

Aug. 18, 1931.

M. C. TERRY

1,819,528

REFRIGERATOR

Filed Oct. 30, 1928

2 Sheets-Sheet 1

Fig. 1.

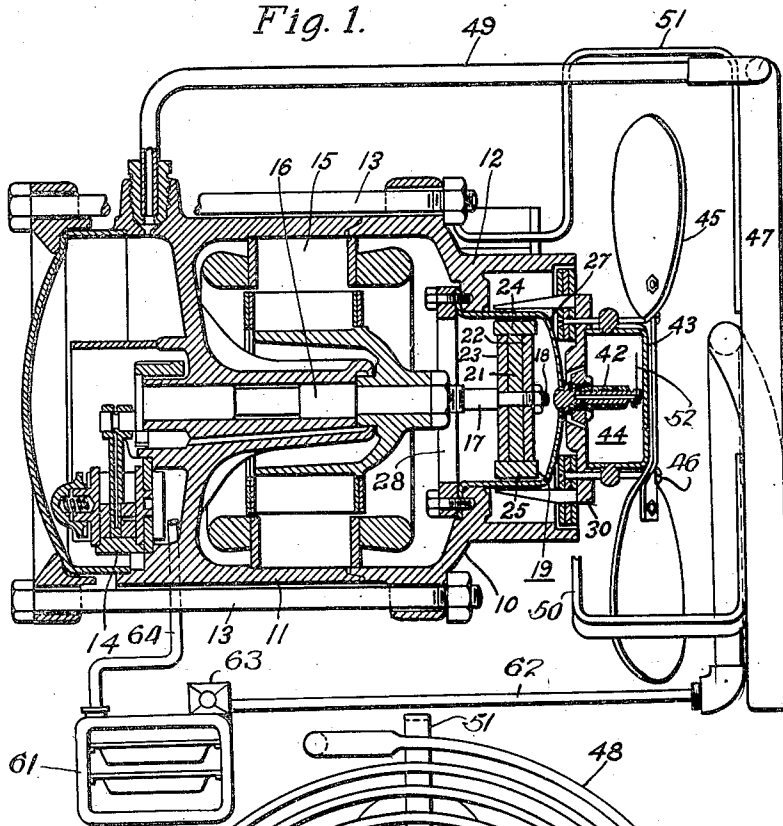
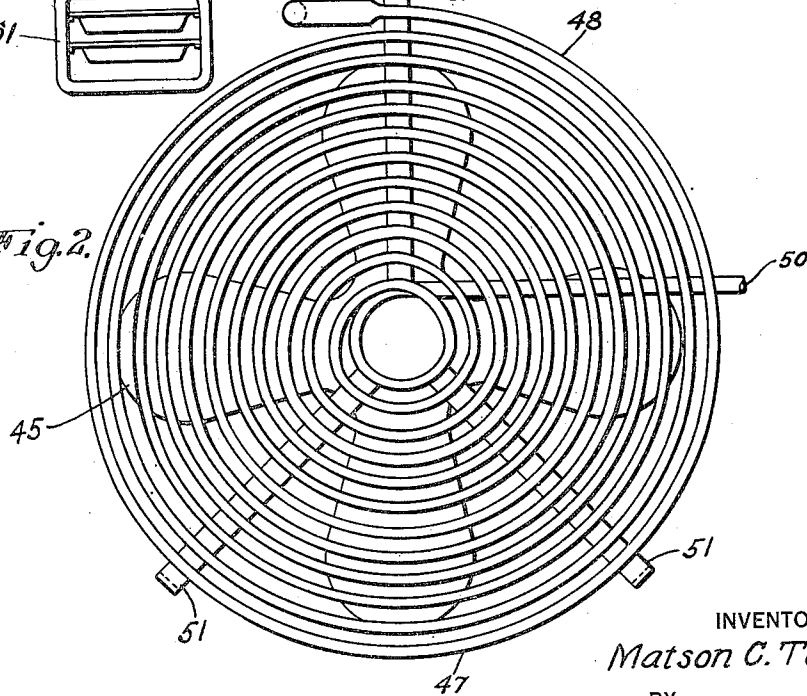


Fig. 2.



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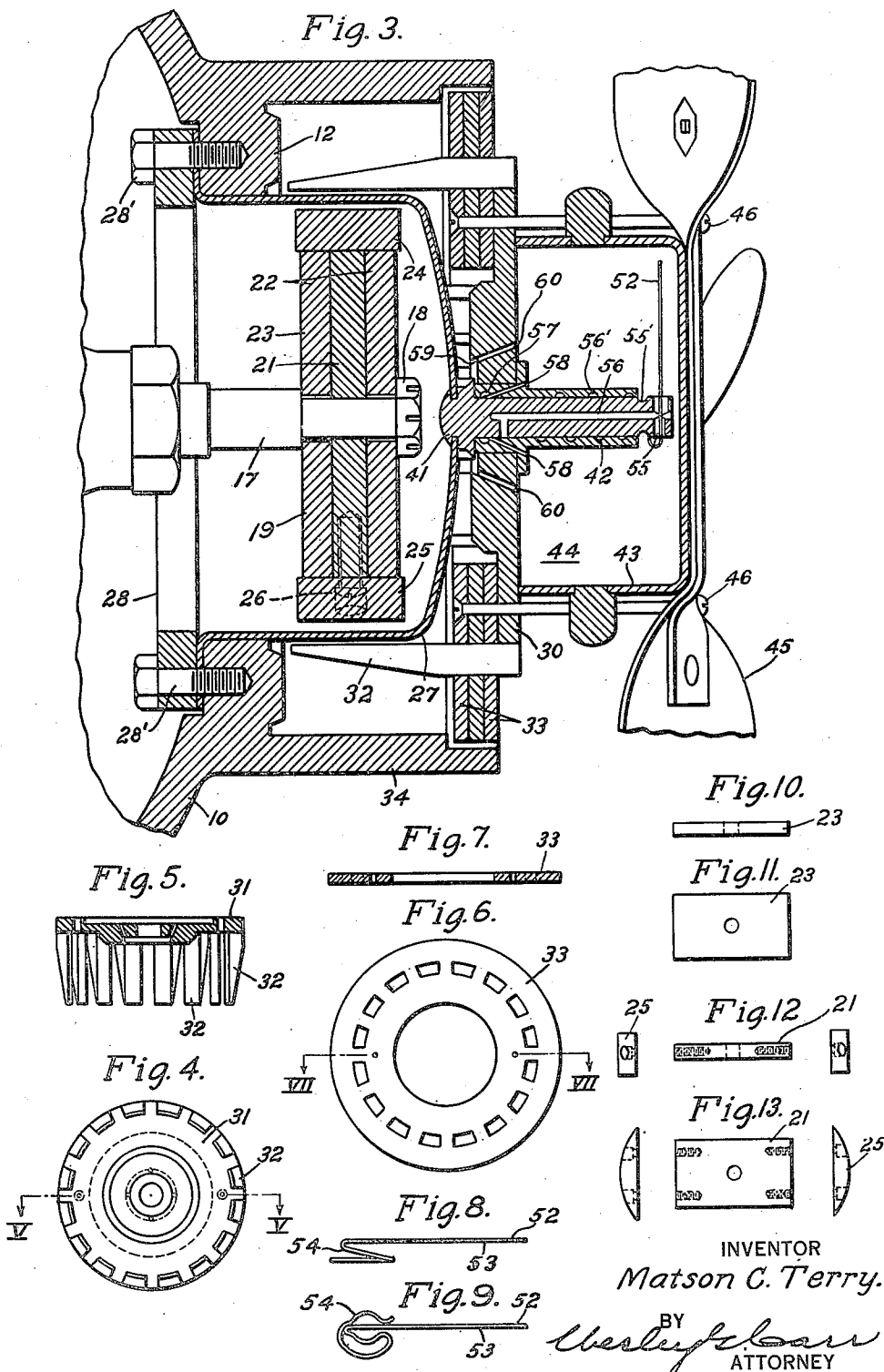
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

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REFRIGERATOR

Application filed October 30, 1928. Serial No. 316,068.

My invention relates to refrigerating machines and particularly to refrigerating machines of the compression type and of small capacity, such as are suitable for household use, and it has for an object to provide apparatus of the character designated which shall operate with an extraordinary degree of efficiency, reliability and effectiveness.

It has for a further object to provide, in compression refrigerating apparatus comprising essentially a compressor for translating and compressing refrigerant vapor, a motor for driving the compressor, a condenser for liquefying the compressor refrigerant vapor and an evaporator for absorbing heat from the elements to be cooled and, incidentally, vaporizing the liquefied refrigerant and an improved arrangement for cooling the condenser which shall be especially applicable to refrigerating machines wherein the motor and the compressor are both totally enclosed in a fluid-tight or hermetically sealed casing.

It has for still another object to provide a fan, together with an improved means for driving the same, which fan shall be located exteriorly of the casing enclosing the compressor and the motor, but which shall be motivated by the latter without, in any way, affecting the fluid-tight qualities for hermetically sealing the casing enclosing the motor and the compressor.

These and other objects are effected by my invention, as will be apparent from the following description and claims taken in connection with the accompanying drawings, constituting parts of this application, in which:

Fig. 1 is a sectional view of a sealed-motor compressor unit embodying my invention;

Fig. 2 is an end view showing the condenser and the fan;

Fig. 3 is an enlarged sectional view of a portion of what is shown in Fig. 1, showing the details of the fan drive;

Fig. 4 is a plan view of the toothed secondary rotor element;

Fig. 5 is a section taken on line V—V of Fig. 4;

Fig. 6 is a plan view of a secondary rotor disk;

Fig. 7 is a section on line VII—VII of Fig. 6;

Fig. 8 is an elevation and Fig. 9 a plan view of the lubricating pin;

Fig. 10 is an elevation and Fig. 11 is a plan view of the magnetic portion of the primary rotor element;

Figs. 12 and 13 are an elevation and a plan view, respectively, of the non-magnetic portion and pole pieces of the primary rotor element.

In many refrigerating machines heretofore constructed, a separate compressor and a motor for driving the same have been provided with an external drive shaft for connecting the motor to the compressor. Such refrigerating machines, however, require the provision of a stuffing box or gland for the shaft connecting the motor to the compressor in order to prevent the escape of refrigerant fluid from, or the infiltration of air into, the compressor housing. The provision of such gland is, however, undesirable for the reason that it must be adjusted or attended to frequently if it is to maintain a seal about the drive shaft which shall be entirely fluid tight and unless it is so maintained, there is apt to be either a leakage of refrigerant fluid out of the system or an infiltration of air into the system. As refrigerating machines of the household type have a relatively small volumetric capacity, a slight amount of leakage of refrigerant or infiltration of air will interfere materially with the successful operation of the machine. Refrigerating machines of this character are generally referred to as of the open type.

It has, therefore, been proposed to have the compressor and its driving motor located in a single, hermetically sealed casing, which may be adapted to contain refrigerant fluid. By means of such an arrangement, the requirement for a stuffing box or gland for the drive shaft connecting the motor to the compressor is entirely dispensed with, inasmuch as the entire operating mechanism may be confined within the interior of the casing, whereby complete fluid-tightness of the re-

frigerating system is assured. Refrigerating machines of this character are generally referred to as of the enclosed type.

With refrigerating machines of the open type, a fan is usually provided for circulating cooling air over the condenser, which fan may be readily connected or coupled to the external drive shaft connecting the motor to the compressor. Then again, it may be embodied integrally with the fly wheel provided on the compressor. However, with refrigerating machines of the enclosed type, the fan for circulating cooling air over the condenser must necessarily be located exteriorly of the casing which encloses the motor and the compressor and, to drive this fan by connecting or coupling the same mechanically to either the motor or the compressor inside of the casing, would involve the provision of a fan drive shaft extending through the casing and, hence, the entire basic idea of providing a totally enclosed hermetically sealed system would be defeated. It has, therefore, been proposed to provide a second or separate motor for driving the fan, which motor is located exteriorly of the enclosing casing and directly coupled to the fan. Preferably, the arrangement is such that the separate motor-driven fan draws cooling air over the condenser and discharges it over the casing enclosing the motor and compressor, so that the condenser, the motor and the compressor are effectively cooled. However, the latter arrangement is objectionable in some respects in that it involves the provision of two motors, together with starting and control apparatus for each. Furthermore, a motor of very small capacity is sufficient for driving the fan and such motors, are relatively inefficient and relatively unreliable, as compared with the main motor, that is, the motor driving the compressor. In addition, the provision of two motors increases the manufacturing cost of the refrigerating machine. Furthermore, if separate motors are provided for the condenser and the fan, and the fan motor fails to operate, inadequate condensation of the gaseous refrigerant will result, and dangerously high pressures will be produced as long as the compressor continues to operate.

It has also been proposed, in enclosed refrigerating machines, to dispense with the fan and to depend upon the natural radiation of the heat of condensation to the atmosphere. However, such a provision greatly increases the cost of condensation because of the necessity of providing an enlarged condenser surface, as compared with a condenser cooled by a forced draft, even taking into consideration the cost of the fan and its driving means, and, in addition, interferes with the compactness of the refrigerating machinery. In other words, in order to obtain the same condenser efficiency, using the

natural radiating surface of the condenser only, it is necessary to use an inordinately large amount of expensive condenser material, as compared with the amount of condensing surface necessary when forced air circulation is used.

I have, therefore, conceived the idea of providing, in enclosed refrigerating machines, a fan for effecting a forced circulation of air over the condenser, and, preferably, in addition, over the casing enclosing the motor and the compressor, or, in the event that the casing is adapted to act as the condenser over the casing alone and of having such fan driven inductively from the motor or compressor located inside the enclosing casing. By means of such arrangement, only one motor is required and the hermetical sealing of the enclosing casing is not, in any way, affected or interfered with. Furthermore, such arrangement provides a refrigerating machine capable of operating with a higher degree of efficiency than refrigerating machines of the type in which a fan is dispensed with and with a higher degree of reliability and a higher overall efficiency than refrigerating machines wherein a separate motor is provided for driving the same, my experiments showing that an inductive driving arrangement for the fan consumes only one-sixth to one-seventh of the electrical energy necessary for a separate fan motor.

Referring now to the drawings for a more detailed description of my invention, I show a hermetically sealed casing 10 embodying a central cylinder 11 provided with removable end cover plates secured thereto and retained in fluid-tight engagement therewith, by bolts 13. Disposed within the casing 10 is a refrigerant compressor 14 driven by a motor 15, the motor being operatively connected to the compressor by a suitable drive shaft 16. While, in the present embodiment, I have shown a compressor of the reciprocating type directly coupled to the motor, nevertheless it is understood that my invention is also applicable to any form of compressor having the moving parts thereof entirely confined within the enclosing casing. Furthermore, while I show a form of compressor which is directly coupled to the motor, nevertheless, it is obvious that other forms of drive means may be provided without departing from the spirit or scope of the present invention.

The drive shaft 16 is provided with an extended portion 17 to which is secured, as by a nut 18, a primary rotor element 19. The latter is composed of a central, non-magnetic retaining member 21 interposed between permanent magnets 22 and 23. Secured to the central retaining member are two pole pieces 24 and 25 by suitable means, such as bolts 26. Secured to the casing 10 and sealing the end thereof, is a cup-shaped member 27 composed

of a metal which is relatively non-magnetic and preferably a relatively high electrical-resistance characteristic. The cup-shaped member 27 is secured, in a fluid-tight manner, to one of the end cover plates 12 by a reinforcing ring 28 and bolts 28'. In addition, the cup-shaped member 27 may be further secured to the end cover plate by welding or brazing.

Disposed exteriorly of the cup-shaped member 27 and in proximate relation thereto, is a secondary rotor element 30, which rotor element, as shown in Figs. 4 and 5, is essentially composed of a conducting member 31 having teeth 32 extending in an axial direction and arranged to retain a plurality of discs 33, each of which is preferably composed of material which is a relatively good electrical conductor. Provided on the end plate 12 is an annular projection 34 for housing the secondary rotor element 30.

Located and fixed in the central portion of the cup-shaped member 27 is a bearing pin 41 upon which the secondary rotor element 30 is rotatably supported, a bushing 42 being pressed into or fixedly retained in the axis of the secondary rotor element 30 for effecting bearing engagement with the retaining pin 41. The bearing pin 41 supports the secondary rotor element 30 and provides the axis about which the latter rotates.

Secured to the outer face of the secondary rotor element 30 is a circular member 43 forming a lubricant reservoir 44, while, disposed beyond the lubricant reservoir and in abutting relation therewith, is a cooling fan 45. Both the cooling fan 45, and the circular member 43 are retained in abutting relation with the secondary rotor element 30 by a plurality of circumferentially spaced screws 46, preferably formed as illustrated. A gasket may be provided between the secondary rotor element 30 and the ring member 28 to effect a lubricant seal. A condenser element 47 is disposed adjacent to the fan 45 and in the path of the air stream created thereby.

In the present embodiment, the fan preferably first draws air over the condenser and then discharges it in the direction of the enclosed motor-compressor unit, although it is within the purview of my invention to so arrange the fan that it first draws air over the motor compressor unit and then discharges it over the condenser. However, I have found the former arrangement to be preferable, in that, in this way, heat generated by the motor and compressor during operation, is effectively dissipated after the cool air has passed through the condenser.

The condenser 47 consists, essentially, of a spiral coil of tubing 48 although it is obvious that other forms of condensers may be employed without departing from the spirit or scope of my invention. The condenser 47 receives refrigerant vapor from the enclosed

motor and compressor through a conduit 49 and discharges the liquefied refrigerant through an outlet 50 to the evaporator 61 through the conduit 62 and expansion valve 63. Expanded refrigerant is returned to the compressor 14 through a conduit 64. The condenser 47 may be supported, by means of brackets 51, from the bolts 13 of the casing. The conduit 64 leads directly to a chamber 65 which communicates with the compressor intake side. The conduit 47 which conveys the high-pressure gas to the condenser is directly connected to the interior of the sealed casing, so that the discharge pressure of the compressor prevails within the casing 10. The construction of the compressor is shown and described in the copending application of Frank Conrad and Christian Aalborg, Serial No. 204,401, filed July 8, 1927, for Refrigerator and assigned to the Westinghouse Electric & Manufacturing Company.

Fixed to the bearing pin 41 is a radially-extending lubricating pin 52 for conveying the lubricant from the periphery of the lubricant reservoir to the bearing pin. As shown in Figs. 6 and 7, the lubricant pin 52 is provided with a radially-extending portion 53 and a curved portion 54, the curved portion being offset axially with respect to the radial portion, as shown particularly in Fig. 8. The arrangement is such that, when the radial portion 53 of the pin is inserted in a diametral hole 55 in the bearing pin 41, the curved portion 54 engages or embraces an annular groove 55' in the bearing pin, this portion of the lubricant pin serving as a spring lock washer to retain the secondary rotor element 30 in axial position on the bearing pin.

Provided in the bearing pin 41 and extending longitudinally thereto, is a lubricant passage-way 56 which communicates with the diametral hole 55 for supplying lubricant to the bearing surface intervening between the bearing pin and the bushing 42 of the secondary rotor element. Suitable oil grooves 56' are provided in the bushing 42 for distributing the lubricant over the entire bearing surface. The grooves 56' are preferably of helical form to effect a flow of lubricant throughout the bearing and back to the reservoir 44, the lubricant escaping from the outer end of the bearing and draining into the reservoir. Any lubricant which may travel in the opposite axial direction, that is, towards the motor and the compressor, is trapped by an annular groove 57 provided in the bushing 42 and returned, through a plurality of circumferentially-spaced holes 58, to the reservoir 44. If any lubricant escapes past said trapping means, it becomes deposited upon the inner radial face of the secondary rotor element 30 upon which an annular ledge 59 is provided. The lubricant is moved by centrifugal force and impinged against this ledge from which it is carried, also by

centrifugal force, to the interior of the reservoir by means of a plurality of angularly-disposed, circumferentially-spaced holes, such as 60.

5 In the operation of my device, the motor is started by the operation of means, such as a thermostat (not shown), which is responsive to the refrigerator chamber temperature. The starting of the motor causes the compressor 14, the shaft 16 and the primary rotor element 19 to rotate. The magnets 24 and pole pieces 25 supply flux which passes through the non-magnetic cup-shaped member 27 to the teeth and the body of member 31. As the primary and secondary rotor elements move relative to each other, the flux cuts through the discs 33 carried by member 31, causing a current to flow similar to the armature current in a direct-current motor. This current, reacting with the field around it, causes the secondary rotor element carrying the fan to rotate, thereby producing a forced draft of air to cool the condenser. There is a certain amount of lag present between the primary and the secondary rotor element which causes the fan to rotate at a lower speed than the motor. This lag may be regulated by the size of the air gap between the rotor elements and cup shaped member 27, so that the fan may be driven at considerably less speed than the motor and compressor, thereby reducing or eliminating the noise caused by the fan and, at the same time, producing an effective cooling of the condenser.

35 The term "hermetically sealed casing", as used in this specification, is intended to include the broad meaning generally accepted in the refrigerating industry, that is, a casing which is substantially gas tight and which has no rotating shafts or other moving parts projecting through or beyond its walls. Likewise, the term "fan" includes any movable means designed to circulate air.

45 While I have shown only a single form of my invention, it is apparent that other forms may be provided, all coming within the scope of the appended claims.

I claim as my invention:

50 1. In a refrigerating apparatus, in combination, a hermetically sealed casing, a motor and a compressor within the casing, an evaporator, a condenser, and a fan actuated by the motor for forcing air around the condenser.

55 2. In a refrigerating apparatus, in combination, a hermetically sealed casing, a motor and a compressor within the casing, an evaporator, a condenser, and a fan inductively actuated by the motor for forcing air around the condenser.

60 3. In a refrigerating apparatus, in combination, a hermetically sealed casing, a compressor and a rotating driving element therefor enclosed within the casing, an evaporator, a condenser, and a fan located exteriorly of

the casing and actuated by the rotating driving element.

4. In a refrigerating apparatus, a hermetically-sealed casing, a compressor and driving means therefor located entirely within the casing, an evaporator, a condenser, and a fan located outside the casing and actuated by the compressor-driving means.

5. Refrigerating apparatus comprising a heat-absorbing unit and a heat-dissipating unit, said heat-dissipating unit comprising a hermetically sealed casing containing a motor and a compressor and a fan located exteriorly of the casing and driven by the motor.

6. In a refrigerating apparatus, an evaporator, a condenser, a hermetically sealed casing containing a motor and compressor and means for dissipating heat evolved in the casing and condenser, said means comprising air-circulating means outside the casing and driven by the motor.

7. In a refrigerating apparatus, in combination, a hermetically sealed casing containing a refrigerant-circulating unit including a motor, an evaporator, a condenser and a fan inductively driven from the motor for cooling the condenser.

8. In a refrigerating apparatus, an evaporator, a condenser, a hermetically sealed casing, a motor and a compressor within the casing, a fan located outside the casing, and a magnetic clutch actuated by the motor for driving the fan.

9. In a refrigerating apparatus, an evaporator, a condenser, a hermetically sealed casing, a motor and a compressor within the casing, a fan located outside the casing, and a magnetic clutch actuated by the motor for driving the fan, the clutch having its driving part inside the casing, and its driven part outside the casing.

10. In a refrigerating apparatus, in combination, an operatively connected compressor, condenser and evaporator, a motor for driving the compressor, a hermetically sealed casing enclosing the motor and the compressor, said casing having a portion made of relatively non-magnetic material, a fan for cooling the condenser, a clutch having its driving portion inside the casing adjacent to the non-magnetic wall and its driven portion outside the casing and also adjacent to the nonmagnetic wall, said clutch serving to inductively connect the motor and the fan.

11. In a refrigerating apparatus of the enclosed type, an evaporator, a condenser and a compressor having operative interconnections, a hermetically sealed casing, the compressor and a driving motor therefor being disposed within the casing, a shaft connecting the motor and the compressor, a fan outside the casing, a shaft supporting said fan, a magnet carried by one of said shafts, and an armature carried by the other of said

shafts, whereby the fan is rotated when the motor is operated.

12. In a refrigerating apparatus, in combination an evaporator, a condenser and a compressor operatively interconnected, a motor having a shaft connected to the compressor, a fan having a shaft, a magnet carried by one of the shafts, an armature carried by the other of the shafts adjacent to the magnet, and a hermetically sealed casing enclosing the motor and the compressor, the casing having a wall interposed between the magnet and the armature.

13. In a refrigerating apparatus, in combination, an evaporator, a condenser and a compressor operatively interconnected, a motor having a shaft connected to the compressor, a fan having a shaft, a magnet carried by one of the shafts, an armature carried by the other of the shafts adjacent to the magnet, and a hermetically sealed casing enclosing the motor and the compressor, the casing having a relatively non-magnetic wall interposed between the magnet and the armature.

14. In a refrigerating apparatus, an evaporator, a condenser, a hermetically sealed casing, a compressor and driving means therefor located within the casing, a fan outside the casing for cooling the condenser, and means actuated by the compressor-driving means for driving the fan at a speed less than that of the driving means.

15. In a refrigerating apparatus, an evaporator, a condenser, a hermetically sealed casing, a motor and a compressor entirely within the casing for cooling the condenser, a fan located outside the casing, and means actuated by the motor for driving the fan at less than motor speed.

16. In a refrigerating apparatus, in combination, an evaporator, a condenser, a hermetically sealed casing, a motor and a compressor within the casing, the casing including a wall, a fan rotatably supported by the wall, and means actuated by the motor for driving the fan.

17. In a refrigerating apparatus, in combination, an evaporator, a condenser, a hermetically sealed casing, a motor and a compressor entirely within the casing, the casing having a cup shaped wall of relatively non-magnetic material, a primary rotor element within the casing, a secondary rotor element outside the casing and adjacent to the non-magnetic wall, a fan driven by the secondary rotor element for cooling the condenser, and a projection on the casing extending around the secondary rotor element.

18. In a refrigerating apparatus, a hermetically sealed casing, an evaporator, a condenser, a motor and a compressor within the casing, the casing having a relatively non-magnetic wall, a fan for cooling, the con-

denser located outside the casing and adjacent the wall, and means responsive to movement of the motor for actuating the fan.

19. In a refrigerating apparatus, in combination, a condenser, an evaporator and a compressor operatively interconnected, a fan for cooling the condenser, a common means for driving both the compressor and the fan, and means for hermetically sealing the compressor and at least a portion of said driving means.

20. In a refrigerating apparatus, in combination, an evaporator, a condenser, a hermetically sealed casing, a compressor and driving means therefor located within the casing, a fan located outside the casing and supported thereby, and actuated by the compressor driving means.

21. Refrigerating apparatus comprising a heat-absorbing unit and a heat-dissipating unit, said heat-dissipating unit comprising a rotating driving element, a compressor driven thereby, a hermetically sealed casing enclosing said driving element and compressor, and a fan mounted externally of the casing and having a part adjacent thereto with an air gap between the casing and said part, characterized by the fact that means are provided within the casing for producing a rotating magnetic field in the portion of the casing bounded by the air gap, the part of the fan apparatus adjacent to said air gap being of such nature as to be rotated by said field.

In testimony whereof, I have hereunto subscribed my name this 13 day of Oct. 1928.

MATSON C. TERRY.