

July 17, 1962

F. H. HOPPER
SHIPPING CONTAINER

3,044,607

Filed May 23, 1960

2 Sheets-Sheet 1

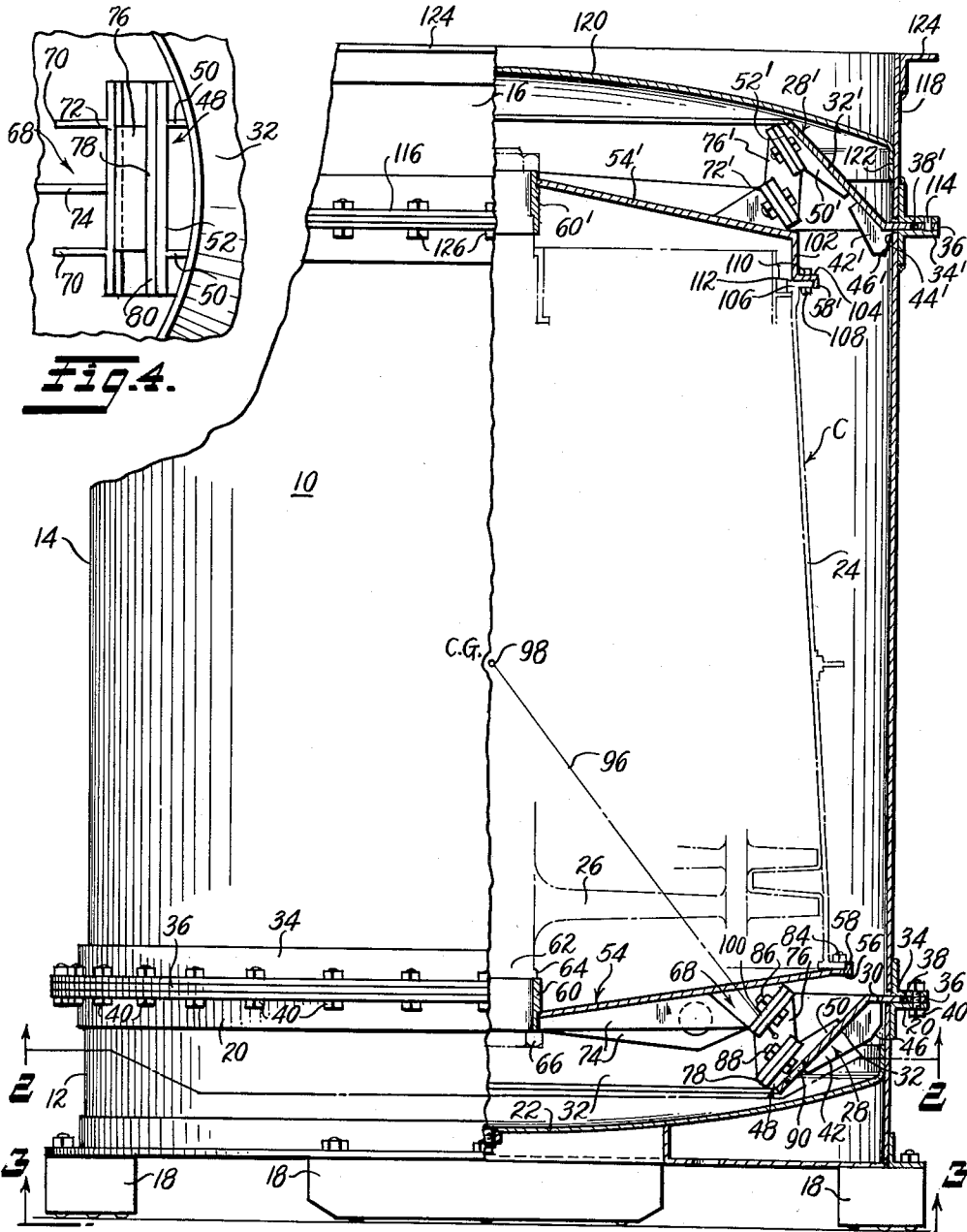


Fig. 1.

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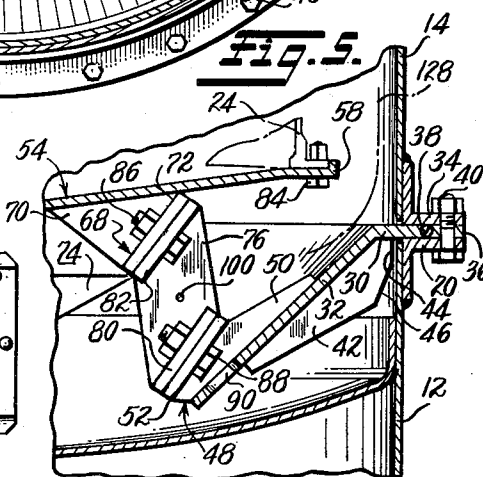
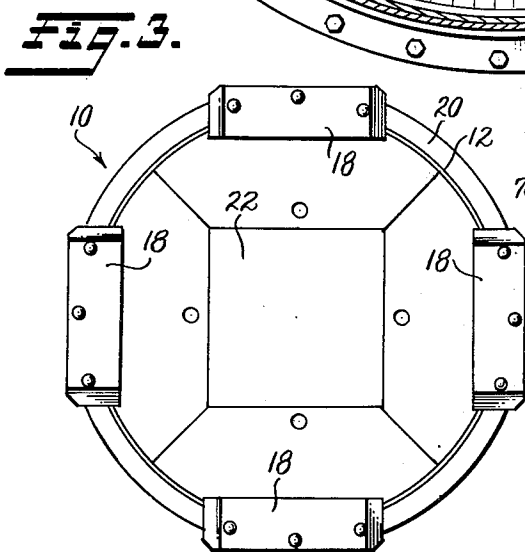
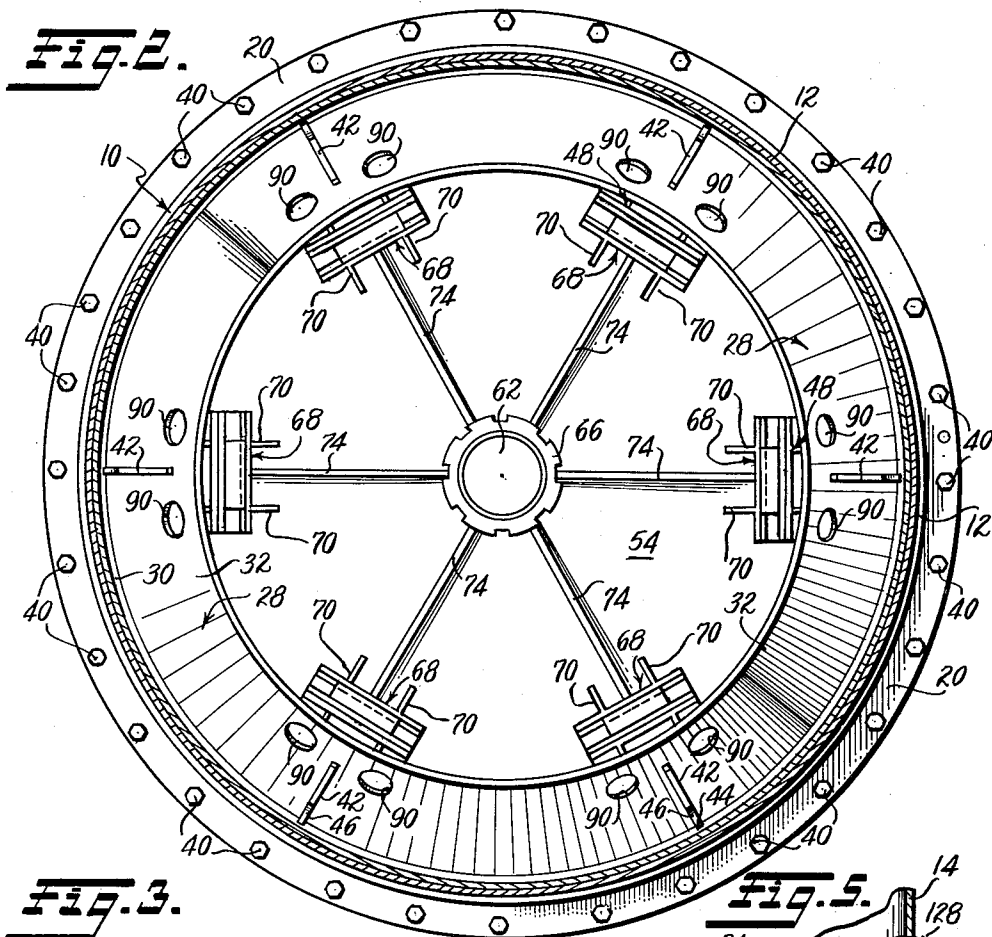
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SHIPPING CONTAINER

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14 Claims. (Cl. 206-46)

This invention relates generally to containers, and more specifically to containers for shipping and handling delicate machine assemblies, such as, for example, machine assemblies having delicately balanced rotors.

In the manufacture of various forms of machine assemblies, such as compressors and turbines intended for high speed operation, it is absolutely essential that the rotors be exactly balanced to avoid the creation of vibrations that occur with an unbalanced rotor, even when unbalanced to a slight degree. Such machines require precision manufacture and assembly involving very close tolerances in dimensions. Great care must be exercised in handling and shipping such assemblies to assure that they are not subjected to undue shocks and jars that might affect the balancing, or cause injury to any part.

It is an object of this invention, therefore, to provide a novel container for a delicate machine assembly in which the assembly is suspended within the container in such a manner that there is no contact between the assembly and the container as the result of shocks and sudden jars as might occur during mishandling and shipping.

It is a further object to provide a novel container for a delicate machine assembly in which the assembly is resiliently suspended within the container in such a manner that lateral and/or axial movement between the assembly and container is permitted under normal shocks and jars without subjecting the assembly to stresses that may cause injury.

It is further object to provide a novel container for handling and shipping a delicate machine assembly having a stator and a rotor in which the assembly is suspended within the container, and the stator and the rotor are resiliently supported by the container so that any shock stresses are taken up by the resilient support without placing any great stresses on the rotor bearings within the stator.

It is a still further object to provide a novel container for handling and shipping a delicate machine assembly in which the assembly is resiliently suspended within the container, and which, when so suspended, may be handled or shipped in any position without danger of injury to the assembly as the result of shocks and jars occurring in handling and shipping.

With the foregoing and other objects in view which will appear in the following description, the invention resides in the novel combination and arrangement of parts and/or details of construction hereinafter described and claimed, and illustrated in the accompanying drawing, in which:

FIG. 1 is an elevation view, partly in section, of a container according to the invention;

FIG. 2 is a sectional view on the line 2-2 of FIG. 1;

FIG. 3 is a bottom end view of the container;

FIG. 4 is an enlarged view of one of the mounts according to FIG. 2; and

FIG. 5 is an enlarged view of one of the mounts according to FIG. 1.

The container, as shown in the drawings, designated in its entirety by the reference numeral 10, comprises a base 12, a tubular casing 14, and a top closure cap 16, the three parts being held in assembled relation by bolts passing through flanges, as will be described hereinafter.

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The base 12 is annular in form, carrying on one end four feet 18 to support the container in an upright position. The upper end of the base includes a flange 20, forming a part of the assembly means. The base also includes an end cap 22 welded at its edge to the base 12, forming the end of an airtight and moisture tight container.

The casing 14 is cylindrical in form, and comprises the side wall of the container in which a compressor C is suspended in spaced relation to the walls of the container.

The compressor C may be of the type shown in the patent to Savin, Jr., No. 2,747,367, and includes a stator 24 and a rotor 26. The supporting structure is such that the stator and rotor are supported so that none of the compressor elements engages the walls of the container structure even in the event of severe mishandling. This arrangement prevails even if the container is positioned other than in a vertical position as shown.

The bottom supporting structure comprises a first support plate 28 including an outer flat ring portion 30 and an inner frusto-conical portion 32. The diameter of the ring portion 30 is greater than the diameter of the casing 14 in order to be received between the flange 20 on the base 12 and a flange 34 on the lower end of the casing 14, as seen in FIGS. 1 and 5. The flanges 20 and 34 are held in spaced relation by a ring 36 having an outer diameter substantially equal to the outer diameter of the flanges 20 and 34, and having an inner diameter slightly greater than the diameter of the ring portion 30, to provide a space to receive an elastic ring 38. A series of bolts 40 pass through aligned holes in the flanges 20 and 34 and in the ring 36, holding the base 12 and casing 14 in assembled relation, while the elastic ring 38 resiliently retains the support plate 28 centered, the outer flat ring portion 30 being radially slidable in the internal groove formed by the flanges 20 and 34, and by the ring 36.

The particular angle which the frusto-conical portion 32 forms with a radial plane is not critical, but in the preferred form this angle is about 45°. A series of radially extending gussets 42 may be welded to the first support plate 28 for reinforcing purposes, the outer edges 44 of which are parallel with the outer walls of the container and lie in a circle having a diameter slightly less than the internal diameter of the container, to serve as a pilot in assembling, as will appear hereinafter. A portion of the gussets 42 adjacent the outer edges 44 is beveled at 46 to facilitate assembly.

The inner face of the frusto-conical portion 32 carries a series of supporting elements 48, six being shown, spaced about the portion 32. Each supporting element is generally U-shaped in section, having a pair of legs 50, arranged on either side of a radius through the container 10 and parallel thereto, the edges of which are welded to the portion 32, and the opposite edges include a supporting surface 52. As seen in FIG. 4, the supporting surface 52 is flat, and projects a short distance beyond the legs 48. The plane of the supporting surface 52 forms an acute angle, of about 45°, with the axis of the container and the axis of the compressor C which is coaxial therewith.

A second support plate 54 of generally frusto-conical form is adapted for connection with a machine assembly to be supported within the container. An outer rim 56 is in the form of a plane and has a diameter considerably less than the inner diameter of the casing 14 to support the machine assembly in spaced relation thereto. The outer edge of the rim 56 includes a peripheral flange 58 adapted to support one end of the compressor stator 24 as shown in FIGS. 1 and 5, being secured thereto by a series of bolts passing through aligned holes in the flange 58 and in a flange on the end of the stator. The inner

edge of the support plate 54 carries an axially extending central bearing ring 60 adapted to receive an end portion of the rotor shaft 62. The latter has a shoulder 64 adapted to engage one end of the bearing ring 60 and a threaded end to mount a threaded clamping ring 66 which bears against the other end of the bearing ring 60. The shoulder 64 and clamping ring 66, engaging opposite ends of the bearing ring, in cooperation with the bearing ring, retain the rotor shaft 62 against axial and lateral movement.

On the outer surface of the frusto-conical support plate 54, adjacent the base thereof, are a series of supporting elements 68. Six of such elements 68 are shown, evenly spaced around the axis of the support plate 54. Each supporting element is generally U-form in section, the spaced legs 70 being mounted parallel to and on opposite sides of a radius through the bearing ring 60, and being welded along the edges to the plate 54. Each supporting element 68 includes along opposite edges of the legs 70 a planar supporting surface 72 disposed at an acute angle, of about 45°, with the axis of the plate 54. As seen in FIG. 4, portions of the supporting surface 72 project beyond the spaced legs 70. A series of radially disposed gussets 74, which may be welded to the support plate 54, supporting surfaces 72, and to the bearing ring 60, serve to stiffen and reinforce the supporting structure, these gussets being disposed between an adjacent pair of legs 70.

It should be noted that the supporting surfaces 52 on the first support plate 28, and the supporting surfaces 72 on the second support plate 54, are equal in number and are both uniformly spaced about the axis of the container, and that the surfaces lie in substantially parallel and spaced planes when brought into cooperative relation as shown in the drawings. The surfaces 52 on the support plate 28, and the cooperating surfaces 72 on the support plate 54 are arranged to face one another, and are connected together, in parallel, spaced relation, by resilient mounts 76, comprising blocks of resilient material, such as rubber, for example, which are vulcanized to a pair of end plates 80 and 82, the end plates 80 and 82 being parallel. The plates 80 and 82 have the same dimensions as the supporting surfaces 52 and 72, respectively.

Referring to FIG. 5, it should be noted that the resilient mount 76, in one transverse cross-section, is in the form of a rhombus, so that forces applied normal to the end plates 80 and 82 will produce a lateral twisting action on the resilient mount 76, but that forces acting parallel to the longitudinal axis of the container 10 will be resisted mostly by compression along the longitudinal axis of the mount.

In assembly, the second support plate 54 is secured to one end of the compressor assembly C as shown, the end of the shaft 62 disposed in the bearing ring 60 and retained in position by the clamping ring 66 and the shoulder 64. The peripheral rim 56 of the support plate is fastened to the flange on the compressor stator by a series of bolts 84, the flange 58 on the outer rim 56 serving as a pilot to guide and maintain the stator in position. The supporting plates 28 and 54 may be secured together by interposing a mount 76 between opposed supporting surfaces 52 and 72 by bolts 86 passing through aligned holes in the surface 72 of each supporting element 68 and the end plates 82 of the mount 76, and by bolts 88 passing through aligned holes in the surface 52 of each supporting element 48 and the end plate 80 of each mount 76. Holes 90 in frusto-conical portion 32 of the first support plate 28 are aligned with the holes in the surfaces 52 and plate 82 to receive a wrench or other tool for tightening the bolts 88 in position. When so assembled, the structure may be up-ended, that end of the compressor C having the mounting structure thereon inserted into the base 12, in which operation the outer edges 44 and beveled portions 46 of the gussets 42 pilot the supporting structure into the base. When so mounted, the peripheral edge of the outer portion 30 of the support plate 28 rests on the flange 20 on the base. The ring 36

can then be placed in position on the flange 20, or the ring 36 could be welded or otherwise secured in position on the flange, forming a recess between the inner wall of the ring 36 and the outer edge of the outer portion 30.

- 5 An elastic ring 38, such as an O-ring of rubber or the like, having a diameter slightly greater than the width of the recess, is placed in the recess, and the casing 14 is then lowered about the compressor C until the flange 34 on the end thereof rests on the flange 20 of the base.
- 10 A series of bolts 40 are passed through aligned holes in the flanges 20 and 34 and in the ring 36, which bolts are tightened to tightly connect the casing 14 to the base 12 and tightly clamp the first support plate 28 between the flanges 20 and 34, compressing the elastic ring 38 in the annular channel or recess provided by the flanges 20 and 34, the outer edge of the portion 30 and the inner edge of the ring 36, thereby urging the support plate 28 into precise concentricity with the cylindrical casing 14 and resiliently supporting the first support plate 28 for limited
- 15 radial movement while rigidly supporting it against axial movement. It should be noted, in this assembly, that the surfaces 52 and 72 are axially offset in a direction parallel to their plane surfaces, and that these surfaces are arranged not only at the acute angle with the axis as described
- 20 above, but are also arranged at an acute angle with reference to a line 96 passing through the center of gravity 98 of the compressor assembly and the center 100 of the mounts 76.

The supporting structure for the upper end of the compressor is similar to that for the lower end described above, and corresponding elements are designated by the same reference numerals with the addition of the superscript "prime."

The first support plate 28' is identical with the support plate 28, except that the gussets 42' are mounted on the inner conical surface of the frusto-conical portion 32' and outer edges 44' and the beveled portions 46' serve as pilots and centering means in the assembly.

The second support plate 54' includes an axially extending skirt 102 having a flange 104 at the end thereof adapted to engage a flange 106 on the upper end of the compressor stator, to which it is fastened by a series of bolts 108 passing through aligned holes in the flanges 104 and 106. The inner surface of the skirt is rabbeted at 110 to receive a shoulder 112 on the upper end of the compressor stator.

Each of the upper and lower end flanges 34' and 34 on the casing 14 carries an axially extending locating dowel 114 which is received within aligned openings in the rings 36' and 36, and in the flange 20 in the base 12 and a flange 116 in the top closure cap 16.

The top closure cap 16 is similar in construction with the base 12, and comprises a cylinder 118 having the same diameter as the base and casing 14. The outer end of the cylinder 118 is closed by a dome-shaped closure 120 having a marginal skirt 122 welded to the interior wall of cylinder 118. The outer end of the cylinder 118 also includes an external flange 124, having the same external diameter as the other flanges 20, 34, 34' and 116.

The second support plate 54' of the top support structure may be attached to the compressor before the lower supporting structure is inserted into the base 12, and before the casing 14 is lowered into position. The first support plate 28' of the top supporting structure may then be bolted in place to the second support plate 54'. The top cap 16 may then be set in place, and secured by bolts 126.

From the foregoing, it is evident that I have devised a container in which the machine assembly is resiliently suspended within the container. By suitably selecting the angularity of the surfaces 52 and 72, and the surfaces 52' and 72', and the resilience of the mounts 76 and 76', it is possible to make sure that the total deflection of the machine assembly or compressor C under any shock loading will not carry the support plates 54 and 54' into en-

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gement with the walls of the container. Thus, the dot-dash line 128 represents the extent to which the corner of the support plate 54 can move under the greatest shock load. It is evident that this limiting position results from the particular position of the mounts 76 and 76', so that any deflection of the plate 54 with respect to the plate 28, or of the plate 54' with respect to the plate 28', loads the compressor portion of the mounts 76 and 76' both in shear and compression. It is also evident that the attachment of the plates 54 and 54' to the compressor stator housing is not a load-carrying arrangement, since the loads are intended to be carried entirely through the bearing rings 60 and 60' supporting the compressor shaft 62. The shipping container and the supported assembly can be vibrated in any or all directions, but, by means of the controlled deflection arrangement described above, a failure of the mount system could not result in a dropping of the load. The sealing rings 38 and 38' at the joints insure an air-tight and a moisture-tight construction.

It will be understood that various changes may be made in the arrangement of the parts of the suspension system disclosed herein without departing from the principles of the invention, and the scope of the annexed claims.

I claim:

1. A container for shipping and handling delicate machine assemblies and the like, comprising: a tubular casing having a transverse cross section greater than that of the machine assembly to provide a clearance between the machine assembly and the casing; a first support plate, disposed generally transversely of the longitudinal axis of said casing, having a flat peripheral rim disposed in a plane normal to said longitudinal axis, said support plate carrying at least one supporting element having a supporting surface axially offset from the plane of the support plate and disposed at an acute angle relative to a plane normal to said longitudinal axis; a second support plate having means for connection with one end of a machine assembly, said second support plate, when connected with one end of a machine assembly, being disposed generally transversely of the longitudinal axis of said machine assembly, said second support plate carrying at least one supporting element having a supporting surface axially offset from and disposed at an acute angle relative to the plane of the second support plate, said supporting surfaces on the respective supporting elements being disposed in parallel, generally axially, spaced relation and facing opposing directions; and resilient mounting means interconnecting said supporting surfaces to support the machine assembly within said container free from contact with the walls of the casing, said support plates constituting the sole supporting means for the machine assembly.

2. A container for shipping and handling delicate machine assemblies and the like as defined in claim 1, in which the planes of the opposed supporting surfaces are disposed at an acute angle with reference to the longitudinal axis of the container.

3. A container for shipping and handling delicate machine assemblies and the like as defined in claim 1, in which the planes of the opposed supporting surfaces are disposed at an acute angle with reference to a line passing through the center of gravity of the assembly and the center of the mounting means.

4. A container for shipping and handling delicate machine assemblies and the like as defined in claim 1, in which said casing is made up of a series of interconnected sections having radially extending flanges at both ends of each of said sections, and in which said first support plate includes a portion of frusto-conical form attached to said peripheral rim, and in which said flat peripheral rim has an external diameter greater than the internal diameter of said casing and is received between adjacent flanges of the flanged sections and secured thereto.

5. A container for shipping and handling delicate machine assemblies and the like as defined in claim 1, in which said assemblies include a rotor and a stator sur-

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rounding and rotatably supporting said rotor, said second support plate being annular in form, the inner edge thereof including means to engage and to support the rotor, and the outer rim including means to engage and to support the stator.

6. A container for shipping and handling delicate machine assemblies and the like, comprising: a tubular casing having a cross-section greater than that of the machine assembly; means to suspend a machine assembly within the casing free of contact with the wall of the casing including a first pair of supports carried by the casing, one adjacent each end of the container; a second pair of supports, said second pair of supports being adapted to be connected with opposite ends of a machine assembly; each of said first pair of supports including a first support plate disposed generally transversely of the longitudinal axis of said casing and having a flat peripheral rim disposed in a plane normal to said longitudinal axis, each first support plate carrying at least one supporting element having a supporting surface axially offset from the plane of the first support plate and disposed at an acute angle relative to a plane normal to said longitudinal axis, each of said second pair of supports including a second support plate having means for connection with one end of a machine assembly, each second support plate, when connected with one end of a machine assembly, being disposed generally transversely of the longitudinal axis of said machine assembly, each second support plate carrying at least one supporting element having a supporting surface axially offset from and disposed at an acute angle relative to the plane of the second support plate, said supporting surfaces on the respective supporting elements on each end of the container being disposed in parallel, generally axially spaced, relation; and resilient mounting means interconnecting said spaced supporting surfaces to support the machine assembly free from contact with the wall of the casing, said support plates constituting the sole supporting means for the machine assembly.

7. A container for shipping and handling delicate machine assemblies and the like as defined in claim 6, in which said assemblies include a rotor and a stator surrounding and supporting said rotor, and in which each of said second pair of support plates is annular in form, the inner edge thereof including means to engage and to support the rotor, and the outer rim including means to engage and to support the stator.

8. A container for shipping and handling delicate machine assemblies and the like as defined in claim 6, in which each of said first pair of support plates includes a frusto-conical portion attached to said flat peripheral rim, a series of said supporting elements and surfaces circumferentially spaced and attached to each frusto-conical portion, the second support plate on each end carrying the same number of support elements and surfaces as carried by the frusto-conical portion and being in axially spaced, opposing, relation therewith, and means securing the resilient mounting means between respective spaced surfaces.

9. A container for shipping and handling delicate machine assemblies and the like having a rotor and a surrounding stator, comprising: a tubular casing having a cross-section greater than that of the stator to receive a rotor and stator assembly; means to suspend a stator and rotor assembly within the casing free of contact with the wall of the casing including a first pair of supports carried in spaced relationship by the casing and extending inwardly thereof, a second pair of supports, cooperating with the supports of said first pair respectively, each of said second pair of supports having means for connection with one end of the stator and the adjacent end of the rotor; and resilient mounting means, at each end of the casing, interconnecting one of said first supports with one of said second supports, said first and said second pairs of supports constituting the sole supporting means for the machine assembly.

10. A container for shipping and handling delicate machine assemblies and the like having a rotor and a surrounding stator as defined in claim 9, including end closure members on the tubular casing.

11. A container for shipping and handling delicate machine assemblies and the like having a rotor and a surrounding stator as defined in claim 9, in which each of said first pair of supports comprises a first support plate having a supporting element attached thereto, and in which each of said second pair of supports comprises a second support plate having a supporting element attached thereto, each of said supporting elements including a flat supporting surface axially offset relative to the plane of the respective first and second support plates, the supporting surface on a first support plate and a supporting surface on a cooperating second support plate, on each end of the container, being opposed, parallel, and axially spaced from one another.

12. A container for shipping and handling delicate machine assemblies and the like having a rotor and a surrounding stator as defined in claim 11, in which each of said first support plates includes a frusto-conical support portion, and in which each of said second support plates includes a frusto-conical portion, said supporting elements and said supporting surfaces being carried by said frusto-conical portions.

13. A container for shipping and handling delicate machine assemblies and the like having a rotor and a surrounding stator as defined in claim 11, in which each of

said first support plates includes a frusto-conical support and a peripheral flat rim, and in which each of said second support plates includes a frusto-conical support portion, said supporting elements and said supporting surfaces being carried by said frusto-conical portions, and including means carried by said casing and cooperating with said peripheral flat rim for resiliently supporting said first support plates by the tubular casing.

14. A container for shipping and handling delicate machine assemblies and the like having a rotor and a surrounding stator as defined in claim 11, in which each of said first support plates includes a peripheral rim, means providing internal slots in the wall of the casing, said peripheral rims being slidably engaged in said slots, and resilient means disposed between said peripheral rims and the walls of said annular slots to absorb shocks acting transversely of the longitudinal axis of the container.

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