

Mar. 6, 1923.

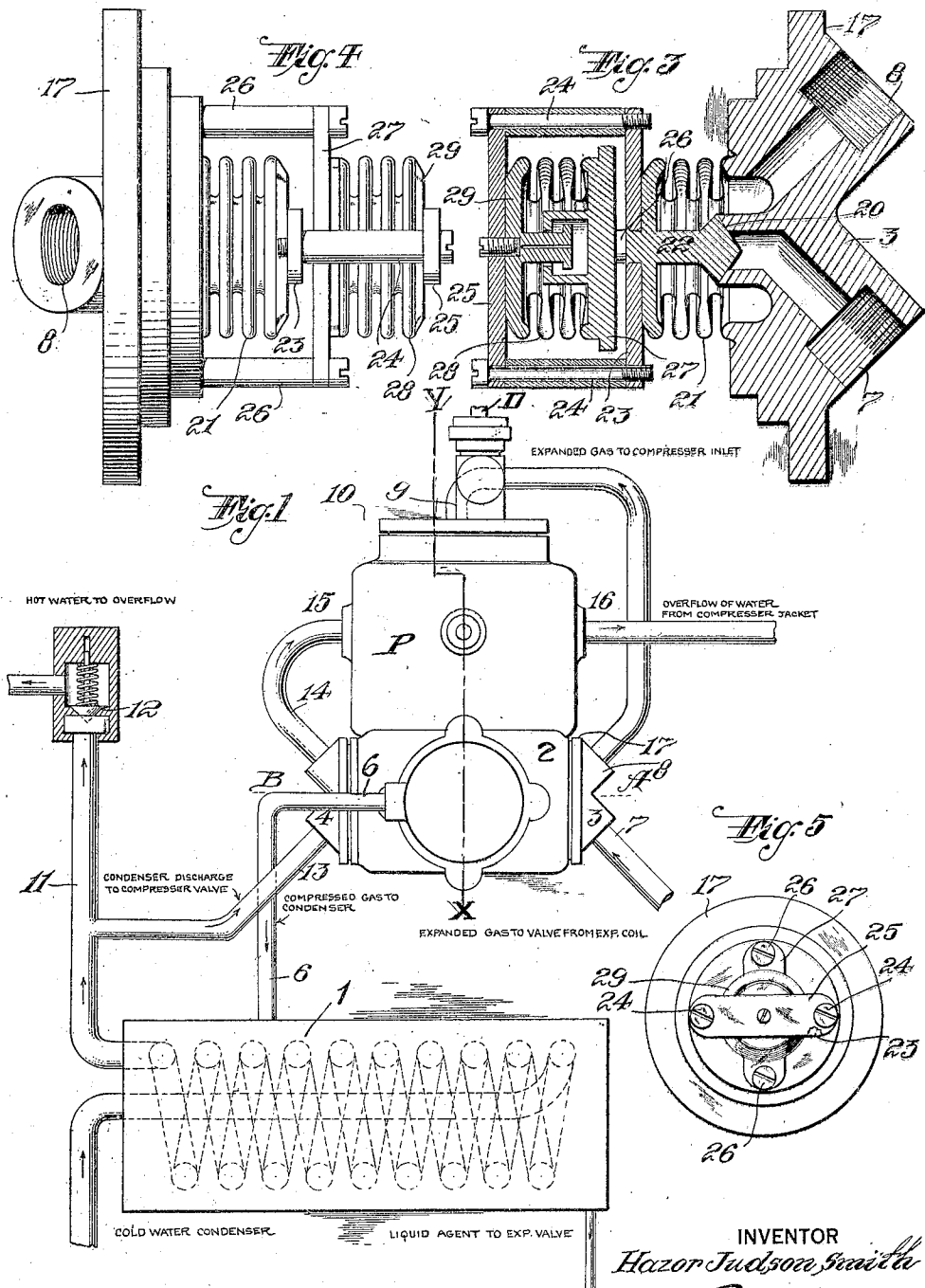
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METHOD FOR PREVENTING EMULSIFICATION OF REFRIGERATING AGENT IN THE SEALING OIL.

FILED FEB. 5, 1921.

3 SHEETS—SHEET 1.



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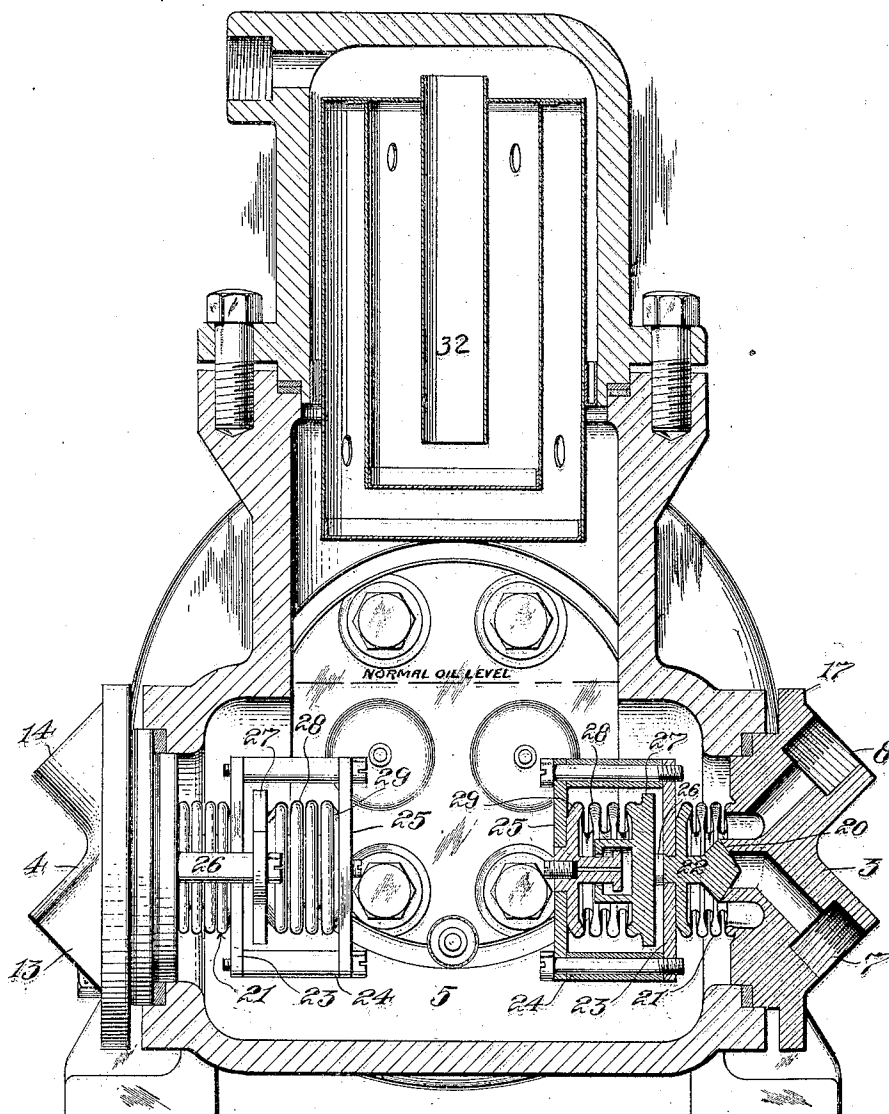
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3 SHEETS—SHEET 2.

Fig. 2



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3 SHEETS—SHEET 3.

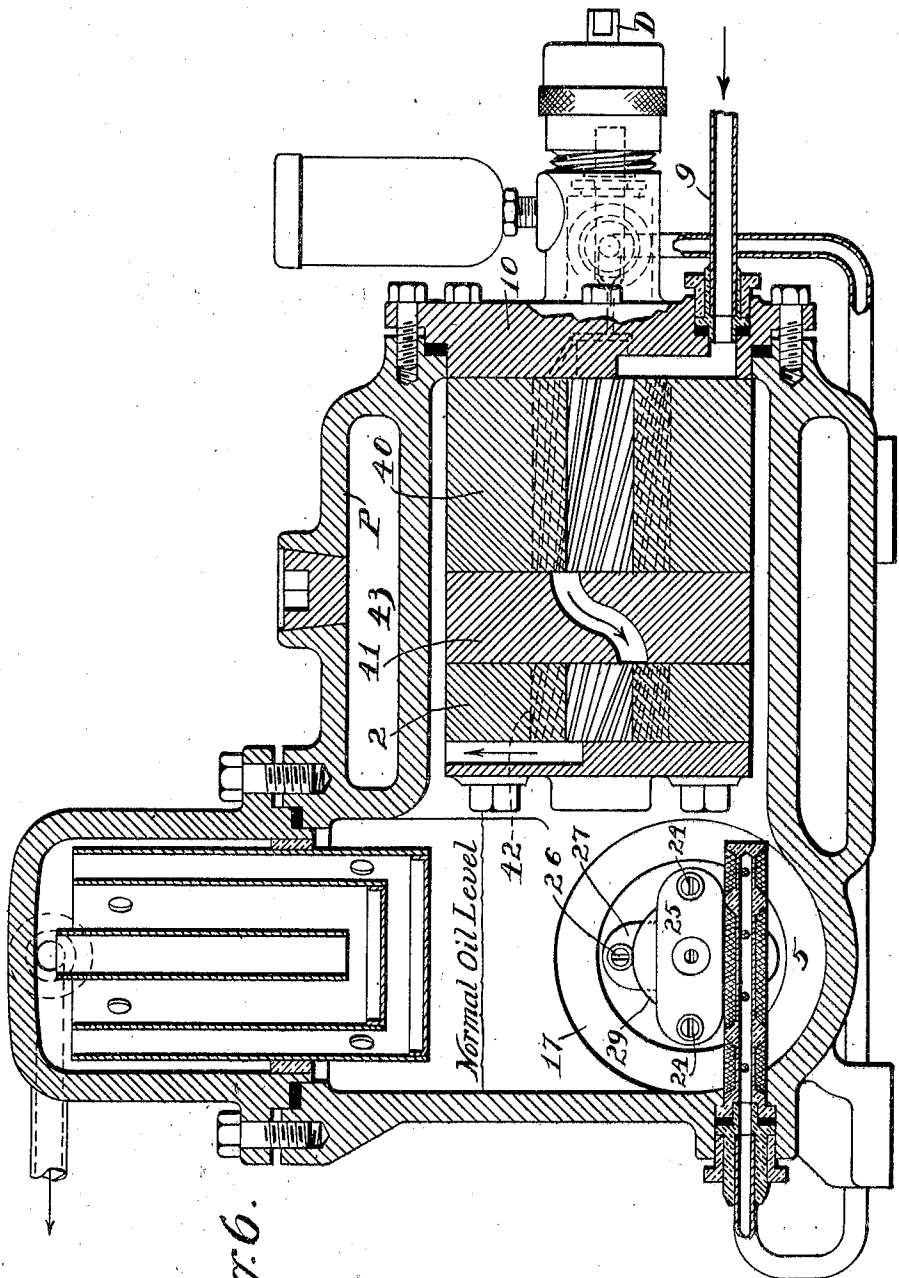


Fig. 6.

Inventor
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UNITED STATES PATENT OFFICE.

HAZOR JUDSON SMITH, OF CHICAGO, ILLINOIS, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, OF ONE-FOURTH TO WILLARD REID AND ONE-HALF TO ALFRED HASTINGS CHAPIN, BOTH OF SPRINGFIELD, MASSACHUSETTS.

METHOD FOR PREVENTING EMULSIFICATION OF REFRIGERATING AGENT IN THE SEALING OIL.

Application filed February 5, 1921. Serial No. 442,893.

To all whom it may concern:

Be it known that I, HAZOR JUDSON SMITH, a citizen of the United States, residing in Chicago, Cook County, State of Illinois, have invented certain new and useful Improvements in Methods for Preventing Emulsification of Refrigerating Agent in the Sealing Oil, of which the following is a specification, reference being made to the accompanying drawings, forming a part thereof.

This invention relates to refrigerating systems of the small or miniature type; and more particularly to ice machines of the type designed and intended to be self-operating.

Under certain conditions of operation, such as following a relatively long idle or stand period when the compressor may be as cold as the condenser, or following a stand period during which the expansion valve has leaked and a quantity of the refrigerating liquid has more or less flooded the low side, by which I mean the coils in the brine tank, it has been found that, in ice machines where oil is used as a sealing medium, when the machine starts up again some of the liquid refrigerating agent will be drawn directly into the compressor. The compressor and the sealing medium or oil having cooled off or become cold, there is no immediately available heat to tend to throw off the refrigerating gas or liquid to the condenser and the cold oil will rapidly take on or absorb gas or liquid refrigerating agent. Once started, this absorption increases rapidly and, instead of the compressor warming up and permitting the oil and gas or liquid to separate and the gas to pass on to the condenser, the oil and its absorbed refrigerating agent will be circulated as a sealing and lubricating medium and injected into the pump mechanism at a point having a lower pressure than the high side. This allows the refrigerating agent to boil out of the oil, setting up a condition of internal refrigeration, and the compressor and sealing medium will get colder and colder until the machine is actually refrigerating in the compressor, itself. When it gets to doing this it will not correct itself, too little or no refrigeration is taking place in the expansion coils and the

machine will continue to run without doing its work of properly cooling the box.

In the use of ethyl chloride, sulphur dioxide, pictet fluid, methylic ether or ammonia in an oil sealed pump the fundamental conditions leading to supercharging or emulsification are quite similar and the method we have perfected and the valve here shown are nearly indispensable to a reliable machine.

The use of a stream of water to cool the condenser and then the compressor brings new factors into the problem of preventing emulsification or supercharging. In an air cooled machine there is bound to be a relative balance of the surfaces of the compressor and condenser so far as convection is concerned and the fact that the compressor is the initial source of heat tends to maintain during operation a higher temperature in the compressor than in the condenser. Under ordinary conditions the use of a protective mechanism is limited to the first part of a run after both compressor and condenser have cooled to practically air temperature. The natural balance of the elements (compressor and condenser) naturally protects the oil during runs under ordinary conditions and follow the natural variations of the day.

In a water cooled machine a series of new factors are brought in which either singly or in combination produce pressure-temperature conditions which result in supercharging or emulsification. I will enumerate a few of them. If the water is allowed to flow after the machine stops running it will chill both condenser and compressor to practically the same temperature and the machine will immediately emulsify when it starts. If the stream of water through the cooling system be too great the temperature differential between incoming and discharge water will be low and therefore the compressor will run at about the temperature of the condenser and emulsification follows. If the stream of water is too small for the proper cooling of the machine and condenser then the pressure of the high side will run up to a high point and the machine suffer a loss in efficiency as a result.

If the water fails to flow while the ma-

chine is in operation the pressure and temperature of the high side will rise along the pressure-temperature line of the agent used and the oil will become emulsified or supercharged. If now while supercharged the water comes into the condenser and thence to the compressor the rapid drop in temperature of the condenser will result in a rapid drop in its pressure with the result that the agent impounded in the oil will boil off into the condenser and if the temperature drop of the condenser has been sufficiently rapid the boiling agent will take the oil with it into the condenser. This puts a machine completely out of service and leaves the compressor without lubrication or seal. A machine regulated by thermostatic means from the box or brine will thus run to a breakdown and either destroy the compressor or the electric motor.

I therefore use in the water cooled machines two pressure-temperature valves 3 and 4. 3 controls the flow of refrigerating gas to the inlet of the compressor; and 4 is connected in the water line 11 to the compressor 2 and controls the flow of water to the compressor. The compressor water line 11 in which the pressure-temperature valve 4 is situated is a by-pass line from the tail of the condenser 1. A pressure relief valve 12 in the discharge line from the condenser situated behind the inlet to the compressor by-pass forces the water through the by-pass if the valve 4 be open, otherwise it overflows through the relief valve 12 if the conditions within the compressor hold the pressure-temperature valve in a closed position.

It will be readily understood from the above description that these valves 3 and 4 will shut off the supply of water to the compressor jacket and the supply of gas to the compressor if the temperature-pressure conditions within the compressor are such as to permit emulsification and these valves will stay closed until the friction of the pump has raised the temperature of the compressor above the danger point. If during the run the low side floods or a decided change in the conditions within the compressor occur the valves will close until the temperature-pressure has returned to the predetermined point.

To prevent emulsification to a harmful extent the temperature of the oil when in contact with the gas in the high side must be enough higher than the condensing temperature (for the given condition of air or water temperatures) to present a superheated surface to the contact of the gas. This difference in temperature between gas and oil is a variable and is affected by the nature of the oil and the kind of refrigerating gas used. No hard and fixed rule has been arrived at because of the variable stated. However for any combination of oil and

agent there is a working difference that is easily obtained by observation and it is at this point or just above it that we are operating.

In order to establish and hold this predetermined difference in temperature we use a pressure-temperature valve as shown in the accompanying drawing. This valve is automatic and is so constructed that it remains closed until the temperature of the oil which surrounds it has attained the predetermined difference above the temperature of the condenser. The temperature of the condenser is always evident in the pressure of the high side along the pressure-temperature curve of the particular agent which is used in the machine. Therefore we have a pressure in the high side of the machine that corresponds with the temperature of the liquefied agent in the condenser. We use a pressure sensitive element charged with the same liquefied gas as is used for the refrigerating process or a gas of similar pressure-temperature characteristics and this pressure sensitive element then becomes a temperature sensitive element and its pressure for temperature will be along the same line or curve as the pressure for temperature curve of the agent within the condenser. Now if the temperature of the compressor and its oil be the same as the temperature of the condenser the element submerged within the oil will have a pressure within it equal to the pressure upon it and therefore in equilibrium. Now the valve itself is connected to a diaphragm exposed to the pressure of the high side and therefore the pressure element cannot open the valve to which it is connected until the heat of the oil and the element itself is enough higher than the temperature of the condenser to set up a pressure within the element great enough to overcome the pressure of the high side on its ends and the pressure of the high side against the diaphragm which carries the valve. The relationship of the areas of the ends of the element and the diaphragm determines the ratio of heat required to open the valve, or determines how much hotter the compressor must be as compared to the condenser before the machine can open its inlet lines and take gas from the expansion coils. Naturally the compressor will heat up rapidly if the inlet line be shut off and the compressor allowed to pull a high vacuum against the pressure of the condenser. The frictional heat alone without a negative heat subtraction is sufficient to heat up the compressor and the oil within it. As soon after the machine starts to run as this heat factor or differential is developed the low side opens automatically and the machine functions as a refrigerating machine without the possibility of emulsification or supercharge of the oil seal. No condition

can arise that can cause supercharge as the valve automatically closes off the low side unless the pressure-temperature condition is favorable and correct.

- 5 Under certain conditions of "temperature and pressure" of the compressor and the condenser this absorption or surcharging will occur even if no liquid refrigerating agent is drawn into the compressor. When
10 the above situations develop the machine is almost certain to "emulsify" and this requires a "service" call for correction.

The object of this invention is to produce a method or system that will eliminate these
15 objectionable features by preventing the supercharging of the sealing oil.

Having thus set forth my invention I will now describe an embodiment thereof.

In the drawings:—

- 20 Figure I is a diagrammatic view of my refrigerating system with the pressure temperature valves connected in the inlet line and the water line of the compressor.

Figure II illustrates a section through the
25 compressor on line A B.

Figures III, IV and V are details of the valve used in my system.

Figure VI is a section through the pump member along the line $x-y$ Figure I.

- 30 Referring now by reference to the drawings:

In the diagrammatic sketch Figure I, I have chosen to illustrate a water cooled machine showing the condenser 1 and compressor 2 with the two pressure-temperature
35 valves 3 and 4 in the lines. Valve 3 is in the gas return line from the expansion coils 30 and the valve 4 in the by-pass water line from the tail of the condenser.

40 The valves are submerged in the sealing oil in the oil pocket shown at 5, directly under the oil separator 32 Figure II. The line 6 is the gas discharge line from the compressor oil separator to the condenser.

45 Gas from the expansion coils enters the pressure-temperature valve 3; at 7 and leave it at 8 thence passing to the inlet of the compressor at 9. The inlet 9 is in the face plate 10 which carries the members of the pump
50 or compressor assembly. Water which has been used to cool the condenser 1 passes off through the pipe 11 and either flows to the drain through the relief valve 12 or enters the pressure-temperature valve 4, at 13,
55 leaves it at 14 and enters the compressor jacket at 15 after which it passes around the compressor, absorbing its heat and leaves the jacket through the overflow at 16.

The object of the relief valve 12 in the
60 line 11 is to set up a back pressure in that line which will force the water stream through the pressure-temperature valve 4 and on around the compressor jacket if the valve 4 be open and to provide an escape
65 for the condenser water if the valve be

closed. By holding the drawings up to the light you will see a complete refrigeration cycle in which: blue is the liquid refrigerant; yellow, the cold expanded gas; red, the hot compressed gas; brown, the oil; 70 green, the water.

The valves 3 and 4 are identical in construction, so only one need be described and the parts numbered alike.

I employ a face plate 17 having the passages 7 and 8 opening into the two sides of the valve seat 20. Fastened to the face of the plate 17 is the diaphragm 21 carrying the head 22 which is also the male member of the valve 3. Attached to the head 22 is
75 the cross arm 23 which is in turn attached by the bolts 24 to the cross arm 25. Supported upon the plate 17 by the bolts 26 is the diaphragm head plate 27 to which is attached the diaphragm 28. The head 29
80 closes the opposite end of the diaphragm 28 and produces a sealed chamber within the assembly 27, 28 and 29. The formation of the heads 27 and 29 permit of their interlocking and establishing a limit of expansion of the element 27, 28 and 29. This
85 element is charged with liquid refrigerant like that used in the machine or a similar volatile liquid and its gas. Its pressure for temperature curve will be identical with that
90 of the liquid refrigerant within the high side. The passage 7 is attached to the line from the expansion coils and the passage 8 is attached to the inlet of the compressor. Now if the valve be closed the compressor
100 cannot take gas from the expansion coils neither can it draw liquid refrigerant from a flooded low side.

When the temperature of the oil within the compressor and surrounding the thermal
105 element 27, 28, 29 is the same as the temperature of the condenser the back pressure from the liquid within the condenser will equal the pressure of the gas within the thermal element. The pressure of the
110 condenser then pressing against the head will forcibly close the valve. With the inlet shut off the temperature of the compressor will rapidly rise because of the frictional heat of the moving parts and the rapid motion
115 of the sealing oil through the gears. As soon as the compressor and the oil within it have taken on sufficient heat to raise the temperature of the thermal element to where its internal pressure is sufficient to overcome
120 the pressure of the high side on both the head 29 and the head 22, the valve will open and because of the fact that the machine is pulling a high vacuum in the passage 8 while the valve is closed; and because this
125 high vacuum will be reduced to the working back-pressure of the machine when the valve is open, the relief of that part of the differential pressure of 22 which was represented by the high vacuum will let the valve
130

snap open to its limit. This limit is fixed by the position of the plate 27 as related to the closed position of the valve 22.

When the areas of the two heads 29 and 22 are the same the opening point of the valve occurs when the temperature of the oil is at the point where the pressure for temperature factor within the thermal element 27, 28, 29 is equal to twice the pressure for temperature factor in the condenser. With ethyl chloride and a condenser temperature of 80 degrees Fahr., the temperature of the oil necessary to open the valve would be approximately 108 degrees Fahr. Modification of the ratios of areas of the two heads will produce any predetermined temperature differential but we find that ethyl chloride works best when the above ratio is maintained or exceeded.

By referring particularly to Figure I the gas enters at 7 passes through the thermostatic valve seat 20 coming out at 8, passing through the tube to inlet 9 of the compressor, which is driven by a motor coupled to drive shaft D, passing through the pump P, the gas and oil enter the oil separator 2. Oil and gas are here separated, the oil drops down into oil pocket 5 and gas is discharged at 6 to the condenser, see Figure II.

The water from the condenser enters the valve 4 at 13 and passes out through 14 to inlet 15 of water jacket of the compressor P and out at 16. In the event the thermostatic valve 4 is closed by internal conditions the water then passes through the check valve 12.

Emulsification as used in this specification, means the suspension of the refrigerating agent in the sealing oil; it is the surcharging of the oil.

The oil level is shown at line O, Figure II but may be any place so long as the thermostatic valves are submerged.

The method herein described is carried forth by means illustrated, but changes or modifications may be made without departing from the salient features of my invention; and I therefore intend the following claims to cover such modifications as naturally fall within the lines of invention.

I claim:

1. In a refrigerating machine of the type described the combination of means to control the heat dissipation of the compressor to maintain the temperature of the compressor at a point sufficiently higher than the temperature of the condenser to prevent the sealing medium within the compressor from absorbing a deleterious amount of the refrigerating agent and means for closing the suction line of the compressor until a predetermined temperature and pressure ratio has been attained within the compressor.

2. In a refrigerating machine of the type described the combination with a compres-

sor and a condenser means for automatically closing the suction line of the compressor when the temperature of the compressor falls to a point as compared with the temperature of the condenser when harmful emulsification may occur and opening the suction line to the compressor when a predetermined ratio of temperature has been attained.

3. In a refrigerating machine of the oil sealed type, the combination with a compressor and a condenser of a temperature-pressure responsive means for closing off the cooling water from the compressor when the temperature of the compressor as compared to the temperature of the condenser will permit deleterious supercharging of the oil and opening the cooling water circuit when the temperature of the compressor has risen sufficiently to overcome the hazard of supercharging.

4. In a refrigerating machine of the oil sealed type, the combination of temperature pressure operated valves which close the suction line of the compressor and shut off the cooling water to the compressor when the temperature of the compressor does not exceed the temperature of the condenser by a predetermined amount and which maintain the valves in the open position when the temperature of the compressor exceeds the temperature of the condenser by the predetermined amount.

5. In a refrigerating machine of the type described the combination of a condenser cooling circuit, a compressor cooling circuit using the tail of the condenser stream, a pressure relief valve permitting escape of the condenser cooling stream ahead of the compressor when the compressor water circuit is closed and means for automatically controlling the stream of cooling medium through the compressor said means being actuated by the changes in the temperature pressure condition of the compressor, for the purpose set forth.

6. In a refrigerating machine of the type described, a compressor shell, a rotary pump element within the shell, an oil body within the shell, a valve having a temperature sensitive element submerged in the oil and a diaphragm exposed on one side to the pressure of the high side and exposed upon the other side to a lower pressure, so arranged that the valve remains closed until the temperature surrounding the sensitive element produces a pressure within the sensitive element which exceeds the pressure of the high side to a predetermined degree.

7. In a refrigerating machine of the type described, a valve having a diaphragm exposed to the pressure of the high side, a pressure element charged with the refrigerating agent used in the machine or a volatile agent of similar physical properties, said diaphragm and valve

being normally in the closed position as the result of the pressure of the high side upon the said diaphragm and capable of being moved to the open position by the pressure element when the temperature of the pressure element exceeds the temperature of the condenser to a predetermined degree.

8. In a refrigerating machine of the type described the method of preventing emulsification of the sealing medium which consists of maintaining the temperature of the sealing medium when exposed to contact with the refrigerating agent in the high side at a point of temperature sufficiently higher than the temperature of the condenser to overcome the tendency of the sealing medium to absorb a deleterious amount of the refrigerating agent.

9. In a refrigerating machine of the type described the method of preventing supercharging of the sealing medium with refrigerating agent in solution which consists of maintaining the temperature of the sealing medium while exposed to contact with the refrigerating medium in the high side at a point sufficiently higher than the temperature of the condenser to limit the absorption of refrigerating agent to a non-deleterious amount.

10. In a refrigerating machine of the type described, the combination with a compressor and a condenser of means responsive to the pressure of the condenser and the temperature of the compressor to close the inlet to the compressor when the temperature of the compressor approaches the temperature of the condenser which will permit condensation of the refrigerant within the compressor.

11. In a refrigerating machine of the type described the combination of a compressor temperature controlling means actuated by the pressure of the condenser and temperature of the compressor, and means to close the inlet to the compressor when the temperature of the compressor approaches the temperature of the condenser.

12. In a refrigerating machine of the type described the combination of a compressor temperature controlling means actuated by the pressure of the condenser and temperature of the compressor and means to open the inlet to the compressor when the temperature of the condenser exceeds the temperature of the compressor by less than a predetermined amount.

13. In a refrigerating machine using oil in the system which serves as a sealing medium, the process of preventing deleterious surcharging of the oil, which consists of maintaining the oil at a temperature above the temperature at which the oil will absorb a deleterious amount of refrigerating agent at the working pressure.

14. In a refrigerating machine using oil in the system which serves as a sealing medium, the method of preventing deleterious surcharging of the oil, which consists of maintaining the oil at a temperature above the temperature at which the oil will absorb a deleterious amount of refrigerating agent at the working pressure and the use of means for shutting off the inlet passage to the compressor while the frictional heat of the idling compressor raises the temperature of the oil to the predetermined point.

15. In a refrigerating machine of the type described, the combination with a compressor and a condenser of means for automatically closing the suction line of the compressor when the temperature of the compressor falls to a point as compared with the temperature of the condenser at which harmful supercharging may occur and for opening the same aforesaid line to the compressor when the predetermined ratios of temperature have been attained.

In testimony whereof, I have signed my name to this specification in the presence of two witnesses.

HAZOR JUDSON SMITH.

Witnesses:

WILLARD REID,
ELLA M. TITUS.