

ARRANGEMENT AND PROCESS FOR MOUNTING A RESONANT SPRING
IN A LINEAR MOTOR COMPRESSOR AND A LINEAR MOTOR
COMPRESSOR

Field of the Invention

5 The present invention refers to an arrangement for
mounting a resonant spring in a compressor of the type
driven by a linear motor and, more particularly, to an
arrangement for mounting a resonant spring of the type
which couples a movable assembly of compression, that
10 is, a piston/rod/actuating means assembly to a non-
resonant assembly, usually defined by a cylinder
crankcase fixed inside a compressor housing. The
invention further refers to a process for carrying out
said mounting, and to a linear motor compressor
15 obtained with the proposed mounting arrangement.

Prior Art

In a linear compressor, the gas compression process
includes, mainly, two sub-assemblies: a first sub-
assembly composed by the cylinder, usually defined in a
20 crankcase, and by the linear motor assembly, which is
also fixed to the crankcase, and which is responsible
for generating the thrust required for displacing the
piston inside the cylinder and, consequently, for the
gas compression; and a second sub-assembly formed by
25 the piston, the rod or connecting rod, the displacement
means, which contains the magnets driven by the motor,
and by the resonant spring, which has one of the ends
thereof connected to the displacement means and the
other end connected to the crankcase.

30 For the proper operation of the compressor, in first
place, it is mandatory that a certain distance be held
between the cylinder top and the piston top, when the
latter is in its compression dead center, such distance
defining the capacity of the compressor and the
35 variability of such capacity. Additionally, it is also
fundamental to ensure the alignment of the piston in
relation to the cylinder and thus minimize the piston

load on the cylinder, which functions as a pneumatic or oil bearing.

It should be understood that in order to obtain a correct spacing between the piston top and the cylinder top, during the mounting process, a chain of tolerances have to be respected, with values being kept within narrow bands, in order that such distance, upon ending the mounting, is kept within acceptable values.

Further, in order to obtain a correct alignment of the piston in relation to the cylinder, the tolerances orthogonal to the main shaft of the compressor also have to be kept with values within narrow bands. This implies high costs for manufacturing the necessary components, demanding complex and costly operations.

A known mounting arrangement, described in the Brazilian patent application PI0705541-2 (WO2009/076734), comprises a first securing means to secure one end of the resonant spring to the actuating means by means of a plastic welding between two plastic components respectively injected, over one end of the spring and over one end of the actuating means. In this solution, said plastic welding of the first securing means has the function of joining and for compensating for axial, lateral and torsional tolerances.

The mounting arrangement of this prior solution does not require very precise tolerances of the components to be mounted to each other, both in the direction of the cylinder axis and in the orthogonal direction, without compromising the concentric positioning of the movable assembly in relation to the cylinder axis, as well as in relation to the distance between a piston top portion in relation to the cylinder top, which distance, as already mentioned, defines the displaced volume and the corresponding refrigeration capacity of the compressor.

Although it is a very interesting solution process-wise, two drawbacks are introduced in the product.

One drawback is due to the fact that the fixation by means of plastic material is very dependent on the type and quality of the plastic being used. Furthermore, the plastic material may undergo thermo-chemical deterioration as time goes by, thereby reducing the reliability of the fixation obtained.

Another drawback is due to the fact that the plastic component defining the first securing means, joining the actuating means to the resonant spring, operates as a second spring which, depending on its rigidity, may amplify the excitement caused by the compression of the gas on the piston top and thus excite resonant modes of the spring.

Another known mounting arrangement described in the Brazilian patent application PI1000181-6 (WO2011/082461) comprises fixation and alignment means of the resonant assembly in relation to the crankcase and linear motor, not requiring too tight tolerances of the components, both in the direction of the main axis and in the orthogonal direction and allowing, even with wider tolerances, to achieve a correct positioning of the piston, with a suitable alignment between the piston and the cylinder.

In said second prior art solution, the alignment adjustments in three directions may be carried out using reliable mechanical fixation means, which do not amplify the excitement generated by the gas compression on the piston top.

In this second known solution, the first securing means comprises a clamp already incorporated to the actuating means and which is fitted around a diametrical end segment of the spring wire and pressed against the latter by means of a tightening bolt. This known union between the actuating means and the spring adjacent end allows obtaining alignment adjustments in two directions, which are the rotation of the actuating means around the diametrical end segment of the spring

wire and the linear displacement of the actuating means along said diametrical segment of the spring. This spring-actuating means union allows for the centralization of the latter in relation to the longitudinal axis of the spring as an initial step in the mounting process of the resonant assembly.

However, in said prior art second solution, the opposite end of the spring comprises one two-piece diametrical segment, defined in two radial portions, each of which being formed by a respective end portion of the spring wire, said two-piece diametrical segment receiving a second securing means defined by an inner vise jaw and an outer vise jaw, the first carrying a half-shell facing the other vise jaw, in order that both vise jaws may be pressed against each other, by means of tightening bolts, around the two-piece diametrical segment of the spring, the outer vise jaw being provided with means for bearing it in the non-resonant assembly, particularly in the cylinder crankcase.

The half-shell is mounted to the inner vise jaw in order to be linearly displaceable in a diametrical direction in relation to the spring and orthogonal to the two-piece diametrical segment of the spring wire, ensuring the possibility of adjustment according to this direction. Furthermore, the spring may be displaced in relation to the half shell in a direction orthogonal to the first direction, that is, in the direction matching that of the two-piece diametrical segment, ensuring the assembly adjustment in a second direction. This mounting arrangement further allows for a third adjustment direction defined by the possibility of rotating the second securing means, defined by the assembly of vise jaws and half shell, around the two-piece diametrical segment of the spring wire.

During the mounting alignment process, the adjustments in the three directions are carried out until the

alignment is properly set. When this happens, both vise jaws are then locked to each other and around the two-piece diametrical segment of the spring wire, by tightening two bolts.

5 Although being more advantageous in relation to the first mounting system using plastic elements, this second known solution requires that during the alignment process of the compression mechanism defining the resonant assembly, the tightening bolts of the
10 inner and outer vise jaw of the second securing means, must to be relieved, allowing the vise jaw to move in relation to the end radial portions of the spring wire. However, the spring presents shape malformations, especially alignment deviations between the end radial
15 portions of the wire in the two-piece diametrical segment. When the load between the two vise jaws is released for carrying out the alignment adjustment, the spring tends to naturally deform, causing the alignment process to be undesirably long. Furthermore, precise
20 equipment are required for measuring the piston positioning in relation to the crankcase, as well as with the magnets in relation to the motor center, since the assembly should not be mechanically forced, for in such case, upon being released, the mechanism would
25 lose alignment due to the tensions present on the spring.

From the disclosure above, it is thus desirable the development of a new solution for the complete alignment of the parts comprised by the resonant
30 assembly, without the drawbacks of the prior solutions mentioned above.

Summary of the Invention

The present invention has the generic object of providing an arrangement for mounting a resonant spring
35 in a linear compressor, of the type considered above and which allows the use of component parts of relatively simple and easy construction and assembly,

without requiring too tight tolerances for obtaining a correct centralized positioning of the piston inside the cylinder and a resistant and reliable mounting, throughout the entire life span of the compressor, without interfering in the operational characteristics of the resonant spring.

The present invention has the further object of providing a mounting arrangement, such as mentioned above and which is able to guarantee, upon the assembly of the piston to the cylinder, a predetermined distance between the piston top and the valve plate, to ensure an adequate capacity to the compressor.

Another object of the present invention is to guarantee a correct positioning of the magnets in relation to the motor, with an adequate concentricity in both directions orthogonal to the piston displacement axis and angularly around said axis, allowing the magnets to travel the space between the motor blades without contacting the latter.

In order to comply with the objects cited above, the present invention provides an arrangement for mounting a resonant spring in a linear motor compressor of the type comprising: a cylinder crankcase defining a cylindrical region inside which is formed a compression chamber; a piston which reciprocates in the compression chamber, an actuating means coupled to the piston; and a resonant spring means having a first diametrical end segment affixed to the actuating means by a first securing means and a second diametrical end segment fixed to the cylinder crankcase by a second securing means.

According to the invention, the second securing means comprises: a base vise jaw rigidly affixed to the second diametrical segment of the resonant spring means in a predetermined position; a top vise jaw mounted, by a first tightening means, between two opposite portions of the cylinder crankcase and seated and compressed, by

at least one second tightening means and in a axially and radially adjustable manner in relation to the shaft of the resonant spring means, against the base vise jaw, locking the latter to the top vise jaw, in a
5 condition in which the axes of the end diametrical segments of the resonant spring means intercept the axis of the cylindrical region of the cylinder crankcase and in which the piston presents a predetermined axial position inside said cylindrical
10 region.

Considering the previous fixation of the resonant spring means to the movable assembly of compression, in a condition in which the axis of both parts are kept coaxial to each other, the present construction for the
15 mounting arrangement, particularly for the second securing means, allows carrying out the required axial alignment and positioning of the resonant assembly in relation to the cylinder crankcase of the compressor and to the motor, during the assembly of the latter,
20 without risking to lose the alignment between the two radial portions of the second diametrical end segment of the resonant spring means.

The invention also uses the known simplified construction for the first securing means, which is
25 able to allow the first diametrical end segment of the resonant spring means to be fixed to the movable assembly of compression, in a position defined along the relative displacement thereof in the diametrical direction of said first diametrical end segment of the
30 resonant spring means and around said direction, facilitating the coaxial alignment of the resonant spring means with the movable assembly of compression. The invention also refers to a process for mounting the resonant spring means in a linear motor compressor of
35 the type defined above, and to the linear motor compressor obtained.

Brief Description of the Drawings

The invention will be described below, with reference to the enclosed drawings, given by way of example of embodiments of the invention and in which:

Figure 1 represents a schematic and simplified longitudinal sectional view of a compressor driven by a linear motor and having the resonant spring means mounted to the parts of compressor assembly and of non-resonant assembly, according to an arrangement of the prior art;

Figure 2 represents a perspective view of the resonant spring means, having the first diametrical end segment thereof mounted to the first securing means which is carried by the movable assembly of compression, and the second diametrical end segment thereof affixing the base vise jaw of the second securing means, according to a first configuration of the invention;

Figure 3 represents a perspective view similar to that of figure 2, however illustrating the piston already provided with its cylindrical skirt;

Figures 4A and 4B represent a longitudinal diametrical sectional view of the resonant spring means, offset by 90° and illustrating the base vise jaw according to the first configuration of the invention and rigidly affixed to the second diametrical segment of the spring means;

Figure 5 represents a perspective view of the spring means having the first diametrical end segment thereof affixed to the movable assembly of compression, only partially illustrated, and the second diametrical end segment thereof affixing the base vise jaw, with the top vise jaw being illustrated in an exploded condition, said vise jaws being built according to the first configuration of the invention;

Figure 6 represents a schematic and simplified longitudinal sectional view of a compressor of the type shown in figure 1, without the housing, however including the mounting arrangement of the present

invention according to the first configuration;

Figure 7 represents a view similar to that of figure 6, however with the longitudinal section plane offset by 90 degrees in relation to that of figure 6;

5 Figure 8 represents a perspective view of the movable assembly of compression and resonant spring means, mounted to the cylinder crankcase, using the first configuration of the base and top vise jaws;

Figure 9 represents a perspective view of the spring
10 means having the first diametrical end segment thereof affixed to the movable assembly of compression, only partially illustrated, and the second diametrical end segment thereof affixing the base vise jaw, with the top vise jaw being illustrated in an exploded
15 condition, said vise jaws being built according to a second configuration of the invention;

Figure 10 represents a perspective view of the movable assembly of compression and resonant spring means, with the base and top vise jaws of the second configuration
20 and with the tightening means in a mounted position; and

Figure 11 represents a perspective view of the movable assembly of compression and resonant spring means, mounted to each other and to the cylinder crankcase,
25 with the tightening means in an exploded position and using the second configuration of the base and top vise jaws.

Detailed Description of the Invention

As already mentioned, the mounting arrangement of
30 resonant spring of the present invention is described for a refrigeration compressor construction driven by a linear motor.

As exemplarily shown in figure 1 of the attached drawings, the compressors, usually used for
35 refrigeration and driven by an electric motor of the linear type, comprise a housing 1, usually hermetic and which houses a non-resonant assembly, including a

cylinder crankcase 10 which may be mounted in housing 1 by means of suspension springs 11, for example, coil springs.

The cylinder crankcase 10 incorporates a cylindrical region 12 inside which is housed a sleeve 20 defining a compression chamber 13, having one end 13a usually closed by a valve plate 14 and by a head 15, and an open opposite end 13b through which is mounted a piston 22, incorporating a cylindrical skirt 22a and which reciprocates inside the compression chamber 13 of the sleeve 20. The piston 22 is coupled, usually by means of a rod 30, to an actuating means 40 which carries magnets 41 of a linear motor M which is mounted to the cylinder crankcase 10.

The cylinder crankcase 10 may further incorporate two opposite extensions 17, which take the form of two rods 17a which project axially from the cylindrical region 12, in the same direction, in order to retain, therebetween, the linear motor M. Each rod 17a is provided with a through hole 17b aligned with the through hole 17b of the other rod 17a.

The linear motor M is responsible for providing the necessary thrust for the displacement of the piston 22 inside the compression chamber 13 of the sleeve 20 and consequently, for the compression of refrigerant fluid in gas form.

The movable assembly of compression, defined by the piston-rod-actuating means assembly, is coupled to a resonant spring means 50, mounted in order to apply opposite axial forces on the piston 22, upon the reciprocating axial displacement of the latter inside the compression chamber 13. The resonant spring means 50 acts on the movable assembly of compression, together with the linear motor M of the compressor, also operating as an axial displacement guide of the piston 22. The movable assembly of compression and the resonant spring means define the resonant assembly of

the compressor.

In the prior art construction, illustrated by way of example in figure 1, the resonant spring means 50 is defined by a single coil spring, having a first
5 diametrical end segment 50a and a second diametrical end segment 50b, usually two-piece, said end diametrical segments 50a, 50b being respectively affixed to the movable assembly of compression (usually to the actuating means 40), by a first securing means
10 MF1 and to the non-resonant assembly, for example to the cylinder crankcase 10 or to the supporting structure thereof, by a second securing means MF2.

Although not illustrated in the attached drawings, it should be understood that the resonant spring means 50
15 may be formed by two coil springs, situation in which each of the end diametrical segments 50a, 50b, of the resonant spring means 50 is defined by end radial extensions, substantially facing each other and coaxial to each other, of each of the two coil springs. The end
20 radial extensions may also be positioned so as to overlap and to be substantially parallel to each other, according to another constructive embodiment.

Thus, the resonant spring means 50 may be defined by at least one coil spring, having the first diametrical end
25 segment 50a defined by a continuous spring wire extension and the second two-piece diametrical end segment 50b and defined in two radial portions, each of which being formed by a respective spring wire end portion.

30 The end diametrical segments 50a, 50b, of the resonant spring means 50, in the form of a coil, are coaxial to each other and located according to a direction which is orthogonal to the axis of the resonant spring means 50, not being mandatorily parallel to each other. This
35 type of construction is described and illustrated in said patent application PI1000181-6 (WO2011/082461).

The refrigeration compressor to which is applied the

resonant spring mounting arrangement of the present invention comprises, inside a housing 1, usually hermetic, the same basic components described for the linear motor compressor illustrated in figure 1, with
5 said common components being defined by the same reference numerals.

The first securing means MF1 may comprise, such as already described in said patent application PI1000181-6, two bearing portions 6, opposite to each other and
10 each provided with a recess 7 configured to act as a concave cradle, usually with a semi-circular profile, inside which is partially housed a respective extension of the first diametrical end segment 50a of the resonant spring means 50, which segment is defined by
15 an usually, but not mandatorily, continuous extension of the wired which forms the resonant spring means 50.

In the illustrated construction, the two bearing portions 6 are incorporated to the actuating means 40 and are configured to brace and fix, to each other, the
20 first diametrical end segment 50a of the resonant spring means 50.

The construction of the first securing means MF1 allows the first diametrical end segment 50a of the resonant spring means 50 to be linearly displaced through the
25 interior of the two bearing portions 6, before the final tightening of the latter, according to the diametrical direction of the axis of said first diametrical end segment 50a, and also angularly around said diametrical axis. The positioning of said first
30 diametrical end segment 50a of the resonant spring means 50 may be thus linearly and angularly adjusted during the assembly of the movable assembly, before the final pressing of a tightening means, allowing to easily obtain the desired coaxial fixation of the
35 resonant spring means 50 to the actuator 40, that is, to the movable assembly of compression. It should be understood that the resonant spring means 50 is built

to have the end diametrical segments 50a e 50b thereof positioned in a centralized manner in relation to the axis of the resonant spring means 50, but not necessarily parallel to each other.

5 In illustrated embodiment, the end diametrical segments 50a, 50b of the resonant spring means 50 are located coplanar to each other and according to directions orthogonal to the axis of the resonant spring means 50. In this case, the bearing portions 6 have the axis of
10 their recesses 7 also located orthogonal to the axis of the resonant spring means 50, allowing for the linear adjustment of the positioning of the first diametrical end segment 50a of the spring means to be carried out according to a direction orthogonal to the axis of the
15 resonant spring means 50, and the angular adjustment of said first diametrical end segment 50a to be carried out by the angular displacement of the resonant spring means 50 around the axis of said first diametrical end segment 50a.

20 According to figures 2 to 8 of the present invention, the second securing means MF2 comprises a base vise jaw 60 rigidly affixed to the second diametrical end segment 50b, usually in two pieces, of the resonant spring means 50 in a predetermined position.

25 The second diametrical end segment 50b of the resonant spring means 50 is defined in two radial portions, each being formed by a respective end portion of the spring wire.

According to the same figures 2 to 8, the second
30 securing means MF2 also comprises a top vise jaw 70 mounted, by means of a first tightening means 80, between the two opposite extensions 17 of the cylinder crankcase 10. The second securing means MF2 is further seated and compressed, by a second tightening means 90
35 and in a axially and radially adjustable manner, in relation to the shaft of the resonant spring means 50, against the base vise jaw 60, locking the latter to the

top vise jaw 70, in a condition in which the axis of the end diametrical segments 50a, 50b of the resonant spring means 50 intercept the axis of the cylindrical region 12 and in which the piston 22 presents a
5 predetermined axial position inside the sleeve 20.

The base vise jaw 60 may present two guide surfaces 61, located in planes parallel to each other and orthogonal to the axis of the second diametrical end segment 50b and symmetrical in relation and symmetrical in relation
10 to the longitudinal axis of the resonant spring means 50.

In the construction illustrated in figures 2 to 8, which represents a first embodiment of the invention, the top vise jaw 70 comprises a "U" shaped body 71
15 mounted, by means of the first tightening means 80, between the two opposite extensions 17 of the cylinder crankcase 10 and presenting a basic portion 71a from which projects a pair of flanges 72 parallel to each other, located orthogonally to the axis of the second
20 diametrical end segment 50b and seated and compressed, by the second tightening means 90, each against a respective guide surface 61 of the base vise jaw 60, locking said vise jaw to each other.

In the first embodiment of the present invention,
25 illustrated in figures 2 to 8, the base vise jaw 60 is provided with a through opening 62 joining the two guide surfaces 61 and having the longitudinal axis thereof intercepting the axis X of the resonant spring means 50, with each flange 72 of the top vise jaw 70
30 being provided with a through hole 73.

The second tightening means 90 is defined by a bolt 91, loosely disposed through the through opening 62 of the base vise jaw 60 and tightly through a respective through hole 73 of the top vise jaw 70.

35 The bolt 91 presents an enlarged end head 91a externally seated against one of said flanges 72 and an opposite end 91b threaded inside a locking means MT1

associated to the other of said flanges 72.

According to said first configuration, the locking means MT1 is defined by an opposite end nut 91c, externally seated against the other of said flanges 72 of the top vise jaw 70. Although not illustrated herein in detail, it should be understood that the locking means MT1 may be defined by the through hole 73 itself, internally threaded, of said other flange 72 of the top vise jaw 70.

10 The base vise jaw 60 presents a frontal surface 60a facing the basic portion 71a of the body 71 of the top vise jaw 70, the through opening 62 being defined by a lowered portion 62a open to said front surface 60a of the base vise jaw 60.

15 The first tightening means 80 is defined by a bolt 81, loosely provided through the top vise jaw 70, between the two flanges 72, and between the second tightening means 90 and the basic portion 71a of the top vise jaw 70 and through a through hole 17b provided in rod 17a of each of the two opposite extensions 17 of the cylinder crankcase 10. The bolt 81 has an enlarged end head 81a externally seated against one of said rods 17a and an opposite end 81b threaded inside a locking means MT2 associated with the other of said rods 17a.

20 In the first illustrated configuration (figures 2 to 8), the locking means MT2 is defined by a nut 81c operatively associated with the other of said rods 17a of the cylinder crankcase 10.

Although not illustrated in details in figures 2 to 8, it should be understood that the nut 81c may be externally seated against the other rod 17a of the cylinder crankcase 10, or also be defined by an insert incorporated in said other rod 17a of the cylinder crankcase 10, for example, by over-injecting the latter.

35 The locking means MT2 may be defined by the through hole 17b itself, internally threaded, of said other rod

17a of the cylinder crankcase 10.

The base vise jaw 60 of the first configuration may present a rear surface 64, seated against the second diametrical end segment 50b of the resonant spring means 50 and comprises a bracket 65 having an arcuate median portion 65a and which is seated against said second diametrical end segment 50b, and a pair of lateral tabs 65b, which are seated and rigidly and permanently fixed to said rear surface 64 of the base vise jaw 60, for example, by welding, pressing and locking said second diametrical end segment 50b (two-piece in the illustrated construction) of the resonant spring means 50, to the base vise jaw 60.

According to the construction illustrated in figures 2 to 8, the formation of the compressor starts by mounting the base vise jaw 60 and of the bracket 65 in the second two-piece diametrical end segment 50b of the resonant spring means 50, locking the two end radial portions of the spring wire. From this mounting, the assembly defined by the base vise jaw 60 and bracket 65 will no longer be dismantled, with the bracket 65 being mounted against the rear surface 64 of the base vise jaw 60 by means of pressing followed by fixation, usually by welding, of the lateral tabs 65b against the base vise jaw 60.

In this mounting operation, it is obtained the alignment of the base vise jaw 60 in relation to the axis X of the resonant spring means 50, it being understood that said axis X should pass through the center of the first diametrical end segment 50a on the opposite side of the resonant spring means 50 and also through the center of the median passage 62 of the base vise jaw 60. In this phase of the mounting, it is also important that the guide surfaces 61 of the base vise jaw 60 be positioned in an orthogonal or substantially orthogonal manner in relation to the axis of the second diametrical end segment 50b of the resonant spring

means 50.

In a second mounting phase, the first diametrical end segment 50a of the resonant spring means 50 is mounted to the actuating means 40 using the first securing means MF1, as previously described, however having as reference the base vise jaw 60 already affixed to the second two-piece diametrical end segment 50b of the resonant spring means 50. This method allows the axis of the actuating means 40 to be coaxially aligned with the axis X of the resonant spring means 50 and, consequently, with the axis of the base vise jaw 60.

Next, the top vise jaw 70 is fixed to the base vise jaw 60, using the second tightening means 90, which, when operated, deforms both flanges 72 of the top vise jaw 70, locking the base vise jaw 60 therein. In this phase, the driving of the second tightening means 90 need not be effected definitively and with the maximum required torque. The locking in this phase is preliminary, with the definitive locking being executed only at the end of the mounting process, as described further below.

It should be understood that the design of the flanges 72 and their spacing in relation to the base vise jaw 60 is carried out in order to allow both the assembly and the secure locking of the two vise jaws between each other.

The pre-mounted assembly defined by the actuating means 40, the resonant spring means 50 and the piston 22 are inserted inside the cylinder crankcase 10, with the piston 22 being positioned inside the sleeve 20, which is previously mounted in the cylindrical region 12 of the cylinder crankcase 10 and, consequently, aligned in relation to the cylinder crankcase 10. In this moment, the distance between the top of the piston 22 and the seating plane of the valve plate in the sleeve 20 and in the cylinder crankcase 10 are adjusted to the desired value.

Subsequently, the magnets 41 are centralized in relation to the cylinder crankcase 10, according to both longitudinal planes, orthogonal to each other and which comprise the axis of the cylinder crankcase 10.

5 This centralization may also be carried out by using non-illustrated mounting devices, which are able to centralize the resonant assembly and keep it in a position aligned to the axis of the cylinder crankcase 10.

10 Once the resonant assembly is aligned and positioned in the cylinder crankcase 10, it follows the actuation of the first tightening means 80, located through the opposite extensions 17 of the cylinder crankcase 10, providing the tightening of the rods 17a of said
15 opposite extensions 17 against the adjacent end faces of the top vise jaw 70, locking the latter in relation to the cylinder crankcase 10.

Next, it is carried out the actuation of the second tightening means 90 to provide the compression of the
20 guide surfaces 61 of the base vise jaw 60, locking the latter in the top vise jaw 70.

Since the entire mechanism represented by the resonant assembly is aligned to the axis of the cylinder crankcase by means of the mentioned mounting devices
25 (not illustrated), after driving the two tightening means 80, 90, the mounting devices may be removed, and the resonant assembly being thus provided with the desired alignment.

Figures 9 to 11 illustrate the invention using a second
30 configuration for the second securing means MF2, which also comprises a base vise jaw 60' rigidly fixed to the second diametrical end segment 50b, usually two-piece, of the resonant spring means 50 in a predetermined position, exactly as already described in relation to
35 the mounting of the base vise jaw 60 of the first embodiment. According to the same figures 9 to 11, the second securing means MF2 also comprises a top vise jaw

70' which is likewise mounted, by means of a first tightening means 80', between the two opposite extensions 17 of the cylinder crankcase 10. The second securing means MF2 is also seated and compressed, by
5 two second tightening means 90' and in an axially and radially adjustable manner in relation to the axis of the resonant spring means 50, against the base vise jaw 60', locking the latter to the top vise jaw 70', in a condition such that the axes of the end diametrical
10 segments 50a, 50b of the resonant spring means 50 intercept the axis of the cylindrical region 12, and in which the piston 22 presents a predetermined axial position inside the sleeve 20.

The base vise jaw 60' may present two guide surfaces
15 61', defined in planes parallel to each other and orthogonal to the axis of the second diametrical end segment 50b, and symmetrical in relation to the longitudinal axis of the resonant spring means 50.

In the construction illustrated in figures 9 to 11, the
20 top vise jaw 70' comprises a body 71', "U" shaped and presenting a basic portion 71a' from which projects a pair of flanges 72', parallel to each other, the top vise jaw 70' being mounted, by the first tightening means 80', between the two opposite extensions 17 of
25 the cylinder crankcase 10.

The flanges 72' of the top vise jaw 70' are located orthogonally to the axis of the second diametrical end segment 50b, and seated and compressed, by the second tightening means 90', each against a respective guide
30 surface 61' of the base vise jaw 60', locking said vise jaws to each other.

Each flange 72' of the base vise jaw 70' presents a pair of through holes 73' coaxially aligned to a respective through hole 73' of the other flange 72',
35 and further a median cut 74' defining a gap sufficient to loosely receive the second diametrical end segment 50b of the resonant spring means 50, each of the median

cuts 74' being further provided with an internal end widening 75' inside which said second diametrical end segment 50b is even more loosely positioned, upon the assembly of the compressor.

5 In the second configuration of the invention, the base vise jaw 60' is provided with two through openings 62', joining the two guide surfaces 61a' and disposed parallel and spaced from each other and defined on opposite sides, usually symmetrically, in relation to a
10 plane containing the axis of the resonant spring means 50 and of the second diametrical end segment 50b thereof.

Each of the second tightening means 90' is defined by a bolt 91', loosely provided through the respective
15 through passages 62' of the base vise jaw 60'. The through passages 62' present a diameter greater than that of the bolts 91' in order to allow radial and axial assembly adjustments, as previously described in relation to the first configuration of the invention.

20 Each bolt 91' is located, in a tight manner, through a respective pair of through holes 73' of the top vise jaw 70'.

Each bolt 91' presents an enlarged end head 91a' externally seated against one of said flanges 72' of
25 the top vise jaw 70' and one opposite end 91b' threaded inside a locking means MT1' associated to the other of said flanges 72'.

According to said second configuration, the locking means MT1' is defined by an opposite end nut 91c',
30 externally seated against the other of said flanges 72' of the top vise jaw 70'. Although not being illustrated herein in detail, it should be understood that the locking means MT1' may be defined by through holes 73', internally threaded, of said other flange 72' of the
35 top vise jaw 70'.

In said second configuration, the first tightening means 80' is defined by a bolt 81', loosely arranged

through the top vise jaw 70', between the flanges 72' thereof and through the through hole 17b provided in rod 17a of each of the two opposite extensions 17 of the cylinder crankcase 10. The bolt 81' presents the
5 same construction and assembly already described in relation to the bolt 81 of the first configuration, and the same constructive variations described in relation to figures 2 to 8 are likewise applicable.

The base vise jaw 60' of the second configuration,
10 illustrated in figures 9 to 11, may be mounted to the second diametrical end segment 50b of the resonant spring means 50 exactly in the same manner already described in relation to the configuration illustrated in figures 2 to 8, that is, by using the same bracket
15 65.

According to the construction illustrated in figures 9 to 11, the mounting of the compressor begins by mounting the base vise jaw 60' and the bracket 65 in the second two-piece diametrical end segment 50b of the
20 resonant spring means 50, locking the two end radial portions of the spring wire. From this mounting, the assembly defined by the base vise jaw 60' and bracket 65 will no longer be disassembled, with the bracket 65 being mounted against a rear surface 64' of the base
25 vise jaw 60' by pressing followed by fixation, usually by welding, of the lateral tabs 65b against the base vise jaw 60'. The base vise jaw 60' presents the rear surface 64' thereof facing the basic portion 71a' of the body 71' of the top vise jaw 70', upon mounting the
30 two vise jaws. In this embodiment, the first tightening means 80' is loosely arranged between the flanges 74' and between the basic portion 71a' of the top vise jaw 70' and the rear surface 64' of the base vise jaw 60'.

In this mounting operation, it is obtained the
35 alignment of the base vise jaw 60' in relation to the axis X of the resonant spring means 50. It should be understood that said axis X should pass by the center

of the first diametrical end segment 50a on the opposite side of the resonant spring means 50 and also between the two through passages 62' of the base vise jaw 60'. In this mounting phase, it is also important
5 that the guide surfaces 61' of the base vise jaw 60' be positioned orthogonally or substantially orthogonally to the axis of the second diametrical end segment 50b of the resonant spring means 50.

In a second mounting phase, the first diametrical end
10 segment 50a of the resonant spring means 50 is mounted to the actuating means 40 using the first securing means MF1, as previously described, however having as reference the base vise jaw 60' already previously fixed in the second two-piece diametrical end segment
15 50b of the resonant spring means 50. This method allows the axis of the actuating means 40 to be coaxially aligned to the axis X of the resonant spring means 50 and therefore to the axis of the base vise jaw 60'.

Next, the top vise jaw 70' is fixed to the base vise
20 jaw 60' using the second tightening means 90', which, when actuated, deform the two lateral portions 72a' of the top vise jaw 70', locking the base vise jaw 60' therein. In this phase, the actuation of the second tightening means 90 is not necessarily carried out
25 definitively and with the maximum required torque. The locking in this phase is preliminary, and the definitive locking is carried out only at the end of the mounting process.

It should be understood that the dimensioning of the
30 flanges 72' and the gap thereof in relation to the base vise jaw 60' is carried out in order to allow both the mounting and the safe locking of the two vise jaws to each other.

The pre-mounted assembly defined by the actuating means
35 40, the resonant spring means 50 and the piston 22 is inserted inside the cylinder crankcase 10, said piston 22 being positioned inside the sleeve 20, which is

previously mounted in the cylindrical region 12 of the cylinder crankcase 10 and, consequently, aligned in relation to the cylinder crankcase 10. In this moment, by means of non-illustrated external devices, the distance between the top of the piston 22 and the seating plane of the valve plate in the sleeve 20 and in the cylinder crankcase 10 is adjusted to the desired value.

Next, the magnets 41 are centralized in relation to the cylinder crankcase 10, according to the two longitudinal planes, orthogonal to each other and which contain the axis of the cylinder crankcase 10. This centralization is also carried out by using non-illustrated mounting devices, able to centralize the resonant assembly and keep it in a position aligned to the axis of the cylinder crankcase 10.

Following the resonant assembly alignment and positioning in the cylinder crankcase 10, it is then carried out the actuation of the first tightening means 80' and, subsequently, of the second tightening means 90', exactly as previously described in relation to the first configuration of figures 2 to 8.

In short, the mounting process of the resonant spring, in a linear motor compressor of the type defined above, comprises the steps of: affixing, rigidly and definitively, the base vise jaw 60, 60' to the second diametrical end segment 50b of the resonant spring means 50, in a predetermined and aligned position in relation to the axis X of the resonant spring means 50; affixing the diametrical end segment 50a of the resonant spring means 50 to the actuating means 40 by means of the first securing means MF1, with the axis of the actuating means 40 being arranged coaxially aligned to the axis X of the resonant spring means 50 and to the axis of the base vise jaw 60, 60'; preliminary affixing the top vise jaw 70, 70' to the base vise jaw 60, 60' using at least one second tightening means 90,

90'; inserting the pre-mounted assembly defined by actuating means 40, the resonant spring means 50 and the piston 22 inside the cylinder crankcase 10, with the piston 22 being positioned inside the sleeve 20;

5 adjusting the distance between the top of the piston 22 and the seating plane of the valve plate 14 in the cylinder crankcase 10; centralizing the magnets in relation to the cylinder crankcase 10, according to the two longitudinal planes, orthogonal to each other and

10 which contain the axis of the cylinder crankcase 10, and maintaining the resonant assembly in the aligned position; actuating the first tightening means 80, 80' in order to lock the top vise jaw 70, 70' to the opposite extensions 17 of the cylinder crankcase 10;

15 and actuating at least one second tightening means 90, 90' in order to lock the base vise jaw 60, 60' to the top vise jaw 70, 70'.

CLAIMS

- 1- An arrangement for mounting a resonant spring in a linear motor compressor of the type comprising: a cylinder crankcase (10) defining a cylindrical region (12) inside which is formed a compression chamber (13) a piston (22) reciprocating in the compression chamber (13), an actuating means (40) coupled to the piston (22); and a resonant spring means (50) having a first diametrical end segment (50a), affixed to the actuating means (40) by a first securing means (MF1) and a second diametrical end segment (50b), affixed to the cylinder crankcase (10) by a second securing means (MF2), characterized in that the second securing means (MF2) comprises:
- a base vise jaw (60, 60') rigidly affixed to the second diametrical end segment (50b) of the resonant spring means (50) in a predetermined position;
 - a top vise jaw (70, 70') mounted, by a first tightening means (80, 80'), between two opposite portions of the cylinder crankcase (10) and seated and compressed, by at least one second tightening means (90, 90') and in an axially and radially adjustable manner, in relation to the shaft of the resonant spring means (50), against the base vise jaw (60, 60'), locking the latter to the top vise jaw (70, 70'), in a condition in which the axes of the end diametrical segments (50a, 50b) of the resonant spring means (50) intercept the axis of the cylindrical region (12) of the cylinder crankcase (10) and in which the piston (22) presents a predetermined axial position inside said cylindrical region (12).
- 2- The arrangement, as set forth in claim 1, characterized in that the base vise jaw (60, 60') presents two guide surfaces (61, 61') located in planes parallel to each other and orthogonal to the axis of the second diametrical segment (50b) and symmetric in relation to the longitudinal axis of the resonant spring means (50), the top vise jaw (70, 70') comprising a "U" shaped

body (71, 71'), mounted, by the first tightening means (80, 80'), between the two opposite extensions (17) of the cylinder crankcase (10) and presenting a basic portion (71a, 71a') from which projects a pair of flanges (72, 72') parallel to each other, located orthogonally to the axis of the second diametrical segment (50b) and seated and compressed, by at least one of the second tightening means (90, 90'), each against a respective guide surface (61, 61') of the base vise jaw (60, 60'), locking said vise jaws between each other.

3- The arrangement, as set forth in claim 2, characterized in that the base vise jaw (60, 60') is provided with at least one through opening (62, 62') joining the two guide surfaces (61, 61') and having its longitudinal axis intercepting the axis (X) of the resonant spring means (50), said each flange (72, 72') of the top vise jaw (70, 70') being provided with at least one through hole (73, 73'), said second tightening means (90, 90') being defined by a bolt (91, 91'), loosely arranged through a respective through opening (62, 62') of the base vise jaw (60, 60') and, in a tight manner, through a respective through hole (73, 73') of the top vise jaw (70, 70') and having an enlarged end head (91a, 91a') externally seated against one of said flanges (72, 72') and an opposite end (91b, 91b') threaded inside a locking means (MT1) associated with the other of said flanges (72, 72').

4- The arrangement, as set forth in claim 3, characterized in that the locking means (MT1) is defined by a nut (91c, 91c') externally seated against the other of said flanges (72, 72') of the top vise jaw (70, 70').

5- The arrangement, as set forth in claim 3, characterized in that the locking means (MT1) is defined by through hole (73, 73') itself, internally threaded, of said other flange (72, 72') of the top vise jaw (70, 70').

6- The arrangement, as set forth in any of claims 3 to 5,

characterized in that the cylinder crankcase (10) incorporates two opposite extensions (17) in the form of two rods (17a) projecting axially from the cylindrical region (12) in the same direction, each rod (17a) being
5 provided with a through hole (17b) aligned with the through hole (17b) of the other rod (17a), the first tightening means (80, 80') being defined by a bolt (81, 81'), loosely arranged through the top vise jaw (70, 70'), between the two flanges (72, 72') and between the
10 second tightening means (90, 90') and the basic portion (71a, 71a') of the top vise jaw (70, 70') and through the through holes (17b) of the two opposite extensions (17) of the cylinder crankcase (10), said bolt (81, 81') having an enlarged end head (81a, 81a') externally seated
15 against one of said opposite extensions (17) and an opposite end (81b, 81b') threaded inside a locking means (MT2) associated with the other of said rods (17a).

7- The arrangement, as set forth in claim 6, characterized in that the locking means (MT2) is defined
20 by a nut (81c, 81c') operatively associated with the other of said rods (17a) of the cylinder crankcase (10).

8- The arrangement, as set forth in claim 7, characterized in that the nut (81c, 81c') is externally seated against said other rod (17a) of the cylinder
25 crankcase (10).

9- The arrangement, as set forth in claim 7, characterized in that the nut (81c, 81c') is defined by an insert incorporated in said other rod (17a) of the cylinder crankcase (10).

10- The arrangement, as set forth in claim 6, characterized in that the locking means (MT2) is defined
30 by the through hole (17b) itself, which is internally threaded, of said other rod (17a) of the cylinder crankcase (10).

11- The arrangement, as set forth in any of claims 1 to 10, characterized in that the resonant spring means (50) is defined by at least one coil spring and has the second

diametrical end segment (50b) in two pieces and defined in two radial portions, each of which being formed by a respective spring wire end portion.

12- The arrangement, as set forth in any of claims 1 to 11, characterized in that the base vise jaw (60, 60') presents a rear surface (64, 64') seated against the second diametrical segment (50b) of the resonant spring means (50) and comprises a bracket (65) having an arcuate median portion (65a) seated against said second diametrical segment (50b), and a pair of lateral tabs (65b) seated and rigidly and permanently affixed to said rear surface (64, 64') of the base vise jaw (60, 60'), pressing and locking said second diametrical segment (50b) to the base vise jaw (60, 60').

13- The arrangement, as set forth in any of claims 1 to 12, characterized in that the cylindrical region (12) of the cylinder crankcase (10) houses, therein, a sleeve (20), said compression chamber (13) being defined inside said sleeve (20).

14- The arrangement, as set forth in any of claims 2 to 13, characterized in that the base vise jaw (60) presents a frontal surface (60a) facing the basic portion (71a) of the top vise jaw (70), said through opening (62) being defined by a lowered portion (62a) open to said frontal surface (60a) of the base vise jaw (60).

15- The arrangement, as set forth in any of claims 2 to 13, characterized in that the base vise jaw (60') is provided with two through passages (62'), joining the two guide surfaces (61a'), and being located parallel and on opposite sides in relation to a plane containing the axis of the resonant spring means (50) and the second diametrical end segment (50b) thereof.

16- The arrangement, as set forth in claim 15, characterized in that each flange (72') of the base vise jaw (70') further presents a median cut (74') defining a gap large enough to loosely receive the second diametrical end segment (50b) of the resonant spring

means (50):

17- A process for mounting a resonant spring in a linear motor compressor of the type defined in any one of claims 1 to 16, characterized in that it comprises the steps of:

- 5 - affixing, rigidly and definitively, the base vise jaw (60, 60') to the second diametrical end segment (50b) of the resonant spring means (50), in a predetermined and aligned position in relation to the axis (X) of the resonant spring means (50);
- 10 - affixing the diametrical end segment (50a) of the resonant spring means (50) to the actuating means (40) by means of the first securing means (MF1), with the axis of the actuating means (40) being arranged coaxially aligned to the axis (X) of the resonant spring means (50) and to
- 15 the axis of the base vise jaw (60);
- preliminary affixing the top vise jaw (70, 70') to the base vise jaw (60, 60') using the second tightening means (90, 90');
- inserting the pre-mounted assembly defined by actuating
- 20 means (40), the resonant spring means (50) and the piston (22) inside the cylinder crankcase (10), said piston (22) being positioned inside the compression chamber (13);
- adjusting the distance between the top of the piston (22) and the seating plane of the valve plate (14) in the
- 25 cylinder crankcase (10);
- centralizing the magnets in relation to the cylinder crankcase (10), according to two longitudinal planes, orthogonal to each other and which contain the axis of the cylinder crankcase (10), and maintaining the resonant
- 30 assembly in the aligned position;
- actuating the first tightening means (80, 80') in order to lock the top vise jaw (70, 70') to the opposite extensions (17) of the cylinder crankcase (10); and
- actuating the second tightening means (90, 90') in
- 35 order to lock the base vise jaw (60, 60') to the top vise jaw (70, 70').

18- Refrigeration compressor, characterized in that it

comprises an arrangement for mounting a resonant spring, such as defined in any of the claims 1 to 16.