June 20, 1939. E. R. GILL, SR 2,162,709

DEFROSTING OF REFRIGERATORS

Original Filed May 7, 1930 2 Sheets-Sheet 1

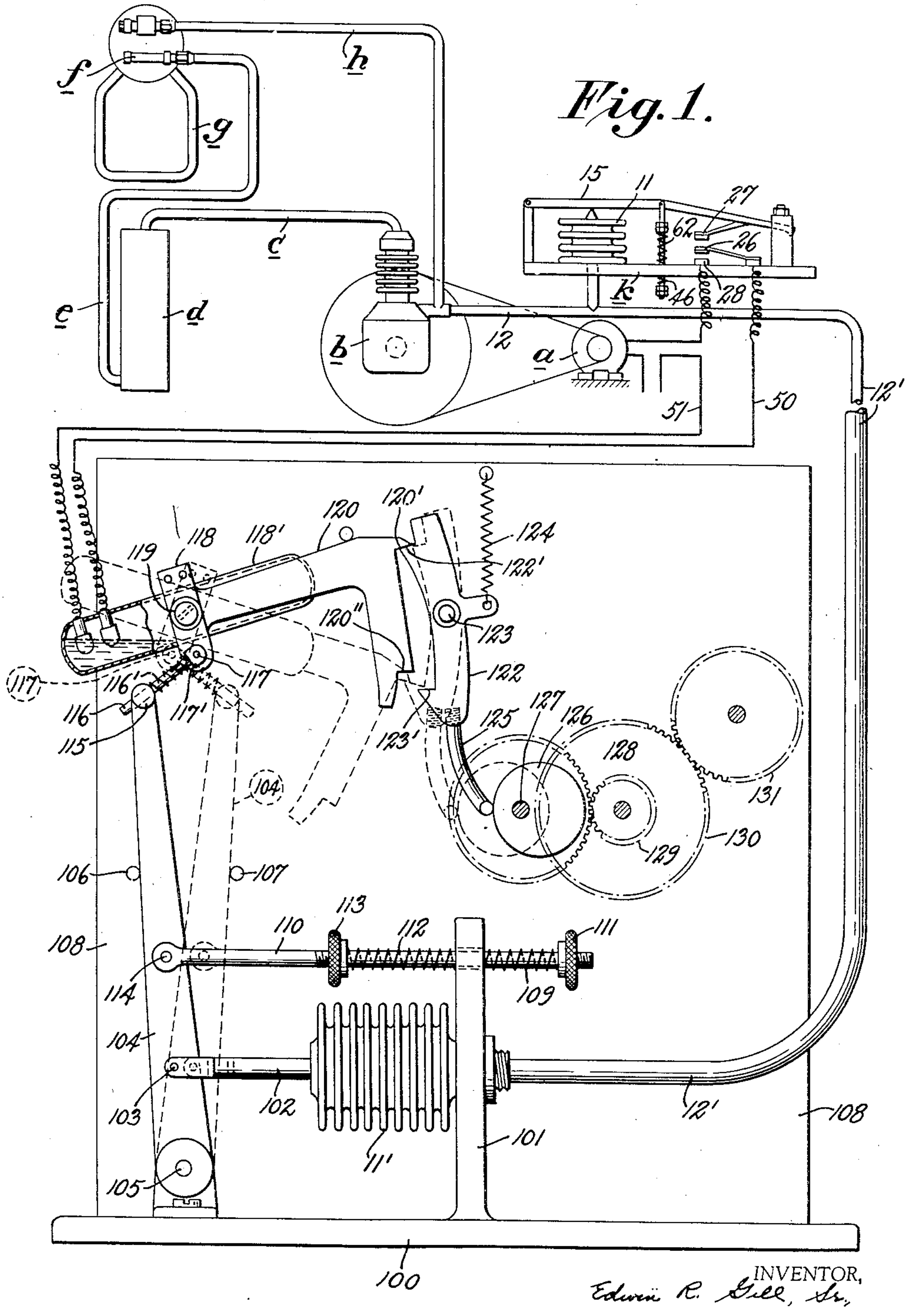

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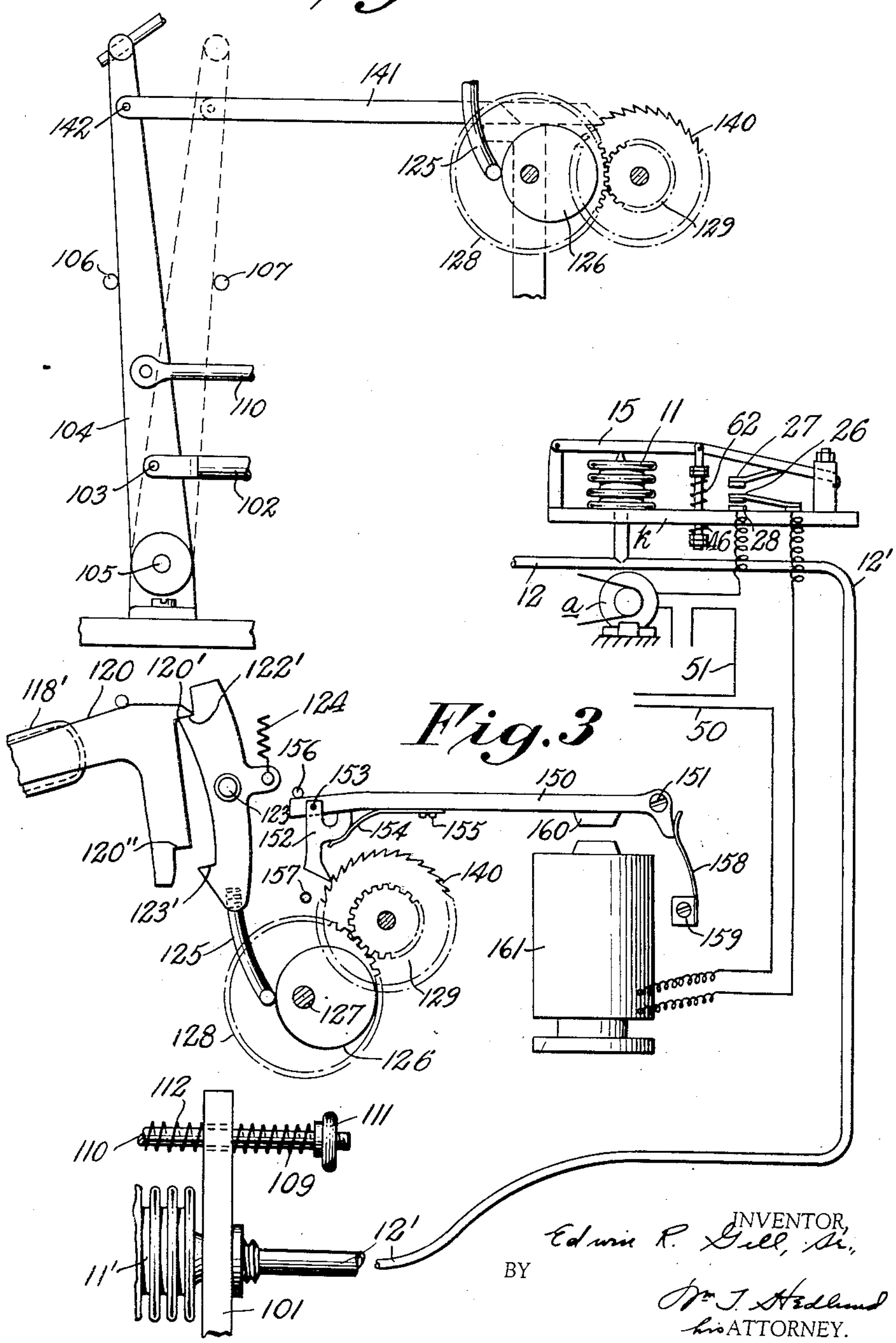
Fig. 2.

Fig. 3



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DEFROSTING OF REFRIGERATORS

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Original application May 7, 1930, Serial No. 450,451. Divided and this application July 30, 1935, Serial No. 33,812

27 Claims. (Cl. 62—4)

This application is a division of my copending application Serial No. 450,451 filed May 7, 1930, now matured into Patent No. 2,084,730, granted June 22, 1937.

My invention relates to refrigerating apparatus, and more particularly to mechanism for automatically initiating defrosting periods.

The principal object of the invention herein claimed is to predetermine the intervals at which defrosting takes place so that the defrosting will not occur at undesirable intervals.

Another object of the invention is to automatically restore the refrigerating system to normal operation as soon as the defrosting period is over.

The invention will be clear from the following description taken in conjunction with the accompanying drawings showing a preferred form and variations thereof, and of which:

Fig. 1 shows a refrigerating machine of the compressor type having my invention applied thereto;

Fig. 2 shows one modification thereof; and

Fig. 3 shows another modification.

The system of refrigeration apparatus to which the invention is applied is well known and comprises an electric motor *a* for operating a compressor *b* for compressing a volatile refrigerant, for example, sulphur dioxide. A pipe *c* connects the high pressure side of the compressor with the condenser *d* where the refrigerant is liquefied. The liquid is forced through pipe *e* to the valve *f* for controlling escape of liquid to the low pressure cooling pipes or units *g* in the region which is to be refrigerated. Evaporation of the refrigerant takes place and the vapor is drawn through pipe *h* to the low pressure side of the compressor *b* to complete the cycle.

A pipe 12 connects pipe *h* with the metal bellows 11 of the switch *k* for closing and opening the power circuit of the electric motor *a*, thereby starting and stopping the motor and the compressor. The switch *k* may be of the general type shown in U. S. Patents 1,658,342 and 1,805,701. Bellows 11 moves in response to variations of suction line pressure in pipe *h* and causes movement of an arm 15. Springs 46 and 62 act against arm 15 to control and limit the movement thereof caused by movement of bellows 11. Adjustment nuts are provided to vary the tension of springs 46 and 62. Suitable and known snap action mechanism is provided whereby switch contacts 26, 27 and 28 are closed or opened in accordance with high and low pressures respectively.

The parts hereinbefore mentioned operate briefly as follows:

Assuming the switch to be in open circuit position, the compressor is not working and the pressure on the low pressure side of the system is rising. When the temperature of the region surrounding the cooling unit rises to approximately 28° F. the pressure of the refrigerant causes the bellows 11 to expand sufficiently to raise the arm 15 to close the switch, whereupon the electric motor is started and the compressor operated thereby. This produces refrigeration in known manner and when the refrigerated region attains a given low temperature the bellows 11 contracts and opens switch *k* to stop the motor and compressor.

By varying the resistance of the arm 15 to upward movement, the degree of temperature at which the switch closes the motor circuit can be either raised or lowered. This is ordinarily accomplished by adjustment springs as shown. The circuit closing temperature may be raised by increasing the resistance to compression of the spring 46. This means provides for the closing of the circuit under ordinary running conditions, as when the temperature is to be allowed to rise as high as 28° F. The lower limit or range of working temperature may be varied by means of the adjustable coil spring 62. Inasmuch as this spring tends to move the switch arm upward, a movement of the adjusting nut downward increases the upward urge of the spring and makes it more difficult for the bellows to pull the switch arm down to open the motor circuit. The compressor therefore operates to produce a lower pressure on the low pressure side of the system and a correspondingly lower temperature of the refrigerated region before the motor circuit can be opened.

In refrigerating systems, the evaporator is maintained below 32° F. and moisture deposits thereon from the air and freezes, forming a coating of frost which builds up and must be periodically removed. To the known refrigerating device, I have added a novel defrosting mechanism which operates a switch in series with switch *k*. The defrosting period is automatically initiated by a chronometric device at selected times (as for example, midnight of each day). Preferably the defrosting period is terminated by a condition of the structure affected by the defrosting mechanism.

Referring to the mechanism shown in the lower part of Fig. 1, an electric motor control switch is shown which comprises a base 100 having a standard 101 upon which is mounted the auxiliary bellows 11' which communicates with the low pressure side of the system by the auxiliary pipe 12'. The free end of the bellows is provided with a rod 102 which is pivoted at 103 to the switch lever 104. This lever is pivoted at 105 to the base 100 and its limits of movement defined by stops 106 and 107 carried by the upright 108. The outward movement of lever 104 is opposed by a coil spring 109 which surrounds the threaded rod 110 and abuts against the standard 101, and the nut 111 threaded on said rod. The resistance offered by said spring may be varied by adjustment of the position of said nut. A similar spring 112 and nut 113 provide a similar adjustable resistance for opposing the inward movement of the lever 104. The rod 110 is pivoted to said lever at 114.

At the extremity of the lever 104 is a pivotal stud 115 having a bore which receives a slideable pin 116. This pin is pivoted at 117 to the frame 118 of a mercoid switch 118', which is in series with the usual motor switch *k* as shown by leads 50 and 51. Coil spring 116' surrounds said pin 116 and is interposed between stud 115 and shoulder 117' of pin 116. Switch 118' is pivoted on a screw or stud 119 carried by the upright member 108 and an extension arm 120 is attached to and turns with the mercoid switch 118' and has shoulders 120' and 120'' for supporting it in the position shown in full lines and at a slightly lower position respectively. The arrangement of these parts is such that when arm 104 is in full line position, the switch 118' is likewise in full line position, but upon movement of arm 104 to dotted line position the switch 118' will be suddenly snapped by spring 116' on passing the dead center into its dotted line position, unless such responsive movement of switch 118' is prevented, in which case arm 104 can move back and forth without moving the switch 118' out of the full line position.

An escapement pawl 122 is pivoted at 123 to the upright 108 and is normally held in full line position by tension spring 124. The upright end of pawl 122 is provided with a shoulder 122' and at its lower end with a shoulder 123'. A curved rod 125 is secured to the lower extremity of said pawl 122 and by the action of spring 124 is held against the surface of a cam or eccentric 126 mounted on arbor 127. The arbor 127 is driven by the gears 128, 129, 130 and 131, forming part of a clockwork train of a time keeping device of any type, which may be, for example, an ordinary eight-day clock. The gearing may be such as to cause one revolution of the eccentric per each 24 hours, or any other desired interval of time.

The device operates as follows:

So long as the pawl 122 remains in full line position and arm 120 is supported by the catch 120' received on the shoulder 122', the switch 118' remains in full line position and the motor circuit is made through the mercoid switch 118'. During such times, the repetition of the normal cycle is controlled by the ordinary switch *k* in a normal way. Such movements as take place of arm 104 during such time are without effect upon the closing of the motor circuit through the switch 118', the provision of spring 116' permitting such movement of arm 104 to take place without imparting movement to switch 118'.

When the timekeeping device has rotated the eccentric into the dotted line position this movement shifts the pawl 122 also to dotted line position so that the shoulder 122' of pawl 122 releases the shoulder 120' of arm 120, whereupon in case lever 104 is in dotted line position, or if not, then upon the next movement of said lever to said position, the arm 120 falls a short distance until it is stopped by the shoulder 120'' engaging catch 123' of pawl 122. Such slight turning movement, however, of arm 120 and switch 118' leaves the motor circuit still complete through the mercoid switch 118', and the normal cycle of operation still in effect through the main switch *k*.

Upon turning movement of the clockwork and cam member 126, catch 123' is moved back by spring 124 until the shoulder 120'' is released by said catch 123', whereupon, if lever 104 is in dotted line position, or if not, then upon the next movement of said lever to such position, the arm 120 and switch 118' are released and turn through the snapping action of the connection 115, 116, 116' and 117 to the dotted line position in which the motor circuit is broken by the mercoid switch 118'.

So long as the mercoid switch remains in such motor circuit breaking position the motor and compressor are at rest and the temperature of the refrigerated region permitted to rise irrespective of whether the motor circuit is completed or broken at the principal motor control switch. The defrosting cycle so instituted continues until the temperature of the defrosted region rises to a point productive of a pressure of the vapor in the auxiliary bellows 11' considerably higher than that required to close the circuit through the main switch *k* and which is sufficient to cause such auxiliary bellows 11' to move the switch lever 104 and switch 118' from dotted to full line position, whereupon the shoulder 120' of arm 120 becomes engaged with catch 122' of pawl 122 and the motor circuit is completed through the switch 118' by turning to such full line position. The arm 120 will then be supported by pawl 122 until the eccentric 126 has made almost a complete revolution, whereupon the described operation will be repeated after an interval which may be practically any desired interval of time, the normal cycle of operation occurring in sequence in the regular way during such interval.

The device of Fig. 2 is similar to that of Fig. 1 in all respects except that instead of providing a timekeeping device or clock for causing rotation of the eccentric 126 a cycle counting device is used. This device comprises a ratchet wheel 140 mounted on the same arbor as the gear 129 and given a step-by-step movement by a pawl arm 141 which is pivoted at 142 to the switch arm 104. Each normal cycle of operation of the system causes the pawl 141 to advance the wheel 140 a distance of one or more teeth and to interpose (at least) one defrosting cycle for each revolution of the eccentric 126. If by reason of the slight curvature of the eccentric, the rod 125 has not at the end of the defrosting cycle moved the pawl 122 sufficiently to bring the shoulder 122' into position for supporting the arm 120, another defrosting cycle will ensue, and thereafter the series of normal cycles will occur until the eccentric again reaches the position for tripping the arm 120. Such repetition of defrosting cycles might also occur in the operation of the device of Fig. 1.

The device of Fig. 3 is similar in all respects to that of Fig. 2, except that the pawl 141 for advancing the ratchet 140 is replaced by a lever 150 pivotally supported at 151 and carrying at its free end a pawl 152 pivoted thereto at 153. A flat spring 154 is secured to the arm 150 by a screw 155 and normally holds it in the position shown. The lever 150 is provided with an armature 160 which is attracted by an electro-magnet 161 whenever the same is energized. The magnet is connected either in shunt or in series with the motor by which the compressor is driven and is energized every time the motor circuit is closed by the principal motor control switch, which is once for every normal cycle. Such energization causes the long arm of lever 150 to be pulled downward whereby the toothed wheel 140 is advanced the pitch of one tooth in a counter-clockwise direction. When the motor circuit is open the magnet is deenergized and the spring 158 thereupon returns the lever arm 150 to the position shown. The gear 129 operates an eccentric as in Figs. 1 and 2 for causing a defrosting cycle to be interposed in a series of normal cycles as described in connection with the device of Fig. 1.

It will be obvious that in the system the normal control switch may be operated by a temperature responsive thermostat instead of by pressure of the evaporator. Also it will be clear that the invention may be applied to the control of other forms of energy supply, such as the control of flow of gas by controlling valves. Various other changes will be apparent to those skilled in the art.

I claim:

1. A refrigerating system including means to supply energy thereto, a first energy supply control member, a second energy supply control member, said members being arranged in series with respect to supply of energy, means responsive to variations in temperature below a given temperature to actuate said first energy supply control member, means to periodically actuate said second energy supply control member to restrain the energy supply, and means responsive to temperature above said given temperature to actuate said second energy supply control member to restore the supply of energy.

2. A refrigerating system including means to supply energy thereto, a first energy supply control member, a second energy supply control member, said members being arranged in series with respect to supply of energy, means responsive to variations in pressure below a given pressure to actuate said first energy supply control member, means to periodically actuate said second energy supply control member to restrain the energy supply, and means responsive to pressure above said given pressure to actuate said second energy supply control member to restore the supply of energy.

3. A refrigerating system including means to supply energy thereto, a first energy supply control member, a second energy supply control member, said members being arranged in series with respect to supply of energy, spring-resisted means responsive to variations in temperature below a given temperature to actuate said first energy supply control member, spring-resisted means to periodically actuate said second energy supply control member to restrain the energy supply, means responsive to temperature above said given temperature to actuate said second energy supply control member to restore the supply of energy, and means for adjusting the spring-resisted means.

4. A refrigerating system including means to supply energy thereto, a first energy supply control member, a second energy supply control member, said members being arranged in series with respect to supply of energy, spring-resisted means responsive to variations in pressure below a given pressure to actuate said first energy supply control member, spring-resisted means to periodically actuate said second energy supply control member to restrain the energy supply, means responsive to pressure above said given pressure to actuate said second energy supply control member to restore the supply of energy, and means for adjusting the spring-resisted means.

5. A refrigerating system including means to supply energy thereto, a first energy supply control member, a second energy supply control member, said members being arranged in series with respect to supply of energy, means responsive to variations in temperature below a given temperature to actuate said first energy supply control member, means movable step-by-step to periodically actuate said second energy supply control member to restrain the energy supply, and means responsive to temperature above said given temperature to actuate said second energy supply control member to restore the supply of energy.

6. A refrigerating system including means to supply energy thereto, a first energy supply control member, a second energy supply control member, said members being arranged in series with respect to supply of energy, means responsive to variations in temperature below a given pressure to actuate said first energy supply control member, means movable step-by-step to periodically actuate said second energy supply control member to restrain the energy supply, and means responsive to pressure above said given pressure to actuate said second energy supply control member to restore the supply of energy.

7. In a refrigerating system, a compressor for compressing a gas or vapor, means comprising an electric circuit for driving said compressor, means responsive to a normal upper limit of temperature of the refrigerated region for closing said circuit to drive the compressor, a time keeping device and means actuated by said time keeping device to allow the temperature of the refrigerated region to rise above said normal upper limit, said time keeping device actuated means including means responsive to a given high temperature of the refrigerated region to close the circuit.

8. In a refrigerating system, a compressor for compressing a gas or vapor, mechanism comprising an electric circuit for driving said compressor, means responsive to a normal upper limit of temperature of the refrigerated region for closing said circuit to drive the compressor, an electromagnetic counting device actuated by movement of said means, and means actuated by said counting device for temporarily causing a defrosting operation.

9. Refrigerating apparatus including a cooling unit, means for circulating a refrigerant medium through the cooling unit, control means for normally starting and stopping the circulation of refrigerant medium at predetermined high and low temperatures to provide normal refrigeration cycles, means for providing defrosting cycles including chronometric means controlling the circulation of refrigerant for initiating defrosting cycles, and temperature responsive means responsive to a temperature of the cooling unit above said predetermined high temperature for terminating said defrosting cycles.

10. Refrigerating apparatus including a cool-

ing unit, means for circulating a refrigerant medium through the cooling unit, and control means for normally starting and stopping the circulation of refrigerant medium at predetermined high and low temperatures of the cooling unit, said control means being provided with chronometric means for periodically raising to a predetermined higher temperature the temperature at which the circulation is started.

11. Refrigerating apparatus including a cooling unit, means for circulating a refrigerant medium through the cooling unit, control means for normally starting and stopping the circulation of refrigerant medium at predetermined high and low temperatures of the cooling unit to provide refrigerating and idle cycles, and means operated mechanically independently of the said control means but responsive to the cycling of the circulating means for periodically raising the temperature at which the circulation is started.

12. Refrigerating apparatus including a cooling unit, means for circulating a refrigerant medium through the cooling unit, control means for normally starting and stopping the circulation of refrigerant medium at predetermined high and low temperature limits of the cooling unit to provide refrigerating and idle cycles of the circulating means, and a cycle counting device powered mechanically independently of said control means but responsive to the cycling of said refrigerant medium for periodically varying one of the temperature limits of the control means.

13. Refrigerating apparatus including a cooling unit, means for circulating a refrigerant medium through the cooling unit, means for conducting electric energy to said circulating means, means for controlling the conduction of electric energy to the circulating means according to cooling unit temperatures, and means energized by electric energy flowing under the control of the control means to the circulating means for periodically controlling the supply of electric energy to the circulating means according to a different temperature of the cooling unit.

14. Refrigerating apparatus including a liquefying means and an evaporating means, control means for normally starting and stopping the action of the liquefying means at predetermined high and low evaporator temperatures to provide normal refrigerating cycles, means for providing defrosting cycles including chronometric means for controlling the action of the liquefying means for initiating defrosting cycles, and temperature responsive means responsive to a temperature of the evaporating means above said predetermined high temperature for terminating the defrosting cycles.

15. Refrigerating apparatus including a liquefying means and an evaporating means, control means for normally starting and stopping the action of the liquefying means at predetermined high and low evaporator temperatures to provide normal refrigerating cycles, said control means being provided with chronometric means for periodically raising to a predetermined higher temperature, the temperature at which the action of the liquefying means is started.

16. Refrigerating apparatus including a liquefying means and an evaporating means, control means for normally starting and stopping the action of the liquefying means at predetermined high and low evaporator temperatures to provide normal refrigerating and idle cycles, and means operated mechanically independently of the control means but responsive to the cycling of the liquefying means for periodically raising the temperature at which the action of the liquefying means is started.

17. A refrigerator including a cooling unit, oscillated means for controlling the flow of a refrigerant through said unit, and a chronometric device for frustrating said oscillated means for a period.

18. A refrigerator including a cooling unit, means normally controlling the circulation of a refrigerant through said unit, means for frustrating said normal control means for a period, and means for limiting the duration of the period.

19. A refrigerator including a cooling unit, means normally controlling the circulation of a refrigerant through said unit, means for frustrating the normal control means during a period, and means for temporarily frustrating the second mentioned means.

20. A refrigerator including a cooling unit, means normally controlling the circulation of a refrigerant through said unit, time controlled means for rendering said normal control means ineffective during a defrosting period, and means for delaying the operation of said second mentioned means.

21. A refrigerator including a cooling unit, means normally controlling the circulation of a refrigerant through said unit, a device for limiting the operation of said normal control means for a period of time, means for delaying the operation of the limiting device, and means for restoring the control of said cooling unit to said normal control means at the end of said period.

22. A refrigerator including a cooling unit, means normally controlling the circulation of a refrigerant through said unit, and means for limiting the operation of said normal control means for a period of time and for limiting the duration of the period of time.

23. Refrigerating apparatus including a cooling unit, means for circulating a refrigerant medium through the cooling unit, means for conducting electric energy to said circulating means, temperature responsive means for normally controlling the supply of electric energy to said circulating means, and a ratcheting device powered mechanically independently of said temperature responsive means for stopping the supply of energy to said circulating means.

24. Refrigerating apparatus including a cooling unit, means for circulating a refrigerant medium through the cooling unit, means for conducting electric energy to said circulating means, temperature responsive means for normally controlling the supply of electric energy to said circulating means, a ratcheting device powered mechanically independently of said temperature responsive means for stopping the supply of energy to said circulating means, and electrically operated means for operating said ratcheting device.

25. Refrigerating apparatus including refrigerant liquefying means and refrigerant evaporating means, means for supplying energy to the liquefying means, temperature responsive means for controlling the supply of energy to the liquefying means, and a ratcheting device powered mechanically independently of said temperature responsive means for changing the control of the supply of energy to the liquefying means.

26. Refrigerating apparatus including refrigerant liquefying means and refrigerant evaporating means, means for supplying energy to the liquefying means, temperature responsive means for controlling the supply of energy to the liquefying means, and a ratcheting device powered mechanically independently of said temperature responsive means for interrupting the supply of energy to the liquefying means.

27. Refrigerating apparatus including refrigerant liquefying means and refrigerant evaporating means, means for supplying energy to the liquefying means, temperature responsive means for controlling the supply of energy to the liquefying means, and a ratcheting device operated by a portion of the energy supplied by said supply means for changing the control of the liquefying means.

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