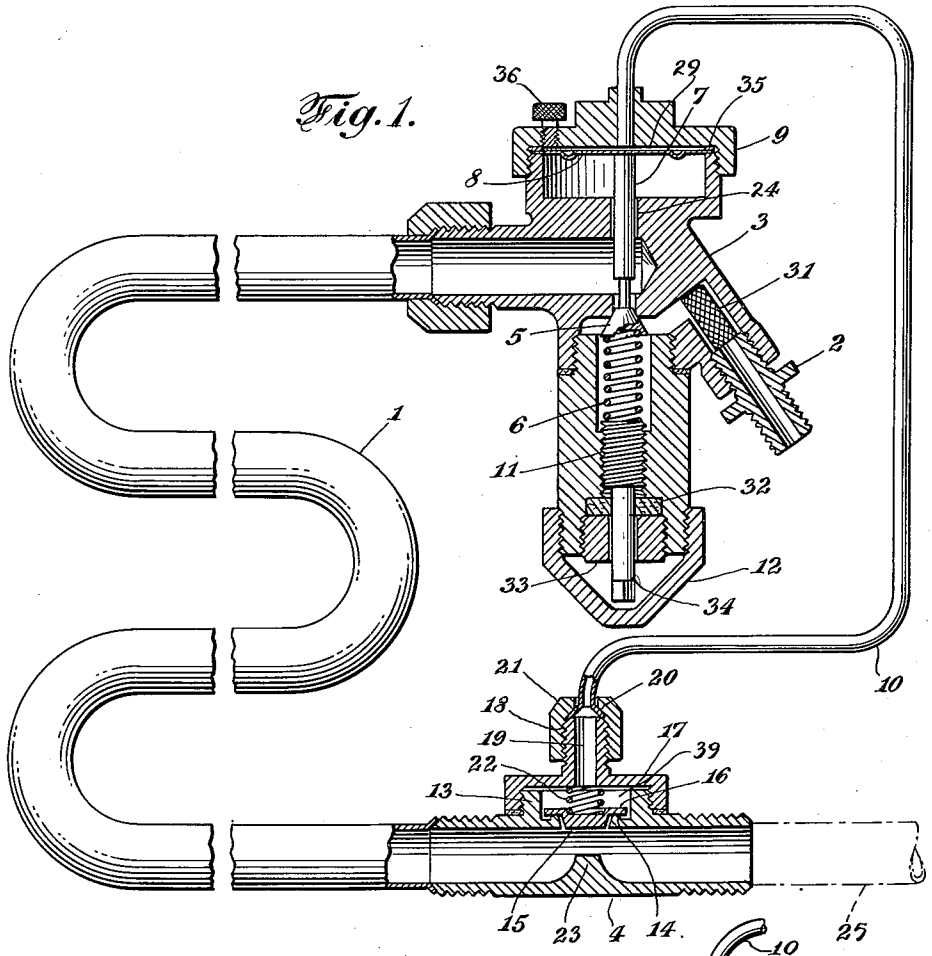


Fig. 2.

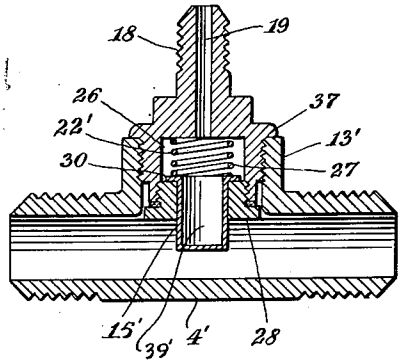
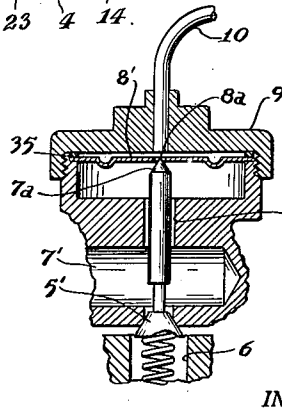


Fig. 3.



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CONTROLLING DEVICE FOR REFRIGERATOR SYSTEMS

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8 Claims. (Cl. 62—8)

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This invention is an improvement in controlling devices; and particularly controlling devices for refrigerating systems of the compression and evaporation type.

An important object of my invention is to provide a thermostatic controlling device that is efficient and certain in operation, and with the thermostatic element manually charged or self-charging upon installation, so that it does not have to be charged separately or in advance to prepare it for mounting in the system of which it is a part. It therefore contains the same refrigerant as the system, is very sensitive, fully responsive only to changes within the system and normally unaffected by conditions outside of the same.

A further object is to provide a simple and practical thermostatic controlling device that can be easily incorporated into the system, is strong, tight, durable, virtually proof against damage by accidents, and so constructed that it can be easily and quickly repaired if a leak occurs, merely by replacement of the principal element therein.

Another object is to provide a refrigerant controlling device capable of acting at a comparatively smaller difference between the pressure in its own thermal element and the pressure in the system, thereby increasing the evaporator coil capacity.

A still further object is to provide a thermostatic refrigerant controlling device containing a thermal element into which, after installation in a system, a gaseous charge of refrigerant is forced automatically at a limited pressure, proper and best suited for that individual system; such limited charge having the effect of preventing an overload on the compressor and motor during the initial period of the running cycle; and any damage during the idle period, especially when installed under abnormal conditions so that the thermal device is exposed to high temperature outside atmosphere.

The nature and advantages of the invention are fully described herein and the novel features are pointed out in the claims. But this disclosure is by way of example only and I may vary the details of the construction illustrated, without departing from the general design in which the invention is embodied.

On the drawings,

Figure 1 shows in outline part of a refrigeration system containing my invention;

Figure 2 shows in section a modification of my controlling device; and

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Figure 3 a further modification.

An expansion or evaporation coil is indicated at 1. It is supplied with refrigerant through a pipe joined to a connecting element or coupling 2 that is screwed into tight union with the expansion valve casing 3. The liquid refrigerating medium flows into the coupling 2 and through the casing to the coil 1, where it starts to expand and evaporate into a gas, and the opposite end or outlet of this coil is joined to a coupling 4 to which is joined the return connection or suction pipe that conducts the gaseous refrigerant back to the compression pump. In the casing 3 is a valve 5, which cuts off communication when closed between the supply pipe and the coil 1. The valve is engaged by a compression spring 6 that tends to hold it against its seat, and the stem 7 of this valve is connected to a diaphragm 8, or it may just make contact therewith.

The valve 5 operates in a well-known manner to admit the refrigerant to the coil 1 as required. The casing has a hollow boss on its exterior and the diaphragm is secured against the outer rim of this boss by a screw cap 9. This cap 9 is coupled to a pipe 10 by a soldered or threaded connection. The pressure space 29 within the boss under the cap 9 permits movement of the diaphragm 8, and when the latter is forced inward by an excess of pressure above it, the valve 5 is opened. The force of the spring 6 is regulated by a screw stem 11 in the casing 3, the stem projecting from the casing and being covered by a screw cap 12. Leakage is prevented by the gland packing 32, compressed by the threaded nut 33.

The pipe 10 is united to the coupling 4 by a soldered connection, or a threaded connection, as desired. The coupling 4 has the form of a T or other convenient shape with a short stem represented by a boss 13 enclosing a chamber 39, with an aperture at its inner end or bottom and communicating with the bore of the coupling 4. The bottom has an annular shoulder 14 which serves as a seat for a member 15 having a rim 16 resting on the shoulder 14 and making sealed or leakproof contact therewith. The edge of the shoulder may have the form of a rib in relief, so that the rim 16 can engage it to better advantage. A cap 17 is screwed on to the boss 13 and this cap has a neck 18 with a duct 19 extending therethrough. The outer end of the neck is conical and over it fits the expanded end 20 of the pipe 10. The connection is completed by means of a cap or coupling nut

21 which binds the end of the pipe on the neck. A spring 22 in the boss 13 presses against the cap 17 at one end and upon the member 15 at the other and holds the latter against the seat 14. Opposite the member 15, the bore of the coupling 4 may be provided with a baffle projection 23.

The casing 3 with the valve 5 and diaphragm 8 therein is a well known unit and, except for the upper thermostatic portion, forms no part of this invention; which relates chiefly to the coupling 4 and the thermal device or unit which consists of the heat exchanging or transmitting member 15, the thermal chamber 39, the connecting pipe 10, the pressure space 29, and the diaphragm 8; or, in place of diaphragm 8, a flexible metal bellows that has a similar purpose and function as the diaphragm 8. The construction and operation details described herein relate mainly to the application of the thermal device to the so-called thermostatic expansion valve of the diaphragm type, but it is equally applicable to the thermostatic expansion valve of the bellows type, and also to other varieties of controls, switches and safety devices.

In many ordinary refrigerating systems of this kind, the pipe 10 leading from the casing 3 terminates in a bulb which is secured to the outside of the coil 1 adjacent the suction or outlet end by a bolted metal clamp, said bulb, pipe 10 and the pressure space 29 having previously been evacuated of air, charged with a certain refrigerant at a fixed predetermined pressure, closed, and sealed by soldering in the manufacturing process. With my invention all of these processes are unnecessary, making for economy in production, and there is no external bulb which often causes less efficient and responsive operation because the bulb is subject to conditions outside the system as well as within it.

The thermal device can never contain the wrong refrigerant, which should always be the same as in the system proper, because it is not pre-charged before installation. When first connected, and refrigerant is introduced into the coil 1 and coupling 4, the increased pressure raises the member 15 off the seat 14 allowing gas to enter thermal chamber 39 and pass up through pipe 10. Then, if the purge or vent plug 36 is loosened, the air that was in the thermal device passes out, and when plug 36 is retightened, the thermal element is filled with gas at a pressure slightly less than that in coil 1, the difference being equal to the light pressure of spring 22.

In most compression systems of this type, the operation of the compressor unit is controlled by a pressure control switch, said switch starting the motor when the desired maximum pressure is reached in coil 1, coupling 4, and return line 25. When the compressor starts a reduction in pressure occurs in return line 25, coupling 4, coil 1, and casing 3, and on the inner surface of diaphragm 8, but the pressure in the thermal device and on the outer surface of diaphragm 8 does not immediately drop, but remains at the same level, which is nearly equal to the maximum, or starting pressure of the system. Thus an excess of pressure is produced on the outer surface of the diaphragm 8, and when this excess pressure overcomes the opposing pressure of the spring 6, the valve 5 is forced away from its seat, allowing liquid refrigerant to flow into coil 1. The charge contained in the thermal device is superheated gas with the pressure automatically

limited to the particular maximum operating pressure in that individual system, or only slightly less. Thus, since the suction pressure drops rapidly after the compressor starts until valve 5 opens, and since a high operating suction pressure usually causes an overloaded condition in the compressor and motor, the automatic limited charge acts to reduce the time period of such overloaded condition to negligible proportions.

If, due to unusual conditions, the casing 3, pipe 10 and coupling 4, are placed in the open air outside the refrigerated space, as has been done in prior systems a high pressure charge in the thermal device may force valve 5 open during the idle period, causing a flooded condition in the low pressure portion of the system, with probable damaging results. The low automatic limited charge will not force valve 5 to open no matter how high the ambient temperature, because superheated gas expands but very little with considerable increase in temperature.

If, as with certain high temperature evaporators, a thermal device charge higher than the maximum operating pressure is required, this higher charge is easily effected manually, by turning the electrical switch off and raising the gas pressure in coil 1 and coupling 4 to a point slightly above the pressure required in the thermal device, during which process gas is forced into the same at the proper pressure, and the system is ready for operation.

With the compressor in operation and valve 5 in open position, refrigerating performance is somewhat improved over that of the conventional expansion valve with externally clamped bulb. Evaporating liquid refrigerant flows through coil 1, and gas slightly superheated above the temperature of the evaporating liquid passes through coupling 4, in intimate contact with member 15 and the gas in thermal chamber 39, the temperature of the latter being substantially the same as that of the gas flowing through coupling 4. Thermal chamber 39 has sufficient space to contain, when condensed, all of the gas in the thermal device, including pipe 10 and pressure space 29, and accordingly the pressure in space 29 and on the outer surface of diaphragm 8 is that which corresponds to the temperature of the now chilled and semi-saturated gas in thermal chamber 39. The temperature of the latter is higher than that of the liquid in coil 1, and since the pressure on the inner surface of diaphragm 8 corresponds to the temperature of the liquid refrigerant in casing 3 and coil 1, there exists an excess of pressure on the outer surface of diaphragm 8 over that on the inner surface of same, such excess pressure corresponding directly to the superheat of the gas in coupling 4, the refrigerant all being the same, with identical pressure-temperature relationship. To obtain maximum capacity and efficiency in any coil, the superheat at its outlet should be as low as possible providing valve 5 closes whenever, due to liquid surging through into the suction line 25, such superheat approaches, or reaches, zero. Whereas the conventional expansion valve with externally clamped bulb, due to the effect of higher ambient temperature, and slower and less accurate response to temperature changes in the adjacent suction line, requires a superheat adjustment averaging about 10° F., the enclosed, intimately contacting and sensitive thermal chamber 39 permits a superheat adjustment of about 5° or 6° F., with attendant increase in coil capacity and efficiency.

In the construction shown in Figure 2, a fitting 26 has a neck 18 with a duct 19 through it as before. The fitting is hollow, containing a space which receives a spring 22'. The inner end of the fitting in the coupling is closed by a hollow nut 28 with a smooth bore therethrough in which is a hollow cup-shaped member 15'; containing a thermal chamber 39', and having a rim or a collar 30 resting on the inner end of this nut. The spring 22' holds the rim 30 against the nut 28, and the member 15' projects through the nut into the bore of the coupling so as to be in contact with the refrigerant passing therethrough. The foregoing is a compact, replaceable fitting which screws into the boss 13' on the coupling 4' by the external threads on fitting 26. The operation of this device is the same as above described.

In Figure 3, the diaphragm 8' in the boss 9' has a central aperture 8a, and the stem 7' of the valve 5 has a tapered upper end 7a that can fill this aperture and obstruct it fully. With this construction the thermal element is charged through the aperture 8a instead of through coupling 4 or 4'; the springs 22 or 22' are omitted, and the member 15' is firmly attached to, or made a part of, the wall of coupling 4, or if the fitting of Figure 3 is used, the valve 15' is omitted and the nut 28 has no hole therein. Charging of the thermal device takes place the same as heretofore described, gas pressure in coil 1 exerting pressure on the inner surface of diaphragm 8 which is forced outward, away from the pointed end 7a of the valve stem 7'. The aperture 8a is then open and clear for the passage of gas into pipe 10' and thermal chamber 39 or 39'. Purging is accomplished by loosening of nut 21 or a vent plug opening into thermal chamber 39 or 39'.

The utility of the device will now be apparent. The construction of the coupling permits any desired or limited charge into the pipe 10 and operation and control solely by inside conditions is afforded. The screw 36 in the cap can be employed for venting or purging. The fitting member 26 has a flange or collar 37 which engages tightly the rim of the boss 13'.

The superheat in coupling 4 is controlled by the pressure of the spring 6 on the valve 5, said superheat and spring pressure being increased or decreased by turning adjusting stem 11 inward or outward, respectively.

The device requires no external bulb or clamp and need not be precharged. When it is connected in place the device is self-charging and all that is necessary when all the connections have been made and the system itself is charged with refrigerant is to remove the screw 36 so that the line 10 can be vented. The refrigerant in the coil 1 when it fills the coupling 4 in line 25 lifts the valve 15 and fills the line 10 with the same refrigerant that is used in the operation of the system. The charge is limited to the pressure in the coupling 4. The device is suitable for all refrigerants and is completely self-enclosed and self-contained making a separate thermal unit. It can be interchanged or renewed at will and is well adapted for replacing an old feeler bulb that has to be clamped to the return pipe 25.

Having described my invention, what I believe to be new is:

1. A refrigerating system having an evaporator coil, a casing containing an expansion valve at the inlet end of the coil, connection for supplying refrigerant to the coil through the casing and a connection for conducting it from the coil at the outlet end, a coupling at the outlet end of the coil, a heat transferring member in said coupling, means in said casing for controlling said valve, and an open conduit connecting said coupling and said means, said coupling having a fitting attached thereto, the fitting being hollow, and closed by a hollow nut at its inner end, the member projecting through the nut into the coupling, and having a flange at its end engaging said nut, said fitting having a spring therein pressing said member, and a neck on its outer end secured to the conduit.

2. A refrigerating system having an evaporator coil, a casing containing an expansion valve having a stem at the inlet end of the coil, connection for supplying refrigerant to the coil through the casing and conducting it from the coil at the outlet end, and a connection for a thermal device having an open pipe united at one end to the casing and having its opposite end disposed adjacent the outlet of the coil, and means for controlling the valve in the casing, said device having a movable heat-transferring part and a port controlled thereby to put said pipe into communication with said last-named connection to admit refrigerant in said last-named connection to said pipe.

3. A refrigerating system having an evaporator coil, a casing containing an expansion valve having a stem at the inlet end of the coil, connection for supplying refrigerant to the coil, through the casing and conducting it from the coil at the outlet end, and a connection for a thermal device having an open pipe united at one end to the casing and having its opposite end disposed adjacent of the coil, and means for controlling the valve in the casing, said device having a movable heat-transferring part and a port controlled thereby to put said pipe into communication with said last-named connection to admit refrigerant in said last-named connection to said pipe, said part and said port being adjacent the outlet of the coil.

4. A refrigerating system having an evaporator coil, a casing containing an expansion valve having a stem at the inlet end of the coil, connection for supplying refrigerant to the coil through the casing and conducting it from the coil at the outlet end, and a connection for a thermal device having an open pipe united at one end to the casing and having its opposite end disposed adjacent the outlet of the coil, and means for controlling the valve in the casing, said device having a heat-transferring part and a port controlled thereby to put said pipe into communication with said last-named connection to admit refrigerant in said last-named connection to said pipe, said means being in the casing and having a port therein.

5. A refrigerating system having an evaporator coil, a casing containing an expansion valve at the inlet end of the coil, connection for supplying refrigerant to the coil through the casing and a connection for conducting it from the coil at the outlet end, a heat-transferring member adjacent said last-named connection at the outlet end of the coil, means in said casing for controlling said valve, and an open conduit between said means and said member, the connection containing said member having an aperture in which said member is movably mounted and a cap over said member and united to the conduit so that said member may respond to pressure in said last-named connection to admit refrigerant vapor from said system into said thermal device.

6. A refrigerating system having an evaporator coil, a casing containing an expansion valve in the inlet end of the coil, connection for supplying refrigerant to the coil through the casing and a connection for conducting it from the coil at the outlet end, a coupling at the outlet end of the coil, a heat-transferring member in said coupling, means in said casing for controlling said valve, and an open conduit connecting said coupling and said means, the coupling containing said member having an aperture in which said member is movably mounted and a cap over said member and united to the conduit so that said member may respond to pressure in said last-named connection.

7. A refrigerating system having an evaporator coil, a casing containing an expansion valve at the inlet end of the coil, connection for supplying refrigerant to the coil through the casing and a connection for conducting it from the coil at the outlet end, a coupling at the outlet end of the coil, a heat-transferring member in said coupling, means in said casing for controlling said valve, and an open conduit connecting said coupling and said means, the coupling containing said member having an aperture in which said member is movably mounted and a cap over said member and united to the conduit so that said

member may respond to pressure in said last-named connection.

8. A refrigerating system having an evaporator coil, a casing containing an expansion valve at the inlet end of the coil, a connection for supplying refrigerant to the coil through the casing and a connection for conducting it from the coil at the outlet end, a cap attached to the outside of the connection at the outlet end, said connection having an opening leading to the interior thereof beneath said cap, a heat-transferring member under the cap located in said opening and having its inner end exposed to the inside of said connection, the cap having a duct in the outer end, and a conduit fixed to said cap communicating with said duct and connected to said casing.

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