

Dec. 3, 1929.

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1,738,104

COMPRESSOR AND THE LIKE

Filed Nov. 10, 1927.

3 Sheets-Sheet 1

FIG. 6

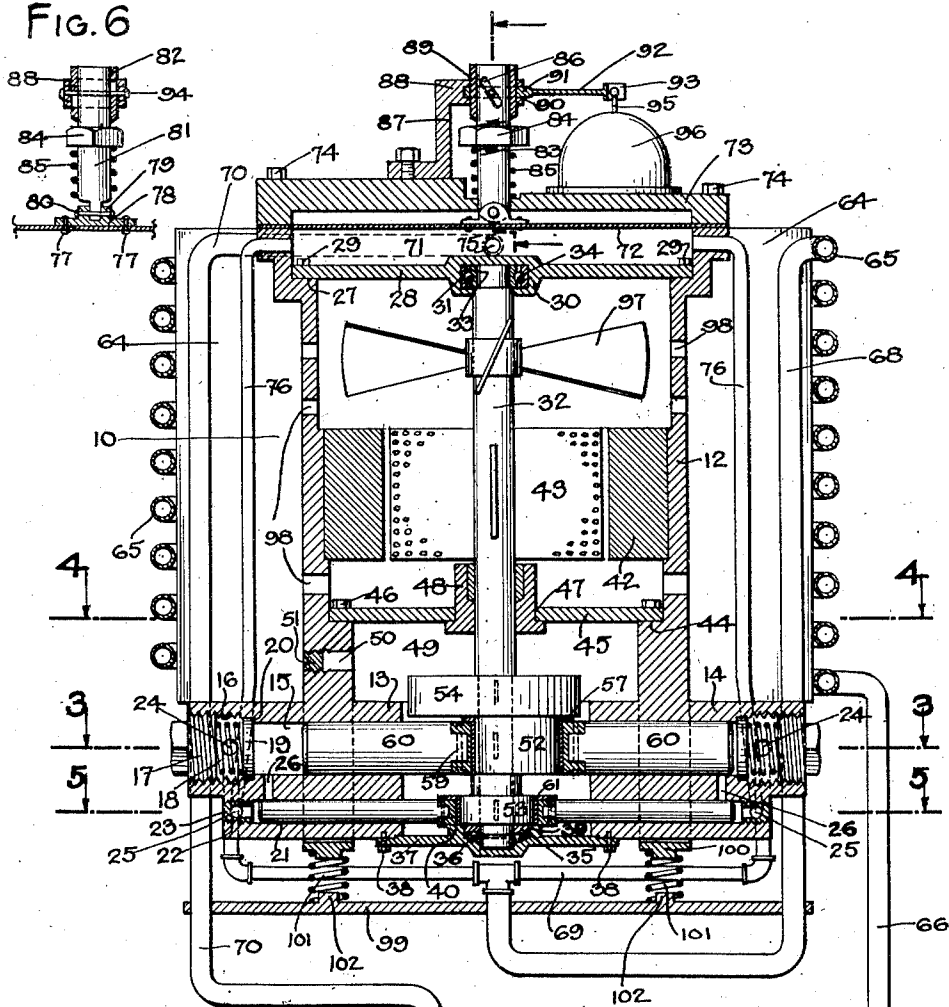
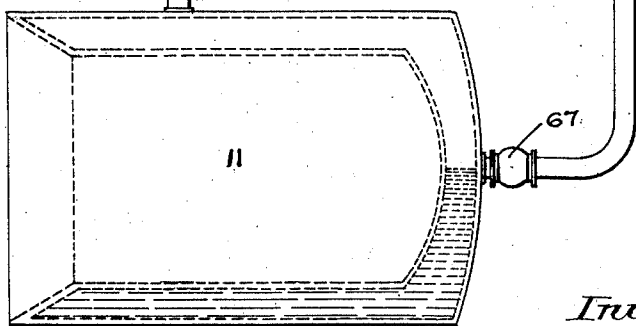


FIG. 1



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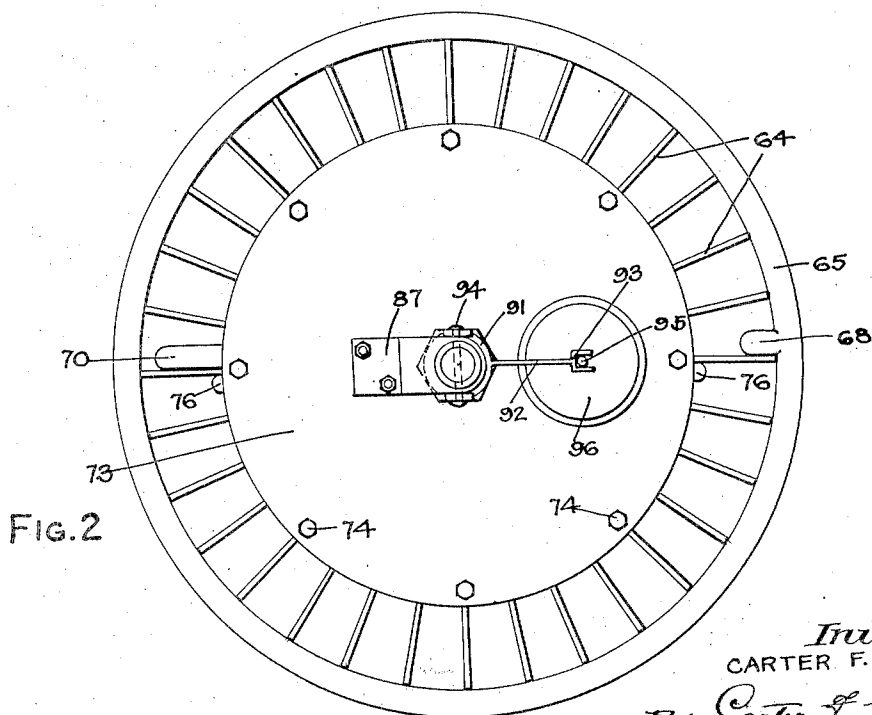
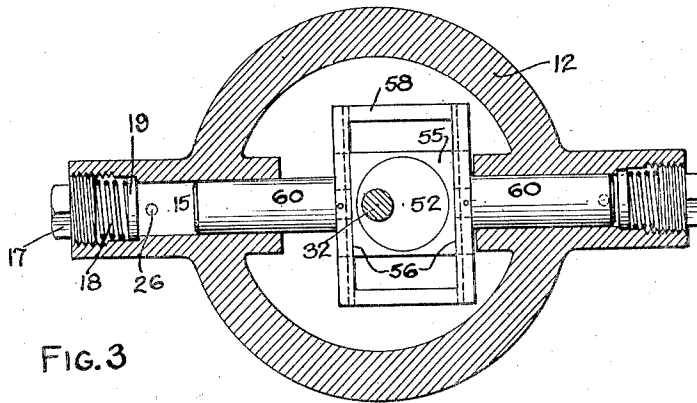
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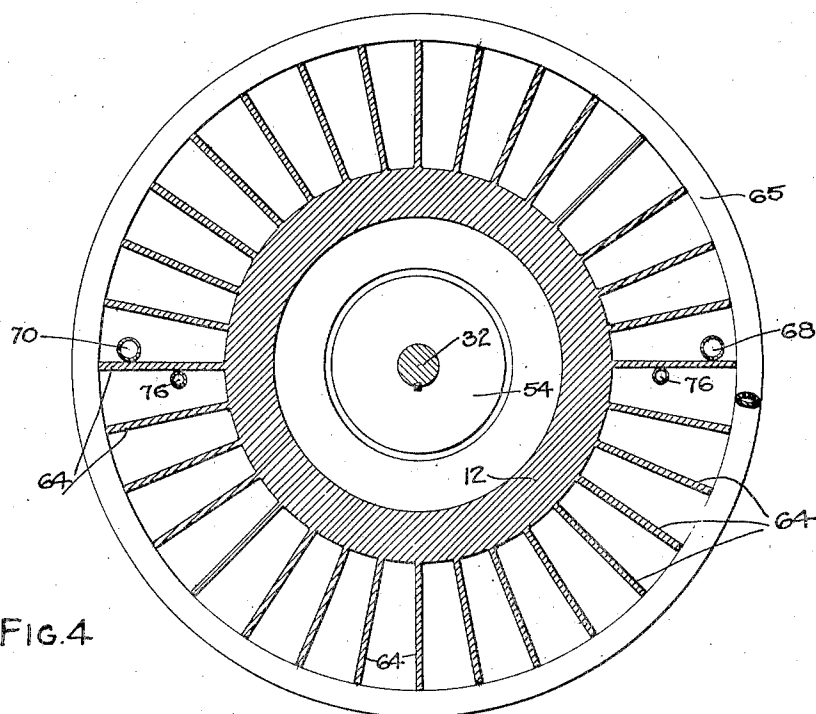


FIG. 4

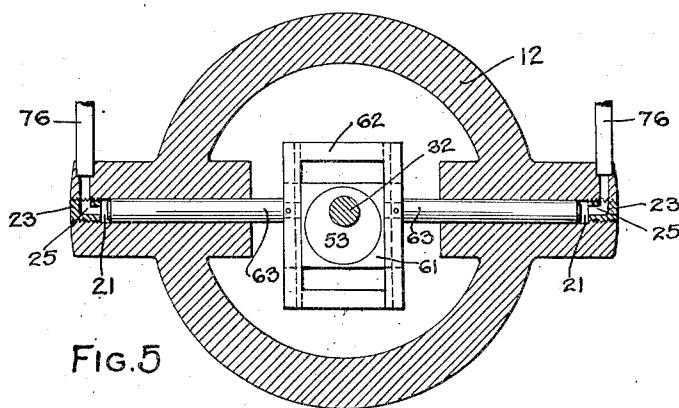


FIG. 5

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UNITED STATES PATENT OFFICE

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COMPRESSOR AND THE LIKE

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This invention relates to improvements in pumps, compressors and the like and more particularly to such apparatus as is used for pumping liquids, compressing gases or creating vacuums or the like.

While in this particular application, the invention is described as a compressor for use in connection with electric refrigerating apparatus, it is to be understood that it is not intended to be confined to such use exclusively and that it may be used with equal facility not only as a compressor but also as a pump for pumping fluids, such as air, oil, water and the like. For purposes of illustration, however, the invention is herein described as being applied to an artificial refrigerating machine of the compression type wherein refrigeration is produced by the latent heat of vaporization of a refrigerant, the refrigerant in the form of a gas being forced by the compressor into a condenser where it is liquefied by cooling and then permitted to return to an evaporator.

A further object of the invention is the provision in a refrigerating machine of a compressor the operating member of which is carried by the shaft of the operating motor or similar device, this compressor member being operable to alternately move a pair of pistons into compressing position.

A still further object of the invention is the provision of a second pair of plungers which are operable simultaneously with the main compressor pistons to seal the inlet ports to the compressing chambers during the compressing strokes of said main pistons, said plungers being further operable to immediately open said ports as the pistons start on their return or suction strokes.

A still further object of the invention is the provision of a chamber which is in communication with the suction side of the compressor, said chamber including an element which is sensitive to variations in pressure of the fluid to thereby control automatically the operation of the compressor.

A still further object of the invention is the provision of a diaphragm as part of the control mechanism of a compressor which is sensitive to variations in pressure of the fluid,

said diaphragm being operatively associated with means for opening or closing an electric switch for controlling a prime mover which in turn operates the compressor.

Other objects of the invention including objects relating to details of construction and efficiency of operation, will appear more fully hereinafter.

In the accompanying drawings:—

Figure 1 is a vertical sectional view of the invention as embodied in a refrigerating apparatus;

Figure 2 is a top plan view of the construction shown in Figure 1;

Figure 3 is a horizontal section taken on the line 3—3 of Figure 1;

Figure 4 is a horizontal section taken on the line 4—4 of Figure 1;

Figure 5 is a horizontal section taken on the line 5—5 of Figure 1; and

Figure 6 is a vertical section through the control mechanism taken on the line 6—6 of Figure 1.

Referring more particularly to the drawings it will be seen that the invention is embodied in a refrigerating unit, designated generally by the reference numeral 10, and which unit serves to condense and then compress a refrigerant such as sulphur dioxide, methyl chloride, ethyl chloride, carbon dioxide, or the like which is then delivered in the form of a liquid to an evaporator, designated generally by the reference numeral 11. This evaporator 11 may be of any usual construction and forms no part of the invention except as it is related to the refrigerating unit 10 and accordingly it is not believed that a more detailed description of this evaporator need be made in this specification.

The refrigerating unit 10 comprises generally a main casing 12, the cross section of which is shown most clearly in Figure 1. Preferably this casing 12 is of a form which is capable of being readily cast out of any suitable metal, the casting being provided at its bottom with a pair of diametrically opposed enlargements, portions of which project interiorly of the casing, as at 13 and portions of which project exteriorly of the casing, as at 14. These enlargements are sub-

sequently bored out to provide cylinders 15 for the purpose to be hereinafter explained. It will be understood that the bores of the enlargements are co-axially aligned and, as appears clearly in Figure 1, the outer portions of said bores are interiorly threaded as at 16. Closure members 17 which are threaded into the outer ends of the cylinders 15 serve to effectually seal said ends at the same time that they constitute outer abutments for the coil springs 18, which latter are arranged to force the valves 19 upon their valve seats 20.

Arranged immediately below the main cylinder bores 15 are a second pair of diametrically opposed and co-axially aligned bores 21, these bores 21 being of smaller diameter than the bores 15. The outer ends of these bores 21 are also exteriorly threaded as at 22 for reception of the closure members 23 threadedly received therein. Between the valves 20 of the main cylinders (which valves may be of the usual poppet type) and the closure members 17 is arranged an outlet port 24, while the inlet ports 25 in the closure members 23 are in communication with the cylinders 15 through the openings 26 extending between the said cylinders 15 and the bores 21. It will be observed that the said openings 26 are each located just to the inside of the respective main cylinder valves 20, the reason for which will appear later.

As appears most clearly in Figure 1 the internal surface of the casing 12 is provided adjacent its upper end with an annular shoulder 27 upon which is seated a plate 28, this plate 28 being secured in position by means of the screws 29. The central portion of this plate 28 is provided with a downwardly opening socket 30 having pressed or otherwise secured therein an outer ball bearing race 31. Extending downwardly from the plate 28 is a vertically extending shaft 32, the upper end of which has secured thereto an inner ball bearing race 33 which is adapted to be concentrically received within the external race 31. Ball bearings 34 are provided between said external and internal races. The lower end of this vertically extending shaft 32 has keyed or otherwise secured thereto a ball bearing race 35, which latter rests, through the intervention of the ball bearings 36 upon a bottom supporting member 37, this latter member being secured to the bottom of the casing 12 by means of the screws 38. It will be observed that the member 37 is provided with a central socket 39 within which the lower end of the shaft 32 is received at the same time that it is provided with an upstanding flange 40 which is concentrically arranged with respect to the bearing member 35 carried by the shaft 32. The upper and lower supports for the shaft 32 constructed as just described insure the positive maintenance of said shaft in a vertical position at the same time that it permits

it to be rotated freely about its vertical axis. It is to be understood, of course, that the shaft 32 may be supported for rotation about its vertical axis in any other suitable manner.

Arranged within the refrigerating unit 10 within the upper portion of the casing 12 is a prime mover for the shaft 32, in this instance an electric motor, the stator 42 of which is secured upon the casing 12 in any suitable manner and the rotor 43 of which is secured upon the shaft 32 also in any suitable manner. Immediately below this prime mover it will be seen that the internal surface of the casing 12 is provided with an annular shoulder 44 upon which is seated a plate 45, this plate 45 being secured in position by means of the screws 46. The plate 45 is provided with a central aperture 47 within which is received a seal or other suitable packing device 48 which closely embraces but does not interfere with the free rotation of the shaft 32 therewithin. It will be apparent that the plate 45 constitutes a partition between the upper and lower portions of the casing 12 thereby providing a chamber 49 for receiving a lubricating oil intended to lubricate the moving parts of the compressor to be described hereinafter. This oil chamber 49 is filled with lubricant by way of the opening 50 which is normally closed by the threaded plug 51.

Secured to the lower end of the shaft 32 are a pair of eccentrics 52 and 53, the latter being of smaller diameter than and disposed immediately beneath the former. A balance wheel 54 is keyed to the shaft 32 immediately above the upper and larger eccentric 52. If desired, the eccentric 52 and the balance wheel 54 may be formed integrally although in this particular instance it is believed more advisable to secure them separately upon the shaft 32. Embracing the upper eccentric 52 and relatively rotatable with respect thereto is a follower 55, the opposite sides 56 of which are parallel and are provided at their upper ends with oppositely extending flanges 57. This follower 55 is received within a substantially rectangular crosshead 58, the longer sides of which are disposed at right angles to the common axis of the main cylinder bores 15. Pivotaly secured to opposite sides of this rectangular crosshead 58 by means of the screws or bolts 59 are a pair of oppositely projecting pistons 60, the common axis of which is coincident with the common axis of the cylinder bores 15. It will be apparent that as the shaft 32 is rotated about its vertical axis the eccentric 52 will be rotated in such manner as to cause its follower 55 to partake of a reciprocating movement within the crosshead 58 thereby causing the latter to move first toward one of the bores 15 and then back to the opposite bore 15 and so on, this movement of the crosshead 58 being always along the line of the common axis of

said cylinder bores. Inasmuch as the pistons 60 are secured to the crosshead 58, they will be in turn forced to reciprocate within their respective cylinders, one of the pistons being caused to travel outwardly and into compressing position as the other and opposite piston is caused to travel inwardly and out of compressing position. In other words, as will be readily understood, the pistons 60 are alternately moved into compressing position.

Exactly as in the case of the upper and larger eccentric 52 a follower 61, similar to the follower 55, embraces the lower and smaller eccentric 53, this lower follower 61 being in turn reciprocable within a second crosshead 62. This second crosshead 62 is also of rectangular form and secured to the opposite and longer sides thereof are a pair of oppositely projecting plungers 63, these plungers being reciprocable within their respective bores 21. As appears most clearly in Figure 1 the plungers 62 are of a length substantially greater than the length of the main pistons 60. The eccentric 53 is keyed to the shaft 32 at an angle of substantially 90° with respect to the eccentric 52, the result being that as one of the pistons 60 is moved along its compressing stroke, its corresponding plunger 63 will also move in the same direction and then back an equal distance without however venting the opening 26 extending between the main piston and the plunger cylinders. As the main piston, however, begins its return stroke the plunger 63 will also move in the same direction to vent the opening 26 and then back again to seal this opening at approximately the instant that the piston 60 is ready to begin its compression stroke again.

The relative movements of the main pistons 60 and their corresponding valve controlling plungers 63 may be readily followed by examining Figure 1. In this figure it will be seen that the right-hand piston 60 is at the end of its compression stroke while the left-hand piston 60 is at the end of its return stroke. In this position of the pistons 60 it will be seen that the plungers 63 have assumed a symmetrical position with respect to the axis of the shaft 32, the outer ends of each of these plungers 63 projecting beyond the openings 26 a distance sufficient to seal the same. Now, as the right-hand piston 60 begins its return stroke and the left-hand piston 60 its compression stroke, the right-hand plunger 63 will move to the left to vent the right-hand opening 26 while the left-hand plunger 63 will continue to maintain the left-hand opening 26 sealed through the entire extent of the compression stroke of the left-hand piston 60. The advantages of this arrangement are of course obvious, the most important one being that the pistons 60 are thereby enabled to draw the vapor through

the inlet 25 and the opening 26 immediately as they begin their return strokes, and conversely the openings 26 are adequately sealed at the instant that the pistons begin their compressing strokes thereby permitting a maximum compression of a maximum amount of vapor to take place. The advantage of this arrangement is that the pistons, at all times, are performing useful work and that at no time does either of the pistons 60 create a vacuum to be formed in the cylinders which would have the tendency of drawing the refrigerant from between the surfaces of the pistons and their cylinder walls. It is to be understood, of course, that the pistons 60 and the plungers 62 are adequately lubricated by reason of the fact that they all operate in a bath of oil contained within the chamber 49.

Projecting radially from the external surface of the casing 12 and secured thereto in any suitable manner are a plurality of fins 64, these fins extending substantially from the top of the casing 12 to just above the outwardly projecting portions 14 of the main piston cylinders. Surrounding these radial fins and suitably maintained in position thereupon is a continuous tubing 65 preferably of copper, in the form of a spiral the lower end of which tubing is provided with an extension 66 leading to the evaporator 11 through an expansion valve 67. The upper end of this spiral tubing 65 is connected through a pipe 68 to another pipe 69 leading commonly to the outlet chambers 18 of the main cylinders 15. The compressed gas which is forced out of the cylinders 15 passed the valves 19 and through the outlets is forced through the pipes 69 and 68 to the upper end of the spiral tubing 65 wherein it is cooled and thereby condensed to subsequently flow through the pipe 66 into the evaporator 11 in the form of a liquid.

Refrigeration is produced by the latent heat of vaporization of the refrigerant within the evaporator 11, the vapor resulting from the vaporization of the liquid in said evaporator being conducted through the pipe 70 to a chamber 71 provided in the upper part of the refrigerating unit 10. Essentially, this chamber 71 is constructed as follows. The bottom of the chamber 71 is formed by the plate 28 constituting the support for the upper end of the shaft 32. The top of the casing consists of a relatively flexible diaphragm extending across the top of the casing 12 and the edges of which are securely clamped in position thereupon by means of an upper member 73 rigidly secured upon the top of the casing by means of the screws 74. The member 73 is undercut to permit the diaphragm 71 to flex upwardly or downwardly as the case may be. The vapor resulting from the vaporization of the refrigerant liquid in the evaporator is conducted through the pipe 70 into this chamber 71 by way of the inlet 75.

From the chamber 71 the vapor therewithin is conducted through the pipes 76 to the inlet ports 25 in the suction sides of the compressor.

It is desirable in refrigerating machines of this character that they be operated entirely automatically and it is for this purpose that the diaphragm 72 constituting the upper wall of the vapor chamber 71 is employed. Secured to the center of the diaphragm 71 preferably by the rivets 77 is a bifurcated member 78, the branches 79 of which extend upwardly. Pivotaly mounted between these branches 79 by means of the pin 80 is an upstanding member indicated generally by the reference numeral 81. The upper portion 82 of this member 81 is of a tubular construction while the intermediate portion thereof is exteriorly threaded as at 83. A nut 84 is threadedly received over this threaded portion 83 of the member 81 and constitutes an upper abutment for a coil spring 85 surrounding the lower portion of the member 81. The upper surface of the member 73 through which the member 81 projects is provided with a centrally arranged socket 85 within which is seated the lower end of the coil spring 85, the member 73 thus constituting the lower abutment for this spring. It will be seen that in the construction just described the coil spring 85 tends constantly to urge the diaphragm 72 in an upward direction, the force of the spring being regulated by means of the nut 84.

The tubular portion 82 of the member 81 is provided in its diametrically opposed sides with a pair of inclined slots 86, the longitudinal axes of which intersect each other. Secured upon the upper surface of the upper member 73 is a substantially Z-shaped member 87 the upper and horizontally extending branch of which is centrally apertured as at 89, to receive the tubular portion 82 of the member 81. The branch 88 is further provided with a horizontally extending slot 90 therein, the horizontal depth of which is somewhat greater than the external diameter of the tubular portion 82 of the member 81. Received within this slot 90 and embracing the tubular portion 82 of the member 81 is an annulus 91 from one side of which extends an arm 92 having a bifurcated end 93. It will be seen that by reason of the fact that the member 87 is fixed against movement in any direction, the annulus 91 which is received within the slot 90 is prevented from moving vertically but yet is free to oscillate about a vertical axis. Projecting through the annulus 91 and through the slots 86 of the tubular portion 82 of the member 81 is a pin 94, this pin being arranged to lie in a substantially horizontal position. The bifurcated end 93 of the arm 92 is arranged to embrace opposite sides of the operating member 95 of a toggle switch 96, the terminals of

which are connected in suitable manner to the motor 42—43.

The operation of the control mechanism is as follows. It will be evident that as the member 81 is urged upwardly by the action of the coil spring 85, the slots 86 operating upon opposite ends of the pin 94 will cause the annulus 91 to oscillate and thereby cause the toggle switch member 95 to swing to one side. Assuming that the toggle switch operating member 95 is in the "off" position, the motor 42—43 will not be operating and accordingly the compressor will also not be operating. In this condition, the vapor produced in the evaporator will, in time, build up a sufficient pressure in the chamber 71 to cause the diaphragm 72 to be flexed upwardly and thereby lift the member 82 with the result that the annulus 91 and its arm 92 will be oscillated in a direction such as to swing the toggle switch operating member 95 into the "on" position, thereby setting the motor 42—43 into operation. The compressor will then begin to exhaust the vapor from the chamber 71 whereupon the pressure therein will be decreased sufficiently to permit the diaphragm 72 to return to its normal unflexed position. In returning to this latter position the diaphragm 72 will cause the member 82 to be lowered with the result that the arm 92 will be caused to swing in the opposite direction and so throw the toggle switch operating member 95 again into its "off" position. This cycle is of course continuous and permits of an intermittent operation of the refrigerating apparatus.

In order to provide for a circulation of air in and about the motor 42—43 it is desirable to secure a fan 97 upon that portion of the shaft 32 which extends between the plate 28 and the rotor 43. Openings 98 are formed in the sides of the casing 12 above and below the stator 42 such that a circulation of air may be obtained from the exterior of the casing 12 to and through the interior thereof. The air which is thus forced out of the casing 12 not only cools the motor but also assists in cooling the condensing pipe 65 and thereby hastens the condensing action of the refrigerant therein.

If desired the refrigerating unit 10 may be cushioned against vibration by supporting the same above its base 99 by means of rubber pads 100 arranged at the upper ends of a plurality of suitably spaced compression coil springs 101, the lower ends of these springs being held against lateral displacement by the upstanding projections 102 formed in the base 99.

It is to be understood, of course, that while the compressor unit has been illustrated as being applied to a refrigerating apparatus it may be used with equal facility in other capacities or in any other types of apparatus. It is to be further understood that various

changes in construction and design of the compressor may be made from time to time without departing from the spirit of the invention and it is accordingly intended to claim the same broadly as well as specifically as indicated by the appended claims.

What is claimed as new and useful is:

1. A compressor apparatus comprising a main shell or casing within which is housed a prime mover, a vertically extending shaft located within said casing and arranged for rotation by said prime mover, a pair of diametrically opposed cylinders arranged at the bottom of and integral with said casing, a pair of pistons operable within said cylinders, and means carried by said shaft for simultaneously reciprocating said pistons within their respective cylinders.

2. A compressor apparatus comprising a hollow casing, a prime mover housed within said casing, a vertically extending shaft located within said casing and arranged for rotation by said prime mover, a pair of diametrically opposed cylinders formed in the walls of said casing, a pair of pistons operable within said cylinders, and an eccentric secured to the lower end of said shaft and arranged to cause said pistons to move simultaneously in one direction and then in the other.

3. A compressor apparatus comprising a casing, a motor located within said casing, a compressor also located within said casing and arranged to be driven by said motor, a plate closing the upper end of said casing, a diaphragm spaced above said plate to form a fluid receiving chamber therebetween, and means operatively associated with said diaphragm and arranged to operate an electric switch for controlling said motor upon variations of pressure within said chamber.

4. In a compressor apparatus, a mechanism for controlling the operation of a power driven compressor, said mechanism including a flexible diaphragm influenced by the pressure of a fluid thereagainst, a vertically extending member operatively connected to said diaphragm and arranged to be moved along its vertical axis as the pressure on said diaphragm is increased, an arm extending laterally from said vertically extending member, and means for producing a movement of said arm in a plane which is substantially normal to the axis of said vertically extending member as the latter is moved vertically along said axis and a switch operable by said arm.

5. In a compressor apparatus, an integral casting constituting a housing for a prime mover, a rotatable shaft upon which is secured said prime mover, a plate closing the bottom of said casting and constituting an end bearing for said rotatable shaft, and a second plate arranged within said casting between said prime mover and said first men-

tioned plate to provide a lubricant receiving chamber in the lower portion of said casting, said second mentioned plate being provided with an oil seal surrounding said rotatable shaft.

6. In a compressor apparatus, an integral motor casting, a rotor operable within said casting upon a vertically extending shaft, a pair of plates extending across the top and bottom of said casting and constituting respectively upper and lower bearing members for the ends of said shaft, and a control mechanism for said motor arranged upon the outside of the upper bearing plate.

7. In a control mechanism for a compressor or the like, a flexible diaphragm influenced by the pressure of a fluid thereagainst, a tubular member operatively connected to said diaphragm and arranged for axial movement as the pressure against said diaphragm is increased or decreased, said member being provided in opposite walls thereof with a pair of oppositely inclined slots, an arm extending laterally from said tubular member, and a pin extending through said slots and said arm and a switch operable by said arm.

8. In a compressor apparatus, an integral casting having vertical side walls, a plate closing the top thereof containing a bearing, and supporting a vertically rotatable shaft, a rotor thereon, a stator carried by the casting walls, a bearing plate below the rotor supported upon a shoulder in the wall, inwardly projecting opposed cylinders integral with the casting and below the second mentioned bearing plate, a third bearing plate closing the bottom of the casing and supporting the lower end of the shaft, an operative connection between the shaft and pistons within the cylinders, a diaphragm above the top plate, a cap over the diaphragm, switch actuating mechanism upon the cap and in operative engagement with said diaphragm.

9. In a compressor apparatus, an integral casting having vertical side walls, a prime mover housed within said walls, a vertically extending shaft located within the casting and adapted to be rotated by the prime mover, a pair of cylinders arranged at the bottom and integral with the casting, a pair of pistons operable within the cylinders, a lubricant reservoir between the cylinders and the prime mover, the lower section of the casting being closed by means of a plate, said casting having projecting spring supports, and means to prevent lateral displacement of the springs, whereby the entire unit is cushioned against vibration.

In testimony whereof, I have hereunto affixed my signature.

CARTER F. HALL.