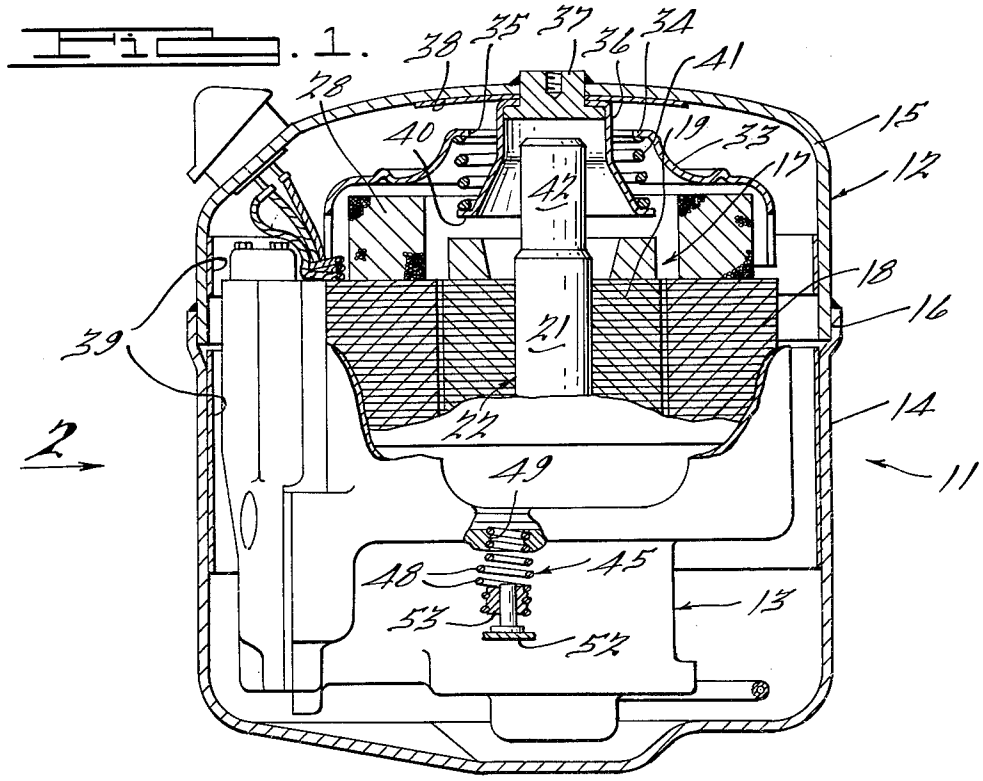
Nov. 2, 1965 E. L. GANNAWAY 3,215,343

INTERNAL SUSPENSION FOR COMPRESSORS

Filed July 15, 1963

FIG. 1.



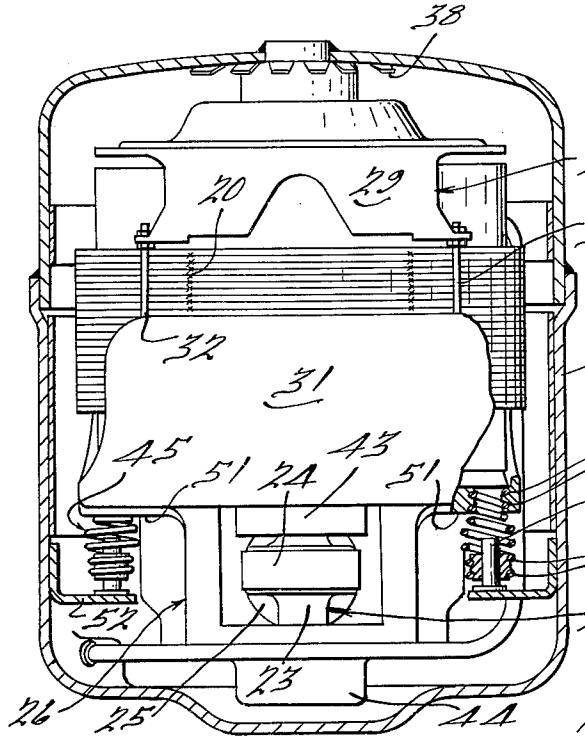


FIG. 2.

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INTERNAL SUSPENSION FOR COMPRESSORS

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9 Claims. (Cl. 230—235)

This invention relates generally to hermetically sealed refrigeration motor-compressor assemblies, and particularly concerns improved means for mounting the motor-compressor unit in the shell of the assembly in such manner as to reduce the transmission of vibrations to the shell and further, to prevent excessive movement of the motor-compressor unit within the shell during starting and stopping as well as during shipment.

It is an object of the invention to provide a novel and improved mounting means for a motor-compressor unit in which top-mounted spring suspension means and a crankshaft extension coact with shell-mounted components to prevent the stator laminations from being shifted by striking the shell, thereby maintaining proper air gap clearance even under violent handling conditions which sometimes prevail during shipment.

It is a further object to provide an improved suspension means of this character which utilizes stabilizer springs of novel shape to connect the lower portions of the motor-compressor unit to the shell, the springs having a markedly greater fatigue life than those conventionally used while retaining optimum flexibility and rigidity characteristics.

It is a further object to provide an improved motor-compressor unit suspension means having these characteristics, which enables the unit to be assembled vertically into an oval shell simply by lowering the unit into the lower shell half.

It is another object to provide an improved suspension means of this nature which eliminates the need for rubber elements between the motor compressor unit and the shell, such rubber elements being susceptible of deterioration during use of the refrigeration system.

It is a further object to provide an improved suspension means of this character which is combined with means for reducing high frequency vibrations transmitted from the motor-compressor unit to the shell.

Other objects, features, and advantages of the present invention will become apparent from the subsequent description and the appending claims, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a side elevational view in cross section, with parts broken away, showing the upper portion of the novel suspension means, and

FIG. 2 is a sectional view taken in the direction of the arrow 2 of FIGURE 1 and showing the lateral stabilizer springs which constitute the lower portion of the suspension means.

Referring more particularly to the drawings, the motor-compressor assembly is generally indicated at **11** and is of the hermetically sealed type commonly used with refrigeration systems. The assembly comprises a shell generally indicated at **12** and a motor-compressor unit generally indicated at **13** and sealed within shell **12**. The shell is of the oval type and comprises a lower section **14** and an upper section **15**, these sections having interfitting portions located at **16** and welded together.

Motor-compressor unit **13** comprises an electric motor generally indicated at **17** having a stator **18** and a rotor **19** within the stator, the stator and rotor both being of laminated construction. Conventionally, the laminations of stator **18** are held together by a number of relatively thin vertical weld beads **20**, so that impact of some laminations on shell **12** could cause them to shift laterally relative to the others. The laminations of rotor **19** are fixed to the upper end **21** of a crankshaft generally indicated at **22**, and the crankshaft is of sufficient rigidly to prevent the rotor from engaging the stator even when subjected to severe lateral impact. The lower end **23** of crankshaft **22** has an eccentric portion on which is rotatably mounted a connecting rod **24** for piston **25** of the compressor, the latter being indicated generally at **26**. The dimensions of unit **13** are such as to be spaced from all portions of shell **12** by the suspension means about to be described.

A mounting member generally indicated at **27** is secured above coil **28** of motor **17**, this member having a pair of downwardly extending relatively wide legs **29** secured to housing **31** of unit **13** by upwardly extending bolts **32**. The main portion of member **27** is of circular shape above coil **28**. Member **27** has a dome-shaped central portion **33** with an inwardly directed flange **34** surrounding a clearance aperture **35**.

A bell-shaped suspension member **36** is centrally secured to the top of shell section **15** by means of a securing member **37**. Member **37** is of circular shape, having a narrower portion extending through a central aperture in shell section **15** and welded thereto, and a wider lower end spaced below the top of section **15**. Bell member **36** has an inwardly directed upper end secured between member **37** and shell section **15**. In addition, a thin member **38** of spring-like material is secured between bell member **36** and shell section **15**.

Member **38** has a plurality of radially extending circumferentially spaced fingers which in their unstressed position are flat but will conform to the downwardly concave shape of the top of shell section **15** when installed. Additional spring-like members **39** are mounted within shell sections **14** and **15** to dampen vibrations. The natural frequencies of vibration of members **38** and **39** are substantially different than the natural frequency of vibration of shell **12**.

Bell member **36** extends downwardly from member **37** and has an outward flare at its lower portion terminating in an outwardly directed flange **40** directly below flange **35** of member **36**. A helical coil compression spring **41** is disposed between flanges **35** and **40** and serves to support unit **13**. The upper and lower ends of spring **41** which could be termed the main or suspension spring, are confined against lateral movement by their respective engagement with members **27** and **36**.

An upward extension **42** is provided on shaft **22**, this extension being disposed centrally within and spaced horizontally from bell member **36**. The distance which shaft extension **42** must move along any radius before striking bell member **36** is less than the radial distance in the same direction of any portion of stator **18** from shell **12**. Extension **42** and bell member **36** thus coact to prevent any striking of stator **18** on the interior of shell **12**, the impact of which might affect the air gap in motor **17**. It should be observed that the only bearings for supporting shaft **22** are located at **43** and **44** (see FIGURE 2) on opposite sides of connecting rod **44** but that, as suggested above, shaft **22** is sufficiently stiff to prevent even hard impact of extension **42** on bell member **36** from closing the air gap between the stator and rotor.

The diameter of spring **41** relative to its height, and the wire gage used, impart strength to the spring sufficient to prevent engagement of shaft extension **42** with bell member **36** during starting and stopping of unit **13**, when maximum vibration amplitude usually occurs. The diameter of aperture **35** is of course sufficient to maintain clearance between members **33** and **36**. The prevention of engagement of bell member **36** by the components of

unit 13 will prevent hammering noises during starting and stopping.

A pair of diametrically opposed stabilizer springs generally indicated at 45 serve to maintain lateral stability of the lower portion of unit 13 with respect to shell 12. These springs are of a helical coil type, having narrower coil diameters at their upper ends 46 and lower ends 47, with relatively wide coil diameters for the center coils 48, the diameters gradually varying between the end and mid portions. The upper coils 46 of each spring 45 are fixed within corresponding grooves in apertured portions 49 on the undersides 51 of housing 31, these undersides being spaced a substantial distance above the bottom of shell section 14. A pair of L-shaped brackets 52 are fixed to shell section 14 and extend inwardly under portions 51 of housing 31. A pair of sleeves 53 are fixed to lower coils 47 of springs 45 by grooves on the sleeves, and a pair of posts 54 are secured to brackets 52 and extend upwardly through sleeves 53, the sleeves being slidable on the pins.

To assemble unit 11 spring 41 may be positioned between members 27 and 36, and sleeves 53 slipped onto pins 54. It is thus seen that the suspension means is particularly adapted for use with oval shell 12, since the assembly may be accomplished by vertical movement.

In operation, the entire weight of unit 13 will be maintained by spring 41, which will also serve the function of preventing impact of shaft extension 42 on bell member 36 during starting and stopping of the unit. If, during shipping, assembly 11 is handled with excessive violence, shaft extension 42 will strike bell member 36 preventing the laminations of stator 18 from striking shell 12.

Stabilizer springs 45 will impart lateral stability to the lower portion of unit 13. The novel shape of springs 45 serves the purpose of increasing fatigue life while maintaining spring flexibility. This is accomplished by permitting the use of heavier gage wire for the stabilizer springs than would be used with helical springs of conventional shape, the larger diameter center coils providing the same overall flexibility that would be present with constant diameter spring coils of smaller gage wire. The decreased stress is brought about not only by the increase in wire gage, but by substantially equalizing the stress along the entire unsupported length of the spring. In springs with fixed ends subjected to transverse end forces, as in the present case, the total stress is obtained by adding the shear stress to the bending stress. The bending stress is theoretically zero at the center of the unsupported spring wire. In a spring of constant coil diameter, the shear stress is constant along the entire unsupported length, so that the total stress is greater at the ends where fatigue failure usually takes place. However, shear stress is roughly proportional to spring coil diameter, so that by reducing the diameter at the ends of the spring, the shear stress is minimum where the bending stress is maximum. The total stress thus tends to be equalized along the length of the spring.

While it will be apparent that the preferred embodiment of the invention disclosed is well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. In a suspension for a vertically disposed motor-compressor unit enclosed within a hermetically sealed shell, a bell member secured to the top of the shell interior and extending downwardly therefrom, an annular mounting member at the top of said motor-compressor unit surrounding said bell member, opposed flanges on said bell member and mounting member, the flange on said mounting member being spaced above the flange on said bell member, compression spring means disposed between said flanges and supporting the weight of said motor-compressor unit, and an upward shaft extension on said motor-compressor unit disposed within the confines of said bell and in spaced relation therewith.

2. In a suspension for a vertically disposed motor-compressor unit enclosed within a hermetically sealed shell, a bell member secured to the top of the shell interior and extending downwardly therefrom, an annular mounting member at the top of said motor-compressor unit surrounding said bell member, opposed flanges on said bell member and mounting member, the flange on said mounting member being spaced above the flange on said bell member, compression spring means disposed between said flanges and supporting the weight of said motor-compressor unit, means on said bell member and said mounting member for restraining the lower and upper ends of said spring means respectively against lateral movement, and an upward shaft extension on said motor-compressor unit disposed within the confines of said bell and in spaced relation therewith, the resistance of said spring means to lateral deflection being sufficient to prevent engagement of said shaft extension with said bell member during normal starting and stopping of said motor-compressor unit.

3. In a suspension for a vertically disposed motor-compressor unit enclosed within a hermetically sealed shell, a bell member secured to the top of the shell interior and extending downwardly therefrom, an annular mounting member at the top of said motor-compressor unit surrounding said bell member, opposed flanges on said bell member and mounting member, the flange on said mounting member being spaced above the flange on said bell member, compression spring means disposed between said flanges and supporting the weight of said motor-compression unit, and an upward shaft extension on said motor-compressor unit disposed within the confines of said bell and in spaced relation therewith, the distance along any radius from the normal position of said shaft extension to said bell member being less than the distance in the same radial direction from the normal position of the motor-compressor unit to said shell.

4. In a suspension for a vertically disposed motor-compressor unit enclosed within a hermetically sealed shell, a bell member secured to the top of the shell interior and extending downwardly therefrom, an annular mounting member at the top of said motor-compressor unit surrounding said bell member, opposed flanges on said bell member and mounting member, the flange on said mounting member being spaced above the flange on said bell member, helical coil compression spring means disposed between said flanges and supporting the weight of said motor-compresosr unit, means on said bell member and said mounting member for restraining the lower and upper ends of said spring means respectively against lateral movement, and an upward shaft extension on said motor-compressor unit disposed within the confines of said bell and in spaced relation therewith, the resistance of said spring means to lateral deflection being sufficient to prevent engagement of said shaft extension with said bell member during normal starting and stopping of said motor-compressor unit, the distance along any radius from the normal position of said shaft extension to said bell member being less than the distance in the same radial direction from the normal position of the motor-compressor unit to said shell.

5. In a suspension for a vertically disposed motor-compressor unit enclosed within a hermetically sealed shell, a bell member secured to the top of the shell interior and extending downwardly therefrom, an annular mounting member at the top of said motor-compressor unit surrounding said bell member, opposed flanges on said bell member and mounting member, the flange on said mounting member being spaced above the flange on said bell member, compression spring means disposed between said flanges and supporting the weight of said motor-compressor unit, an upward shaft extension on said

motor-compressor unit disposed within the confines of said bell and in spaced relation therewith, a plurality of stabilizer springs in circumferentially spaced relation, each stabilizer spring comprising a helical wire coil fixed at its upper end to an underside of the motor-compressor unit and extending downwardly therefrom, and slidable post-and-sleeve means connecting the lower ends of said stabilizer springs to the shell interior.

6. In a suspension for a vertically disposed motor-compressor unit enclosed within a hermetically sealed shell, a bell member secured to the top of the shell interior and extending downwardly therefrom, an annular mounting member at the top of said motor-compressor unit surrounding said bell member, opposed flanges on said bell member and mounting member, the flange on said mounting member being spaced above the flange on said bell member, compression spring means disposed between said flanges and supporting the weight of said motor-compressor unit, an upward shaft extension on said motor-compressor unit disposed within the confines of said bell and in spaced relation therewith, a plurality of stabilizer springs in circumferentially spaced relation, each stabilizer spring comprising a helical wire coil fixed at its upper end to an underside of the motor-compressor unit and extending downwardly therefrom, the coil diameters of said stabilizer springs being relatively small adjacent the upper and lower ends thereof and relatively large adjacent the centers thereof, and slidable post-and-sleeve means connecting the lower ends of said stabilizer springs to the shell interior.

7. In a suspension for a vertically disposed motor compressor unit enclosed within a hermetically sealed shell, a first member secured to the top of the shell interior and extending downwardly therefrom, an annular mounting member at the top of said motor-compressor unit surrounding said first member, oppposed flanges on said first member and mounting member, the flange on said mounting member being spaced above the flange on said first member, compression spring means disposed between said flanges and supporting the weight of said motor-compressor unit, a plurality of stabilizer spring in circumferentially spaced relation, each stabilizer spring comprising a vertically disposed helical wire coil fixed at its upper end to an underside of the motor-compressor unit and extending downwardly therefrom, the coil diameters of said stabilizer springs being relatively small adjacent the upper and lower ends thereof and relatively large adjacent the centers thereof, and slidable post-and-sleeve means connecting the lower ends of said stabilizer springs to the shell interior.

8. In suspension means for a vertically mounted motor-compressor unit having an electric motor above a compressor and connected thereto by a crankshaft, the unit being disposed within an oval type of shell having upper and lower hermetically sealed halves, a bell member centrally secured to the top of the shell interior and extending downwardly therefrom, the lower end of said bell member having an outwardly extending flange, a flat spring-like member with radially extending arms secured between said bell member and the top of the shell interior, the natural frequency of said spring-like member being substantially different than the natural frequency of vibration of said shell, said arms being urged against said shell to dampen high frequency vibrations, an annular

mounting member secured to said motor-compressor unit and extending thereabove, an inwardly directed flange at the upper end of said mounting member spaced vertically above said bell member flange, a helical coil compression spring disposed between said flanges, said bell member and mounting member restraining the lower and upper ends of said spring respectively against lateral movement, an upward extension on said crankshaft centrally disposed within said bell member and spaced therefrom, the strength of said spring in a lateral direction being sufficient to prevent engagement of said shaft extension with said bell member when said motor-compressor unit starts and stops, the distance along any radius from the normal position of said shaft extension to said bell member being less than the radial distance in the same direction from the upper portion of said motor-compressor unit to said shell, a pair of stabilizer springs, each spring comprising a helical wire member having relatively narrow diameter coils at its upper and lower ends and relatively wide diameter coils at its center, the coil diameters gradually changing between the narrower and wider portions, the upper coils of said stabilizer springs being fixed to the underside of said motor-compressor unit, a sleeve fixed to the lower coils of each stabilizer spring, inwardly extending brackets on the shell interior below said stabilizer springs, and pins mounted on said brackets and slidably mounted within said sleeves.

9. A device for flexibly interconnecting two spaced members supported for relative movement, comprising a helical coil spring formed of a length of wire of constant gage, the wire coils adjacent opposite ends of said spring having a relatively small diameter, the wire coils adjacent the central portion of said spring having a relatively large diameter, the diameters of the coils between said small and large diameter coils being of graduated diameter, whereby the shear stress in said large diameter coils will be greater than the shear stress in said small diameter coils when said members are moved laterally with respect to each other, a fixed connection between one end of said spring and one of said members which prevents lateral, pivotal and axial movement of said spring end with respect to its attached member, and means connecting the other end of said spring to the other member in a manner which prevents pivotal and lateral but permits axial movement of said other spring end relative to said other member, said last-mentioned means comprising a sleeve fixed to the other end of said spring and slidable on a pin fixed to said other member, the large diameter coils being unengaged by said members, whereby the minimum bending stress and maximum shear stress along said spring will occur in said large diameter coils.

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