

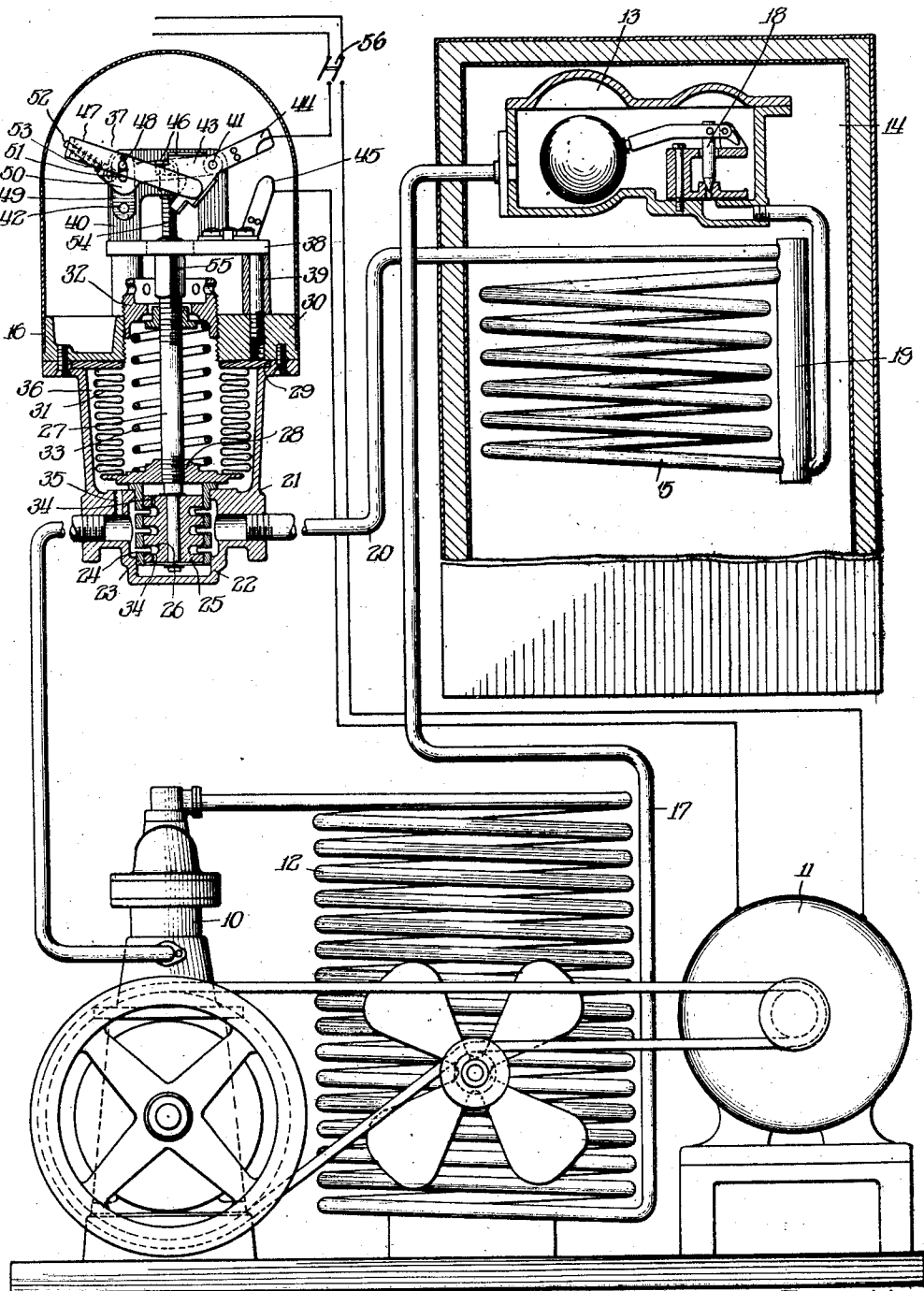
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REFRIGERATING APPARATUS

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REFRIGERATING APPARATUS.

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To all whom it may concern:

Be it known that I, JAMES H. DENNEDY, a citizen of the United States, and resident of Evansville, in the county of Vanderburg and State of Indiana, have invented a certain new and useful Improvement in Refrigerating Apparatus, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to refrigerating apparatus and in particular to that type of compressor - condenser - expander system wherein the compressor is controlled in response to the pressure in the expander or low pressure side. The chief object of my invention is to prevent the overloading of the compressor and the electric motor which drives the compressor, especially when the system has been allowed to become warm and the pressure in the low pressure side has increased greatly above its normal operating pressures.

I accomplish this end by employing a pressure reduction valve made a component part of a pressure-controlled switch device which starts and stops the compressor motor. With this arrangement I need provide but a single spring pressed diaphragm element which serves for both the pressure-controlled switch mechanism and the pressure reduction valve.

If a pressure reduction valve is inserted between the pressure-controlled switch and the expanding chamber, some means must be provided for preventing the pressure reduction valve from closing before the pressure on the switch has built up to the predetermined maximum for which it is set. Otherwise, although the pressure rises in the expanding chamber, the pressure-controlled switch would never be actuated because the pressure reduction valve would shut off the pressure too soon. This danger can be avoided by so setting the pressure reduction valve that it will be closed by a pressure somewhat higher than the maximum pressure for which the pressure-controlled switch is set, thereby providing a margin of safety of, for example, two pounds. An object of my invention is the reduction of this margin of safety so that the maximum pressure which is ever admitted to the compressor is reduced sub-

stantially to the pressure for which the pressure-controlled switch is set. I secure this reduction in the margin of safety in part by providing a snap action for the pressure reduction valve as it closes and in part by providing a common adjustment for the pressure-controlled switch and for the pressure reduction valve.

These and further objects and advantages of my invention are explained in the following description of one particular embodiment.

In the accompanying drawing, which illustrates this embodiment, I have shown somewhat schematically a refrigerating system, the float control for the low pressure side, and also the valve and switch mechanism with which my invention is concerned, being shown in vertical section. The high pressure side of the system comprises a compressor 10 driven by an electric motor 11, an air-cooled condenser 12 and a float valve chamber 13 located within the refrigerated compartment 14, while the low pressure side comprises the heat absorbing coils 15 and the pressure-controlled switch unit 16 which opens and closes the electric switch of the motor 11 in response to pressure fluctuations in the low pressure side caused by the temperature changes therein.

Vaporized refrigerant is withdrawn from the low pressure side by the compressor 10 and discharged as compressed refrigerant to the coils of the condenser 12 where it condenses and flows to the float chamber 13. The high pressure of the uncondensed refrigerant in the condenser forces the condensed refrigerant upwardly through the line 17 into the float chamber 13. As fast as the liquid refrigerant is delivered to the float chamber 13 the float valve 18 admits it into the low pressure side, the liquid first flowing to the lower end of the header 19 of the heat absorbing coil 15. When the compressor stops, following the pumping period, the pressure in the condenser 12 is at its maximum and substantially no more liquid refrigerant will be thereafter forced into the float chamber because the condenser will gradually cool off and lessen the pressure therein. A substantial volume of liquid refrigerant is maintained in the coil 15 and the pressure of the vaporized refrigerant thereabove bears a definite relation to the temperature of the coil. This phase

of the system is more fully described in my co-pending application, Serial No. 521,427, filed December 10, 1921.

At the end of the pumping operation the coil 15 will be at its lowest temperature which will be somewhat lower than the temperature of the refrigerated compartment 14. The refrigerated compartment 14 may itself contain the perishables or other ultimate bodies to be refrigerated or may be one compartment of a refrigerator absorbing heat from other compartments through the medium of a natural or forced flow of air; or the compartment 14 may be the cooling chamber in a brine circulating system.

From the top of the coil 15 a line 20 leads back to the compressor. The pressure switch unit 16 is inserted in this line and is responsive to the pressure therein. The mechanism is set to close the circuit of the motor 11 when the pressure in the line 20 has reached a predetermined maximum for starting operation of the compressor, and to open the circuit of the motor when the compressor has brought the pressure in the line 20 down to a predetermined minimum.

The valve and pressure-controlled portions of the switch mechanism 16 are carried within a cup-shaped casing 21. This casing has a chambered vertical bore 22 in its bottom which is intersected by a horizontal cross bore affording connections for the line 20. A bushing 23 shouldered at its upper end to position it longitudinally of the bore is held with a driving fit in the latter. The bushing has a plurality of superposed slots 24 at its opposite sides communicating with the connections with the line 20. A valve head 25 is reciprocally mounted with a snug fit within the bushing 23 and the valve head has annular grooves 26 for mating the slots 24 of the bushing. The reduced lower end of a shaft or piston stem 27 passes through the piston head 25 and is secured thereto.

The shaft 27 carries a circular plate 28 which normally rests on the upper end of the bushing. A ring 29 is clamped between the upper flange of the casing 21 and the cap member 30 of the switch unit. A flexible metal bellows or sylphon 31 is disposed between the plate 28 and the ring 29, its ends being sealed to these respective members. The central opening of the cap member 30 is internally threaded to receive a plug 32 by means of which the pressure of the compression spring 33 interposed between it and the plate 28, may be varied.

Small relief ducts 34 lead from the upper and lower grooves 26 of the valve head into the spaces above and below the head to balance the valve. The grooves 26 in the head, it may be explained, are annular, while the slots 24 in the bushing extend through comparatively short arcs at the opposite sides

of the bushing. When the grooves and slots are in registry as shown in the drawing, communication is established between the two sides of the line 20, but if the valve head 25 be moved upwardly a fraction of an inch, the grooves will move out of registry with the slots and effectively close communication.

A duct 35 leads from the posterior side of the valve to the chamber 36 formed between the wall of the casing 21 and the sylphon 31 and also below the plate 28. When the valve head is in the position shown in the drawing the pressure in the line 20 will be communicated through the relief duct 34 and the duct 35 to the bottom and the sides of the sylphon. When the pressure thus built up exceeds the pressure of the spring 33 the plate 28 will be moved upwardly carrying with it the shaft 27 and valve head 25.

The rise and fall of the shaft 27 actuates a snap-over switch mechanism 37. This switch, as previously stated, opens and closes the circuit of the motor. However, I contemplate that the movement of the shaft 27 could control some other kind of mechanism for starting and stopping the effective operation of the compressor.

The sylphon diaphragm and the means for varying the spring pressure thereon are disclosed in further detail and are claimed in my co-pending application, Serial No. 571,680, filed July 29, 1922, and the particular form of switch mechanism I have shown here is of the type described in that application and also described and claimed in Patent No. 1,502,717 issued to me July 29, 1924.

In the preferred form of snap-over switch mechanism I have shown a base 38 of suitable insulating material which is held a spaced distance above the cap member 30 by studs 39. A pair of side plates 40 are mounted on the base and carry pivot pins 41 and 42 extending transversely therebetween. A pair of knife arms 43 are pivoted on the pin 41 and carry at their outer ends knives or blades 44 forming the movable contacts of the switch and adapted respectively to engage the stationary clips 45 secured to the base 38. The inner ends of the levers 43 carry pairs of flanges 46 at their upper and lower sides. A yoke member 47 is pivoted on a fulcrum pin 48, the legs of the yoke member extending between the flanges 46 of the knife levers 43 to engage the flanges. The fulcrum pin is carried at the upper end of a link 49 mounted on the side plates by the previously mentioned pin 42. An actuating lever 50 is pivoted on the pin 41 and provided with a slotted opening 51 through which the fulcrum pin 48 passes. Adjacent the slot 51 the free end of the actuating lever 50 pivotally supports a spring rod 52 passing at its free end through a suitable hole in

the web of the yoke member 47 and carrying a compression spring 53 interposed between the yoke and the actuating lever. A threaded rod 54 is pivoted to the actuating lever 5 intermediate the ends of the lever and extends downwardly through a central opening in the base 38. The lower end of the rod 54 and the upper end of the shaft 27 are adjustably connected by a left and right threaded nut 55.

When in the position shown in the drawing with the plate 28 in its lowermost position, the switch knife 44 is held up by the yoke member which contacts its lower flanges, the yoke member being held against counter-clockwise rotation by the upward force component of the spring 53. As the coil 15 absorbs heat from the compartment 14 the liquid refrigerant in the coil will boil and thereby raise the pressure of the vaporized refrigerant in the low pressure side. As the coil 15 continues to absorb heat the pressure in the line 20 will be built up. This pressure is transmitted through the valve head 25 and into the pressure chamber 36. As soon as the pressure in the chamber 36 over-balances the spring 33 the shaft 27 will move upwardly.

The actuating lever 50 is swung upwardly by the shaft 27 until the pivoted inner end of the spring rod 52 comes to the center line passing through the fulcrum pin 48 and the connection of the outer end of the rod 52 with the web of the yoke member 37. During this much of the movement of the shaft 27 the yoke member remains stationary and thus holds the knives 44 fixed in their open position. At such position, it should be noted, the spring 53 exerts no vertical component on the actuating lever 50 tending either to raise or lower the shaft 27.

A slight further upward movement of the shaft 27, however, will force the pivotal connection of the spring rod past the dead center relation and the spring 53 thereupon snaps the yoke member 47 counter-clockwise to contact the upper flanges of the knife levers 43 and drive the knives 44 into their stationary clips 45. The circuit for the motor being closed, the compressor will remain in operation until the pressure in the line 20 is brought down to a predetermined minimum.

The tripping of the snap-over mechanism as just described gives a certain snap to the closing of the valve also. The spring 53, although disclosed as of small diameter, is comparatively a heavy spring and exerts considerable force. The force of the spring is also multiplied by the leverage on the shaft 27 gained by the actuating lever 50. The small vertical component of the spring 53 thus tends to a certain extent to lift the shaft 27. As the pressure in the line

forces the plate 28 upwardly, the grooves 26 in the valve head move almost out of registry with the slots 24 by the time the dead center relation of the snap-over mechanism is reached. When the switch mechanism 70 snaps over, the spring 53 will exert an added upward pressure on the shaft 27 as has just been explained. By suddenly adding this force to the pressure of the refrigerant in the chamber 36, the plate 38 will be moved upwardly a slight distance against the spring 33 with the result that the grooves of the valve head will move entirely out of registry with the slots in the valve bushing.

The compressor will soon bring down the pressure in the line posterior to the valve and in the chamber 36. This will permit the valve head 25 to descend sufficiently to admit a little more vaporized refrigerant 85 from the anterior side of the line as needed to maintain the posterior side of the line at the pressure for which the pressure-controlled device is set. When the pressure has been brought down to the predetermined minimum the spring 33 will overbalance the fluid pressure on the plate 28 and the shaft 27 will pull the switch mechanism down past its dead center and snap it over to the open position shown in the drawing. 95 The valve will then again be fully open.

In the instance where the system is to be closed down, as for repairs or because the refrigeration will not be required for some time, the line switch 56 will be opened so that when the pressure-controlled switch is snapped to its closed position the compressor will not be actuated. As the compartment 14 gradually warms up, the vapor pressure in the coil 15 will reach a pressure many times the normal operating pressure. 105

When it is desired to put the system in operation again, the switch 56 is closed and the motor then starts the compressor. If the compressor were not in some way protected against an excessive pressure in the line 20, it would be drawing in refrigerant at a very considerable pressure and required to compress this refrigerant. The pressure of the charge drawn into the pump cylinders at such time would be so high that the small motor—which is sufficient only to carry the load for ordinary operation—would be entirely inadequate, with the result that it would quickly overheat and perhaps burn out. When my valve is employed in the line 20, however, the pressure of the refrigerant which the compressor under such conditions would be drawing in would not be over the maximum pressure for which the pressure-controlled switch was set, which is usually about seven pounds per square inch. 120

The compressor must of course first bring down the high pressure in the chamber 36 130

in the line posterior to the valve, but the pipes are of small diameter and the pressure-controlled switch located very close to the compressor in actual installation so that the volume of refrigerant pumped at the high pressure is practically negligible. The valve head 25 with its associated sylphon and spring 33 will act as a pressure reduction valve to keep the pressure of refrigerant admitted to the compressor down to the seven pounds. In this way the compressor is at all times protected against excessive pressures tending to overload the motor or cause a disquieting knock in the compressor.

While I have shown this particular embodiment of my invention, I contemplate that changes may be made therein without departing from the spirit or scope of my invention.

I claim:

1. The combination with a refrigerating apparatus having a low pressure side including an expanding chamber and a high pressure side having a condenser, a compressor and a motor to drive the compressor, of a pressure control device in the low pressure side between the expanding chamber and the compressor for starting and stopping the motor, said device comprising a spring-pressed diaphragm element subjected to the pressure of the low pressure side, a switch mechanism actuated at predetermined points by movement of the diaphragm element to open and close the circuit of the motor, and a valve member operated by the diaphragm element for regulating the flow of refrigerant from the expanding chamber to the compressor.

2. The combination with an artificial refrigerating system consisting of a compressor, a condenser, and an expander, and an electric motor for driving the compressor, of a switch mechanism for opening and closing the circuit of the motor, a pressure-reducing valve between the expander and the compressor, and a diaphragm element subjected to the pressure in the expander, which diaphragm element actuates both the switch mechanism and the valve.

3. The combination with a refrigerating system having a heat absorbing expanding chamber, a compressor pumping from the chamber, and a condenser, of a pressure-controlled mechanism of the spring-pressed diaphragm type subjected to the pressure of the chamber for starting and stopping operation of the compressor, a pressure-reducing valve of the spring-pressed diaphragm type between the chamber and the compressor, and a common member which correspondingly varies the spring tension for both the pressure-controlled mechanism and the pressure-reducing valve.

4. The combination with a refrigerating

apparatus having a high pressure side including a compressor and a condenser, and a low pressure side forming a vaporizing chamber, and having a motor for driving the compressor, of an electric switch for starting and stopping the compressor motor, a pressure-reducing valve between the chamber and the compressor, and an element movable in response to pressure fluctuations in the chamber which controls both the switch and the valve.

5. The combination in a refrigerating system, of a vaporizing chamber, a compressor for withdrawing vaporized refrigerant therefrom, a condenser, a motor for driving the compressor, an electric switch for starting and stopping the motor, a snap-over mechanism for opening and closing said switch, a diaphragm element subjected to pressure of vaporized refrigerant in the chamber, an actuating member secured to the diaphragm element and connected with the snap-over mechanism, said mechanism, when snapped by movement of the actuating member, imparting an additional force to the member, a pressure reduction valve between the chamber and the compressor and also connected to the diaphragm element, the valve being arranged to be finally closed by said additional movement of the member imparted by the snap-over mechanism.

6. The combination with a refrigerating apparatus consisting of a compressor, a condenser, and an evaporator and a motor for driving the compressor, of a combined pressure-controlled switch for controlling the motor and pressure reduction valve between the evaporator and compressor, comprising a casing forming a pressure chamber, a diaphragm forming a wall of the chamber, a spring for the diaphragm, a stationary valve port formed in the casing, a movable valve element for cooperating with said port connected to said diaphragm, a switch mechanism supported on said casing and connected with the diaphragm to be operated thereby, inlet and outlet passages in the casing communicating with the evaporator and the condenser, respectively, and means for adjusting the pressure of the spring.

7. The combination with a refrigerating apparatus consisting of a compressor, a condenser, and an evaporator and a motor for driving the compressor, of a combined pressure-controlled switch for controlling the motor and pressure reduction valve between the evaporator and compressor, comprising a casing forming a pressure chamber, a diaphragm forming a wall of the chamber, a spring for the diaphragm, a stationary valve port formed in the casing, a movable valve element for cooperating with said port connected to said diaphragm, a switch mechanism supported on said cas-

ing and connected with the diaphragm to be operated thereby, inlet and outlet passages in the casing communicating with the evaporator and the compressor, respectively, 5 means for adjusting the pressure of said spring, and an adjustable actuating member connecting the diaphragm and switch.

8. In a refrigerating system, the combination of a vaporizing chamber, a compressor for withdrawing vaporizing refrigerant therefrom, a condenser, an electric motor for driving the compressor and a unitary pressure-controlled switch and pressure-reducing valve comprising a casing forming 15 a pressure chamber, a spring-pressed diaphragm element constituting a wall of the chamber, a bore in the casing, a valve head reciprocally mounted therein, inlet and outlet ports in the opposite sides of the bore, 20 a passage in the head for registering with the ports, the head being connected to the diaphragm element for reciprocation thereby, discharge means connecting the vaporiz-

ing chamber and the compressor with the inlet and outlet ports, respectively, said 25 chamber being in communication with one of said discharge means, a switch for opening and closing the circuit of the motor, a snap-over mechanism mounted on the casing for controlling the switch, an actuating 30 member for the snap-over mechanism connected with the diaphragm element, and means for adjusting said member, the valve head being set relatively to the diaphragm element to close communication between 35 the ports only after the pressure in the chamber has risen above the maximum pressure for which the snap-over mechanism is set to operate the switch.

In witness whereof, I hereunto subscribe 40 my name this 27th day of October, 1924.

JAMES H. DENNEDY.

Witnesses:

LUCY BUTTRUM,
F. W. BECKER.