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(54) **SUSPENSION ELEMENT FOR LINEAR COMPRESSOR**

(76) Inventors: **Crispin Roger Halkyard**, North Shore City (NZ); **Ian Campbell McGill**, Auckland (NZ)

Correspondence Address:
TREXLER, BUSHNELL, GIANGIORGI, BLACKSTONE & MARR, LTD.
105 WEST ADAMS STREET
SUITE 3600
CHICAGO, IL 60603 (US)

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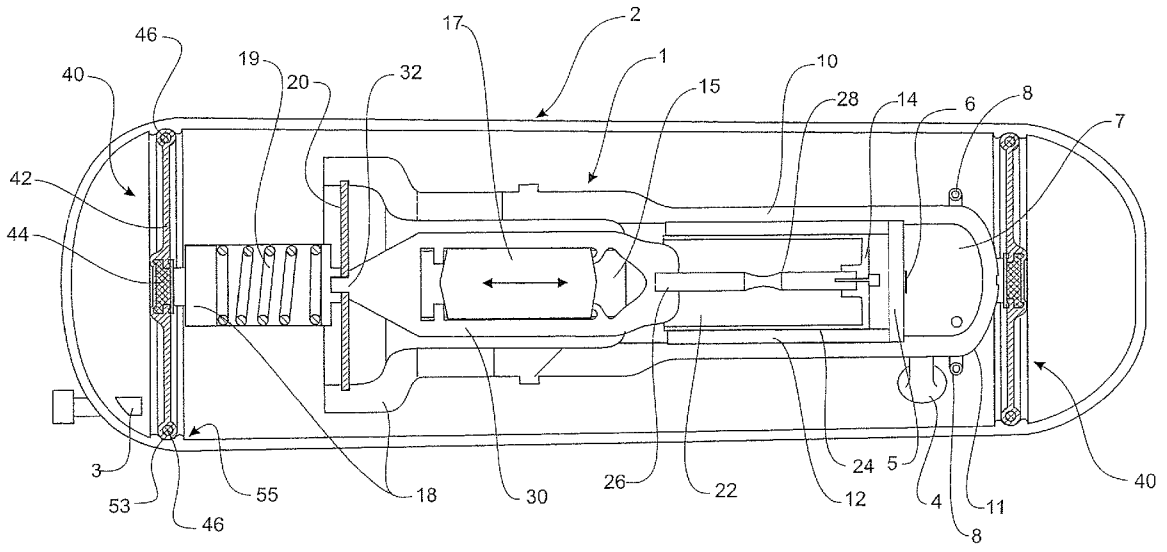
(57) **ABSTRACT**

In a refrigeration compressor a pair of suspension elements support a linear compressor within a hermetic shell. Each suspension element includes a hub component is fixed to one of the compressor or shell. A substantially rigid ring is secured to the other of the compressor or shell, an elastic membrane extends across the area of the ring and is secured to the ring around its periphery. The hub component is secured to the membrane at the centre of the ring.



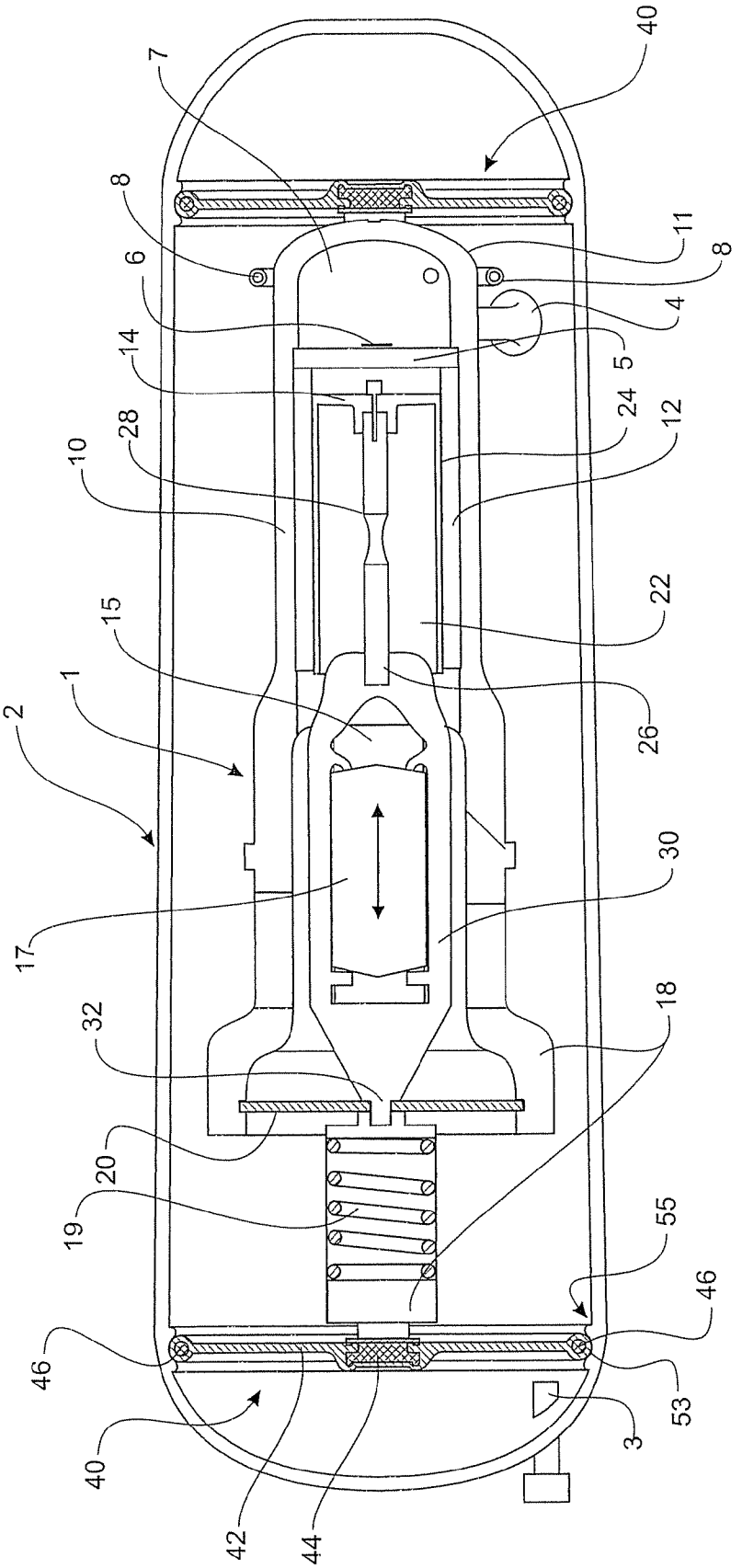

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FIGURE 1

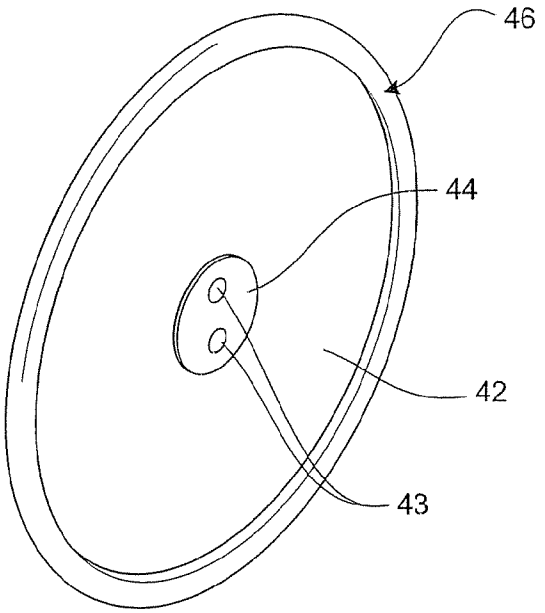

FIGURE 2

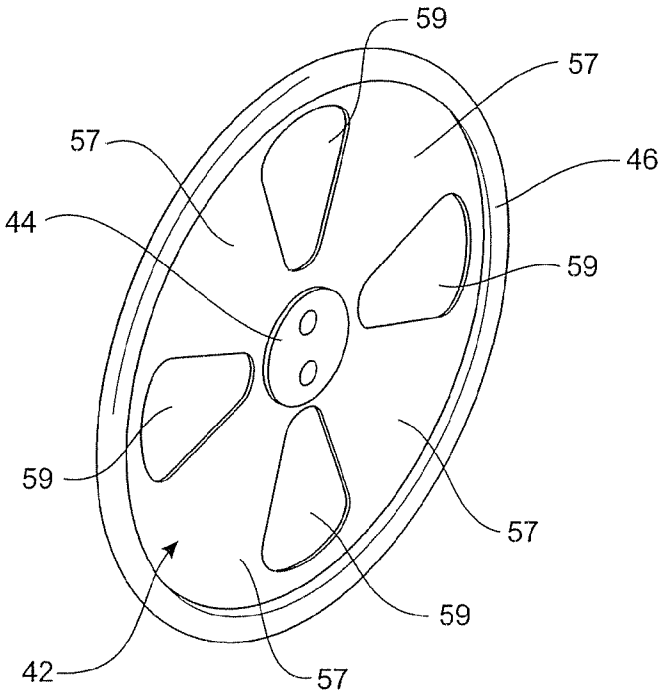

FIGURE 3

SUSPENSION ELEMENT FOR LINEAR COMPRESSOR

FIELD OF THE INVENTION

[0001] The present invention relates to linear compressors, and in particular linear compressors of the type suitable for use in a vapour compression refrigeration system.

BACKGROUND TO THE INVENTION

[0002] Linear compressors of a type for use in a vapour compression refrigeration system are the subject of many documents in the prior art. One such document is our co-pending PCT patent application PCT/NZ2004/000108. That specification describes a variety of developments relating to compressors, many of which have particular application to linear compressors. The present invention relates to further improvements to compressor embodiments such as are described in that patent application, which provides a general description of an example compressor to which the present invention may be applied. However the present invention may also be applied beyond the scope of the particular embodiments of linear compressor disclosed in that application. Persons skilled in the art will appreciate the general application of the ideas herein to other embodiments of linear compressors such as are found in the prior art.

[0003] PCT/NZ2004/000108 describes a number of arrangements for suspending a linear compressor assembly in a hermetic shell using coil springs.

[0004] The present invention relates generally to suspension elements for suspending the compressor assembly within the hermetic shell not using coil springs.

SUMMARY OF THE INVENTION

[0005] It is an object of the present invention to provide a suspension element with improved characteristics with particular application to a linear compressor and/or to provide refrigeration compressors incorporating such elements, or to at least provide the industry with a useful choice.

[0006] In a first aspect the invention consists in a suspension element for use in supporting a linear compressor within a hermetic shell, said element comprising:

[0007] a hub component adapted for fixing to a first object,

[0008] a substantially rigid ring, and

[0009] an elastic membrane extending across the area of said ring and secured to said ring around its periphery,

[0010] said hub component being secured to said membrane at the centre of said ring.

[0011] According to a further aspect said membrane is moulded over said ring, and is moulded over at least a part of said hub component.

[0012] According to a further aspect said membrane comprises a natural or artificial rubber, polyurethane material, or rubber substitute.

[0013] In a further aspect the present invention consists in a refrigeration system compressor comprising a hermetic housing, a linear compressor within said hermetic housing, said compressor including at least two relatively reciprocating parts, with one part typically being much greater mass than the other part, the relative reciprocation of the centre of mass of each part occurring along an axis of reciprocation, and

[0014] at least a pair of suspension elements substantially as set forth in one or more of the above paragraphs, the hub portion of each said suspension element being connected with said compressor part of greater mass, such that the centre of said hub at least substantially coincides with said axis of reciprocation, and the ring portion of each said element being fixed to at least one part of said hermetic housing.

[0015] To those skilled in the art to which the invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the scope of the invention as defined in the appended claims. The disclosures and the descriptions herein are purely illustrative and are not intended to be in any sense limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. **1** is a side elevation in cross-section of a refrigeration compressor including a linear compressor suspended in a housing. The compressor is suspended in the housing at each end by a suspension element according to a preferred embodiment of the present invention.

[0017] FIG. **2** is a perspective view of a suspension element according to a first embodiment of the present invention.

[0018] FIG. **3** is a perspective view of a suspension element according to a variation of the invention where the membrane does not cover the entire area bounded by the ring.

DETAILED DESCRIPTION

[0019] Referring to FIG. **1**, the compressor for a vapour compression refrigeration system includes a linear compressor **1** supported inside a housing **2**. Typically the housing **2** is hermetically sealed and includes a gases inlet port **3** and a compressed gases outlet port **4**. Uncompressed gases flow within the interior of the housing surrounding the compressor **1**. These uncompressed gases are drawn into the compressor during intake stroke, compressed between the piston crown **14** and valve plate **5** on the compression stroke, and expelled through discharge valve **6** into a compressed gases manifold **7**. Compressed gases exit the manifold **7** to the outlet port **4** in the shell through a flexible tube **8**. To reduce the stiffness effect of discharge tube **8** the tube is preferably arranged as a loop or spiral transverse to the reciprocating axis of the compressor. The intake to the compression space may be through the piston (with an aperture and valve in the crown) or through the head, divided to include suction and discharge manifolds and valves.

[0020] The illustrated linear compressor **1** has, broadly speaking, a cylinder part and a piston part connected by a main spring. The cylinder part includes cylinder chassis **10**, cylinder head **11**, valve plate **5** and a cylinder liner **12**. It also includes stator parts **15** for a linear electric motor. An end portion **18** of the cylinder part, distal from the head **11**, mounts the main spring relative to the cylinder part. In the illustrated embodiment the main spring is a combination of coil spring **19** and flat spring **20**.

[0021] The piston part includes a hollow piston **22** with sidewall **24** and crown **14**. A rod **26** connects between the crown **14** and a supporting body **30** for linear motor armature **17**. The rod **26** has a flexible portion **28** approximately at the centre of the hollow piston **22**. The linear motor armature **17** comprises a body of permanent magnet material (such as ferrite or neodymium) magnetised to provide one or more poles directed transverse to the axis of reciprocation of the piston within the cylinder liner. An end portion **32** of armature support **30**, distal from the piston **22**, is connected with the main spring **19**, **20**.

[0022] This briefly describes a linear compressor of a type for which the suspension element of the present invention is useful. However it will be appreciated that the usefulness of the suspension element of the present invention is not restricted to linear compressors of the type and configuration illustrated. It is generally applicable where operation of the linear compressor results in the relative reciprocation of the centre of mass of the piston carrying part and the centre of mass of the cylinder part along the linear axis.

[0023] The suspension element of the present invention is most usefully applied to support the heavier of the relatively moving assemblies, typically the cylinder part assembly. In the preferred manner, such as illustrated in FIG. **1**, a suspension element **40** is provided at each extreme end of the compressor. This is so that a centre of the suspension element can be aligned with the axis of relative reciprocation of the centres of mass of the two main assemblies.

[0024] The suspension element of the present invention is particularly adapted for a linear compressor, which exhibits a linear oscillating motion rather than a planar oscillating motion. An isolating suspension element **40** is provided at either end of the compressor.

[0025] In the preferred embodiments illustrated in FIGS. **2** and **3**, each suspension element **40** includes an elastic membrane **42**. The elastic membrane **42** spans between a central hub **44** and a surrounding ring **46**. One of the hub or ring is fixed to the compressor. The other of the hub or ring is fixed to the compressor shell. Fixing the surrounding ring **46** to the compressor is most likely to be convenient. In the embodiment illustrated, the central hub **44** is connected to the compressor substantially on the centreline so that the plane of the membrane **42** is perpendicular to and intersects the centreline of the compressor. The supporting ring **46** assists with assembly of the compressor, allowing the compressor assembly to be placed into a lower half shell fully supported, with the upper half shell subsequently fitted.

[0026] The hub **44** is adapted for connection to the compressor. For example the hub **44** may include one or more apertures **43** for receiving a fastener or fasteners, or may include a suitable clip for engaging a suitable complementary feature on the compressor.

[0027] Referring to FIG. **1**, the ring **46** is preferably fitted within a suitable receptacle of the housing. For example an annular groove **53** in the inside surface **55** of the housing may retain the ring. One half of the annulus of the groove may be formed in each half of the housing and the ring may be captured in the groove as the housing is assembled. A number of open clips in each half of the housing could be provided instead of a continuous groove.

[0028] Each membrane suspension element **40** is preferably arranged in the housing with the hub **44** secured to a respective end of the compressor assembly. The suspension element is arranged such that the plane of the membrane **42** is fully perpendicular to the axis of reciprocation of the compressor.

[0029] In a variation, illustrated in FIG. **3**, the membrane **42** may not cover the whole area defined by the ring. The membrane may include a plurality of separate sections (spokes) **57** extending from hub **44** to ring **46** or the membrane may include a plurality of openings **59** distributed around the area between hub and ring.

[0030] The membrane **42** may be a high performance natural or artificial rubber or polyurethane material, or other material having suitable elastic properties. Examples include natural rubber, Sunprene (a polypropylene and natural rubber composite available from DuPont) or thermoplastic rubber. The material may be moulded over the outer ring component.

[0031] The outer ring component **46** may be of steel or other suitable rigid material.

[0032] The membrane **42** may also be moulded over the hub component **44**, which may be any suitable material, and include any suitable adaptation for facilitating fixing to the compressor.

1. A suspension element for use in supporting a linear compressor within a hermetic shell, said element comprising:

a hub component adapted for fixing to a first object,

a substantially rigid ring, and

an elastic membrane extending across the area of said ring and secured to said ring around its periphery,

said hub component being secured to said membrane at the centre of said ring.

2. A suspension element as claimed in claim 1 wherein said membrane is moulded over said ring, and is moulded over at least a part of said hub component.

3. A suspension element as claimed in claim 1 wherein said membrane comprises an artificial rubber or polyurethane material.

4. A suspension element as claimed in claim 2 wherein said membrane comprises an artificial rubber or polyurethane material.

5. A refrigeration system compressor comprising a hermetic housing, a linear compressor within said hermetic housing, said compressor including at least two relatively reciprocating parts, with one part typically being much greater mass than the other part, the relative reciprocation of the centre of mass of each part occurring along an axis of reciprocation, and

at least a pair of suspension elements each comprising:

a hub component adapted for fixing to a first object,

a substantially rigid ring, and

an elastic membrane extending across the area of said ring and secured to said ring around its periphery,

said hub component being secured to said membrane at the centre of said ring,

the hub portion of each said suspension element being connected with said compressor part of greater mass,

such that the centre of said hub at least substantially coincides with said axis of reciprocation, and the ring portion of each said element being fixed to at least one part of said hermetic housing.

6. A refrigeration system compressor as claimed in claim 5 wherein said membrane is moulded over said ring, and is moulded over at least a part of said hub component.

7. A refrigeration system compressor as claimed in claim 5 wherein said membrane comprises an artificial rubber or polyurethane material.

8. A refrigeration system compressor as claimed in claim 6 wherein said membrane comprises an artificial rubber or polyurethane material.

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