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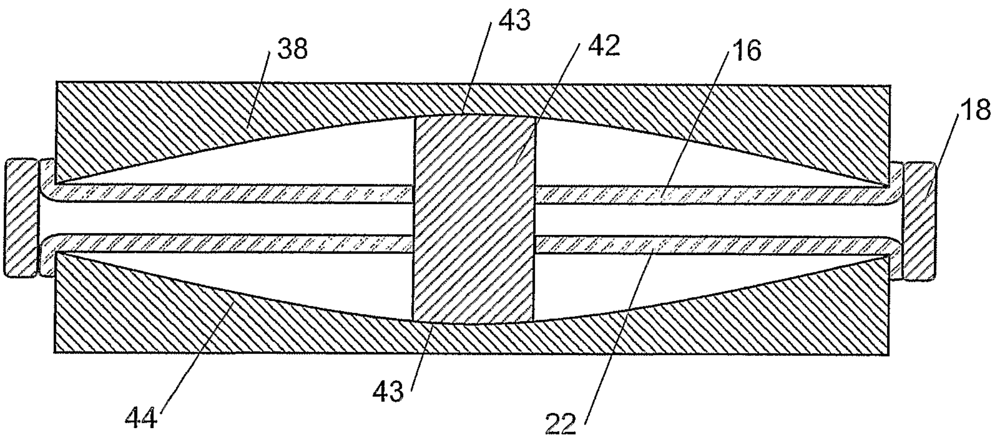
(54) Title: A SELF-CENTRING SLIDING BEARING



(57) **Abstract:** The invention is a bearing assembly having upper and lower bearing seats and a sliding load bearing member between the seats. The sliding member is fitted with elastic self-centering means. The assembly in operation damps relative horizontal movement between the upper and lower seats, the self-centering means returning the sliding member to a centered position at rest. Typically a structure rests upon and is secured to the upper seat and the lower seat rests upon or is fixed to a foundation. The relative horizontal movement may be caused by earthquakes, wind loads or the like.

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A SELF-CENTRING SLIDING BEARING

Technical Field

This invention relates to sliding bearings. More particularly it relates to sliding bearings with elastic self-centring. In a preferred embodiment sliding bearings according to the invention may be used in seismic isolation, but they may be used in other applications to dampen relative movement between a structure and another structure or ground supporting the first structure.

Background Art

In the field of seismic isolation the use of sliding bearings is well known. One known type of sliding bearing is a bearing assembly having upper and lower bearing seats and a load bearing sliding member between the seats, the member being able to slide relative to both seats. Examples of such bearing assemblies are in US 4,320,549; US 5,597,239, US 6,021,992, and US 6,126,136.

In another type of sliding bearing the sliding member is fixed to one or other upper or lower bearing seat. In such an embodiment the sliding member is may be a pillar projecting from the bearing seat to which it is affixed. It is usually the upper seat which is movable relative to the slider member. Examples of this type of sliding bearing are found in US 4,644,714; US 5,867,951; US 6,289,640; the embodiments shown in each of figures 4 to 6 in US 6,021,992; and the embodiments shown in figures 4 and 5 of US 6,126,136.

Some of the above mentioned sliding bearings have a curved bearing seat surface and a corresponding curved surface on the sliding element which provide a form of passive self-centring of the sliding element and the bearing seats. None of either types of sliding bearings mentioned above have elastic self-centring.

"Self-centring" is, for the purposes of this specification, urging the sliding element and the upper and lower bearing seats to remain in or return to substantially symmetrical alignment with the longitudinal axis passing through the upper and lower bearing seats and the sliding element perpendicular to a horizontal plane.

An advantage of elastic self-centring is that it provides a means to control the elastic shear stiffness of the bearing to ensure that the isolated structure has a natural period which exceeds the period of the seismic event or other horizontal forces which the bearing assembly is designed to damp so as to enhance the effectiveness of the seismic isolation.

Another advantage, particularly when the sliding member is movable with respect to both the upper and lower bearing seats, is that a bearing assembly may be constructed of a reduced cross sectional area in comparison with a bearing assembly without elastic self-centring. The sliding member in figures 2, 3, 7 & 9 is at rest at the midpoint between the upper and lower seats.

It is an object of this invention to go some way towards achieving these desiderata or at least to offer the public a useful choice.

Accordingly, the invention may be said broadly to consist in a bearing assembly comprising:

an upper bearing seat, a lower bearing seat and a sliding load bearing member there between, said sliding member optionally being fixed to one or other of said upper and lower bearing seats, friction between said sliding member and said upper or lower bearing seats, or between said sliding member and said upper and lower bearing seats, in use, damping relative horizontal movement between said upper bearing seat and said lower bearing seat,

said assembly, when said sliding member is fixed to one or other of said upper or lower bearing seats further comprising an elastic self-centring means co-operable with said upper or lower bearing seats to urge said seat to which said sliding member is not fixed to return to or remain in a centred position relative to said sliding member and the seat to which said sliding member is fixed.

Preferably said elastic self-centring means is an elastic sleeve surrounding the outer peripheries of said upper and lower seats.

In another embodiment the invention may be said broadly to consist in a bearing assembly comprising:

an upper bearing seat, a lower bearing seat and a sliding load bearing member therebetween, said sliding member optionally being fixed to one or other of said upper and lower bearing seats, friction between said sliding member and said upper or lower bearing seat, or between said sliding member and said upper and lower bearing seats, in use, damping relative horizontal movement between said upper bearing seat and said lower bearing seat,

said assembly further comprising an elastic self-centring means co-operable with said sliding means and one or other or both of said upper and lower bearing seats to urge said sliding means to return to or remain in a centered position.

In one embodiment said sliding member is not fixed to either of said upper or lower bearing seats.

Preferably said elastic self-centring means comprises a diaphragm, said sliding member being located at or near or joined to the centre of said diaphragm, the periphery of said diaphragm being joined to or adjacent to the periphery of one or both of said upper and lower bearing seats.

In another embodiment, wherein said sliding member is not fixed to either said upper or lower bearing seats, said self-centring means comprises two said diaphragms.

In another embodiment said elastic self-centring means includes both a said sleeve over the outer periphery of said upper and lower bearing seats and one or two said diaphragms.

The invention also consists in a bearing assembly comprising:

an upper bearing seat, a lower bearing seat and a sliding load bearing member there-between, said sliding member being slideable relative to each of said upper and lower bearing seats, friction between said sliding member and said upper and lower bearing seats, in use, damping relative horizontal movement between said upper bearing seat and said lower bearing seat,

said assembly further comprising an elastic self-centring means comprising a sleeve over the outer periphery of and co-operable with the said upper and lower bearing seats to urge said seats to return to or remain in a centered position relative to said sliding member and a rigid member extending peripherally outwardly from said slider to cooperate with said sleeve to centre said slider between said upper and lower seats.

In one alternative said rigid member is affixed to said elastic sleeve and abuts said sliding member.

In one embodiment said rigid member is a disc.

In another embodiment said rigid member is a hub and a plurality of spokes.

Alternatively said sliding member is substantially cylindrical in shape and the bearing surfaces of said lower and upper bearing seats are substantially flat.

Preferably said sliding member is of regular geometrical shape in cross-section.

Alternatively one or other of the bearing surfaces of said upper or lower bearing seats is curved and the corresponding bearing surface of said sliding member is curved to cooperate therewith.

Preferably said diaphragm is made of vulcanized rubber.

Preferably said sleeve is made of vulcanized rubber or other appropriate elastic material.

In a further embodiment the invention may be said broadly to consist in a bearing assembly comprising:

an upper bearing seat, a lower bearing seat and a sliding load bearing member therebetween, said sliding member being fixed to one or other of said upper and lower bearing seats, friction between said sliding member and the upper or lower bearing seats to which it is not fixed, in use, damping relative horizontal movement between said upper bearing seat and said lower bearing seat,

said assembly further comprising an elastic self-centring means co-operable with said upper or lower bearing seats to urge said seats to return to or remain in a centred position relative to said sliding member and the other of said upper or lower bearing seats.

Preferably said elastic self-centring means comprises a plurality of blocks of elastic material disposed between said upper seat and said lower seat peripherally outwardly from said sliding member, said blocks contacting and being joined to each of said upper and lower seats.

Preferably said blocks are made of rubber.

In another embodiment the invention consists in a bearing assembly comprising:

an upper bearing seat, a lower bearing seat and a sliding load bearing member there-between, said sliding member being slideable relative to each of said upper and lower bearing seats, friction between said sliding member and said upper and lower bearing seats, in use, damping relative horizontal movement between said upper bearing seat and said lower bearing seat,

said assembly further comprising an elastic self-centring means comprising a solid plate member attached to and extending peripherally outwardly from said sliding member, a plurality of blocks of elastic material disposed between said upper seat and said solid plate member, and between said lower seat and said solid plate member peripherally outwardly from said sliding member, said blocks contacting and being joined to each of said upper and lower seats and said plate member.

Preferably said blocks are made of rubber.

The invention may also be said broadly to consist in a method for seismically isolating a structure which comprises installing a bearing assembly as herein above defined between said structure and a foundation.

In one alternative said foundation is another structure.

This invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more of said parts, elements or features, and where specific integers are mentioned herein which have known equivalents in the art to which this invention relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

Brief Description of the Drawings

The invention may be more fully understood by having reference to the accompanying drawings wherein:

Figure 1 is a sectional view of one embodiment of the invention in which a sliding element is fixed to the lower bearing seat and elastic self-centring is provided by both a diaphragm and a sleeve.

Figure 1a shows the embodiment of figure 1 displaced in the course of an earthquake.

Figure 1b shows a variation of the embodiment shown in figure 1 where there is only a diaphragm providing elastic self-centring.

Figure 1c shows a variation of the embodiment shown in figure 1 where there is only a sleeve providing elastic self-centring.

Figure 2 and 2a are sectional views of another embodiment of the invention in which the sliding element is movable relative to both the upper and lower bearing seats and two diaphragms and a peripheral sleeve providing elastic self-centring means.

Figure 3 is a sectional view of a further embodiment of the invention in which elastic self-centring means is provided by a peripheral sleeve and a sliding member with a rigid peripheral projection extending to the rubber sleeve and beyond the peripheries of the upper and lower bearing seats.

Figure 4 is a sectional view of an alternative to the embodiment in figure 3 in which the rigid projection from the sliding member does not extend beyond the periphery of the upper and lower bearing seats.

Figure 4a shows the embodiment in figure 4 in use with the lower bearing seat moved horizontally relative to the upper bearing seat.

Figure 5 is the detail shown in the circle V in each of figures 3 and 4.

Figure 6 is a sectional view of an embodiment of the invention similar to that shown in figure 1 but with the bearing face of the upper bearing seat being curved.

Figure 7 is a sectional view of a bearing assembly similar to that shown in figure 2 but with the bearing faces of the upper and lower bearing seats being curved.

Figure 8 is a side elevation of a further embodiment of the invention in which rubber blocks provide elastic self-centring.

Figure 8a is the embodiment illustrated in figure 8 displaced in a manner which would happen during an earthquake.

Figure 9 is a side elevation of a still further embodiment in which the sliding member is slideable relative to an upper and lower bearing seat, and in which elastic self-centring is provided by a solid disc extending peripherally outwardly to rubber blocks.

Figure 9a illustrates the embodiment of figure 9 where the lower bearing seat has been displaced in use.

Figure 10 (on drawing sheet 3/5) is a side elevation, partly in section, of an alternative to the embodiment in figure 9 in which the bearing surfaces of the upper and lower seats, and of the sliding element are curved.

Figure 11 is a plan view of a further embodiment of a bearing according to the invention.

Figure 12 is a side sectional view shown by the section line XII-XII in figure 11.

DETAILED DESCRIPTION OF THE INVENTION

Construction of First Embodiment

A bearing assembly according to a first embodiment of the invention is illustrated in figure 1. This embodiment has a lower bearing seat 12, preferably made of stainless steel, from which projects a sliding member 14. There is a layer of polytetrafluoroethylene (PTFE) or other suitable sliding material 15 on the load bearing upper face of sliding member 14.

The upper bearing seat 10 is also made of stainless steel. Its face is substantially flat and rests on the PTFE layer 15 of sliding member 14.

Bearing seats 10 and 12 may be of any regular geometrical shape in cross-section. In one preferred embodiment they are circular in cross-section.

Surrounding the outer periphery of upper bearing seat 10 and lower bearing seat 12 is a sleeve 18, preferably of vulcanised rubber.

Also provided is a diaphragm 16 made of vulcanised rubber. In the embodiment illustrated the diaphragm 16 has a central hole of diameter slightly smaller of that sliding member 14 so as to be able to slide over and remain in place on sliding member 14. The outer periphery of diaphragm 16 is fitted within a recess 17 on the outer face of bearing seat 10 by sleeve 18. However, it may be clamped into place by a metal ring or by other means known to those skilled in the art.

In the embodiments illustrated in figures 1 and 1a the elastic self-centring forces are provide by a combination of sleeve 18 and diaphragm 16. However, self-centring can be achieved by a sleeve alone or a diaphragm alone. In the embodiment shown in figure 1b the self-centring means is a diaphragm 16. In figure 1c it is a sleeve 18. These are exemplary of alternatives to the embodiments shown in figures 2, 6 and 7 as well.

Sleeve 18 may contain annular reinforcing rings of stiffing material embedded into the rubber of the sleeve. These serve to stabilize the sleeves during large displacement by spreading the displacements more equally.

Construction of Second Embodiment

The construction of a second embodiment of the invention is illustrated in figure 2. In the embodiment illustrated in figure 2 upper and lower bearing seats 10 and 12 are of similar construction to the seats in figure 1. The difference is that lower bearing seat 12 has a continuous flat load bearing surface. Between the bearing seats is a sliding member 20. In a preferred embodiment this sliding member 20 is a cylinder made of PTFE. It is able to move horizontally relative to both the upper bearing seat 10 and the lower bearing seat 12.

In this embodiment there are a pair of rubber diaphragms 16 and 22, each having a central hole through which the sliding member 20 is fitted in a snug fit. The peripheries of diaphragms 16 and 22 are held in recesses at the outer peripheries of bearing seats 10 and 12 by a rubber sleeve 18 as with the embodiment illustrated in figure 1.

Construction of Third Embodiment

A third embodiment is illustrated in figure 3. In this embodiment the sliding member is an annulus 24 having a central web 26, preferably of stainless steel. As illustrated in detail in figure 5 in the recesses 31 defined below and above web 26 within annulus 24 there is a laminated construction. This consists of a rubber layer 28 secured to the web 26 inside of the annulus 24. A second layer 30, preferably of stainless steel with a recess in its lower face is affixed to the rubber layer 28. The lower bearing seat contacting surface is disc shaped PTFE insert 32. The same laminated structure is provided above web 26. Thus the load bearing surfaces of the sliding element in the embodiment in figure 3 which contact the faces of the upper bearing seat 10 and the lower bearing seat 12 are of each of PTFE.

There is also provided projecting outwardly from the sliding element in the assembly of figure 3 a disc 34. The outer periphery of disc 34 extends outwardly beyond the outer peripheries of upper bearing seat 10 and lower bearing seat 12. A rubber sleeve 18 extends over the peripheral edge of disc 34 as well as around the peripheral edges of upper bearing seat 10 and lower bearing seat 12.

Construction of Fourth Embodiment

The embodiment illustrated in figure 4 is substantially the same as that in figure 3 except that the outer periphery of disc 34 lies substantially in vertical registry with the outer peripheries of upper bearing seat 10 and lower bearing seat 12 respectively. This is in contrast to the disc 34 in the embodiment in figure 3 which extends peripherally beyond the peripheries of seats 10 and 12.

Disc 34 serves as a rigid connection between sleeve 18 and the sliding member. The invention contemplates other mechanical equivalents. Instead of a solid disc 34, a perforated disc may be used. It would also be possible to have spokes extending outwardly from annulus 24. It is equally contemplated that a disc 34 may be attached to the inner surface of sleeve 18 and not attached to the slider. In such an embodiment perforated discs or spokes with inner and outer annular rims could also be employed for the same purpose.

Construction of Fifth Embodiment

The embodiment illustrated in figure 6 is substantially the same as that in figure 1. It consists of a lower bearing seat 36 from which projects a sliding member 40 having a PTFE load bearing surface 39 at its upper end. In the assembly of figure 6 the bearing face of the upper bearing seat 38 is spherical rather than flat. The load bearing surface 39 of the sliding member 40 has a convex spherical curve which corresponds to the concave spherical curve of the load bearing surface of upper bearing seat 38.

The diaphragm 16 and the sleeve 18 are of the same material and construction of those described in the embodiment illustrated in figure 1.

Construction of Sixth Embodiment

The embodiment illustrated in figure 7 is similar in construction to that illustrated in figure 2. However, as with the embodiment in figure 6 the load bearing surface of the upper bearing seat 38 is spherical as is the load bearing surface of the lower bearing seat 44. The sliding member 42 has hemispherical load bearing end surfaces 43 of shape which corresponds to the inner surfaces of the upper and lower bearing seats 38 and 44.

Diaphragms 16 and 22 and sleeve 18 illustrated in figure 7 are of the same materials and construction as the corresponding diaphragms and sleeve described in relation to figure 2.

Construction of Seventh Embodiment

In the bearing assembly illustrated in figure 8 upper and lower bearing seats 10 and 12 are stainless steel plates. The sliding member 46 is substantially cylindrical in shape and is either fixed to or forms an extension of upper bearing seat 10. A layer of PTFE 48 is provided on the lower face of sliding member 46.

Lower bearing seat 12 is similarly a plate of stainless steel.

Disposed between upper and lower seats 10 and 12 are a plurality of rubber blocks 50. Blocks 50 are preferably cylindrical in shape and are affixed to the inner faces of seats 10 and 12 by means of collars 51 and 52. In the embodiment illustrated there are provided four blocks which are disposed symmetrically near the periphery of the seats. The block 50 which would be in front of sliding member 46 in figure 8 is not shown for simplicity.

The cross-sectional shape of each of the blocks 50 may be round, rectangular or square or other regular geometrical shape. In an embodiment not illustrated there can be a rubber block in the form of a single annulus. The blocks are preferably disposed symmetrically so as to better provide a self-centring force.

The rubber may be natural or artificial rubber in a manner well known in the rubber bearing art.

In another alternative not shown the blocks can be in the form of a laminate having alternating layers of rubber and steel or other solid material.

Construction of Eight Embodiment

In the embodiment illustrated in figure 9 there is an intermediate solid disc 54 which provides a function similar to that provided by disc 34 in the embodiments shown in figures 3 and 4. The sliding member can be a single stainless steel cylinder passing through disc 54 or a pair of cylinders 56 and 58 as illustrated in figure 9. There are PTFE layers 57 and 59 providing the sliding surfaces of the sliding members 56, 58 against the inner faces of upper and lower seats 10 and 12 respectively. The rubber blocks 50 are the same as those illustrated in figure 8 and disposed symmetrically much in the same way. They are affixed at either end to the upper seat 10, the upper face of disc 54, the lower face of disc 54 and the upper of bearing seat 12 and held in position by collars 51 and 52.

Construction of Ninth Embodiment

The components of the embodiment illustrated in figure 10 are the same as those in figure 9 except that the upper and lower seat 10, 12 bearing faces are curved. The PTFE layers 57 and 59 have corresponding curved faces which contact the seats 10, 12.

Construction of Tenth Embodiment

In the embodiment illustrated in figures 11 and 12 the bearing has an upper plate 60 on which a structure may rest and a lower plate 62 which may rest on a foundation or further structure. The inward faces 61 and 63 of the plates 60 and 62 are coated with stainless steel.

The sliding member 64 consists of an opposed pair of annulus halves 70 similar to the annulus illustrated in figures 3 to 5. As with the previous construction in a recess in each annulus half there is inserted, progressing outwardly, three layers. The innermost layer 72 is of rubber. The next layer 74 is of steel and the outer face 76 is of PTFE.

The self-centring for this bearing is provided by upper diaphragm 66 and lower diaphragm 68 which are fitted over the sliding member 64 in much the same manner as the diaphragms 16 and 22 in figure 2.

The outer periphery 82 of upper diaphragm 66 is fitted over a rim 80. There are provided a set of four bolts 78 as illustrated in figure 11 which secure the diaphragm edge 82 to rim 80 and rim 80 to upper plate 60. Similarly a set of four bolts 78 secures diaphragm edge 84 to rim 86 and rim 86 to lower plate 62.

Bolts (not illustrated) passed through holes in plates 60 and 62 may be threaded into nuts 88 and 89 in order to secure a structure to other plate 60 and to secure lower plate 62 to a foundation or a further structure.

Operation of First Embodiment

The embodiment in figure 1 is illustrated in operation in figure 1a. An external force, such as an earthquake, has moved lower bearing seat 12 to the position illustrated. This relative horizontal movement between the upper bearing seat 10 and the lower bearing seat 12 is damped by the friction between the upper surface 15 of sliding member 14 and the inner surface of bearing seat 10.

It will be seen that sleeve 18 has been stretched both on the right and left sides of the bearing assembly. The elasticity in the sleeve 18 will urge the upper bearing seat 10 to return to the rest position shown in figure 1. Similarly the left hand portion of diaphragm 16 is stretched while the right hand portion is slack. While the relative movement between the upper and lower bearing seats is being damped by the friction between the sliding element 14 and the upper bearing seat 10, both the sleeve 18 and the diaphragm 16 will urge the sliding member 14 and the upper valve seat 10 to the centred position illustrated in figure 1.

Although the embodiment illustrated in figure 1 has both a diaphragm 16 and a sleeve 18 other embodiments within the scope of the invention can include an assembly which has only a diaphragm 16 and another assembly which has only an elastic sleeve 18.

Operation of Second Embodiment

In the embodiment illustrated in figure 2a the elastic self-centring force from both the elastic sleeve 18 and the pairs of diaphragms 16 and 22 will urge the sliding member 20 and the bearing seats 10 and 12 to a centred position. The left side of diaphragm 22 is slack and the right side is stretched in figure 2a. Diaphragm 16 is stretched and slack in the same manner as is illustrated in figure 1a.

Operation of Third and Fourth Embodiments

Referring to figure 4a, an earthquake force has displaced the lower bearing seat 12 to the right. Frictional forces between the load bearing faces of sliding member 24 and the load bearing faces of seats 10 and 12 will damp the relative movements between the seats. Elastic sleeve 18 will urge both the upper and lower bearing seats and the disc 34 into a centred position.

Operation of Fifth and Sixth Embodiments

In the embodiments illustrated in figures 6 and 7 the curved surfaces of the bearing seats add additional passive centring forces to the elastic self-centring provided by the diaphragms 16 and 22 and the sleeve 18.

Operation of Seventh Embodiment

In a seismic event the seismic forces will move the lower bearing seat 12 as illustrated in figure 8a. The friction between sliding member 46 and bearing seat 12 will damp that force. The rubber blocks 50 will serve to return the bearing assembly to a centred position.

Operation of Eighth Embodiment

Similarly, as illustrated in figure 9a, seismic forces have moved lower bearing seat 12 as shown. The damping friction between the PTFE layer 57 and bearing seat 10 and PTFE layer 59 and bearing seat 12 will dampen the motion. The pairs of rubber blocks 50 together with disc 54 serve to centre the assembly to the position illustrated in figure 9.

Operation of Ninth Embodiment

In the embodiment illustrated in figure 10 the curved surfaces of the bearing seats 10 and 12 add supplementary passive centring forces to the elastic self-centring provided by the rubber blocks 50 and disc 54.

Operation of Tenth Embodiment

The embodiment illustrated in figures 11 and 12 operates in the manner of the second embodiment illustrated in figures 2 and 2a.

Advantages

One advantage provided by elastic self-centring of a seismic sliding bearing is that it provides a means for controlling the period of the isolated structure so that the period of the isolated structure exceeds the period of the earthquake. In seismic isolation this is better known as period shift. The concept is more full described in "Introduction to Seismic Isolation", Skinner *et al.*, John Wiley & Sons, (1993), pages 4 to 7.

Another advantage is that it minimises the cross sectional area occupied by the bearing assembly. The advantages of the bearing assembly illustrated in Figures 2, 4, 7, 9 and 10 is that they are double acting. That is, the top and the bottom seats 10 and 12 move in opposite directions relative to the sliding member thereby reducing the required size of the sliding surface of the bearing seats by a factor of two.

The total horizontal force required to operate the bearing assembly F(horizontal) is given by the sum of the force to overcome the friction, $F(\mu)$, the force to deform the rubber diaphragm, F(m), plus the forces required to deform the rubber sleeve, F(w). The forces to deform the rubber are mainly elastic in nature.

Thus:

$$F(\text{horizontal}) = F(\mu) + F(m) + F(w)$$

Where $F(\mu) = \mu.F(\text{vertical})$

$F(m) \approx [(\text{rubber}).t(m)]x$

$F(w) \approx [\alpha.E(\text{rubber}) + \beta.G(\text{rubber})].[A(w)/h(w)]x$

Where μ = the coefficient of friction between the two sliding surfaces

F(vertical) = (total mass) . g

t(m) = thickness of the diaphragm (see figure 1)

x = horizontal displacement of the top seat relative to the bottom seat, where x = 0 when the seats are centred.

α = a geometric term for the diaphragm

β = a geometric term for the sleeve

E(rubber) = Young's modulus for the rubber diaphragm

G(rubber) = the shear modulus of the rubber sleeve

A(w) = the cross sectional area of the sleeve

h(w) = the height of the sleeve (see figure 1)

One of the applications of the bearing assembly is as a support for seismic isolation. Seismic isolation is the technique whereby the natural period of oscillation of the structure is increased to a value beyond that of the main period of the earthquake together with a optimum value of damping. Optimum values of these two factors enable a reduction in the acceleration transmitted to the structure by a factor of at least two.

The bearing assembly of this invention is a compact self contained unit which can be designed to maximise the effectiveness of seismic isolation.

WHAT IS CLAIMED IS:

1. A bearing assembly comprising:

an upper bearing seat, a lower bearing seat and a sliding load bearing member therebetween, said sliding member optionally being fixed to one or other of said upper and lower bearing seats, friction between said sliding member and said upper or lower bearing seats, or between said sliding member and said upper and lower bearing seats, in use, damping relative horizontal movement between said upper bearing seat and said lower bearing seat,

said assembly, when said sliding member is fixed to one or other of said upper or lower bearing seats, further comprising an elastic self-centring means co-operable with said upper or lower bearing seats to urge said seat to which said sliding member is not fixed to return to or remain in a centred position relative to said sliding member and the seat to which said sliding member is fixed.

2. An assembly as claimed in claim 1, wherein, said elastic self-centring means is an elastic sleeve surrounding the outer peripheries of said upper and lower seats.

3. A bearing assembly comprising:

an upper bearing seat, a lower bearing seat and a sliding load bearing member therebetween, said sliding member optionally being fixed to one or other of said upper and lower bearing seats, friction between said sliding member and said upper or lower bearing seat, or between said sliding member and said upper and lower bearings seats, in use, damping relative horizontal movement between said upper bearing seat and said lower bearing seat, said assembly further comprising an elastic self-centring means co-operable with said sliding means and one or other or both of said upper and lower bearing seats to urge said sliding means to return to or remain in a centered position.

4. An assembly as claimed in claim 3, wherein said sliding member is not fixed to either of said upper or lower bearing seats.

5. An assembly as claimed in claim 3 or 4, wherein said elastic self-centring means comprises a diaphragm, said sliding member being located at or near or joined to the centre of said diaphragm, the periphery of said diaphragm being joined to or adjacent to the periphery of one or both of said upper and lower bearing seats.

6. An assembly as claimed in any one of claims 3 to 5, wherein said sliding member is not fixed to either said upper or lower bearing seats, said self-centring means comprises two said diaphragms.

7. An assembly as claimed in any one of claims 3 to 6, wherein said elastic self-centring means includes both a said sleeve over the outer periphery of said upper and lower bearing seats and one or two said diaphragms.

8. An assembly as claimed in any one of claims 5 to 7 wherein said diaphragm or said two diaphragms comprises or comprise vulcanised rubber.

9. A bearing assembly comprising:

an upper bearing seat, a lower bearing seat and a sliding load bearing member therebetween, said sliding member being slideable relative to each of said upper and lower bearing seats, friction between said sliding member and said upper and lower bearing seats, in use, damping relative horizontal movement between said upper bearing seat and said lower bearing seat,

said assembly further comprising an elastic self-centring means comprising a sleeve over the outer periphery of and co-operable with the said upper and lower bearing seats to urge said seats to return to or remain in a centred position relative to said sliding member and a rigid member extending peripherally outwardly from said slider to cooperate with said sleeve to centre said slider between said upper and lower seats.

10. An assembly as claimed in claim 9, wherein said rigid member is affixed to said elastic sleeve and abuts said sliding member.

11. An assembly as claimed in claim 9 or 10, wherein said rigid member is a disc.

12. An assembly as claimed in claim 9 or 10, wherein said rigid member is a hub and a plurality of spokes.

13. An assembly as claimed in any one of claims 9 to 12, wherein said sliding member is substantially cylindrical in shape and the bearing surfaces of said lower and upper bearing seats are substantially flat.

14. An assembly as claimed in any one of claims 9 to 12, wherein said sliding member is of regular geometrical shape in cross-section.

15. An assembly as claimed in any one of claims 9 to 14, wherein one or other of the bearing surfaces of said upper or lower bearing seats is curved and the corresponding bearing surface of said sliding member is curved to cooperate therewith.

16. An assembly as claimed in any one of claims 2, 7 and 9 to 15, wherein said sleeve is made of vulcanized rubber or other appropriate elastic material.

17. A bearing assembly comprising:

an upper bearing seat, a lower bearing seat and a sliding load bearing member therebetween, said sliding member being fixed to one or other of said upper and lower bearing seats, friction between said sliding member and the upper or lower bearing seats to which it is not fixed, in use, damping relative horizontal movement between said upper bearing seat and said lower bearing seat,

said assembly further comprising an elastic self-centring means co-operable with said upper or lower bearing seats to urge said seats to return to or remain in a centred position relative to said sliding member and the other of said upper or lower bearing seats.

18. An assembly as claimed in claim 17, wherein said elastic self-centring means comprises a plurality of blocks of elastic material disposed between said upper seat and said lower seat peripherally outwardly from said sliding member, said blocks contacting and being joined to each of said upper and lower seats.

19. An assembly as claimed in claim 18, wherein said blocks are made of rubber.

20. A bearing assembly comprising:

an upper bearing seat, a lower bearing seat and a sliding load bearing member therebetween, said sliding member being slideable relative to each of said upper and lower bearing seats, friction between said sliding member and said upper and lower bearing seats, in use, damping relative horizontal movement between said upper bearing seat and said lower bearing seat,

said assembly further comprising an elastic self-centring means comprising a solid plate member attached to and extending peripherally outwardly from said sliding member, a plurality of blocks of elastic material disposed between said upper seat and said solid plate member, and between said lower seat and said solid plate member peripherally outwardly from said sliding member, said blocks contacting and being joined to each of said upper and lower seats and said plate member.

21. An assembly as claimed in claim 20, wherein said blocks are made of rubber.

22. A method for seismically isolating a structure which comprises installing a bearing assembly as claimed in any one of the preceding claims between said structure and a foundation.

23. A method as claimed in claim 22, wherein said foundation is another structure.

FIGURE 1

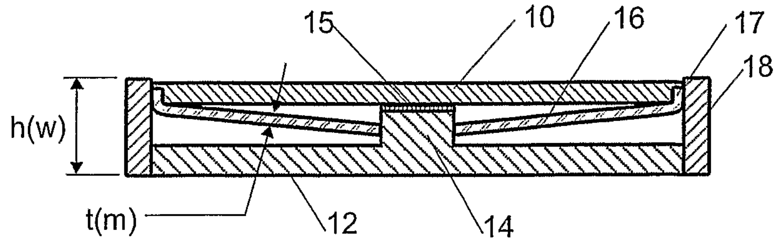


FIGURE 1a

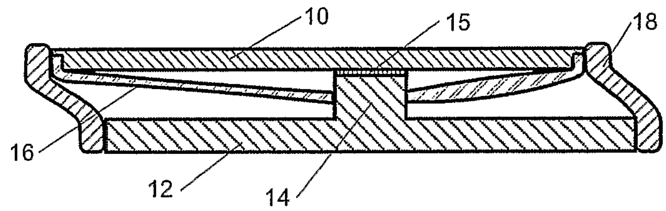


FIGURE 1b

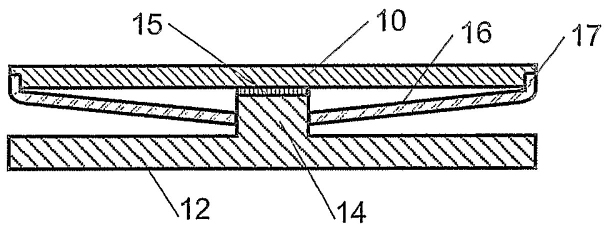


FIGURE 1c

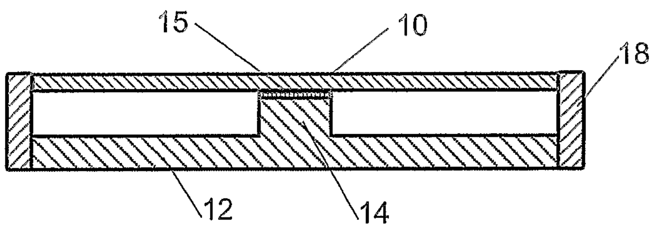


FIGURE 2

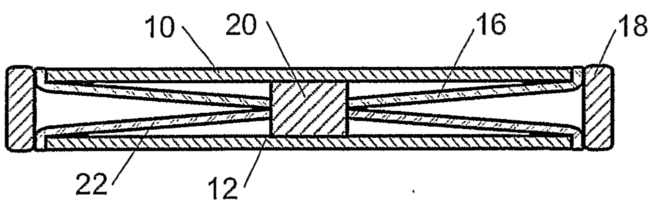
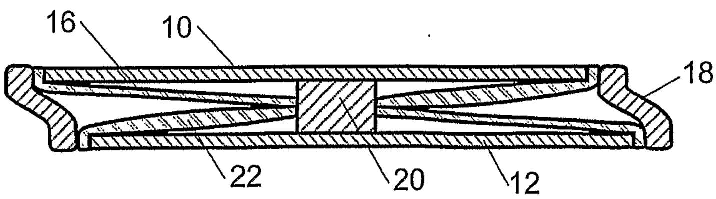


FIGURE 2a



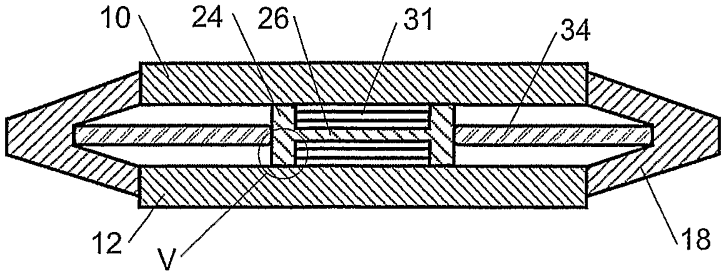


FIGURE 3

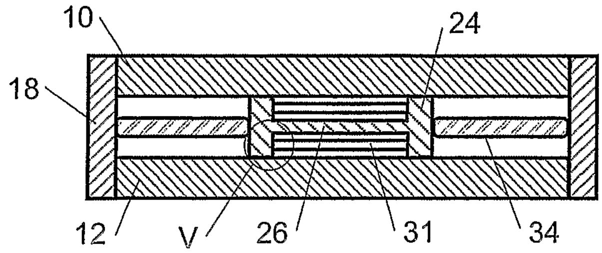


FIGURE 4

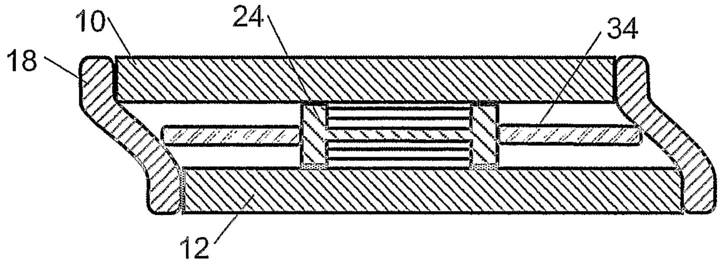
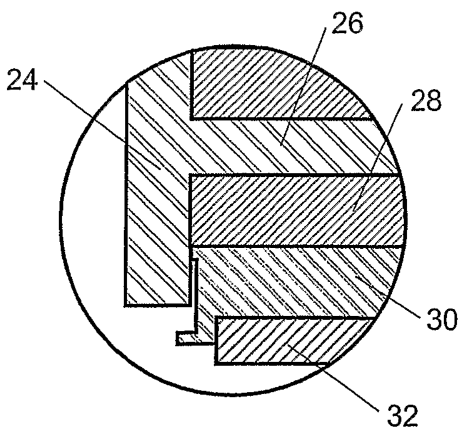


FIGURE 4a

FIGURE 5



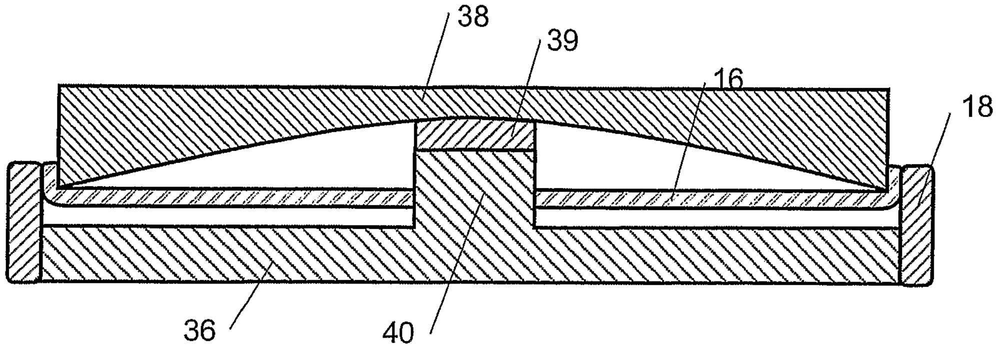


FIGURE 6

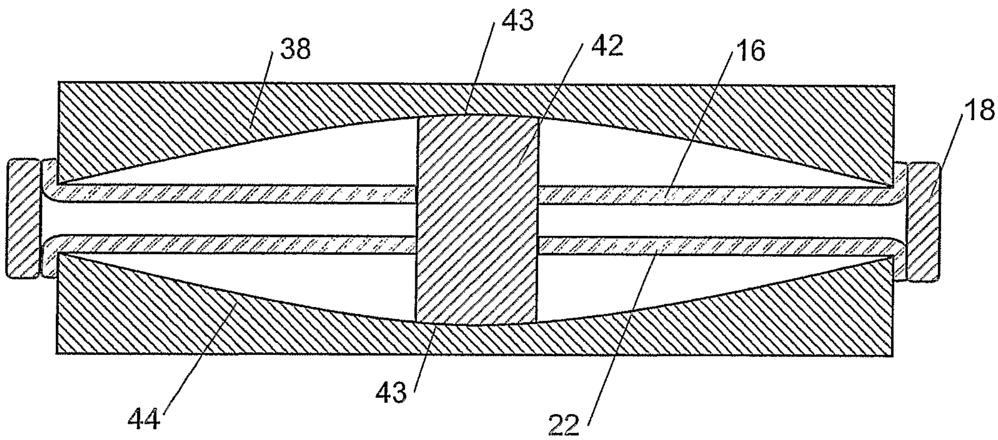


FIGURE 7

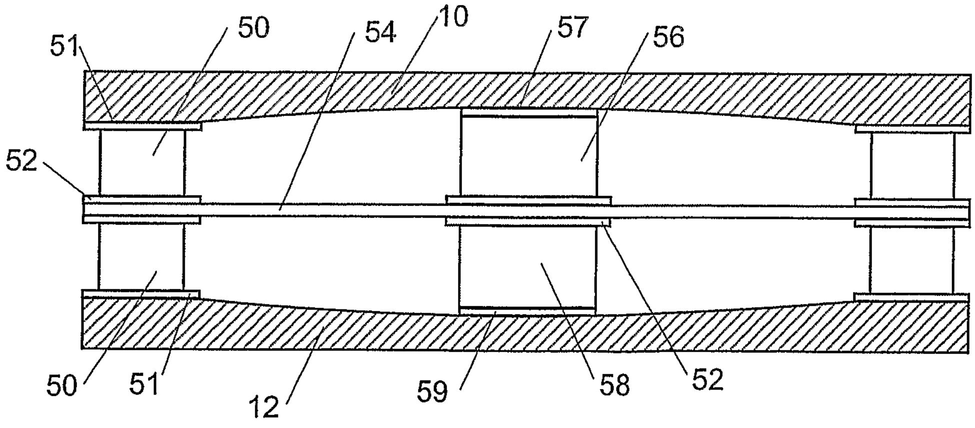


FIGURE 10

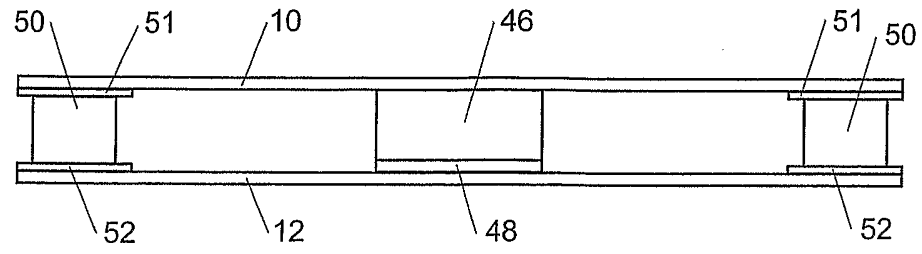


FIGURE 8

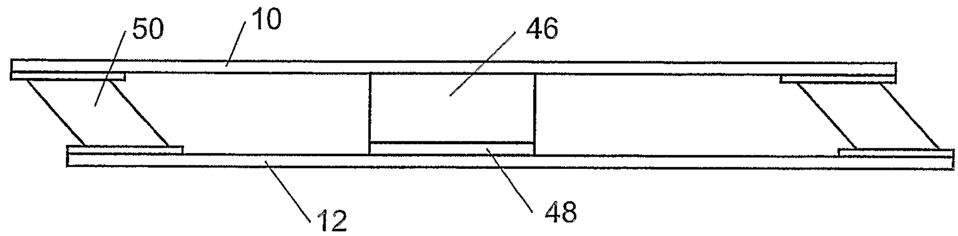


FIGURE 8a

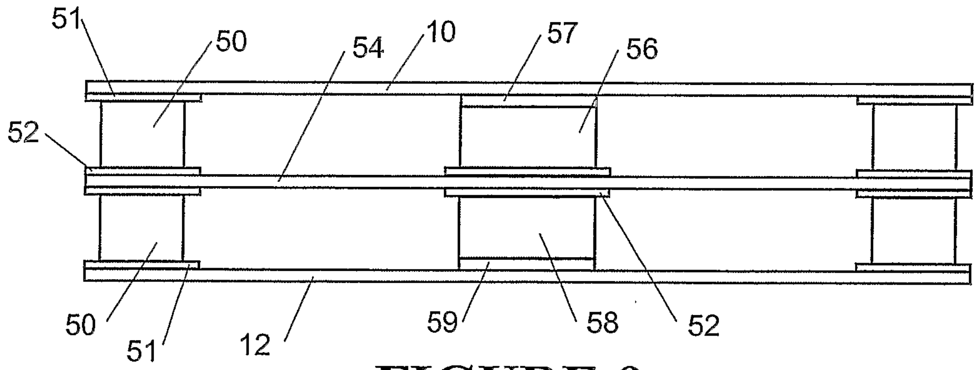


FIGURE 9

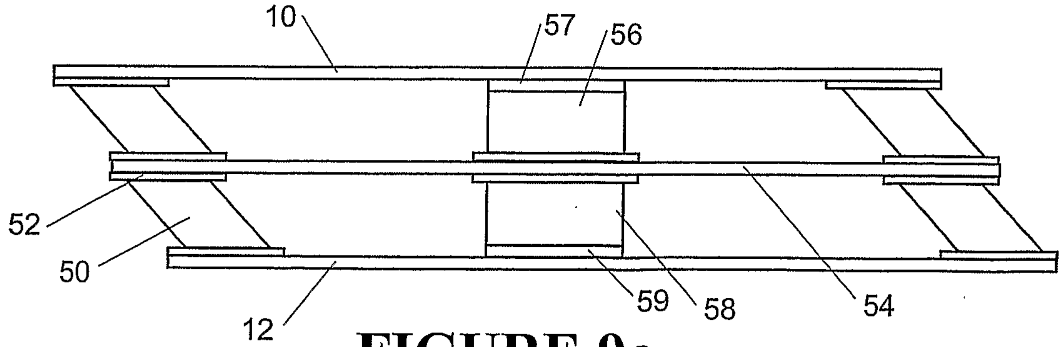


FIGURE 9a

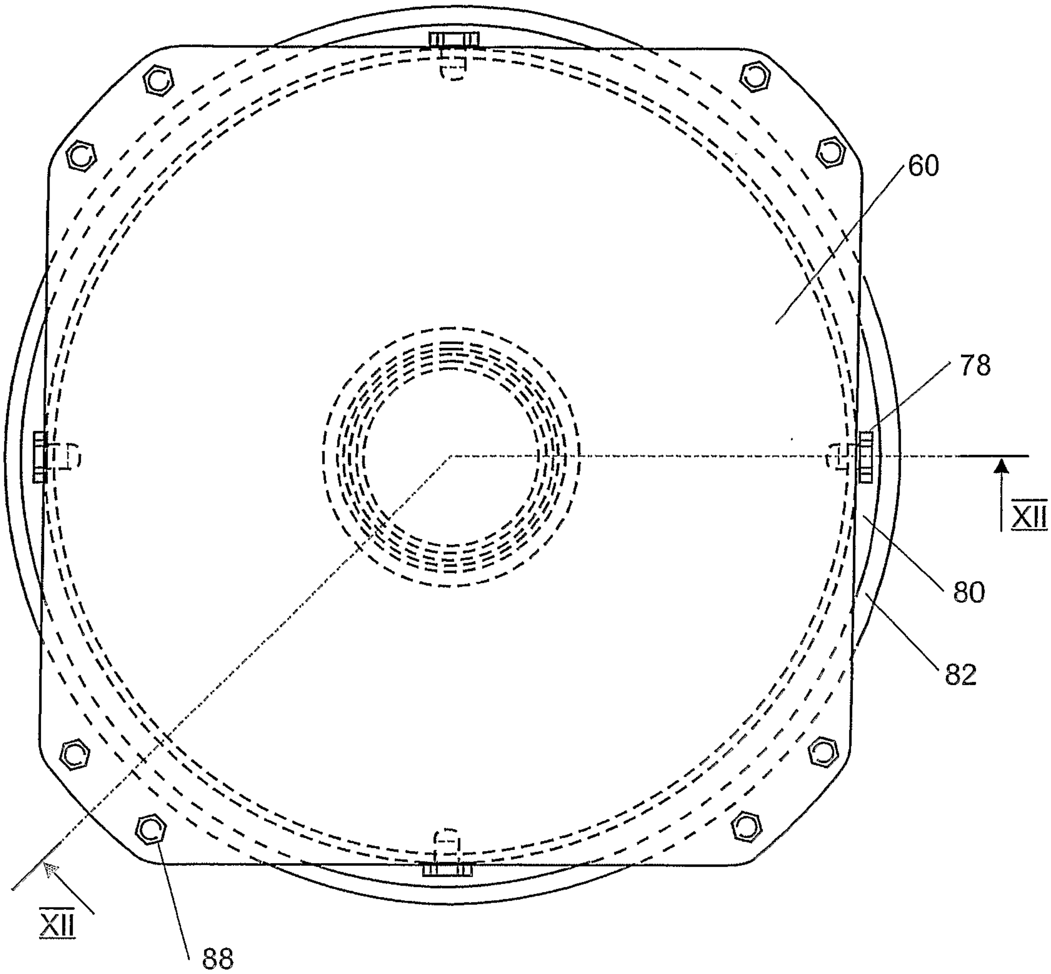


FIGURE 11

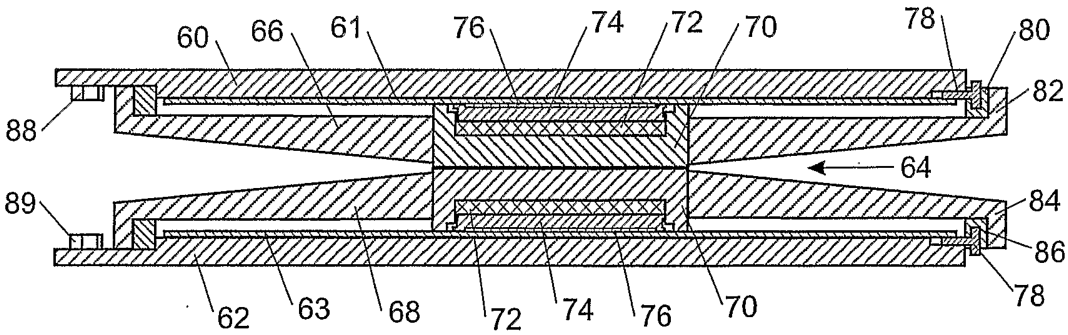


FIGURE 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2004/000045

A.	CLASSIFICATION OF SUBJECT MATTER
Int. Cl. [7]:	E04B 1/36, E04H 9/02, E02D 27/34, E01D 19/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : E04B 1/36, E04H 9/02, E02D 27/34, E01D 19/04

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Derwent DWPI - IPC above + Keywords bearing, slid+, elastic, resilient, spring......

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2002/084030 A (FINE CO LTD) 24 October 2002. All document.	1-23
X	GB 2099932 A (FYFE) 15 December 1982. All document.	1-23
X	WO 1994/015047 A (LOGIADIS) 7 July 1994. All document.	1-23
X	FR 2572446 A (TOSHIBA KK) 2 May 1986. All document.	1-23
X	EP 439272 B (SUMITOMO GOMU KKK) 29 May 1996. All document.	1-23
X	JP 09-031919 A (KAIMON KK) 4 February 1997. Derwent English language abstract, Accession no. 97-162189 Class Q41 .	1-23
X	JP 10-038022 A (SHINDO TOMIHARU) 13 February 1998. Derwent English language abstract, Accession no. 98-182569 Class Q46 .	1-23

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 June 2004	16 JUN 2004

Name and mailing address of the ISA/AU

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/NZ2004/000045

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
WO	02084030	KR	2002079049	KR	2002079050		
GB	2099932	CA	1186359	GB	2122276		
WO	9415047	AU	57136/94	EP	0690948	NZ	259020
		US	5669189				
FR	2572446	JP	61106864	US	4662133		
EP	0439272	JP	3217533	JP	4136542	JP	4136543
		NZ	236812	US	5261200		
JP	9031919						
JP	10038022						

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX