United States Patent [19]

Byers

[11] **3,771,270**

[45] **Nov. 13, 1973**

[54] **SELF-CENTERING HORIZONTALLY TRANSLATABLE SUPPORT/HOLD-DOWN APPARATUS FOR BUILDING STRUCTURES AND THE LIKE**

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[22] Filed: **Dec. 13, 1971**

[21] Appl. No.: **207,026**

[52] **U.S. Cl.** **52/167**, 52/573, 248/20, 248/25

[51] **Int. Cl.** **E04h 9/02**

[58] **Field of Search** 248/17, 18, 20, 24, 248/25; 52/167, 573; 287/91

[56] **References Cited**

UNITED STATES PATENTS

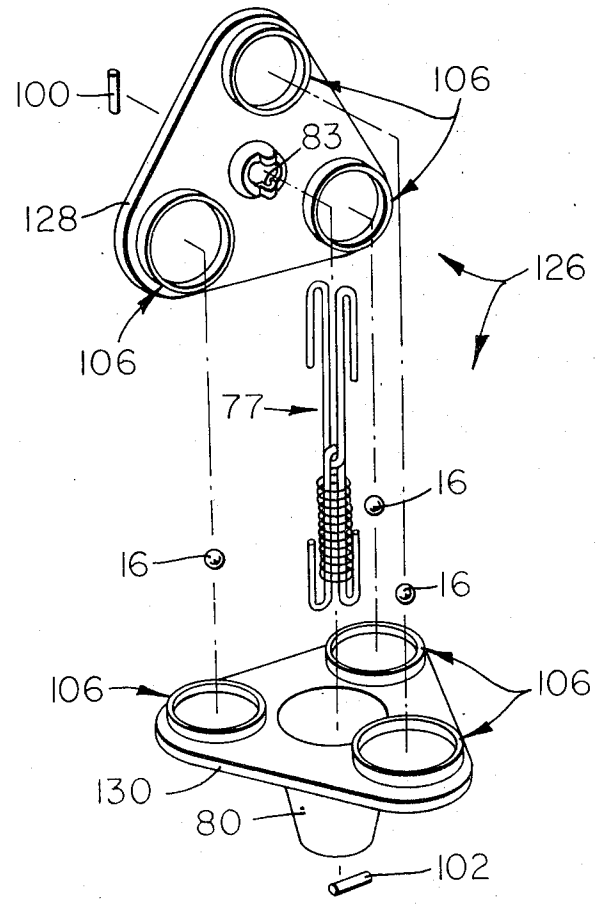
1,695,373	12/1928	Harper	248/25 X
2,414,506	1/1947	Bowen	248/20
2,753,587	7/1956	Quinn	16/85 X
2,249,871	7/1941	Taigman	248/17
575,771	1/1897	Sumner	287/91
2,035,143	3/1936	Cavaglieri	52/167
2,690,074	9/1954	Jones	52/167
3,212,745	10/1965	Lode	52/167 X

Primary Examiner—Alfred C. Perham
Attorney—George B. Almeida

[57] **ABSTRACT**

A pair of confronting conical support surfaces confine therebetween a spherical ball bearing to define a structure support means which allows horizontal translation in any direction of one support surface relative to the other via the ball bearing. Structure hold-down means generally integral with the conical surfaces limits the vertical movement therebetween when the earth is at rest or when moving, while allowing horizontal translation. The structure support means and the structure hold-down means are disposed between the structure and its foundation, whereby horizontal movement of the earth due to earthquakes, etc., moves only the lower support surface. The upper support surface and the building experiences no horizontal movement due to the building inertia, and the frictionless lateral translation allowed by the ball bearing. The support means and the hold-down means may be combined in an integral unit of various configurations, or may be separated into separate units spaced between the structure and its foundation.

11 Claims, 16 Drawing Figures



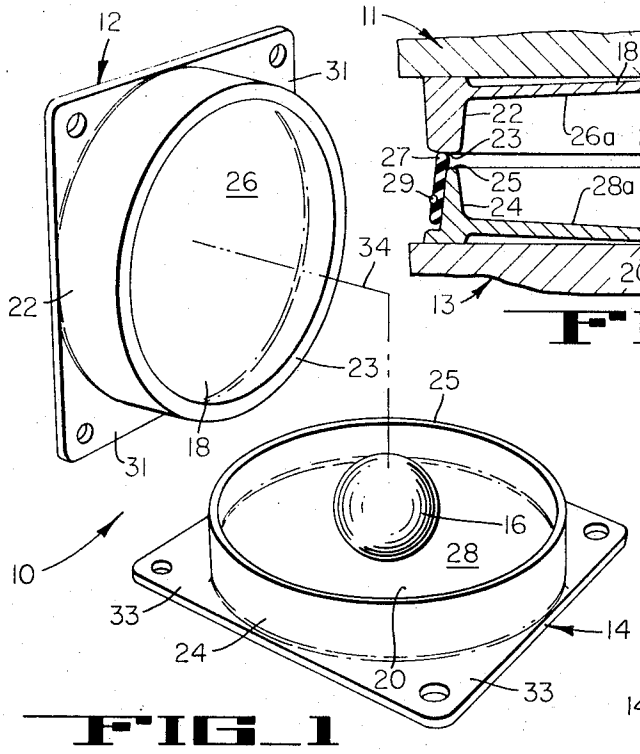


FIG_1

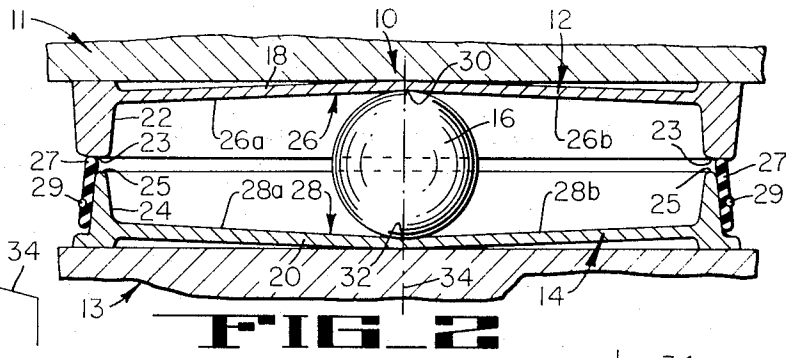


FIG_2

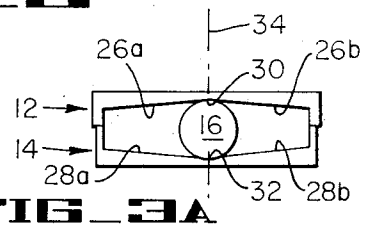


FIG_3A

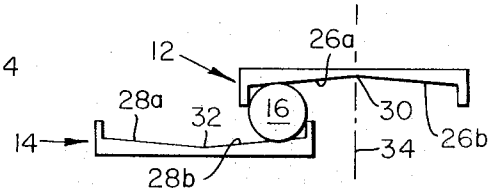


FIG_3B

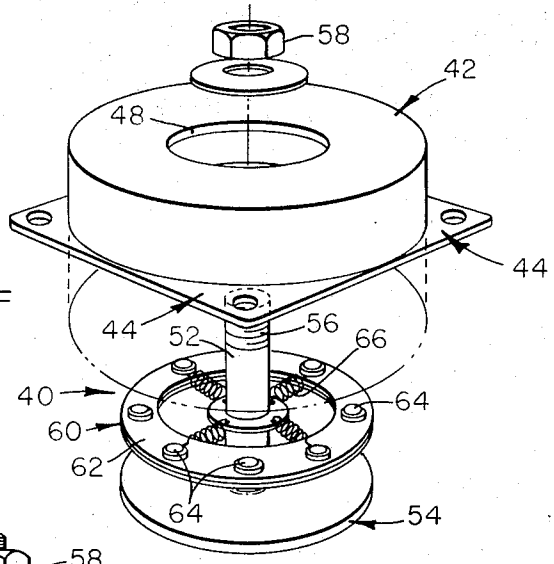
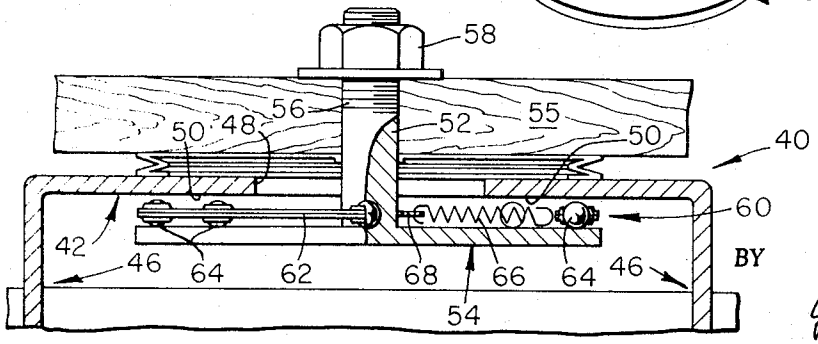


FIG_4

FIG_5



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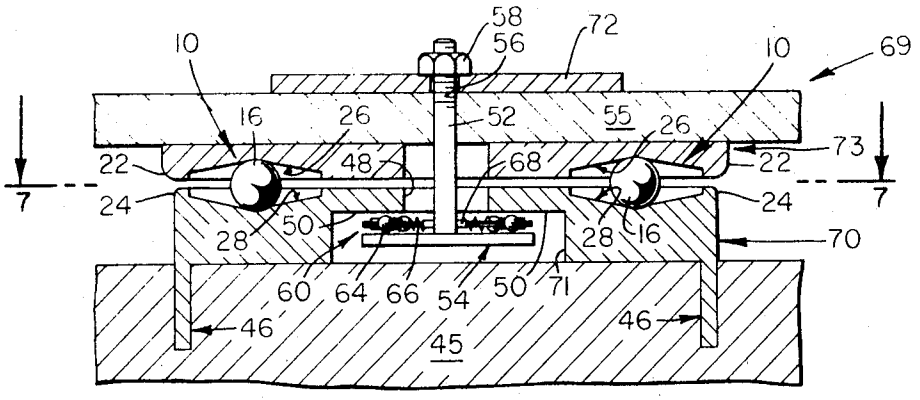


FIG_6

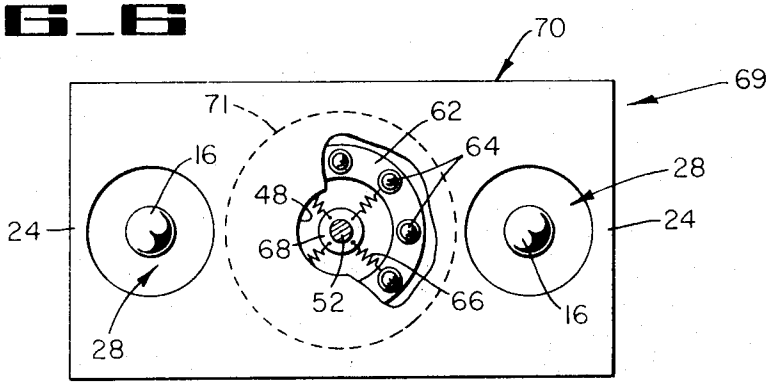


FIG_7

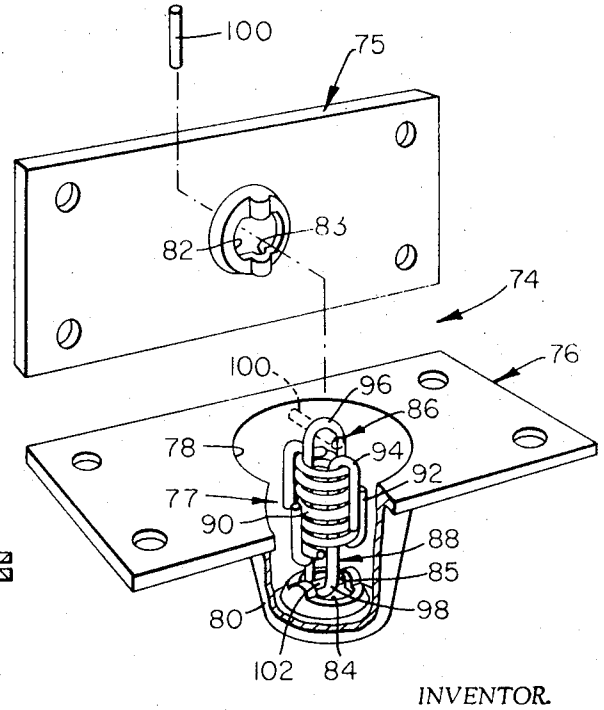


FIG_8

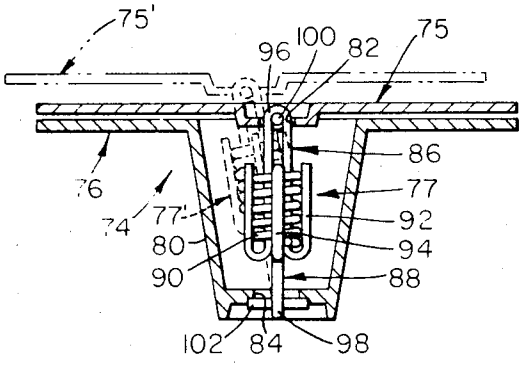


FIG_9

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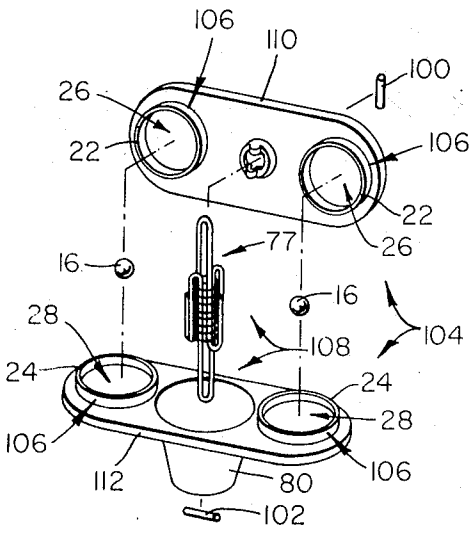


FIG_10

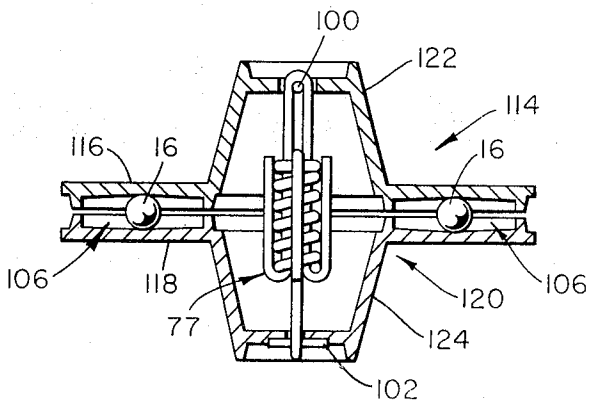


FIG_11

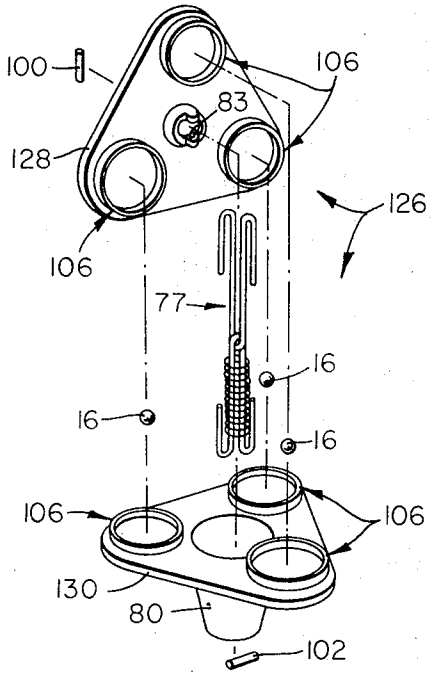


FIG_12

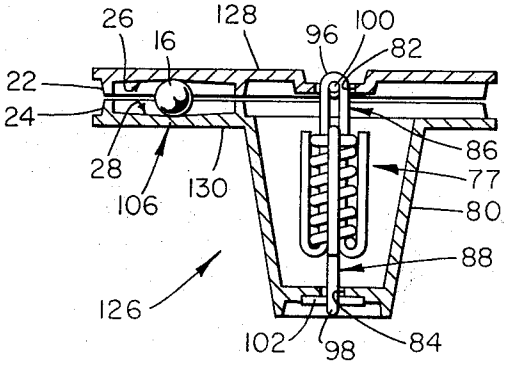


FIG_13

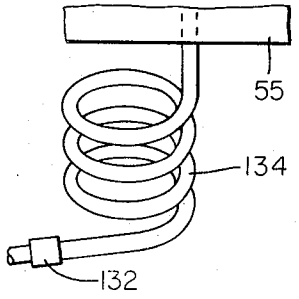


FIG_14

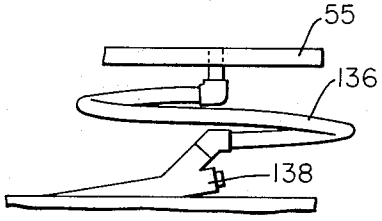


FIG_15

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SELF-CENTERING HORIZONTALLY TRANSLATABLE SUPPORT/HOLD-DOWN APPARATUS FOR BUILDING STRUCTURES AND THE LIKE

BACKGROUND OF THE DISCLOSURE

1. FIELD

The present invention relates to earthquake damage prevention devices, and more particularly to a self-centering, horizontally translatable support and hold-down apparatus for buildings, large equipment installations, and other large structures.

2. PRIOR ART

Various devices have been developed in the past which may be used to support various associated types of structures to allow horizontal movement of the structure relative to its foundation. Various planar, inclined, spherical, etc., configurations are known, however none of the prior art devices provide a practical, horizontally translatable, self-centering device which is particularly adaptable as an earthquake-proof device, and which includes means for preventing excess vertical movement of the structure relative to the foundation. Likewise, prior art configurations are not readily adaptable to modern building construction techniques and/or associated building codes, which in earthquake prone areas of the United States are becoming increasingly stringent. That is, prior art earthquake-proof supports have been developed without providing for practical adaptation to present day building codes, standards, etc.

SUMMARY OF THE INVENTION

The present invention provides a structure support-/hold-down which overcomes the shortcomings of the prior art devices by providing not only an industrially acceptable device for support of buildings, machinery, and other structures, but also one which meets, and thus conforms to the stringent building codes in areas of the country which are earthquake prone, e.g., provides a simple, low cost, mechanically engineered apparatus. Various embodiments are contemplated by the invention combination for horizontal translation of a structure relative to its foundation, while limiting vertical movement therebetween.

In one embodiment, the invention employs an (upper) conical, support member, a confronting (lower) conical base member, and a smoothly surfaced spherical ball disposed therebetween. The ball acts as a single bearing confined between the members, whereby one member is free to translate in any horizontal direction relative to the other member by rolling upon the ball. A structure hold-down device is contemplated in integral or separate combination with the support device to prevent vertical movement of the supported structure when at rest or during any period of horizontal translation.

One hold-down device includes an annular bearing plate integrally formed with the support member and thus secured to the structure foundation, and having a central opening therethrough. A bearing device including a circular hold-down plate, is integrally formed with the base member and is thus secured to the structure floor framework or plate via a shaft extending through the opening. A series of bearings are confined between the annular bearing plate and the hold-down plate. A second hold-down device includes a modified form of

the support and base plates, wherein heavy spring means is coupled therebetween to provide spring-loaded, limited, vertical movement. In either hold-down means, horizontal translation is allowed between the members, but vertical movement between the structure plate and its foundation is limited.

Adjunct features, in combination with the structure support and holddown of the invention, include flexible hose and pipe utility connections which absorb any horizontal movement as well as vertical movement allowed by the invention, and thus experienced by the structure relative to its foundation, without disrupting the utility service.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a blown-apart perspective of a structure support means of the invention.

FIG. 2 is a cross-section of the device of FIG. 1.

FIGS. 3A and B are cross-sections of either a conical or a planar surface support apparatus, depicting the invention structure positions when the associated structure is at rest and when it is horizontally displaced due to earth movement, impact, etc.

FIG. 4 is a blown-apart perspective separately illustrating structure hold-down means of the invention combination.

FIG. 5 is a cross-section of the hold-down means of FIG. 4.

FIG. 6 is a cross-section of an integral structure support/hold-down apparatus employing in combination the means of FIG. 1 and FIGS. 4 and 5.

FIG. 7 is a partially broken-out plan of the apparatus of FIG. 6.

FIG. 8 is a blown-apart perspective of another embodiment of hold-down means in accordance with the invention.

FIG. 9 is a cross-section of the apparatus of FIG. 8 upon assembly.

FIG. 10 is a blown-apart prspective of an integral structure support/hold-down apparatus employing in combination the means of FIGS. 1 and 8.

FIG. 11 is a cross-section of an integral structure support/hold-down apparatus such as depicted in FIG. 10, but with symmetrical, and thus identical, upper and lower bearing plates.

FIG. 12 is a blown-apart perspective of another embodiment of an integral support/hold-down apparatus.

FIG. 13 is a cross-section taken along section line 13—13 of FIG. 12.

FIGS. 14 and 15 are elevations of flexible utility connections employed in combination with the structure support/hold-down apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1 and 2, there is shown a structure support means 10 of the invention combination, which provides structure support while allowing horizontal translation of a structure 11 relative to its supporting foundation 13 (FIG. 2). To this end, the structure support means 10 includes an (upper) conical support member 12, a (lower) conical base member 14 and a smoothly surfaced spherical ball 16 disposed between the confronting conical members 12 and 14. The ball 16 acts as a single ball bearing rotatably confined between the members, to allow one member to frictionlessly translate in any horizontal direction relative to

the other member, by rolling on the ball **16.** When the structure support means **10** is employed as a building support the components **12–16** are formed of metal such as, for example, cast iron, steel, aluminum, etc., however, the components may be formed of plastic, fiberglass, hard rubber, etc., depending upon the operating conditions, loads, environment, sizes, etc., associated with the specific application, or type of structure.

The members **12, 14** are generally identical in configuration and shape and include a support bearing plate **18** and a base bearing plate **20** respectively, which terminate in continuous annular flanges **22, 24** respectively at substantially equal radii. The annular flanges **22, 24** have confronting surfaces **23, 25** respectively, wherein edge surface **23** of member **12** is substantially wider and of larger diameter than the surface **25** of the base member **14.** Thus a resilient band seal **27,** secured about the flange **24** via a fastener **29,** bears against the confronting wider surface **23** along one edge of the seal **27** to provide accordingly a seal between the flanges **22, 24.** The specific seal means shown may be replaced by a larger diameter thin rubber, or folded aluminum, bellows, sleeve, etc. (as depicted in FIG. **5** infra) which may bear against, or otherwise connect to, the opposing flanges **22, 24,** etc. As shown in FIG. **1,** the members **12, 14** include mounting means **31, 33** integrally formed with the plates **18, 20** and flanges **22, 24** respectively. The mounting means herein include holes for receiving bolts for fastening the respective members **12, 14** to the structure **11,** machinery base, etc., as well as to the foundation **13.** Obviously, other mounting means may be employed.

In accordance with the invention, inside confronting surfaces **26, 28** of the bearing plates **18, 20** respectively are radially inclined, or tapered, to define very shallow, opposing, conical configurations whose apexes **30, 32** lie along a common axis (when the plates and flanges are in the coaxial, at rest, position shown in FIGS. **2** and **3A.**) Note that the inclined surfaces **26, 28** are equally tapered; i.e., a radius **26***a* of plate **18** diametrically opposed to a radius **28***b* of plate **20,** are substantially parallel (see the cross sections of FIG. **2**). Likewise, radius **26***b* is substantially parallel with radius **28***a,* as are all other diametrically opposed radii of the plates **18, 20.**

By way of illustrating the structure support means **10** operation, it is assumed that the support bearing plates **18** of a spaced series of the support means **10** are secured to the bottom (floor frame, plate, etc.) of a structure (building, machinery, etc.) and the base bearing plates **20** are secured to a foundation affixed to the earth. If sudden lateral vibration is experienced by the earth's surface (as during an earthquake) the base member **14** is readily translated in any horizontal direction below the support member **12.** That is, due to the inertia of the structure, the earth's surface (and thus the base member **14**) is free to vibrate, translate, etc., under the support member **12** (and thus the structure) with little motion being imparted to the structure. On the other hand, if the structure is impacted by some force, the support members **12** secured thereunder are free to translate horizontally relative to the base members **14** in response to the force, to thereby absorb the impact with a minimum of damage to the structure. Note in all cases that, after the vibrations cease, the ball **16** tends to return to the apex **32,** of the base bearing plate **20,** and the support bearing plate **18** simultaneously repositions its apex **30** with the ball **16,** as shown in FIGS. **2** and **3A.** Thus the support means **10** is self-positioning.

Note that although the support means shown in FIGS. **3A** and **3B** has been described herein as a conical surface type of device, the FIGS. **3A** and **3B** (as well as FIG. **2**) also describe the cross section of a planar surface, unidirectional type of support means. Thus numerals **26***a,* **26***b,* **28***a,* **28***b* refer to plane surfaces, and numeral **16** refers to a cylindrical (roller) bearing.

FIGS. **4** and **5** illustrate an embodiment of a hold-down means **40** of the invention combination. An annular base member **42** is secured as by bolts via holes in flanges **44** (FIG. **4**) or is embedded into an associated concrete foundation **45** (as at **46,** FIG. **5**). The annular base member **42** includes a central opening **48** of selected diameter, wherein a selected annular portion extending radially outward from the opening **48** defines a bearing surface **50.**

A shaft **52** is welded or bolted to a hold-down bearing plate **54** at one end, and is demountably secured to a floor framework **55,** plate, sill, etc., (FIG. **5**) of the structure, machinery base, etc., as by means of a threaded portion **56** and a mating nut **58.** The threaded portion **56** provides means for adjusting the spacing between the hold-down plate **54** and the bearing surface **50** of member **42,** and thus for determining the allowable vertical movement of the hold-down means **40** as further described below. Although the demountable end of the shaft **52** is shown coupled to the floor framework **55,** it may be demountably secured instead to the hold-down plate **54.**

A ball bearing device **60** which herein constitutes the translatable hold-down mechanism, includes a spacing collar **62** which contains a series of ball bearings **64.** Collar **62** is circumjacently positioned about the shaft **52** by means of radially extending springs **66** secured thereto at one end and at the other end to a washer **68** loosely disposed about the shaft **52.**

In operation, slight upward movement of the floor frame **55** causes like upward movement of the shaft **52** and hold-down plate **54.** Plate **54** lifts bearing means **60** until the bearings **64** bear against the bearing surface **50** of the base member **42.** Further vertically upward movement of the floor frame and thus of the structure is prevented by the hold-down means **40,** although frictionless horizontal translation is allowed via action of the ball bearing device **60.**

Referring to FIGS. **6** and **7,** there is shown an integral structure support/hold-down apparatus **69** utilizing the basic configurations of the support means shown in FIGS. **1–3A, B,** and of the hold-down means shown in FIGS. **4–5.** The base member **42** of FIGS. **4–5** is replaced by base member **70** in FIGS. **6, 7,** which includes a pair of structure support means **10** integrally formed within the member **70.** The member **70** includes a relatively thick cross-section wherein a cavity **71** is machined to provide the bearing surface **50,** and is secured to the concrete foundation **45** via extension portions as at **46.** The ball bearing device **60** is positioned between the hold-down plate **54** and the bearing surface **50** of the member **70.** The shaft **52** extends from the plate **54** through the central opening **48** and a hole in the floor framework **55.** A large area steel washer **72** may be disposed under the nut **58** and against the framework **55** to firmly secure the plate **54** to the framework **55.**

The pair of structure support means **10** include annular flanges **24** and conical surfaces **28** formed in the top surface of the member **70**. A support plate **73** replacing the plate **12** of FIGS. 1–3A, B, is secured to the floor framework **55**, as by flanges and bolts, etc., as shown in FIG. **1**. The structure support means **10** includes annular flanges **22** and conical surfaces **26** formed in the lower side of the plate **73**, in confronting relation to the respective flanges **24** in the member **70**. A spherical ball **16** is disposed between the surfaces **26, 28** of each of the means **10**.

As may be seen, the apparatus **69** provides a self-centering, horizontally translatable support integral with a hold-down means, wherein plates and members of the two devices are integrally formed to perform the combined functions of limiting vertical movement while allowing horizontal translation with a single integral apparatus.

Referring to FIGS. **8** and **9** another embodiment **74** of a hold-down means comprises an (upper) plate **75** and a (lower) base plate **76**, which are coupled together via a horizontally translatable spring device **77**. The latter constitutes the horizontally translatably hold-down mechanism analogous to the ball bearing device **60** of FIGS. **4–7**, both of which perform the function of limiting the extent of vertical movement of a structure relative to its foundation, while allowing horizontal translation via action of the support means of previous mentioned in FIGS. **1–3A, B**.

Base plate **76** has a central opening **78** formed therein, which is secured to, or is integrally formed with, a truncated cone member **80** integrally formed with the plate **76**, and which extends perpendicularly away from the upper plate **75**. Plate **75** has a central opening **82** in register with the opening **78**, and the smaller end of the cone member **80** has a central opening **84** in line with the opening **82** in plate **75**. Spring means **77** includes a pair of identical spring retainers **86, 88**, each formed of steel rods bent into a double "U" shape. A spring **90** is confined in partial compression by the double "U" portions **92, 94** of the spring retainers **86, 88** respectively. Central connecting portions **96, 98** thereof extend through the openings **82, 84** respectively, and are secured to depressions **83, 85** at either side of the openings in the associated plates **75, 76**, via pins **100, 102** respectively. FIG. **9** depicts in phantom line the vertically-limiting action of the hold-down means **74** during horizontal translation of the structure relative to its foundation (or vice versa). Plate **75'** moves laterally, while further upward movement thereof relative to plate **76** is prevented by the complete compression of the spring **90** between the spring retainers **86, 88**. Cone member **80** provides mounting for the spring device **77'** while allowing room for pivoting of the latter.

Both the hold-down means of FIGS. **4, 5** and FIGS. **8, 9** and the support means of FIGS. **1, 3A, B** are shown individually; i.e., separate from each other, for purposes of facilitating the description of the invention.

However, the invention combination contemplates the hold-down means of either FIGS. **4, 5** (as shown in FIGS. **10–13**) as integrally formed with the support means of FIGS. **1–3A, B**, to define an integral unit. To this end, FIG. **10** depicts another combined support-/hold-down apparatus **104** employing a pair of structure support means **106** (means **10** of FIGS. **1, 2**) between which is disposed a hold-down means **108** (means **74** of FIG. **8–9**). The apparatus **104** includes a support plate **110** and a base plate **112** which together with the support means **106** and hold-down means **108** defines an integral unit. The means **108** includes spring device **77** coupled between the plates **110, 112** as previously described in FIGS. **8, 9**. The support means **106** includes annular flanges **22, 24**, tapered confronting surfaces **26, 28** and respective spherical balls **16**, in a configuration identical to that described with reference to FIGS. **1, 2**.

FIG. **11** depicts in cross section a modified version **114** of the support/hold-down apparatus **104** of FIG. **10**, wherein the support and base plates **110, 112** are replaced by symmetrical support and base plates **116, 118**. Thus a hold-down means **120** includes truncated cone members **122, 124** integrally formed in both the plates **116, 118** respectively. The cone members **122, 124** are similar in configuration to the cone member **80** of FIGS. **8–10**, except that members **122, 124** are essentially one-half the member **80** depth, given a spring means **77** of similar overall length. The distance between pins **100, 102** (i.e., the total lengths of the cone members **122, 124**) is dependent upon the overall length of the spring means **77**, the extent of compression of the spring **90**, and the amount of vertical travel permissible, and/or selected, between the support and base plates **116, 118**; i.e., between the structure and its foundation.

Referring now to FIGS. **12** and **13** there is shown still another embodiment **126** of the structure support-/hold-down apparatus of the invention, employing triangular support and base plates **128, 130** with structure support means **106** of previous mentioned disposed at each corner of the triangular configuration. The means **106** include annular flanges **22, 24**, tapered confronting surfaces **26, 28** and spherical balls **16**, each identical to that of FIGS. **1** and **2**. The plates shown here have a flat, and an extending truncated cone member, type configuration (as shown in FIG. **10**) with centrally located openings **82, 84** defining means for securing the central connecting portions **96, 98** of the spring means **77**. However, the symmetrical plate configuration of FIG. **11** may be employed in the triangular configuration of FIGS. **12, 13**. The spring means **77** of previous mentioned is disposed between the plates **128, 130** with pins **100, 102** disposed through the retainer connecting portions **96, 98** respectively, which are nestled into the depressions **83, 85** formed in the plates **128, 130** immediately about the openings **82, 84** respectively.

The invention has particular application as an anti-earthquake support for structures. It is installed in the self-centered position depicted in FIGS. **2, 3A**. The resilient annular seal **27**, which may be included in all the combined structures of FIGS. **6, 7, 10–13**, prevents the entrance of foreign matter such as dirt, leaves, etc. Subsequently, upon the occurance of vibration or other translation of the earth's surface, as during an earthquake, the base member **14** is free to translate below the ball **16**, relative to the support member **12**, as depicted in FIG. **3B**. In the conical configuration shown here, the relative translation may be in any direction along the horizontal. Note that the relative movement between the two members of any of the embodiments is essentially frictionless; that is, the slight, parallel taper of the inside surfaces **26, 28**, in conjunction with

the spherical ball **16**, allow ready translation in any direction with a minimum of friction.

The degree of pitch may be varied as required by the particular application, e.g., increased pitch may be utilized for the conical inner surfaces **26, 28** whereby increased resistance to horizontal translation is provided, and vice versa.

Various alternative embodiments are contemplated by the invention, wherein for example a roller bearing, e.g., a cylinder, may be employed in place of the ball **16**, wherein the plates **18, 20** are inclined plane surfaces rather than conical surfaces. Such a configuration is shown by the cross sections of FIGS. **2, 3A, 3B**. In this configuration, translation is permitted only in one dimension, rather than in two dimensions as in the above description. However, two dimension translation may be provided by employing two sets of rollers and respective inclined planes, perpendicularly arranged with respect to each other on different planes located between the building base and its foundation.

Referring to FIGS. **14** and **15**, horizontal translation of the building requires flexible connecting means for the utilities introduced to the building structure, machinery, etc. Accordingly gas, water, etc., utilities may be coupled through the floor framework **55** of a building via a spirally coiled connector pipe **134**. Pipe **34** is preferably formed of a partially flexible material such as copper, or may be formed of a flexible conduit, bellows, etc.

As shown in FIG. **15** sewage connections may be made through the floor framework **55** via a signel turn, large, connector means **136** which couples at the lower end to the cleanout Tee **138** of the sewage drain. The connector means **136** again is preferably made of a partially flexible material, or of a flexible conduit, bellows, etc.

I claim:

1. A structure support/hold-down apparatus for disposition between the base of a structure and its foundation to allow horizontal translation of the structure relative to the foundation while limiting the vertical movement therebetween, comprising the combination of;

structure support means including a support plate secured to the base of the structure and a base plate secured to the foundation and including a pair of confronting inclined surfaces therein for confining a bearing member therebetween; said inclined surfaces defining conical surfaces formed in the respective plates in the confronting relation; said bearing member comprises a sphere disposed between the confronting conical surfaces, the surfaces being horizontally translatable relative to each other via rotation therebetween of the bearing member; and

hold-down means including a hold-down mechanism integrally coupled as a unit from the support plate to the base plate, and horizontally translatable in any direction with minimized friction relative to the structure support means while positively limiting vertical movement between the pair of confronting conical surfaces and thus between the structure and its foundation.

2. The apparatus of claim **1** wherein the hold-down mechanism includes a spring device coupled between the support and base plates, which further includes a spring confined therebetween which upon fully compressing provides the positive limit of vertical movement.

3. A structure support/hold-down apparatus for disposition between the base of a structure and its foundation to allow horizontal translation of the structure relative to the foundation while limiting the vertical movement therebetween, comprising the combination of;

structure support means including a support plate secured to the base of the structure and a base plate secured to the foundation and including a pair of confronting inclined surfaces therein for confining a bearing member therebetween; said inclined surfaces defining conical surfaces formed in the respective plates in the confronting relation; said bearing member comprises a sphere disposed between the confronting conical surfaces, the surfaces being horizontally translatable relative to each other via rotation therebetween of the bearing member; and

hold-down means including a hold-down mechanism operatively coupled to limit vertical movement between the pair of plates while allowing horizontal translation in any direction; wherein said hold-down mechanism includes a spring device coupled between the support and base plates, the device including a spring confined therebetween which upon fully compressing provides the extent of vertical movement;

said support and base plates having fastener means for demountably securing a pin to each plate; wherein at least one of the plates includes a truncated cone member integral therewith and adapted to receive therein the spring device, one end of the spring thereof being coupled to one of the plates via a respective fastener means while the other end thereof is coupled to the cone member of the other plate via its fastener means.

4. The apparatus of claim **3** wherein the spring device includes spring retainer means in the form of a pair of rods bent in the double "U" configuration, said spring being confined between the double "U" portion of the retainer means, a connecting portion between the double "U" portions of the retainer means being secured to respective plates via respective pins of the fastener means.

5. The apparatus of claim **3** wherein each of the support and base plates include integrally formed truncated cone members extending oppositely therefrom, said fastener means being disposed at the opposite ends of the cone members to secure the respective ends of the spring device thereto while providing space therein for lateral movement of the spring device.

6. The apparatus of claim **3** wherein a pair of structure support means are integrally formed as a unit with the spring device, said support and base plates including two pairs of respective opposing annular flanges, each defining therein the conical surfaces for receiving therebetween a respective sphere.

7. The apparatus of claim **6**, wherein the support and base plates are triangular in shape, wherein a structure support means is disposed in each corner of the triangular plates in opposing relation, and the spring device is integrally secured via fastener means located at the center of the plates.

8. A structure support/hold-down apparatus for disposition between the base of a structure and its foundation to allow horizontal translation of the structure rel-

ative to the foundation while limiting the vertical movement therebetween, comprising the combination of;

structure support means including a support plate secured to the base of the structure and a base plate secured to the foundation and including a pair of confronting inclined surfaces therein for confining a bearing member therebetween; said inclined surfaces defining conical surfaces formed in the respective plates in the confronting relation; said bearing member comprises a sphere disposed between the confronting conical surfaces, the surfaces being horizontally translatable relative to each other via rotation therebetween of the bearing member; and

hold-down means including a hold-down mechanism operatively coupled to limit vertical movement between the pair of plates while allowing horizontal translation in any direction; wherein said hold-down mechanism includes a bearing surface formed in one of the plates, a hold-down member coupled to the other of the plates and extending in confronting relation below the bearing surface, and a bearing assembly disposed therebetween and spaced a selected vertical distance from the bearing surface, wherein positive limit vertical movement is provided when the hold-down member urges the bearing assembly upward for contact against the bearing surface.

9. The apparatus of claim **8** wherein the hold-down mechanism includes a bearing base plate secured to the foundation, including a central opening therein with an annular bearing surface formed under the base plate about the opening, said hold-down member being secured to the structure via a shaft passing through the opening in the bearing base plate, wherein said bearing assembly includes an annular spacing collar and a series of captive ball bearings disposed about the shaft between the annular bearing surface of the bearing base plate and the hold-down member.

10. The apparatus of claim **8,** wherein a pair of structure support means are integrally formed as a unit with the hold-down mechanism, said support and base plates including two pairs of respective opposing annular flanges, each defining therein the conical surfaces for receiving therebetween a respective sphere.

11. The apparatus of claim **10,** wherein the support and base plates are triangular in shape, wherein a structure support means is disposed in each corner of the triangular plates in opposing relation, and the hold-down mechanism is integrally secured from plate to plate at the centers thereof.

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