G. A. KRAMER.

REFRIGERATING APPARATUS.

APPLICATION FILED JAN. 4, 1917.

1,281,027.

Patented Oct. 8, 1918.

3 SHEETS—SHEET 1.

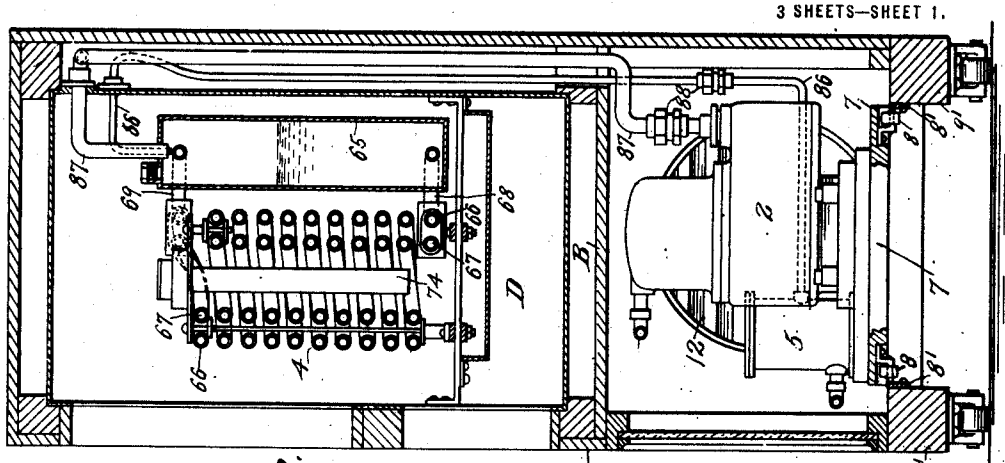

Fig. 2.

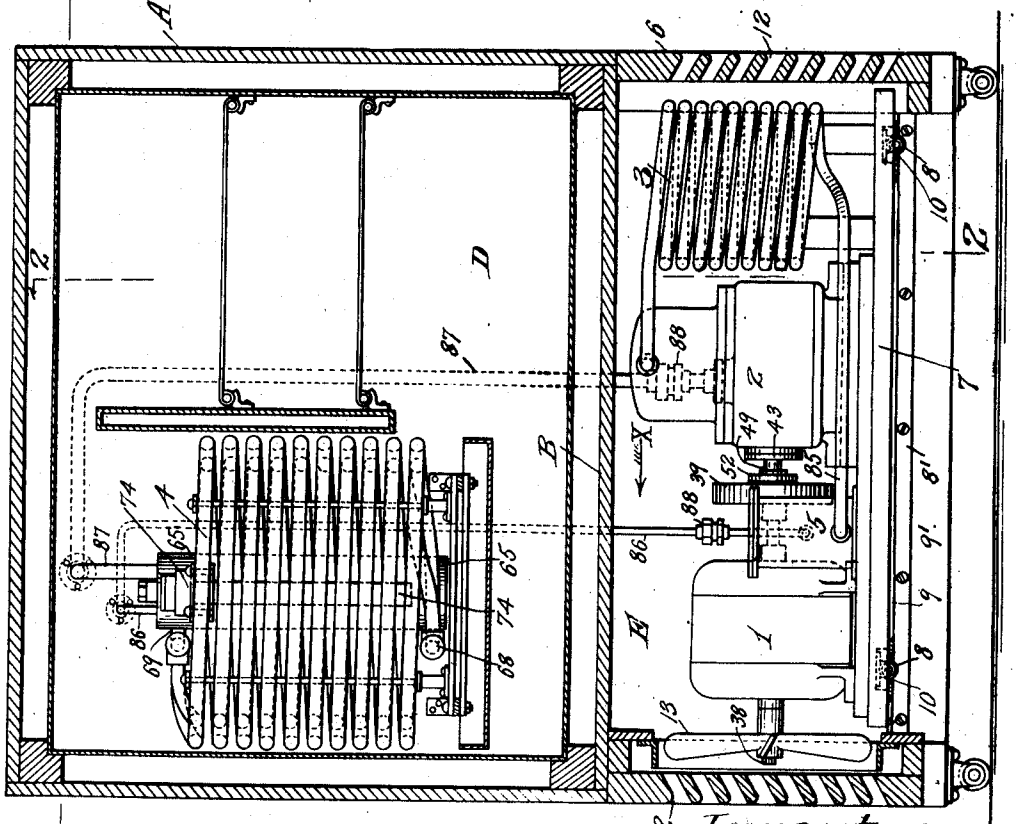

Fig. 1.

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3 SHEETS—SHEET 2.

Fig. 4.

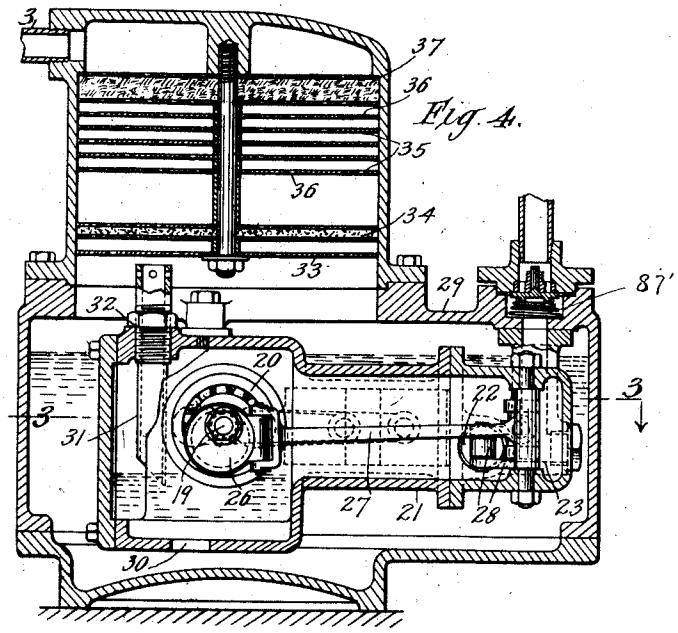


Fig. 6.

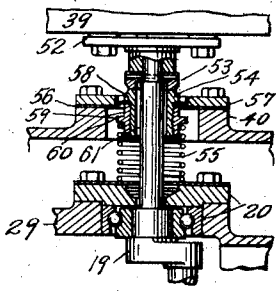


Fig. 5.

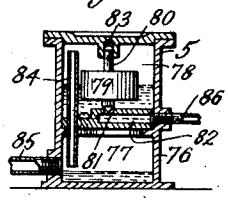


Fig. 3.

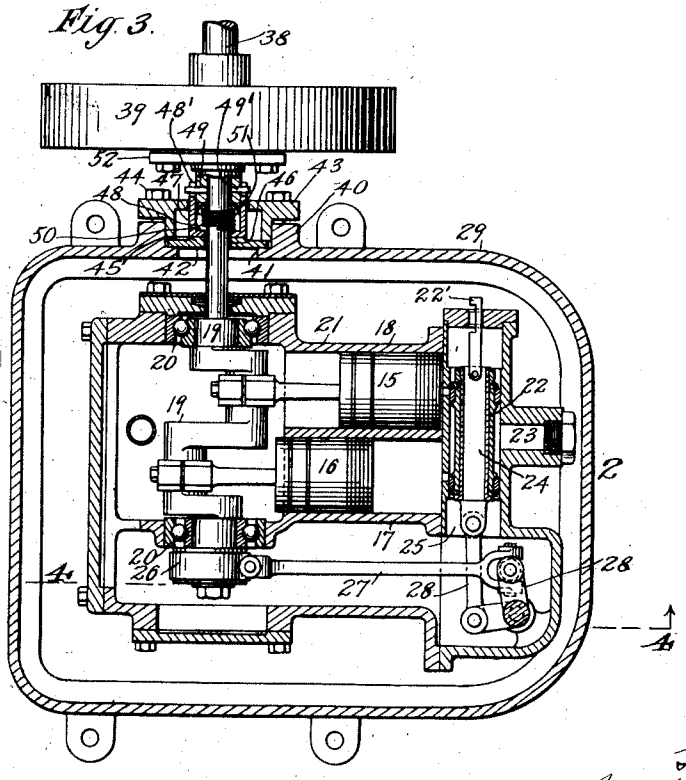
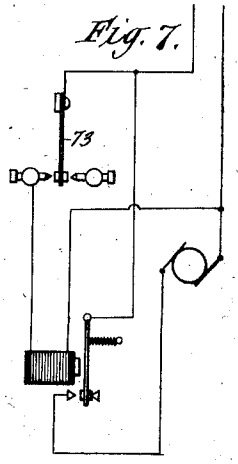


Fig. 7.



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3 SHEETS—SHEET 3.

Fig. 8.

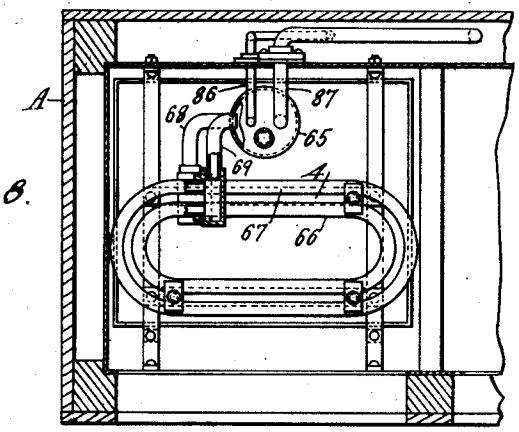


Fig. 11.

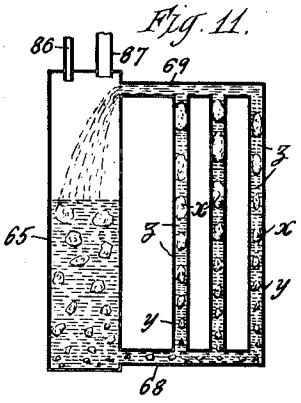


Fig. 9.

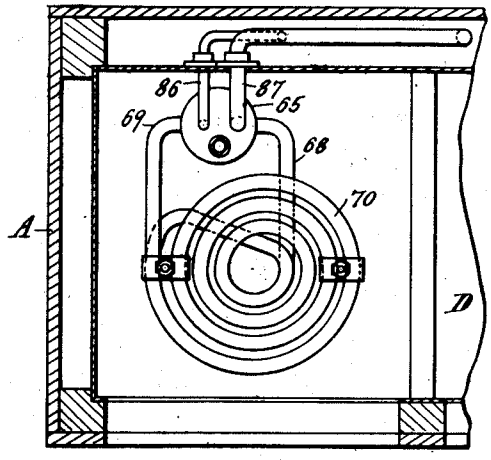
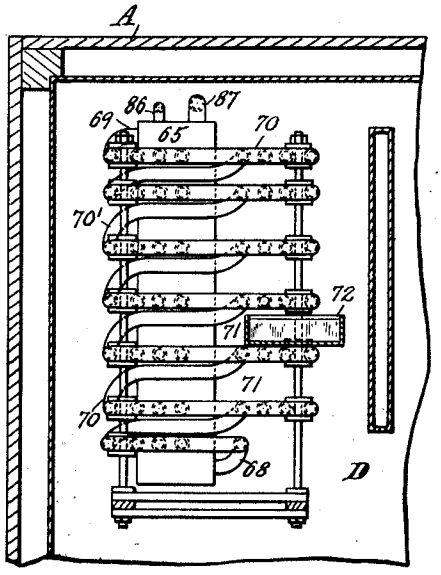


Fig. 10.



Inventor:

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UNITED STATES PATENT OFFICE.

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REFRIGERATING APPARATUS.

1,281,027. Specification of Letters Patent. Patented Oct. 8, 1918.

Application filed January 4, 1917. Serial No. 140,504.

To all whom it may concern:

Be it known that I, GUSTAV A. KRAMER, a subject of the King of Hungary, and now resident of New York, county of New York, and State of New York, have invented certain new and useful Improvements in Refrigerating Apparatus, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to certain improvements in refrigeration systems in which the refrigerant action is obtained from the evaporation of a volatile liquid such as ethyl or methyl chlorid, and it particularly relates to such systems when employed in connection with the small refrigerating systems commonly termed household refrigerators.

It is the special object of the present invention to produce such a household refrigerator of great refrigerating efficiency, which will be entirely automatic in its action for long periods, requiring no attention from the user, and in which the operation of the system can be conducted at low cost.

It is a further object of the invention to improve the different elements of the apparatus so as to make the system more efficient and economical than heretofore suggested. It is a further object of the invention to provide an improved compressing mechanism for such systems which shall be self-oiling and therefore require no attention for long periods. It is a further object of the invention to provide an improved evaporating or refrigerating coil, giving a larger evaporating or cooling surface and requiring but a small amount of refrigerant liquid compared with prior coils, thus effecting an economy in cost. It is a further object of the invention to provide an improved construction for supporting and arranging the condensing and cooling elements of the system, so that they may be efficiently cooled, and readily removed for inspection and repair when necessary.

With these and other objects in view not specifically referred to, the invention will now be described in detail with reference to the accompanying drawings, in which—

Figure 1 is a vertical elevation, partly in section, of a refrigerator, showing the general arrangement of a system embodying the invention in connection with a small household refrigerator.

Fig. 2 is a vertical cross-section on line 2—2 of Fig. 1;

Fig. 3 is a plan view, partly in section, on an enlarged scale, showing the compressor and the connection from the compressor to the prime mover for operating the same;

Fig. 4 is a cross-section taken on line 4—4 of Fig. 3, showing the method employed for immersing the compressor in the lubricant, and the lubricant separator employed;

Fig. 5 is a detail sectional view of the float valve and siphon for returning the refrigerant from the condenser to the coil;

Fig. 6 is a detail sectional view on an enlarged scale, showing a modification of the connection from the compressor to the prime mover;

Fig. 7 is a diagrammatic illustration of the thermostat and circuit for operating the motor;

Fig. 8 is a horizontal sectional view of part of the construction shown in Fig. 1, the section being taken on the line 8—8 of Fig. 1;

Fig. 9 is a plan view, partly in section, showing a modified form of the cooling or evaporating portion of the apparatus;

Fig. 10 is a vertical section illustrating the same modification of the cooling or evaporating portion of the apparatus shown in Fig. 9; and

Fig. 11 is a diagrammatic view of the improved refrigerating or cooling coil showing the manner of circulation of refrigerant therein.

Referring to the drawings, the invention has been illustrated as employed with the receptacle or box usually employed for household purposes, but it may, if desired, as to some features, be used in other relations. This box is marked generally A, and for reasons hereinafter referred to, is preferably divided by a partition as B into what may be called a cooling compartment or chamber D and a space E in which is located part of the refrigerating apparatus, this space being as shown, preferably located below the chamber D at the bottom of the box.

In apparatus constructed in accordance with the invention, means will be provided

for effecting the refrigerating or cooling cycle, which will include a prime mover, as an electric motor 1, a compressor 2 driven therefrom, a cooling or condensing coil 3, a refrigerating coil 4 in which the methyl chlorid or other refrigerant is evaporated, and an automatic refrigerant valve 5 for returning the condensed refrigerant from the condensing coil to the refrigerating coil or the refrigerating coil side of the system. Certain of these parts are of novel and improved construction, and are arranged in a novel manner in the box, and will be more specifically referred to hereinafter.

In apparatus embodying the invention in its preferred form, the motor, compressor, cooling coil and valve construction will be arranged on a support in a chamber of suitable dimensions provided in the receptacle, this chamber, in the particular construction shown, being that marked E before referred to and positioned at the bottom of the refrigerator. This construction is adopted so that the elements referred to may be assembled on their support and the support inserted or removed from the refrigerator as a whole by merely disconnected the connections to the refrigerator coil. The particular construction adopted whereby these parts may be moved from the box as a unit may, of course, vary. In the apparatus illustrated, however, one end of the compartment E, as, for instance, that marked 6, may be removably secured to the box, and the support and the parts referred to carried thereby moved from the box through this end. To facilitate the removal of the parts as a unit, they are supported on a sliding base 7, which is provided with small rollers 8 running on rails 9. These rails are, in the best constructions, at each of their ends cut away, as indicated at 10 (Fig. 1, so that the rolls will drop down into the cut away portions and act as a stop for positioning the support in the box. The rails may be supported in any suitable manner, as for instance, by screws 8′ secured to the frame 9′ of the box structure.

In machines constructed in accordance with the invention, the motor, valve, compressor and cooling coil will be so arranged in the box and the compartment will be so constructed, that an efficient cooling of the parts may be effected. While this may be done in various ways, as illustrated the compartment E, in which the parts referred to are located, is, when the support 7 is in position, a closed compartment, except for suitable air inlets and outlets. These outlets, of course, may be of any suitable configuration and suitably placed in the compartment, and they are readily and easily formed as indicated at 12 by latticing the ends of the box. The various members referred to are arranged in this latticed compartment so that the cooling action of the air passing through the lattice work will take effect where it is most needed. Thus the cooling coil 3 is arranged next the lattice work, with the compressor adjacent it and the motor at the other end of the compartment. Various means may be employed to produce an air circulation through the compartment. As shown, there is provided a fan 13, the blades of which are set so as to produce an air current which will travel from right to left, as indicated by the arrow X, Fig. 1. With this construction, the air first passes the cooling coil where it is most needed, and then the compressor, and finally the motor, all the parts being by this arrangement very effectively cooled.

When an electric motor is employed as the prime mover, any suitable type may be used. The cooling coil 3 may be of any suitable configuration or size. As illustrated, for cheapness and simplicity in manufacture, it is a simple coil of pipe of the required dimensions.

As is usual in systems of the type to which the present invention relates, the vaporized refrigerant is compressed by a compressor unit indicated generally in Fig. 1 by the numeral 2. Any suitable type of compressor or pump may be employed, but in machines embodying the invention in its best form, a novel arrangement of the compressor or pump, and a novel method of lubricating and cooling the compressor or pump, will be employed. Such construction forms one important feature of the invention and is shown in detail in Figs. 3, 4, and 6, and will now be described.

In high-speed air compressors or pumps of the type necessary for use in apparatus of this character, difficulty has been experienced in properly cooling the compressor. In refrigerating apparatus, furthermore, of the type to which this invention relates, and in which the lubrication of the compressor must be automatic for long periods, it is necessary that there be supplied an amount of lubricant greatly in excess of that actually required for the lubrication of the compressor. Both of these features are provided for by the present invention. The particular construction whereby they may be effected may, of course, vary widely, but the construction illustrated has been found in actual practice to be effective for the purposes desired. As shown, the compressor is an ordinary two-cylinder pump having pistons 15, 16 working in cylinders 17, 18, and operated from a crank shaft 19 mounted in suitable ball bearings 20 in the crank case 21. A piston valve 22 of usual construction controls the passage of the vapor from the inlet 23 to the cylinders, and the compressed vapor from the upper cylinder 18 shown in Fig. 3 passes through a passage 24 in the

valve to and through a passage 25, and the compressed vapor from the lower cylinder 17 passes directly through passage 25 into the casing 29, the vapors being thus directed for a purpose hereinafter referred to. The valve 22 may, if desired, be oiled in any suitable manner, as by a hook-shaped member 22′ which acts to draw oil into the valve casing. This valve is operated in any suitable manner, as by eccentric 26, lever 27, and links 28. As before stated, a supply of lubricant is provided for lubricating the compressor which is greatly in excess of that actually needed for lubricating purposes, this excess of lubricant serving to make the apparatus automatic for long periods, and further, this excess of lubricant is utilized for assisting in cooling the compressor. The particular construction used for this purpose may be varied, but as illustrated the crank case of the compressor is carried in a housing 29 which is suitably mounted on the support 7, before referred to. This housing is of sufficient dimensions to hold the desired excess of lubricant, and the lubricant has a free circulation around this housing and through the crank case of the compressor, entering the crank case of the compressor through a suitable opening or port such as that marked 30 in Fig. 4.

This arrangement permits an excess of lubricant and, at the same time, by the lubricant circulating through the crank case and through the housing the heat generated by the compressor is, through the liquid, transferred to the housing which, having a much larger surface, can be more effectively cooled by the air current generated by the fan or other medium, as before described.

The compressed gas, as before stated, passes from the piston valve through the crank casing and leaves the crank casing on its way to the condensing coil through a suitable channel which may be, as shown, a pipe 31, which is adjustably mounted as shown at 32 in the crank casing. This pipe is dimensioned so that the end of the pipe will project into the crank casing to a level at which it is desired to keep the lubricant in the casing during the operation of the compressor, the compressed vapors passing through the crank casing holding the lubricant and escaping from the casing above the level of the lubricant through the pipe, and acting to keep the lubricant in the crank casing at the desired predetermined level.

As the condensed vapors carry with them a certain amount of lubricant which must be kept out of the rest of the system, an oil or lubricant separator is employed. Any suitable separator for separating the particles of lubricant from the compressed vapors may be used. In the particular construction illustrated the pipe 32 delivers to a separator positioned on the top of the housing 29, before referred to. This separator contains a perforated partition 33, above which may be placed some granulated or similar material 34, which will tend to catch the particles of lubricant and hold them back from the compressed vapor. A plurality of baffle plates 35 are arranged in the separator above the granulated material, these baffle plates being provided with holes 36 which are preferably in staggered relation with each other to assist in the separation. At the upper end of the separator, above the baffle plates, is or may be a filter device 37, which may be a sheet of felt or the like.

The compressor is driven, as before stated, from any suitable prime mover, as an electric motor, through shaft 38 and fly wheel 39. It is necessary in the construction described, in which the lubricant is carried in a housing, that the connections between the motor shaft and the crank shaft of the compressor be such that leakage of the lubricant around the connection shall be reduced to a required minimum, so that there shall not be any substantial loss of lubricant. Various constructions may be employed for this purpose, but a stuffing gland of novel construction is shown in the drawings which has been found to be very efficient in practice, and which preferably will be employed. In the construction illustrated, referring first to Fig. 3, the housing 29, before referred to, is provided with a boss 40 which is cut out on the inside to form a seat 41. On this seat 41 is a disk or plate 42 which is held against the seat so as to be liquid-tight by a flanged holder ring 43 secured in place by bolts 44. The central portion of the disk 42 is slightly raised, as shown at 45, and this portion of the disk is finely polished. The disk is provided with a central perforation through which the end of the crank shaft 19 passes, a very slight clearance opening 46 being left about the shaft. Coöperating with this disk 42 is a hollow runner or traveler 47. This runner 47 has its lower face highly polished so as to have a close fit with the polished face 45 of the disk 42, which shall be substantially liquid-tight, a very small amount of liquid being permitted to pass between these plates for the purpose of lubricating. This amount of liquid is determined by a spring 48 which presses the two polished surfaces against each other and permits only sufficient lubricant to enter between them as will suffice for their lubrication. As the pressure of the lubricant varies in the crank case during the operation of the apparatus, and as the spring must not be of such strength as to hold the plates in liquid-tight relation with each other at the highest occurring pressure of the lubricant, means are provided for assisting the spring in holding the surfaces together. While these means may

vary somewhat, the pressure of the lubricant is utilized for this purpose. While the specific means may vary somewhat, in the construction illustrated in Fig. 3 the hollow runner 47 is closed at one end by a plug 49 fast on the shaft 19, before referred to, a lubricant chamber 50 being formed between the plug and the bottom of the runner. This chamber at its upper part is rendered liquid-tight by a cup washer 51. The runner 47 is slotted at its upper end, as indicated at 48′, and through the slots passes a pin 49′, this pin also passing through the plug 49, thus putting the runner in contact with the plug and at the same time permitting a slight sliding movement of the plug, so that the spring will always hold the runner in suitable contact with the plate or disk 45, before referred to. With this construction, the lubricant under high pressure can pass through the clearances 46 in the plate and runner and thus enter the liquid chamber 50 in the runner and add its pressure to the pressure of the spring and hold the two surfaces in the required liquid-tight relation with each other.

The crank shaft 19 and motor shaft 18 are coupled together by any suitable coupling, a coupling 52 being indicated in Fig. 3.

With the construction as thus far described an ample supply of lubricant is provided, the heat of the compressor is diffused so that it is more easily cooled by the air current, and, furthermore, the compressor being sealed by the liquid in the housing, all of its joints are tight and danger of loss of refrigerant is reduced to a minimum, as long as the glands are tight and the lubricant-level is maintained above the glands.

In Fig. 6 is illustrated a modification embodying the principle of the stuffing gland just previously described and shown in Fig. 3. The specific construction shown in Fig. 6, however, is somewhat different from that shown in Fig. 3, and will now be described. In the construction shown in this figure, the crank shaft 19 has fast thereon and turning therewith a fixed collar or nut 53, which has a highly polished lower surface. Coöperating with this collar or nut 53 is a runner nut or bushing 54 slidable on the crank shaft 19. This bushing 54 is backed by a spring 55, which takes against the bearing 20 of the crank case before referred to. This spring 55 performs the same function as the spring 48, before referred to in the description of the gland shown in Fig. 3. As the pressure increases during the operation of the apparatus, as heretofore explained, means are provided to assist the spring 55 in holding the polished surfaces of the nut and bushing in such close contact as only to permit the desired amount of lubricant to enter between the surfaces. In the construction shown for effecting this in the modification of Fig. 6, the bushing is yieldingly supported by means of a liquid-tight flexible diaphragm 56 clamped between the boss 40 and a top plate 57, the diaphragm at its inner edges taking against a shoulder 58 in the bushing and being clamped at that point against the shoulder by a nut 59. This nut 59 in the particular construction illustrated forms one abutment for the spring 55, being provided with a flange 60 for this purpose. The lubricant is admitted from the housing to the polished surfaces by means of a narrow passage 61 around the crank shaft.

Machines constructed in accordance with the invention will include what may be herein termed the refrigerating coil, that is, the coil in which the evaporation of the liquid refrigerant takes place to produce the required low degree of temperature. The character of this coil may be widely varied, but for the purpose of obtaining a maximum evaporating surface, a coil of novel design will preferably be employed, and this coil will now be described. Generally speaking, this coil will include a container or reservoir for the refrigerant, this reservoir connecting with the suction inlet of the compressor and with the return from the condenser, a certain amount of cooling being effected in this container. This container may be called the primary container, its chief function being to act as a storage receptacle for the bulk of the refrigerant. In addition, however, to the primary container, the coil will comprise an additional evaporating or refrigerating coil having a much larger evaporating surface, the chief function of which is vaporizing or cooling, though it holds a small amount of refrigerant and may be termed a secondary container, this container connecting with the primary container or reservoir, so that the refrigerant may circulate from the primary container through the secondary container and back to the primary container. The secondary container is made up of a plurality of relatively small passages which may be either in the form of small pipes vertically arranged, or arranged in the form of a coil or coils, and in these coils the greater part of the vaporizing and consequent cooling is effected. This arrangement provides a large area of evaporating surface, and consequently permits of the use of a smaller quantity of refrigerant, provides for quicker cooling, and effects a great increase in the whole efficiency of the apparatus. The operation of the secondary coils by which this increased efficiency is obtained is illustrated diagrammatically in Fig. 11, in which the course of the liquid through the relatively small passages of the coil from the primary container and back thereto, is indicated. As

shown, in this figure, the bubbles of vapor *x* pass up through the small passages *y* and carry with them small portions of the liquid refrigerant, these portions being marked *z*. The area of the passages is, of course, kept of such dimensions that the bubbles of vapor will not pass through the passages without lifting the liquid with them. The vapor bubbles act to effect the circulation of the refrigerant required.

The preferred construction for effecting this continuous circulation and increased evaporating power of the apparatus is that illustrated in the drawings. Referring first to Figs. 2 and 8, a preferred construction is shown where the apparatus is to be employed simply for cooling the receptacle and where no ice-making is desired. In the construction here illustrated, there is provided a primary container or resevoir 65 and a secondary evaporating coil consisting in the present instance of a pair of small pipes 66, 67, coiled as shown, for the sake of saving space with superimposed coils. The two pipes 66, 67 take off from a common pipe 68 located near the bottom of the reservoir 65, and the liquid and vapor is returned from these coils through a common return pipe 69. The reservoir 65 and the coils 66, 67, are dimensioned so as to hold a sufficient amount of refrigerant for the automatic operation of the apparatus and to provide a sufficient surplus over and above what is actually necessary for a working cycle, so that a slight loss in refrigerant will be taken care of and the apparatus will automatically operate for considerable periods of time without renewing the refrigerant supply.

In some cases it is desirable to provide means for making ice. When such construction is desired, means will be provided by the present invention for effecting this. While the particular construction for so doing may vary, a construction such as illustrated in Figs. 9 and 10 of the drawings is preferred, in which the secondary evaporating chamber comprises a single coil 70 formed with superimposed spirally wound coils which may be separated as at 71 a sufficient width to permit of the insertion of a tray 72 or other suitable water-container, the water being frozen to ice in this tray, the coils as shown being horizontally arranged to form a support and interconnected by pipes 70′ to form a continuous passage.

The apparatus is automatically controlled, the motor or other prime mover being stopped or started in accordance with the temperature that it is desired to keep in the refrigerator. While this may be accomplished in various ways, in the particular construction illustrated there is provided a thermostat 73 (see Fig. 7) inclosed in a casing 74 supported in the secondary cooling coil. It is to be understood, however, that this thermostat may be located at any desired place in the refrigerator. This thermostat operates through suitable circuits shown in Fig. 7 for operating the motor.

As before stated, the apparatus is automatic in its action, the condensed refrigerant being returned from the coil to the container or reservoir 65 before referred to. While the means for effecting this may be varied, in the particular construction illustrated there is provided a refrigerant return valve indicated generally by the numeral 5 (Fig. 5) located between the condensing coil and the container. While the construction of this return valve may be somewhat varied, as illustrated the valve casing 76 is divided into upper and lower chambers 77, 78, the chamber 78 being a float valve chamber, and having seated therein an upwardly moving float valve 79. The spindle 80 of this float valve, at its lower end, closes a port 81 in a hollow partition 82, the upper end of the valve spindle being held in a suitable guide 83. Connecting the lower chamber 77 of the valve chamber 78 is a siphon tube 84, the lower end of which is spaced from the bottom of the chamber 77 as shown.

The condensed liquid from the condensing coil 3 passes to the chamber 77 of the valve 5 through pipe 85, this pipe entering the chamber at a point somewhat above its bottom, thus forming a trap for catching any of the particles of lubricant which may come over with the condensed refrigerant. The chamber 77, in the construction shown, thus acts as a collecting chamber in which the condensed refrigerant collects. As small particles of lubricant, which is usually glycerin, and certain other impurities may pass over with the refrigerant, and as these have a greater specific gravity than the methyl chlorid, they sink to the bottom of the chamber. The siphon tube 84 therefore does not extend clear to the bottom of the chamber 77, but is spaced therefrom, and so does not siphon over the impurities which collect and are trapped at the bottom of the chamber, and these impurities are kept from going back into the system. When a sufficient amount of refrigerant has collected in the chamber 77, the siphon operates to siphon it over into the valve chamber 78, from which, when a sufficient amount is there collected, through the lifting of the valve, the refrigerant passes through port 81 and hollow partition 82 through pipe 86 to the top of the reservoir or container 65, above referred to. It will be understood, however, that if desired the refrigerant may be returned to any other part of the container 65, or the secondary coil. The evaporated refrigerant or vapor is drawn to the compressor 2 through a pipe 87 and check valve 87′. The pipes 86, 87 pass down at

the back of the refrigerator and join, respectively, to the return valve and condenser by couplings 88 by simply unloosening which the compressor condensing coil, motor and return valve may be withdrawn as a unit from the box as before explained.

While the invention has been shown and described in its preferred form, it will be understood that various changes may be made in the details of the various parts forming the complete apparatus without departing from the invention, and it is understood that such changes and variations may be made.

What is claimed is:

1. In a refrigerating apparatus, the combination with a refrigerator body having a refrigerating coil therein, a compartment adjacent thereto, an air inlet and outlet to and from the compartment, means for producing and directing a current of air through the compartment, and a condensing coil and compressor connected with the refrigerating coil and arranged in the compartment in the path of the air current.

2. In a refrigerating apparatus, the combination with a refrigerator body having a refrigerating coil therein, a compartment adjacent thereto, an air inlet and outlet to and from the compartment, means for producing and directing a current of air through the compartment, and a condensing coil and compressor connected with the refrigerating coil and arranged in the compartment in the path of the air current, the parts being arranged so that the air current contacts first with the condensing coil and then with the compressor.

3. In a refrigerating apparatus, the combination with a refrigerator body, of a refrigerating coil therein, a compartment in the refrigerator body having air inlets and outlets at its ends, means for producing and directing a current of air through the compartment, and a condensing coil and compressor located in the compartment and connected with the refrigerating coil and in the path of the air current, the condensing coil being located next the air inlets at one end of the compartment so that the air current comes first in contact with the condensing coil and then with the compressor.

4. In a refrigerating apparatus, the combination with a refrigerator body having a compartment in which is located a refrigerating coil, a second compartment having latticed ends to provide air inlets and outlets and located in the refrigerator body, a condensing coil and compressor located in the second compartment with the coil next the air inlets, and a fan for drawing a current of air through the compartment, the air current first contacting with the condensing coil and then with the compressor.

5. In a refrigerating apparatus, the combination with a refrigerator body having a compartment containing a refrigerating coil, a second compartment having ends provided with openings to provide air inlet and outlet, a movable support in the second compartment, a condensing coil, a condenser, a motor and a fan, all carried on the support, with the condensing coil next the air inlet end of the compartment, and connections from the condensing coil and compressor to the refrigerating coil.

6. In a refrigerating apparatus, the combination with a refrigerator body, of a movable support therein, a condensing coil, a condenser, a motor and a fan, all carried on the support, tracks in the refrigerator body, rolls on the support riding on the tracks, and slots in the tracks through which the rolls may project for stopping the support in proper position when moved in the refrigerator body.

In testimony whereof, I have hereunto set my hand.

GUSTAV A. KRAMER.