

Aug. 14, 1956

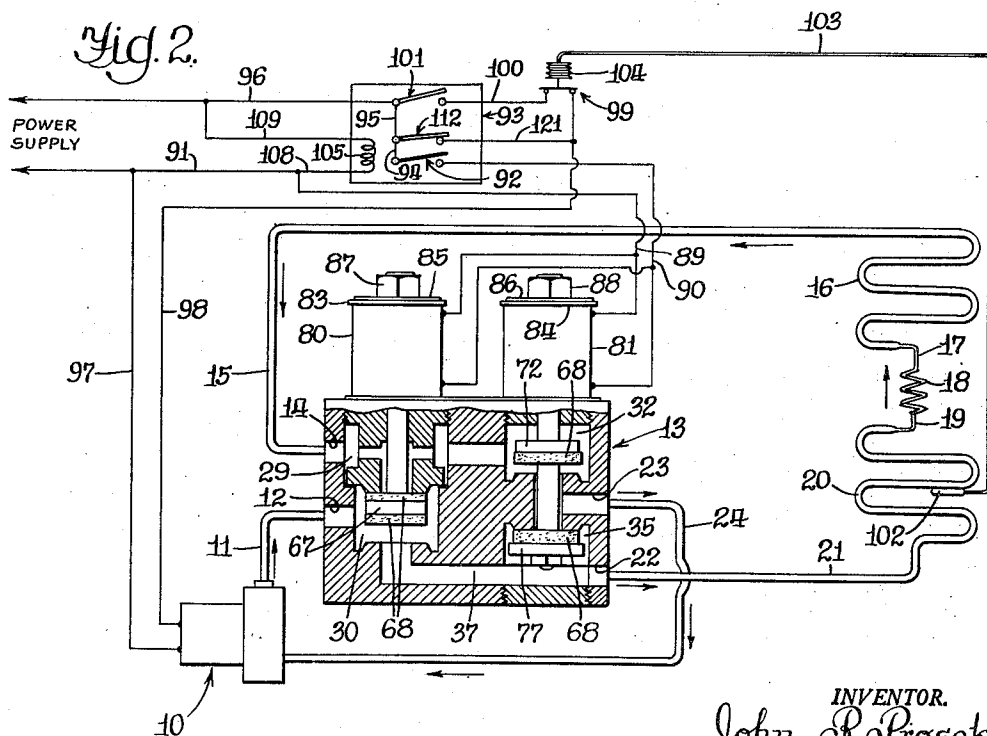
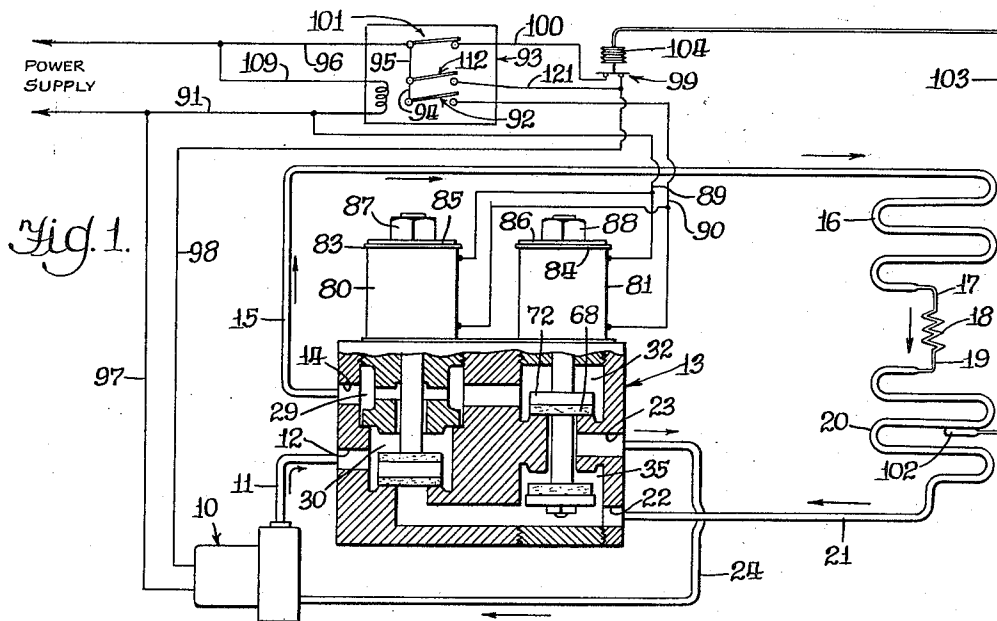
J. R. PROSEK

2,758,447

FOUR WAY REVERSING VALVE

Filed Jan. 19, 1952

3 Sheets-Sheet 1



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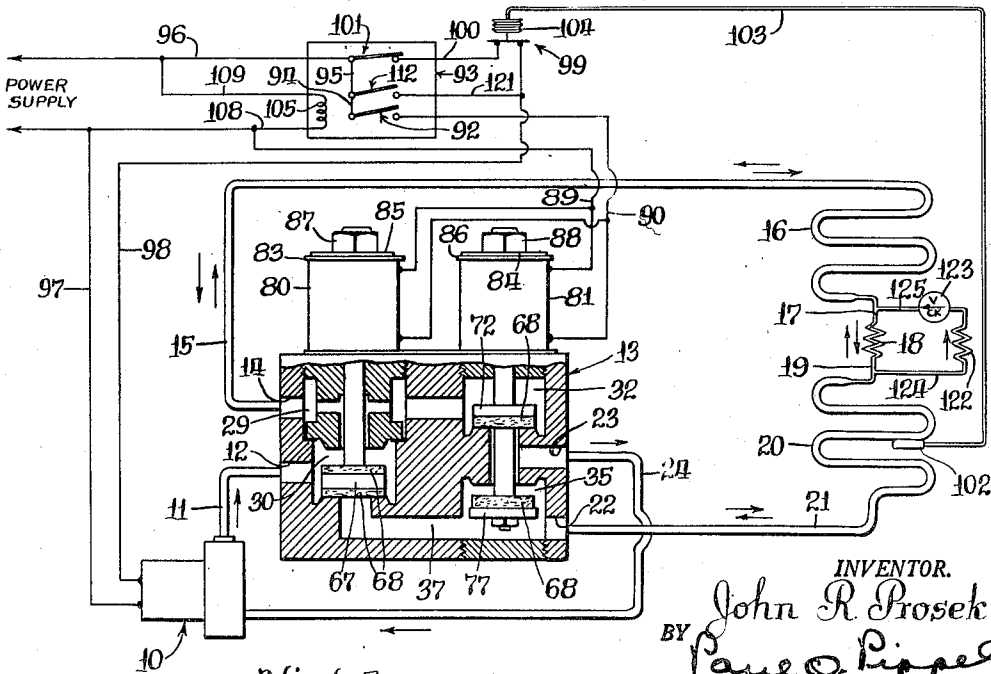
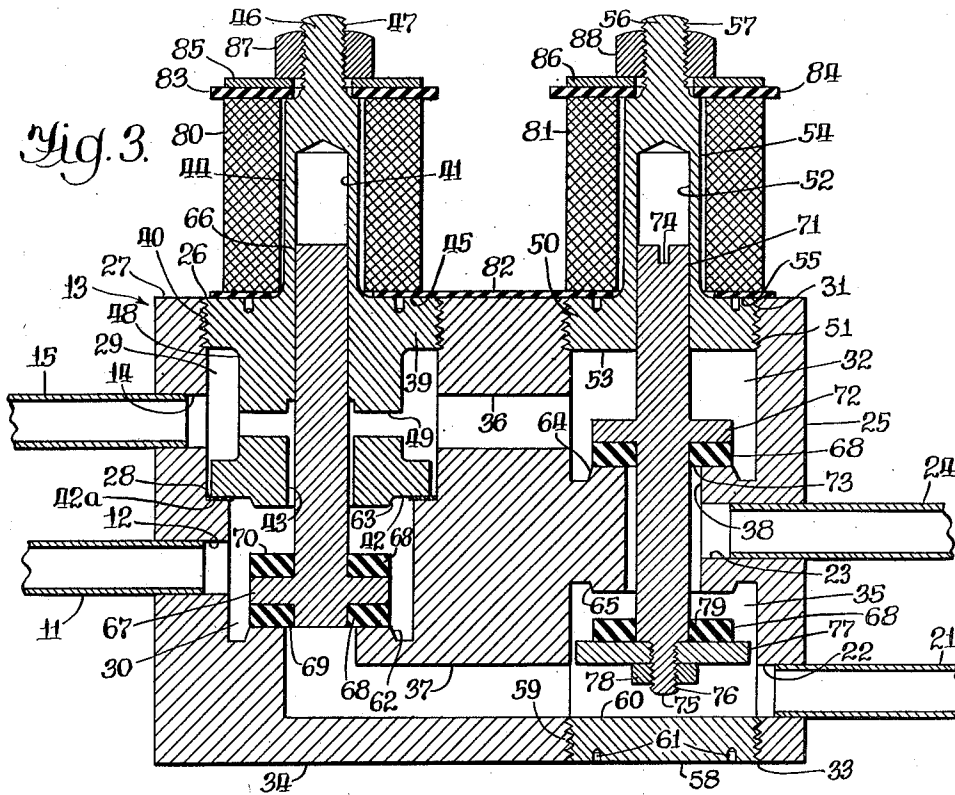
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FOUR WAY REVERSING VALVE

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3 Sheets-Sheet 2



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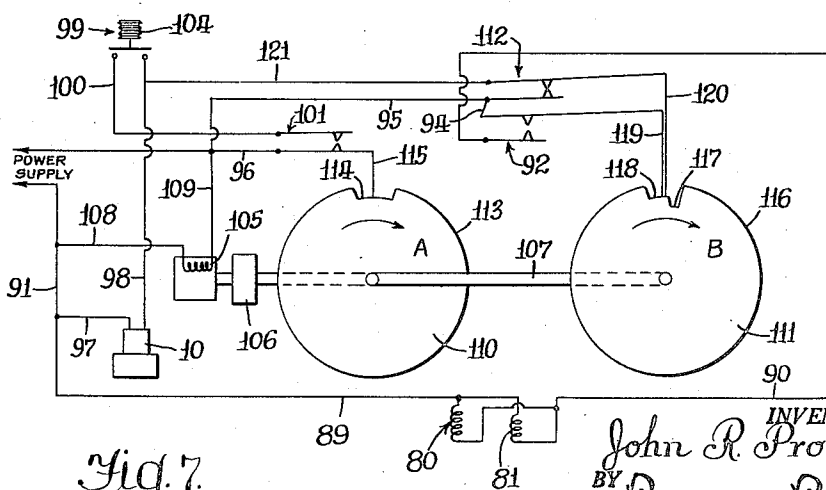
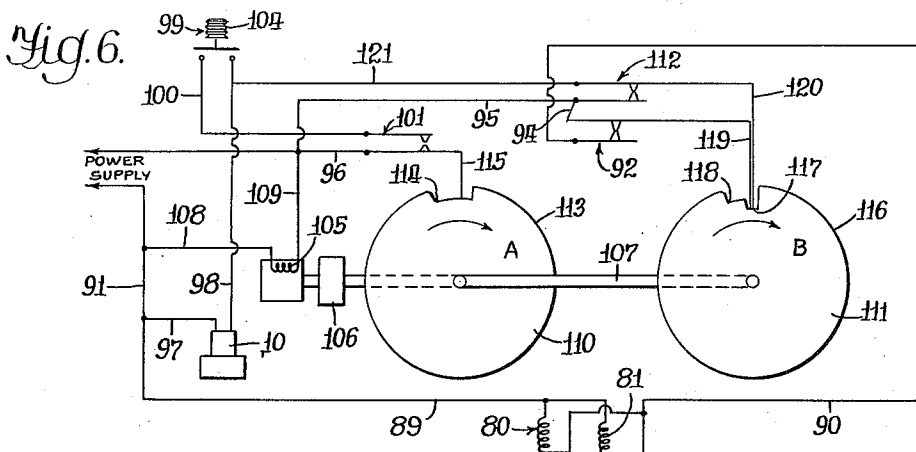
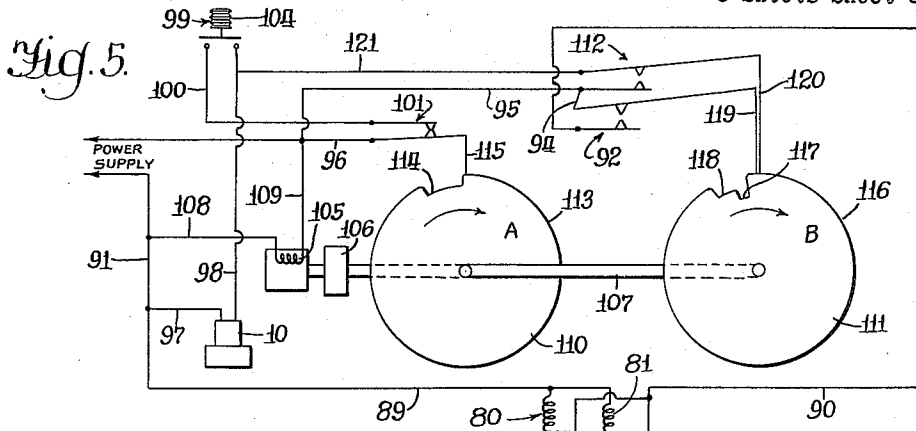
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FOUR WAY REVERSING VALVE

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3 Sheets-Sheet 3



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2,758,447

FOUR WAY REVERSING VALVE

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Application January 19, 1952, Serial No. 267,244

9 Claims. (Cl. 62—4)

This invention relates to mechanical refrigeration apparatus but more especially it is concerned with apparatus of this character that is adapted for operation at times on the reverse cycle, and to an improved reversing valve that operates to reverse the direction of flow of refrigerant through a portion of the refrigerating apparatus during the period such apparatus is operating on a reverse cycle.

The principal object of this invention is to provide an improved system and arrangement of refrigeration apparatus wherein the apparatus may be effectively operated to produce refrigeration for cooling purposes, or alternately to produce heat for space heating or evaporator defrosting purposes.

Another object is to provide an improved arrangement for operating refrigeration apparatus on the reverse cycle.

Another important object is to provide an improved multiple valve for reversing the direction of flow of refrigerant through a portion of a refrigerating system.

A further object is to provide a solenoid operated, hermetically sealed multiple-type valve for reversing direction of refrigerant flow through portions of a refrigerating system.

Another object is to provide an improved refrigerant evaporator defroster wherein a timer control mechanism and a reversing valve device are incorporated in a refrigeration system and arranged to cooperate in reversing the direction of flow of refrigerant therein so that hot refrigerant vapors are passed directly into the evaporator cooling unit prior to being directed into the condenser thereof.

An additional object is to provide a simplified arrangement for decreasing the pressure drop across the flow restricting device of a refrigerating system when such system is operated on the reverse cycle for defrosting purposes.

The foregoing and other objects and features of this invention will become apparent as the disclosure is more fully made in the following detailed description of a preferred embodiment of the invention as illustrated in the accompanying sheets of drawings in which:

Fig. 1 is a schematic drawing of a refrigeration system utilizing an improved reversing valve and cooperating timer control device. The system as depicted is shown as operating on the normal or refrigeration cycle.

Fig. 2 is similar to Fig. 1 but depicts the system as operating on the reverse or defrosting cycle.

Fig. 3 is an enlarged sectional detail of an improved solenoid operated reversing valve.

Fig. 4 is a schematic drawing of a refrigeration system, similar to that of Fig. 1 but modified so as to include an auxiliary capillary restrictor device that is operable on the defrost or reverse cycle to reduce refrigerant flow restriction through said system. Direction arrows indicate the direction of flow through the system during both the refrigeration as well as the reverse cycle.

Fig. 5 is a schematic layout of the timer control device and of the electrical circuits associated therewith.

2

In this view the refrigeration system is operating on the normal or refrigeration cycle.

Fig. 6 is a view similar to Fig. 5 but in this view the relative position of the components of the system are shown as at the start of the defrost cycle.

Fig. 7 is a view similar to Fig. 6 but depicts the system a few minutes after the defrost cycle has been in operation.

In the embodiment of the invention selected for illustration it will be noted that a generally conventional refrigeration system has been schematically depicted for purposes of simplification of drawings. As shown the system includes a conventional hermetically sealed refrigerant motor-compressor unit 10 the outlet or discharge of which is connected by a conduit 11 to a port or opening 12 in a four-way reversing valve indicated generally by the numeral 13. Another port or opening 14 in said valve is connected by a conduit 15 with one side of a condenser 16 whose opposite side or outlet, in turn, is connected by a conduit 17 to one side of a capillary restrictor tube 18. The opposite end of said capillary tube is connected through conduit 19 with one side of an evaporator cooling unit 20 while the opposite or suction side of said evaporator is connected by a conduit 21 to another port or opening 22 in the valve 13. A further port or outlet 23 in said valve is connected by conduit 24 with the suction inlet of the compressor to complete the refrigerant carrying circuit, which, it will be understood, will be charged with a suitable refrigerant in accordance with standard practices in the art.

The reversing valve 13 plays an important role in the operation of the presently proposed refrigeration system because it functions to reverse the direction of flow of refrigerant through a portion of the circuit, while at the same time continuing refrigerant in the same direction of the flow through another portion thereof when the system operates on its reverse cycle. By so doing hot refrigerant vapors are passed directly into the evaporator cooling unit and may be utilized for defrosting the evaporator if the refrigeration system is incorporated in a refrigerator or freezer cabinet, or for space heating purposes if the refrigeration system is utilized in an air conditioning or a heat pump type of installation.

The proposed valve may be fabricated as two separate and individual valve units interconnected by suitable conduit lines, or it may be fashioned as a unitary structure with all valve elements incorporated into a common body-like casing or housing. In the preferred embodiment illustrated, the details of which are best seen in the enlarged section of Fig. 3, the valve includes a unitary body 25, fashioned of a non-magnetic material such as brass or the like for reasons which will presently be apparent, having a series of side openings or ports 12, 14, 22, and 23 which communicate directly with a plurality of refrigerant carrying chambers and passages therewithin, as hereinafter described in detail. Extending inwardly from an opening 26 in the top wall 27 of one side of said body, the left-hand side as viewed in Fig. 3, there is provided a longitudinal recess having an annular abutment or shoulder 28 therein that aids in delimiting said space into an upper chamber 29 and a coextensive lower chamber 30. On the opposite side of said body, or the right-hand side as viewed in Fig. 3, there is provided another recess that extends inwardly from an opening 31 in said top wall to form an upper chamber 32, and in concentric alignment with said upper chamber, but axially spaced therefrom, there is a further recess that extends inwardly from an opening 33 in the bottom wall 34 to form a lower chamber 35. Opening into one wall of the upper chamber 29 is the port 14 while the port 12 opens into an adjacent wall in the lower chamber 30. Disposed in horizontal alignment with the

3

port opening 14, but diametrically opposed therefrom, is a passage 36 whose opposite ends communicate directly with the upper chambers 29 and 32, respectively, disposed on opposite sides of said valve body. A similar passage 37 also connects the respective lower chambers 30 and 35, while a further passage 38 connects the upper right-hand chamber 32 with its proximate lower chamber 35. The port 22 is positioned to open into the lower chamber 35, while the remaining port 23 communicates directly with the interconnecting passage 38.

The open end of the upper chamber 29 is closed by a plug-like valve guide insert 39 that is positioned within the body wall opening 26 and fixedly retained there-within by suitable means such as the screw threads 40. A centrally disposed longitudinal recess 41 extending inwardly from the end wall 42 of said insert is adapted to function as a valve stem guide, while an enlarged portion 43 of said recess proximate the opening thereof is provided to facilitate the flow of refrigerant through the valve as will presently be explained. The upper end of said valve guide insert is formed with a reduced section portion 44 that projects from the top end wall 45 thereof and joins with a further reduced section portion 46 having screw threads 47 on the end thereof. The valve guide insert 39 is dimensioned so that the bottom end wall 42 thereof will be tightly seated against the face of the abutment or shoulder 28 when said insert is fixedly positioned within the opening 26, and, when so positioned, said insert bottom end wall 42 also functions as the top or ceiling wall for closing the lower chamber 30. If desired, a soft metallic gasket 42a may be interposed between the surfaces 28 and 42. An elongated annular groove or recess 48 extending around said insert is disposed so that opposite sides thereof open, respectively, adjacent the port 14 and the passage 36, while a plurality of radially extending ducts or passages 49, all in the same horizontal plane in said insert but only one of which is illustrated as in Fig. 3, serve to provide interior communication for the refrigerant between radially opposite sides of said annular recess, as well as between the centrally disposed enlarged recess portion 43 and various circumferentially spaced portions around said annular recess.

The open end of the upper chamber 32 is also closed by a plug-like valve guide insert 50 that is positioned within the opening 31 and fixedly retained therewithin by suitable screw thread means 51. A central valve guide recess 52 extends inwardly from the end wall 53 of said insert, while said end wall additionally functions as a top or ceiling wall for closing the upper chamber 32. The upper end of said latter insert is fashioned similarly to that of the insert previously described and has a reduced section portion 54 that projects from the top end wall 55 thereof and joins a further reduced section portion 56 provided with screw threads 57.

The open end of the lower chamber 35 is closed by a plug-like insert 58 that is positioned within the opening 33, in the bottom wall 34 of said valve body, and fixedly retained therewithin by suitable screw threads 59, and as so positioned the inner wall 60 of said insert serves as the lower or bottom wall for said lower chamber.

A pair of radially spaced notches or recesses 61, in the exterior or exposed wall of each of the plug-like inserts 39, 50 and 58, all of which are of a non-magnetic material such as brass or the like, are provided for receiving a spanner wrench tool that may be employed for tightening said inserts into position in the valve body 25.

The opposite faces or end surfaces of the lower chamber 30 are fashioned with raised annular ring-like ridge portions 62 and 63, respectively, that are adapted to function as valve seats for receiving opposite faces of a valve disc as will be more fully explained herein. In the present instance, of course, the upper face or top wall 42 of the lower chamber 30 is the end wall of the

4

insert member 39 as previously described. In the upper chamber 32 only the lower end surface or face is similarly fashioned with a valve seating ridge or ring-like portion 64 thereon, while in the lower chamber 35 it is the upper end surface or face that is provided with a similar valve seating ridge or ring 65.

A valve stem 66, of a magnetic material such as steel, is fashioned with an integrally formed valve disc 67 disposed proximate one end thereof, and the opposite sides of said disc are covered with a suitable resilient facing material, represented by the numeral 68, to form the valve faces 69 and 70, respectively. Said valve stem is dimensioned so as to slide easily within the guide recess 41, while the length of said stem is proportioned so that a portion of the end thereof will extend well into that portion of said guide recess disposed within the first reduced section of the insert when the valve face 69 is firmly seated against the lower seat 62. Another valve stem 71, likewise of a magnetic material such as steel, is fashioned with an integrally formed valve disc 72 disposed intermediate the ends of said stem, and the lower side of said disc is covered with facing material 68 to provide a valve face 73. The upper end of the stem 71, which is fashioned with a transverse slot 74 therein, is dimensioned for slidable positioning within the guide recess 52, in the insert 50, while the opposite or lower end of the said stem is provided with a reduced section portion 75 having screw threads 76 thereon. A valve disc 77, of some suitable material such as brass and having a threaded opening in the center thereof, may be threadably positioned on said reduced section and fixedly retained thereon by a suitably threaded nut 78. The upper side of said disc 77 is provided with a covering of valve facing material 68 to provide the valve face 79 on one side thereof. The slot 74 in the upper end of the valve stem 71 is provided to facilitate the adjustment of the retaining nut 78 against the valve disc 77 after said stem and disc are positioned and assembled into the valve body. The valve facing material 68 may be any suitable resilient material that is equally resistant to heat, Freon refrigerant, and oil. The synthetic rubber product sold commercially under the name of Neoprene has been found satisfactory for this purpose. Said facing material may be affixed to the valve discs by any suitable securing means such as by molding, mechanical crimping or by the use of adhesives. In the preferred embodiment illustrated the material is molded to the discs.

Electro-magnet solenoids coils 80 and 81 of conventional construction are positioned over the respective insert reduced section portions 44 and 54, and a layer of an insulating gasket material 82, such as the hard fibrous material commonly used with electrical equipment or the like, is inserted between said coils and the top of the valve body all as indicated particularly in Fig. 3. Discs 83 and 84 of an insulating material, such as hard paper or plastic or the like, are positioned over the upper ends of said coils and then washer-like retaining discs 85 and 86, of a rigid metallic material, are positioned over said insulating discs and fixedly secured thereagainst by the threaded nuts 87 and 88. The windings of the solenoids 80 and 81, which are connected in parallel so that the magnets operate substantially simultaneously, are connected by the conductors 89 and 90 to the electrical energizing circuit. Conductor 89, for instance, is connected to conductor 91 which joins one side of the electrical power supply, while conductor 90 is connected to one contact or terminal of the switch 92, forming part of a timer control mechanism 93, and another terminal thereof is connected by conductors 94, 95 and 96 to the opposite side of the power supply circuit.

When the refrigerating system operates on its normal refrigeration cycle the thermostatic control for starting and stopping the motor-compressor unit, in ac-

5

cordance with evaporator requirements, is generally conventional even though it operates through said timer control mechanism. One end of the compressor motor winding is connected by a conductor 97 to the conductor 91, in turn, connected with one side of the electrical power supply. The opposite end of said motor winding is connected by a conductor 98 to one contact or terminal of a thermostatically operated switch 99 whose opposite contact or terminal is connected by conductor 100 to one terminal of the single pole single throw switch 101, incorporated in said timer control, and the opposite terminal thereof is connected by conductor 96 to the other side of the electrical supply circuit. The thermostatic control, which is generally conventional, includes a feeler bulb 102 that is disposed in close association with the refrigerant evaporator 20 and is connected by a conduit 103 with a Sylphon bellows 104, in turn, linked to the blade of the switch 99 for opening and closing a circuit across the contacts thereof. Normally, on the refrigeration cycle, the timer control switch 101 is closed and the thermostatic control for the system is free to energize and deenergize the compressor motor, as is well understood in the art, in accordance with the refrigeration demands manifested through the action and operation of the feeler bulb control disposed in association with the evaporator.

The timer control mechanism 93, which may be any one of several such devices available on the commercial markets for similar time controlled operations and as shown schematically in Figs. 5, 6 and 7, comprises generally a synchronous electric motor-operated clock 105 that operates through a speed-reduction gear box 106 to rotate a cam-carrying shaft 107 once in every twenty-four hours. The coils of said clock motor are connected, by way of conductors 108 and 109, directly across the power supply line and, as so arranged, the motor operates continuously and without regard to the position of the thermostatically controlled, or other, power supply opening switches. Positioned on the shaft 107, for rotation therewith, are two cams 110 and 111 for actuating, respectively, the single pole switch 101 and the two single pole switches 92 and 112 that selectively energize and deenergize the compressor motor circuit together with that of the valve operating solenoids 80 and 81.

The cam 110 has an outer peripheral surface that for purposes of description will be referred to as a flat portion 113 and a depressed or notched portion 114 thereon so that when the switch arm 115 rides said flat portion the contacts of the switch 101 are closed (see Fig. 5) and power is supplied, by way of conductors 96, 100, 98, 97 and 91, to operate the refrigerant compressor, but when the arm 115 drops into the recessed or depressed portion 114 the contacts of the switch 101 are broken (see Figs. 6 and 7) and the power supply to the compressor motor interrupted, whereupon the compressor motor will remain idle so long as said cam-riding arm engages the notch or recess 114. The cam 111, which actuates the two switches 92 and 112, includes an outer peripheral or a flat portion 116 and depressed or notched portions of two different depths and perimeter lengths. The first depressed portion or notch 117 has the greatest depth but the shortest perimeter length, while the second notch 118 is somewhat shallower but of greater perimeter length. When the switch arms 119 and 120 ride the flat portion 116 of said cam (see Fig. 5) the contacts of both switches 92 and 112 will be broken and no current will flow through the solenoids 80 and 81. However, when the cam rotates and said switch arms drop into the deep notch 117 the contacts of both switches 92 and 112 will be closed (see Fig. 6) substantially simultaneously and current will flow from one side of the power supply by way of conductors 96 and 95, jumper 94, switch 92, and conductor 90 to one side of said solenoids, and by way of conductors 91 and 89 to the other

6

side of said supply to complete the circuit therethrough and energize said solenoid coils and thereby operate both operable elements of the reversing valve 13. At the same time current will also flow from one side of the power supply by way of conductors 96 and 95, switch 112, conductors 121 and 98 to one terminal of the motor-compressor unit 10, and by way of conductors 97 and 91 to the other terminal of said unit to start said motor compressor.

The timer is arranged so that the cam-riding switch arms 119 and 120 will remain approximately one minute in the deep notch 117 which, of course, is sufficient to shift the reversing valve 13 and to start up the motor-compressor unit on the reverse or defrost cycle. Upon completion of this short period the arms 119 and 120 will rise out of said deep notch and ride the shallow depression 118, whereupon the contacts of switch 92 are broken (see Fig. 7) and current flow through the solenoids 80 and 81 is interrupted. At the end of the shallow notch 118 the switch arms 119 and 120 rise out of the depressed portion and then proceed to ride the flat portion 116 of said cam. When this occurs the contacts of switch 112 will also be broken and the flow of current through the compressor motor interrupted and the compressor will stop operation. As soon as the compressor stops the pressures in both sides of the refrigeration circuit start to equalize and eventually will be sufficiently equalized to permit the reversing valve, by virtue of the weight of the plunger-like valve stems, discs and facings thereon, to return to normal position. This will occur just before the switch arm 115 reaches the end of the depressed portion 114 in the cam 110 so that when said arm rises out of the depression and again rides the flat portion 113 thereof the contacts of switch 101 will be closed to restart the compressor unit and continue the normal or refrigeration cycle.

The sequence of operations will be as follows: once each twenty four hours the cam 110 will allow the arm 115 to drop into the notch 114 to break the normally closed switch 101 and interrupt the operation of the compressor; approximately five minutes later the cam 111 allows switch arms 119 and 120 to drop into the deep notch 117 thus simultaneously making the normally open switches 92 and 112 to energize the solenoids 80 and 81 and restart the compressor; approximately one minute thereafter the switch arms 119 and 120 rise out of the deep notch 117 and ride the shallow notch 118, whereupon the switch 92 disengages and opens the circuit to the solenoids 80 and 81; then after fifteen minutes the switch arms 119 and 120 rise completely out of notch 118 and again ride the flat portion 116 of said cam, whence switch 112 is broken and the compressor stopped; and, approximately four minutes later the switch arm 115 rises out of the depressed portion 114 of cam 110 to make switch 101 and restart the compressor and put the system back on the normal or refrigeration cycle. In this complete cycle the switch 101 is off approximately twenty five minutes. During the time the switch arms 119 and 120 are in the depressed portion of cam 111 the direction of refrigerant flow through a portion of the circuit is reversed, as indicated in Fig. 2, and hot refrigerant vapors are fed into the evaporator for defrosting purposes.

Operation

During the normal or refrigeration cycle the switch arms 115, 119 and 120 ride the flat portions of the cams 110 and 111 and thus cause the electrical circuit through the solenoids 80 and 81 to be interrupted, and the circuit through the motor-compressor unit 10 to be completed by way of the thermostatic switch 99 and timer control switch 93. When this occurs the compressor is in operation and refrigerant is discharged therefrom through conduit 11 and port 12 into chamber 30, of the reversing valve 13, where the refrigerant's high pressure is effective for holding the valve disc 67 against the seat 62 and

closing the passage 37. From the chamber 30 the refrigerant passes through the enlarged recess 43, radial passages 49 and the annular recess 48 into the chamber 29. From here a portion of the refrigerant passes by way of passage 36 into chamber 32 where the high pressure of the refrigerant likewise serves to maintain the valve disc 72 against the valve seat 64 and close off the passage 38. The remainder of said refrigerant leaves chamber 29 through port 14 and is directed by way of conduit 15 into the condenser unit 16. From the condenser the refrigerant next passes through conduit 17 into the capillary tube 18 and then through conduit 19 into the evaporator unit 20. After passing through the evaporator the refrigerant, which has now been substantially reduced in pressure, flows through conduit 21 and port 22 into chamber 35. The pressure of the refrigerant not being sufficient at this time to effect seating of the valve disc 77 or to cause unseating of the disc 67 the refrigerant will pass around the disc 77 through a portion of the vertical passage 38 and port 23 into the suction conduit 24 from whence it will be returned to the compressor to complete the cycle.

The reverse cycle, which may be utilized for heating or defrosting, is initiated by switch arm 115 dropping into the notch 114 on cam 110 and interrupting the operation of the compressor unit. For a short time thereafter no refrigerant flows through the system and the pressures therewithin tend to equalize. At about the time these pressures are substantially equalized the switch arms 119 and 120 drop into the deep notch 117, in cam 111, and cause substantially simultaneous energization of the solenoids 80 and 81, and of the motor-compressor unit 10. Since the refrigerant pressures within the system will have been fairly well equalized by the time this occurs the valve stems 66 and 71, and their associated valve discs, are easily raised as a result of energizing said solenoids; hence the valves will have been shifted by the time refrigerant again starts to flow. Refrigerant now flows from the compressor through conduit 11 and port 12 into chamber 30 where the pressure of the refrigerant is effective in holding the valve disc 67 against its upper seat 63 and closing off the enlarged recess passage 43. Although the solenoids only stay energized for a short time, as previously described, it will be appreciated that the refrigerant pressure in this part of the system will be sufficiently high to continue to maintain the valve discs against their upper seats even after the energizing current is interrupted. From chamber 30 refrigerant passes by way of passage 37 into chamber 35 where the refrigerant pressure will effectively maintain the valve disc 77 against the seat 65 and close off the passage 38. From chamber 35 the refrigerant passes through port 22 and conduit 21 into the evaporator unit 20 where the heat of the refrigerant may be utilized for defrosting or heating purposes. Leaving the evaporator the refrigerant passes through conduit 19, the capillary tube 18 and conduit 17 into the condenser unit 16. From the condenser the refrigerant passes by way of conduit 15, port 14, radial passages 49, and passage 36 into chamber 32. From the latter chamber the low pressure refrigerant flows through the vertical passage 38 and port 23 into the suction conduit 24 by which it is returned to the compressor, to complete the cycle. Upon completion of the defrosting or heating period switch arm 120 rises out of the notch 118 and interrupts the current flow through the compressor motor thereby stopping the compressor and the flow of refrigerant through the system. After this stoppage has continued for a short while the pressures within the system will again be substantially equalized and the valve discs 67, 72 and 77 become free to shift, by virtue of their own weights, and to seat in normal position before the compressor motor is again energized as a result of switch arm 115 rising out of notch 114 in cam 110.

It has been found, as heretofore described in U. S.

Patent 2,694,296, issued November 16, 1954, to John R. Prosek and Joseph A. Galazi, when refrigeration apparatus, such as is customarily incorporated in a food-preserving type of refrigerator or freezer-chest cabinet, is operated on the reverse cycle for defrosting purposes that the desirable pressure drop from the evaporator unit through the flow restricting device to the condenser is somewhat less than that ordinarily required for most satisfactory operation on the normal refrigeration cycle; hence when the same degree of refrigerant flow restriction is employed on both cycles unsatisfactory operation can be expected on at least one of the two cycles. Since the conventional refrigeration system is most frequently balanced for ideal operation during the normal refrigeration cycle, and since no highly suitable means has, heretofore, been developed to compensate for or to effect such desired variation in flow restriction, it will readily be understood why such a system cannot be expected to perform entirely satisfactorily on the reverse cycle when so operated for evaporator defrosting purposes.

In the conventional refrigeration system, such as is primarily illustrated herein, a capillary tube restrictor is employed to reduce pressure and to meter the flow of refrigerant between the condenser and evaporator, but when the direction of flow of refrigerant therein is frequently or periodically reversed, as it is during the defrosting operation, the fixed and inflexible characteristics of this restrictor device limit its adaptability and usefulness under such varying conditions. Furthermore, because of its substantially identical flow restricting characteristics in both directions it cannot be balanced for effective reverse flow operation and, at the same time, be made to provide satisfactory operation during the normal or refrigeration cycle. When properly balanced for normal operation the capillary tube restrictor offers so much restriction to refrigerant flow, that when the flow is reversed in direction, the refrigerant entering the evaporator has a tendency to remain largely in the evaporator, and, as a consequence, the passage of refrigerant through the refrigerant carrying circuit may be so slow that heating of the food storage compartments in the refrigerator or freezer cabinet frequently occurs before the defrosting of the evaporator unit is accomplished. Now, in order to overcome difficulties and shortcomings of this character, it is proposed to provide the hereinafter described apparatus which effectively accomplishes the necessary and desired variation in flow restriction when the direction of refrigerant flow through the refrigeration system is reversed for defrosting purposes.

The proposed improved variable restricting means (see Fig. 4) includes an auxiliary capillary restrictor tube 122 and a one-way check valve 123 connected together as a by-pass circuit in parallel with the principal capillary tube 18. One end of the auxiliary capillary 122 is connected by conduit 124 into conduit 19 joining the evaporator with the principal capillary, while the opposite end of said auxiliary capillary is connected to the check valve 123 which, in turn, is connected through the conduit 125 into conduit 17 that connects the principal capillary with the condenser. As so disposed the two capillary tubes are connected in a parallel flow relationship and the check valve, which permits flow therethrough in only one direction, is arranged so that when refrigerant flows from the evaporator through the capillary to the condenser, as during the defrosting cycle, the valve is opened and the refrigerant flow is divided between the two capillary tube paths in accordance with well-known hydraulic principles. As a result the overall restriction or pressure drop between the evaporator and condenser is considerably reduced from that encountered when refrigerant flows in the reverse direction i. e., from the condenser to the evaporator, and only one capillary is permitted to pass refrigerant therebetween.

The check valve 123, which is generally conventional

in construction, may be fabricated with a spring loaded disc, a spring loaded needle, a spring loaded ball, a flap-per type, a magnet controlled disc, or any one of a number of other different constructions or types of check valves now commercially available, and since the details of such structure are not pertinent to the present invention no further description or illustration thereof is believed necessary. The present invention, however, does envisage that said check valve may be manually as well as automatically controlled by well-known valve operating mechanisms.

From the foregoing it will be appreciated that the proposed invention provides a novel and improved refrigeration circuit that is highly adaptable to reverse cycle operation, particularly for evaporator defrosting purposes. The arrangement, furthermore, envisages the use of a reversing valve that provides many distinct advantages for use in systems of this character as for instance; the movable elements of the valve are contained in a hermetically sealed body or casing thus the probability of leakage is greatly minimized; the valve stems are independent of one another and good operation does not depend on equal travel of the stems, or the relative heights or thickness of the elastomers; the valves operate against individual seats and operate independently of one another, thus greater manufacturing tolerances may prevail because only limited precision is required; there are no springs, levers or linkage mechanisms or the like to wear and get out of adjustment; and the valve can readily be made on a production basis at reasonable cost. The arrangement further assures good seating of the valve because the high pressures of the circuit will always act to aid the seating thereof. In the proposed arrangement pressures will generally be equalized within the system before the reversing valve is actuated; hence the solenoid operating magnets may be of light inexpensive construction because they oppose only low pressures; furthermore, the length of time they are energized is very short hence the objectionable A. C. hum as well as heating of the solenoid magnets is minimized.

Although the proposed invention has been shown and its use described in connection with an evaporator defrosting arrangement, 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 it is desired, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What is claimed is:

1. In refrigerating apparatus, the combination of a compressor, a condenser, an evaporator, a flow-restrictor tube, a flow-reversing valve, conduits connecting said condenser, flow-restrictor tube, and evaporator in series, additional conduits connecting said flow-reversing valve with said compressor, condenser, and evaporator, in operating relationship whereby said reversing valve functions to direct the flow of refrigerant from the compressor selectively either through the condenser and thereafter through the evaporator in one direction or through the evaporator in the opposite direction and thereafter through the condenser, a second flow-restrictor tube, a second valve operable for the passage of refrigerant therethrough in one direction only, conduits connecting said second flow-restrictor tube and second valve in series, and additional conduits connecting said second valve and second restrictor tube assembly in parallel flow relationship with said first flow-restrictor tube, whereby when the reversing valve is in operating position for directing the flow of refrigerant first through the evaporator and thereafter through the condenser the refrigerant will also flow through the second flow-restrictor tube to supplement the flow thereof through said first flow-restrictor tube.

2. In refrigerating apparatus, the combination of a compressor, a condenser, an evaporator, a flow-restrictor tube, a solenoid operated flow-reversing valve, conduits connecting said condenser, flow-restrictor tube, and evaporator in series, additional conduits connecting said flow-

reversing valve with said compressor, condenser, and evaporator, in operating relationship whereby said reversing valve functions to direct the flow of refrigerant from the compressor selectively either through the condenser and thereafter through the evaporator in one direction or through the evaporator in the opposite direction and thereafter through the condenser, timer control means including cam-operated switches for selectively energizing and deenergizing electric power circuits connected with the compressor and with the solenoid-operated reversing valve, a second flow-restrictor tube, a second valve operable for the passage of refrigerant therethrough in one direction only, conduits connecting said second flow-restrictor tube and second valve in series, and additional conduits connecting said second valve and second restrictor tube assembly in parallel flow relationship with said first flow-restrictor tube, whereby when the reversing valve is in operating position for directing the flow of refrigerant first through the evaporator and thereafter through the condenser the refrigerant will also flow through the second flow-restrictor tube to supplement the flow thereof through said first flow-restrictor tube.

3. In refrigerating apparatus, in combination: a compressor; a condenser; an evaporator; a flow-restrictor tube; a flow-reversing valve including a body having four chambers arranged in pairs to provide a right-side pair and a left-side pair with the individual chambers of each pair coaxial and vertically arranged, vertical passages interconnecting the individual chambers of each pair, passages connecting together the upper chambers and the lower chambers respectively of each pair, ducts for connecting the upper chamber of said left pair with the condenser and for connecting the lower chamber of said pair with the compressor, a duct for connecting the lower chamber of said right pair with the evaporator, a duct for connecting the interconnecting passage of said right pair with the compressor, each of the chambers of said right pair having a valve seat adjacent said vertical interconnecting passage, the lower chamber of said left pair having valve seats both on top and bottom thereof, a valve stem carrying two single acting valve discs arranged to cooperate respectively with the seats in said right pair of chambers, a valve stem carrying a double acting valve arranged to cooperate with the seats in the lower chamber of said left pair, a resilient facing fixedly mounted on each valve disc, and a pair of solenoids cooperative one with each valve stem to shift said stem and their resiliently faced discs in one direction, the same being shifted in the opposite direction by gravity; conduits connecting said condenser, flow-restrictor tube, and evaporator in series; additional conduits connecting said reversing valve with said compressor, condenser, and evaporator, in operating relationship whereby said reversing valve functions to direct the flow of refrigerant from the compressor selectively either through the condenser and thereafter through the evaporator in one direction or through the evaporator in the opposite direction and thereafter through the condenser.

4. A reversing valve for a compressor-condenser-evaporator type refrigerating system, comprising, a valve body having a pair of axially aligned spaced-apart recesses extending inwardly one from the top and one from the bottom proximate one end thereof and another single recess extending inwardly from the top proximate the opposite end of the body, said single recess having an annular shoulder intermediate the ends thereof, a plug-like closure member threadably positioned in one end of said single recess and having a portion thereof of reduced diameter projecting therewithin and engaging said shoulder to form an upper and a lower chamber within said recess, said closure plug having an exterior annular recess intermediate the ends of the reduced portion thereof and a plurality of radially extending passages opening on opposite sides of said annular recess, said closure member being additionally provided with a longitudinally

extending recess that communicates with said radial passages to provide a passage between the upper and lower chambers of said single recess, said axially aligned recesses having one end of each covered by a closure member threadably positioned therein to provide upper and lower axially aligned chambers, a duct interconnecting said latter chambers, a duct interconnecting said both lower chambers, a duct interconnecting said both upper chambers, ducts for connecting the upper and lower chambers of said single recess respectively with the condenser and compressor, a duct for connecting the lower chamber of said axially aligned chambers with the evaporator, a duct for connecting the interconnecting duct between said axially aligned chambers with the compressor, each of said axially aligned chambers having a valve seat adjacent said interconnecting duct, the lower chamber of said single recess having a valve seat on the top and on the bottom thereof, a valve stem carrying two single acting valves arranged to cooperate respectively with the seats of said axially aligned chambers, a valve stem carrying a double acting valve arranged to cooperate with the seats in the lower chamber of said single recess, and a pair of solenoids cooperative one with each of said valve stems to shift the valve stems and their valves in one direction, the same being shifted in the opposite direction by gravity.

5. A reversing valve for a compressor-condenser-evaporator type refrigerating system, comprising; a valve body having a pair of axially aligned spaced-apart recesses extending inwardly one from the top and one from the bottom proximate one end thereof and another single recess extending inwardly from the top proximate the opposite end of the body, said single recess having an annular shoulder intermediate the ends thereof, a plug-like closure member threadably positioned in one end of said single recess and having a portion with a reduced diameter projecting therewithin to engage said shoulder to form an upper and a lower chamber within said recess, said closure plug having an exterior annular recess intermediate the ends of the reduced portion thereof which cooperate with the wall of said single recess to delimit the upper chamber thereof, and a plurality of radially extending passages opening on opposite sides of said annular recess, said closure member being additionally provided with an enlarged longitudinally extending recess that communicates with said radial passages to provide a passage between the upper and lower chambers of said single recess, said axially aligned recesses having one end of each covered by a closure member threadably positioned therein to provide upper and lower axially aligned chambers, the closure members of both of said upper chambers being fashioned with upwardly extending projections and having longitudinally extending guide recesses within said members, a duct interconnecting the upper and lower of said axially aligned chambers, a duct interconnecting said both lower chambers, a duct interconnecting said both upper chambers, ducts for connecting the upper and lower chambers of said single recess respectively with the condenser and compressor, a duct for connecting the lower chamber of said axially aligned chambers with the evaporator, a duct for connecting the interconnecting duct between said axially aligned chambers with the compressor, each of said axially aligned chambers having a valve seat adjacent said interconnecting duct, the lower chamber of said single recess having a valve seat on the top and on the bottom thereof, a valve stem carrying two single acting valves arranged to cooperate respectively with the seats of said axially aligned chambers, a valve stem carrying a double acting valve arranged to cooperate with the seats in the lower chamber of said single recess, said valve stems being adapted for slidable positioning within the respective guide recesses in said closure members, and a pair of solenoids removably positioned over the upwardly extending projections of said closure members

and being cooperative with said valve stems to shift said stems and their valves in one direction, the same being shifted in the opposite direction by gravity.

6. In refrigerating apparatus, the combination, comprising; a compressor; a condenser; an evaporator; a capillary flow-restrictor; a flow-reversing valve; conduits connecting said condenser, capillary flow-restrictor, and evaporator in series; additional conduits connecting said flow-reversing valve with said compressor, condenser, and evaporator in operating relationship, whereby said reversing valve functions to direct the flow of refrigerant from the compressor selectively either through the condenser and thereafter through the evaporator in one direction or through the evaporator in the opposite direction and thereafter through the condenser; a second capillary flow-restrictor; a second valve operable for the passage of refrigerant therethrough in one direction only; conduits connecting said second capillary flow-restrictor and second valve in series; and additional conduits connecting said second valve and second capillary flow-restrictor in parallel flow relationship with said first capillary flow-restrictor for supplementing the flow of refrigerant from the evaporator to the condenser at such time as the reversing valve is in position for directing the flow of refrigerant first through the evaporator and thereafter through the condenser.

7. In refrigerating apparatus, the combination, comprising a compressor; a condenser; an evaporator; a capillary flow-restrictor; a solenoid-operated flow-reversing valve; conduits connecting said condenser, capillary flow-restrictor, and evaporator in series; additional conduits connecting said flow-reversing valve with said compressor, condenser, and evaporator in operating relationship whereby said reversing valve functions to direct the flow of refrigerant from the compressor selectively either through the condenser and thereafter through the evaporator in one direction or through the evaporator in the opposite direction and thereafter through the condenser; timer control means including a cam-operated single pole switch, and two separate cam-operated single pole switches for selectively energizing and deenergizing electric power circuits connected with the compressor and with the solenoid-operated reversing valve; a second capillary flow-restrictor; a second valve operable for the passage of refrigerant therethrough in one direction only; conduits connecting said second capillary flow-restrictor and second valve in series; and additional conduits connecting said second valve and second capillary flow-restrictor assembly in parallel flow relationship with said first capillary flow-restrictor for supplementing the flow of refrigerant from the evaporator to the condenser when the reversing valve is in the operating position that directs the flow of refrigerant first through the evaporator and thereafter through the condenser.

8. In refrigerating apparatus, in combination: a compressor; a condenser, an evaporator; a flow-restrictor tube; a flow reversing valve including a body having a pair of axially aligned spaced apart recesses extending inwardly one from the top and one from the bottom proximate one end thereof and a single recess extending inwardly from the top proximate the opposite end of the body, said single recess having an annular shoulder intermediate the ends thereof, said axially aligned recesses having one end of each covered by closure means to provide upper and lower axially aligned chambers, a duct interconnecting said latter chambers, a plug-like closure member positioned in one end of said single recess and having a portion thereof of reduced diameter extending inwardly and engaging said shoulder to form an upper and lower chamber within said recess, a duct interconnecting said latter upper and lower chambers, a duct interconnecting said lower chambers, a duct interconnecting said upper chambers, the upper and lower chambers of said single recess having ports therein adapted for communicating respectively with the condenser and compressor, the lower chamber of said axially aligned chambers having a port therein adapted for com-

communicating with the evaporator, the interconnecting duct between said axially aligned chambers having a port therein adapted for communicating with the compressor, each of the chambers of said axially aligned chambers having a valve seat adjacent said interconnecting duct, the lower chamber of said single recess having a valve seat on the top and on the bottom thereof, a valve stem carrying two single acting valves arranged to cooperate respectively with the seats of said axially aligned chambers, a valve stem carrying a double acting valve arranged to cooperate with the seats in the lower chamber of said single recess, a pair of solenoids cooperative one with each of said valve stems to shift the valve stems and their valves in one direction, the same being shifted in the opposite direction by gravity; conduits connecting said condenser, flow-restrictor tube, and evaporator in series; additional conduits connecting the ports of said reversing valve with said compressor, condenser, and evaporator, in operating relationship whereby said reversing valve functions to direct the flow of refrigerant from the compressor selectively either through the condenser and thereafter through the evaporator in one direction or through the evaporator in the opposite direction and thereafter through the condenser.

9. In refrigerating apparatus, in combination: a compressor; a condenser, an evaporator; a flow-restrictor tube; a flow reversing valve including a body having a pair of axially aligned spaced-apart recesses extending inwardly one from the top and one from the bottom proximate one end thereof and a single recess extending inwardly from the top proximate the opposite end of the body, said single recess having an annular shoulder intermediate the ends thereof, said axially aligned recesses having one end of each covered by closure means to provide upper and lower axially aligned chambers, a duct interconnecting said latter chambers, a plug-like closure member positioned in one end of said single recess and having a portion thereof with a reduced diameter extending inwardly and engaging said shoulder to form an upper and a lower chamber within said recess, the closure members for both of said upper chambers being fashioned with upwardly extending projections and having longitudinally extending guide recesses within said members, a duct interconnecting the upper and lower chambers of said single recess, a duct interconnecting said both lower

chambers, a duct interconnecting said both upper chambers, the upper and lower chambers of said single recess having ports therein adapted for communicating respectively with the condenser and compressor, the lower chamber of said axially aligned chambers having a port therein adapted for communicating with the evaporator, said interconnecting duct between said axially aligned chambers having a port therein for communicating with the compressor, each of the chambers of said axially aligned chambers having a valve seat adjacent said interconnecting duct, the lower chamber of said single recess having a valve seat on the top and on the bottom thereof, a valve stem carrying two single acting valves arranged to cooperate respectively with the seats of said axially aligned chambers, a valve stem carrying a double acting valve arranged to cooperate with the seats in the lower chamber of said single recess, said valve stems being adapted for slidable positioning within the respective guide recesses in said closure members, and a pair of solenoids disposed one around each of said closure member projections and cooperative with said valve stems to shift said stems and their valves in one direction, the same being shifted in the opposite direction by gravity; conduits connecting said condenser, flow-restrictor tube, and evaporator in series; additional conduits connecting the ports of said reversing valve with said compressor, condenser, and evaporator, in operating relationship whereby said reversing valve functions to direct the flow of refrigerant from the compressor selectively either through the condenser and thereafter through the evaporator in one direction or through the evaporator in the opposite direction and thereafter through the condenser.

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