

June 11, 1940.

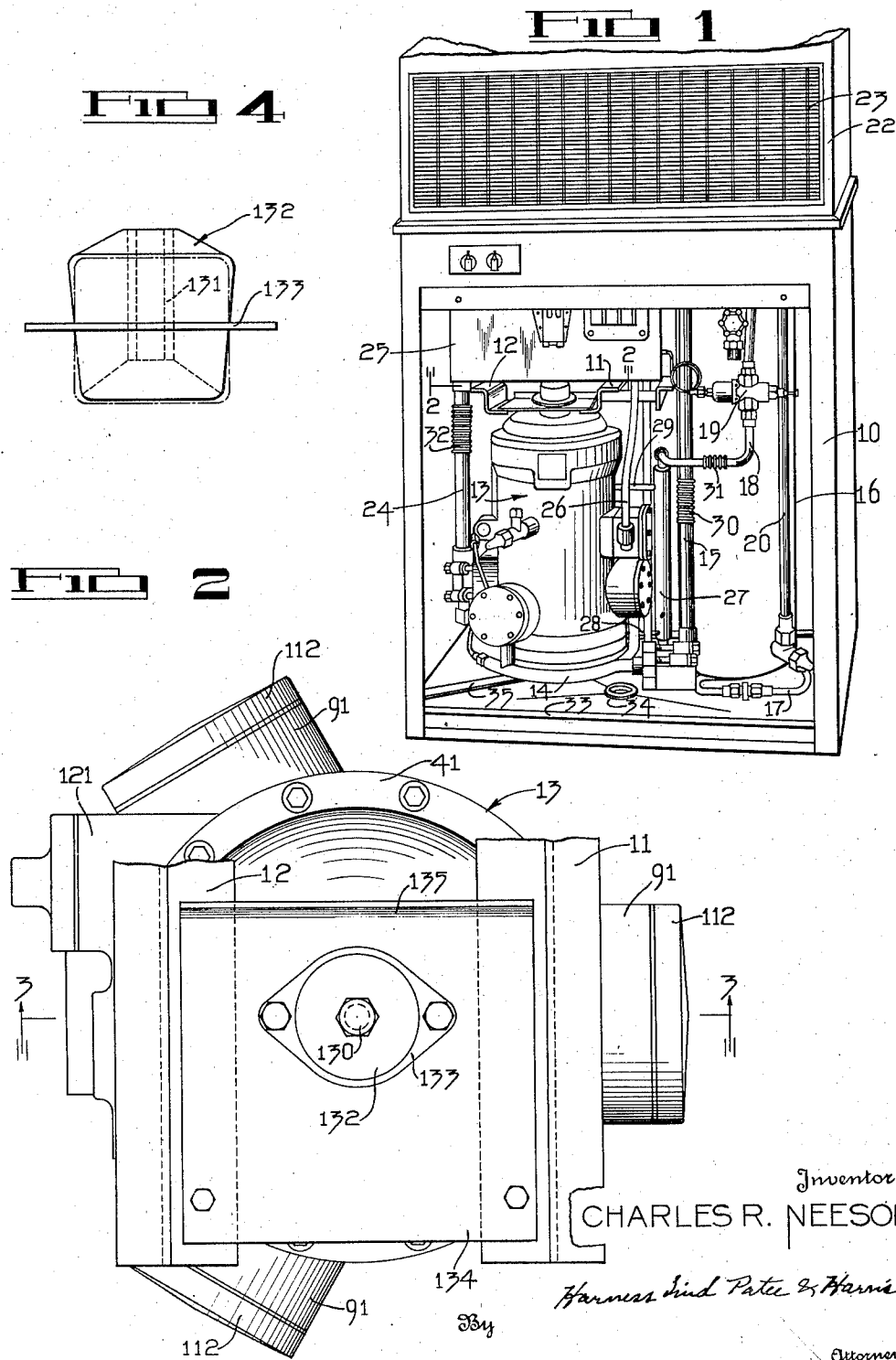
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2,204,510

COMPRESSOR MOUNTING

Filed May 29, 1937

2 Sheets-Sheet 1



UNITED STATES PATENT OFFICE

2,204,510

COMPRESSOR MOUNTING

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Application May 29, 1937, Serial No. 145,585

2 Claims. (Cl. 230—235)

The present relates to refrigerating machinery, particularly, to the compressing unit and related portions thereof. The principal object of the invention is to provide a compressing unit such that vibrations will be substantially eliminated, and means for mounting the unit such that vibrations will not be transmitted to other portions of the equipment. Other objects are to devise a compressor which is simple in design, which can be operated at very high speeds, which may be easily assembled and disassembled, and which is not susceptible to damage through ordinary shocks and strains. A further object of the invention is to provide a unitary casing, enclosing the compressing unit, condenser, controls and other related parts, in one sound-proof and heat-insulated enclosure.

Other and further objects and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawings wherein like numerals refer to like parts throughout.

In the drawings:

Figure 1 discloses the casing in which is mounted the compressing unit, condenser, controls and related parts, and which, in this instance, is shown as being adjoined to the cooling compartment of an air conditioner;

Figure 2 is a partial plan view taken along line of 2—2 of Figure 1, showing the manner of mounting the compressing unit in the cabinet;

Figure 3 is a vertical section of the compressing unit, taken along line 3—3 of Figure 2 and showing sufficient details for an understanding of the features to be claimed; and

Figure 4 is a side view of the compressing unit mounting member.

Referring to Figure 1, there is disclosed a cabinet 10 comprising upright side and rear walls forming a complete enclosure together with a removable front panel (not shown). The cabinet is preferably formed of sheet metal made sufficiently rigid by a built-in frame of light angle bars including parallel, horizontally disposed Z-bars 11 and 12, each having its lowermost leg extending toward the other leg and forming a pair of horizontal tracks upon which the compressing unit may be mounted so as to be capable of being removed horizontally from within the cabinet. The cabinet is preferably lined with a layer of porous material which tends to prevent the radiation of heat from the compressing unit and condenser, and to deaden any noises resulting from the operation of the machine.

The compressing unit 13 is mounted on the Z-

bars so as to be capable of swinging or of partially rotating, as will be subsequently described. The compressing unit discharges hot gaseous refrigerant under high pressure into the discharge manifold 14 which is connected to an upright high-pressure pipe 15. The refrigerant, which is preferably a stable compound such as dichlorodifluoromethane, passes into the upper portion of an upright condenser shell 16, which is rigidly attached to the casing and framework. A cold water inlet pipe 17 is connected to the lower end of a heat transfer device such as a finned pipe (not shown), coiled within the shell 16. The cold water flowing upward through the coil cools and condenses the gasified refrigerant passing downward through the shell in accordance with the well-known contraflow principle. Liquified refrigerant is collected in the bottom of the shell and the warm water flows outward through a discharge pipe 18. A valve 19 in the discharge pipe regulates the flow of water, the valve being manually controlled, or automatically controlled in accordance with the demand of the machine, as desired. The liquified refrigerant under the pressure of the gas, is forced upward through a liquid pipe 20 which extends into the cooling compartment 22 of an air conditioning system (or into the chamber to be cooled if the machine is used for refrigerating foods, etc.). In this instance, the cooling coil (not shown), is located in the compartment 22, into which air is introduced through the inlet grille 23 (or ejected through the outlet grille 23, as the case may be). The liquid refrigerant evaporates in the cooling coil, thereby removing heat from the air in compartment 22, and gaseous refrigerant returns to the compressor through the suction pipe 24.

A control panel 25, supporting switches, circuit breakers, transformers or other electrical equipment desired or made necessary due to the type of equipment, local power conditions, etc., is mounted in the casing above the Z-bars 11 and 12. A flexible power cable 26 extends from the control panel to the compressing unit 13, which contains a motor, as will presently appear. The compressor and motor require a constant supply of oil which is sealed into the compressing unit, and therefore is heated by the reciprocating parts and by a compressed gas. In order to cool the oil, an oil discharge pipe 28 extends from the lower part of the compressor into a tube 27 of larger diameter which is attached at its upper end to an oil return pipe 29 leading back to the upper part of the compressing unit. The warm water discharged from the evaporator shell is led

through pipe 18 to the upper end of a tube concentrically positioned within tube 27 and is discharged from the lower end of the tube through a waste pipe (not shown), and the oil, being hotter than the water warmed by the compressed gas, is cooled by the water in accordance with the contraflow principle. Details of the oil cooling system are clearly illustrated in my copending application Serial No. 145,586, filed concurrently herewith.

Flexible inserts in pipes 15, 18 and 24, such as metallic bellows 30, 31 and 32, respectively, permit a certain amount of swinging or twisting movement of the compressing unit 13 without endangering connections or other parts of the assembly. The lower part of the cabinet 10 supports a drip pan 33, having a waste outlet 34, by means of which condensed moisture may be withdrawn from the cabinet. A shipping plate 35 is detachably fastened to the cabinet 10 and extends beneath the compressing unit. This shipping plate is adapted to be detachably fastened to the bottom of the compressing unit (as in Fig. 3) in order to prevent movement of the compressing unit during shipment of the assembly.

It is apparent that the entire compressing unit, condenser and control panel assembly may be manufactured and shipped as a unit, as distinguished from prior practice of buying separate pieces of equipment and assembling them in the field. It is also apparent that the cooling compartment 22 may contain coils, expansion valves, thermostatic control elements, blowers, etc., all of which are assembled and connected at the plant of the manufacturer. It is therefore possible to be certain that the correct amount of oil and refrigerant is charged into the machine and that the expensive and uncertain operations of making a large number of connections in the field will be eliminated. Likewise, the entire refrigerating mechanism may be tested and proven satisfactory under careful supervision and inspection.

Figures 2, 3 and 4 disclose the elements of the compressor and motor assembly and clarify the operation of the machine and the objects of the present invention.

The compressing unit 13 comprises a cast shell 40, cover plate 41 and oil sump 42, bolted together to form a casing partially enclosing the operating mechanism. The upper part of the shell is recessed at 43 and a ring 44, fitted into the shell, forms therewith a passage for the cooled oil entering through pipe 29. The stator 45 of an electric motor is fixed to ring 44 and is cooled by the oil flowing past the ring. A baffle 46 extends partially around the recess 43 to form two passages 47 and 48, passage 48 being narrow in comparison to passage 47 and communicating with a bore 49 in the shell wall. With the compressing unit suspended as shown, oil flows in at the bottom of recess 43 and out at the top through passage 48 into bore 49. However, if the compressing unit is mounted in a horizontal fashion with pipe 29 at or near the top, the cool oil will drip from both sides of ring 44, fill passage 47 completely, and then emerge through passage 48 and bore 49.

The stator 45 holds the motor windings 50, which are connected to the cable 26, through a gas-tight connection (not shown). The windings may be dipped or coated with a suitable, self-hardening substance which prevents vibration and chafing of the wires, eliminates alternating current hum, and protects the wire insulation

from the harmful effects of oil and refrigerant gases. Such substances are well-known and may vary with the type of refrigerant used, a particular substance being disclosed in my copending application, Serial No. 145,588, filed concurrently herewith.

The rotor 51 is connected to the crankshaft 52 which is supported in bearing 53 mounted in a housing 54. The housing 54 and its radially spaced supporting arms 55 are integrally cast with the shell so as to form a rigid mounting for the crankshaft. In assembling the machine the crankshaft is inserted in the bearings from the lower end, a collar 56 is brought to rest on the upper surface of the upper bearing 53, rotor 51 is positioned, and key 57 is inserted to lock the crankshaft, collar and rotor from relative rotative movement. After the key 57 is placed in the position shown in Fig. 3 a counterweighted collar 58 is positioned over the threaded end of shaft 52 and nut 59 is located in tightened position to hold the counterweight, rotor, collar and key against axial, relative movement and to fit the shaft and collar 56 with sufficient axial clearance with respect to the ends of bearing 53. The lower end of shaft 52 is provided with an enlarged head 60 to which is attached a counterweight 61 and which is also provided with an offset crank 62. A bearing 63 is fitted on the crank and is surrounded by the bearing straps of piston rods 64. The number of pistons may vary so that the angular spacing of the pistons will also vary according to known principles of dynamic balancing. If three pistons are provided as shown, they should be spaced 120° apart; if two, 90° apart; if five, 72° apart; and if seven, slightly less than 51° 26' apart. The pistons are thus balanced against themselves, while the counterweight 61 balances against the centrifugal effect transmitted to the shaft through the offset crank 62. The counterweight 58 is provided in order to make a balanced couple out of the rotor assembly on one side of bearing 53 and the piston assembly on the opposite side of bearings 53, which eliminates whipping of the shaft.

The bearing 63 and piston rods 64 are held on the crank by a cap 70 and extended locking pin 71. The pin 71 is eccentrically positioned with respect to the centerline of shaft 52 and acts as the driver for a pump rotor shaft 72 concentrically mounted in a pump head 73 attached to a pump housing 74 integral with the oil sump 42. The pin 71 rotates shaft 72 through engagement with a cross-bar 79. The pump is preferably of the interlocked gear type comprising an idler and crescent assembly 75 and a rotor 76, having a suction inlet at 77 and a discharge outlet at 78. Further details of one form of pump suitable for the purpose are described in my copending application, Serial No. 145,586, filed concurrently herewith.

The oil leaves the pump through outlet 78, traverses pipe 28, oil cooler 27, and enters the recess 43 through pipe 29. After cooling the motor and entering bore 49, the oil is caused to lubricate the crankshaft and pistons, as follows:

Bore 49 communicates with a bore 80 through one of the supporting arms 55, which leads to the annular space defined by shaft 52, bearings 53 and housing 54. From this space the oil is forced by the static pressure of the pump upward to emerge from between the end of upper bearing 53 and collar 56, and downward to emerge from between the end of lower bearing 53 and head 60. A splash ring 82 is mounted on arms 55 to

prevent oil from being whipped against the stator windings adjacent the collar 56. Oil thus returned to the crankcase drips into the sump 42 through large openings 83 between the arms 55.

5 The oil which emerges adjacent head 60 also drips into the sump 42. In order to lubricate the piston rod bearing and cylinder walls, a passage 84 leads from the space between the bearings 53 to holes in crank pin 62 and bearing 63. The oil which emerges from between the piston rods is whipped into the cylinders and against the casing walls between the cylinders. Most of this oil drips into the sump but some may be entrained with the refrigerating gas and eventually 10 returned to the compressing unit after passing through some or all of the refrigerating equipment.

The pistons operate in cylinder liners 90 inserted through discharge heads 91 cast integrally with the shell 40, the liners extending through an integrally cast suction manifold 92 communicating with the suction pipe 24 through suction head 93. The expanded gas returning to the compressing unit passes into the compression space of the cylinder through screen 94, annular recess 95, passages 96 and suction valve 97, the valve being lifted from its seat against the force of springs 98 when a vacuum is created by the retraction of piston 99. Further assurance of capacity performance is provided by permitting gas to enter ports 100 which are uncovered by piston 99 at the end of its suction stroke. On the compression stroke the ports 100 are closed, the greater internal pressure with the aid of springs 98 seats valve 97, and discharge valve 105 is raised from its seat on member 106 and liner 90 against the force of springs 107 held in header 108. The compressed gas flows through the discharge valve into the discharge head 91 and into space 109 communicating with the discharge manifold 14. As soon as the piston commences to retract, the increased external pressure aided by springs 107 causes valve 105 to become seated and suction to be established.

45 The member 106 is provided with a convex interior head fitting a concavity in the end of piston 99 in order that any entrained globules of liquified refrigerant or oil may be dispersed rather than trapped in globular form. As a further safety measure the member 106 and header 108 are bolted together and joined to a floating spacer 110 in which springs 98 are mounted. This assembly is urged against the end of liner 90 by a spring 111 bearing against cap 112. The spring 111 is of sufficient strength to keep the valve assembly seated, but is designed to permit relief against accidental over-pressures. The caps 112, shell 40, cover plate 41 and oil sump 42 complete a substantially cylindrical casing hermetically enclosing the motor and compressor assembly. Further details of the piston and valve assembly are set forth in my copending application, Serial No. 145,589, filed concurrently herewith, now Patent No. 2,137,965, granted November 22, 1938.

After assembling the compressor as heretofore related it is joined to the refrigerating equipment as shown in Fig. 1, and the assembly is dehydrated, then charged with the proper amounts of oil and refrigerant. The suction manifold 92 is provided with an opening 115 through which oil (entrained with the expanded gas) may return to the sump. This opening also permits the internal pressures of the entire system to balance when the compressor is idle,

thereby preventing strains on the valves and other parts and keeping the oil under some pressure at all times. It is apparent that during operation the entire interior of the compressing unit will be at the pressure of the gas after expansion and that the space 109 within the discharge head 91 will be at a higher pressure. When the machine stops the high pressure gas will quickly pass through the system and through the manifold 92, opening 115 and openings 83 10 until a balanced pressure is reached. There will then be no strains on valves 97 and 105 or the springs 98 and 107.

Oil and certain refrigerants, such as dichlorodifluoromethane, tend to form a solution, the proportions of which vary according to the pressures and temperatures involved. Under balanced pressures and lowered temperature when the machine is idle, the solution in the sump stabilizes at a low oil concentration as the refrigerant gas dissolves in the oil. When the machine starts gas is drawn from within the unit by way of opening 115 and oil is forced out of the unit by the oil pump. As the oil pressure immediately builds up in bore 49 before the gas pressure in the high pressure side of the system has reached its peak, the oil pressure can be utilized to perform two functions, namely to prevent foaming of the oil-refrigerant solution in the sump due to rapid dropping of internal pressure, and to prevent the compressor from functioning until the rotor is rotating at full speed. The first function is important since otherwise the unit would become filled with a mass of minute bubbles of refrigerant encased in oil. This latter would have a tendency to unseat the valves and might prevent proper lubrication or refrigeration. The second function is important since the motor can be made smaller if compression is accomplished only under conditions such that the rotor and shaft assembly act as a flywheel. To this end bore 49 is connected to a crossbore 120 leading to an unloading device (not shown) encased in boss 121. Crossbore 120 also leads to an oil pressure relieving device (not shown) designed to prevent excessive oil pressures. The details of the unloading device and of the pressure relieving device are set forth in my copending application, Serial No. 145,587, filed concurrently herewith.

In order to take full advantage of the inherent characteristics of the compressing unit as heretofore described the motor is operated at very high speeds, such as 1150 or 1750 R. P. M. The motor is rapidly brought up to speed, resulting in the production of an unequalized strain due to the inertia of the rotor, shaft and piston assembly. In order properly to mount the compressing unit so as to prevent too great a shock upon starting, as well as to prevent vibrations from being transmitted to the refrigerating mechanism, the unit is preferably suspended at its longitudinal center of gravity and permitted to swing freely in all directions and to rotate in both directions. The unit is also designed so that its axis of revolution substantially coincides with its longitudinal center of gravity, and since the rotor, shaft and piston assembly is balanced, it can be seen that the unit could be mounted rigidly, either upright or on its side as previously mentioned. Since it is principally designed for use in an assembly such as shown in Fig. 2, it is preferably suspended as shown in order to eliminate the necessity for expensive foundations. The combination of the dynamically balanced unit and suspension mounting

can be assembled with the refrigerating equipment as in Fig. 2 at the factory of the manufacturer, and the air conditioner or other device when sold is immediately ready for use when placed on the floor of a residence, office or store and connected to the sources of electricity and water (when water is used to cool the compressed gas and the oil). The primary functions of the suspension member then become the elimination of shocks due to the inertia of the operating parts when the unit starts and the elimination of vibrations when the unit is in operation.

The suspension device comprises a bolt 130 extending from the cover plate 41 substantially concentrically with the axis of the unit. The bolt is surrounded by a tube 131 to which is bonded a resilient member 132 preferably composed of toughened rubber. A collar 133 is bonded to the member 132, the collar being located substantially midway of the member, and having an internal diameter such as to leave a substantial mass of rubber between it and the tube 131. The collar is rigidly attached to a supporting plate 134, preferably having a stiffening, angularly extended edge 135. The supporting plate is attached to the horizontal inwardly extending legs of Z-bars 11 and 12, which form tracks by means of which the compressor is slidably guided in assembling or disassembling the machine. As shown in full lines in Fig. 4, the member 133 is preferably distorted axially when formed so that the weight of the compressor is necessary to center the tube 131 longitudinally with respect to collar 133, as shown in dot and dash outline.

Figures 1 and 4, which fully illustrate the suspension device, show that it not only permits partial rotation of the compressing unit but permits oscillation thereof in any direction. If certain vibrations should cause an axial application of force to the compressing unit the mass of rubber between the collar 133 and tube 131 would permit axial movement of the compressing unit. Likewise the compressing unit may swing in any direction to compensate for lateral vibrations set up by the compressor and motor. In starting and stopping the compressor the maximum unbalanced forces are created and the casing may rotate as much as three or four degrees without, however, placing any undue strain upon the cabinet.

Having described the preferred embodiment of the present invention it should be apparent to those skilled in the art that modifications in arrangement and detail thereof may be devised within the scope of my invention. The following claims are to be interpreted as embracing such modifications.

I claim:

1. In combination, a compression unit including a motor and compressor assembly having parts rotatable about a substantially vertical axis, and a substantially cylindrical casing hermetically enclosing said assembly, discharge and

suction pipes connected to said casing and refrigerating mechanism connected to said pipes, a cabinet forming a support for at least a portion of said refrigerating mechanism, a support member for said unit carried by said cabinet and positioned above said casing, a single suspending means for resiliently suspending substantially the entire weight of said unit from said support member to provide resiliently restrained limited rotation of said casing relative to said support member about a vertical axis due to variation in the speed of rotation of said parts, said means comprising a member fixed to one end of said casing and extending upwardly substantially centrally of said end, a substantially cylindrical rubber element between said members and having a substantially axial bore, one of said members extending into said bore and being bonded to the rubber of said element, the other of said members being secured to the outer portion of said element, the portions of said members in contact with said element being radially spaced a sufficient distance to support the weight of said unit and resiliently restrain said limited rotation substantially entirely by stretching stresses of said rubber, whereby said element prevents transmission of vibrations from said unit to said support member and permits resiliently restrained partial rotation of said unit and oscillation thereof in all directions relative to said support member, and flexible portions in said discharge and suction pipes permitting said rotation and oscillation without straining said pipes.

2. In combination, a compression unit including a motor and compressor assembly having parts rotatable about a substantially vertical axis, and a casing enclosing said assembly, discharge and suction pipes connected to said casing, a support member for said unit positioned above said casing, a single suspending means positioned substantially vertically above the center of gravity of said unit for resiliently suspending substantially the entire weight of said unit from said support member to provide resiliently restrained limited rotation of said casing relative to said support member about a vertical axis due to variation in the speed of rotation of said parts, said means comprising a member fixed to the upper portion of said casing and spaced from said support member and a rubber element secured to and positioned between said members to support the weight of said unit and resiliently restrain said limited rotation substantially entirely by stretching stresses of said rubber, whereby said element prevents transmission of vibrations from said unit to said support member and permits resiliently restrained partial rotation of said unit and oscillation thereof in all directions relative to said support member, and flexible portions in said discharge and suction pipes permitting said partial rotation and oscillation without straining said pipes.

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