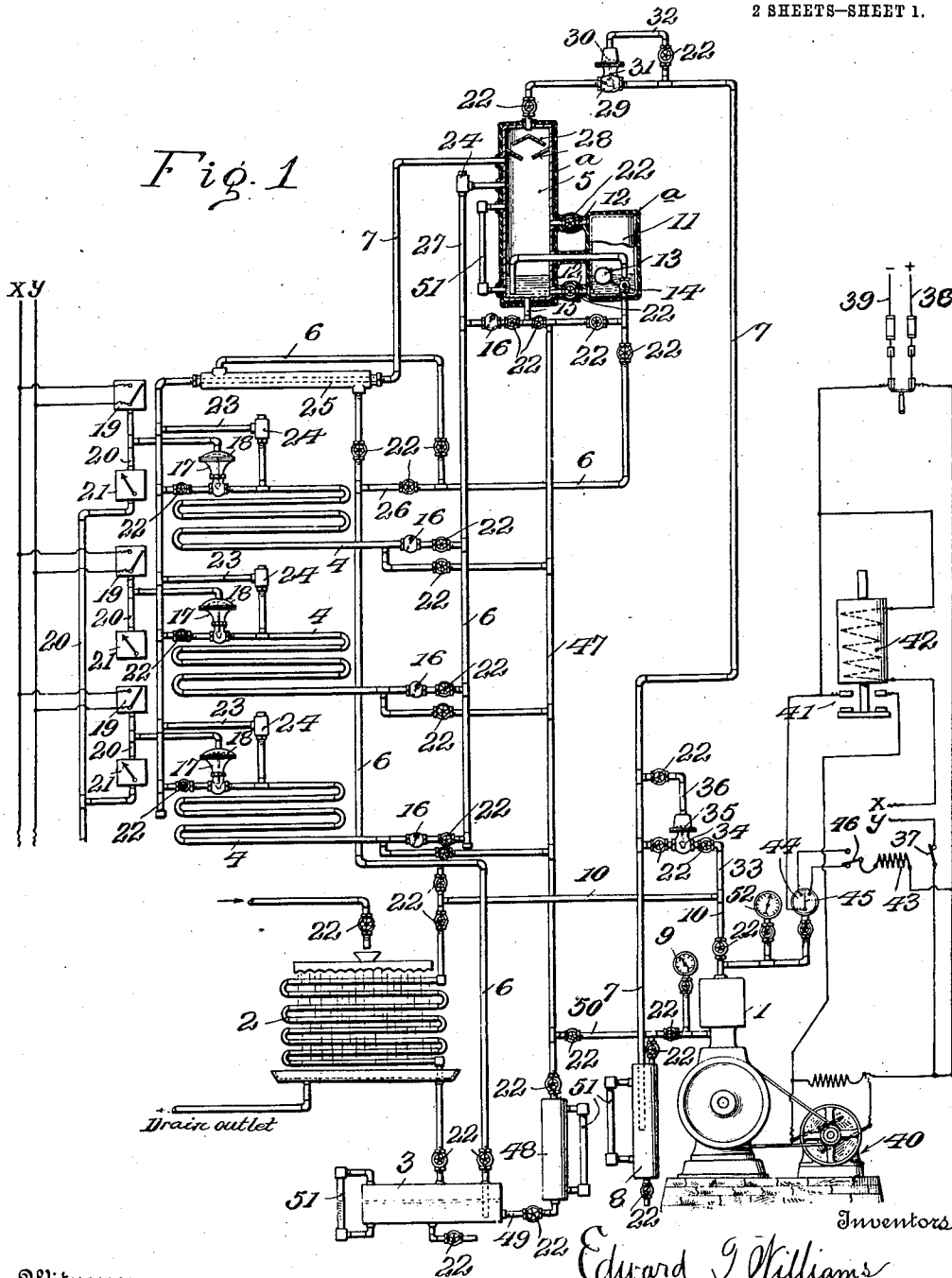


E. T. WILLIAMS & H. T. BERNHARD.
 AUTOMATIC REFRIGERATING SYSTEM.
 APPLICATION FILED JAN. 4, 1910.

1,050,894.

Patented Jan. 21, 1913.

2 SHEETS-SHEET 1.



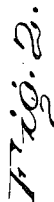
Witnesses

W. A. Williams
 H. S. Imrie

Edward J. Williams
 Harry T. Bernhard
 By Robertson & Johnson Attorneys

APPLICATION FILED JAN. 4, 1910.

2 SHEETS—SHEET 2.



H. L. Imitie.

By *Robertson & Johnson* Attorneys

UNITED STATES PATENT OFFICE.

EDWARD THOMPSON WILLIAMS, OF BROOKLYN, NEW YORK, AND HARRY THEODORE BERNHARD, OF WEST HOBOKEN, NEW JERSEY.

AUTOMATIC REFRIGERATING SYSTEM.

1,050,894.

Specification of Letters Patent.

Patented Jan. 21, 1913.

Application filed January 4, 1910. Serial No. 536,343.

To all whom it may concern:

Be it known that we, EDWARD T. WILLIAMS and HARRY T. BERNHARD, citizens of the United States, and residents, respectively, of Brooklyn, in the county of Kings and State of New York, and of West Hoboken, in the county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Automatic Refrigerating Systems, of which the following is a specification:

Our invention relates to refrigerating systems of the type in which the refrigerating action is secured by the absorption of the sensible heat of one substance, by, and its conversion into latent heat, of, another substance. This result is commonly effected by expanding a liquid to a gas. The liquid we prefer to use is anhydrous ammonia but any other liquid which will "boil off" at a reduced pressure would answer and though we use the word ammonia hereinafter in describing the system we are not of course limited to the use of that fluid.

The objects of our invention will more fully appear hereinafter but may in general terms be stated to be the provision of a reliable automatic refrigerating system in which the temperature of individual cooling rooms may be controlled independently, and with extreme nicety, and in which proper and safe operation at all times is assured.

Our invention differs radically from all former systems of which we have knowledge in that it is a suction control instead of an inlet expansion control system, the regulation and control of the work done in the coils being accomplished by the control of a valve or valves on the suction side of the coil instead of by the control of inlet or expansion valves on the feed side of the coil. In former systems the liquid was permitted to expand wholly or partially into a gas on its admission to the cooling coils and the inlet valve governing this expansion was automatically controlled and constituted the key to the system. In our system on the contrary the liquid is permitted to flow into the cooling coils as needed filling the same and "boiling off" to absorb heat, the suction

of the compressor reducing the pressure to permit this. Our system is therefore known as a flooded or "boiling off" system, and it is this "boiling off" that we control by automatically varying the passage at the suction end of the coil in correspondence with a thermostat. Boiling back is prevented by the use of check valves as will be more fully explained hereinafter.

Refrigerating plants to meet practical requirements should be able to maintain with exactness the temperature of each refrigerating chamber without reference to the temperature of any other such chamber, the variations in temperature between different chambers being often wide. One of the gravest defects of inlet expansion systems is the necessity of a series arrangement of the coils with a thermostatic control on the last coil only, the cooling medium having to pass successively through all the coils of which there may be a large number. Efforts to arrange the coils in multiple with individual inlet expansion valves have failed, for it is found that in expanding automatically from more than one point the gas is apt to short circuit through one or two of the coils, which would get too much refrigeration, while other coils in the system would be entirely without it. The clumsy expedient of manually controlled by-passes obviously can not meet the difficulty.

In our system the cooling coils are preferably arranged in multiple and each may be used separately from and independently of every other coil or may be temporarily cut out entirely if desired. For each coil there is an individual automatic thermostatic control which may be set to maintain the desired pressure and therefore temperature therein and which assists in controlling the operation of the motor. In addition to providing means whereby each coil may be completely cut off from the system, and in order to prevent the breakage of the coils from the expansion of the incompressible liquid therein, we have made use of a by-pass from the coil to the suction line, there being in the by-pass an automatic pressure relief valve set to open when the pressure within the closed coil becomes dangerously

great. Novelty is not claimed for the specific form of thermostatic control illustrated nor for the specific form of pressure relief valve. This may be of any well known type and it is not necessary that the thermostatic control should be pneumatic although this is desirable since it secures positive action. On the contrary the thermostatic control may be electric, hydraulic or of other suitable character. We do however claim the individual thermostatic control in combination with other parts of the system.

In the practical working out of our system it has been necessary to devise means to prevent violent fluctuations in the ammonia level which would destroy the usefulness of the system by abruptly varying pressure and temperature conditions therein. These fluctuations are due largely to the tendency of the ammonia to boil back into the trap and over into the suction side of the line. We overcome this difficulty in four ways. First by providing an auxiliary tank connected by restricted passages with the trap and containing a float valve which controls the admission of ammonia to the trap. The purpose of this construction is to remove the float valve from the trap where it might be subjected to the severe and rapid fluctuation of the level of the liquid and to locate it where the level of the liquid is substantially constant and where, therefore, it can act to feed ammonia gradually as it is needed. The restricted connections between the trap and the auxiliary tank prevent changes of level in the trap from being felt immediately and severely in the auxiliary tank. We have also interposed check valves between the various cooling coils and the feed line and trap and have interposed another check valve between the feed line and the trap. It will be obvious that these check valves prevent the ammonia from boiling back into the trap or into other coils. To relieve undue pressure, however, a by-pass controlled by a relief valve is provided between the feed line and the trap so that when pressure becomes dangerously great this by-pass is automatically opened. A heat exchanger constitutes another means to maintain a constant level in the system. This is located on the suction side of the cooling coils, the exchange in temperature being effected between the warm high pressure ammonia in the feed line before it enters the trap and tank and the relatively cool low pressure ammonia from the coils. This both increases the temperature of the low pressure ammonia which is returned to the compressor and, by reducing the temperature of the high pressure ammonia causes it to approximate the temperature of the ammonia already in the trap and thus prevent boiling

on its introduction into the tank. The fourth means of preventing fluctuations consists of insulating the trap and float valve tank to prevent the absorption of heat from the surroundings, which might cause the liquid to boil. We also provide for the protection of the compressor against undue back pressure which sometimes occurs on starting the machine and while running warm. This protection is secured by the employment of an automatic pressure valve in the suction line having a motor connected with the line on the suction side of the valve. Undue pressure on the suction side of this valve will automatically cause it to close the suction line until the pressure has been reduced to normal. This idea has been used elsewhere and we do not lay claim to it save as it enters into combination with other parts of our system.

Another feature of our invention is the protection of the compressor and of the system from the danger of air leaking in, which would be likely to happen should the pressure in the suction end of the line become lower than atmospheric pressure. To prevent this result we provide a by-pass between the discharge end of the line and the suction end of the line, this by-pass being governed by an automatic pressure valve, the position of which is controlled by the pressure in the suction end of the line. When this pressure drops below atmospheric pressure or below the point determined upon, the valve opens the by-pass and thus connects the discharge side of the compressor with the suction side of the line so that a portion of the gas is pumped into the suction end of the line and back to the compressor until proper pressure conditions are restored, when the valve automatically closes the by-pass. We also employ a safety series switch in the circuit controlling the motor, operated automatically on an undue pressure rise in the discharge end of the line to stop the motor until proper conditions are restored and then to start it again. In multiple in the said circuit are the individual thermostatically controlled switches corresponding each to its particular coil. The employment of pressure controlled safety switches is old in various pressure systems, such switches constituting well known protecting means. We provide also manual means for controlling the motor such as the hand switch shown in the main circuit.

Another feature of the invention is the arrangement of the pump out line, tank and connections.

Referring to the drawings: Figure 1 is a view, mainly diagrammatic, of an embodiment of our system. Fig. 2 is a detail view, mainly in section, showing a valve for regu-

lating the flow through a coil, the diaphragm motor for operating the same and the thermostat and connections.

Our invention is most clearly shown in Fig. 1 which, as stated, is mainly diagrammatic. While the details of the construction of the various valves, the thermostatic controls and the pressure control are not in themselves of our invention but are well known and may be purchased on the market, we have illustrated in Fig. 2 a valve and the means for automatically controlling the same.

In the system selected for illustration of our invention 1 designates the usual compressor; 2 the condenser; 3 the receiver for refrigerant; 4 the cooling coils; 5 the trap; 6 the feed line and 7 the suction line. In systems of this general character the cooling action, as above stated, is secured by permitting ammonia or other equivalent liquid to expand and thus take up heat, recompressing it, cooling and liquefying it and allowing it to expand again in a regular cycle of operations. In our flooded refrigerating system the feed line, coils and part of the suction line contain the liquid refrigerant the level of which should be closely maintained. In the system illustrated the elements above enumerated operate in the general way above mentioned. The compressor compresses the warm expanded gas and forces it into the condenser where it is cooled and liquefied and from which it passes into the liquid receiver, from which again its course is through the feed line 6, the end of which is below the level of the liquid in the receiver, to the trap 5 at the top of the system. From the said trap by another portion of the feed line 6 which may be described as the supply line, it flows into the various cooling coils which are arranged in multiple across the feed line 6 and the suction line 7, and thence it is returned through the suction line to the compressor.

The method of controlling the flow in the feed line and of maintaining an even level in the trap will be first considered. It will be noted first however that the compressor 1 is of usual construction having the auxiliary trap 8 to prevent liquid from being carried over into it and being protected from oil where it is of a type to need such protection by any well known means. With it is associated on its suction side the usual suction gage 9, which acts also as a gage for the pump-out line. The compressor discharges hot gas into a pipe 10 leading to the condenser. In order to secure the desired exactness in the control of the flow of liquid to the trap and thus assist in maintaining the desired level we provide the auxiliary tank 11 which may be made of say 4" extra heavy pipe capped at each end connected at the top

and bottom of the tank to the trap 5 by pipes 12 having restricted passages controlled by hand valves. In this tank 11 is arranged a float 13 controlling a valve 14 in the feed line, the said valve governing the flow of liquid to the trap 5.

The arrangement described prevents any violent movement of the ammonia level in the large trap from communicating itself with sufficient violence to the small tank, to prevent the proper movement of the float valve. This float and valve may be of any suitable known construction adapted to withstand ammonia. In this connection we wish to state that although we have shown only one trap, auxiliary tank, float valve and connections, a plurality of sets of these elements would be employed should the height of the system require it; as would be the case for instance, if the height were over forty feet, since the weight of the liquid in such a system would otherwise create a pressure in the lower coils which might interfere with the securing of a sufficiently low temperature. The trap 5, auxiliary tank 11 and the connections between them are provided with insulation *a*. This prevents expansion of the ammonia at this point, since this cannot occur without the absorption of heat. So little heat can reach the ammonia in the trap that there is no material expansion therein notwithstanding the fact that the trap is open to the suction line. The trap 5 is above the cooling coils and is connected below the level of the liquid to the feed end of the coils and above the level of the liquid to the suction end of the coils so that the liquid may flow by gravity into the coils.

From the bottom of the trap 5 leads the outlet pipe 15 which is a part of the feed line. In this portion of the feed line leading from the trap to the coils are check valves 16 which serve an important purpose in our system. One of these valves is located between the trap and all of the coils, and in addition a check valve is located between each individual coil and the feed line. The purpose of these check valves is to prevent boiling back of the ammonia and consequent derangement of the ammonia level and loss of control. This boiling back would otherwise be likely to occur if the temperature in one of the coils should suddenly be increased as by leaving open the door of the refrigerating compartment in which the coil is located. It will be apparent that the idea of interposing a check valve between the coils and the high pressure line is applicable also where the coils are arranged in series, and that the statement in some of the claims that a coil is connected, or that coils are connected, to both the high pressure and the low pressure or to both the feed and suction lines does not exclude such series relation.

It is often desirable to have the temperature of one room greatly different from that of other rooms, the desired temperature depending of course upon the use to which the refrigerating chamber cooled by the coil is to be put. In order to secure this desirable individual control we have arranged the coils in multiple between the feed and suction lines 6, 7, instead of in series, and have provided each coil on its suction side with a thermostatic control. As already stated, this thermostatic control may be of any desired and suitable character. To be suitable however it must be more than a mere means of cutting the coil into and out of the system. Its function is to enable the work done in a coil to correspond with the temperature requirements that particular coil is called upon to meet. In Fig. 1 of the drawing we have illustrated diagrammatically a well known form of thermostatic control, which may be obtained in the market and which involves two compressed air motors the supply to and release from which of air under pressure is controlled by the thermostat, the pressure varying as the temperature and the arrangement thus resulting in the desired continuous control. On the drawing we have shown a pressure control valve 17 on the suction side of each coil. These valves have each a motor 18 which, as indicated in dotted lines, is conveniently a diaphragm motor, the admission of air to which tends to close the valve and the release of air from which tends to permit the valve to open in response to the action of springs not shown. When the temperature is too low the thermostat lets air into the motor and when the temperature is too high lets it out. It will be obvious that these valves are movable variable distances, the amount of their movement being determined by the thermostatic controls which also effect it. This movement corresponds roughly but not necessarily exactly to the change in temperature. As the temperature rises the valve opens and as it drops the valve closes being able to occupy closed position, open position or any intermediate position the temperature requirements at the moment necessitate. We also provide a switch 19 for each coil, the said switches being arranged in multiple as will be more fully explained hereinafter. Each switch is pressure controlled preferably by a diaphragm motor which it is not thought necessary to illustrate. 20 is a small pipe supplying air under pressure. This pipe, as stated, is controlled in a well known manner by a thermostat 21 of known construction. These thermostats are located in the refrigerating chamber with the coil to which each corresponds and are set to maintain the temperature between certain limits which may be varied as desired.

The arrangement above described will be more fully understood on reference to Fig. 2 in which are illustrated in detail one of the valves 17 controlling the boiling off of ammonia from a coil 4, the diaphragm motor 18 for operating the same and the thermostat 21 for automatically varying the position of the valve by introducing air into the diaphragm motor or permitting it to escape therefrom. At the left of this figure is shown the valve 17 having the casing *b* provided with the valve seat *c* with which cooperates the valve proper or valve plug *d* carried by the valve stem *e*, sliding in an extension *f* of the valve casing. This extension carries a support *g* to the top of which is secured the double diaphragm *h* by means of the top *k* of the motor. Beneath the double diaphragm is the plug *l* carried by the valve stem *e* and pressed upward by the springs *m* which act against a stationary part *n* supported by the part *g*. The air pipe 20 enters the casing of the motor above the double diaphragm *h* by the duct *o*. It will be obvious that the admission of air through the duct *o* will force the diaphragm down against the pressure of the springs distances varying according to the amount of air so introduced, it being possible to close the valve completely or to move it to and retain it in intermediate positions. It is obvious also that when air is allowed to escape through the duct *o* the reverse operation takes place, it being possible to stop and hold the valve at fully opened or closed position or at any intermediate position.

The means by which the admission to or outlet of air from the diaphragm motor is controlled will now be described. *p* is a compressed air reservoir communicating by another part of the pipe 20 with a duct *q* in the casing *r* on which the thermostat is adjustably mounted. *s* is an air chamber in the casing *r* to which the duct *q* leads and from which leads the duct *t* which by the pipe 20 is in communication with the diaphragm motor. A valve *u*, spring pressed toward closed position, controls the admission of air to the air chamber *s*, this chamber being closed by an elastic diaphragm *v* carrying a block *w* in which is a duct *w*¹ controlled by a valve *w*², spring pressed toward open position. The valve *u* is normally closed and the valve *w*² is normally open when permitted by the thermostat to be so. A projection on the valve *u* contacts with the head of the valve *w*². The thermostatic element is an expansible disk *A* containing a volatile liquid whose pressure increases and decreases according to changes in temperature, causing the disk to increase and decrease in thickness. The block *w* is connected so that it moves with

the disk A either in the opposite sense, as above described, or in the same sense. The thermostatic disk A is secured to the lever B adjustably mounted on the casing *r* as shown, the details of this construction not needing any description. In the arrangement shown, a lever C pivoted at D on the adjustable lever E is connected at its upper end at F to the block *w* and at its lower end at G to the back of the thermostatic chamber. It will be evident at once that as the fluid in the air-tight thermostatic disk A expands with an increase of temperature the duct *w'* will be opened permitting egress of air from the air chamber *s* and in consequence from the diaphragm motor 18, permitting the valve *d* to move upward a distance depending on the amount of air permitted to escape. When, on the contrary, the thermostatic disk A decreases in thickness as the temperature decreases, the valve *w'* is closed and egress from the chamber *s* is thus prevented and the valve *u* is opened, permitting compressed air to pass from the duct *q* to the air chamber *s* and thence to the diaphragm motor where it acts to move the valve *d* downward against the pressure of the spring an amount depending on the amount of air admitted to the motor. The air chamber *s* thus acts as an equalizing chamber, the operation of the valves and the diaphragm *v* being in each instance to reach a position in which the pressure in the chamber, if any, equalizes that exerted by the thermostatic disk. It will be apparent that the changes in temperature will cause changes in the pressure conditions in the diaphragm so that the position of the valve *d* will correspond to temperature conditions in the chamber where the thermostat is located. If there were no direction changing mechanism such as the lever C between the thermostat and the block *w*, the valve plug *d* would be arranged below instead of above the valve seat *c*. This of course is a mere detail of construction.

As stated the cooling coils 4 are arranged in multiple between the feed and suction lines 6, 7, and each is provided at its feed end and at its suction end with ordinary globe valves 22 for isolating the coil. In this way each coil may be completely cut out without interfering with the operation of any of the other coils. As ammonia is incompressible and, if its temperature should rise too much, would burst a coil if the ends thereof were completely closed, we provide a by-pass 23 from each coil to the suction line. In each of these by-passes is located a pressure relief valve 24 of any usual and suitable type which when the pressure becomes dangerously great will temporarily open the passage through the by-pass to the necessary extent.

Reference has already been made to the desirability of maintaining as nearly as possible an unvarying level in the system and means have already been described whereby we attain this result. Another feature of our system which aids in its accomplishment is the location of a heat exchanger for the warm high pressure refrigerant and the cool low pressure refrigerant. This exchanger 25 is located in that portion of the feed line 6 through which the liquid flows before reaching the trap 5. The inflowing liquid passes very slowly through the exchanger and the result is that the temperature of this liquid is lowered so that it approximates the temperature of the liquid in the trap thus avoiding violent changes in level. This exchanger may be of any usual sort. We have shown it diagrammatically as a pipe of larger size to convey the high pressure refrigerant and surrounding the suction line through which the low pressure refrigerant flows. The precise part of the suction line on which the exchanger is located is not material, although we have shown it as between the coils and the trap. Means are provided for cutting out the heat exchanger as follows: The by-pass 26 normally closed by the globe valve 22 and the globe valves 22 in the feed line adjacent the by-pass. Obviously the latter valves may be closed and the valve in the by-pass opened to cut out the exchanger.

In order to protect the supply portion of the feed line against undue pressure we employ a by-pass 27 between the feed line 6 and the upper part of the trap 5 above the level of the liquid. In this by-pass is located a pressure relief valve 24 which operates in the same manner as do the other valves of this character described in connection with the cooling coils. We prefer to provide the trap 5 with baffles 28.

In a system of this character it is necessary to protect the apparatus against an unduly high pressure at the suction side thereof, particularly when the machine is starting up or while running while the piping system is warm. To secure this protection we provide a pressure controlled valve 29 which may be of any usual type suitable for use in an ammonia system. The diaphragm 30 is indicated in dotted lines as is the valve stem 31. The diaphragm constitutes a motor which is connected by the pipe 32 with the suction side of the valve, the valve being set to respond to an unduly high pressure operates to close or restrict the passage through the suction line until the compressor has reduced the pressure in the suction line sufficiently to permit the valve to occupy its normal position again. Another difficulty arises in connection with the operation of such a system in that the pressure

in the suction line and in the compressor may drop below atmospheric pressure. This would quickly happen where all but one or two of the coils in a large plant were shut down with the machine running at full speed. There would then be danger of air getting into the system. To protect the compressor and the system against this we provide a by-pass 33 connecting the discharge side of the motor with the suction line 7. This by-pass is normally closed by a pressure controlled valve 34 operated by a motor the diaphragm of which 35 is shown in dotted lines. This motor is connected with the suction line by a pipe 36 and is set to hold the by-pass normally closed but to open when the pressure drops below the predetermined point. When the by-pass is closed the compressor takes gas from the suction line 7 through the trap 8 and forces it out through the gas discharge pipe 10 into the system. When however pressure in the suction line 7 drops too low and the by-pass opens, a portion of the compressed gas is forced into the suction line, the gas being pumped around and around until proper pressure conditions are restored when the by-pass will close automatically.

In connection with the discharge side of the motor we provide a pressure controlled safety switch 37 of known type, which, as will shortly appear, indirectly controls the motor circuit so as to stop the compressor when the pressure becomes unduly high and start it again when the low limit is reached. This switch is arranged in series in the circuit of the motor controlling solenoid in which the switches 19 are arranged in multiple.

In practice we prefer to make use of some one of the approved starters now on the market in which the resistance in the circuit of the motor is gradually cut out in starting. For the sake of clearness however we have not shown the detailed internal wiring, but have illustrated a simpler circuit arrangement which will now be described. 38 and 39 are respectively the positive and negative leads of the main line which furnish current to the motor 40. In the motor circuit there is a break controlled by the double pole switch 41 operated by the solenoid 42, which is bridged across the motor circuit and which includes in series the safety switch 37 and in multiple the switches 19, the portion of the circuit in which these switches are located being for convenience designated by X, Y at the left hand side and also at the right hand side of the drawing.

The safety switch 37 is of the tumbler variety and is actuated by an electromagnet 43 bridged across the main circuit. An adjustable safety pressure regulator 44 of known construction such as is already on

the market, a Bourdon tube regulator for instance, having a pointer switch 45 controls the circuit of electromagnet 43, being so arranged that as the pointer contacts on the high pressure side the current passes through the magnet coil 43, opening the switch 37 and at the same time throwing the switch 46, located to be reversely operated to the switch 37, to its lower position, thus breaking the circuit of the motor controlling solenoid 42 and in consequence the circuit of the motor 40 and stopping the compressor. In the operation described the switch 46 has, as stated, been moved to its low pressure position, and, when the pointer switch 45 makes contact with the low pressure point, the circuit of the solenoid 42 is again made by the action of the tumbler switch 37 which at the same time moves the switch 46 to high position. This in turn makes the circuit of the motor and starts up the compressor again.

To facilitate the repair and examination of the system, we have provided a pump-out line 47 connected with the feed line below the trap 5 and with each of the cooling coils 4 on their feed side beyond the check valve 16. In connection with this line is a reservoir 48 which should be large enough to contain all the ammonia from one or two of the largest coils. The reservoir is connected by a pipe 49 with the receiver, and the pump-out line above the reservoir is connected with the suction side of the compressor by the pipe 50. Globe valves 22 are located as shown in the various parts of the line and connections so as to enable any desired part of the system to be drained independently of the rest. The procedure in draining is to close the globe valves 22 in the pipes 49 and 50 and in the connections to those parts of the system which it is not desired to drain. When the liquid has been drained into the reservoir 48, the globe valve 22 immediately above it and the globe valve 22 between the trap 8 and the pipe 50 may be closed, the globe valves 22 in the pipe 50 opened and gas pumped out by the compressor. The liquid may be admitted from the reservoir to the receiver as desired.

Globe valves have been mentioned specifically in a number of instances already. Various other globe valves are located in convenient positions, but the manner in which they are used would seem to be obvious and not to need special explanation. We have also shown usual gage tubes 51 on the traps 5 and 8 and on the pump-out reservoir 48. A pressure gage 52 is located on the discharge side of the compressor.

The importance of individual automatic thermostatic controls has been noted but their advantages may be made clearer by the following explanation: The individual au-

5 tomatic thermostatic control for each coil may be set to open or close the valve on the suction side of the coil, thus permitting of boiling off, or preventing boiling off, and therefore controlling the temperature of the room. The action of each of these valves is "graduated", that is, it is so controlled by the thermostat as to partially open or close in correspondence with slight variations of temperature, and to completely open or close in correspondence with certain greater variations of temperature. It has thus the additional feature of varying, due to the restriction or increasing of the orifice through the valve, of the "boiling off", of the ammonia, and thus providing an additional temperature control. This thermostat control also assists in controlling the operation of the motor.

20 The operation of the system has already been explained so that a recapitulation thereof is unnecessary.

25 The advantages of the system have been pointed out and we need only add that it is the intention to which we lay claim rather than the particular embodiment illustrated herein.

What we claim is:

30 1. An automatic refrigerating apparatus comprising in combination a circulatory system, means for circulating a refrigerating medium therein, a cooling coil forming a part of said system, a valve on the suction side of said coil movable variable distances, and an automatic control for said valve effecting such variable movement.

40 2. A flooded refrigerating system comprising in combination a compressor, a condenser, a liquid receiver, a trap, a cooling coil, a feed line connecting said parts, a suction line to the compressor, and automatic means on the suction side of the coil to open and close the coil and to otherwise vary the opening through it for regulating the boiling off of the liquid therein.

45 3. A flooded refrigerating system comprising in combination, a compressor, a condenser, a liquid receiver, a feed line connecting said parts, a cooling coil, a trap above the coil, connections between said receiver and trap, connections between said trap and both ends of said coil to permit a gravity feed of the liquid thereto, a suction line connecting the trap and compressor, and a thermostatic control for said coil on the suction side thereof varying the size of the opening through the coil between open and closed as the temperature changes within the predetermined temperature range.

60 4. A flooded refrigerating system comprising in combination a compressor, a condenser, a liquid receiver, a trap, connections between the said parts, a cooling coil, said trap having an outlet and an inlet between

which the level of the liquid normally stands, 65 means for maintaining the level of the liquid in said trap substantially constant, connections between the outlet of the trap and the feed side of the coil, connections between the suction end of the coil and the inlet of the trap, a valve near the suction end of the coil to govern the passage of refrigerating medium therethrough, a thermostatic control for operating said valve, and connections between the trap above the liquid 70 and the compressor. 75

5. A flooded refrigerating system comprising in combination a compressor, a condenser, a liquid receiver, a trap, a cooling coil, a feed line connecting said parts, a suction line from the trap to the compressor, automatic means on the suction side of the coil for regulating the boiling off of the liquid therein, and a check valve on the feed side of the coil to prevent refrigerating fluid 85 from flowing back through the feed line.

6. A flooded refrigerating system comprising in combination a compressor, a condenser, a liquid receiver, a feed line connecting said parts, a cooling coil, a trap 90 above the coil, connections between said receiver and trap, connections between said trap and both ends of said coil to permit a gravity feed of the liquid thereto, a suction line connecting the trap and compressor, a thermostatic control for said coil on the suction side thereof, and a check valve in the feed line between the trap and the coil to prevent refrigerating fluid from flowing back through the feed line. 100

7. A flooded refrigerating system comprising in combination, a compressor, a condenser, a liquid receiver, a feed line with which said parts are in connection, a suction line, a trap in communication with both said 105 lines, cooling coils below said trap and in communication with said trap and with said suction line, automatic means to vary the flow through the coils, and a check valve on the feed line side of each coil. 110

8. A flooded refrigerating system comprising in combination, a compressor, a condenser, a liquid receiver, a feed line with which said parts are in connection, a trap in the said feed line, automatic means for controlling the feed of liquid to the trap to maintain a liquid level in the system, cooling coils in communication with the feed line beyond the trap, a check valve in the said line between the trap and the coils, a suction line in communication with the coils, trap and compressor, and thermostatic means on the suction side of the coils for controlling the boiling off of the liquid. 115 120

9. An automatic refrigerating apparatus, 125 comprising a circulatory system including a feed line and a suction line, means for circulating refrigerant in said system, cooling

coils connected in multiple across said feed and suction lines, and a valve in each coil at its suction end thermostatically responsive to and having variable movements corresponding roughly with the temperature variations adjacent said coil within the predetermined temperature range.

10. An automatic refrigerating system comprising in combination, a liquid receiver, a compressor, a condenser, a feed line connecting said parts, a suction line to the compressor, a plurality of cooling coils connected in multiple across the feed and suction lines, and independent thermostatic controls for individual coils for separately and continuously regulating the flow of refrigerant therethrough as the temperature changes.

11. A flooded refrigerating system comprising in combination, a compressor, a condenser, a liquid receiver, a trap, a feed line connected with the discharge side of the compressor and with said other parts, a suction line connected with the suction side of the compressor, a plurality of cooling coils below said trap connected in multiple across said feed and suction lines, a valve in the suction side of each of said coils movable variable distances, and an independent thermostatic control for each of said valves effecting such variable movement and determining its amount.

12. A flooded refrigerating system comprising in combination, a compressor, a condenser, a liquid receiver, a trap, a feed line connected with the discharge side of the compressor and with said other parts, a suction line connected with the trap above the liquid and with the suction side of the compressor, a plurality of cooling coils below said trap connected therewith and disposed in multiple across said feed and suction lines, a valve in the suction side of each of said coils movable variable distances, an independent thermostatic control for each of said valves effecting such variable movement and determining its amount, and a check valve in each coil on the feed side thereof.

13. In an automatic flooded refrigerating system, a cooling coil, means for isolating the same from the rest of the system, a normally closed by-pass connecting the coil with the suction side of the line, and a pressure relief valve in the by-pass to open the same on excess pressure.

14. In a flooded refrigerating system in combination, a liquid receiver, a compressor, a condenser, a feed line with which said parts are in connection, a suction line, a plurality of cooling coils connected in multiple across said feed and suction lines, means to isolate individual coils, by-passes from individual coils to the suction line, and pressure relief valves in the by-passes.

15. In a flooded refrigerating system in combination with a compressor, a condenser, a liquid receiver, a cooling coil, trap and connections, an auxiliary tank in restricted communication with said trap, and a float valve in said auxiliary tank on the low pressure side of the system controlling the flow from the ammonia feed line.

16. A flooded refrigerating system comprising in combination, a compressor, a condenser, a liquid receiver, a feed line with which said parts are in communication, a relatively large trap, a relatively small tank, restricted connections between said trap and tank, a float valve in said tank for controlling the flow of liquid from the feed line to the trap, cooling coils below the trap and connected with the trap below the level of the liquid, a check valve between said trap and coils, a suction line connecting the suction end of the coils with the trap and compressor, and thermostatic means to control the passage of refrigerant through the coils.

17. In an automatic refrigerating system, a compressor, a condenser, a liquid receiver, a trap, a feed line with which said parts are in connection, automatic means for controlling the feed of liquid to the trap, cooling coils connected with the feed line beyond the trap, a suction line connected with the suction side of the refrigerating coils, with the trap and with the compressor, a portion of said feed line between the receiver and the trap being located in proximity to a portion of the suction line to effect an exchange of temperature, and means to control the coils.

18. A flooded refrigerating system comprising a compressor, a condenser, a liquid receiver, a trap, a feed line having a portion for delivering liquid refrigerant to the trap, an automatic valve in said portion for controlling the flow of refrigerant to the trap, the said feed line having another portion to conduct refrigerant from the trap, cooling coils below the trap, and in communication with said last named portion, a suction line in communication with said cooling coils, trap and compressor, the portion of the feed line between the condenser and the trap and some portion of the suction line beyond the coils being located in proximity to effect an exchange of temperature between the warm high pressure refrigerant in the feed line and the cool low pressure refrigerant in the suction line to assist in maintaining the level in the ammonia trap, and automatic means on the suction side of the coils to control the boiling off of the liquid refrigerant therein.

19. An automatic flooded refrigerating system comprising in combination, a liquid receiver, a compressor, a cooling coil, a trap,

connections between said receiver and trap, between said trap and the feed end of said coil and between the suction end of said coil and said trap, connections between said trap and said compressor, a condenser, connections between said compressor, condenser and receiver, and an automatic pressure regulating valve between said trap and said compressor controlling the pressure in said connection between them.

20. An automatic refrigerating system comprising in combination, a liquid receiver, a compressor, a condenser, a feed line connecting said parts, a suction line to the compressor, a plurality of cooling coils connected in multiple across the feed and suction lines, independent thermostatic controls for individual coils for separately and continuously regulating the flow of refrigerant therethrough as the temperature adjacent said coils changes, a motor for driving the compressor, a motor controlling circuit, and a switch governed by each thermostatic control said switches being arranged in multiple in the motor controlling circuit.

21. In an automatic refrigerating system in combination with a compressor, a feed line connected with the discharge side of the compressor, a suction line connected with the suction side of the compressor, a plurality of cooling coils connected in multiple across said feed and suction lines, a valve in the suction side of each of said coils to vary the passage of refrigerant therethrough by opening and closing the coil and by otherwise varying the size of the opening through it, an electric motor for driving the compressor, a circuit for controlling the electric motor having in multiple a plurality of switches each of which corresponds with one of the cooling coils, and a thermostatic control corresponding to each coil and controlling the valve and the switch corresponding to that particular coil.

22. In an automatic refrigerating system in combination with a compressor, a feed line connected with the discharge side of the compressor, a suction line connected with the suction side of the compressor, a plurality of cooling coils connected in multiple across said feed and suction lines, a valve in the suction side of each of said coils movable variable distances to control the passage of refrigerant therethrough, an electric motor for driving the compressor, a circuit for controlling the electric motor having in multiple a plurality of switches each of which corresponds with one of the cooling coils, a thermostatic control corresponding to each coil effecting the variable movement of the valve and controlling the switch corresponding to that particular coil, a safety pressure regulator connected to the discharge side of the line adjacent the com-

pressor, a switch in series in the motor controlling circuit, and means whereby the safety pressure regulator controls said series switch.

23. In an automatic refrigerating system, a feed line, a suction line, a compressor, connections between both said lines and the compressor, a normally closed connection between the discharge side of the compressor and the suction line, a valve in communication with the suction line automatically responsive to the pressure in the suction line and set to open the connection between the discharge and suction sides of the compressor when the pressure in the suction line falls below a predetermined point.

24. An automatic refrigerating system comprising a compressor, a condenser, a liquid receiver, a trap, cooling coils, and necessary connections therefor, a pump-out line having valve controlled connections with the various coils and with the ammonia trap, a pump-out tank below the coils and trap and forming a part of the pump-out line, a connection between the pump-out tank, and the receiver, and connections between the pump-out tank and the compressor.

25. In an automatic refrigerating system, a liquid receiver, a compressor, a condenser, cooling coils, a feed line connecting said parts, a suction line connecting the cooling coils with the compressor, and automatic means for preventing both undue increase and undue decrease of pressure in the suction line.

26. An automatic refrigerating system comprising in combination, a feed line, a suction line, a compressor connected to both, a plurality of cooling coils connected in multiple across said lines, a single automatic valve in the feed line between said compressor and coils, a valve on the suction side of each coil regulating the opening through said coil, and a thermostatic control for each of said last mentioned valves.

27. A refrigerating system comprising in combination, a feed line, a suction line, a compressor connected to both, a cooling coil connected to said lines, a check valve in the feed line between said coil and compressor permitting free flow to said coil but preventing boiling back, and means for controlling the flow of refrigerant through said coil.

28. A flooded refrigerating system comprising in combination, a feed line, a suction line, a compressor and a liquid receiving trap in communication with both said lines, a plurality of cooling coils connected to said lines, a check valve in the feed line between said coils and trap, and means for controlling the flow of refrigerating liquid through the coils.

29. A refrigerating system comprising in combination, a high pressure line, a low pressure line, a compressor and a liquid receiving trap connected to both said lines, a
5 cooling coil having its feed end connected to the lower part of said trap and its suction end to the upper part of said trap, a check valve in the connection between the trap and the feed end of the coil, a valve in the suction
10 end of the coil, and a thermostatic con-

trol for moving said valve variable distances in general correspondence with temperature changes affecting the thermostatic control.

Signed by us at New York city, N. Y. this 30th day of December, 1909.

EDWARD THOMPSON WILLIAMS.

HARRY THEODORE BERNHARD.

Witnesses:

JENNIE DUPREE,

MABEL O. FAHNESTOCK.