Aug. 16, 1932. W. G. ABBOTT, JR 1,871,645

REFRIGERATING MACHINE

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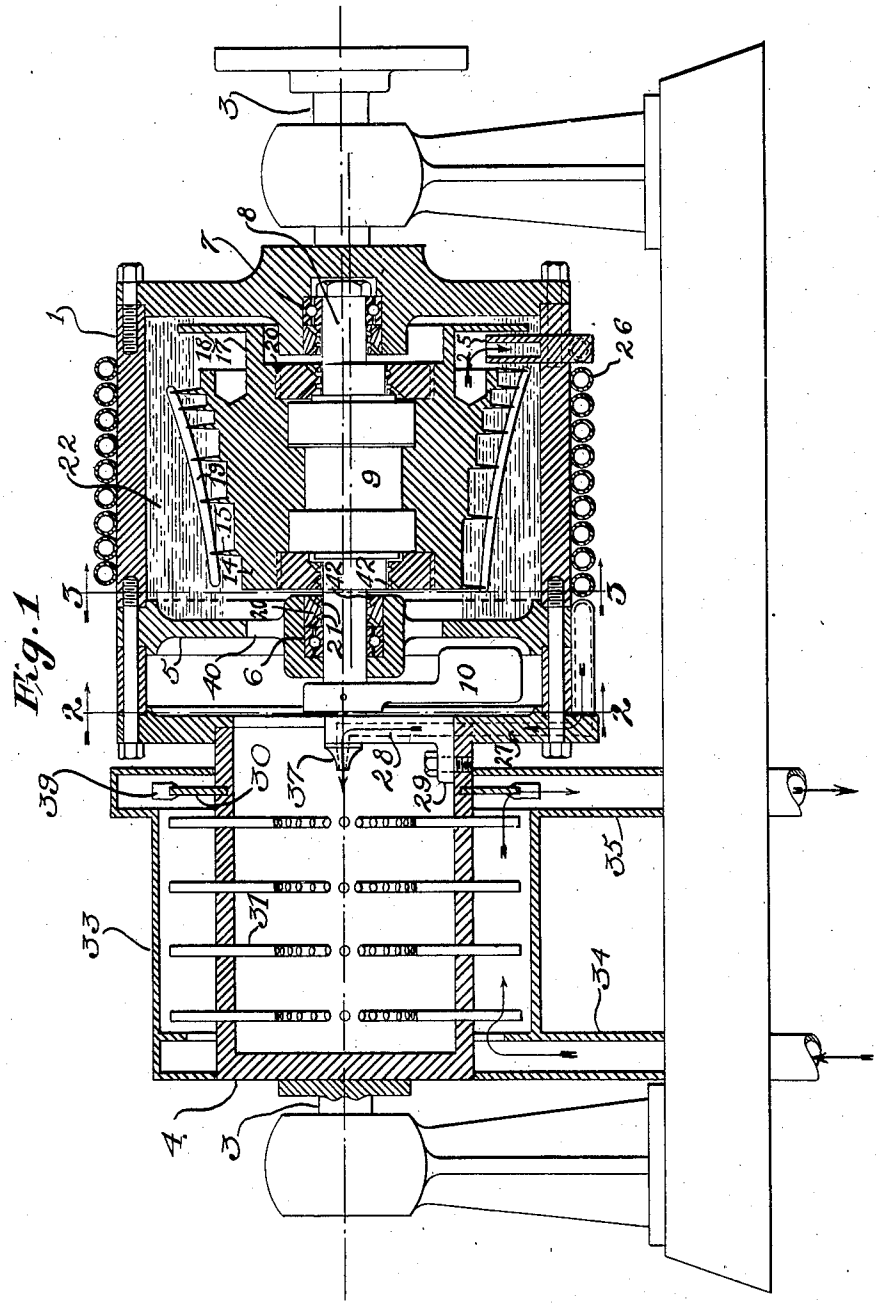


Fig. 1

Inventor:
William G. Abbott, Jr.
By Roberts Cushman & Woodberry
Att'ys.

Aug. 16, 1932. W. G. ABBOTT, JR 1,871,645

REFRIGERATING MACHINE

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Fig. 2

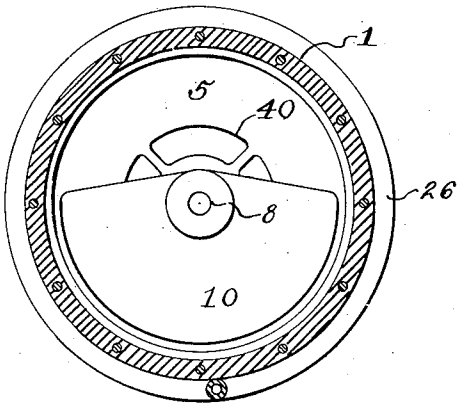


Fig. 3

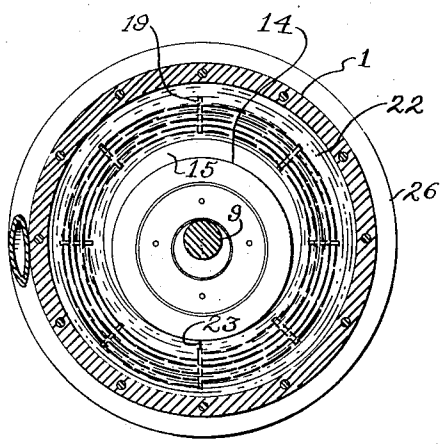
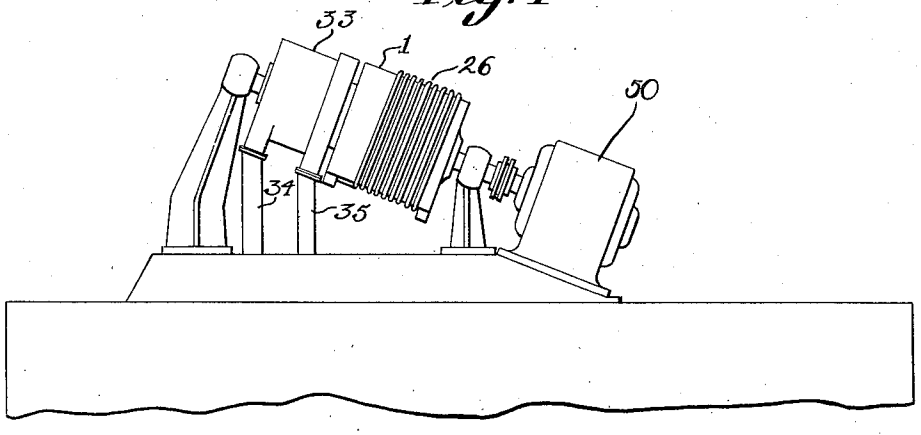


Fig. 4



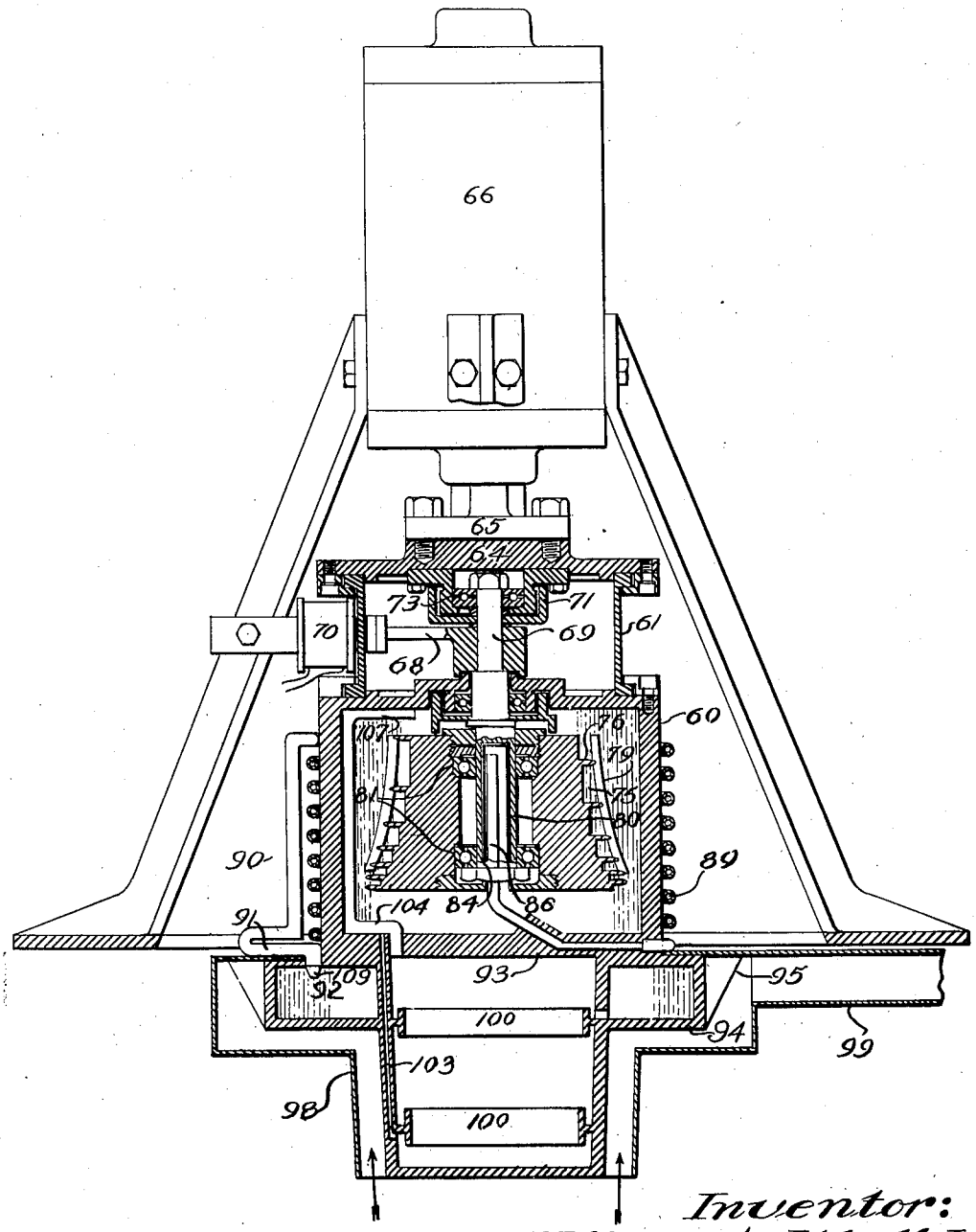
Inventor:
William G. Abbott, Jr.
By Roberts Cushman & Woodbury
Attys.

Aug. 16, 1932. W. G. ABBOTT, JR 1,871,645

REFRIGERATING MACHINE

Filed June 30, 1928 4 Sheets-Sheet 3

Fig. 5



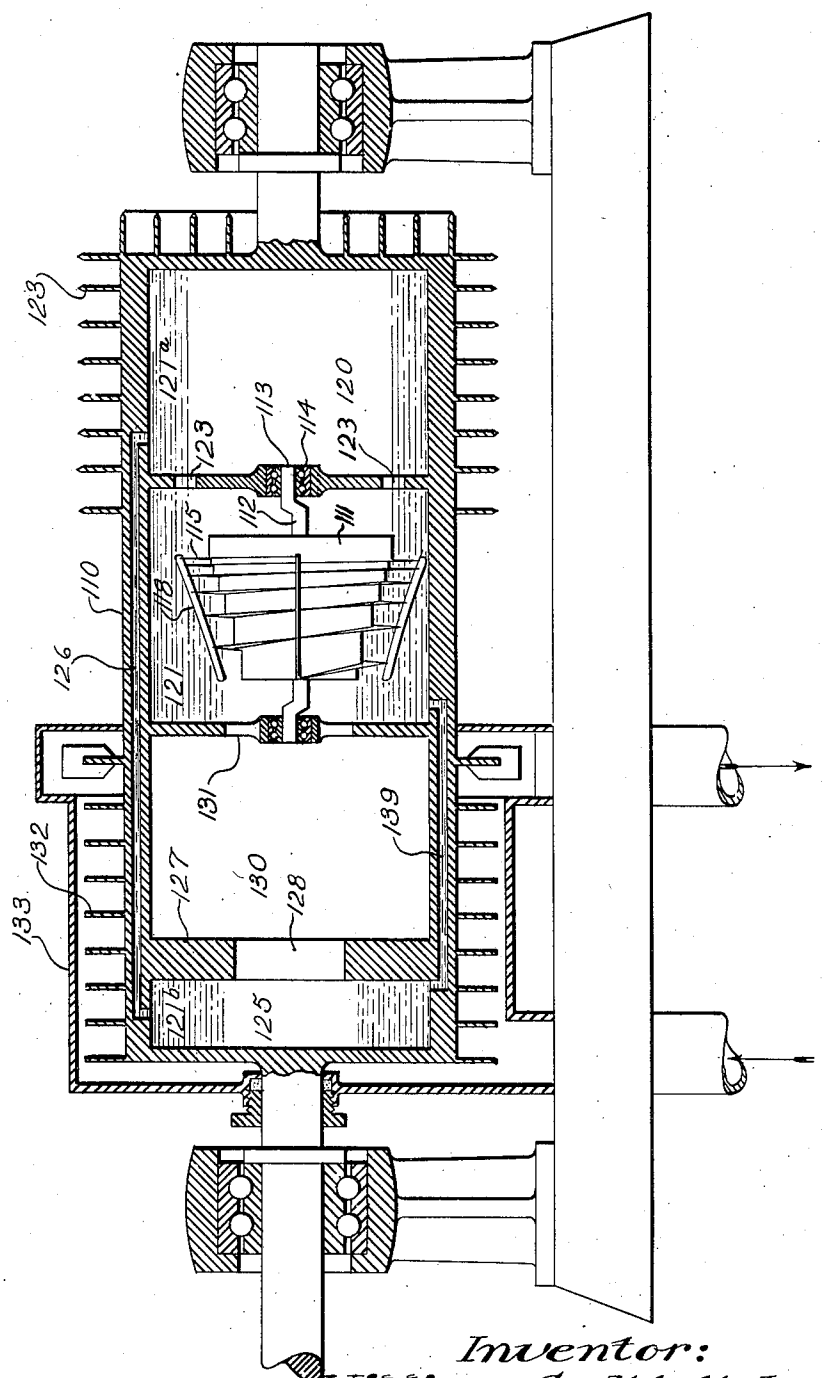
Inventor:
William G. Abbott, Jr.
by Roberts, Cushman & Woodberry.
Attys.

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REFRIGERATING MACHINE

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Fig. 6



Inventor:
William G. Abbott, Jr.
by Roberts, Cushman & Woodberry
Atty's.

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UNITED STATES PATENT OFFICE

WILLIAM G. ABBOTT, JR., OF MILFORD, NEW HAMPSHIRE

REFRIGERATING MACHINE

Application filed June 30, 1928. Serial No. 289,432.

This invention relates to an improved type of refrigerating machine of the compressor type, and to various features of the compressor or pump which are advantageous in machines of this type.

My United States Patent No. 1,102,222 discloses a rotary pump which makes use of a rotating annulus of liquid, the latter cooperating with an inner member in providing fluid pockets and in varying the effective size of the latter, thus compressing the fluid. A compressor of this character is highly efficient and is adapted to high speed operation without objectionable noise or vibration. In addition to those general advantages, a compressor of this type is particularly advantageous when incorporated in a refrigerating machine of the character herein disclosed wherein the refrigerant cooler or condenser is located upon the rotary casing of the compressor or is secured thereto so that the comparatively high speed of rotation is imparted to the refrigerant cooler which accordingly may be of moderate dimensions. Furthermore, a compressor of the indicated type is particularly advantageous and efficient when used for pumping refrigerant, since the liquid annulus or ring may be arranged to maintain the fluid being compressed at a temperature lower than that which it would generally possess in compressors of the conventional type. Thus this part of the refrigerant cycle may approach the conditions characteristic of isothermic compression rather than adiabatic compression, thereby enhancing the efficiency of the machine. Furthermore, a refrigerating machine of this type may be provided with a rotary cooling unit which is particularly adapted to absorb heat from a circulating cooling medium such as brine, air, or the like.

The particular structural embodiment of the invention which is provided herein permits the essential moving parts of the machine to be located within a single rotary unit or casing which may be sealed and filled with a suitable liquid or liquids and thereupon will need no further care for a long period of time.

Furthermore, the utilization of a centrifugally held liquid body cooperating with a rotor to provide fluid pockets of varying capacity to effect compression of the pocketed fluid results in the provision of pumping means wherein the maximum pressure is definitely limited by the artificial head of the centrifugally held body of liquid. In other words, development of excessive fluid pressure in the liquid pockets would cause so great a displacement of the surrounding liquid that the liquid seal would become broken and the pocketed vapor would be released. Thus automatically operable pressure-relieving means is inherent in apparatus of this character.

Accordingly objects of the invention among others are to provide silent and compact refrigerating machine which is highly efficient, which is adapted to be substantially self-contained, which is automatically protected against the occurrence of excessive internal pressures, which is free from the need of frequent attention, and which generally is an improvement upon the state of the art.

In the drawings,

Fig. 1 is a central sectional view through one embodiment of the improved machine;

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

Fig. 3 is a section on line 3—3 of Fig. 1;

Fig. 4 is an elevational view of the machine as located upon the top of a conventional refrigerator;

Fig. 5 is a central section through another form of machine; and

Fig. 6 is a similar view of another embodiment of the invention.

Referring to the accompanying drawings and more particularly to Fig. 1 thereof, it may be seen that my improved refrigerating machine comprises a rotatable casing or drum 1 having a suitable extension 4, the casing and extension forming a sealed unit, which is mounted upon axial supports 3, and the axis of rotation of said casing passing through, or being included by, said casing. Adjoining one end of the casing 1 is a partition 5, the intermediate portion of which carries a suitable bearing 6, while the opposite end of casing 1 carried a similar bearing 7. A shaft 8 is rotatably mounted with-

in bearings 6 and 7 and is provided with an intermediate offset or throw 9 to provide an axis eccentrically disposed in relation to the axis of rotation of the drum 1 and to the centers of bearings 6 and 7. Depending from the end of the shaft 8 adjoining the partition 5 is a weight or pendulum 10, a suitable space or chamber being formed between the partition 5 and the adjoining end of the casing to receive the same. It is evident that the weight of member 10 serves to hold the eccentric portion or throw of shaft 8 in position and to prevent the same from rotating in response to the rotation of drum 1.

Mounted upon the eccentric portion 9 of this shaft is an inner rotor 14, adapted to rotate about an included axis. The latter carries a helical fin 15 and gradually increases in diameter from the end adjoining the partition 5 to the end which adjoins the outer wall of drum 1. The spiral flange 15 is also arranged to define a helical passage of decreasing width as it approaches the larger end of rotor 14. The large end of the rotor is preferably provided with an extension 17 of reduced diameter which carries an annular flange 18 to cooperate with a liquid annulus 22 described below in providing a high pressure chamber. Secured upon the edge of helical member 15 are a series of blades 19, Figs. 1 and 3, these blades and/or the helical member 15 being suitably notched, and the blades and the helical member 15 being welded or otherwise secured to each other.

The bearings 6 and 7 are the bearings upon shaft 8 about which rotor 14 rotates and are each provided with suitable lubricant supplying members 20. These members may be provided with a plurality of circular grooves 21 adjoining the respective shafts, suitable diagonal ducts 22 being provided to permit lubricant to flow to these grooves and from the same under the influence of centrifugal force to the adjoining bearings.

Located within drum 1 is a suitable body of liquid 22 which upon rotation of the casing at comparatively high speed will form a liquid annulus due to the action of centrifugal force. Due to the eccentric mounting of rotor 14 in relation to casing 1 and consequently in relation to this liquid annulus, a series of crescent shaped pockets, Fig. 3, are formed within each of the turns of the helical passage. A suitable body of fluid to be compressed is caught in the first convolution of the passage and, upon rotation of rotor 14 in relation to the liquid annulus, passes through the passage which gradually decreases in size; thus the fluid is compressed as it approaches the flange 18 which projects into the liquid annulus to form a gas-tight seal at this point. As the capacity of the convolutions decreases, the increasing pressure of the trapped fluid tends to distort or displace the inner surface of the liquid annulus, and accordingly the diameter of the rotor is correspondingly increased so that a suitable liquid seal is maintained about all portions of the edge of the helical flange except the entering end thereof designated by numeral 23, Fig. 3, which alternately projects into the uncompressed fluid at the small end of the rotor and is immersed entirely in the liquid annulus.

A suitable pipe 25 projects into the space between flange 18 and the end of the helical member 15, the open end of this pipe being located radially inward from the inner surface of the liquid drum so that the compressed refrigerant passes into pipe 25. A continuation of this pipe forms the refrigerant cooling or condensing coil 26 which preferably is formed of helically disposed piping arranged about the outer surface of drum 1. The opposite end of this spiral duct adjoining the pendulum chamber is connected to an inwardly extending passage 27 which in turn has a continuation provided by a passageway 28 in a suitable bracket 29 secured to the interior of the cooler 4. Bracket 29 provides a suitable tapered nozzle or expansion outlet 37 for the compressed refrigerant, this nozzle preferably being arranged to direct the latter in a direction substantially parallel to that of the axis of rotation of casing 1.

The cooler is arranged to surround the outlet of nozzle 37 and may carry heat conducting elements 31 in the shape of copper rods, fins or the like which project inwardly through the walls of casing 4 and outwardly beyond the same. A fixed chamber or jacket 33 may be located about these fins, being connected with suitable ducts 34 and 35 through which any suitable cooling medium such as air is circulated to and away from the heat conductors 31. The casing 4 may carry an annular flange 30 at the periphery of which are secured a plurality of vanes or fins 39 which are adapted to be rotated at high speed due to the rotation of casing 4, these fins being arranged to aid the natural circulation of the cooling medium through casing 33, it being evident that the cooling medium thus passes the rapidly moving heat conductors 31 and quickly gives its heat up to the same being impelled during this movement by the vanes 39 so that it passes back in a cooled condition to the cooler proper within the refrigerator or to any other suitable region where cooling or refrigeration is desired. Suitable openings 40 are provided in the partition 5 to permit the expanded and heated refrigerant to return to the pumping chamber.

In practice a machine of this character may have its axis of rotation tilted to the horizontal as indicated in Fig. 4 so that there will be a tendency for liquid which accidentally passes into the pendulum chamber to re-

turn to the compression chamber within casing 1. If desired a magnet (rather than gravity) may be arranged to attract the metal member 10 to hold shaft 8 from rotating.

In the operation of a machine of this character, any suitable fluid may be utilized to provide the liquid drum, carbon tetrachloride or mercury for example being advantageous for this purpose, due to their comparatively high weights. Any suitable refrigerant, such for example as ethyl chloride, may be used within this machine, while the cooling medium passing about the cooler may be air, brine or the like. It is evident that rotation of the casing 1 due to the action of any suitable driving motor 50 is sufficient to cause the formation of the liquid drum 22, this liquid rotating due to its frictional engagement with the rotating walls of casing 1. The blades 19 which engage the rotating liquid annulus are impelled in the same direction, and accordingly rotor 14 is rotated without necessity for a direct connection to exterior driving means. Relative rotation of the rotor 14 in relation to the crescent-shaped pockets of refrigerant formed by each turn of the helical passage causes these bodies gradually to decrease in size and the refrigerant to be correspondingly compressed and/or condensed. The flange 18 projects into the liquid drum to provide a liquid seal to prevent leakage of the refrigerant about the larger end of the rotor, thus avoiding the necessity of a stuffing box at this point. The drum 22 may be formed of liquid which itself is a suitable lubricant for the bearings which are supplied by grooves 21 and ducts 42 or a suitable amount of oil may be located within the machine, together with the compression liquid refrigerant.

The rotating helical refrigerant coil has a propeller-like action upon the surrounding air so that there is an active movement of air past the coil which not only serves to cool the latter, but to cool the wall of casing 1 and the liquid annulus therein. Consequently the cooled compressed refrigerant is supplied under pressure to the nozzle 37, where expansion and/or vaporization takes place and the temperature of the refrigerant drops to a low point, and heat is rapidly absorbed from the conductors 31. Due to the propeller-like action of the helical flange 15, which ordinarily may occur as a result of the slight relative rotation of the helical flange and liquid body, there is a constant tendency for the inner portion of compression fluid, i. e. mercury, to be impelled along the rotor 14, consequently there is a countermovement of the compression fluid which adjoins the wall of casing 1. Thus the air has an active circulation past the outer surface of this wall, while the compression liquid has an active circulation adjoining its inner surface, whereby heat from the compressed refrigerant may be rapidly dissipated to the surrounding air. Therefore the liquid annulus not only acts as a pumping medium or a piston forming medium, but also acts as an effective liquid cooling jacket for the gas or refrigerant being compressed. Accordingly heat is rapidly absorbed from the refrigerant as its volume is being reduced, and it tends to be acted upon under conditions approaching that of isothermic rather than adiabatic expansion, so that the thermal efficiency of the machine is enhanced. Similarly the arrangement of the cooling coil 26 upon the exterior of the rotating casing permits the impingement of a comparatively large amount of air upon the surface of the coil, and thus permits the effective cooling of the refrigerant without the necessity for special fans, forced drafts or the like.

The machine shown in Fig. 5 has vertically disposed axes of rotation for the inner and the outer rotors. The latter, which is designated by the numeral 60, comprises a hollow casing which is provided with an upward extension 61 that is in turn connected by means of plates 64 and 65 to the drive shaft of an electric motor 66. The wall of the cylindrical casing 61 is preferably formed of material which is not affected by magnetic action. A suitable armature 68 is secured to the vertical shaft 69 which is mounted within the casing extension 61, while a suitable electromagnet 70 is located outside the casing in the region of armature 68. Thus energization of the magnet results in attracting the armature 68 and in holding the shaft 69 in place without substantial rotation of the same.

A guard 71 may be located about the thrust bearing 73 at the upper end of shaft 69 within the casing extension 61. A suitable rotor 75 is located within casing 60, and carries a helical flange 76 of variable pitch, the rotor itself being tapered in the same manner described above. The helical passage upon the rotor has its large or low pressure end at the top of the latter and its restricted or high pressure end adjoining the bottom of the same. Any suitable compressor fluid such as carbon tetrachloride is located within the casing 60. Suitable blades 79 are secured to the outer edge of the helical flange 76 by welding or any suitable means, and are adapted to maintain the liquid in the drum in a substantially annular position when the rotor is spinning. In other words, rotation of rotor 75 results in the formation of a liquid annulus due to the action of centrifugal force.

The shaft 69 is provided with an offset depending extension 80 about which the rotor 75 is adapted to turn. Suitable anti-friction bearings 81 may be arranged between shaft extension 80 and the rotor, being protected by suitable guard washers, packing, or the

like. A thimble 84 extends upwardly into the hollow shaft portion 80 being open to the high pressure chamber at the bottom of the rotor. A pipe 86 projects upwardly into the thimble 84 and is continued outwardly in a radial direction to the condensing coil 89. The latter is disposed about the casing 60 being in the form of a helical coil which terminates in the substantially vertical pipe 90. The latter is provided with a trap portion 91 adjoining the cooler chamber 92. The latter is separated from the high pressure chamber by a partition 93 and comprises a downward extension of the casing 60.

The annular enlargement 94 of this cooler is provided with suitable external plates or fins 95 which are adapted to impel a current of cooling fluid such as air about the cooler 92. Any suitable jacket 98 may be located about the cooler, being adapted to receive air from the refrigerator proper or directly from the atmosphere and to lower the temperature of the same, circulating the fluid back to the refrigerator through the pipe 99. Disposed within the cooler 92 are a plurality of annular rings 100 each of which are joined to the wall of the cooler by a suitable web or flange, thereby providing a plurality of annular troughs about the wall of the cooler.

A duct 103 extends upwardly with a moderate outward inclination from the bottom of the cooler, this duct joining a pipe 104 in the casing 60. Pipe 104 has a lower end terminating in the cooler and an upper end 107 that has a slight downward inclination over the upper end of the inner rotor. A suitable reducing nozzle or outlet 109 is located at the end of pipe 90, being adapted to permit the existence of a pressure difference in the condenser coil and the cooler.

In the operation of apparatus of the type shown in Fig. 5 the motor 66 causes the casing 60 and its extensions 61 and 92 to rotate at a comparatively high speed forming a liquid annulus in the rotor chamber 60. The magnet 70 being energized, if desired simultaneously with the motor 66, attracts the armature 68 thus preventing the shaft 69 from rotating and holding the extension 80 in its offset position in relation to the axis of rotation of the outer rotor.

The blades 79 upon rotor 75 are acted upon by the rotating body of liquid and thus cause the inner rotor to turn about bearings 81 and shaft extension 80. Since the inner rotor is provided with a helical passage of gradually diminishing capacity, each convolution of which is partially submerged in the centrifugally held body of liquid, this relative movement causes a difference in pressure between the upper and lower ends of the rotor. Accordingly the refrigerant such as ethyl chloride is compressed as it passes through the helical passage to the high pressure chamber at the bottom of the inner rotor. The compressed vapor thence passes into the thimble 84 and the pipe 86 to the condensing coil 89, which is being rotated in the atmosphere at comparatively high speed. Due to the back pressure provided by the nozzle 109 and due to the cooling effect thus provided, the refrigerant is cooled and condensed by the time it passes down pipe 90 to the nozzle 109. It is evident that the arrangement of the pipe 90 causes the condensing refrigerant to move toward the nozzle 109 under the action of the artificial liquid head which is due to the effect of centrifugal force.

At nozzle 109 the pressure upon the condensed refrigerant is released and the same passes into the cooler as an expanding vapor, thus reducing the temperature of cooler 92. Due to the vacuum or low pressure existing at the top of the rotor, refrigerant vapor is drawn from the cooler through the pipe 104 to the low pressure chamber where the refrigerant is again trapped by the entering end of flange 76. The fins 95 upon the outside of the rotatable cooler serves to induce a circulation of cooling fluid about the same, this fluid for example being air, brine or any desired material which circulates to the region of refrigeration. The compressor liquid may preferably be less volatile than the refrigerant. Accordingly any portion of the former which passes into the cooler tends to remain a liquid, being held centrifugally above rings 100 until the machine stops rotating and thus permitting the more volatile refrigerant to vaporize and return to the compressor. When a device of this character stops rotating the compressor liquid within the casing 60 tends to fall to the bottom of the same, remaining in this position until the device is started.

Any vapor which is within cooler 92 including the compressor fluid which may have become entrained in the refrigerant and circulated with the same tends to condense when the low pressure provided by the rotor ceases. The resulting liquid will accordingly collect in the annular troughs provided by rings 100, any surplus liquid passing downward to the bottom of cooler 92. Due to the outward inclination of duct 103 the liquid collected at this point, which includes the less volatile compressor liquid, will tend to be returned to the pipe 103 and thence to the chamber 60 when the device is again rotated at high speed. Vapor condensing in pipe 104 when the machine is idle will not form a liquid trap under the action of centrifugal force when the machine is again started, but will be drained out of either one of the pipes or the other.

Fig. 6 illustrates a further embodiment of my invention which presents an arrangement of chambers and ducts particularly adapted to use with refrigerant and com-

pressor fluids which are more or less miscible or with a single fluid acting both as a refrigerant and compressor fluid. This form of the invention comprises a rotary casing 110 which is divided into a plurality of compartments. One of these compartments contains a suitable inner member or drum 111 which is supported upon the offset portion or throw 112 of a shaft 113, the ends of this shaft being mounted in bearings 114 in the walls of the pump chamber and the axis of the shaft ends being in concentric alignment with the axis of rotation of casing 110.

The weight of the rotor 111 tends to act as a pendulum to hold the throw 112 of shaft 113 in a depending position, i. e. to hold the axis of rotation of rotor 111 in a fixed eccentric relation to the axis of casing 110. If desired, a pendulum may also be provided to aid in obtaining this result, as illustrated in Fig. 1, or the magnetic means of Fig. 5 may be used for a like purpose.

The rotor 111 may be provided with a helical flange 115 of the general type described above, which is provided with a gradually diminishing pitch as it approaches the larger high pressure end of the rotor whereby fluid within the helical passage may be compressed. Suitable blades 118 are secured to the edge of the flange in the same manner as described above. Adjoining the high pressure end of the pumping chamber is a condensing chamber 120 which may be connected to the pumping chamber by suitable openings 123 which adjoin the surface of the centrifugally held body of liquid 121 within the pumping chamber. Suitable check valve elements or the like may be arranged, if desired, within the passages 123 to permit the movement of the fluid from the pumping to the condensing chamber and to prevent movement of the same in the opposite direction.

The compressed fluid which passes into the chamber 120 engages the liquid body 121^a which is in effect a continuation of the liquid body 121. Suitable cooling flanges 123 may be arranged about this portion of the drum 110, (a jacket for circulating air or the like being disposed about the same, if desired) so that the liquid body 121^a is cooled and is effective in condensing the compressed fluid within the chamber 113 which is added to the liquid body 121^a. A longitudinal passage 126 extends along the outer wall of casing 110 between the chamber 120 and the expansion chamber 125 so that a body of liquid 121^b is disposed within the latter, due to the action of centrifugal force and the tendencies of the pressures at opposite ends of pipe 126 to equalize.

A suitable annular partition 127 divides chamber 125 from the cooling chamber 130, the partition 127 providing a central opening 128 between these chambers. Chambers 125 and 130, and more particularly the latter, are provided with suitable outwardly projecting cooling elements or fins 132 which rotate in a jacket 133 which may receive any suitable medium to be cooled, such as air, brine or the like. Disposed between the pump chamber and chamber 130 are suitable openings 131 which are adapted to permit vapor to be drawn from chambers 125 and 130 to the low pressure end of the pump where a suction is produced.

A liquid return passage 139 is arranged to receive liquid from the inner surface of the body 121^b when the radial depth of the same exceeds the depth of the low pressure end of liquid body 121, this passage 139 being adapted to return this liquid to the liquid body 121.

In the operation of a machine such as disclosed in Fig. 6, the casing 110 is rotated at a suitable speed to permit the formation of a liquid annulus 121 in the pump chamber. Rotation of this liquid body causes a similar movement of blades 118 and rotor 111, whereby vapor is drawn from chambers 125 and 130 and the liquid in the former chamber is constantly being vaporized and the temperature in the same is materially lowered. The vapor is compressed in the helical passage and passed through the openings 123 into the condenser chamber 120 at a comparatively high temperature where the cooling effect of the liquid body 121^a and the fins 123 cause the vapor to become condensed and added to the volume of liquid body 121^a.

As a result of the accretions to this body, liquid flows from chamber 120 to chamber 125, i. e. from the body 121^a to the body 121^b and the cycle is completed. When there is an over supply of liquid in the chamber 125 it will tend to be returned to the pump chamber through the duct 139 due to the action of centrifugal force. Particularly when the compressor fluid is heavier than the refrigerant the particles of the former which stray into the pipe 126 and the chamber 125 will tend to collect adjoining the outer wall of the latter where they will be received by the passage 139 and be immediately returned to the pumping chamber. Due to the pumping effect of the helical flange the amount of fluid in chamber 120 tends constantly to be increased, and there is a fluid movement from this chamber to chamber 125 from which the refrigerant is normally drawn in the form of vapor. It is thus evident that a machine of the type shown in Fig. 6 is adapted to operate with refrigerant and compressor liquids which may mix with each other, the refrigerant being vaporized and liquefied during successive portions of the cycle and the compressor fluid preferably remaining a liquid.

In each of the refrigerating machines described above the maximum pressure which can be obtained by the pumping means is limited by the artificial liquid head which is

imposed upon the rotating liquid annulus by centrifugal force. As soon as the pressure of the pocketed fluid at the smaller end of the helical passage rises unduly, the liquid which normally forms a seal about the helical flange will become displaced and the pressure released. In addition the pendulum, magnet or other means utilized to prevent the inner shaft from turning provides a yieldable resistance against the turning of this shaft in response to excessive pressures within the container. However, normally the liquid seal will be broken before the pendulum will tend to be rotated due to excessive pressures or before the armature will be moved out of its normal position in relation to the magnet.

It is thus evident that I have provided a simple rotating refrigerating machine of the compressing type which may be free from reciprocating parts, valves, stuffing boxes, etc. and accordingly is quiet and substantially vibrationless in operation. At the same time this machine is compact and self-contained, the inner rotor and the liquids being completely sealed within casings and it is adapted to run for an indefinite period without requiring special attention.

I claim:

1. In a refrigerating system, a rotary compressor, including a rotary casing containing a body of liquid, said casing being arranged upon rotation to maintain said liquid in the form of an annulus, a rotor within the casing rotatable about an axis eccentric in relation to the inner surface of the annulus, said rotor having a helical passage partially submerged in the liquid of said annulus, said passage being arranged to have a large inlet end to receive refrigerant and tapering to a smaller outlet end to give up compressed refrigerant, a duct for cooling compressed refrigerant connected to the outlet of the helical passage, said duct extending spirally about the rotary casing and being arranged to vent refrigerant into a cooler, the liquid in said annulus being circulated past the inner surface of the wall of the casing by the arrangement of the helical passage, and air being swept past the outer surface of the wall by rotation of the spiral duct.

2. In a refrigerating system, a rotary compressor, including a rotary casing containing a body of liquid, said casing being arranged upon rotation to maintain said liquid in the form of an annulus, a member within the casing, said member cooperating with the annulus to provide fluid pockets of successively diminishing capacity, whereby the contained fluid is compressed, a cooler connected to said member, a duct collecting compressed fluid from the pockets, a cooler connected to the duct, and means permitting the expansion of the fluid passing from the duct to the cooler.

3. In a refrigerating system, a rotary compressor, including a rotary casing containing a body of liquid, said casing being arranged upon rotation to maintain said liquid in the form of an annulus, a rotor within the casing rotatable about an axis eccentric in relation to the inner surface of the annulus, said rotor having a helical passage partially submerged in the liquid of said annulus, said passage being arranged to have a large inlet end to receive refrigerant and tapering to a smaller outlet end to give up compressed refrigerant, a cooler connected to said outlet, a passage for cooling compressed refrigerant arranged to rotate with the casing and arranged to receive refrigerant compressed in said helical passage and to conduct the same to the cooler, and a return passage to permit vapor to be drawn from the cooler to the inlet end of the helical passage.

4. In a refrigerating system, a rotary compressor, including a rotary casing containing a body of liquid, said casing being arranged upon rotation to maintain said liquid in the form of an annulus, a rotor within the casing rotatable about an axis eccentric in relation to the inner surface of the annulus, means whereby the annulus may impart rotary movement to the rotor and means tending to maintain the axis of the rotor and the casing in fixed relation to each other, a passage for cooling compressed refrigerant arranged to rotate with the casing, and a cooler connected to said passage.

5. In a refrigerating system, a rotary compressor, including a rotary casing containing a body of liquid, said casing being arranged upon rotation to maintain said liquid in the form of an annulus, a rotor within the casing rotatable about an axis eccentric in relation to the inner surface of the annulus, said rotor having a helical passage partially submerged in the liquid of said annulus, said passage being arranged to have a large inlet end to receive refrigerant and tapering to a smaller outlet end to give up compressed refrigerant, a duct for cooling compressed refrigerant connected to the outlet of the helical passage, said duct extending about the rotary casing, and a rotary cooler secured to the drum and means permitting the expansion of refrigerant passing from said duct to the cooler.

6. In a refrigerating system a rotary compressor, including a rotary casing containing a body of liquid, said casing being arranged upon rotation to maintain said liquid in the form of an annulus, a rotor within the casing rotatable about an axis eccentric in relation to the inner surface of the annulus, a helical passage on the rotor, means whereby the annulus may impart rotary movement to the rotor, means to maintain the axis of the rotor and the casing in fixed relation to each other, said liquid being circulated past the inner surface of the casing wall due to the

arrangement of the helical passage upon the rotor, and spirally disposed cooling means upon the outer surface of said wall, whereby air is swept past said wall to receive heat from the liquid of the annulus.

7. In a refrigerating system, a rotary compressor, including a rotary casing containing a body of liquid, said casing being arranged upon rotation to maintain said liquid in the form of an annulus, a rotor within the casing rotatable about an axis eccentric in relation to the inner surface of the annulus, said rotor having a helical passage partially submerged in the liquid of said annulus, said passage being arranged to have a large inlet end to receive refrigerant and tapering to a smaller outlet end to give up compressed refrigerant, and a rotary cooler secured to the casing, said cooler carrying an impeller for circulating a fluid about said rotating cooler.

8. A refrigerating machine comprising a rotary unit containing a body of liquid, rotary compressor means associated with said liquid and rotatable about an included axis within said unit, a cooling passage for compressed refrigerant connected to the compressor means and arranged about the outer wall of the unit, a rotary cooler carried by said unit, a jacket about said cooler to permit a fluid to circulate thereabout, and an impeller to aid circulation of said fluid.

9. A refrigerating machine comprising a refrigerant compressor, said compressor including a rotary unit containing a body of liquid, said unit being arranged upon rotation to maintain said liquid in the form of an annulus, and rotary compressor means actuated by said liquid annulus and rotatable about an included axis within said unit, a cooling passage for compressed refrigerant connected to the compressor means and arranged about the wall of the unit, and a cooler connected to said cooling passage.

10. A refrigerating machine comprising a refrigerant compressor, said compressor including a rotary unit containing a body of liquid, said unit being arranged upon rotation to maintain said liquid in the form of an annulus, a rotor within said unit and rotatable about an axis eccentric in relation to the inner surface of said annulus, and means whereby the annulus may impart a rotary movement to the rotor, a cooling passage for compressed refrigerant connected to the compressor means and arranged about the outer wall of the unit, and a rotary cooler carried by said unit, said passage having an expansion outlet in said cooler.

11. A refrigerating machine comprising a refrigerant compressor, said compressor including a rotary unit containing a body of liquid, said unit being arranged upon rotation to maintain said liquid in the form of an annulus, a rotor within said unit and rotatable about an axis eccentric in relation to the inner surface of said annulus, means whereby the annulus may impart a rotary movement to the rotor, and means tending to maintain the axis of the rotor in fixed relation to that of said unit, a refrigerant cooling passage connected to said compressor, said passage forming a helix about the outer wall of the unit, whereby movement of air past its surface is exhausted by rotation of the unit, and a cooler connected to the outlet of said passage.

Signed by me at Milford, N. H., this 27th day of June, 1928.

WILLIAM G. ABBOTT, JR.