



J. F. HOFFMAN.  
REFRIGERATING APPARATUS.  
APPLICATION FILED JUNE 26, 1918.

1,350,550.

Patented Aug. 24, 1920.

3 SHEETS—SHEET 2.

FIG. 2.

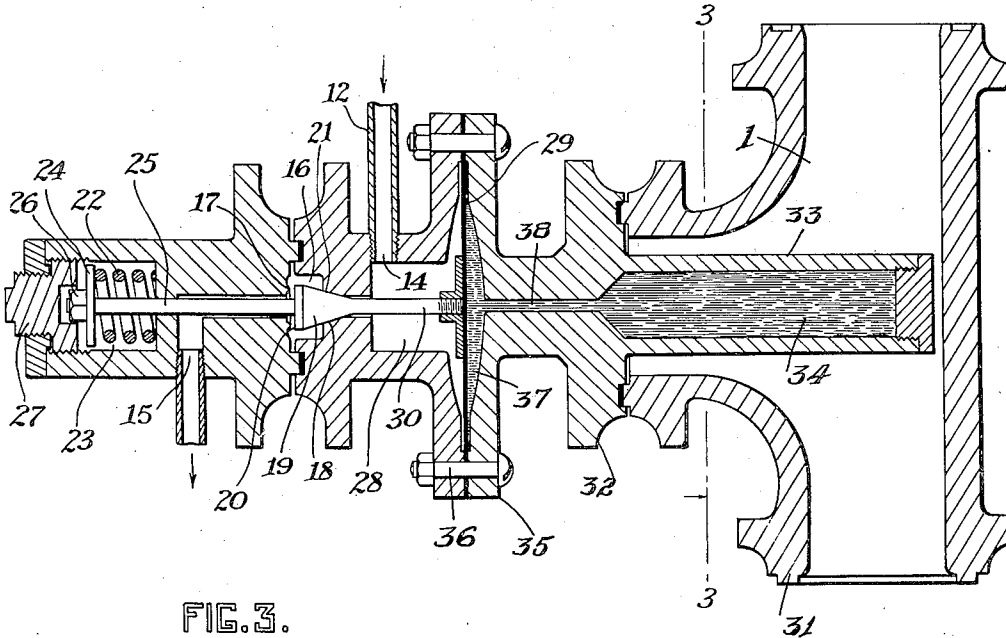


FIG. 3.

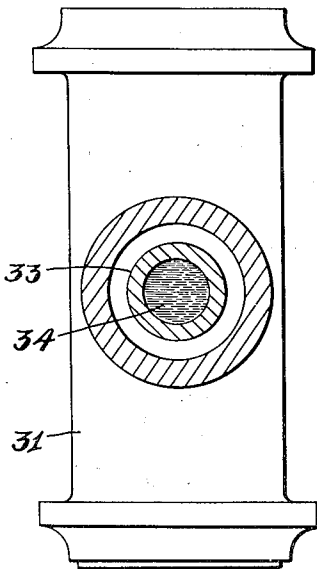
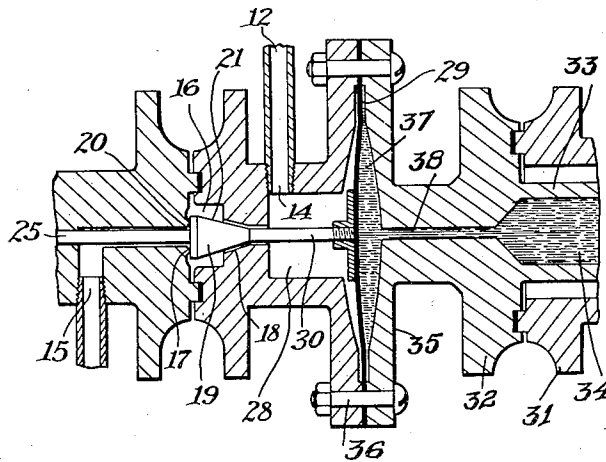


FIG. 4.



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FIG. 5.

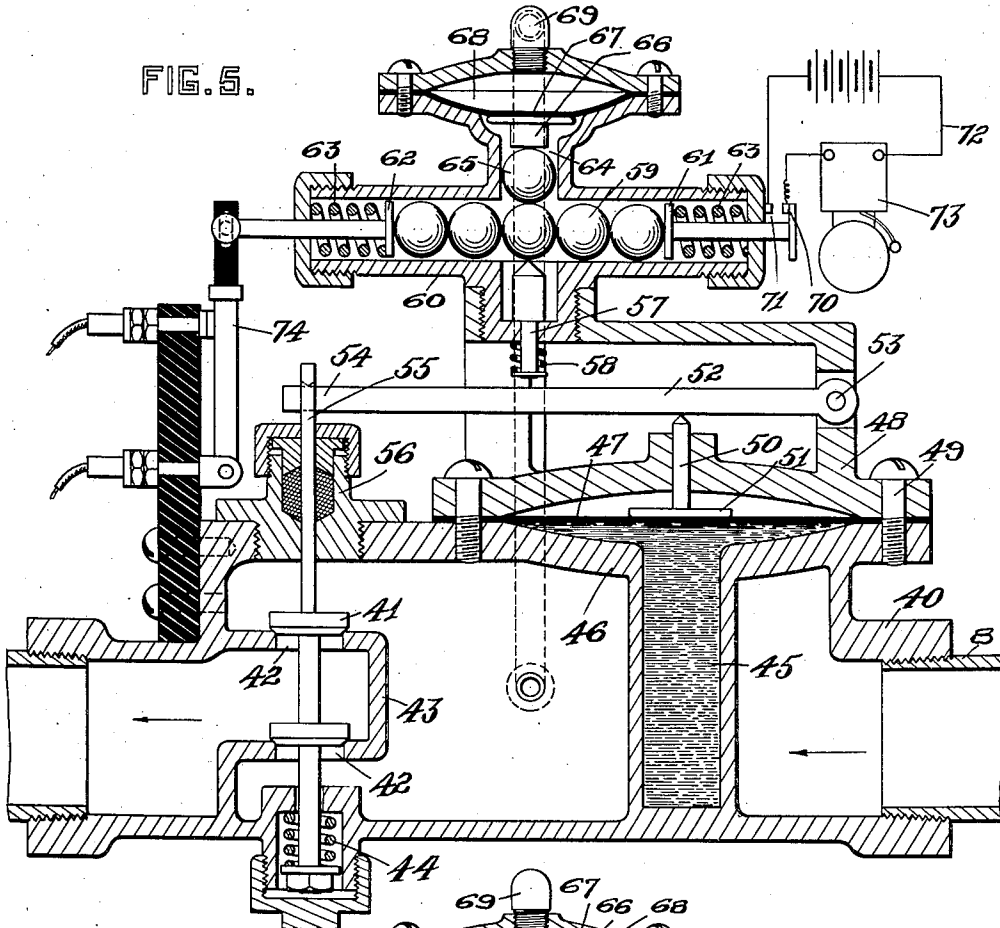
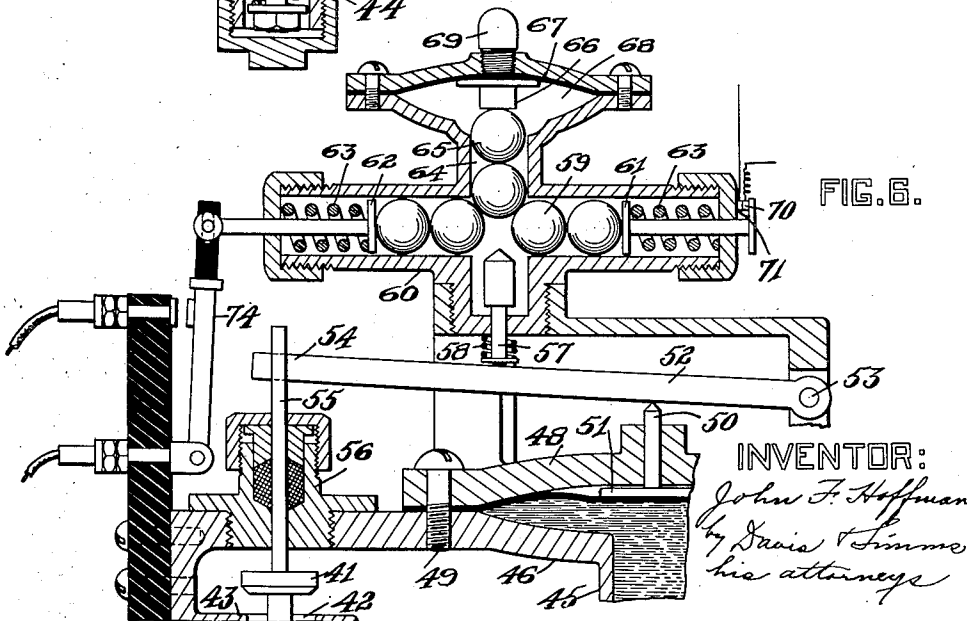


FIG. 6.



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# UNITED STATES PATENT OFFICE.

JOHN F. HOFFMAN, OF ROCHESTER, NEW YORK.

## REFRIGERATING APPARATUS.

1,350,550.

Specification of Letters Patent. Patented Aug. 24, 1920.

Application filed June 26, 1918. Serial No. 242,054.

*To all whom it may concern:*

Be it known that I, JOHN F. HOFFMAN, a refrigerating engineer, citizen of the United States, and resident of Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Refrigerating Apparatus, of which the following is a specification.

The present invention relates to refrigerating apparatus and more particularly to the type employing a fluid, such as ammonia, which is liquefied and then evaporated in contact with a refrigerating or cooling surface to produce the desired degree of temperature, an object of this invention being to provide for automatically maintaining a substantially constant temperature in the cooling or refrigerating surface notwithstanding the varying demands upon such surface.

To this and other ends, the invention consists of certain parts and combinations of parts all of which will be hereinafter described, the novel features being pointed out in the appended claims.

In the drawings:—

Figure 1 shows diagrammatically a refrigerating system embodying the present invention;

Fig. 2 is a sectional view through the valve which controls the supply of liquid to the refrigerating or cooling surface, the valve being shown closed against one of its seats;

Fig. 3 is a section on the line 3—3, Fig. 2;

Fig. 4 is a detail sectional view similar to Fig. 1, showing the valve closed against another of its seats;

Fig. 5 is a sectional view through a valve which controls the quantity of the water used to condense the ammonia as well as the temperature of the system; and

Fig. 6 is a fragmentary view, showing the manner in which the stopping of the system is produced.

A well known type of refrigerating system now in use embodies the main suction line 1 leading to the compressor 2, which may be driven in any suitable manner, as by an electric motor 3. From the compressor a discharge line 4 leads to an oil trap, not shown, and from the latter to a condenser. This condenser embodies inner tubes 5 surrounded by outer tubes 6 with

spaces between them, and inner tubes conducting cooling water from a supply pipe 7 through the outer tubes and being, in turn, connected with a drain or discharge pipe 8 which leads through the jacket of the compressor 2, and from the jacket, by way of a drain pipe 9, to any suitable place, such as a sewer. The spaces between the inner tubes and the outer tubes 6 of the condenser serve to conduct the ammonia gas which, being in a compressed state and contacting with the water tubes 5, which are of lower temperature, condenses and is discharged into the ammonia receiver 10 by way of the pipe 11. From the ammonia receiver a supply pipe 12 extends to one or more cooling surfaces 13 which are designed as usual to perform any desired work, such as making ice, or cooling beer, water, or other fluid, and also in cooling perishable foods.

A refrigerating plant or system is constructed to produce a certain capacity, and this capacity is obtained by maintaining a certain degree of saturation of the gas in the cooling surface. The nearer this saturation is maintained, the more efficient will be the refrigerating system. If the saturation falls below this degree, that is, less saturated, then a dry condition exists in the machine and the ammonia gas will enter the compressor slightly superheated, whereas, if this saturation be increased, a wet condition will exist and the ammonia gas entering the compressor will be accompanied by sufficient liquid to absorb the heat of the compressor, so that the temperature of the discharge will be that at which the ammonia gas accompanied by sufficient liquid ammonia will condense under the pressure to which it has been compressed, both of these conditions rendering the refrigerating system less efficient.

According to this invention, provision is made whereby the degree of saturation of the gas for which the plant is designed is automatically maintained constant, so that a maximum efficiency is secured. This result is preferably obtained by controlling the liquid supply to the cooling surfaces by thermostats which are affected by the temperatures of the discharges from the cooling surfaces, the liquid supply also being controlled by the pressure in the liquid supply, provision being made for maintaining this

pressure constant, preferably by controlling the temperature of the outlet water from the condenser.

To secure the above results, near each cooling surface a valve casing is introduced in the liquid supply 12, said casing having an inlet port 14 and an outlet port 15 with a communicating passage between them. In this passage is preferably arranged a valve chamber 16 with valve seats 17 and 18, respectively, for engagement by a valve member 19, said valve member having a shoulder 20 for engagement with the seat 17 and a tapered portion 21 for engagement with the seat 18. When the valve member is in one extreme position, it coöperates with the seat 17 to close the passageway, and when in the other extreme position, it coöperates with the seat 18 to close the passageway. A spring 22 is mounted within a chamber 23 in the valve casing and acts upon a collar 24 which is secured to a stem 25 that extends from the valve member 19, such spring tending to hold the shoulder 20 of the valve member 19 against the seat 17. A nut 26 on the stem defines the position of the abutment washer 24 in order to increase or decrease the tension in the spring 22, this nut being controlled from the outside of the casing by a nut 27 having screw threaded engagement with the walls of the chamber 23.

To the end that the valve member 19 may be held away from the seat 17 under the pressure within the supply pipe 12, the valve casing may be provided with a chamber 28 between the inlet 14 and the valve seat 18, and in this chamber a diaphragm 29 may be arranged, said diaphragm, in this instance, being a sheet of steel and being connected by a stem 30 with the valve member 19. It is apparent that pressure of the liquid in the supply pipe will act on this diaphragm 29 and tend to move the valve 19 away from the seat 17 and toward the seat 18, but should the pressure in the supply pipe 12 decrease for any reason whatsoever, then the valve shoulder 20 will move toward the seat 17 under the action of the spring 22.

The valve member 19 may also be controlled by the temperature of the fluid in the main line 1, into which the cooling surfaces discharge, and to this end a coupling member 31 may be introduced into the main line 1 in proximity to each cooling surface 13, and in this coupling member, which may be in the form of a T, a thermostat may be introduced. In this instance, this thermostat embodies a casting 32 fitted to the central arm of the T 31 to close said arm and having a projecting chamber 33 in which a readily expansible fluid 34, such as liquid ammonia, is placed. The casting 32 also has a flanged portion 35, which is bolted at 36 to the casing of the valve member 19, and acts

to support the diaphragm 29 between said valve casing and the casting 32. The flange 35 has a concave face opposed to the diaphragm 29, forming a chamber 37 which communicates through a narrow passageway 38 with the chamber 33. With this arrangement it will be apparent that the changes in temperature in the main suction line 1 will be communicated to the expansible fluid 34 which, in turn, will act upon the diaphragm 29 and control the position of the valve member 19.

As before pointed out, the pressure in the supply pipe 15 is automatically maintained constant during the normal operation of the machine, consequently, it is possible to so adjust the valve tension that the valve member 19 lies out of contact with both of the seats 17 and 18, subject only to variations in the temperature of the fluid in the main line 1, it being understood, of course, that the adjustment in the first instance is effected for a certain temperature in the main line. It is apparent that a reduction in the temperature of the main line will cause the valve member 19 to move toward the seat 18, thus either closing the supply pipe 12 or reducing the flow therethrough while an increase in temperature in the main line 1 will increase the flow through the supply pipe 12. However, should the pressure in the supply pipe be reduced, then the valve shoulder 20 will coöperate with the seat 17 and cut off the supply completely.

To the end that fine particles in the liquid supply shall not reach the seats of the valve 19, a strainer device 39 may be introduced in the liquid supply pipe to collect all such particles.

For the purpose of controlling the pressure in the liquid supply 12, the mechanism shown in detail in Figs. 5 and 6 is employed. This mechanism connects with the outlet or drain or discharge pipe 8 of the condenser and comprises a casing 40 interposed in the drain pipe 8 and having a valve member 41 which, in this instance, is of a reciprocating form and coöperates with two openings 42 in a partition 43 within the casing 40. A spring 44 has a tendency to seat the valve, while a thermostat affected by the discharged water controls the position of the valve under said spring. In this instance, the thermostat is formed by a chamber 45 arranged in the path of the fluid flowing through the casing 40, said chamber being flared at its top at 46 and closed by a slight diaphragm 47, the diaphragm being held at its edges by the casting 48 bolted at 49 to the valve casing 40. A readily expansible fluid such as liquid ammonia is contained within the chamber 45 and acts upon the diaphragm 47 to move the latter with the different changes in temperature in the discharge water. Connection between this diaphragm 47 and the valve 41

may be effected by a plunger 50 which is guided through the top of the casting 48 and bears at its lower end at 51 upon the diaphragm. The upper end of the plunger 50 engages the lever 52 which is pivoted at 53 to the casting 48, and has its free end 54 passing through an opening in the upper end of a stem 55 which projects through a packing box 56 in the top of the valve casing 40. It is apparent that through this mechanism variations in the temperature of the discharge water will operate the valve 41 to vary the flow of the discharge water through the valve casing, and in this way maintain a substantially constant temperature under the varying load conditions. By maintaining the temperature of the condenser constant, the pressure of the liquid in the supply pipe 12 will also be maintained constant. Ordinarily, the temperature of the discharge water from the condenser should be maintained at substantially 90° Fahr.

There also may be provided means controlled by the temperature of the discharge water for automatically stopping the compressor whenever the supply of water to the ammonia condenser is cut off while the machine is in operation. The cutting off of the main water supply will immediately cause an extra amount of heat in the discharge water pipe 8, thus affecting the thermostat 45 to an extreme degree, causing the lever 52 to move upwardly beyond its normal path of operation. To utilize this extreme movement of the lever 52 for stopping the compressor, a mechanism coöperates with said lever and comprises, in this instance, a plunger 57 normally held in its lowermost position by a spring 58 and having its upper end bearing against an intermediate one of a series of balls 59 which are arranged within a casing 60 secured to the casting 48. At opposite ends of the series of balls plungers 61 and 62 are arranged, each plunger being acted upon by a spring 63 surrounding such plunger. The casing 60 is provided with a chamber 64 directly above the ball 59 that is engaged by the plunger 57, and in this chamber 64 a ball 65 bearing against that ball 59 engaged by the plunger 57. This ball 65 is, in turn, engaged by the projection 66 on a diaphragm 67 which is controlled by fluid within the chamber 68 above the diaphragm. The chamber 68 communicates by a by-pass 69 with the valve casing 40, so that the diaphragm 67 is subjected to the pressure of the fluid or water within the discharge pipe 8. At the time that the thermostatic device is operated under the increased temperature to shift the lever 52, so that the latter engages the plunger 57, the pressure in the chamber 68 decreases, due to the lack of water in the valve casing 40, and, as a consequence, the diaphragm 67 is free to move upwardly, thus

offering no resistance to the movement of the ball 65 and the ball 59 that is acted upon by the plunger 57, so that both balls shift upwardly to the chamber 64 under the action of the plunger 57, and this movement is facilitated by the springs 63 acting upon the plunger 61. The plunger 61 may be utilized for engaging the contact 70 with the contact 71 in order to close the circuit 72 of an alarm bell 73, whereas the plunger 62 may be connected to the blade 74 of a switch which controls the circuit of the electric motor 3, thus not only giving an alarm but stopping the motor which drives the compressor 2. In Fig. 6, the parts are shown in the positions they occupy when the central ball 59 has been shifted.

From the foregoing it will be seen that there has been provided a valve for controlling the liquid supply to a cooling surface of a refrigerating system which is subject to the pressure of the supply liquid as well as the temperature of the discharge from the cooling surface, thus making it possible to supply an amount of ammonia to the cooling surface in proportion to the demand of such surface and thereby making it possible to run the plant with greater economy. The refrigerant leaves the cooling surface in a non-saturated condition and enters the compressor in a dry condition so that greater work power is secured from the compressor. As each cooling surface has a separately controlled supply valve, the increased or lowered demands of one surface does not affect the other surface, but, instead, each supply valve increases or decreases the supply of liquid ammonia to its cooling surface in proportion to the demands of said surface so that the temperature of the surface remains substantially constant and the discharge from the surface is non-saturated and less horse power is required to operate the compressor, thus keeping the system working under the most economic conditions.

If the pressure in the supply pipe should vary to any great extent it would interfere with the power operator and real regulator of the suction temperature controlling device, and it is for this reason that the liquid supply valve is affected by the pressure in the supply pipe. It will be noted that this pressure is maintained constant by controlling the discharge of the cooling water of the condenser. This water becomes heated from the heat of compression and is carried away at a temperature of about 90° Fahr. It can therefore be used for thermostatically controlling its discharge, as by opening the valve wide the water will flow freely and the temperature will lower while the pressure of the ammonia supply will also lower, and by retarding the discharge, the temperature of the water will increase and the

pressure of the liquid supply will also increase. The shutting off of the water increases the temperature and increases the pressure in the discharge so that the compressor is stopped and an alarm is given.

What I claim as my invention and desire to secure by Letters Patent is:—

1. In a refrigerating system, a cooling surface, and a valve for controlling the liquid supply to said surface controlled jointly by the pressure of the liquid supply and the temperature of the discharge from the cooling surface and having provision for cutting off said liquid supply with a reduction of pressure in the liquid supply.

2. In a refrigerating system, a cooling surface, a valve for controlling the liquid supply to said surface controlled by the temperature of the discharge from said surface, and means for automatically maintaining constant the pressure of the liquid in the liquid supply leading to said surface.

3. In a refrigerating system, a cooling surface, a valve for controlling the liquid supply to said surface controlled by the temperature of the discharge from the cooling surface, and separate thermostatic means for automatically maintaining constant the pressure of the liquid in the liquid supply leading to said surface.

4. In a refrigerating system, a cooling surface, a valve for controlling the liquid supply to said surface, a condenser having a cooling water discharge and connected with said surface, a valve for controlling said cooling water discharge, and thermostatic means for moving the valve in accordance with the temperature of the discharge water to control the pressure in the liquid supply leading to the cooling surface.

5. In a refrigerating system, a cooling surface, a valve for controlling the liquid supply to said surface controlled jointly by the pressure of the liquid supply and the temperature of the discharge from the cooling surface, and means for automatically maintaining constant the pressure of the liquid in the liquid supply.

6. In a refrigerating system, a cooling surface, a valve for controlling the liquid supply to said surface controlled jointly by the pressure of the liquid supply and the temperature of the discharge from the cooling surface, and separate thermostatic means for automatically maintaining constant the pressure of the liquid in the liquid supply.

7. In a refrigerating system, a cooling surface, a valve for controlling the liquid supply to said surface controlled jointly by the pressure of the liquid supply and the temperature of the discharge from the cooling surface, a condenser having a cooling water discharge, a valve controlling said discharge, and thermostatic means for mov-

ing the valve in accordance with the temperature of the discharge water to control the pressure in the liquid supply to the cooling surface.

8. In a refrigerating system, a cooling surface and a valve for controlling the liquid supply to the cooling surface controlled by the temperature of the discharge from the cooling surface and having provision for closing to cut off the liquid supply upon the reduction of the pressure in the fluid supply.

9. In a refrigerating system, a cooling surface, and a valve for controlling the liquid to such cooling surface comprising two seats, a valve member movable in one direction to cooperate with one seat and in the other direction to cooperate with the other seat, a diaphragm connected to the valve member and subject to the inlet pressure of the liquid supply to hold the valve member from one of said seats, a spring for moving said valve member toward the said seat, and a thermostat connected with said valve member to control its position with reference to the other seat and subject to the temperature of the discharge fluid from the cooling surface.

10. In a refrigerating system, a cooling surface and a valve for controlling the flow of liquid to such cooling surface comprising two seats, a valve member for cooperating with either seat, a spring for moving the valve toward one seat, means subject to the pressure of the liquid supply for holding the valve away from said seat, and thermostatic means for controlling the position of the valve with reference to the other seat subject to the discharge temperature of the cooling surface.

11. In a refrigerating system, a cooling surface, and a valve for controlling the flow of liquid to such cooling surface comprising two seats, a valve member for cooperating with either of said seats, a spring for moving the valve member toward one of said seats, a diaphragm connected to the valve member and having one face thereof subject to the pressure of the liquid supply to the cooling surface to hold the valve away from said seat against the action of the spring, and a fluid thermostat subject to the temperature of the discharge fluid from the cooling surface and having the fluid thereof acting on the diaphragm in opposition to the supply liquid pressure to control the position of the valve member with reference to the other seat.

12. In a refrigerating system, a cooling surface, and a valve for controlling the flow of liquid to such surface comprising a valve seat, a valve member for cooperating with the seat, a diaphragm connected to the valve member and subject to the pressure of the liquid supply, and an expansible fluid ther-

mostat subject to the temperature of the discharge fluid from the cooling surface, the fluid of said thermostat acting directly on the diaphragm in opposition to the pressure thereon by the liquid supply.

13. In a refrigerating system, a cooling surface, a valve for controlling the supply to said surface controlled by the temperature of the discharge from the surface and also by the pressure of the liquid supply, a condenser for the liquid supply having a cooling water conductor, and automatic means for controlling the discharge of the cooling water to maintain the pressure of the liquid supply constant.

14. In a refrigerating system, a cooling surface, a valve for controlling the liquid supply to said surface controlled by the temperature of the discharge from the surface, a condenser for the liquid supply having a cooling water conductor, a valve in the discharge of the cooling water conductor, and a thermostat affected by the discharged cooling water and controlling the valve to maintain a constant pressure in the cooling surface.

15. In a refrigerating system, a cooling surface, a valve for controlling the flow of

liquid to said surface controlled by the pressure of the liquid supply and also by the temperature of the discharge from the liquid supply, a condenser for the liquid supply having a cooling water conductor, a valve in the discharge of the cooling water conductor, and a thermostat affected by the discharged cooling water to maintain the pressure of the liquid supply constant.

16. In a refrigerating system of the type embodying a cooling surface, a liquid supply and a condenser for the liquid supply having a cooling water conductor, and a compressor for delivering the fluid to the condenser; a stop mechanism for the compressor controlled by the temperature of the fluid in the cooling water conductor discharge.

17. In a refrigerating system of the type embodying a cooling surface, a liquid supply and a condenser for the liquid supply having a cooling water conductor, and a compressor for delivering the fluid to the condenser; a stop mechanism for the compressor controlled by the temperature and the pressure of the fluid in the cooling water conductor discharge.

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