

March 2, 1937.

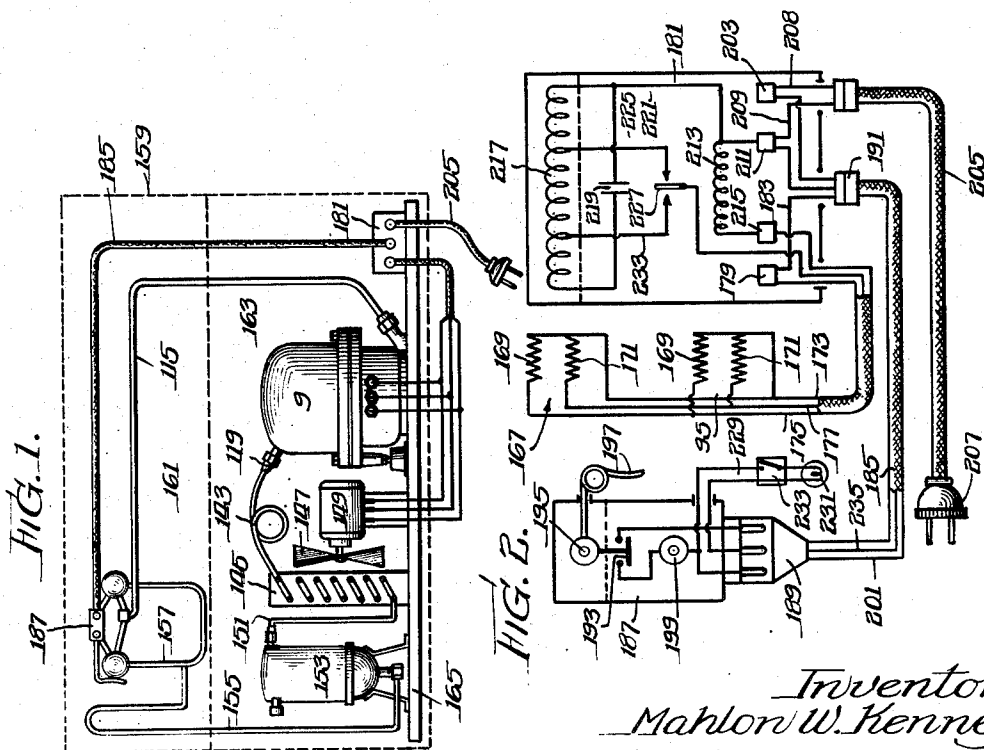
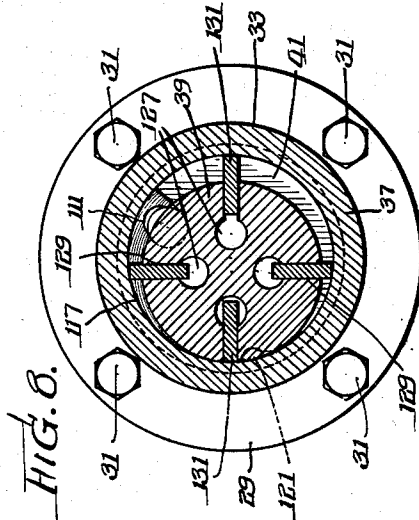
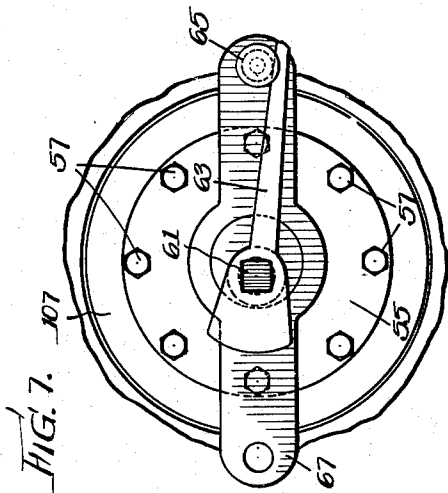
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2,072,307

COMPRESSOR

Filed May 14, 1934

3 Sheets-Sheet 1



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 Mahlon W. Kenney
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3 Sheets-Sheet 2

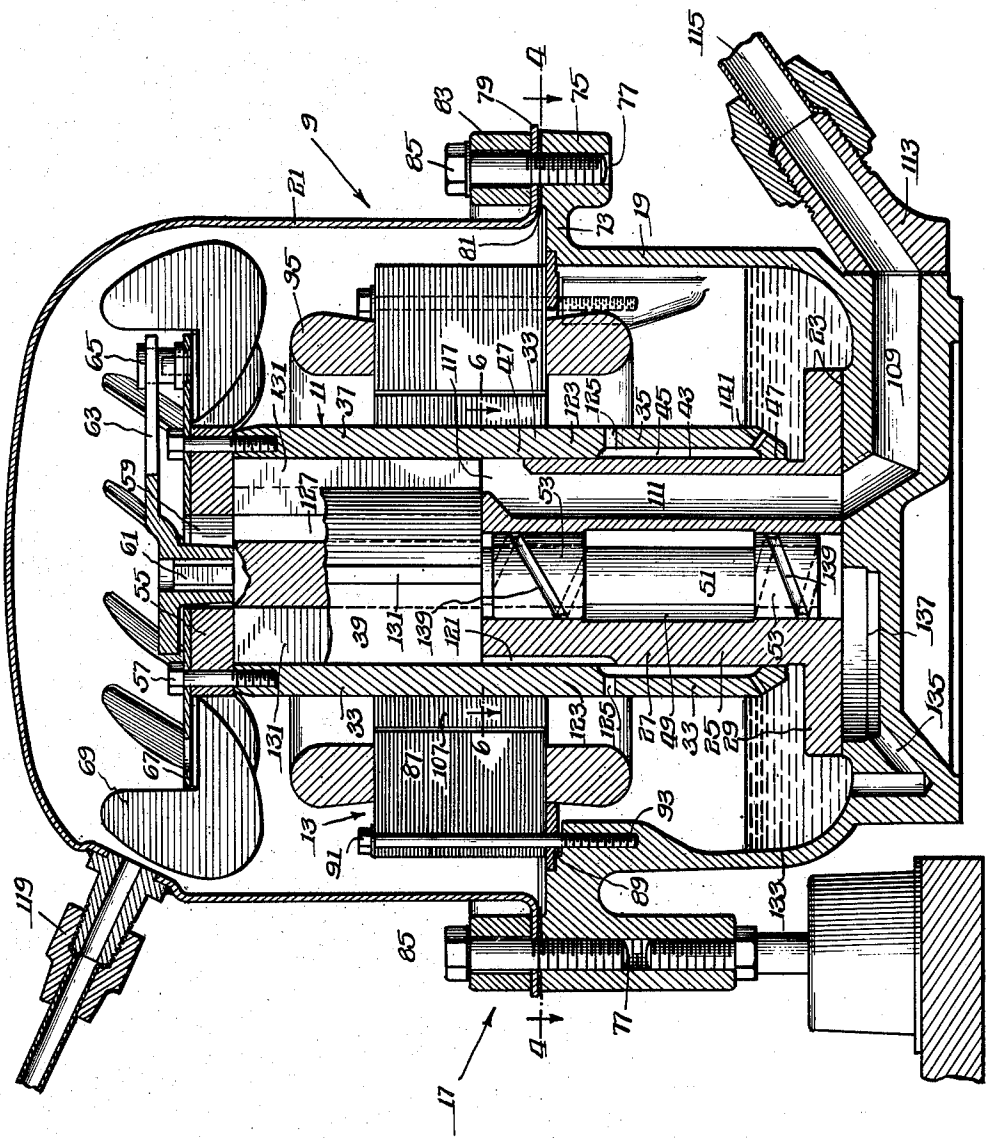


Fig. 3.

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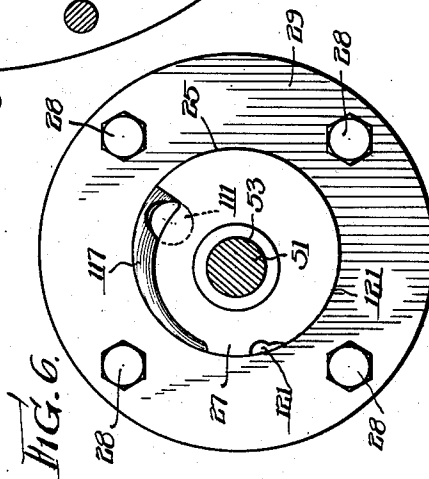
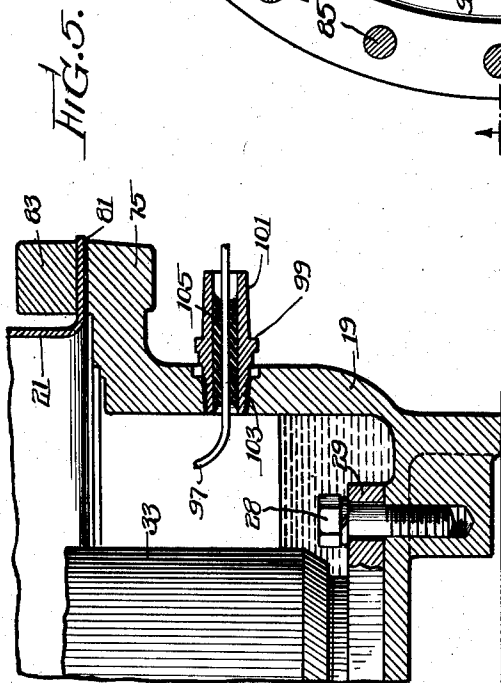
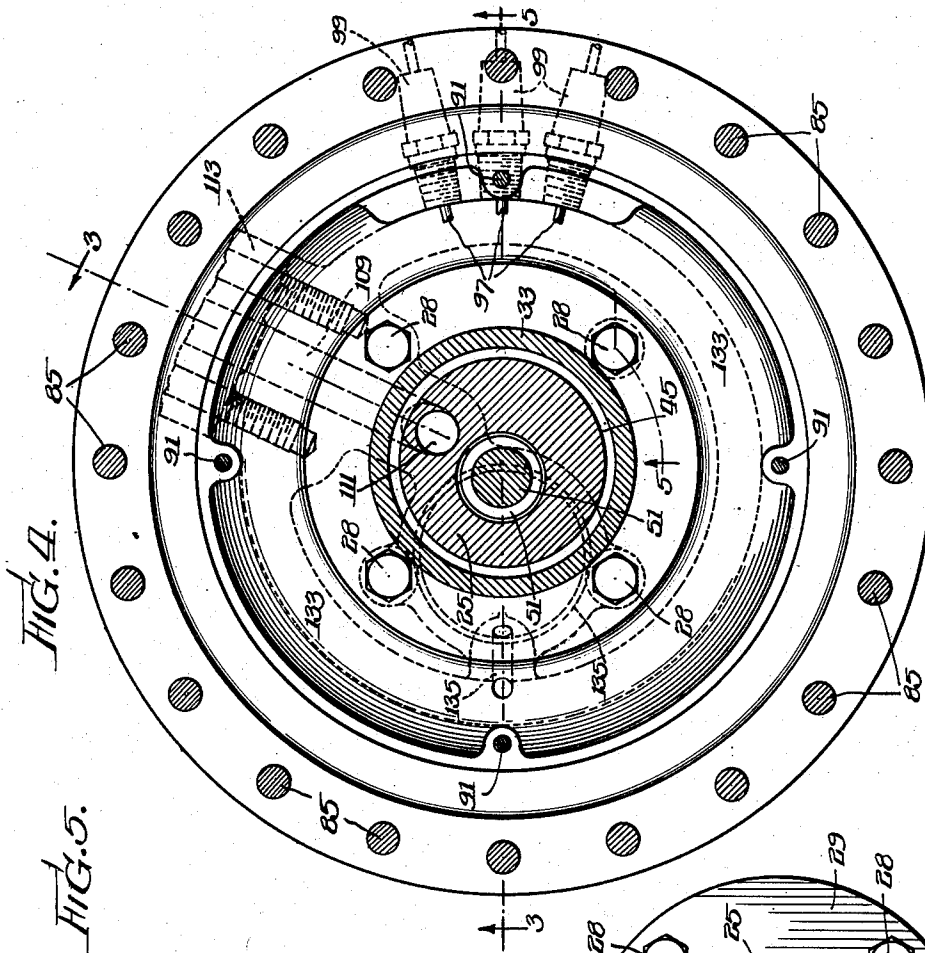
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COMPRESSOR

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3 Sheets-Sheet 3



Inventor:-
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UNITED STATES PATENT OFFICE

2,072,307

COMPRESSOR

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Application May 14, 1934, Serial No. 725,473

12 Claims. (Cl. 230—140)

This invention relates, in general, to motor-generator units, and has more particular reference to a unit comprising fluid pressure generator powered by an electrically operated motor, the unit being adapted, more especially, for use as a refrigerant compressor in a refrigerating system of the so-called compression-evaporation type wherein a suitable refrigerating medium, in gaseous form, is cyclically compressed, condensed to liquid form by cooling and evaporated for the purpose of absorbing heat.

The invention has for an important object the provision of an improved device particularly well adapted for use in refrigerating systems as applied in domestic refrigeration and, to this end, characterized by simplicity of construction, whereby assembly of the unit is facilitated and manufacturing costs consequently reduced, the device being compact, efficient in operation, providing for substantially noiseless operation and including simple, self-contained means for adequately lubricating its operating parts whereby the same is adapted for continuous operation over long periods of time without attention, and consequently may be used to advantage in domestic refrigerators.

Another important object is to provide a motor compressor unit of the character mentioned wherein the compressor and its driving means comprise a sealed unit whereby the necessity of sealing the compressor shaft against the escape of fluid under pressure is eliminated, the invention including the provision of means for adequately lubricating the moving parts of the sealed unit so that the same may operate continuously, without attention as to lubrication, during extended periods.

Among the other important objects of the invention is to utilize the working medium as a heat transfer agency within the sealed unit for cooling the operating parts thereof, and to this end provide means for circulating the working medium in the vicinity of said parts; to mount the operating parts on a support base comprising a pedestal extending in a lubricant bath and utilizing the movement of the operating parts to pump the lubricant between the working surfaces thereof; to provide a compressor comprising a sleeve and a rotary impeller within the sleeve and eccentric with respect thereto, the sleeve being journaled on outer cylindrical surfaces of a support pedestal and the impeller having a shaft journaled in the pedestal eccentric with respect to the sleeve whereby to facilitate assembly of the parts on the pedestal by merely dropping them

into position; to facilitate the assembly of the sleeve-like cylinder by arranging the same for endwise support on the impeller in substantially floating position with respect to the pedestal, whereby the cylinder may shift axially to release the load under abnormal load conditions; to provide simplified inlet and outlet ducts to the working space between the impeller and cylinder, and more particularly to form said ducts in the support pedestal and to define at least one duct by and between the pedestal and one of the working elements; to arrange the sleeve-like cylinder element with means providing valve action in the outlet duct responsive to the operating movement of the cylinder; to provide a common guiding and support element for both cylinder and impeller; to form the cylinder element and the support pedestal with co-operating surfaces providing a muffler chamber; and in general to simplify and reduce the cost of devices of the character mentioned through the several unique features hereinafter disclosed.

Numerous other objects, inherent advantages, and functions of the invention will be apparent as the same is more fully understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment of the invention.

Referring to the drawings:

Figure 1 is a diagrammatic view of a compression-evaporation refrigerating system having a sealed motor-compressor unit embodying the present invention;

Figure 2 is a diagrammatic view of an electrical system, which may be used to supply power for operating the refrigerating system illustrated in Figure 1;

Figure 3 is a view in vertical section taken through the motor-compressor unit of the system shown in Figure 1;

Figure 4 is a view in horizontal section taken substantially along the line 4—4 in Figure 3;

Figure 5 is a view in vertical section taken substantially along the line 5—5 in Figure 4; and

Figures 6, 7, and 8 are horizontal views taken substantially along the lines 6—6, 7—7, and 8—8 in Figure 3.

To illustrate the invention, I have shown on the drawings a fluid-forcing device particularly adapted for use as a compressor in a refrigerating system of the compression-evaporation type, and while I contemplate the use of devices embodying the invention particularly in combination forming a refrigerating system, it will be obvious that the invention is not neces-

sarily restricted in every feature to compressors or to devices used for refrigerating purposes. In fact, the invention includes features adapted to hydraulic devices generally, and embodies features of advantage not necessarily restricted to devices incorporated in a compression-evaporator system. The invention, however, is particularly well adapted for embodiment in fluid-forcing means, namely a compressor, to provide a substantially leak-proof device, noiseless and efficient in operation over long periods of time without attention, whereby the same is especially well suited for use in refrigerating systems applied to domestic service.

To provide the foregoing characteristics, the compressor is formed as a sealed unit including fluid-forcing means 11 and driving means 13, preferably comprising an electric motor, the fluid-forcing and driving means being housed in a substantially hermetic casing 17, formed in any suitable fashion, and preferably comprising a base 19 on which the fluid-forcing and driving means are supported in position extending upwardly of the base, and a cover section 21 secured on and to the base in position to enclose the fluid-forcing and driving means. The cover section 21 cooperates to form hermetically sealed housing for the mechanism of the unit.

The base 19 is preferably formed as a substantially cup-shaped casting of material sufficiently strong to form a rigid support for the operating elements of the motor compressor unit.

The casting preferably includes an outstanding peripheral flange 73 at its upper edge, the flange being thickened in its outer portion to form an annular rim 75 provided at spaced apart points therein with threaded sockets 77. The cover section 21 is also preferably of cup-shaped form, and is preferably made of heat-conducting material in sheet form, thereby serving to dissipate the heat generated by the operation of the mechanism within the casing. The cover section may be conveniently fabricated by spinning or otherwise forming sheet metal stock and, as formed, is preferably provided with an outstanding peripheral flange 79 so that when the cover section is inverted on the base, the flange 79 will register with the rim 75, and the casing portions may be sealingly secured together in position to enclose the fluid-forcing and driving elements 11 and 13 by interposing an annular gasket 81 between the rim 75 and flange 79, and by securing the rim 75 and flange 79 together in any suitable manner as by means of the annular clamping ring 83, which is applied behind the flange 79 and the bolts 85, which penetrate perforations in the ring 83 and flange 79 and thread into the socket 77 of the rim 75.

The bottom of the cup-shaped casting is formed with an upwardly facing seat 23 on which is mounted a pedestal 25 having an upstanding portion 27 and a flanged end 29 which rests upon the seat 23 being secured thereto in any suitable or preferred fashion as by means of bolts or studs 31. The compressor and movable portion of its driving motor are supported on the pedestal 25.

The fluid-forcing mechanism 11 preferably comprises a cylindrical sleeve 33 having a lower portion 35 embracing and rotatably seated upon the upstanding portion 27 of the pedestal and a portion 37 extending upwardly of the pedestal to provide a working chamber within the sleeve above the pedestal. The compressor 11 also comprises an impeller member 39 of substan-

tially cylindrical shape and rotatably mounted on the pedestal, and supported in the working chamber within the sleeve above the pedestal, said impeller member 39 being of lesser diameter than the internal diameter of the working chamber, and being mounted with its rotating axis eccentric with respect to that of the sleeve to a degree such that the impeller, on one side of the compressor, is in contact with the inner surface of the sleeve leaving a crescent-shaped working space 41 between the outer surface of the impeller and the inner surface of the sleeve.

Inlet means, comprising a manifold 117, in communication with one end of the crescent-shaped working space, and outlet means, comprising a duct 121, in communication with the other end of the crescent-shaped working space, are provided to deliver the work material to and from the work space.

The impeller 39 also is formed with one or more channels 127 extending parallel to and spaced from its axis and a radial slot 129 is formed between each channel and the cylindrical surface of the impeller. The channels 127 and slots 129 extend from end to end of the cylindrical portion of the impeller and a fluid-forcing vane or blade 131 is carried in each slot, said blades being long enough to extend from end to end of the impeller. The outer edges of the blades are slightly rounded so that the same may engage and press upon the inner surface of the sleeve at all times during the rotation of the sleeve and impeller, and define, in the working space, one or more compression chambers adapted cyclically to increase and decrease in volume during the rotation of the parts.

In order to support the sleeve and impeller in the proper eccentric relationship, the upstanding portion 27 of the pedestal is formed with outer cylindrical walls 43 upon which the lower end 35 of the sleeve forms a running fit. The inner surfaces of the sleeve are cut away to form an annular space 45 between the sleeve and the cylindrical sleeve-bearing portion of the pedestal so that the sleeve bears upon the pedestal at spaced annular portions 47 at the opposite ends of the space 45. The upstanding portion 27 of the pedestal 25 is also provided with an axial bore 49 forming a journal eccentric with respect to the outer cylindrical pedestal surface 43 and the impeller member 39 is formed with an axial shaft 51 which extends into the journal 49, the shaft 51 being preferably formed with spaced bearings 53 which slidably fit into the journal 49 whereby to rotatably support the impeller on the pedestal in eccentric position with respect to the sleeve. The upper end of the pedestal provides a step-bearing on which the impeller 39 is rotatably supported at its lower end so that to assemble the impeller on the pedestal, it is merely necessary to insert the shaft 51 in the journal 49 and permit the weight of the impeller to retain it in position upon the step-bearing at the upper end of the pedestal. The upper end of the sleeve 33 is or may be provided with a bearing plate 55, which may, of course, be formed integral with the sleeve, but which is preferably formed as a separate plate, and secured in position by means of the bolts or studs 57. This plate is of annular shape having a substantial opening 59 and is adapted to rest upon the upper end of the impeller member and support the sleeve in position, so that after the impeller is assembled on the pedestal, the sleeve may be assembled in operating position by merely dropping it over the impeller and the pedestal.

Means is provided to cause the impeller and sleeve to rotate in unison in order to cause the crescent-shaped space 41 to move relatively around the axis of the sleeve in order to perform the fluid-forcing function of the compressor. It will be understood, of course, that the relative position of the crescent-shaped work space 41, with respect to the base 19, does not change, but that as the sleeve and impeller rotate in the direction illustrated by the arrow in Figure 8 of the drawings, each compression space, defined between the sleeve and impeller between the blades 131, will expand while said compression space is in communication with the inlet manifold 117. Each compression space will have maximum volume at the instant that the trailing blade, defining said space, registers with the trailing wider end of the intake manifold and cuts off the compression space from further communication therewith. As the parts continue to rotate, the compression space, with work material entrapped therein, will decrease in diametric volume capacity as the surfaces of the sleeve and impeller come together as a result of the rotation of the parts so that the work material will become compressed, and may be expelled under pressure through the outlet duct 121 as soon as the leading blade of the compression space has uncovered said duct. Any suitable means may, of course, be utilized to cause the sleeve and impeller to rotate on the pedestal in unison, but I prefer to form the impeller with an upwardly extending stub-shaft 61 of non-circular cross-sectional configuration. This stub-shaft extends through the opening 59 and is fitted with a radially extending arm 63. The sleeve also is formed with a projection comprising a stud 65 adapted to engage the arm 63 so that when the sleeve is rotated, as by means of the motor 13, the stud 65 will bear against one side of the arm 63 and cause the impeller to rotate on its axis. The stud 65 is preferably carried on the end of an arm 67, which in turn, is secured to the end of the sleeve by means of the bolts 57, although the stud may, of course, be formed and mounted on the sleeve in any suitable or preferred fashion. In addition, the upper end of the sleeve may carry a fan element 69 for the purpose of circulating air within the housing 17.

Any suitable means 13 may, of course, be used to drive the compressor, but I prefer to utilize an electric motor having an annular stator 87 secured in substantially horizontal position to the base 19, the stator resting in a seat 89 formed in the open end of the cup-shaped casting forming the base 19 and being held in position in any suitable fashion as by the studs 91, which thread into threaded sockets 93 formed in the base.

In the illustrated embodiment, the stator 87 is provided with electrical windings 95, which may be energized from an electrical power source external to the casing of the unit by means of conductors 97, which are electrically connected with the windings and which extend from the casing through sealed plugs 99 mounted in a wall of the casing 19. The plugs 99 may comprise substantially cylindrical sleeves 101 having externally threaded ends 103 fitting into threaded perforations formed in the casing wall. The conductors 97 extend through said sleeve, the interior of which, around said conductors is filled with a suitable sealing and insulating material 105.

The driving motor 13 also comprises a rotary portion 107, which is fixed on and carried by the sleeve 33 in position within the annular stator 87 so that when the sleeve is assembled on the ped-

estal, the rotating motor element 107 will be carried by and supported by the sleeve in position to cooperate with the stationary motor portion 87, and be driven by the dynamo electrical effects developed by the stator whenever the windings 95 thereof are electrically energized. It will be noted that the rotating element of the motor, since it is carried by the sleeve, is journaled upon the pedestal by the same means utilized to support an operating part of the compressor. By forming the rotating element of the motor as a mechanically integral part of the sleeve, I am not only able to reduce the overall size and weight of the unit, but also am able to eliminate the provisions of additional bearings for the rotating motor element. Furthermore, I am able to facilitate the assembly of the unit, since the rotating part of the motor is fitted on and assembled in the structure simultaneously with the compressor sleeve.

The bottom of the base 19 is formed with an inlet duct 109, one end of which opens in the seating surface 23 in position to communicate with the lower end of a duct 111 formed axially in the pedestal. The duct 109 has another end opening on a side wall of the casing 19, and the casing carries a fitting 113, whereby said end of the duct 109 may be connected to refrigerant conduit 115, through which the work material to be compressed may be delivered to the unit. The pedestal duct 111 opens into the intake manifold, which is formed as a cutaway portion 117 at the upper end of the pedestal. The cutaway portion 117 has an inner edge extending substantially opposite the edge of the impeller 33 and an outer edge coinciding with the inner wall of the sleeve. The cutaway portion lies opposite one arm of the crescent-shaped work space 41 and extends, in the illustrated embodiment, from a point near the point of contact between the impeller and the sleeve, a distance substantially one-third of the circumference of the pedestal. The discharge duct means leading from the work space 41 into the casing 17 is or may be provided in the sleeve 33 or the pedestal 35, or both, whereby working material, compressed in the working space by the rotation of the sleeve and impeller, may be expelled therefrom into the interior of the casing 17, from whence the compressed work material may escape through a discharge fitting 119, which is preferably formed in the cover section 21 of the casing. As shown in Figure 3 of the drawings, the discharge duct means, permitting the escape of the work material from the compression space, comprises the duct 121 located at the upper end of the pedestal in position communicating with the arm of the crescent-shaped work space remote from the intake manifold 117.

The duct 121 also communicates with the space 45 between the pedestal and the lower portions of the sleeve so that the compressed work medium may be delivered from the work chamber into this space, which functions to a certain extent as a muffler for ironing out the pulsating effect imparted to the work material in being compressed and discharged. The lower portions of the sleeve also are provided with perforations 125 communicating with the annular chamber 45 and the interior of the casing 17 outside of the sleeve 33, and through which perforations, the compressed medium may escape into the casing and thence through the outlet 119. It is also possible to provide a valve discharge effect by shortening the duct 121 so that it does not communicate with the chamber 45 and by arranging the perforation

125 in the sleeve portion 123, there being at least one perforation 125 for each compression space defined by the vanes 131 of the impeller and properly spaced circularly in the sleeve, care being taken to arrange the perforations 125 in such a way that they do not communicate with the inlet manifold 117 at any time during the rotation of the sleeve. With such an arrangement, the discharge is normally closed except when the perforations 125 register with the duct 121, the perforations 125 being so disposed in the sleeve that they register with the duct 121 at the instant when it is desired to discharge the compressed material. For instance, the perforations 125 may be arranged to discharge the compressed medium only after the pressure within the compression space has attained a predetermined value so as to prevent material under pressure within the casing 17 from flowing back into the compression space through the outlet port. Alternately, the perforations 125 may be arranged as shown and the upper end of the chamber 45 provided with extensions at proper intervals to register with the shortened duct 121, thus providing a valved discharge into the chamber 45 from whence the compressed medium may escape through the perforations 125.

In order to provide adequate lubrication for the working parts of the unit, the base 19 provides a reservoir for a lubricating medium 133, and the base is formed with a conduit 135 communicating the lowermost portion of this lubricant reservoir with a chamber 137, which opens on the seat 23 in position communicating with the lower end of the pedestal channel 49 in which the impeller shaft 51 is journaled. The bearing means 53 and the journal, in which the same is mounted, are formed with co-operating means comprising helical grooves 139 in the bearing means whereby, upon rotation of the impeller and its shaft 51, the lubricant in the chamber 137 will be drawn upwardly through the channel 49 past the bearings, and thereby lubricate the same, the lubricant being thence delivered at the lower end of the impeller and entering the channels 127. The lubricant will then find its way upwardly through the channels 127, which extend entirely through the impeller and a part of the lubricant will eventually escape through the opening 59 and be thrown outwardly onto the walls of the cover section 21, and will thence drain back into the reservoir contained in the base 19. During its passage through the channels 127, part of the lubricant will escape radially outwardly through the slots 129 in which the blades 131 are mounted, and will serve to lubricate the blades during the radially reciprocating movement of the same in the slots as well as to lubricate the edges of the blades which slide in contact with the inner surface of the sleeve. Lubricant, so delivered, in excess of that required for adequate lubrication of the blades, will be delivered out of the working space with the compressed work medium through the outlet duct 121, and will accumulate in the space 45 and serve to lubricate the cooperating bearing surfaces of the pedestal and sleeve. Eventually, this oil also will flow back into the reservoir in the base 19, and to facilitate such flow, I may form ducts 141 in the lower portions of the sleeve.

As a lubricating medium, I prefer to employ a suitable mineral oil and contemplate the compressor more especially for use in the compression of a refrigerating medium comprising dichloromethane with which mineral oils do not

form solution to any great extent, so that even though the lubricant and work medium are mingled together in the compression space, the compressed material, in gaseous form, expelled from the work space into the housing 17, does not require treatment to separate it from the lubricant, but the lubricant drains to the reservoir in the base 19 while the compressed gases circulate in the housing, and finally escape through the outlet 119.

When the device is in operation, the rotation of the fan 69 on the sleeve 33 will cause a circulation within the casing section 21, of the compressed gases delivered therein from the fluid-forcing device or compressor. The compressed gases are thus caused to travel around the operating parts of the unit exposed above the lubricant reservoir, and will absorb heat therefrom, and will deliver at least a part of the absorbed heat to the casing section 21, which, being of heat-conducting material, will dissipate the heat readily into the surrounding atmosphere, the remaining heat absorbed by the work material being carried with said material through the outlet 119. The compressed gases themselves are used as a heat-transfer medium for cooling the operating parts of the unit. It is within the contemplation of the present invention to provide the casing 21 with means, such as outwardly extending fins, for increasing the heat dissipating capacity of the cover section 21, however, the provision of such means is not essential to satisfactory operation of the device.

As heretofore mentioned, the device of my present invention is particularly well adapted for use as a compressor in a refrigeration system, and in Figure 1 of the drawings I have shown the outlet 119 of the unit connected as by means of a pipe or a conduit 143 with a condenser 145 in which the compressed medium delivered from the unit may be condensed to liquid form by cooling the same. The condenser 145 may be of any suitable or preferred construction, and is preferably cooled by forced-air drafts initiated by a fan 147 powered by an electric motor 149, which is preferably of a character adapted for parallel operation from the source of electrical power used to energize the motor 13 of the unit. The liquefied refrigerating medium delivered from the condenser may be conducted through a conduit 151, which may include refrigerant drying or dehydrating means, through an expansion valve 153, preferably of the float-controlled type, from which the liquid refrigerant is or may be delivered through a conduit 155 to a refrigerant evaporator or boiler 157 of any suitable or preferred construction, and in which the liquid refrigerant is evaporated to gaseous form, being absorbed at the boiler during such evaporation. The evaporated refrigerant may be returned from the boiler 159 to the inlet connection 113 of the sealed motor compressor unit through the conduit 115, thus completing the refrigerating cycle. Such a system is well adapted to refrigerators for domestic service in which the several elements of the system are mounted in a suitable cabinet indicated generally at 159. This cabinet preferably includes a refrigerating compartment 161, in which the evaporator or boiler 157 is disposed in position to absorb heat from the atmosphere within the refrigerating compartment. The motor compressor unit, the condenser, and its cooling fan, and the expansion valve, may be located in a mechanism chamber 163 formed in

the cabinet 159, the compartments 161 and 163 being preferably arranged in superposed relationship in the cabinet. The elements of the refrigerating system contained in the compartment 163 may be mounted on a common support element 165 whereby the same may be introduced into and removed from operating position in the compartment 163 as a single assembly unit in order thus to facilitate the manufacture and repair of the refrigerator. With such an arrangement, the conduits 115 and 155 may be permanently built into the walls of the cabinet during the course of its construction, while the boiler 157 and the parts carried on the support 165 may be assembled in place and connected with the conduits 115 and 155 after the cabinet has been fabricated.

As heretofore mentioned, the motors 13 and 149 are arranged for parallel operation from a common electrical power source and, in Figure 2 of the drawings, I have shown an electrical control system for this purpose. Each motor preferably has a plurality of like windings 169 and 171, which are connected together at one end to a common conductor 173. The opposite ends of the windings 169 of each motor are connected together to a conductor 175 and the free ends of the windings 171 are likewise connected to a conductor 177. The common conductor 173 is connected to a terminal 179 located in a casing 181, which is or may be located in any convenient position in the cabinet 159, as on the support 165. The terminal 179 is connected by means of a conductor 183 forming a part of a cable 185 extending in the refrigerator cabinet from the casing 181 to a thermostat control casing 187 located adjacent the evaporator 157. The opposite ends of the cable 185 may be provided with detachable connectors 189 and 191 to facilitate connection. The conductor 183, when the parts are assembled and connected for operation, is connected to one side of a switch 193 located in the casing 187, which switch is controlled by thermostat means, manually adjustable as by the control knob 195 which is preferably mounted on the casing 187, the thermostat means including a thermostatic element 197, which extends from the casing 187 into heat-exchange relationship with the atmosphere in the refrigerating compartment in the vicinity of the boiler 157. The thermostatic means is cooperatively associated with the switch 193, so that the same may be opened and closed automatically in response to temperature changes in the refrigerating chamber. The other side of the switch 193 is connected through a manually operable switch 199, preferably mounted in the casing 187, and through a conductor 201 forming a part of the cable 185 to a terminal 203 located in the casing 181. The terminal 203 in turn is connected by a conductor 208 forming a part of a cable 205 with means 207 preferably in the form of an electrical plug of ordinary construction, adapted for removable connection in a power outlet socket of the character ordinarily provided in commercial or domestic electric power systems. The cable 205 has another conductor 209 adapted for detachable connection in the power delivery circuit by means of the plug 207, which conductor is connected with a terminal 211 located in the casing 181. This terminal 211 is electrically connected with one end of a solenoid 213, also located within the casing 181, the other end of which solenoid is connected with a terminal 215 mounted in the casing 181. The

conductor 175, leading from the motor winding 169, is connected with this terminal 215. When the plug 207 is connected in an external power circuit, power will be delivered through the cable 205 to the terminals 211 and 203 in order to energize a circuit including in series the conductor 201, the switches 193 and 199, the conductors 183 and 173, the windings 169 of the motors, in parallel, the conductor 175 and the solenoid 213. In parallel with the portion of this circuit, which includes the solenoid 213 and the motor windings 169, is an additional circuit including the windings 171 of the motors, the conductor 177, and a winding comprising an induction coil 217, the opposite ends of which are connected together through a condenser 219 and by means of a conductor 221 to one side of the solenoid 213, said induction coil being provided with taps 223 and 225, which are connected to stationary contacts between which is mounted a shiftable blade 227, which moves in response to the current flowing through the solenoid 213 and is adapted to selectively engage one or other of the contacts. The blade 227 is connected to the conductor 177 and consequently controls the character of the power delivered to the circuit containing the windings 171 of the motors. The motors are preferably of the so-called capacity type induction motors, the windings 171 forming split phase windings whereby the induction motors may be positively started in operation when energized with single-phase alternating current. It will be noted that both of the parallel circuits including the motor winding are controlled by the switches 193 and 199 so that when the plug 207 is connected in a power outlet, the motors will remain inactive until both of the switches 193 and 199 are closed. The switch 199, being manually operable, affords manual control for the motors, while the switch 193 provides an automatic control so that the motors will be placed in operation when the temperature in the refrigerating compartment 161 rises above a predetermined value, which may be determined by means of the knob 195. When the plug 207 is connected to an external power source adapted to deliver single-phase alternating potential between the terminals 203 and 211, upon the closure of the switches, alternating current will be delivered through the parallel circuit heretofore mentioned, which includes the windings of the motors. The current delivered to the windings 171, however, will have a different phase relationship with respect to that delivered to the windings 169 because of the reactive effect imparted by the induction coil 217 and the condenser 219. At the instant of starting, the switch 217 will engage one or other of the contacts 223, 225, so that the proper phase difference for starting the motors will be imparted to the current delivered through the several windings. As the motors reach operating speed, however, the blade 227 will engage the other of said contacts 223, 225, in order to alter the phase relationship of the current delivered to the windings, it being understood that the phase relationship of current required in the several windings for maximum efficiency varies during starting and normal operation of the motors.

The electrical system also includes a circuit 229 including a lamp 231 and a control switch 233, said circuit being connected between the conductor 201 of the cable 185 and another conductor 235 contained in said cable and connected to the terminal 211 so that whenever the plug

207 is connected to the external power source, the lamp 231 will be energized providing the switch 233 is closed. The lamp 231 is arranged in any suitable or convenient position within the compartment 161, and the switch 233 is arranged to cooperate with the door usually provided in domestic refrigerators for giving access to the compartment 161. The switch 233 cooperates with the door so that it is normally held in open position whenever the door is closed. When the door is open, however, the switch 233 closes so that the lamp 231 provides illumination for the compartment 161 whenever the door giving access thereto is open.

It is thought that the invention and numerous of its attendant advantages will be understood from the foregoing description, and it is obvious that numerous changes may be made in the form, construction, and arrangement of the several parts without departing from the spirit or scope of my invention, or sacrificing any of its attendant advantages; the forms herein described being preferred embodiments for the purpose of illustrating my invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is as follows:

1. A machine comprising a base providing an upstanding pedestal having cylindrical side walls, a piston element carried on said pedestal in position extending above the top thereof, a cylinder element enclosing the piston and having portions journaled on the cylindrical side walls of the pedestal, means to admit a fluid work medium to said cylinder, the side walls of said pedestal having a groove forming, with the walls of the cylinder element, an outlet duct for the work medium, said outlet duct communicating with the space within the cylinder at the top of the pedestal and being connected with an opening in the cylinder walls substantially below the top of the pedestal.

2. A machine comprising a base providing an upstanding pedestal having cylindrical side walls, a piston element supported by said pedestal in position extending above the upper end thereof, said piston having lesser diameter than the pedestal and having its side surface in alignment with the cylindrical wall of the pedestal on one side thereof, a cylinder element enclosing the piston and having depending portions embracing and journaled for rotation on the cylindrical walls of the pedestal whereby to provide a work space between the piston and the cylinder above the pedestal, said work space having crescent-like cross sectional configuration, an inlet duct for a fluid work medium formed in said pedestal and opening into one horn of the crescent-like work space at the top of the pedestal, and an outlet duct connected with the other horn of the work space and comprising a groove formed in a cylindrical side wall of the pedestal on which the dependent portions of the cylinder are journaled.

3. A machine comprising a base providing an upstanding pedestal having cylindrical side walls, a piston element supported by said pedestal in position extending above the upper end thereof, said piston having lesser diameter than the pedestal and having its side surface in alignment with the cylindrical wall of the pedestal on one side thereof, a cylinder element enclosing the piston and having depending portions embracing and journaled for rotation on the cylindrical walls of the pedestal whereby to pro-

vide a work space between the piston and the cylinder above the pedestal, said work space having crescent-like cross sectional configuration, means forming an inlet duct for a fluid work medium communicating with one horn of said crescent shaped work space and a groove formed in a side wall of the pedestal and extending from the top of the pedestal opposite the other horn of the work space to a point substantially below the top of the pedestal, said groove forming with the dependent portions of the cylinder an outlet port from the work space.

4. A machine comprising a base providing an upstanding pedestal having cylindrical side walls, a piston element supported by said pedestal in position extending above the upper end thereof, said piston having lesser diameter than the pedestal and having its side surface in alignment with the cylindrical wall of the pedestal on one side thereof, a cylinder element enclosing the piston and having depending portions embracing and journaled for rotation on the cylindrical walls of the pedestal whereby to provide a work space between the piston and the cylinder above the pedestal, said work space having crescent-like cross sectional configuration, means forming an inlet duct for a fluid work medium communicating with one horn of said crescent shaped work space and a groove formed in a side wall of the pedestal and extending from the top of the pedestal opposite the other horn of the work space to a point substantially below the top of the pedestal, said groove forming with the dependent portions of the cylinder an outlet port from the work space, the dependent portions of the cylinder element having an opening therein substantially below the top of the pedestal in position communicating with said groove and forming, with the walls of said pedestal, a muffler chamber into which the fluid medium may be discharged through the outlet port substantially without noise, and means forming an outlet for the fluid medium from said muffler chamber.

5. A machine comprising a base providing an upstanding pedestal having cylindrical side walls, a piston element supported by said pedestal in position extending above the upper end thereof, said piston having lesser diameter than the pedestal and having its side surface in alignment with the cylindrical wall of the pedestal on one side thereof, a cylinder element enclosing the piston and having depending portions embracing and journaled for rotation on the cylindrical walls of the pedestal whereby to provide a work space between the piston and the cylinder above the pedestal, said work space having crescent-like cross sectional configuration, means forming an inlet duct for a fluid work medium communicating with one horn of said crescent shaped work space and a groove formed in a side wall of the pedestal and extending from the top of the pedestal opposite the other horn of the work space to a point substantially below the top of the pedestal, said groove forming with the dependent portions of the cylinder an outlet port from the work space, the dependent portions of the cylinder element having an opening therein substantially below the top of the pedestal in position communicating with said groove and forming, with the walls of said pedestal, a muffler chamber into which the fluid medium may be discharged through the outlet port substantially without noise, and a duct formed in the walls of the cylinder element and providing an outlet for the fluid medium from the muffler chamber.

6. A machine comprising a base providing an upstanding pedestal having cylindrical side walls, a piston element carried on said pedestal in position extending above the top thereof, a cylinder element enclosing the piston and having portions 5 journaled on the cylindrical side walls of the pedestal, means to admit a fluid work medium to said cylinder, the side walls of said pedestal forming, with the walls of the cylinder element, an outlet duct for the work medium, said pedestal 10 comprising an element removable on the base and the means to admit a fluid work medium to the cylinder comprising a longitudinal channel in the pedestal opening at the opposite ends of the 15 pedestal and communicating with a channel formed in the base.

7. A machine comprising a base providing an upstanding pedestal having cylindrical side walls, a piston element carried on said pedestal in position extending above the top thereof, a cylinder 20 element enclosing the piston and having portions journaled on the cylindrical side walls of the pedestal, means to admit a fluid work medium to said cylinder, the side walls of said pedestal forming, with the walls of the cylinder element, an outlet duct for the work medium, said base 25 comprising a casing enclosing the pedestal, cylinder and piston, and into which casing the work medium, discharged through said outlet duct from within the cylinder, enters.

8. A machine comprising a base providing an upstanding pedestal having cylindrical side walls, a piston element carried on said pedestal in position extending above the top thereof, a cylinder 35 element enclosing the piston and having portions journaled on the cylindrical side walls of the pedestal, means to admit a fluid work medium to said cylinder, the side walls of said pedestal forming, with the walls of the cylinder element, an outlet duct for the work medium, said base 40 comprising a cup-shaped element, and said pedestal being mounted on the bottom of the cup-shaped element in position extending within the walls thereof, and a removable cover for the 45 cup-shaped element enclosing the portions of the piston and cylinder elements which extend above the pedestal, said cover forming with the cup-shaped base a sealed housing for the operating parts, and adapted to form a receiver for the work medium discharged from said parts 50 through said outlet duct.

9. A machine comprising a base providing an upstanding pedestal having cylindrical side walls, a piston element carried on said pedestal in position extending above the top thereof, a cylinder 55 element enclosing the piston and having portions journaled on the cylindrical side walls of the pedestal, means to admit a fluid work medium to said cylinder, the side walls of said pedestal forming, with the walls of the cylinder element, an outlet duct for the work medium, said pedestal 60 providing a bearing channel communicating at the lower end of the pedestal with a lubricant

source, said piston having a shaft received in said bearing channel and co-operating means on the shaft and pedestal for delivering lubricant through said channel from said source, and delivering the same within the cylinder for the purpose of lubricating the operating parts of the 5 machine.

10. A machine comprising a base providing an upstanding pedestal having cylindrical side walls, a piston element carried on said pedestal in position extending above the top thereof, a cylinder 10 element enclosing the piston and having portions journaled on the cylindrical side walls of the pedestal, means to admit a fluid work medium to said cylinder, the side walls of said pedestal forming, with the walls of the cylinder element, an outlet duct for the work medium, said base comprising a cup-shaped element and the pedestal 15 being mounted on the bottom of said cup-shaped element in position extending within the walls thereof, an electric motor having an annular stationary portion mounted on said cup-shaped element in position to encircle the cylinder element, said motor having a rotary portion fixed on said 20 cylinder in position within the annular stationary portion of the motor, and cover means carried by the cup-shaped element in position to enclose the cylinder and motor, said cover forming with the base a sealed housing for the unit.

11. A machine comprising a base providing an upstanding pedestal having cylindrical side walls, a piston element carried on said pedestal in position extending above the top thereof, a cylinder 35 element enclosing the piston and having portions journaled on the cylindrical side walls of the pedestal, means to admit a fluid work medium to said cylinder, the side walls of said pedestal forming, with the walls of the cylinder element, an outlet duct for the work medium, said pedestal being formed with an upwardly facing bearing 40 receiving said piston element, whereby the same is supported at a desired operating elevation on the pedestal, the cylinder element enclosing and resting its weight upon the piston element and movable axially with respect to the piston element in order to provide for unloading the machine 45 when abnormal loading conditions prevail.

12. A machine comprising a base providing an upstanding pedestal having cylindrical side walls a piston element carried on said pedestal in position extending above the top thereof, a cylinder 50 element enclosing the piston and having portions journaled on the cylindrical side walls of the pedestal, means to admit a fluid work medium to said cylinder, the side walls of said pedestal forming, with the walls of the cylinder element, an outlet duct for the work medium, said cylindrical side walls of the pedestal and the cylinder portions journaled thereon cooperating to form a 55 muffler chamber with which the outlet duct communicates.

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