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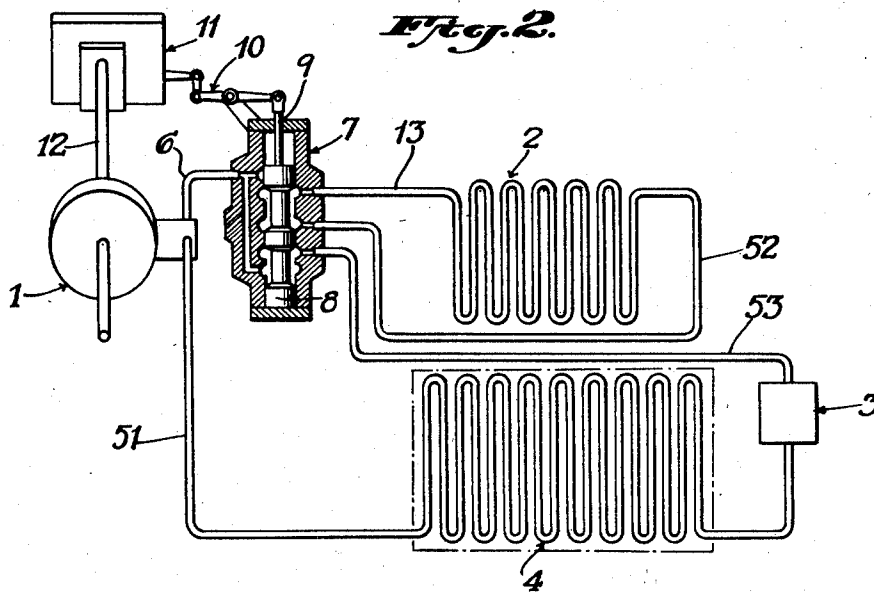
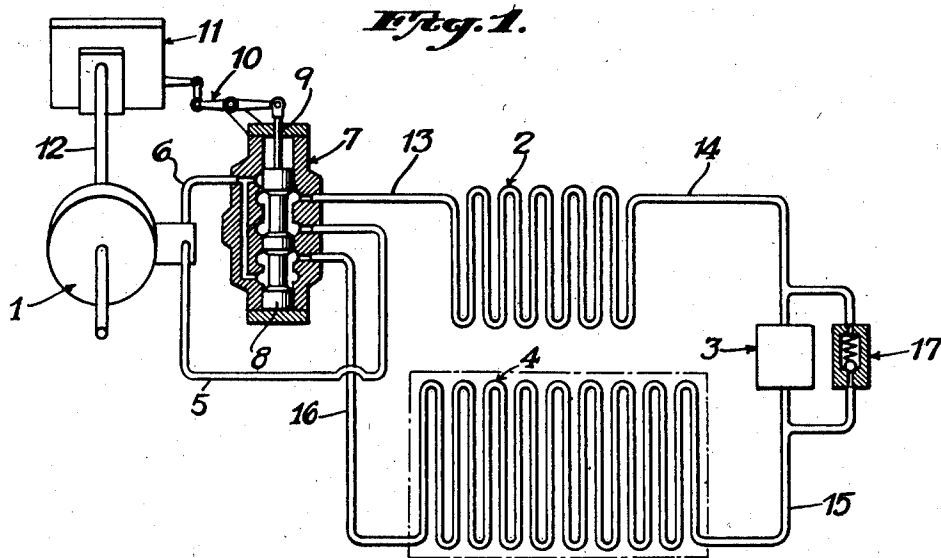
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2,534,031

DEFROSTING SYSTEM FOR REFRIGERATORS

Filed Aug. 19, 1944

3 Sheets-Sheet 1



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Fig. 4

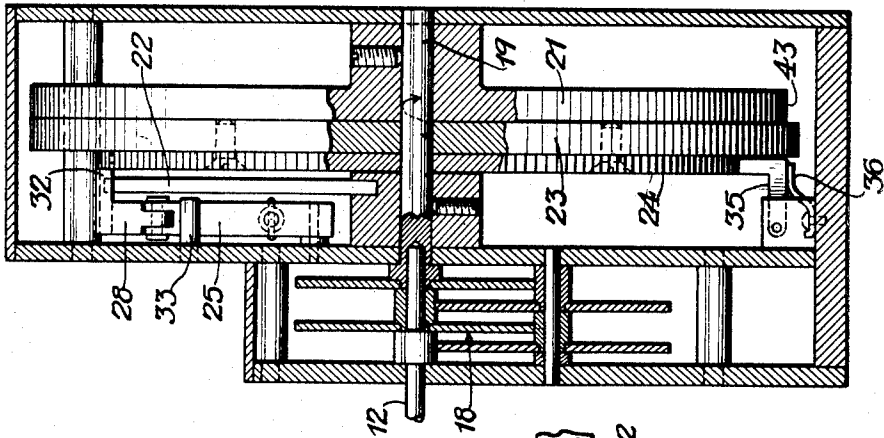
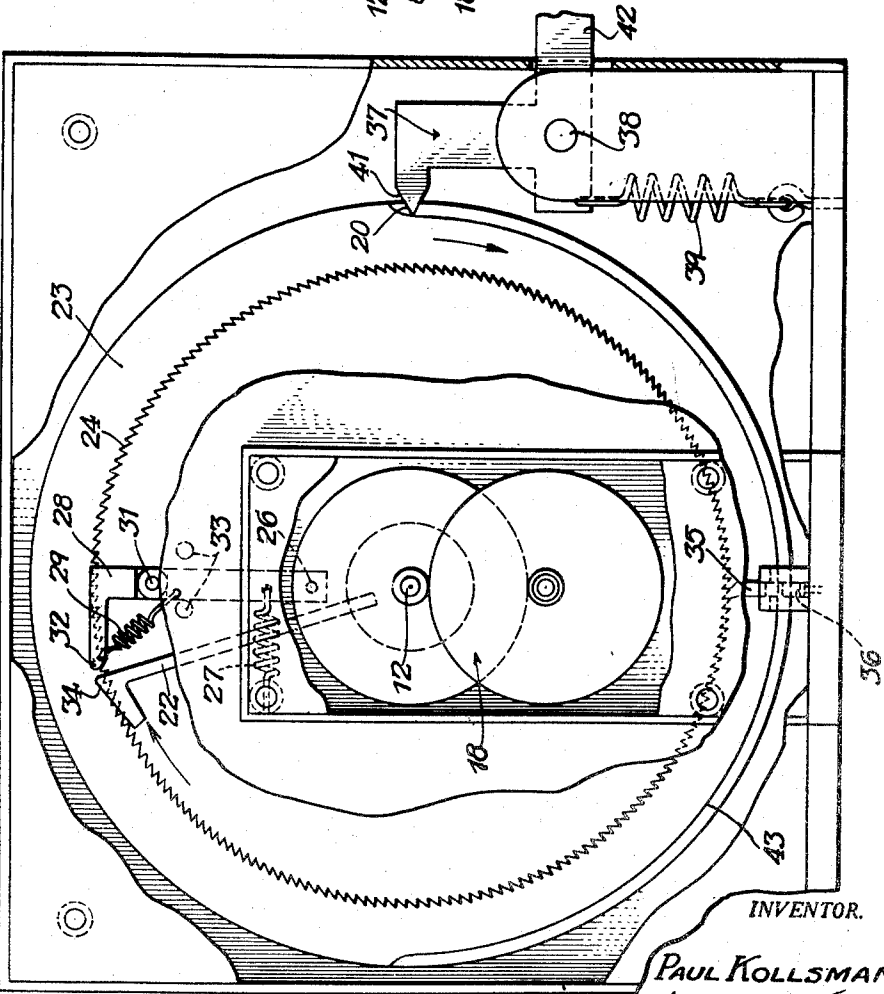


Fig. 3



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Fig. 5.

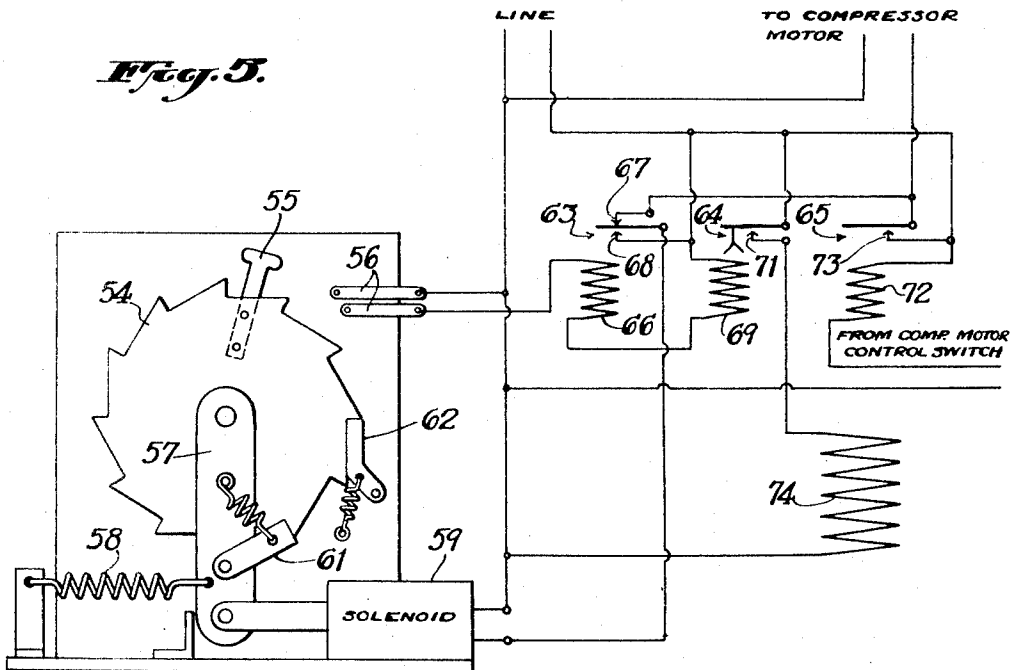
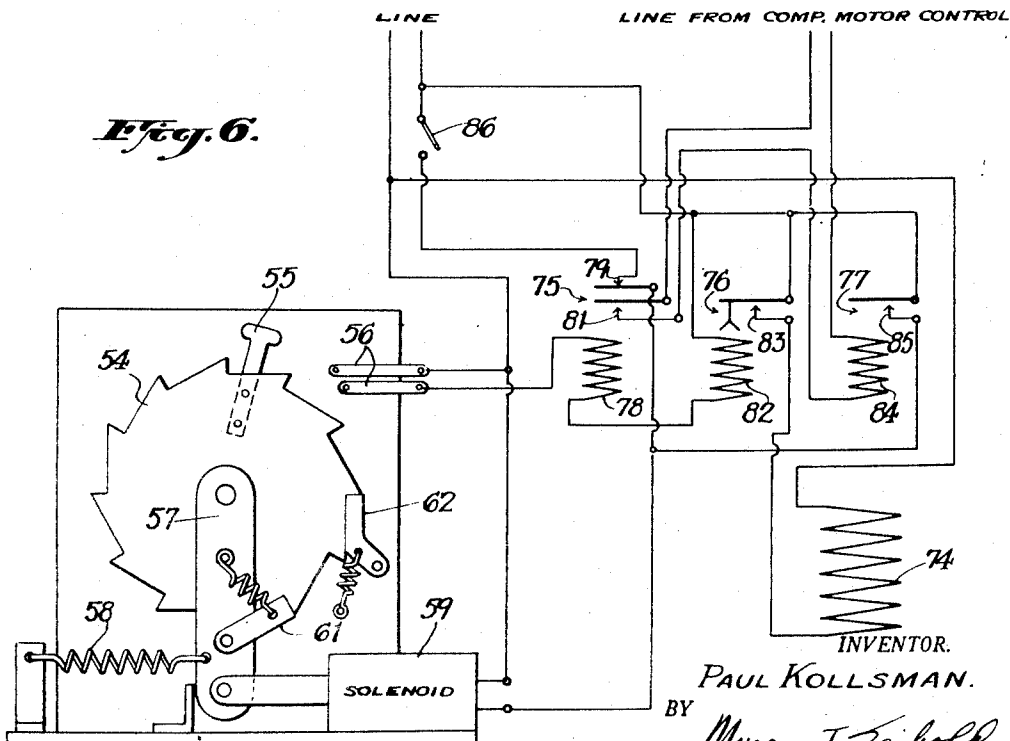


Fig. 6.



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2,534,031

DEFROSTING SYSTEM FOR REFRIGERATORS

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Application August 19, 1944, Serial No. 550,165

5 Claims. (Cl. 62-115)

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This invention relates to refrigeration systems and, more particularly, to the defrosting of the evaporators in such system.

One object of the invention is to provide a refrigerator system with means for automatically passing warm refrigerant fluid through the evaporator to quickly remove the frost deposited thereon.

Another object of the invention is to provide for the cyclic and automatic supply of warm refrigerant fluid to the evaporator coils in response to the occurrence of events in the operation of the refrigerator.

Another object of the invention is to automatically and periodically reverse the direction of flow of the refrigerant fluid in a refrigerant system to effect a quick defrosting of the evaporator.

Another object of the invention is to automatically and periodically pass the refrigerant fluid directly to the evaporator without passing through the condenser.

Other objects and features of the invention will be readily apparent to those skilled in the art from the specification and appended drawing illustrating certain preferred embodiments in which:

Figure 1 is a schematic representation of a refrigeration system with means for reversing the direction of flow of the refrigerant fluid.

Figure 2 is a schematic representation of a refrigeration system with means for by-passing the condenser and passing the refrigerant fluid directly through the evaporator.

Figure 3 is a view, in elevation, with parts broken away, of a timing device for controlling the defrosting operation.

Figure 4 is a view of the timing device of Figure 3 shown partly in side elevation and partly in section.

Figure 5 is a schematic representation of a modified form of control in which the defrosting operation is effected in response to the start and stop operations of the compressor motor.

Figure 6 is a schematic representation of a control similar to Figure 5 but in which the defrosting operation is initiated in response to the operations of opening of the refrigerator door.

The refrigerating system diagrammatically shown in Figure 1 comprises a compressor 1, a condenser 2, an expansion valve 3, and an evaporator 4. The compressor has an inlet or suction line 5 and an outlet or compressor line 6 which are connected to a reversing valve 7 having a movable core 8 operated through a rod 9 and a linkage indicated at 10 by a timing device 11

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more particularly shown in Figures 3 and 4 and which is connected to be driven by the shaft 12 which drives the compressor 1. The compressor side of the condenser 2 is connected by the pipe line 13 to the reversing valve 7 and the exit side of the condenser is connected through pipe line 14 to the expansion valve 3 whose outlet is in turn connected through pipe line 15 to the evaporator 4. The suction side of the evaporator 4 is connected through the pipe line 16 to reversing valve 7. A check valve shown at 17 by-passes the expansion valve 3 and is connected to prevent passage of refrigerant fluid during the cooling cycle but to permit free passage of the refrigerant fluid about the expansion valve during the defrosting cycle.

The position of the reversing valve 7 which controls the direction of flow of the refrigerant fluid is determined by the timing device 11 shown in detail in Figures 3 and 4. An operating shaft 12 is driven with the compressor and operates through a reduction gearing indicated at 18 to effect a reduced rotation of the shaft 19. For example, assuming the speed of rotation of the compressor shaft at 500 R. P. M., the reduction gearing 18 may be selected to produce a resultant speed of rotation of the shaft 19 of one revolution every four minutes. Mounted upon the shaft 19, so as to be rotatable therewith, are a cam wheel 21 and a lever arm 22. Rotating freely on the shaft 19 is a second cam wheel 23 carrying a ratchet wheel 24 rigidly attached thereto. An arm 25 is pivotally mounted on a fixed part as at 26 and is biased by a tension spring 27 in a counterclockwise direction as viewed in Figure 3. On the free end of the arm 25 is pivoted a pawl 28 biased by spring 29 about its pivot 31 in a counterclockwise direction into its limiting position as shown in Figure 3. The pawl 28 has an extension 32 adjacent its left hand end as viewed in Figure 3 which extension 32 engages with the teeth of the ratchet wheel 24. A pair of pins 33 are provided to serve as limiting stops determining the extremes of rotation of the arm 25. The lever arm 22 is provided with a head 34 engageable with the extension 32 on the pawl 28. A retaining element 35 biased by a spring 36 is provided to engage the ratchet wheel 24 and retain it from undesired free movement, the element 35 providing sufficient friction to prevent free movement of the ratchet wheel but insufficient to oppose its ratcheting movement.

An operating bellcrank lever 37 is provided pivoted at 38 to a fixed part and biased by a strong operating spring 30 in a counterclockwise direc-

tion. One arm of the bellcrank 37 is provided with a nose portion 41 engaging the cam wheels 21 and 23 and the opposite arm 42 is connected to the operating linkage 10 for the core 8 of the reversing valve 7. The cam wheel 21 is provided with an elongated peripheral notch 43, extending over one half of the periphery of the cam in the specific embodiment shown. The cam wheel 23 has a small notch 20 therein of approximately the same size as the nose 41 of the bellcrank 37 and the same depth as the notch 43 and in which the nose is seated as shown in Figure 3. While any number of teeth for the ratchet wheel 24 may be selected, it will be assumed for the purposes of explanation of the timer that 180 teeth are provided.

As the shaft 12 from the compressor rotates, it will, through the reduction gearing 18, effect rotation of the shaft 19. As the shaft 19 rotates, it effects rotation of the arm 22 and each time the head 34 of arm 22 engages the extension 32 of pawl 28, the ratchet wheel 24 and the cam 23 connected thereto will be moved through the angle of one tooth. As the head 34 engages the extension 32, it will rotate the arm 25 about its pivot 26 into engagement with the right hand pin 33 shown in Figure 3. During this movement, the ratchet wheel 24 is rotated. Thereafter, upon continued rotation of the arm 22, the pawl 28 is rotated about pivot 31 to disengage the extension 32 from the teeth on ratchet 24 and to move the extension into a position to permit the head 34 of the arm 22 to freely slide thereunder. Thereafter, the pawl 28 and arm 25 return to the position of Figure 3 under the bias of their springs 29 and 27 and the lever arm 22 continues through its rotation until it again comes into its engaging position. The bellcrank 37, as shown in Figure 3, is in the defrosting position with the nose 41 within both the small notch 20 in the cam 23 and the elongated notch 43 in the cam 21. This position can occur only when the two notches are in alignment which will be for a half revolution of the cam 21. In the position of Figure 3 with the direction of rotation illustrated, the end of the notch 43 in the cam 21 is just about to engage the nose 41 and rotate bellcrank 37 in a clockwise direction to change the reversing valve 7 to its normal cooling cycle. The ratchet wheel 24 will be rotated to also move the notch 20 in the cam 23 and the two notches will not again come into alignment to permit a defrosting operation until the ratchet wheel 24 has made a complete revolution. With the specific constants assumed, by way of example, this would mean after 180 rotations of the shaft 19 or after twelve hours of compressor operation. Since the notch 43 extends for one half of the periphery of the cam 21 which is rotating at a speed of one revolution every four minutes, it is seen that the defrosting cycle during which the warm refrigerant fluid is passed through the evaporator is effective for two minutes. The device specifically disclosed by way of example thus provides for a defrosting cycle of two minutes after every twelve hours of compressor operation.

The refrigerating system of Figure 1 is shown in its defrosting cycle in which the compressor line 6 is connected through valve 7 to the line 16 leading to the evaporator 4 so that the warm compressor fluid is being passed directly through the evaporator. This results in quickly raising the evaporator temperature to remove the frost condensed thereon without appreciably raising

the temperature of the refrigerator and of the refrigerated materials. In the example specifically given, it has been found ample to reverse the cycle for an interval of about two minutes for every twelve hours of actual compressor operation. The result is a completely automatic defrosting system carried out periodically in response to the length of the compressor operation for cooling, to quickly raise the temperature of the evaporator alone by the reversal of flow of the refrigerant fluid.

The system of Figure 2 is similar in some respects to that of Figure 1 and like reference numerals have been given to like parts. However, the defrosting cycle in this system is effected by by-passing the condenser and sending the warm refrigerant directly into the evaporator but without reversing the direction of flow through the evaporator. In this system, the suction line 51 of the compressor is connected directly to the evaporator while the compressor line 6 is connected as before to the reversing valve 7. The outlet line 52 of the condenser 2 is, in this embodiment, returned to the reversing valve and the expansion valve 3 is also connected by line 53 to the reversing valve. In the system of Figure 2, the parts are shown in the defrosting cycle and the compressor outlet line 6 is connected through the expansion valve directly to the line 53 leading through expansion valve 3 to the evaporator 4. Since the heat of compression of the refrigerant fluid is not removed in the condenser, the result is a rise in the evaporator temperature which will remove the condensed frost therefrom.

In Figure 5 is diagrammatically illustrated a control system for effecting the defrosting cycles of either Figure 1 or Figure 2 in response to the number of starting operations of the compressor rather than in response to its length of operation as in the system using the timer shown in Figures 3 and 4. This system embodies a counter represented by a ratchet wheel 54 carrying a bridging contact 55 adapted to close the circuit through a pair of spaced stationary contacts 56. A pivoted lever 57 is biased in a clockwise direction by a spring 58 and is rotated in a counterclockwise direction upon the action of a solenoid 59. The lever 57 carries a pawl 61 engaging with the teeth of the ratchet wheel 54 to effect step by step rotation thereof. A retaining latch 62 is provided to prevent reverse rotation of the ratchet wheel. There are provided three operating relays indicated at 63, 64 and 65. The relay 63 has an operating coil 66, a normally closed contact 67 and a normally open contact 68. The relay 64 has an operating coil 69 and a normally open contact 71. The relay 64 is of the time delay type with the delay operating in the opening direction so that the contacts do not open until a predetermined time interval after de-energization of the operating coil 69. The relay 65 comprises an operating coil 72 and a normally open contact 73. The coil 74 represents the operating coil of solenoid for effecting the operation of a reversing valve having the mechanical elements of the valve 7 of Figures 1 and 2 but adapted for electrical actuation and moving to the defrosting position when the coil 74 is energized.

In the operation of the system of Figure 5, the compressor motor control switch will close when the system calls for a cooling cycle. This will effect energization of the operating coil 72 of the relay 65 which closes contact 73. This will energize the compressor motor to initiate compres-

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sor operation and will also energize the solenoid 59 through the normally closed contact 67. Energization of the solenoid 59 will effect a counterclockwise rotation of the ratchet wheel 54 to advance it one step. As the compressor is successively operated through a plurality of cooling cycles, the ratchet wheel 54 will be rotated until the contact 55 bridges the spaced stationary contacts 56. This will effect energization of the operating coils 66 and 69 of the relay 63 and 64, respectively, and the opening of contact 67 and closing of contacts 68 and 71. Opening of contact 67 de-energizes the solenoid 59 to effect the return of the lever 57 but the closing of the contact 68 re-energizes the solenoid 59 and thus advances the ratchet wheel 54 through a second step to break the electrical circuit through contacts 55 and 56. Closing of the contact 71 energizes the operating coil 74 for the electrically operated reversing valve 7 and thus initiates the defrosting cycle in which the warm refrigerant fluid is passed through the evaporator. The interruption of the circuit at contacts 55 and 56 de-energizes the coils 66 and 69 but the contact 71 remains closed through the predetermined time interval for which the relay 64 is set, this predetermined time interval determining the duration of the defrosting cycle. At the expiration of the time interval for which relay 64 is set, the contact 71 opens to de-energize the coil 74 whereupon the reversing valve returns into its cooling position and normal operation of the refrigeration system is resumed.

The system illustrated in Figure 6 is somewhat similar to that of Figure 5, but the control of the defrosting cycle is determined by the number of operations of opening of the door of the refrigerator. This system uses the identical counter of Figure 5 and like reference numerals have been applied. Also the solenoid coil 74 is utilized for the purpose of operating the reversing valve. Three electric relays are provided indicated at 75, 76, 77, the relay 75 having an operating coil 78 and two pole switching contacts of which contact 79 is normally closed and contact 81 normally open. The relay 76 has an operating coil 82 and a normally open contact 83, this relay being of the time delay type with the delay occurring after de-energization of coil 82 prior to the opening of the contact 83. The relay 77 has an operating coil 84 and a normally open contact 85. An electric switch having contacts indicated at 86 is provided which is operated by the refrigerator door as it is opened and closed. The compressor motor circuit is not shown in this diagrammatic representation but the energizing line for the relay operating coil 84 is indicated as coming from the compressor motor control. In the operation of the system of Figure 6, the ratchet wheel 74 is moved in step by step relation as the switch 86 is operated to closed and open position in response to opening and closing of the refrigerator door. When the contact 55 reaches stationary contacts 56, the operating coils 78 and 82 of relay 75, 76 are energized to open contact 79 and close contacts 81 and 83. Opening of contact 79 de-energizes solenoid 59. Closing of contact 81 sets up the circuit through which the operating coil 84 of relay 77 is energized when the compressor motor control switch closes to operate the compressor. Closing of contact 85 re-energizes the solenoid 59 to move the ratchet wheel 54 through another step and disengages contacts 55, 56. The opening of the circuit at contacts 55, 56 de-energizes the operating

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coils 78 and 82 to permit the return of relays 75, 76 to their normal positions. The closing of contact 83 energizes the solenoid coil 74 for the reversing valve to establish the system in position for a defrosting cycle. After de-energization of the operating coil 82, contact 83 is maintained closed for the determined time interval for which the time delay relay is set and this determines the length of time the defrosting operation is carried out. Upon opening of the contact 83, the coil 74 is de-energized and the system returns to its normal cooling cycle.

While applicant has illustrated several controlling systems in response to which the quick defrosting cycles are initiated, it is understood that the invention in its broader aspects contemplates the initiation of the periodic defrosting cycle by any desired means. Many possible arrangements will be readily apparent within the scope of the invention, for example the use of a simple time clock switch operating on a pure time interval, as well as other arrangements for establishing the periodic heating of the evaporator. The systems specifically shown are, however, preferred as representing an approach toward the determination of the frequency of the defrosting cycle in terms of the probable amount of frost which will condense upon the evaporator.

While certain preferred embodiments of the invention have been specifically disclosed, it is understood that the invention is not limited thereto as many variations will be readily apparent to those skilled in the art and the invention is to be given its broadest possible interpretation within the terms of the following claims.

I claim:

1. In a refrigerating system, a compressor in which the refrigerant fluid is compressed, said compressor including a rotating shaft, a condenser in which the compressed refrigerant is cooled, an evaporator in which the refrigerant expands to reduce the temperature, said compressor being normally connected to cause fluid flow through the condenser and then through the evaporator, means normally ineffective for periodically and automatically passing through the evaporator warm refrigerant fluid at a temperature such as to cause a defrosting cycle in the evaporator, and means periodically operable by said compressor upon completion of a predetermined number of revolutions of said compressor shaft for rendering said refrigerant passing means effective.

2. In a refrigerating system, a compressor in which the refrigerant fluid is compressed, said compressor including a rotating shaft, a condenser in which the compressed refrigerant fluid is cooled, an evaporator in which the refrigerant expands to reduce the temperature, said compressor being normally connected to cause fluid flow through the condenser and then through the evaporator as required, means for reversing the direction of fluid refrigerant flow through the system so as to pass warm refrigerant fluid through the evaporator to effect removal of frost condensed thereon, and means periodically operable upon completion of a predetermined number of revolutions of said compressor shaft for actuating said flow reversing means.

3. In a refrigeration system, a compressor for the refrigerant fluid, a condenser, an evaporator, a fluid expansion means between said condenser and said evaporator, a check valve by-passing said expansion means, a directional valve controlling the connection of said condenser and

evaporator to said compressor and normally positioned to pass fluid through the condenser prior to its passage through the expansion means and the evaporator in order to effect a cooling cycle at the evaporator, said valve being reversible to direct warm fluid from the compressor directly through the evaporator and the check valve to effect rapid defrosting, and valve operating means periodically operable by said compressor upon completion of a predetermined number of compressor revolutions to actuate said valve to effect the quick defrosting cycle and thereafter return the valve to its normal cooling position.

4. In a refrigeration system, a compressor for the refrigerant fluid, a condenser, an evaporator, a fluid expansion means between said condenser and said evaporator, a directional valve controlling the connection of said condenser and evaporator to said compressor and normally positioned to pass fluid through the condenser prior to its passage through the expansion means and the evaporator in order to effect a cooling cycle at the evaporator, said valve being reversible to direct warm fluid from the compressor directly through the evaporator to effect a quick defrosting cycle, said valve operating means being automatically operable at periodic intervals to effect rapid defrosting, and valve operating means periodically operable upon completion of a predetermined number of compressor revolutions to first move the valve into the defrosting position and after completion of a further number of revolutions restore the valve to its cooling position.

5. In a refrigerating system, a compressor in which the refrigerant fluid is compressed, a con-

denser in which the compressed refrigerant fluid is cooled, an evaporator in which the refrigerant expands to reduce the temperature, an expansion valve between the condenser and the evaporator normally controlling the passage of fluid therebetween, a check valve by-passing said expansion valve, said check valve preventing passage of fluid therethrough from the condenser to the evaporator but permitting free passage of fluid from the evaporator to the condenser, said compressor being normally connected to cause fluid flow through the condenser to the evaporator, and means for periodically and automatically reversing the direction of fluid refrigerant flow through the system so as to pass warm refrigerant fluid through the evaporator to effect removal of frost condensed thereon, the fluid in its reversed flow passing freely through said check valve.

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