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D. W. R. MORGAN ET AL

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COOLING APPARATUS

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Fig. 1.

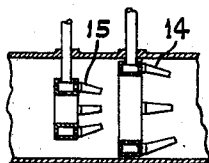
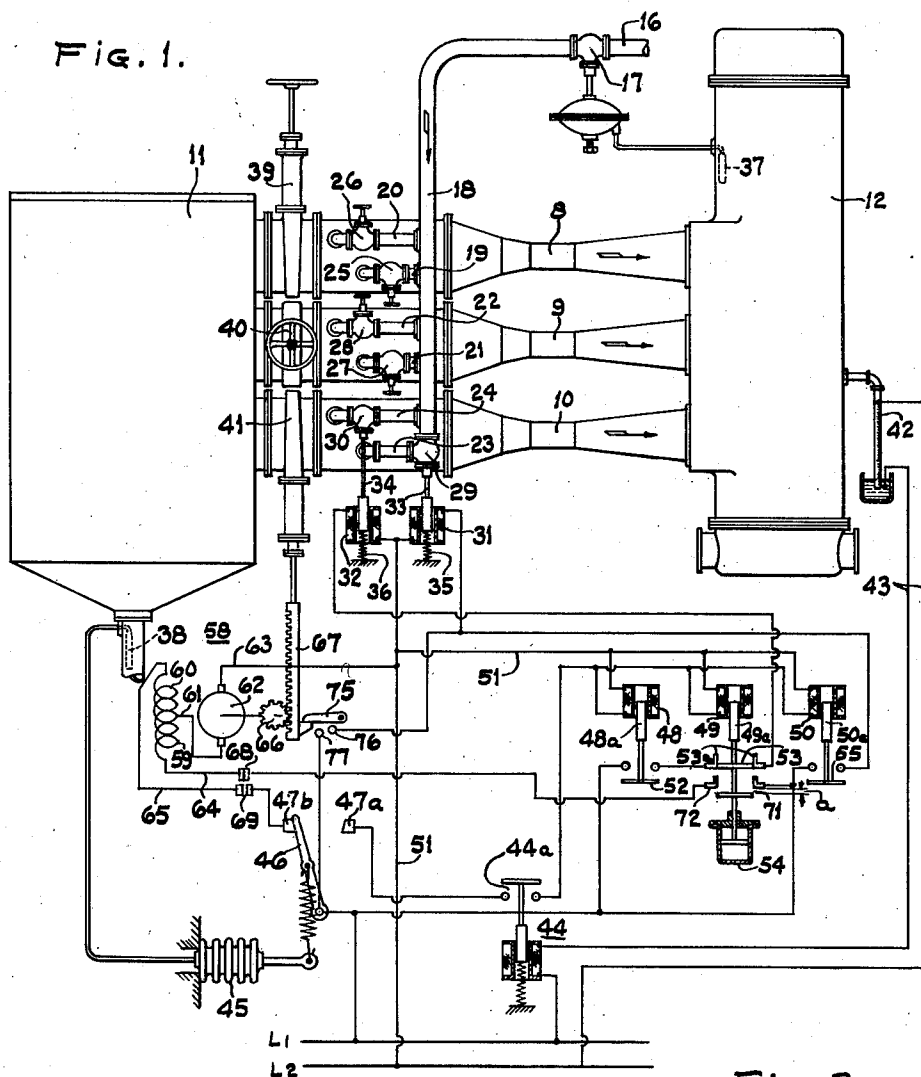
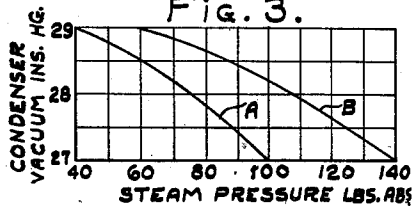


Fig. 2.

WITNESSES:

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Fig. 3.



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UNITED STATES PATENT OFFICE

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COOLING APPARATUS

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Application October 20, 1933, Serial No. 694,512
Renewed February 7, 1935

13 Claims. (Cl. 62—152)

Our invention relates to ejectors and it has for an object to improve the performance thereof so as to minimize the consumption of motive fluid, for example, steam.

Where ejector apparatus is used for vacuum producing purposes, for example, with steam jet cooling or refrigeration, economy in steam consumption may be secured by careful attention to the steam flow requirements and by designing the nozzles for maximum efficiency for specific steam conditions and condenser vacuum. Greater steam flow is required to start an ejector than to maintain it in operation. Accordingly, therefore, if greater steam nozzle capacity is provided to secure greater flow for starting and less steam nozzle capacity with less flow is provided to maintain the ejector in operation, more economical performance may be secured. Since flow is a function of the pressure of steam supply, an ejector may be maintained in operation, with improved economy because of the low pressure of the supply, by steam supplied at such a pressure to nozzles of such a design that it is not self-starting. To secure the economical advantage of providing only the necessary flow to maintain the ejector in operation, we provide a set of running nozzles having such design and giving such flow as will maintain operation. However, as the running nozzles, for the pressure supplied, are not self-starting, we provide an additional or starting set of nozzles which are effective, with the running nozzles, to start the ejector; the starting nozzles being stopped after stable operation of the ejector is secured. It is to be understood, of course, that the set of running nozzles would be self-starting if the pressure of steam supplied were increased to a sufficient point, but better performance is to be had by maintaining the steam pressure at a value consistent with safely maintaining the ejector in operation after it is started. For example, a nozzle may have such a design, that, if steam were supplied to it at a pressure of 125 pounds per square inch or above, it would be self-starting; and, after being started, it would be maintained in operation until the pressure supply declined to the "break" point, for example, 100 pounds per square inch. Economy of consumption may, therefore, be secured by supplying steam to a nozzle at a pressure slightly above the "break" point, for instance, in the example assumed, at a pressure around 105 pounds per square inch. Therefore, a further object of our invention is to provide an ejector furnished with steam at a pressure such that the nozzles necessary to main-

tain stable operation do not provide sufficient flow for starting but wherein additional, or starting, nozzles are employed to be used, with the running nozzles, to start the ejector, the starting nozzles being stopped after stable operation of the ejector is secured.

It is desirable to maintain the evaporator within reasonably narrow limits of temperature in order that refrigeration may be best effected; and, to this end, we provide a thermostat in the evaporator or tank which controls the operation of the ejector—upon a predetermined minimum temperature being attained in the tank or evaporator, the ejector is stopped at that point and upon a predetermined maximum temperature of the tank or evaporator, the ejector is started. Starting of the ejector with our two sets of jets entails control of the latter so that the ejector may be started and then maintained in operation. Hence, the thermostat associated with the tank or evaporator operates mechanism to render both sets of jets effective, the mechanism including suitable delay means effective after a predetermined period for cutting out the starting nozzles. Therefore, a further object of our invention is to provide apparatus having these advantageous features of construction and of operation.

In some installations, because of variation in the refrigeration load, it may be desirable to provide a plurality of ejectors in connection with the evaporator or tank; the base demand being taken care of by one or more ejectors and variations thereabove being taken care of by one or more ejectors which are automatically stopped and started in response to tank or evaporator temperature conditions. Each of the ejectors is supplied with steam from a common source whose pressure is such that each ejector has both running and starting jets as already pointed out. Each of the ejectors is provided with control valves for the running and starting jets thereof, the ejector or ejectors subject to tank or evaporator temperature control having their valves opened and closed in response to evaporator temperature. Accordingly, the control mechanism for the latter ejector or ejectors not only serves to isolate the latter with respect to the tank or evaporator but also to secure the stopping and starting operations already referred to. Therefore, a further object of our invention is to provide a refrigeration arrangement of this character wherein a multiplicity of ejectors is employed so that one or more thereof may be placed in operation to carry the then existing

normal base load, variations being taken care of by automatic ejectors responding to evaporator or tank temperature, all of the ejectors employing running and starting jets and the steam being supplied thereto at a pressure securing most economical operation.

Where a multiplicity of ejectors is arranged in parallel between an evaporator and a condenser, at least one of the ejectors being subject to automatic control in response to evaporator temperature, it is desirable to close the passage of the latter ejector when it is not in operation in order to avoid any tendency to equalization of evaporator and condenser pressures. Accordingly, therefore, we provide the automatic ejector with a gate valve which is closed whenever the ejector is stopped, and we prefer to have the control of opening and of closing of the gate valve interconnected with control of the jets of the ejector so that, in starting, both the running and starting jets are placed in operation before the gate valve is opened and the starting jet is not stopped until after the gate valve is opened to insure stable ejector operation, and, in stopping the ejector, the gate valve is closed before the running jet is stopped, whereby under all conditions of operation of the automatic ejector it is assured that the passage therefor cannot be effective as a by-pass tending to equalize pressures in the evaporator and condenser. Accordingly, therefore, a further object of our invention is to provide apparatus having these advantageous features of control and of operation assuring prevention of the automatic ejector passage serving as the by-pass between the evaporator and the condenser.

These and other objects are effected by our invention, as will be apparent from the following description and claims taken in accordance with the accompanying drawing, forming a part of this application, in which:

Fig. 1 is a diagrammatic view of a liquid cooling system including ejectors constructed and controlled in accordance with our invention;

Fig. 2 is a detailed view of the arrangement of the nozzles in the ejectors shown in Fig. 1; and,

Fig. 3 is a diagram illustrating an operating principle involved in our invention.

Referring now to the drawing more in detail, in Fig. 1, we show ejectors 8, 9, and 10 for translating medium from a suitable source, for example, from the tank or evaporator 11, the translated medium being compressed and discharged against a suitable back pressure, for example, to that existing in the condenser, shown at 12. The ejectors 8, 9, and 10 are of conventional construction, the suction ends being connected to the evaporator or tank at 11, and the discharge ends communicating with the interior of the condenser, at 12. Our invention consists in the modified arrangement for supplying steam and for controlling motivation of jets so as to secure most economical operation.

The rate of steam consumption during the starting period is higher than that required to maintain the ejector in operation after being started. Therefore, as shown in Fig. 2, we provide two sets of jets or nozzles, a set of running jets or nozzles 14 and a set of starting jets or nozzles 15, both sets being effective when an ejector is started and the starting set 15 being cut out after the ejector is started and is in normal operation. The reason why two sets of nozzles are employed to satisfy the above condi-

tions is that the motive steam for the jets is supplied at such a pressure that most economical operation can be secured, the pressure being such that, for the design and capacity of running nozzles required for normal operation, the flow of the latter nozzles is insufficient to effect starting and it is, therefore, necessary to increase the flow at such time by starting nozzles.

If the characteristics of an ordinary jet are considered, it will be found that a considerable range exists between what might be termed the self-starting point and the "break" point. For example, it might be assumed that the nozzle set 14 would have sufficient flow to start the ejector if steam were supplied thereto at 125 lbs. per square inch and that, after starting, the ejector would be maintained in operation by the nozzle set 14 until the pressure dropped to 100 lbs. per sq. inch. This will be clear from a consideration of Fig. 3, wherein the line A represents the "break" limit for a nozzle, that is, if the pressure of motive steam supplied to the nozzle falls below the line A for any condition, then the nozzle will cease to operate. The line B represents the limit below which the nozzle is not self-starting and above which it is self-starting. A substantial margin, therefore, occurs between the lines A and B where a nozzle is not self-starting but where it is able to maintain operation after being started.

From the point of view of economy of steam consumption, the ejector apparatus is operated to the best advantage, if steam is supplied thereto within the margin between the lines A and B and preferably slightly above A. In accordance with our invention, steam is supplied to the nozzles at a pressure somewhat above the "break" point, the steam consumption being more and more economical as the break point is approached; and to compensate for the inability of the nozzles or jets 14 to be self-starting, the additional nozzles or jets 15 are employed, the nozzles or jets 15 serving to assist the nozzles 14 during the starting period and being rendered inactive after the ejector is started and is in normal operation. To this end, we show a steam line 16 having a pressure control valve 17 for controlling the pressure of steam supplied to the header 18 and from the latter to the running and starting jets of the ejectors. Steam from the header 18 is conveyed to the running and starting jets of the ejector 8 through passages 19 and 20 and from the header 18 to the running and starting jets of the ejector 9 through passages 21 and 22. Likewise, the starting and running jets of the ejector 10 are supplied with steam from the header 18 through passages 23 and 24, respectively. A plurality of valves 25 to 30, inclusive, are disposed in the passages 19 to 24, inclusive, for controlling the flow of steam therethrough.

To start an ejector, both valves, for example, valves 25 and 26 are opened; and, after the ejector is in stable operation, the valve controlling the steam flow to the starting nozzles, for example, the valve 26, is closed.

As pointed out hereinafter the ejector 10 is automatically operated so that the valves 29 and 30 are provided with automatic means for opening and closing operations. Preferably the means employed include solenoids 31 and 32 having their cores connected through stems 33 and 34 to the valves 29 and 30, respectively, the arrangement being such that energization of the solenoids opens their respective valves. Springs 35 and

36 are used to bias the valves 29 and 30 to their closed positions.

A thermostat 37 is preferably disposed within the condenser 12 for controlling the pressure reducing valve 17 so that steam is supplied from the main 16 to the header 18 at the most economical operating pressure. As the ejector 10 is subject to automatic control, the tank or evaporator 11 is provided with a thermostat 38 which controls mechanism for starting and stopping the same. The starting and running jet arrangement under control of the evaporator temperature conditions with pressure of steam supplied to the nozzles under control of condenser temperature conditions is disclosed and claimed in the application of J. W. McNulty and M. A. Nelson, Serial No. 694,513, filed October 20, 1933, and assigned to the Westinghouse Electric & Manufacturing Company.

The non-automatic ejectors 8 and 9 preferably have different capacities, so that any one or different combinations thereof with the automatic ejector may be arranged to suit the load demand, the ejectors 8 and 9 being operated singly or in combination to take care of a base load and the automatically operated ejector 10 being started in response to an increase in load. Each of the ejectors 8, 9, and 10 are provided with stop valves 39, 40 and 41, respectively, the stop valve of an ineffective ejector being closed to prevent pressure equalization between the condenser and the evaporator.

The automatic control apparatus associated with ejector 10 preferably includes means to prevent the control apparatus from being effective to place the ejector in operation unless a predetermined vacuum in the condenser is maintained. To this end, we show a vacuum gauge at 42 wherein the column of mercury functions as a contact to open a local circuit at 43 which controls the energization of a relay 44, the circuit 43 being connected in shunt across line conductors L-1 and L-2 leading to a source of power not shown. It will be seen that the relay 44 is energized to close its contacts 44a when the vacuum in the condenser 12 is such that the contact through the mercury column is completed.

A description of the control circuits for effecting automatic operation of the ejector 10 will now be given. By way of example, we show the thermostat 38 including a bellows 45 which expands with a rise in temperature and which contracts with a decrease in temperature. Expansion of the bellows 45, incident to increase in the evaporator temperature to a sufficient extent, moves the switch arm 46 into engagement with the contact 47a and contraction of the bellows incident to a decrease in evaporator temperature causes the switch arm 46 to engage a second contact 47b. When the arm 46 engages the contact 47a, a circuit will be completed from the line conductor L-1 through the arm 46, contact 47a, the closed switch 44a and through a relay solenoid 48, a dash-pot solenoid 49 and a relay solenoid 50, through the conductor 51 leading to the other line conductor L-2. Energization of the solenoid 48 pulls up the core 49a to close contacts 52, energization of the solenoid 49 pulls up the core 49a to open a moving contact 53 relative to elongated contacts 53a after a suitable interval to provide for delayed shutting off of the starting jets, and energization of the solenoid 50 raises its core 50a to close contacts 55.

Closing of the contacts 55 completes a circuit

from the line side L1 through the solenoid 31, conductor 51, to the return L2, thereby providing for opening of the running jet valve 29. The starting jet solenoid 32 is energized at the same time, current therefor passing from the line side L1, through the contacts 52 and 53, to the solenoid 32, and from the latter to the return line 51 going to the other line side L2. A dash pot 54 which provides a time delay when moved upwardly and which is associated with the core 49a assures sufficient delay in interruption of the starting jet solenoid 32 to provide for stable operation of the automatic ejector 10 before the starting jets are stopped.

Upon the attainment of a predetermined low temperature in the evaporator 11, the arm 46 will move away from the contact 47a, whereupon the circuits for the valve solenoid 31 and the circuits for the relay solenoids 48 and 50 and the dash-pot switch solenoid 49 will be interrupted and the steam supply to the ejector will be completely shut off and the relays and the dash pot switch will resume the position shown in Fig. 1.

The gate valve 41 serves to close the passage of the ejector 10 when the latter is not in operation, whereby such passage is prevented from equalizing pressures in the evaporator and in the condenser. Preferably, the gate valve is operated in timed relation with the control of the ejector. To this end, by way of example, we show the gate valve opened and closed by the reversible electric motor, at 58, having split field elements 59 and 60 having a common lead 61 going to the armature 62, the latter being connected by a lead 63 to the return 51 going to the line side L2. Leads 64 and 65 are connected to the field elements 59 and 60, respectively; and it will be apparent that, if a circuit is completed through one lead, the motor will run in one direction, and, if the circuit is completed through the other lead, the motor will run in the other direction.

Motion of the armature 62 is applied to the gate valve so as to open and close the latter, the armature being shown as provided with a pinion 66 meshing with a rack 67 connected to the gate valve.

The motor, at 58, is provided with a conventional limit switch having contacts 68 and 69, one of these contacts being closed incident to opening of the other, that is, opening of contacts 68 to end the necessary motor travel to open the gate valve closes the contacts 69 so that when the lead 65 is later energized the motor will operate in the other direction to close the gate valve.

With the contact arm 46 engaging the contact 47a, the ejector 10 will be energized and thereafter the starting jet will be interrupted due to the time delay afforded by the dash-pot controlled contacts 53 and 53a. Incident to rendering the automatic ejector effective, current also passes from the line side L1 through the contact 68 and the lead 64 to the field element 59 to cause rotation of the motor 58 in such a direction as to open the gate valve 41. If the arm 46 moves away from the contact 47a and engages the contact 47b incident to attainment of a predetermined low evaporator temperature, then a circuit will be completed from the line side L1 through the contacts 69, the lead 65 and the field element 60 to operate the motor in the other direction so as to bring about closing of the gate valve 41.

The relay 52 is provided to interrupt a circuit from the line side L1, the contacts 53--53a,

and the solenoid 32 after the arm 46 moves away from the contact 47^a and the dash-pot contacts 53 and 53^a are again closed.

While the gate valve 41 may be closed currently with stopping and starting of the automatic ejector 10 in order to prevent the ejector passage from equalizing pressures in the evaporator and in the condenser, this result may be achieved more effectively by providing such sequences that the gate valve is completely closed before the supply of steam to the automatic ejector is cut off and the supply of steam to both the running and starting jets of the automatic ejector is established before the gate valve is opened. Also, we prefer to have the running and starting jets maintained in operation after the gate valve is opened so as to insure stable operation of the ejector before steam is cut off from the starting jets.

Referring to the sequence of the events accompanying starting of the ejector, we show a movable contact 71 connected to the core 49^a and arranged to engage with the elongated contacts 72, engagement thereof taking place after a short distance of travel of the core, for example, the distance "a". This provides for a sufficient interval to insure starting of the running and starting jets. Upon engagement of the contacts 71 and 72, current is supplied from the line side L1, through the contact 68, the lead 64, and the field element 59 to energize the motor, at 58, to open the gate valve, operation of the motor ceasing due to opening of the limit switch contacts 68 and closing of the contacts 69 when the gate valve is fully open. We prefer that the starting jets shall not be stopped until after the gate valve 41 is open so that the ejector may be stabilized under working conditions, this sequence being easily provided for by making the contacts 53^a sufficiently long and the dash pot 54 sufficiently slow in action to provide for disengagement of the contacts 53 and 53^a after the motor, at 58, has opened the gate valve, operation of the starting jets being continued until such time as the circuit including the contacts 53 and 53^a is interrupted by the opening of such contacts.

When the automatic ejector 10 is stopped, it is desirable to close the gate valve 41 before the steam supply to the running jets is interrupted. To this end, when the contact arm 46 engages the contact 47^b to energize the motor, at 58, to close the gate valve 41, the latter will start to close, but as the rack 67 has a contact 75 engaging a pair of contacts 76 and 77, connected, respectively, to the solenoid 31 and to the line side L1, it will be seen that the solenoid 31 will continue to be energized to maintain the running jet in operation after the arm 46 moves away from the contact 47^b and until the rack contact 75 disengages the pair of contacts 76 and 77, disengagement of the latter being effected with closure of the gate valve.

While we have referred to running and starting jets, which is the running jet and which is the starting jet may depend upon condenser temperature and pressure conditions and the relative capacities of the jets. Assuming that the capacity and steam consumption of the running jets is somewhat larger than that of the starting jets, with a sufficient reduction in condenser temperature and pressure, as may be occasioned by reduced temperature of circulating water, it may be more economical to use the starting jets as the running jets, both sets of jets, as before, being used to initiate operation of the ejector. Then

again, under other circumstances, for example, with increase in steam pressure to a sufficient extent or with decrease in condenser absolute pressure to a sufficient point, one set of nozzles may be adequate both for starting and running; however, as already pointed out, it is advantageous to reduce the steam flow, as by stopping the starting nozzles, after the ejector is in stable operation. Also, where we refer to "nozzles" or "set of nozzles", either starting or running, it is to be understood that one or more nozzles is intended, the number being a matter of design.

While we have shown our invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications, without departing from the spirit thereof, and we desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What we claim is:

1. In high-vacuum apparatus, a chamber from which vapors are to be withdrawn, a condenser, an ejector for withdrawing vapors from the chamber and for compressing the vapors and translating the latter to the condenser, said ejector including first and second sets of steam nozzles, means for supplying steam under pressure to the sets of nozzles, the normal steam pressure and the nozzles of the sets being such that neither set is capable of starting the ejector unit but at least one of the sets being capable of maintaining the ejector in operation after being started, and means responsive to chamber temperature conditions for controlling said supply means so that, when starting, steam is supplied to both sets of nozzles and after the ejector is in operation the supply of steam to one of the sets of nozzles is interrupted.

2. In refrigerating apparatus, an evaporator, a condenser, a plurality of ejectors connecting the evaporator to the condenser, said ejectors including an automatic ejector having starting and running jets, means responsive to a predetermined high evaporator temperature for supplying steam to both jets to start the ejector and responsive to a predetermined low evaporator temperature to interrupt the supply of steam to the running jet to stop the ejector, said means including a time delay device providing for the automatic cut-off of steam to the starting jets a sufficient time after starting to secure stable ejector operation, a gate valve for opening and closing the passage of the automatic ejector, and means for opening and closing the gate valve and interrelated with said temperature responsive means so that the gate valve is opened after both the running and the starting jets are started and before the starting jet is stopped and is closed before the running jet is stopped.

3. In vacuum apparatus, a chamber from which vapors are to be withdrawn, an ejector for withdrawing vapors from the chamber, said ejector including first and second sets of motive nozzles, means for supplying motive fluid under pressure to the sets of nozzles, and means for automatically admitting motive fluid to both sets of nozzles to start operation of the ejector, for interrupting the admission of motive fluid to the starting nozzles at a time when the ejecting action of the ejector has been established, and continuing the admission of motive fluid to the other set of nozzles during operation of the ejector.

4. In refrigerating apparatus, an evaporating

chamber, a condenser, an ejector for withdrawing vapors from the chamber and for compressing the vapors and translating the latter to the condenser; said ejector including a set of starting nozzles and a set of running nozzles, means for supplying steam under pressure to the sets of nozzles, the normal steam pressure and the nozzles of the sets being such that neither set is capable of starting the ejector but at least one of the sets being capable of maintaining the ejector in operation after being started, and means responsive to an operating condition of the evaporating chamber for controlling said steam supply means to admit steam to both sets of nozzles in starting operation of the ejector and to interrupt the admission of steam to the set of starting nozzles a sufficient time after starting to secure stable ejector operation, and to interrupt the admission of steam to the set of running nozzles to terminate operation of the ejector.

5. In refrigerating apparatus, an evaporator, a condenser, a plurality of ejectors connecting the evaporator to the condenser, said ejectors including an automatic ejector having starting and running jets, means responsive to a predetermined high evaporator temperature for supplying steam to both jets to start the ejector and responsive to a predetermined low evaporator temperature to interrupt the supply of steam to the running jet to stop the ejector, said means including a time delay device providing for the automatic cut-off of steam to the starting jets a sufficient time after starting to secure stable ejector operation, a gate valve for opening and closing the passage of the automatic ejector, and means for opening and closing the gate valve and interrelated with said temperature responsive means so that the gate valve is opened after both the running and the starting jets are started and is closed before the running jet is stopped.

6. In refrigerating apparatus, an evaporator, a condenser, a plurality of ejectors connecting the evaporator to the condenser, said ejectors including running and starting jets, means for supplying motivating fluid to both jets to start the ejector, to interrupt the supply of motivating fluid to the starting jet after stable operation of the ejector has been secured and to interrupt the supply of motivating fluid to the running jet to stop the ejector, valves connected between each ejector and the evaporator for controlling the flow of vapor from the latter to the former, and means for opening and closing said valves so that a valve is opened after both the running and starting jets are started and is closed at least as soon as the running jet is stopped.

7. In refrigerating apparatus, an evaporator, a condenser, a plurality of ejectors connecting the evaporator to the condenser, said ejectors including running and starting jets, means for supplying motivating fluid to both jets to start the ejector, to interrupt the supply of motivating fluid to the starting jet after stable operation of the ejector has been secured and to interrupt the supply of motivating fluid to the running jet to stop the ejector, valves connected between each ejector and the evaporator for controlling the flow of vapor from the latter to the former, and means for opening and closing said valves so that a valve is opened after both the running and starting jets are started and before the starting jet is stopped and is closed before the running jet is stopped.

8. Vapor jet refrigerating apparatus for supplying a refrigerating demand comprising the combination of an evaporator, an ejector for withdrawing vapor therefrom to effect cooling by evaporation of liquid therein, and means operative in response to the refrigerating demand first to supply a greater than normal amount of motive fluid to said ejector to initiate operation thereof and to supply a lesser amount of motive fluid for normal operation at a time when the ejecting action of the ejector is established.

9. Vapor jet refrigerating apparatus for supplying a refrigerating demand comprising the combination of an evaporator, an ejector for withdrawing vapor therefrom to effect cooling by evaporation of liquid therein, and means operable automatically when set in motion first to supply a greater than normal amount of motive fluid to said ejector to initiate operation thereof and to supply a lesser amount of motive fluid for normal operation at a time when the ejecting action of the ejector is established.

10. Vapor jet refrigerating apparatus for supplying a refrigerating demand comprising the combination of an evaporator, an ejector for withdrawing vapor therefrom to effect cooling by evaporation of liquid therein, and means operable automatically when set in motion first to supply a greater than normal amount of motive fluid to said ejector for a predetermined period of time to initiate operation thereof and at the end of same period to supply a lesser amount of motive fluid for normal operation.

11. Vapor jet refrigerating apparatus for supplying a refrigerating demand comprising the combination of an evaporator, an ejector for withdrawing vapor therefrom to effect cooling by evaporation of liquid therein, said ejector having first and second sets of nozzles, and means operative in response to the refrigerating demand first to render both of said sets of nozzles operative to initiate operation of said ejector and thereafter to render one of said sets of nozzles inoperative with the other set of nozzles remaining operative for normal operation of the ejector.

12. Vapor jet refrigerating apparatus for supplying a refrigerating demand comprising the combination of an evaporator, an ejector for withdrawing vapor therefrom to effect cooling by evaporation of liquid therein, said ejector having first and second sets of nozzles, and means operable automatically when set in motion first to render both sets of nozzles operative to initiate operation of said ejector and thereafter to render one of said sets of nozzles inoperative with the other set of nozzles remaining operative for normal operation of the ejector.

13. Vapor jet refrigerating apparatus for supplying a refrigerating demand comprising the combination of an evaporator, an ejector for withdrawing vapor therefrom to effect cooling by evaporation of liquid therein, said ejector having first and second sets of nozzles, and means operable automatically when set in motion first to render both sets of nozzles operative for a predetermined period of time to initiate operation of said ejector and at the end of said period to render one of said sets of nozzles inoperative with the other sets of nozzles remaining operative for normal operation of the ejector.

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