

Oct. 23, 1956

M. Y. WARNER
REFRIGERATOR COMPRESSOR

2,767,903

Original Filed July 16, 1953

3 Sheets-Sheet 1

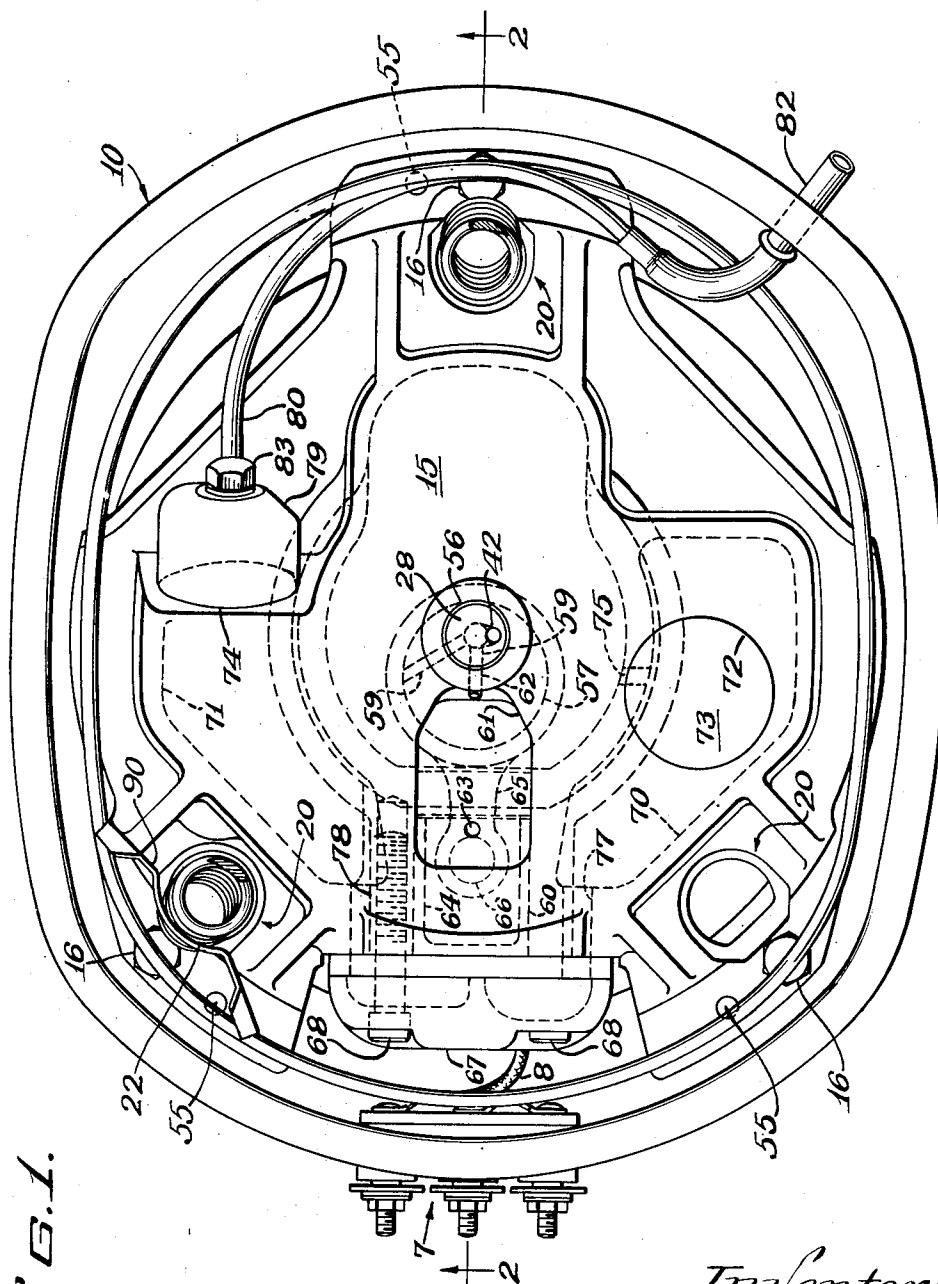


FIG. 1.

Inventor:
Milton Y. Warner
Paul C. Pippel
Atty.

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FIG. 5.

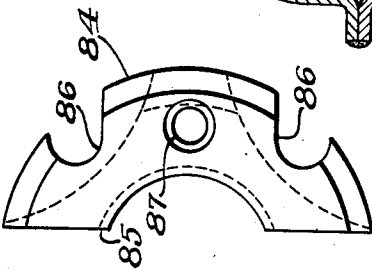
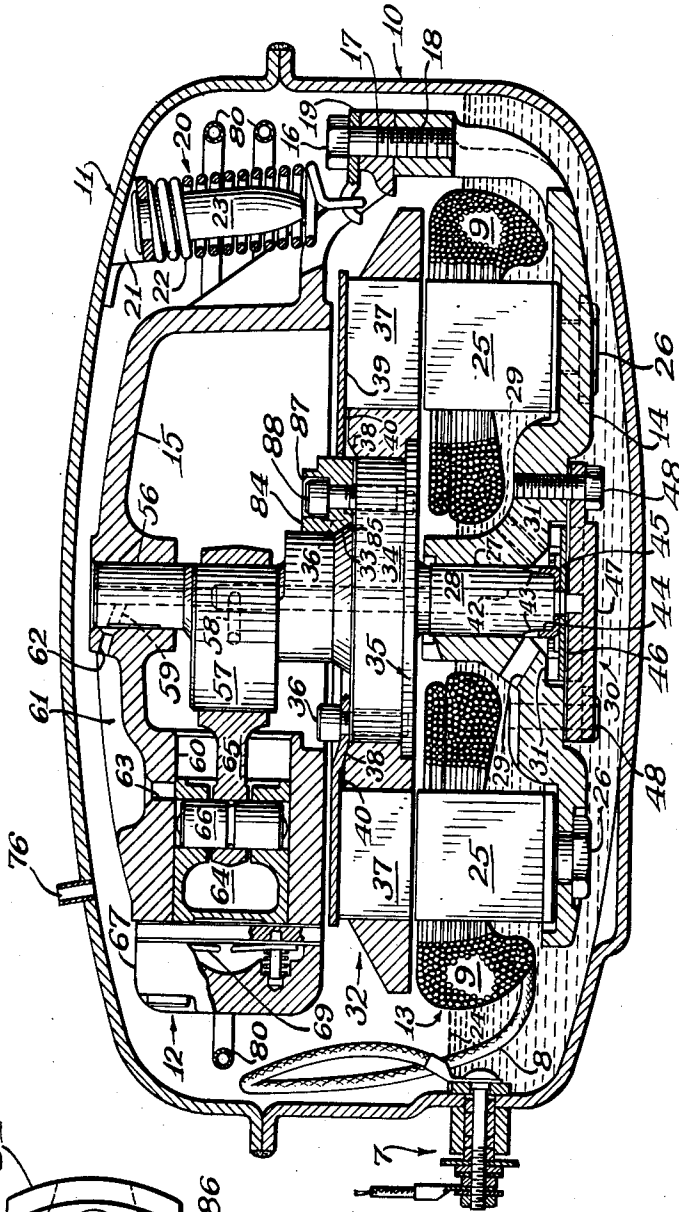


FIG. 2.



Inventor:
Milton Y. Warner
Paul C. Pippel
Atty.

Oct. 23, 1956

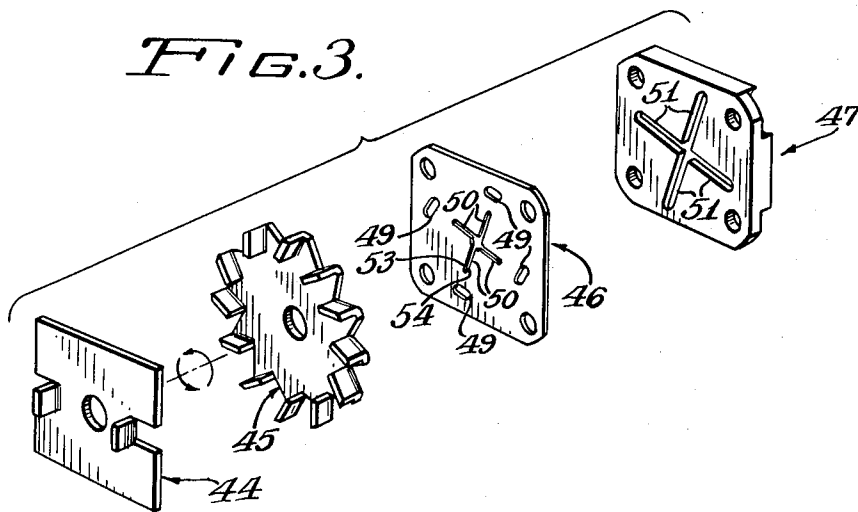
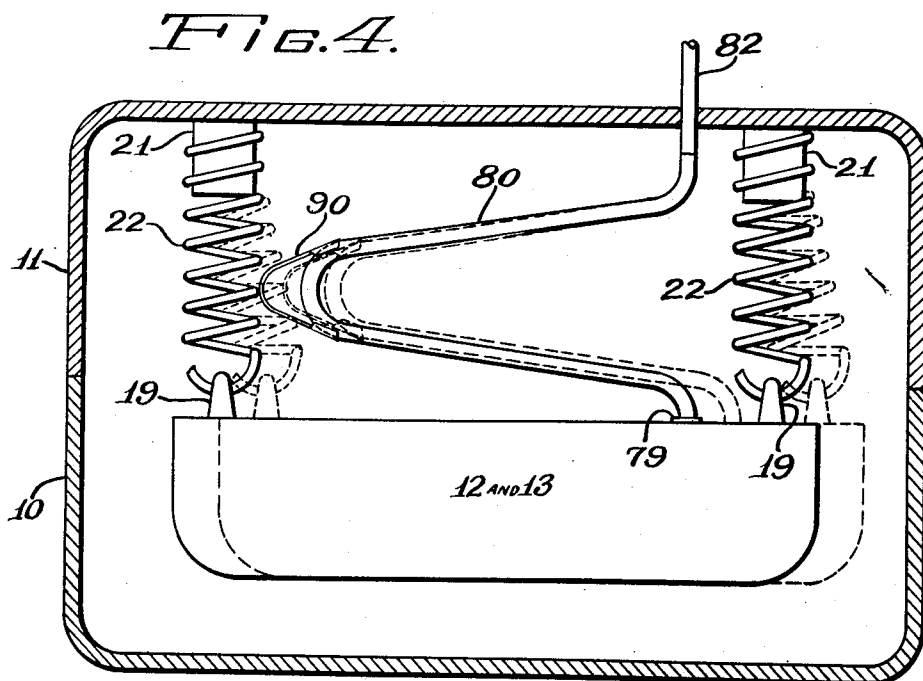
M. Y. WARNER

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3 Sheets-Sheet 3



Inventor:
Milton V. Warner
Paul C. Piper
Atty

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REFRIGERATOR COMPRESSOR

Milton Y. Warner, Evansville, Ind., assignor, by mesne assignments, to Whirlpool-Seeger Corporation, a corporation of Delaware

Original application July 16, 1953, Serial No. 368,293. Divided and this application December 1, 1954, Serial No. 479,802

3 Claims. (Cl. 230—58)

This invention relates generally to motor-compressor units, and more specifically to an improved hermetic motor-compressor unit for use in a refrigeration system wherein the motor is of the axial air-gap type. This application is a division of an original application by the same inventor, filed July 16, 1953, Serial No. 368,293, and entitled "Refrigerator Compressor."

Hermetic motor-compressor units find important use in the refrigeration art, and it is of further importance in that art that these hermetic motor-compressor units have as narrow a width as possible to permit the design of refrigerator cabinets wherein only a small proportion of the available space need be allotted to the motor-compressor unit. One of the chief advantages of an axial air-gap motor is the narrow width of the motor as measured parallel to the axis of rotation. Compared to a conventional motor of similar horsepower this dimension is considerably less. Therefore the object of this invention is to provide a hermetic motor-compressor unit wherein the motor is of the axial air-gap type and wherein the hermetic unit has a possible width substantially less than is possible with the hermetic motor-compressor units presently known in the art.

It is a feature of this invention that a novel oil pump and thrust bearing are provided which maintains the width of the assembly within narrow limits.

It is another feature of this invention that a novel arrangement is provided for lubricating the cylinder of the compressor portion of the unit.

It is a further feature of this invention that a novel counterweight is provided with novel means for mounting the counterweight to balance the crankshaft.

It is another feature of this invention that novel structure is provided for suspending the motor and the compressor within the hermetic casing with means for adjustment of the suspension.

It is a further feature of this invention that a novel snubber is provided to prevent unnecessary vibration of the outlet line of the compressor.

Other objects and features of the present invention will be apparent upon a perusal of the following specification and drawings of which:

Figure 1 is a top plan view of the unit with the upper part of the casing removed;

Figure 2 is a cross sectional view of the assembly shown in Figure 1 taken along the line 2—2;

Figure 3 is an exploded isometric view of the combination oil pump and thrust bearing;

Figure 4 is a diagrammatic view of the snubber arrangement for reducing unwanted vibrations of the outlet line of the compressor; and

Figure 5 is a plan view of the counterweight for balancing the crankshaft.

The present embodiment is the preferred embodiment, but it is to be understood that changes can be made in the present embodiment by one skilled in the art without departing from the spirit and scope of this invention.

Generally, the motor and the compressor are mounted

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within a casing comprising a lower pan 10 and an upper pan 11. These two pans are substantially bowl-shaped and are sealed at the edges thereof to form a hermetic casing. Referring to Figure 2, the axial air-gap motor comprises substantially the lower half of the structure shown therein and the compressor comprises substantially the upper half of the structure shown therein. The motor is generally designated with the character 13 and the compressor is generally designated with the character 12. The motor is generally mounted within and supported by a substantially bowl-shaped stator support frame 14, and the compressor 12 is generally mounted within and supported by a substantially bowl-shaped crankcase 15. The crankcase 15 and the stator support frame 14 are rigidly connected together by three bolts 16, which project through three holes 17 provided in the periphery of the crankcase 15, and which are threaded into three tapped holes 18 in the periphery of the stator support frame 14. The three bolts 16 are triangularly disposed to each other as can be easily seen in Figure 1. A spring hook 19 is attached to the top of the crankcase 15 by the bolt 16, as can be seen in Figure 2. Two other spring hooks 19 are provided which are mounted to the crankcase 15 by the other two bolts 16. It is intended that the unit be mounted longitudinally in a horizontal plane with the compressor portion 12 disposed above the motor portion 13. The internal assembly is resiliently suspended by three suspension members 20. Each of these suspension members 20 comprises a mounting element 21, a coiled spring 22, and a spring hanger 23. The mounting element is connected to the underside of the upper pan 11. To the mounting element 21, the spring hanger 23 is rigidly connected. The spring hanger 23 is generally cone-shaped, and the portion thereof which is adjacent to the mounting element 21, has a number of threads formed thereon which are complementary to the turns of the coiled spring 22. Thus the upper end of the coiled spring 22 is mounted over and threaded onto the spring hanger 23. The lower portion of the coiled spring 22 is formed to have a hook thereon. This hook is mounted in cooperation with the spring hook 19 to thereby resiliently suspend the motor-compressor unit within the casing. Since the coiled spring 22 is threaded onto the spring hanger 23, it may easily be seen that the effective length of the coiled spring 22 may be increased or decreased by threading and unthreading the coiled spring 22 on the spring hanger 23 in increments of 180°.

For lubrication and cooling of the unit a quantity of lubricating oil is provided. The lubricating oil 24 is disposed within the lower pan 10 as can be easily seen in Figure 2, and the amount used is that amount sufficient to substantially submerge the motor 13.

The motor 13 will be described in detail first. As previously noted, the motor is generally supported and contained within a bowl-shaped stator support frame 14.

The stator 25 is rigidly connected to the concave side of the stator support frame 14 by means of bolts 26. The stator 25 includes the field windings 9 which are connected to a cable 8. The cable 8 is in turn connected without the lower pan 10 by the terminal assembly 17. A bearing 27 is provided through the center of the stator support frame 14, and within this bearing 27 the crankshaft 28 is rotatively mounted. The center portion of the convex side of the stator support frame 14 is generally formed with a depression therein. The tip of the crankshaft 28 projects into this depression and a number of holes 29 are formed through the stator support frame 14 from the concave side thereof into the depression. The depression is enclosed by the oil pump and thrust bearing means which are shown generally with the character 30. The portion 31 of the depression of the stator support frame 14 is formed with an involute curve.

The rotor for the motor is shown generally with the character 32. The portion of the crankshaft 28 which cooperates with the rotor 32 is shaped to have a hub 34 and a ring 35. The hub 34 and the ring 35 are tapped for four bolts 36. The rotor 32 is mounted over the hub 34 and against the ring 35 with a light press fit. The major proportion of the rotor 32 is fabricated as a continuous strip of steel wound in a roll and integrally cast with two rings of aluminum and with aluminum bars passing through the steel. The roll of steel 37 has radial holes about its periphery and upon casting the aluminum completely fills these holes to form an integral part with the roll of steel. The inner aluminum ring is tapered as shown at 38. The complete assembly of the rotor also comprises a rotor support disk 39 and a spacer ring 40. The rotor support disk 39 has four holes therethrough which are aligned for cooperation with the bolts 36. When the rotor 32 is mounted to the crankshaft 28, the bolts 36 are tightened to cause the rotor support disk 39 to be bent against the rotor spacer ring 40 and the bevel 38 of the inner aluminum ring of the rotor 32.

For a description of the oil pump and thrust bearing reference is made to Figures 2 and 3. The oil pump and thrust bearing 30 comprises the impeller retainer 44, the impeller 45, the thrust plate facing 46, and the plate 47. The crankshaft 28 is formed with a hole 42 extending axially therethrough. The crankshaft 28 is further formed to have two notches 43 formed at the one end thereof which is disposed within the depression formed within the convex surface of the stator support frame 14. The impeller retainer 44 is formed of a rectangularly shaped material with two prongs extending upward therefrom. The two prongs of the impeller retainer 44 are pressed into the two notches 43 on the end of the crankshaft 28 to thereby maintain the impeller retainer 44 thereagainst. The impeller retainer 44 also has a hole through the center thereof and this hole cooperates with the bore 42 in the crankshaft 28. The impeller 45 is generally circular in shape, and has a plurality of vanes extending from the circular surface thereof, as can easily be seen in Figure 3. The impeller 45 is mounted in cooperation with the impeller retainer 44 so that the edges of the impeller retainer 44 are pressed between the vanes of the impeller 45. The impeller 45 also has a hole formed through the center thereof which cooperates with the hole through the center of the impeller retainer 44 and the bore 42 of the crankshaft 28. The impeller 45 when so mounted operatively cooperates with the involute curve formed within portion 31 of the depression on the convex side of the stator support frame 14, so that any liquid fed centrally of the impeller 45, when the crankshaft 28 is rotating, will be forced outwardly from the vanes of the impeller 45 and in the involute curve. The thrust plate facing 46 which is formed of a hard metal, and the thrust plate 47 are mounted together and rigidly connected over the depression in the convex side of the stator support frame 14. The thrust plate facing 46 is mounted between the thrust plate 47 and the stator support frame 14. The thrust plate facing 46 and the thrust plate 47 are rigidly mounted over the depression on the convex side of the stator support frame 14 by four bolts 48 which project through four holes in the thrust plate facing 46 and the thrust plate 47, and are threaded into four tapped holes in the stator support frame 14. The thrust plate facing 46 is further formed to have four holes 49 formed therethrough, and these holes 49 are positioned beneath the vanes of the impeller 45. The thrust plate facing 46 is further formed to have four slots 50 formed therethrough. The four slots 50 intersect each other at an opening in the center of the thrust plate facing 46, as can easily be seen in Figure 3. These slots 50 are positioned beneath the circular flat portion of the impeller 45. The thrust plate 47 has four channels 51 formed therein.

These channels 51, which are substantially wider than the slots 50, and which may easily be seen in Figure 3, are so positioned as to intersect at an opening in the center thereof. Each of the slots 51 are formed of a length equal to the length of each of the slots 50 plus the distance from the end of each of the slots 50 to the outermost side of the holes 49. The slots 50 of the thrust plate facing 46 are not centered directly above the channels 51 in the thrust plate 47, but are positioned off-center thereof in a direction dependent upon the direction of rotation of the impeller 45. Assuming for purposes of explanation that the impeller 45 is rotating in a counterclockwise direction as viewed in Figure 3, then the side 54 of each of the slots 50 would be the leading edge of these slots and the side 53 of each of these slots would be the trailing edge of these slots. The slots 50 are then positioned in relation to the channels 51 so that the leading edge of each of the slots 50 is positioned upon the center line of each of the channels 51. Thus the leading edges of each of the slots 50 overhang the channels 51 a substantially greater amount than do the trailing edges of each of the slots 50. Thus when the motor 13 is operating, the thrust exerted by the crankshaft 28, due to the magnetic attraction between the rotor 37 and the stator 25, will be distributed throughout the area between the impeller 45 and the thrust plate facing 46, and the thrust plate facing 46 will act as thrust shoe. Now if oil is supplied to the channels 51, a wedge-shaped film of oil will be formed between the trailing and leading edges of the slots 50 as the crankshaft 28 is rotating. This will result in a lubrication of the thrust bearing similar to that supplied by the well known Kingsbury thrust bearing. To discuss the operation of the oil pump, when the crankshaft 28 is rotating, the oil 24 disposed within the lower pan 10 will flow into and through the holes 29 in the stator support frame 14. This oil will flow into the space centrally of the impeller 45. The rotating impeller 45 will move the oil radially thereof into the vanes thereof. From the vanes of the impeller 45, the oil will flow downward through each of the openings 49 in the thrust plate facing 46. From the openings 49, the oil will flow into and through the channels 51 of the thrust plate 47. From the channels 51 of the thrust plate 47, a portion of the oil will flow upward through the center thereof, through the center of the thrust plate facing 46, through the hole in the center of the impeller 45, through the hole in the center of the impeller retainer 44 and into and through the bore 42 of the crankshaft 28. Another portion of the oil flowing through the channels 51 will flow upward through the slots 50 to lubricate the thrust bearing previously described.

To discuss the detailed structure of the compressor 12 reference is made to Figures 1 and 2. The crankcase 15 comprises a substantially bowl-shaped casting, which as previously described is mounted to the peripheral edge of the stator support frame 14 by the bolts 16. To further aid in the alignment of the crankcase 15 with the stator support frame 14 three dowels 55 are provided. A bearing 56 is formed through the center of the crankcase 15 as can easily be seen in Figures 1 and 2. The bearing 56 supports the upper end of the crankshaft 28. The bore 42 extends upwardly through the crankshaft 28 and near the upper end thereof is formed to slant away from the axis of rotation of the crankshaft 28 as can be seen in Figure 1. Thus when the crankshaft 28 is rotated by the motor 13, the oil which flows from the oil pump 30 upward through the crankshaft 28 and out of the top thereof is given a lateral component of motion. Thus as the crankshaft 28 rotates, the oil is sprayed about the inner surface of the upper pan 11 and will then flow downward along the inner walls of the casing to the lower pan 10. As the oil flows along the inner surfaces of the casing, heat from the oil will be conducted to the casing thereby cooling the oil. The

crankshaft 28 is further provided with an eccentric 57 formed as a part thereof. A channel 58 is formed through the eccentric 57 to the bore 42 of the crankshaft 28 to provide lubrication for the eccentric 57. A further channel 59 is formed radially from the bore 42 to the outer surface of the crankshaft 28 which is disposed within the bearing 56. The oil flowing through the channel 59 serves to lubricate the bearing 56 and the cylinder 60. The specific structure cooperating with the channel 59 to provide lubrication for the cylinder 60 includes a depression 61 formed in the upper surface of the crankcase 15, and two holes 62 and 63. The hole 62 is formed in the crankcase 15 from an upper portion of the depression 61 into the bearing 56 and in vertical alignment with the channel 59. The hole 63 is formed through the crankcase 15 from the lowest portion of the depression 61 downward into the cylinder 60. Whenever the crankshaft 28 is rotated to the position wherein the channel 59 is in horizontal alignment with the hole 62, oil flowing upward through the bore 42 will flow through the channel 59, through the hole 62 into and filling the depression 61. From the depression 61 the oil will flow downward through the hole 63 into the cylinder 60. The cylinder 60 is cast as an integral portion of the crankcase 15 on the concave side thereof as can be easily seen in Figure 2. The cylinder 60 is further formed so that the longitudinal axis thereof is at a right angle to the axis of rotation of the crankshaft 28. A piston 64 is slidably mounted within the cylinder 60. A connecting rod 65 is rotatively mounted about the eccentric 57 and is pivotally connected to the piston 64 by a wrist-pin 66, as can be easily seen in Figure 2. It can thus be seen that as the motor 13 is operated to rotate the shaft 28, the piston 64 will operate within the cylinder 60, and oil will flow from the hole 63 to lubricate the piston 64 and the cylinder 60. A cylinder head 67 is mounted over the cylinder 60 in cooperation with the piston 64. The cylinder head 67 is mounted to the crankcase 15 by means of the bolts 68. Within the cylinder head 67 intake and exhaust valves 69 are mounted. These valves may be of any type well known in the art, and therefore the construction thereof will not be described in detail. The crankcase 15 is further provided with two muffler chambers 70 and 71. These muffler chambers 70 and 71 are cast as integral parts of the crankcase 15, the muffler chamber 70 serving as an intake muffler and the muffler chamber 71 serving as an exhaust muffler. A hole 72 in the top of the muffler chamber 70 is provided when the crankcase 15 is cast to aid in the casting thereof. This hole 72 is sealed by a plug 73. A hole 74 is formed through an end wall of the muffler chambers 71 to aid in the casting thereof and to serve as an outlet from the muffler chamber 71. An opening 75 is formed through one wall of the muffler chamber 70. This hole 75 is formed on the concave side of the crankcase 15, so that refrigerant gases are drawn into the muffler chamber 70 through the hole 75, from the concave side of the crankcase 15, from the open spaces about the periphery of and between the crankcase 15 and the stator support frame 14, and from a tube 76 connected through the upper pan 11 of the casing. Any refrigerant gases which enter the muffler chamber 70 are delivered to the cylinder head 67 and the cylinder 60 through a channel 77 formed through the crankcase 15 from the muffler chamber 70 to the cylinder head 67. The exhaust muffler chamber 71 is connected to the cylinder head 67 and the cylinder 60 by means of a channel 78 extending from the exhaust muffler chamber 71 to the cylinder head 67. An exhaust muffler chamber cover 79 is provided over the opening 74 of the exhaust muffler chamber 71. To the exhaust muffler chamber cover 79, a length of tubing 80 is connected. This length of tubing 80 extends from the exhaust muffler chamber cover 79 about the inside of the upper pan 11 in one complete turn, and is then

connected without the upper pan 11 by means of the tube 82. A bolt 83 extends through the exhaust muffler chamber cover 79 to maintain the exhaust muffler chamber cover 79 against the opening 74. This bolt 83 is threaded into a tapped hole in the crankcase 15.

To next describe the operation of the compressor 12, when connected in a refrigeration system (not shown), refrigerant gases are drawn into the tube 76 between the peripheral edges of the crankcase 15 and the stator support frame 14, within the concave side of the crankcase 15, into and through the hole 75, into the intake muffler chamber 70, through the tube 77, into the cylinder head 67 and the cylinder 60, through the cylinder head 67 into and through the tube 78, into the muffler chamber 71, through the hole 74 into the exhaust muffler chamber cover 79, through the tubing 80 and out of the unit through the length of tubing 82.

To balance the crankshaft 28, a specific counterweight 84 is provided. A plan view of the counterweight 84 can be seen in Figure 5, and a cross-sectional view thereof, taken along the line 2—2 of Figure 1, can be seen in Figure 2. The counterweight 84 is formed in the general shape of a semi-circular ring. The lower portion of the inner periphery of the counterweight 84 is formed with a bevel 85 as can be seen in Figure 2. The crankshaft 28 is further shaped to have a circular beveled portion 33. The bevel 85 of the counterweight 84 matches the beveled portion 33 of the crankshaft 28. The outer periphery of the counterweight 84 is formed with two slots 86 therein. These slots 86 are spaced apart a distance equal to the spacing between two of the bolts 36 which maintain the rotor 32 mounted to the crankshaft 28. The counterweight 84 is further provided with a counter-bored hole 87. Further, a portion of the hub 34, between the aforementioned two bolts 36, is tapped so that a bolt 88 may be projected through the hole 87 and threaded thereto. When the counterweight 84 is mounted to the crankshaft 28, the two bolts 36 are positioned within the two slots 86 and the bevel 85 cooperates with the beveled portion 33, and as the bolt 88 is tightened, the counterweight 84 is forced downward and outward until the two bolts 36 are tightly wedged against the two slots 86.

As previously described, the discharge line or length of tubing 80 is connected to the exhaust muffler cover 79, and is further brazed to the length of tubing 82, and is positioned to make a complete loop about the inside of the upper pan 11. The purpose of this loop is to provide sufficient flexibility in the discharge line connection between the compressor 12 and the upper pan 11 so as to allow freedom of movement of the motor-compressor unit with respect to the casing. To dampen any resonant vibrations that may occur in the discharge line 80, a snubber spring 90 is provided. The snubber spring 90 is held by spring action between the discharge line 80 and one of the springs 22 of one of the hanger assemblies 20. As shown, the snubber spring 90 is positioned approximately midway of the discharge line 80 and midway of the coiled spring 22. Thus a point located midway on the coiled spring 22 moves, with respect to the casing, approximately one-half the distance that the motor compressor assembly moves. The midpoint on the discharge line 80 will likewise move about one-half the distance that the motor-compressor assembly will move. Thus movement of the motor-compressor assembly with respect to the casing is not restrained by the snubber spring 90, but any vibration that occurs in the discharge line 80, other than the forced vibration at the frequency at which the motor-compressor assembly is vibrating will be opposed by the restraining action of the snubber. For a detailed description of the operation of the snubber spring 90 reference is made to Figure 4 wherein the structure is shown diagrammatically. As shown the motor-compressor unit 12 and 13 is free to vibrate in any direction. It can be seen that the use of the snubber spring 90

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upon the discharge line 80 does not interfere with the normal movements of the motor-compressor unit 12 and 13 induced by unbalance of moving parts and by variations in torque load. In relation to the vibrations of the motor-compressor unit 12 and 13, it may be seen that if the flexible discharge line 80 should happen to be resonant or near resonance to some disturbing frequency, at some load condition, the discharge line 80, between the ends thereof, might vibrate at a greater amplitude or at a different phase than the end of the loop fastened to the compressor. This condition would produce relative motion between the tube loop and the coiled spring 22. The snubber spring 90 connected between the discharge line 80 and the coiled spring 22, between the ends of the discharge line 80, would exert frictional restraining forces upon such relative motion.

Having described the invention what is considered new and desired to be protected by Letters Patent is:

1. In a device of the class described, a casing fashioned with an opening therethrough, a motor-compressor unit having an outlet thereinto, means including at least one coiled spring resiliently suspending said motor-compressor unit within said casing, a length of tubing, one end of said length of tubing connected to the outlet of said motor-compressor unit, the other end of said length of tubing connected without said casing through the opening in said casing, said length of tubing being formed to have at least one complete loop within said casing, whereby said length of tubing does not substantially interfere with the resilient suspension of said motor-compressor unit, a snubber spring attached to said length of tubing between the ends thereof, said snubber spring further positioned to contact said coiled spring between the ends thereof, so that said length of tubing will not vibrate at a resonant frequency thereof other than the frequency of vibration of said motor-compressor unit when said motor-compressor unit vibrates relative to said casing.

2. In a device of the class described, a casing fashioned with an opening therethrough, a motor-compressor unit having an outlet thereinto, means including a plurality of coiled springs resiliently suspending said motor-compressor unit within said casing, a length of tubing, one end of said length of tubing connected to the outlet of said motor-compressor unit, the other end of said tubing

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connected without said casing through the opening in said casing, said length of tubing being formed to have one complete loop within said casing, whereby said length of tubing does not substantially interfere with the resilient suspension of said motor-compressor unit relative to said casing, a snubber spring positioned within said casing and disposed so as to resiliently engage simultaneously a portion of said length of tubing and one of said coiled springs, whereby said length of tubing will be prevented from vibrating at any resonant frequency other than the frequency of vibration of said motor-compressor unit when said motor-compressor unit is vibrated by the operation thereof, and whereby a minimum of the vibrations of said motor-compressor unit will be transferred to said casing through said length of tubing.

3. In a device of the class described, a casing fashioned with an opening therethrough, a motor-compressor unit having an outlet thereinto, means including a plurality of coiled springs resiliently suspending said motor-compressor unit within said casing, a length of tubing, one end of said length of tubing connected to the outlet of said motor-compressor unit, the other end of said tubing connected without said casing through the opening in said casing, said length of tubing being formed to have one complete loop within said casing, whereby said length of tubing does not substantially interfere with the resilient suspension of said motor-compressor unit, a snubber spring attached to said length of tubing substantially at the center of said loop, said snubber spring further positioned to contact one of said coiled springs substantially at the center thereof, so that when said motor-compressor unit moves a certain amount in any given direction said center of said loop will only move substantially one-half of that amount in cooperation with the movement of the contacted spring to thereby allow free movement of the motor-compressor and to dampen any vibration of said length of tubing relative to said contacted coiled spring.

References Cited in the file of this patent

UNITED STATES PATENTS

2,028,584	Bixler	Jan. 21, 1936
2,463,035	Heitchue	Mar. 1, 1949