Jan. 28, 1930. A. J. KERCHER 1,744,969

REFRIGERATING APPARATUS

Filed Aug. 26, 1925 2 Sheets-Sheet 1

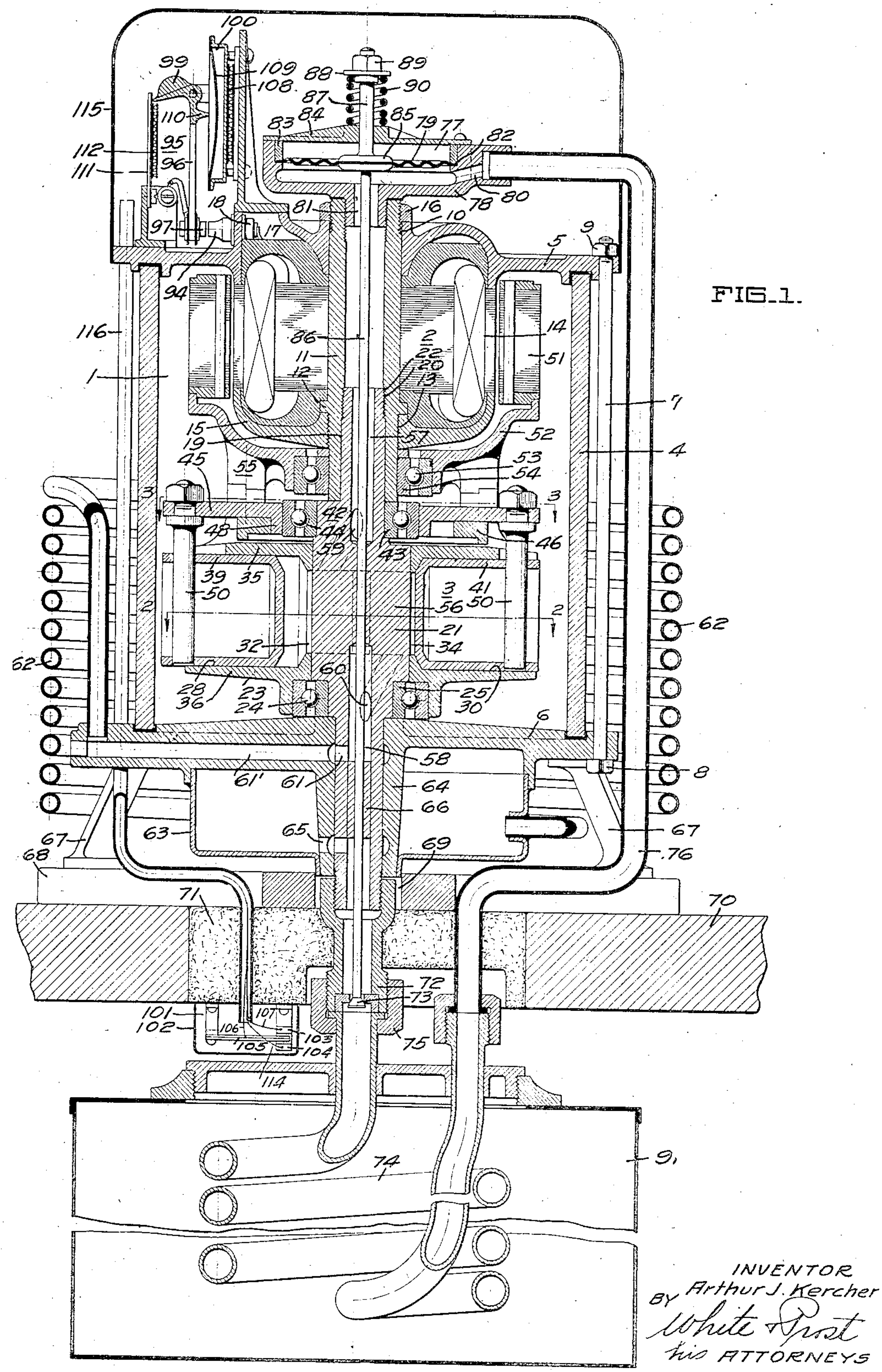


FIG. 2.

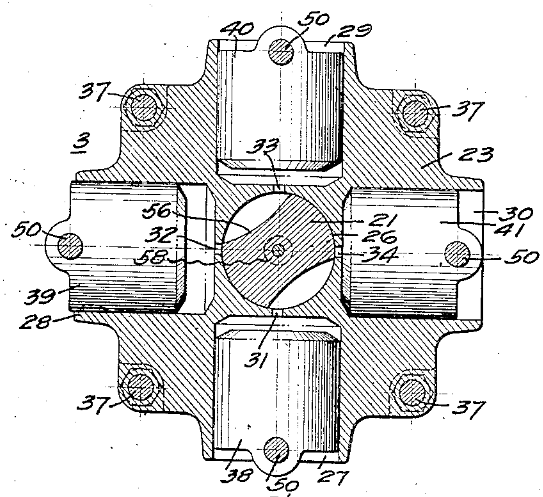


FIG. 3.

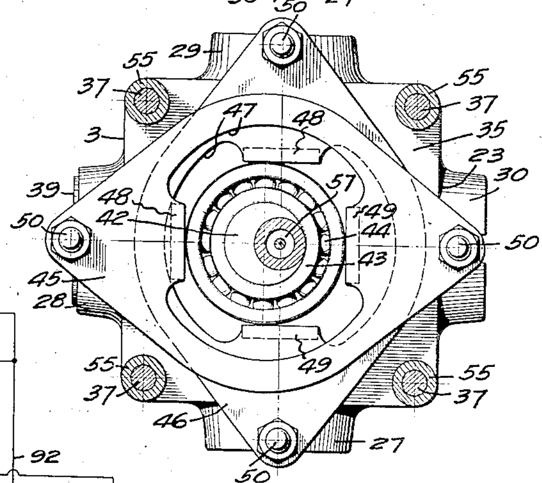
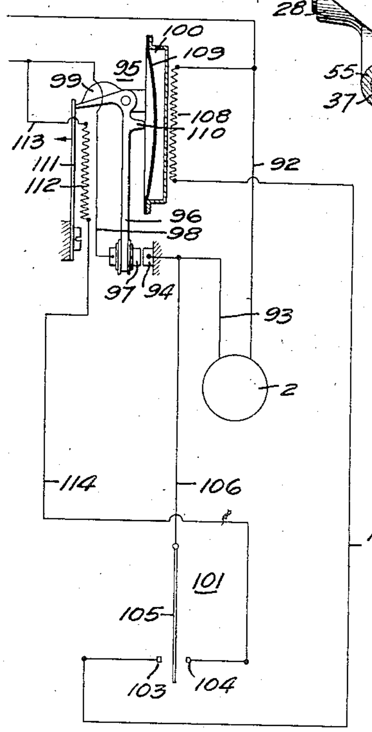


FIG. 4.



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UNITED STATES PATENT OFFICE

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REFRIGERATING APPARATUS

Application filed August 26, 1925. Serial No. 52,511.

This invention relates to refrigerating apparatus and has for its object the provision of a simple, compact and efficient device of this character.

Refrigeration systems commonly utilize a compressible fluid refrigerant such as sulphur dioxide, methyl chloride or ethyl chloride which is passed thru a thermal cycle in order to continuously subtract heat from a given medium. Usually the refrigerant is compressed and heat removed in a condenser or other heat exchange device and is then permitted to expand in suitable passageways or coils to absorb heat. The system may be made continuous by repeatedly recompressing the expanded refrigerant. It has been proposed to adapt such systems to ordinary household refrigerators or ice boxes as a substitute for frequent icing. Prior systems however have been so expensive to manufacture that their cost has made them prohibitive to the average family. In other words, the initial investment required was too high to warrant the abandonment of the older method of icing at frequent intervals

It is therefore an object of this invention to devise a refrigerating apparatus which may be cheaply manufactured and sold at a price within the means of the average domestic consumer. In attaining this object I have carefully considered the cost of production of the apparatus, the facility of installing it in the usual type of ice box or refrigerator, and the ease with which the parts may be assembled in production. As the cost of labor is the most expensive item in securing the requisite parts, I have simplified their construction so that these parts can be readily manufactured from raw material in inexpensive ways. To install the system it is only necessary to provide an opening in the top of the ice box to permit the expansion coil to extend into the ice compartment or brine tank.

The invention possesses other advantageous features some of which with the foregoing will be set forth at length in the following description where I shall outline in full that form of the invention which I have selected for illustration in the drawings accompanying and forming part of the present specification. In said drawings I have shown but one form of the invention but I do not desire to be limited thereto, since the invention as defined in the claims may be embodied in a plurality of other forms.

Referring to the drawings:

Figure 1 is a vertical section, with parts shown in elevation of a refrigerating apparatus embodying my invention.

Fig. 2 is a section taken on the line 2—2 of Fig. 1 illustrating the compressor elements.

Fig. 3 is a section taken on the line 3—3 of Fig. 1 showing means for actuating the compressor pistons; and

Fig. 4 is a diagram illustrating the control elements and circuits of the automatic control system.

Apparatus embodying my invention comprises a sealed casing 1 in which a motor 2 and a compressor 3 are inclosed. The compressor 3 serves to compress the refrigerating medium which is used in the system, and is driven in a manner to be hereinafter described by means of motor 2. The casing 1 comprises a cylindrical member 4 which may be cylindrical in shape and forms the side walls thereof, a top plate 5 which makes a fluid tight joint with the wall member 4 and bottom plate 6, which makes a similar joint. Preferably the top and bottom plates 5 and 6 are secured to the cylindrical member by means of a plurality of bolts 7, one of which is visible in Fig. 1, each of said bolts being provided with a head 8 and threaded at its opposite end to receive a nut 9 whereby the casing parts 4, 5 and 6 may be secured together.

The electric motor for driving the compressor is preferably mounted in the upper portion of the casing. Although it is proposed to employ the motor of the alternating current type, means have been provided for mounting the laminations of the rotor and stator and for insulating the windings in such a way that all vibration and humming noises are reduced to a minimum.

The top plate 5 is provided with a central opening 10, concentric with the axis of the casing 1, in which a hollow member 11 is positioned. The member 11 extends about midway into the casing 1, and is provided with an external shoulder 12 and external threads 13 adjacent thereto near its lower end. The stator 14 of the motor 2 surrounds the hollow member 11 and is supported thereon by means of a cup-shaped member 15 in threaded engagement with the threads 13 of said member 11. The member 11 extends slightly above the top plate 5 and is externally threaded to receive a nut 16. (From the foregoing, it will be seen that by tightening the nut 16, the stator 14 may be rigidly secured to the top plate 5 of the casing 1.) The top plate 5 is also provided with a suitable aperture 17 to accommodate a terminal block 18 for the stator winding.

In the present instance the motor 2 is illustrated as an induction type motor having a round stator primary 14 placed upon stator laminations. This type of motor is simple in construction and can accordingly be manufactured inexpensively. The laminations are of course all punched parts and are held in proper compressed relation by tightening the cup 15 which serves to press upon one end of the stack of laminations. The other or top end of the laminations is thereby pressed against the edge of the corresponding cup which is formed in the top closure plate 5. Since the cup 15 can be urged upwardly to any desired degree by tightening the external nut 16 it is evident that proper support is obtained by simple manipulation and by the aid of inexpensive parts. The windings of the stator are embedded in insulating material which fill the entire space surrounding the coils and above the point where laminations are pressed against the top closure plate 5. This insulation serves to effectively seal the stator assembly against leakage of refrigerant from the sealed casing through the laminations and also serves to prevent vibration of the windings and laminations, thus making the motor operate without noise. The rotor 51 which cooperates with the stator 14 is shown in this instance as of the squirrel cage type, and is adapted to surround the stator. It is preferably mounted upon a spider 52 which is journaled for free rotation about the member 11, as by means of the ball bearings 53 and rings 54. This rotor 51 is connected so as to drive the compressor 3 in a manner to be hereinafter described.

The compressor is preferably mounted directly below the motor so as to be driven by means of a direct connection. The rotating parts of this compressor are preferably adapted to be journaled upon a stationary shaft which is formed as an extension of the hollow member 11. Thus the lower inner portion of the member 11 is slightly enlarged as indicated at 19 and is provided with internal threads 20 adjacent the inner end of the enlarged portion, to receive a stationary shaft forming a valve member 21, which is provided with suitable external threads 22 engaging the threads 20 thereby rigidly securing the valve member 21 to the hollow member 11 to form a single coaxial stationary unit within the casing 1 to which the fixed parts are fastened and upon which the rotatable parts are journaled.

The movable parts of the compressor include a compressor cylinder structure 23 which is journaled on the valve member 21, suitable ball bearings 24 and races 25 for the same being provided at the lower side of the member 23. This compressor cylinder structure, as shown in Fig. 2, is provided with a central circular aperture 26, and a plurality of radially disposed cylinders 27, 28, 29 and 30 which communicate with the central aperture 26 through suitable ports 31, 32, 33 and 34 respectively. Bolts 37 are provided by the aid of which the cylinder structure 23 is fastened to the depending legs 55 of the rotor spider 52, whereby rotation is imparted to the member 23 whenever motor 2 is operating. Pistons 38, 39, 40 and 41 are disposed in the cylinders 27, 28, 29 and 30 and are given a reciprocating motion in these cylinders by the aid of mechanism now to be described. The pistons of course being radially disposed in the structure 23 and being constrained to move only in a radial direction with respect to the member 23, are given a gyratory movement about the axis of this member as it rotates.

Above the cylinder structure 23, the axial valve member 21 is provided with an eccentric 42 which is surrounded by the races 43 for the ball bearings 44. The races 43 are engaged by the piston operating bars 45 and 46. Each of said bars is provided with an opening 47, formed with two inner shoulders or pressure surfaces 48 and 49 diametrically opposite each other and on the longitudinal axes of the respective bars. Said bars 45 and 46 are arranged at right angles to each other and each bar is connected at its ends to two diametrically opposed pistons, that is, the bar 45 is connected with pistons 39 and 41 and the bar 46 is connected with pistons 38 and 40. The bars and pistons are provided with aligned apertures through which pins or bolts 50 extend. The compressor per se does not constitute a part of the present invention, the same being described and claimed in my co-pending application, Serial No. 534,167, filed Feb. 4, 1922, and therefore need not be farther described herein. It is sufficient merely to mention that the bars 45 and 46 rotating relatively to the stationary eccentric 42, are given a radial oscillatory movement which in turn is imparted to the pistons 38, 39, 40 and 41.

At that portion of the valve member 21

which engages the cylinder member 23, the valve member is cut away on opposite sides to form a valve plug 56 for controlling the flow of refrigerant fluid to and from the cylinders. The valve member 21 is formed with axial bores 57 and 58 on opposite sides of the plug 56 and said bores are connected with opposite sides of said plug by ports 59 and 60 respectively as indicated in dotted lines. The lower end of the bore 58 is provided with a port 61 which communicates wth one end of a bore 61′ in the bottom plate 6, the opposite end of which communicates with one end of a cooling coil 62, which is wound around the outside of the casing 1. The opposite end of the cooling coil 62 is connected with a pressure chamber 63, secured to the lower or outside surface of the bottom plate 6. In this pressure chamber is the refrigerating medium which has been compressed by the compressor and which can be later passed to an expansion coil for absorbing heat. The bottom plate is preferably formed with a central hollow member 64, through which the lower end of the valve member 21 extends. The pressure chamber 63 communicates with the bore 58 of the member 21 through a port 65 at a point below the port 61, the bore 58 being closed by a plug 66 between these ports.

It is evident that as thus far described all the main operating parts are simple to manufacture. For example, the hollow stationary spindle assembly is made of parts which can be readily manufactured by automatic machinery at a rapid rate. The radial openings therein involve the use of ordinary drill press tools, and the assembly is simple and can be performed by comparatively unskilled labor as there is do diffiiculty in securing the requisite mechanical cooperation of the parts.

The casing 1 is preferably provided with legs 67 and a suitable base 68 having an opening 69 into which the lower end of the member 21 extends. By this arrangement, the entire unit, which in addition to the parts described, also includes control mechanism and connections to be described hereinafter, may be supported on the top of a refrigerator, such a top being indicated at 70. The top 70 is preferably provided with a cork portion 71 through which the several connections with the unit on the outside of the refrigerator and the parts within the refrigerator are made. The lower end of the valve member 21 is threaded to receive a connection 72 which extends through the cork portion 71, and which is provided with a valve 73. The connection 72 is secured to one end of the expansion coil 74 by a threaded cap 75. The opposite end of the coil 74 is similarly secrued to a pipe 76 which extends through the cork portion 71 and is carried by the unit outside of the refrigerator.

The expansion coil 74 is disposed within a container 91, which is designed to be filled with a liquid having a low freezing point. The terminals of this expansion coil pass thru the removable cover of the container 91 and this cover with the expansion coil 74 is arranged to be removable thru the top of the ice box. The entry of the refrigerating medium from the container 63 where it is under pressure, to the coil 74 where it is allowed to expand and vaporize, is controlled by means of the valve 73 which in turn is operated by a stem 86 connected to a flexible diaphragm 79 adjacent the top of the member 11. This diaphragm is beaded at its edge on a stationary casting 78 which is screwed into the top of member 11 to form a fluid tight connection and is provided with an aperture 81 for receiving the stem 86. In order to secure the diaphragm 79 in position there is provided a clamping ring 83 which is retained in position by means of a clamping spider 84. The bottom side of the diaphragm is subjected to the pressure existing in the coil 74, and for effecting this the pipe connection 76 is led to a port 80 in the diaphragm case 78. The upper side of the diaphragm 79 is exposed to atmospheric pressure since obviously the fit between the upper portion 87 of the stem and the spider 84 cannot be air tight. It is evident that when the atmospheric pressure is greater than the pressure in the coil 74 by a certain amount, a differential pressure will exist which will actuate the stem 87. Thus more refrigerant is caused to pass into the coil 74 to establish an equilibrium or balance of pressure upon the diaphragm 79. The pressure with which the stem 86 is operated is regulated or adjusted by the aid of a nut 89 threaded on the extension 87 of the enlarged portion 85 on the diaphragm 79 whereby the compression of a spring 90 may be varied. This spring acts between the shoulder 88 and the top of the spider 84 to supplement the pressure existing under the diaphragm 79 a more or less amount.

The system described is supplied with a suitable refrigerant fluid such as sulphur dioxide, ethyl chloride or methyl chloride. The fluid enters the hollow member 11, bore 57, inlet port 59, one side of the plug 34, is compressed by the compressor 3, leaves the same through the outlet port 60, enters the bore 58, and passes to the pressure chamber 63 through port 61, passage 61′ and cooling coil 62. The compressed fluid leaves the chamber 63 through port 65, passes through valve 73, enters the expansion coil 74, and is returned from the same to the casing 78 through pipe 76, from which it again enters the hollow member 11. The expansion coil 74 is inclosed in an air tight container 91 which is filled with brine. The pressure within the expansion coil 74 is automatically regulated by means of the valve 73 and diaphragm 79. I control the pressure within the expansion coil 74 by regulating the amount of refrigerant fluid admitted to the same by controlling the distance the valve 73 opens. The valve 73 is in turn controlled by the pressure existing on the opposite sides of the diaphragm 79. Thus, when a predetermined pressure exists in the coil 74, the diaphragm 79 is actuated to hold the valve 73, until the pressure in the coil 74 is reduced. While the valve 73 is closed, if the compressor 3 continues to function at this time, the compressed fluid is stored in the pressure chamber 63.

It is to be particularly noted that the path of the expanded fluid in the tube 11 to the compressor 3 is past the interior of the spider 14, whereby it serves effectively to cool this stator. This is of particular importance for it practically means that substantially all of the heat is externally dissipated by the aid of coil 62. It should also be noted that the rotating cylinder assembly has the effect of an oil and gas separator, the oil being thrown out by centrifugal force whereby little if any is permitted to enter into the storage space 63.

The automatic control system for maintaining a predetermined temperature within the refrigerator may be best understood by referring to Fig. 4, in which one side of the motor 2 is shown as connected to one side of the power circuit by conductor 92. The other side of the motor is connected by a conductor 93 to a fixed contact 94 of a thermostatically controlled switch 95. The switch 95 comprises a pivoted lever 96, which carries a contact 97 which is connected by a conductor 98 to the other side of the power circuit, and which contact cooperates with contact 94. The lever 96 is provided with a counterweight 99 which acts normally to close the switch between its contacts 97 and 94 and thus close the circuit of motor 2. The switch 95 is opened by a pressure cell 100 which is controlled by a thermostatic switch 101 within the refrigerator as shown in Fig. 1, and diagrammatically indicated in Fig. 4. This switch may be of any standard type and is preferably inclosed in a casing 102, below the cork portion 71 in the top 70. The switch 101 is provided with two contacts 103 and 104, and a thermostatic element 105 adapted to move between said contacts. The element 105 is connected by a conductor 106 to conductor 93, and the contact 103 is connected by a conductor 107 to the conductor 92 in series with a heating coil 108 which actuates the pressure cell 100. Thus when the switch arm 105 engages contact 103, the heating coil 108 is connected in parallel with the motor 2. When the coil 108 is heated, the diaphragm 109 of the cell 100 is forced outwardly in a well understood manner to engage a stop 110 on the lever 96 and open the switch 95. The switch 95 is held in its open position by a suitable thermostatic element 111 which engages the lower surface of the counterweight 99 and holds the same open until a predetermined temperature exists in the refrigerator, whereupon the switch 95 is released. This is accomplished by providing a heating coil 112 which actuates the element 111, said coil being connected at one end with conductor 98 by a conductor 113 and with contact 104 by a conductor 114. The switch 95 and the associated mechanism described are preferably mounted on the top-plate 5, and all of the parts supported thereon inclosed by a casing 115 as shown in Fig. 1. The conductors 107 and 114 are also preferably contained in a tube 116 which extends from within the casing 115 to the casing 102.

The operation of my control system above described is as follows: Normally the switch 95 is closed at contacts 94 and 97 and the switch arm 105 of the thermostatic switch 101 within the refrigerator is in a neutral position between contacts 103 and 104. Upon the power circuit being closed, the motor 2 is started, its circuit comprising conductor 92, through the motor, conductor 93, contacts 94 and 97, and conductor 98. As the temperature within the refrigerator drops, the switch arm 105 moves to the left as seen in Fig. 4, and when a predetermined temperature is reached, engages with contact 103 and places the coil 108 in parallel with the motor 2. The coil 108 thereupon becomes heated and actuates the cell 100 to operate switch 95 and open the motor circuit at contacts 94 and 97. The lever 96 having been moved to the left, the lower surface of the counter-weight 99 is engaged by the element 111 and the switch 95 thereby held open. The motor now being inoperative, the temperature in the refrigerator rises, whereupon the switch arm 105 of the thermostatic switch 101 within the refrigerator moves to the right and engages the contact 104 when a predetermined temperature is reached, thereby closing the circuit of the coil 112. Upon this coil becoming heated, the thermostatic element 111 is actuated toward the left which releases the switch arm 96. The switch arm 96 is restored to its normal position through the action of the counter-weight 99, wherein the motor circuit is closed between contacts 94 and 97 and the original conditions in the system established. If at this time, the circuit of the coil 112 is still closed, it will not affect the operation of the system since the lever 96 is in its released position, and the switch arm 105 will move toward the left as the temperature within the refrigerator drops.

From the foregoing, it will be seen that I have provided a closed system, having no moving or running joints within the casing shell, and the danger of leakage of the refrigerant fluid is reduced to a minimum. The sealed casing also prohibits the entrance of moisture into the interior of the casing, so that the refrigerant fluid may be maintained anhydrous, a feature which is essential with some refrigerant fluids, which when combined with water, form reagents that are deleterious to the materials of which the apparatus is constructed.

I claim:

1. A refrigerating apparatus comprising a closed casing, a stationary axial unit extending therethough comprising a hollow member and a valve member, a motor and a compressor connected therewith supported on said unit, a cooling coil connected with said compressor and surrounding said casing, an expansion coil in communication with said cooling coil, a device responsive to pressure within said expansion coil, and a valve controlling the inlet of said expansion coil having a stem extending through said unit and connected with said pressure responsive device to be actuated thereby.

2. A refrigerating apparatus comprising a closed casing, a stationary axial unit extending therethrough comprising a hollow member and a valve member, a motor and a compressor connected therewith supported on said unit, a cooling coil connected with said compressor and surrounding said casing, a pressure chamber in communication with said cooling coil, an expansion coil in communication with said pressure chamber, a device responsive to pressure within said expansion coil, and a valve controlling the inlet of said expansion coil having a stem extending through said unit and pressure chamber, and connected with said pressure responsive device to be controlled thereby.

3. A refrigerating apparatus comprising a closed casing, a stationary axial unit extending therethrough comprising a hollow member and a valve member, a motor and a compressor connected therewith supported on said unit, a heat absorbing device in communication with said compressor, a condenser inserted between the compressor and heat absorbing device, a device responsive to pressure within said heat absorbing device, and a valve controlling the inlet of said heat absorbing device having a stem extending through said unit and connected with said pressure responsive device.

4. A refrigerating apparatus comprising a closed casing, a stationary axial unit therein comprising a hollow member and a valve member connected thereto, a refrigerant fluid compressor in communication with said valve member, an electric motor stator surrounding and fixed on said axial unit, a rotor connected to the compressor and surrounding said stator, said compressor and rotor being journaled on said axial unit, a heat absorbing device in communication with the outlet of said valve member, a condenser inserted between the absorbing device and the compressor, a device responsive to pressure within said heat absorbing device, said pressure responsive device being in communication with said hollow member, and a valve controlling the inlet to said heat absorbing device having a stem extending through said axial unit and connected with said pressure responsive device.

5. In a refrigerating system, a compressor, a condenser for receiving compressed refrigerant discharged from the compressor, a heat absorber for receiving fluid from the condenser, said heat absorber being adapted to remove heat from air confined in a refrigerator chamber, valve means located within said chamber for controlling flow of refrigerant fluid from the condenser to the heat absorber, and means located externally of said chamber for automatically controlling said valve.

6. In a refrigerating system, a compressor, a condenser for receiving compressed fluid refrigerant discharged from the compressor, a heat absorber for receiving fluid from the condenser, said heat absorber being adapted to remove heat for air confined in a refrigerator chamber, valve means located within the chamber for controlling flow of fluid from the condenser to the heat absorber, and pressure responsive means located externally of the chamber for controlling said valve means.

7. In a refrigerating system, a compressor, an electric motor for driving said compressor, heat dissipating means receiving fluid from the compressor, heat absorbing means receiving fluid refrigerant from the heat dissipating means, said heat absorbing means being in thermal contact with air confined within a chamber, an electric circuit for energizing the motor, a switch for opening and closing said circuit, a thermostatic element, and mechanical locking means electrically controlled by said element for locking the switch in open position when the temperature of the air in the chamber drops below minimum value and for permitting the switch to close when the temperature rises above a given value.

8. In a refrigerating system, a compressor, an electric motor for driving said compressor, heat dissipating means receiving fluid from the compressor, heat absorbing means receiving fluid refrigerant from the heat dissipating means, said heat absorbing means being in thermal contact with air confined within a chamber, an electric circuit for energizing the motor, a switch for opening and closing said circuit, a thermostatic element, mechanical locking means electrically controlled by said element for locking the switch in open position when the temperature of the confined air drops below a minimum value and electrical means controlled by said element for closing the switch when the temperature rises above a given value.

9. In a refrigerating system, a casing, a compressor disposed within said casing, heat dissipating means receiving compressed fluid

refrigerant from the compressor, a heat absorbing unit in communication with said heat dissipating means, an electrical motor within the casing for driving said compressor, said motor comprising an inner stationary stator secured to the casing, and an outer rotor directly connected to the compressor.

10. A refrigerating apparatus comprising a casing, a compressor disposed within said casing, said compressor having a stationary shaft extended thru one wall of the casing, a condenser receiving fluid refrigerant from the compressor, and a heat absorber located exteriorly of the casing receiving refrigerating fluid from said condenser and adapted to return the same to the compressor, said shaft having one passage serving as a means of communication between the compressor and the condenser and having another passage serving as a means of communication between the condenser and the heat absorber.

11. In a refrigerating system, means forming a circulatory path for a fluid refrigerant comprising a compressor, condenser and heat absorber serially connected, said path including a hollow stationary member thru which the refrigerant passes, an electric motor for driving the compressor, said motor having a laminated stator surrounding the hollow member, and means for supporting the stator comprising a pair of clamping members, one being positioned upon each side of the stack of laminations in the stator, one of said clamping members being fastened to the hollow member, and means for forcing said clamping members tightly together.

12. In a refrigerating system, means forming a circulatory path for a fluid refrigerant comprising a compressor, condenser and heat absorber serially connected, an electric motor serving to drive the compressor, a casing serving to enclose and mount the motor and compressor, said motor having a laminated stator mounted upon said casing, and means for supporting the stator comprising a pair of clamping members, one being positioned upon each side of the stack of laminations in the stator, and means for forcing said clamping members tightly together.

13. A refrigerating apparatus comprising a sealed casing, a compressor mounted within the casing, a condenser communicating with the outlet of said compressor, a heat absorber communicating with said condenser and adapted to receive fluid refrigerant from the same, said heat absorber being connected with the intake of the compressor so as to return refrigerant to the same, a valve for controlling flow of fluid into said heat absorber, and means extending thru said casing for actuating said valve.

14. A refrigerating apparatus comprising a sealed casing, a compressor mounted within the casing, said compressor having a stationary shaft, a condenser and a heat absorber serially connected, said condenser being connected to the outlet of the compressor to receive fluid refrigerant from the same and said heat absorber being in communication with the compressor inlet, a valve for controlling flow of fluid into said heat absorber, and means extending into said shaft for actuating said valve.

In testimony whereof, I have hereunto set my hand.

ARTHUR J. KERCHER.