C. H. HAPGOOD.
REFRIGERATING APPARATUS.
APPLICATION FILED MAR. 18, 1912.

1,046,588.

Patented Dec. 10, 1912.

3 SHEETS—SHEET 1.

Fig. 1.

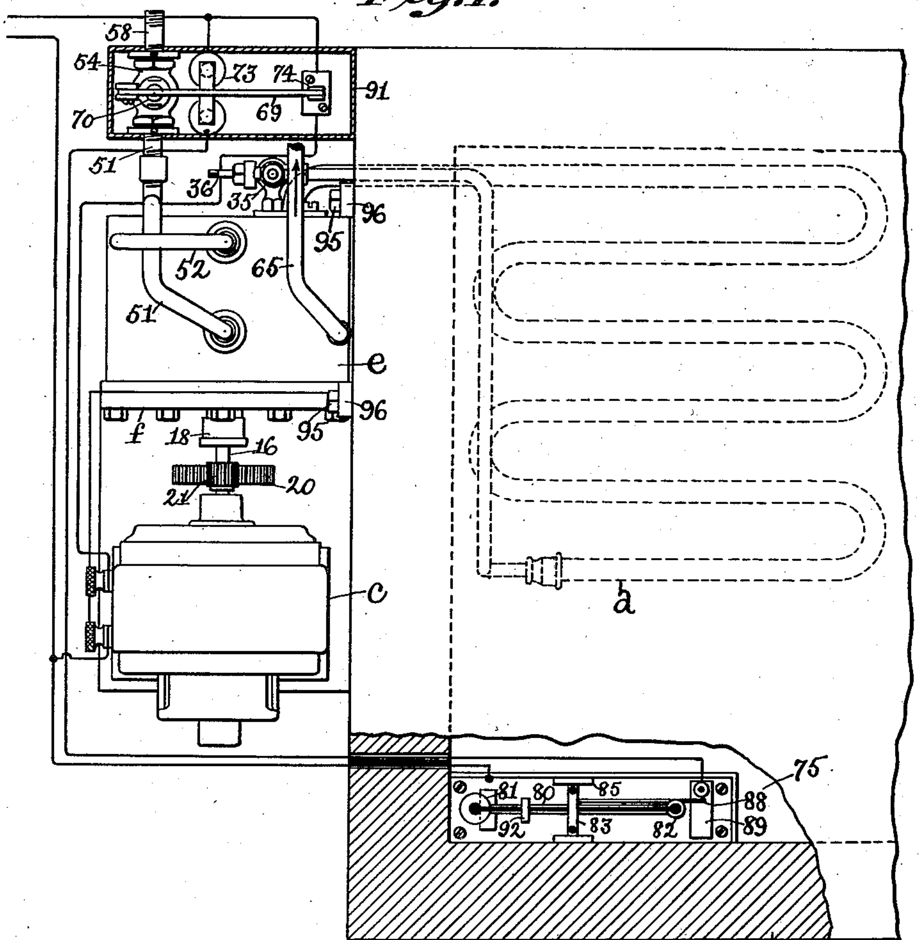

Fig. 2.

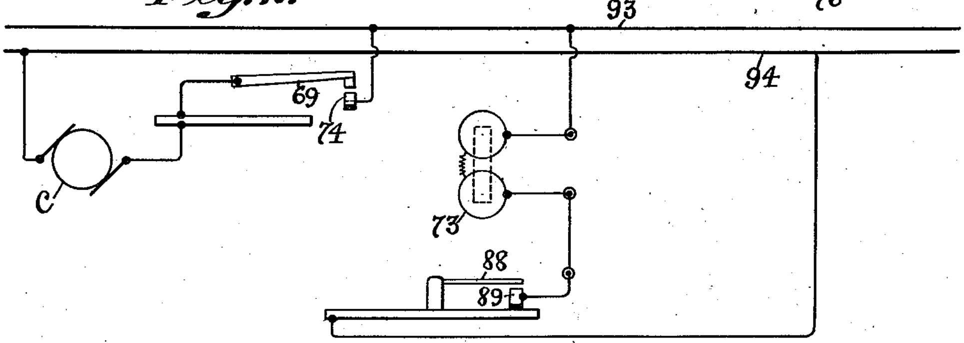

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Fig. 3.

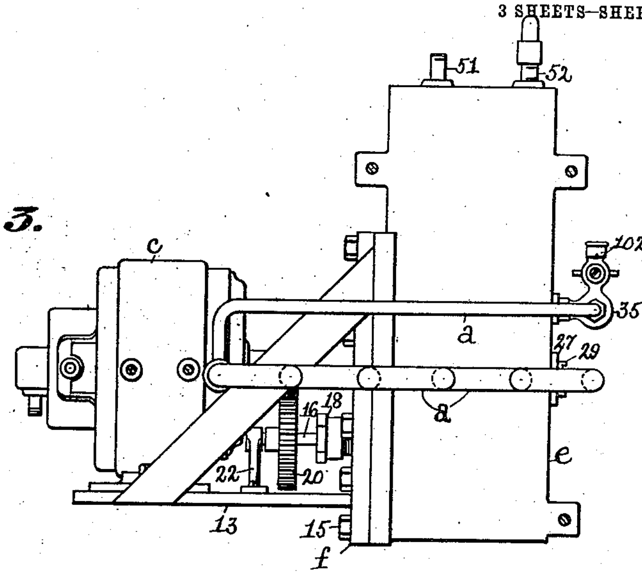


Fig. 4.

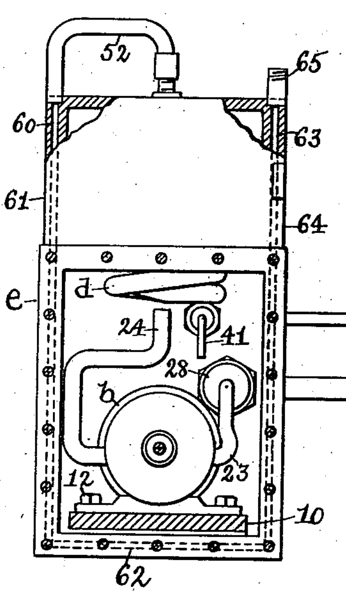


Fig. 5.

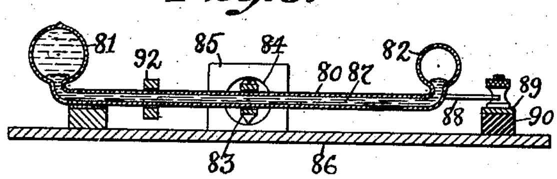
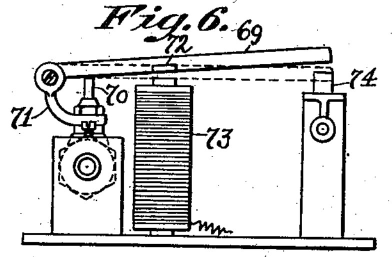


Fig. 6.



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3 SHEETS—SHEET 3.

Fig. 7.

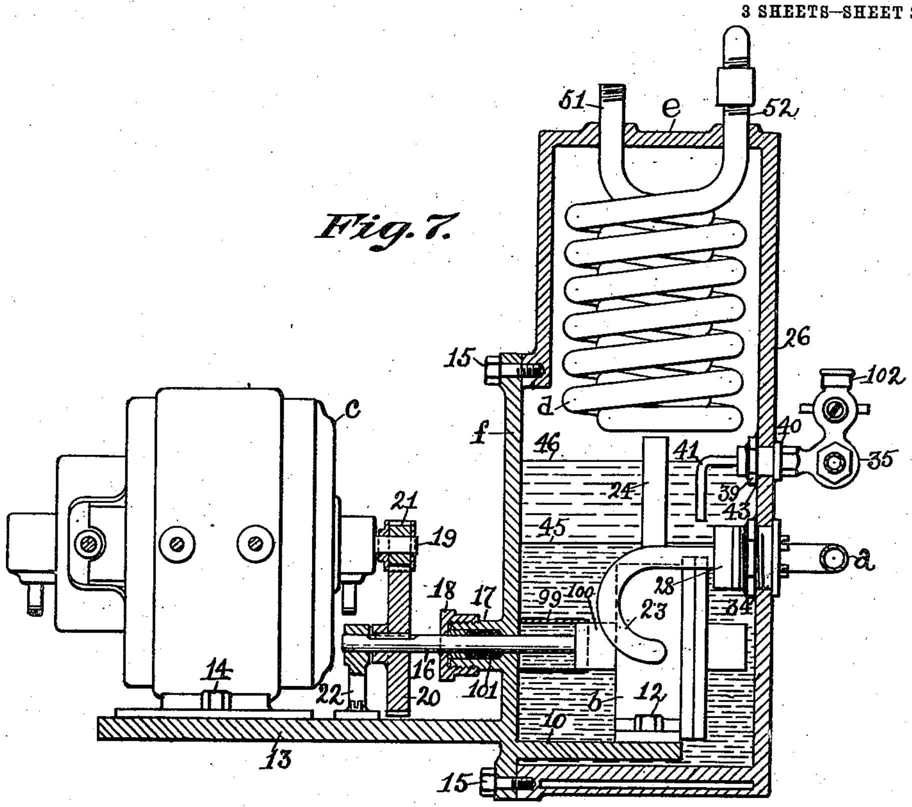


Fig. 8.

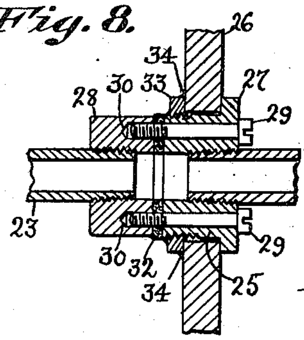


Fig. 9.

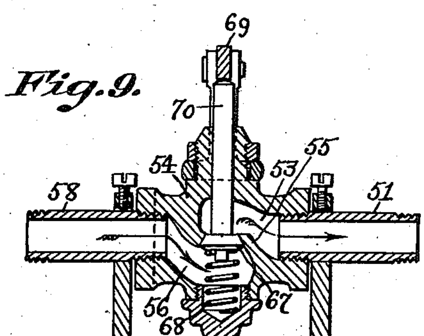
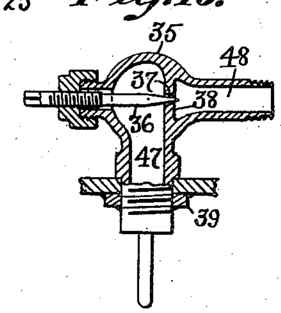


Fig. 10.



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UNITED STATES PATENT OFFICE.

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REFRIGERATING APPARATUS.

1,046,588. Specification of Letters Patent. Patented Dec. 10, 1912.

Application filed March 18, 1912. Serial No. 684,405.

To all whom it may concern:

Be it known that I, CYRUS H. HAPGOOD, a citizen of the United States, residing in Boston, county of Suffolk, and State of Massachusetts, have invented an Improvement in Refrigerating Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention relates to a refrigerating system or apparatus in which a relatively large volume of refrigerating medium or agent may be circulated preferably under a relatively low pressure, whereby a simple, compact, inexpensive and highly efficient apparatus may be obtained which is especially adapted for use in households, to obtain a maximum of refrigeration at a minimum cost.

To this end, I employ a rotary pump for circulating a refrigerating fluid in a closed circuit, which includes the said rotary pump, an expansion chamber or coil having a liquid inlet of relatively small area, in communication with the discharge or outlet side of the rotary pump, which has its suction side connected with the relatively large outlet end of the expansion chamber or coil, whereby a substantially constant fluid pressure is maintained on the suction side of the pump, and the supply of liquid to the expansion chamber is automatically regulated by the fluid pressure in the expansion chamber, and as a result hand or mechanical regulation of the feed of the liquid into the expansion chamber is dispensed with, and the desired or proper average fluid pressure in the expansion chamber required to obtain the proper temperature of the refrigerating chamber and maintain it at the desired point, is obtained.

The invention further has for its object to provide a simple and compact apparatus, which is capable of being assembled as a unit outside of the refrigerating chamber and of being secured to the outside wall of said chamber, with the expansion chamber or coil extended into the chamber through a slot or opening in a wall thereof. Provision is made for cutting in and out an electric motor employed to run the pump, and for opening and closing a valve controlling the flow of water to the condenser.

These and other features of this invention will be pointed out in the claims at the end of this specification.

Figure 1 is a plan view with parts broken away, of a refrigerating apparatus embodying this invention. Fig. 2, a diagram of circuits to be referred to. Fig. 3, a rear elevation of the refrigerating apparatus shown in Fig. 1 detached from the refrigerator. Fig. 4, a side elevation of the apparatus shown in Fig. 3 looking toward the right and with the cover removed. Fig. 5, a detail of the thermostatic circuit controller shown in Fig. 1. Fig. 6, a detail of the relay and valve controlled thereby. Fig. 7, an elevation and section of the apparatus shown in Fig. 3, and Figs. 8, 9 and 10, sectional details to be referred to.

In the present instance, I have shown one embodiment of the invention, which is especially designed for use in households, and which comprises an expansion chamber, preferably in the form of the coil *a* of pipes, a rotary pump *b*, an electric motor *c*, and a condenser *d*. For simplification, the condenser *d* and rotary pump *b* are located in a fluid-tight casing *e*, provided with a removable front wall or cover *f*, having extended from it into the casing, a shelf or platform 10, to which the rotary pump *b* is secured as by bolts 12, and having extended outwardly from it a platform or shelf 13 to which the electric motor *c* is secured as by the bolts 14. The removable cover *f* is secured to the casing *e* by screws or bolts 15.

The cover *f* is provided with an opening through it for the passage of the shaft 16 of the rotary pump, which shaft passes through a stuffing box 17 integral with the cover and having a removable cap 18. The shaft 16 may be coupled directly to the armature shaft 19 of the electric motor *c*, if the latter is a slow running motor, or it may be connected thereto, if a high speed motor, by suitable gearing herein shown as a gear 20 fast on the pump shaft 16 and a pinion 21 on the armature shaft, which meshes with the gear 20. The pump shaft

16 is supported at its outer end as herein shown by a standard 22 erected on the platform 13.

The rotary pump may be of any suitable construction, such for instance as shown in U. S. Patent No. 748707 dated Jan. 5, 1904 and its casing is provided with a suction or inlet pipe 23 and with a discharge or outlet pipe 24, which latter as herein shown is extended upwardly in the casing *e* to a level below the upper wall of the opening in the front of the casing which is closed by the cover *f*, so that the pump may be removed from within the casing with the cover *f*, without disconnecting it from the platform or shelf 10. The suction or inlet pipe 23 of the rotary pump is connected fluid-tight with one end of the expansion coil *a*, which may be effected as shown in Fig. 8. For this purpose, I employ a coupling comprising a sleeve or thimble 25, which is extended through a hole in an end wall 26 of the casing *e* and is provided with a flange 27, and a second sleeve 28 which is secured to the sleeve 25 by screws 29, which extend through the sleeve 25 and enter threaded sockets 30 in the sleeve 28.

The sleeve 25 is provided with internal screw threads, which are engaged by the outlet end of the expansion coil *a*, and the sleeve 28 is provided with internal screw threads which are engaged by the inlet pipe 23 of the pump. A tight joint between the sleeves 25, 28 is obtained by means of a lead or other washer 32. The sleeve 25 is firmly clamped to the end wall 26 of the casing, by a nut 33 which engages screw threads on the exterior of the sleeve 25, and which draws the flange 27 against the rear surface of the wall 26. The joint between the nut 33 and wall 26 may be made tight by solder or brazing indicated by the heavy black line 34, Fig. 8. The front or inlet end of the expansion coil *a* is secured to the end wall 26 of the casing *e* to be supported thereby, and in the present instance said inlet end is secured to a valve fitting 35 containing a needle valve 36, which coöperates with a port 37 in a wall 38 within the fitting. The valve fitting 35 is extended through a hole in the end wall 26 and is secured thereto by a nut 39 and flange 40, see Fig. 7, and said fitting has a liquid inlet pipe 41, which is in open communication with the interior of the casing *e* below the open end of the discharge pipe 24 of the rotary pump.

A fluid tight joint between the nut 39 and casing may be effected by solder or brazing, indicated by the heavy black line 43 in Fig. 7.

The casing *e* is designed to contain glycerin or other fluid lubricant up to a level below the mouth of the inlet pipe 41 for the expansion coil, and if a refrigerating liquid lighter than oil is used, the inlet pipe 41 terminates above the level of the rotary pump, as herein shown, and the oil fills the casing up to about the dotted line 45, and the refrigerating medium or agent is used in such quantity as to cover the mouth of the inlet pipe 41 for the expansion coil and preferably not cover the mouth of the outlet pipe 24 for the pump, the upper surface of the liquid refrigerating agent being indicated by the dotted line 46. The liquid refrigerant passes through the pipe 41 into the inlet passage 47 of the valve fitting 35, and if the needle valve 36 is open, the liquid passes through the port 37 into the outlet passage 48 of the fitting, and thence into the expansion coil *a*, wherein it vaporizes and from which it is drawn through the inlet pipe 23 by the rotary pump and discharged through the outlet pipe 24 into the casing, wherein the vapor is condensed and falls down onto the body of liquid refrigerant therein. It will thus be seen, that the refrigerant is circulated through a closed system, which includes the rotary pump, an expansion chamber, and, in the construction herein shown, includes the casing *e*. The casing *e* also contains within it a condenser in the form of a coil *d* of pipe, which has its inlet and outlet ends 51, 52 extended through the top of the casing. The inlet end 51 of the coil is connected with a source of water supply, and in the present instance said inlet end of the condenser *d* is connected to the outlet passage 53 of a valve fitting 54, see Fig. 9, which is provided with a partition wall 55 having a port which connects the outer passage 53 with an inlet passage 56 of the valve fitting.

The inlet passage 56 has connected to it a pipe 58 which is connected with the supply of cold water, such as the cold water pipe of the house in which the refrigerating plant is located. The outlet end 52 of the condenser or coil *d* is connected with a passage 60, see Fig. 4, formed in one upright wall 61 of the casing *e*, which passage connects with a passage 62 in the bottom wall of the casing, and the latter passage connects with a passage 63 in the opposite upright wall 64 of the casing, with which latter passage is connected the waste or discharge pipe 65, which may be run to any suitable place, as for instance the sink. The circulation of water through the condenser is controlled by a valve 67 coöperating with the port in the wall 55 of the valve fitting 54, and in the present instance said valve is closed by a spring 68 and is opened by a lever 69 acting on the stem 70 of the valve. The lever 69 is pivoted at one end to a bracket 71 attached to the valve fitting 54 and carries the armature 72 of an electromagnet or relay 73. The lever 69 also constitutes the movable member of a circuit controller, and coöperates with the stationary member 74 thereof, see Figs. 1 and 6, said circuit controller governing the circuit of the electric motor *c*, see Fig. 2.

When the electromagnet 73 is energized, the lever 69 is moved to open the valve 67 and also to close the circuit of the motor *c*. The electromagnet 73 is in turn controlled by a thermostatic circuit controller, located in the refrigerating chamber 75 of an ice chest or refrigerator 76 of any suitable or usual construction. The thermostatic circuit controller may and preferably will be made as herein shown, see Figs. 1 and 5, and consists of a tube 80 preferably of glass, terminating at its ends in closed bulbs 81, 82, said tube being suitably pivoted as by means of a cross bar 83 having knife edges at its ends which rest on the walls of circular openings 84 in metal uprights 85 erected upon a base plate 86. The tube 80 is filled with liquid 87, preferably mercury, and the pivot bar 83 has attached to it a metal arm 88, which constitutes the movable member of a circuit controller, the coöperating member of which is shown as a metal plate 89, supported by a block 90 of insulating material which is secured to the metal base plate 86. The larger bulb 81 is designed to be filled with a liquid sensitive to heat, such as ether, methyl alcohol, or the like, while the bulb 82 is filled with a fluid such as air which is compressible. The liquid in the bulb 81 responds to slight changes in temperature, and when heated it expands in the bulb and forces the mercury 87 through the tube 80 into the bulb 82, thereby compressing the fluid therein and adding weight to this end of the tube, which descends and brings the member 88 of the circuit controller into contact with the member 89, thereby closing the circuit of the electromagnet 73. As soon as the temperature is lowered, the liquid in the bulb 81 contracts and the mercury runs back into the bulb 81 from the bulb 82, and the tube turns on its pivot and opens the switch or circuit controller.

The thermostatic circuit controller is located in the refrigerating chamber 75, and may be inclosed in a suitable protective casing (not shown). The electromagnet 73 and the circuit controller for the motor *c* may be inclosed in a suitable casing 91. The thermostatic circuit controller is provided with means for regulating the temperature at which the circuit of the electromagnet or relay 73 should be closed and opened, herein shown as an adjustable weight in the form of a collar 92, which is free to be moved longitudinally on the tube 80. The electric circuits for the motor *c* and the relay or electromagnet 73 are represented in diagram in Fig. 2, and by reference thereto, it will be seen that the relay 73 is in series with the thermostatic circuit controller and is connected with the line wires 93, 94 in a manner well understood, whereas the electric motor *c* and its controlling switch 69, 74 are in series and connected by a separate circuit with the line wires 93, 94.

By reference to Figs. 1, 3, 4 and 7, it will be observed, that the expansion coil *a* is affixed to the casing *e*, which also supports the rotary pump *b* and the electric motor *c*, so that the apparatus is a unit and can be handled and shipped as such, ready to be affixed to the refrigerator or ice chest 76, which need only have a slot cut in one of its walls for the passage into it of the expansion coil, after which the casing can be secured to the refrigerator by screws or bolts 95 passed through lugs 96 on the casing *e*. After the apparatus has been secured to the refrigerator, the slot through which the expansion coil is passed, may be closed in any suitable manner. The condenser *d* is then connected with the valve fitting 54 in the box 91 containing the relay 73, and the thermostatic circuit controller 80 is located in the refrigerating chamber, and the proper electrical connections made.

By reference to Fig. 7, it will be seen that the rotary pump is submerged in lubricant and as a result, the pump is properly lubricated to run indefinitely, and provision is made for the passage of the lubricant into the interior of the pump. To restrict agitation of the lubricating oil in the casing *e* the pump shaft 16 is inclosed by a sleeve 99 fitted over one of the bearing hubs 100 and extended to the cover plate *f*.

The stuffing box 17 contains a packing of Peruvian raw hide 101 or other suitable material capable of withstanding the action of the glycerin or other oil.

A sufficient quantity of liquid refrigerant is added to the casing through the air cock 102 of the valve fitting 35, to bring the refrigerant up to the level of the line 46. In operation, the needle valve 36 is adjusted to uncover sufficient of the port 37 to supply the proper amount of liquid refrigerant to the expansion coil, to obtain the desired degree of cold in the refrigerating chamber 75, which is produced by the evaporation of the liquid refrigerant into gaseous form, which is drawn through the expansion coil *a* by the rotary pump *b* and discharged into the casing *e* through the outlet pipe 24 for the rotary pump. The gas discharged by the rotary pump is liquefied by the condenser, and the liquid refrigerant thus produced drops onto the body or layer of refrigerant which floats on the body of glycerin or other oil.

After the needle valve 36 has been once adjusted to supply the proper amount of liquid refrigerant to the expansion coil necessary or desired to obtain a given pressure in the expansion coil, and thereby obtain the desired temperature in the refrigerating chamber, said valve needs no further attention, for the gaseous pressure in the expansion coil or chamber automatically regulates the supply of liquid refrigerant into the expansion chamber, owing to a substantially constant pressure being maintained by the rotary pump on the suction side of said pump. As a result, adjustments of the expansion or needle valve by hand or mechanically after the apparatus has been started in operation, so as to regulate the supply of liquid refrigerant to the expansion coil to meet the changes of temperature in the condenser, are avoided.

By means of the rotary pump, which exerts a continuous or substantially continuous pull on the gases in one direction in the expansion chamber, a substantially constant presure in the expansion chamber and on the suction side of the pump is obtained.

The rotary pump is especially adapted for handling refrigerants which yield substantially large volumes of gas at relatively low pressures, such for instance as ether, rhigolene, cymogene, carbon bisulfid, carbon tetrachlorid, acetone, sulfur dioxid, methyl ether and the like, and as a rotary pump of small size is capable of handling a large volume of gas, said pump is especially applicable for use in refrigerating apparatus of small size suitable for use in households, which plant can be made small and compact, inexpensive in cost, installation and maintenance, and highly efficient in service, as the desired refrigeration can be produced at a minimum expense and with a plant of minimum size, inasmuch as the refrigerating capacity of the refrigerating plant is increased materially by the use of the rotary pump.

Furthermore by means of the rotary pump a practically valveless system or plant is obtained, as the supply of liquid refrigerant to the expansion chamber or coil is automatically regulated by the gas pressure in said chamber coil, which pressure is maintained substantially constant by the rotary pump.

In the present instance, the internal heat generated by the rotary pump is taken care of by connecting the casing *e* containing the pump with the condenser *d*, whereby the condensing fluid is circulated around the body of lubricant within the casing. In other words, the casing *e* forms part of the condenser in the apparatus herein shown, and also forms a cooling jacket for the rotary pump.

Assume that the apparatus has been applied to a refrigerator or ice chest as represented in Fig. 1, and that the weight 92 has been adjusted on the tube 80 to maintain the circuit of the relay 73 open when the temperature of the refrigerating chamber reaches a predetermined point, say for instance 36° F. In this case, the motor is cut out of circuit and the rotary pump is stopped and the flow of water through the condenser is interrupted. The parts remain in this condition until the temperature of the refrigerating chamber 75 has risen to a predetermined point say 38°, whereupon the thermostat operates as above described to close the circuit of the relay 73, which is energized and moves the lever 69 to open the valve 67 and to close the circuit of the motor *c*, which latter starts up and drives the rotor of the pump *b*. The rotary pump establishes a circulation of the refrigerant by drawing the refrigerant in gaseous form from the expansion coil *a* and discharging it into the casing *e*, where it comes in contact with the condenser *d* and the walls of the casing and is condensed into liquid form, which descends in the casing and accumulates on the body of oil, when the refrigerant used is lighter than oil, as in the present case, in which rhigolene is supposed to be used. The liquid rhigolene passes through the pipe 41 into the fitting 35 and through the port 37 into the expansion coil or chamber *a* and expands therein into gaseous form, thereby producing cold in the refrigerating chamber 75. The rotary pump handles a large volume of refrigerant and continues to draw it from the expansion coil and discharge it into the casing *e*, from which it flows again into the expansion coil. A circulation of a relatively large volume of refrigerant is thus maintained until the temperature of the refrigerating chamber has been lowered to the predetermined point, namely 36° in the supposed instance, whereupon the thermostat operates to open the circuit of the relay 73, which is deënergized and allows the spring 68 to close the valve 67 and through the valve stem 70 to move the lever 69 and open the circuit of the motor *c*, which stops and with it stops the rotary pump, thereby interrupting the circulation of the refrigerant until the temperature of the refrigerating chamber has again risen sufficiently to cause the thermostat to again close the circuit of the relay 73. The rotary pump discharges the refrigerant in gaseous form mixed with lubricant, and the latter being materially heavier than the refrigerant and not miscible therewith readily separates therefrom and descends in the casing *e*.

By reason of the fact that the circulation of the refrigerating fluid is effected by means of a rotary pump, the pressures in the casing *e* and in the expansion chamber or coil *a* are very quickly equalized after the pump is stopped, due to the fact that the rotary pump when inactive is not required to be fluid-tight, but affords opportunity for this equalization of the pressures, thus dispensing with the use of any mechanical means for equalizing the pressure.

The expansion coil herein shown is arranged so that in case any lubricant should pass into it through the inlet pipe 41, it would gravitate to the lower portion of the expansion coil, which is on a level, and would be carried with the gases back to the rotary pump and be discharged thereby into the casing, thus keeping the expansion coils free or substantially free from lubricant, and preventing the accumulation of lubricant in the expansion coil and consequently maintaining the latter in its most effective condition.

The lubricant envelops the pump shaft 16 and thereby seals the casing against the escape of the refrigerant, consequently the system is hermetically sealed to the escape of the refrigerant.

In the present instance, I have described the refrigerant as lighter than oil, but it is not desired to limit the invention in this respect as a refrigerant heavier than oil can be used by extending the inlet pipe 41 down toward the bottom of the casing *e* so as to be covered by the body of refrigerant in said casing below the body of oil. So also I have shown the invention as embodied in an apparatus which is especially designed to be of small size and used with the refrigerator used in households, but it is not desired to limit the invention in this respect as the apparatus can be readily enlarged or modified to enable it to be used with larger refrigerators, as for instance in provision and like stores. I prefer to use the thermostatic circuit controller herein shown as the same is extremely sensitive to temperature changes, and as it can be used in other relations than that herein shown, it is not herein claimed broadly, but will be made the subject matter of another application.

Claims:

1. In a refrigerating apparatus, in combination, a refrigerator, an expansion chamber for a refrigerating medium located in said refrigerator, a casing located outside of said refrigerator, a rotary pump located in said casing and having its inlet pipe connected with the outlet end of said expansion chamber, and having its outlet pipe discharging into said casing, a valve fitting having an inlet passage in open communication with said casing to receive liquid refrigerant therefrom and an outlet passage connected with the inlet end of said expansion chamber, a valve in said fitting, an electric motor supported by said casing on the outside thereof and having its armature shaft connected with the rotary pump to drive the same, a condenser located in said casing, a valve controlling the flow of condensing fluid through said condenser, an electromagnet controlling said valve, a circuit controller for the motor governed by said electromagnet, and a thermostatic circuit controller located in said refrigerator and controlling the operation of said electromagnet, substantially as described.

2. In a refrigerating apparatus, in combination, a casing for containing a liquid refrigerant and a fluid lubricant, a rotary pump located in said casing and having its shaft extended outside thereof, an electric motor connected with said shaft to drive said pump, and an expansion chamber for the refrigerant located outside of said casing and supported thereby and having its inlet end in open communication with said casing and its outlet end connected with the suction side of said rotary pump, substantially as described.

3. In a refrigerating apparatus, in combination, a casing provided with an opening in one of its side walls, a cover for said opening having a shelf extended from one side thereof into said casing and having a second shelf extended outwardly from said casing, a rotary pump supported by the shelf within said casing, a motor supported by the shelf outside of said casing, and means for connecting the said motor with the shaft of said rotary pump, and an expansion chamber located outside of said casing and having a fluid inlet communicating with the casing and an outlet connected with the suction side of said rotary pump, substantially as described.

4. In a refrigerating apparatus, a casing, a rotary pump located therein, an electric motor located outside of said casing and connected with the said rotary pump to drive the same, and an expansion chamber located outside of the casing and supported thereby and having its outlet end connected with the suction side of said rotary pump, substantially as described.

5. In a refrigerating apparatus, in combination, a casing for containing a body of fluid lubricant, a rotary pump located in said casing and immersed in said lubricant, said rotary pump having a fluid inlet and a fluid outlet and an expansion chamber connected with the fluid inlet for said rotary pump, and having a fluid inlet in communication with said casing, substantially as described.

6. In a refrigerating apparatus, in combination, an expansion chamber provided with a relatively small inlet for liquid refrigerant and a relatively large outlet for gaseous refrigerant, a casing for containing a body of fluid lubricant and a body of liquid refrigerant, a pipe connected with the inlet end of the expansion chamber and extended into said casing to supply liquid refrigerant to said expansion chamber, a rotary pump in said casing having its suction inlet connected with the outlet end of said expansion chamber, and having its outlet pipe discharging into said casing and a

condenser for the gaseous refrigerant discharged by said rotary pump, substantially as described.

7. In a refrigerating apparatus, in combination, a casing for containing a fluid lubricant and a liquid refrigerant, an expansion chamber located outside of said casing and provided with a relatively small inlet pipe extended into the casing to receive liquid refrigerant therefrom and having a relatively large outlet for gaseous refrigerant extended into said casing, a rotary pump supported in said casing, and having its suction inlet connected with the outlet for the expansion chamber, and having its outlet pipe in open communication with said casing, and a condenser located in said casing, substantially as described.

8. In a refrigerating apparatus, in combination, a casing for containing a fluid lubricant and a liquid refrigerant, a condenser in said casing, an expansion chamber, a rotary pump having its inlet connected with the outlet of said expansion chamber and its outlet discharging into said casing, and an inlet pipe for said expansion chamber communicating with said casing to receive fluid refrigerant from said casing, substantially as described.

9. In a refrigerating apparatus, in combination, an expansion chamber having an inlet for liquid refrigerant, and an outlet for gaseous refrigerant, a rotary pump having its suction inlet connected with the outlet for the expansion chamber, and a casing for connecting the outlet for said pump with the inlet for said expansion chamber to establish a circulation of refrigerant through said expansion chamber, substantially as described.

10. In a refrigerating apparatus, in combination, a stationary expansion chamber, a refrigerating chamber in which said expansion chamber is located, a stationary casing attached to said refrigerating chamber and a rotary pump loc..ed in said stationary casing and provided with a suction inlet connected with the outlet end of said expansion chamber, and having its outlet in communication with said expansion chamber, substantially as described.

11. In a refrigerating apparatus, in combination, an expansion chamber having a fluid inlet and a fluid outlet, a rotary pump having its inlet connected with the outlet of said expansion chamber and provided with a fluid outlet, means for containing a body of liquid lubricant so as to surround the shaft of said rotary pump and seal the pump against the escape of refrigerant along said shaft, and means for connecting the outlet of said pump with the inlet for said expansion chamber.

12. In a refrigerating apparatus, in combination, a casing, a rotary pump located in said casing and provided with an inlet pipe extended outside of said casing, and with an outlet pipe discharging into said casing, an expansion chamber located outside of said casing and provided with an inlet pipe extended into said casing, substantially as described.

13. In a refrigerating apparatus, in combination, a casing, a rotary pump located in said casing and provided with an inlet pipe extended outside of said casing and with an outlet pipe discharging into said casing, an expansion chamber located outside of said casing and provided with an inlet pipe extended into said casing, and a condenser located in said casing, substantially as described.

14. In a refrigerating apparatus, in combination, a casing for containing a body of fluid lubricant and a body of liquid refrigerant, a rotary pump located in said casing and having its shaft extended through a wall of the casing to the outside thereof and surrounded by said fluid lubricant to seal the casing against the escape of the refrigerant along said shaft to the outside of said casing, and an expansion chamber having a fluid inlet communicating with the said casing to be supplied with liquid refrigerant therefrom and having a fluid outlet connected with the inlet of said pump.

15. In a refrigerating apparatus, in combination, a casing, a rotary pump located therein, an expansion chamber located outside of the casing and supported thereby and having its outlet end connected with the suction side of the said rotary pump, and means to rotate said pump.

16. In a refrigerating apparatus, in combination, a casing provided with an opening in one of its walls, a cover for said opening having a shelf extended from one side thereof into said casing, a rotary pump supported by said shelf within the said casing and having its shaft extended through said cover to the outside of said casing, means to rotate said shaft and an expansion chamber located outside of said casing and having a fluid inlet communicating with the casing and an outlet connected with the suction side of said rotary pump, substantially as described.

17. In a refrigerating apparatus, in combination, an expansion chamber having an inlet for liquid refrigerant and an outlet for gaseous refrigerant, a rotary pump having its suction inlet connected with the outlet for the expansion chamber, and a substantially fluid-tight casing into which the fluid outlet for the rotary pump discharges and with which the fluid inlet for the expansion chamber is in open communication, whereby the pressure between said expansion chamber and said casing may be automatically equalized when said pump is stopped.

18. In a refrigerating apparatus, in com-

bination, a casing, a rotary pump located in said casing and immersed in a body of fluid lubricant, an expansion chamber located outside of said casing and having its fluid outlet connected with the inlet for said rotary pump, and its fluid inlet in communication with said casing, a condenser, and a water jacket for said casing connected with said condenser, substantially as described.

19. In a refrigerating apparatus, in combination, a substantially fluid-tight casing, an expansion chamber located outside of said casing and having an inlet for liquid refrigerant in open communication with said casing, and a rotary pump located in said casing and having its inlet connected with the outlet for said expansion chamber and its outlet in open communication with said casing, for the purpose specified.

20. In a refrigerating apparatus, in combination, an expansion chamber, a rotary pump having its inlet connected with the outlet for said expansion chamber, and a substantially fluid-tight casing in open communication with the inlet for the said expansion chamber and with the outlet for said rotary pump, and a condenser located in said casing, for the purpose specified.

21. In a refrigerating apparatus, in combination, a substantially fluid-tight casing, an expansion chamber located outside of said casing, and a rotary pump located in said casing and having its inlet port connected with the outlet for said expansion chamber and its outlet in open communication with the said casing, said expansion chamber having its inlet in communication with said casing, for the purpose specified.

22. In a refrigerating apparatus, in combination, a substantially fluid-tight casing, an expansion chamber located outside of said casing, a rotary pump located in said casing and having its inlet port connected with the outlet for said expansion chamber and its inlet in open communication with the said casing, said expansion chamber having its inlet in communication with said casing, and a condenser located in said casing, substantially as described.

23. In a refrigerating apparatus, in combination, an expansion chamber provided with a fluid inlet and a gaseous outlet, the latter being located below the said inlet to allow fluid to gravitate through the expansion chamber from the inlet to the outlet, a rotary pump having its inlet connected with the outlet for the expansion chamber and having its outlet discharging at a level above the inlet to the expansion chamber, and a casing for containing liquid refrigerant below the level of the inlet for the expansion chamber and connected therewith and with which casing the outlet for the rotary pump communicates, for the purpose specified.

24. In a refrigerating apparatus, in combination, an expansion chamber, a rotary pump, means for connecting the inlet of said pump with said expansion chamber for the gravitation of liquid from said expansion chamber to said pump, a supply chamber for liquid refrigerant located below the liquid inlet for said expansion chamber and communicating therewith, and with which the outlet for said rotary pump is in communication, for the purpose specified.

25. In a refrigerating apparatus, in combination, a casing for containing a body of fluid lubricant and a liquid refrigerant, an expansion chamber connected with said casing to receive liquid refrigerant therefrom, and a rotary pump located in said casing and having its inlet communicating with the outlet for the expansion chamber and its outlet communicating with said casing, said rotary pump being protected from contact with the liquid refrigerant by the body of fluid lubricant.

26. In a refrigerating apparatus, in combination, an expansion chamber provided with a fluid inlet and a gaseous outlet, the latter being located below the said inlet to allow fluid to gravitate through the expansion chamber from the inlet to the outlet, a rotary pump having its inlet connected with the outlet for the expansion chamber, a casing for containing liquid refrigerant with which the outlet for the rotary pump communicates and with which communicates the inlet for the expansion chamber.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

CYRUS H. HAPGOOD.

Witnesses:

JAS. H. CHURCHILL,

J. MURPHY.