Feb. 10, 1970 F. K. HALL 3,494,554

HOLDDOWN SYSTEMS UTILIZING COMPRESSIVELY DISTORTED ELASTOMER BODIES

Filed Feb. 8, 1968 2 Sheets-Sheet 1

FIG - 1

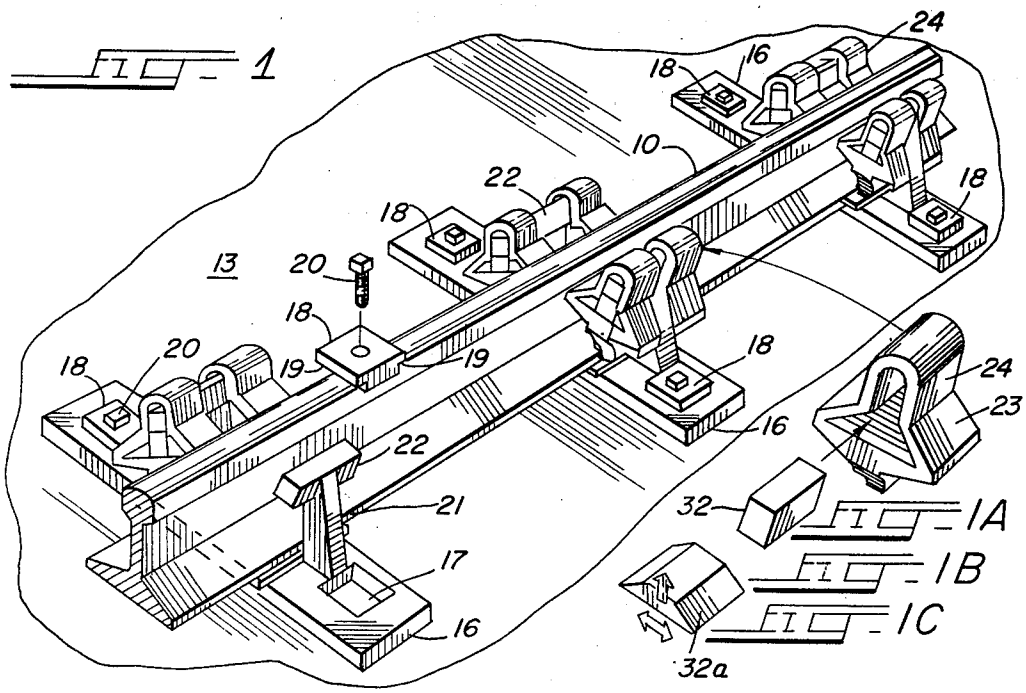



FIG - 1A

FIG - 1B

FIG - 1C

FIG - 2

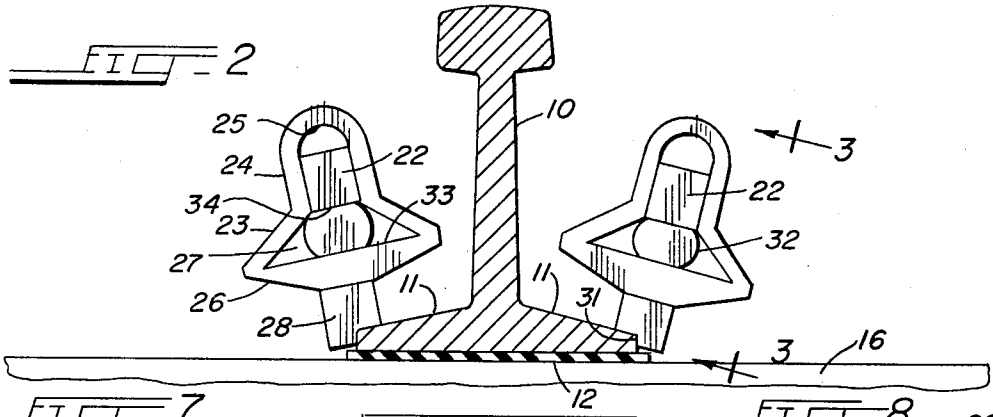
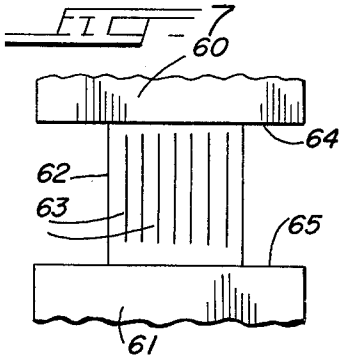



FIG - 7



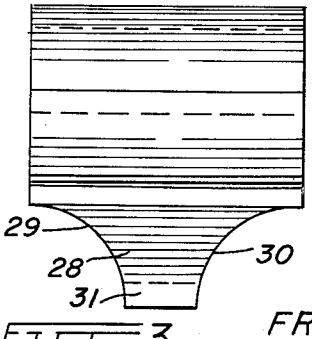
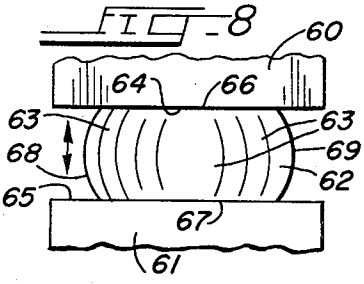




FIG - 3

FIG - 8




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FIG. 4

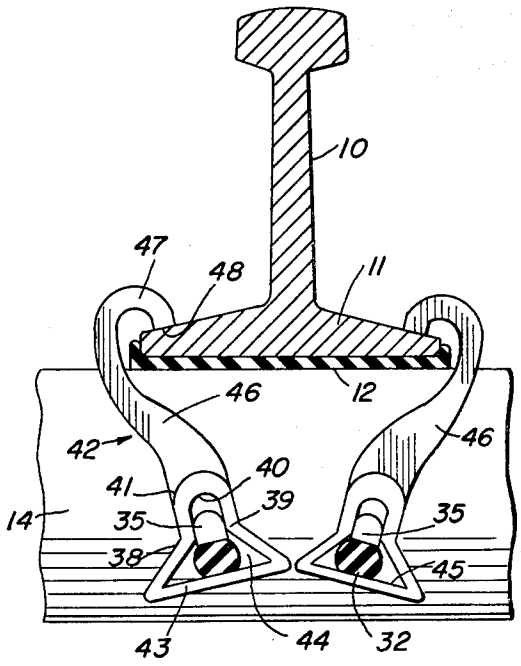



FIG. 5

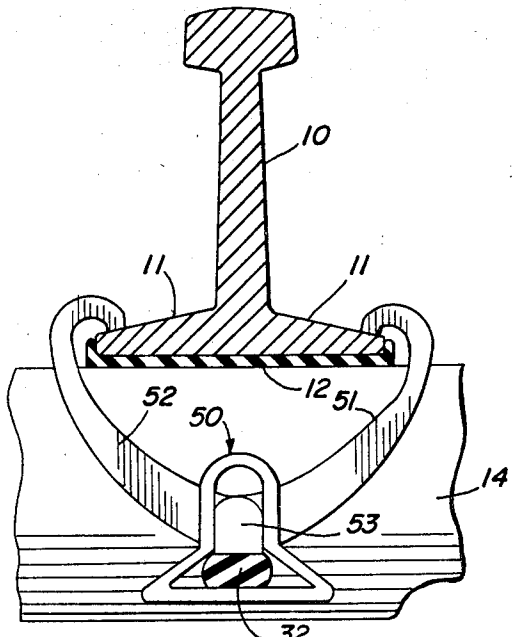



FIG. 10

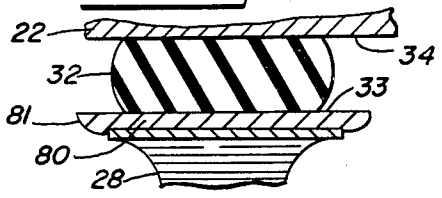
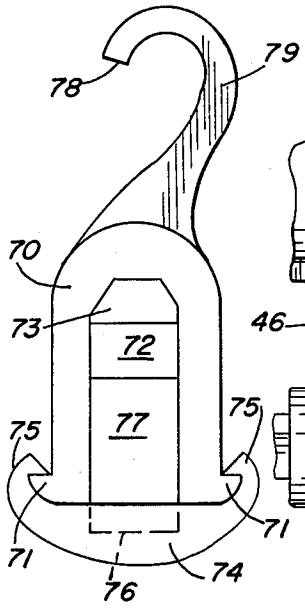



FIG. 9



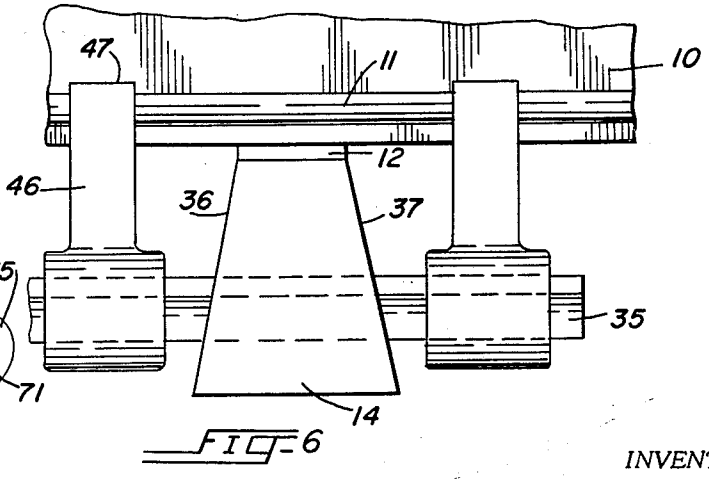




FIG. 6

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# HOLDDOWN SYSTEMS UTILIZING COMPRESSIVELY DISTORTED ELASTOMER BODIES

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Int. Cl. E01b 9/62, 9/68
U.S. Cl. 238—310 11 Claims

## ABSTRACT OF THE DISCLOSURE

Holddown systems for rails and other systems for holding one member relative to another comprising a first member, a second member contiguous thereto to be held in fixed position relative to said first member, and thrust transmitting means between said members including a compressively deformed elastomer body having opposite substantially parallel faces exerting an outward elastic recovery thrust against substantially parallel faces with lines of thrust forces in said compressively deformed member being oriented essentially at right angles to said faces.

## BACKGROUND OF THE INVENTION

The present invention concerns holddown systems particularly adapted to securely position a railroad rail on a support member. The invention particularly concerns the use thereof on rail supports such as concrete ties, concrete beds, metal superstructures, etc. It further pertains to other combinations wherein one member is to be held in position relative to another member and may be used in lieu of bolt connections, welded connections, etc.

Railroad rails traditionally have been mounted on wooden cross ties spaced at close intervals by the driving of railroad spikes into the ties with the head portion of the spike overlapping the base flange of the rail. This has been true of both on ground rail systems and above ground, or elevated rail systems. With the fairly recent advent of improvements in the structural strength of concrete, rail systems embodying concrete ties or concrete beds have awakened the interest of railroad designers. Concrete beds or ties require considerable less maintenance and have a longer useful life than do the traditional wooden ties.

The adaptation of rail systems to the use of concrete ties and concrete road beds, however, also require a departure from the traditional concept of holding the rail on the ties, i.e., by spikes being driven into the wooden ties. Holddown systems for rails on concrete ties and/or concrete road beds or metal superstructures have been developed in recent years. Known holddown systems embody heavy metal structures. Some utilize metal components in torsion stress as the force-exerting members. A specific object of the persent invention concerns improvements in rail holddown systems wherein the traditional, wooden tie concept is abandoned in favor of prestressed concrete ties and/or concrete road beds in on ground or elevated rail systems.

## BRIEF SUMMARY OF THE INVENTION

Briefly, the invention concerns holding systems in general, i.e., systems for holding one member relative to another comprising a first member, a second member contiguous thereto to be held in fixed position relative to said first member, and means for transmitting thrust between said members including a compressively deformed elastomer body having opposite substantially parallel faces exerting an outward elastic recovery thrust against said substantially parallel faces with lines of thrust forces in said compressively deformed member



being essentially at right angles to said faces. An exemplary use thereof comprise rail holddown systems wherein the railroad rails are secured by a series of holddown devices materially different from and considerably improved over the traditional railroad spike. A base member of such device is fixedly secured relative to a concrete bed or tie or to other structural systems supporting the rail, such as metal superstructures in the case of elevated rail systems. This base member may be a bar or bars impedded in and projecting from opposite sides of a concrete tie or may be a member bolted or otherwise attached to the road bed or superstructure. The system further embodies a holddown member having a foot or feet bearing downwardly on the upper face of the base flange. The pressure exerted thereby is of a relatively high magnitude, i.e., in the order of at least several hundred p.s.i. This pressure is provided by an elastomer pressure body positioned between the base member and the hold down member in a state which is distorted compressively from its normal, unstressed state whereby the elastic recovery thrust forces resulting from the compressive distortion exerts a pressure thrust force to relatively high magnitude, sufficient to secure the rail tightly on ties or other rail support members.

The elastomer pressure member is inserted in the holddown system on the construction site. As is well known, it is difficult to insert an elastomer member in a highly compressed state. To facilitate such insertion, the elastomer member may be compressively distorted or flattened, whereafter its temperature is lowered sufficiently to immobilize or "freeze" the member in the compressed or flattened state when the compression force is removed. It is maintained at this temperature until it is inserted on the job in the holddown system. Upon "thawing" or warming, the elastomer body regains its elastic recovery property and recovers toward its normal shape, which is the shape of the elastomer member before compressive distortion and low temperature immobilization thereof. The holddown system is dimensioned so that the inserted elastomer member cannot recover fully its original or normal shape, whereby the elastomer member is in a partially compressed state when it exerts its thrust force through the pressure transmitting member and its foot on the base flange of the rail. Thereby, there exists in effect the elastomer member in a partially compressed state. Through the utilization of the elastic recovery force of said member in attempting to return it to its original or normal state, it functions as the pressure exerting body in the holddown system.

The elastomer member may also be compressed between opposing, preferably substantially parallel faces of a holddown system or the like by other means. For example, the elastomer member may be inserted in an uncompressed state, and one or more shims may be driven between the body and the contiguous face of the holddown member to compress the elastomer member. Alternatively, the holddown device may be made in separate parts and assembled on the job site in a manner whereby the elastomer member is compressed upon assembly. In the case of rail holddown systems, the holddown units may be mounted on the rail without the elastomer member, which is inserted later.

## DESCRIPTION OF THE DRAWINGS

Several preferred forms of the invention are illustrated in the drawings, wherein:

FIG. 1 is a perspective view of a fragment of a railroad rail mounted on a series of rail holddown devices adapted in turn to be secured to ties or other members of the rail supporting structure or road bed;

FIGS. 1A, 1B, and 1C are enlarged, perspective views of the pressure-imparting member, the elastomer block

in its normal, uncompressed state, and the elastomer block in its compressed, immobilized state, respectively;

FIG. 2 is a transverse section through a railroad rail showing the holddown system members in holding position against the base flange of the rail;

FIG. 3 is a side elevation, as viewed from section plane 3—3 of FIG. 2, of the pressure imparting member;

FIG. 4 is a side elevation of another embodiment of a holddown assembly in combination with a railroad rail and a concrete tie, the latter shown in fragment;

FIG. 5 is a view similar to FIG. 4 showing still a further embodiment;

FIG. 6 is a fragmentary side elevation of the embodiment of FIG. 4;

FIG. 7 is a diagrammatic view of opposed members with an uncompressed elastomer body between opposing substantially parallel faces with parallel lines marked on the end face of said body;

FIG. 8 is a similar diagrammatic view of the same combination with said body compressively distorted between said faces;

FIG. 9 is a side elevation of a further embodiment of a holddown member; and

FIG. 10 is a fragmentary cross-section of a still further embodiment utilizing a shim plate.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiment of FIGS. 1–3 constitutes a holddown assembly wherein the assembly is attached to, as by bolts, a rail supporting structure, which may be a series of railroad ties, an elevated or on ground level railroad bed, or a series of cross structures such as steel structural members of an elevated, monorail or dual rail system. The rail **10** has the usual base flange **11**. The base of the rail **10** may rest on rubber pads or cushions **12** which rest on the road bed **13** (or ties **14**, e.g., FIGS. 4 and 5) or on a base plate such as plate **16** of the holddown assembly. The latter plate may rest on the road bed itself, on cross ties thereof, or on elevated superstructures. As shown in FIGS 1–3, the base plate **16** has a pair of rectangular holes **17** which receive the bottom portion of a holddown or mounting plate **18** having lips **19** overlying the edges of the holes **17**. The base plate **16** and mounting plates **18** are bolted by bolts **20** to the underlying support structure **13**.

Each holddown unit has an upwardly extending arm **21** carrying at its upper end a bar **22**. The bar **22** is rigid with the arm **21** and the base plate **16** and projects from opposite sides thereof.

The pressure transmitting member **23** is a hollow member having an inverted U-shaped head portion **24** defining an axial, inverted U-passage **25**. The head portion **24** fits over, and has a sliding relationship with, the rigid bar **22**. Preferably, there is one pressure transmitting member on each side of the arm **21**. The side faces of the bar **22** and the side walls of the inverted U-passage **25** are oriented so that the sliding movement is approximately perpendicular to the upper face of the base flange **11**.

The remainder of the pressure transmission member **23** comprises a wider base segment **26** having a regular trapezoidal, axial passage **27** and a depending foot **28**. As shown in FIG. 3, the front and rear edges **29** and **30** have an arcuate taper so that the flange contacting notch **31** of the foot member has a relatively small area. The purpose of tapering or narrowing toward the flange contacting notch is to increase the force per unit area of thrust of foot member **28** against the flange **11**.

The pressure exerting member comprises an elastomer block or body **32** which is compressively distorted in the assembly of the rail with the holddown devices. Prior to inserting blocks **32** in the passages **25** between the lower face **34** of the bar **22** and the upper face **33** of the passage **27**, the block **32** is distorted by compression into a flattened form. Such form may be the form **32***a* shown in FIG. 1C, i.e., as shaped of a dimension similar to but smaller than the cross section of the passage **27**. It is inserted in the passage **27** in the distorted or compressed shape and thereafter allowed to recover via the elastic forces of the elastomer block or body toward its normal state, i.e., the shape it would assume without any compressive forces exerted thereon. In this elastic recovery, the elastomer body **32** presses against faces **34** and **33** and thus everts a downward thrust on the pressure transmitting member **23**. This force is in turn transmitted through the foot **28** against the upper face of the base flange **11** to hold the rail securely in position.



As aforesaid, it normally would be difficult to insert the compressively distorted, elastomer body **32** in the pressure transmitting member **23**. To facilitate such insertion, it is preferred that the elastomer body **32** be compressively distorted in a flattened shape such as shown in FIG. 1C, and "frozen" or immobilized in this state. It is held at the "freezing" or low temperature immobilization until it is inserted in the passage **27**. As the elastomer body **32** warms, its resilient properties are restored and it seeks to resume its shape prior to compressive distortion and "freezing." In so doing, it becomes wedged between the bar **22** in the upper face **33**, and thus exerts a downward thrust on the pressure transmitting member **23**.

The terms "freezing" and "thawing" above, are nontechnical descriptions. In practice, the elastomer body **32** is formulated so that the elastomer composition will rigidify, through loss of elastic properties, at relatively low temperatures, i.e., in the order of —40° F. and below. The elastomers also should have good resistance to atmospheric deterioration in the presence of sunlight, atmospheric oxygen, and ozone, and should retain their elastic properties also at relatively high temperatures on the order of 100° to 120° F. The elastomer compositions useful for this purpose may be formulated from elastomers which crystallize at relatively low temperatures with the loss of elastic properties upon crystallization. Exemplary thereof are low crystallization neoprene elastomers. However, elastomers which are usually considered to be noncrystalline elastomers, e.g., natural rubber and most synthetic rubbers, can be immobilized or rigidified in the compressively distorted state at low temperatures in the order of 0° F. to —100° F. or even lower. The invention herein contemplates use of any natural or synthetic rubber composition wherein such low temperature immobilization can be attained. The selection of a particular elastomer composition will depend in part on the climate of the locale where the installation is made. In northern parts of the temperate zone, a low temperature immobilization of —30° F. or below is recommended. In the arctic zone, a low temperature immobilization of —60° F. or below is recommended, whereas in southern parts of the temperate zone and in the tropical zone 0° F. or below would be suitable. In each instance, the low temperature immobilization is selected so that it will not be reached and preferably not even closely approached under the coldest climate conditions of the particular locale.

The embodiment of FIGS. 1–3 is particularly adapted for use where the rails are supported on a bed or other support which will be adapted to, or can be constructed to, receive both or like attaching devices to hold the base plate **16** securely in position. In rail systems embodying pre-stressed concrete ties, holddown systems of the type shown in FIGS. 4–6 may be employed. In the embodiment of FIGS. 4 and 6, the pre-stressed rail or ties **14** are molded with a pair of bars **35** projecting from the front and rear faces **36** and **37**. These bars have flat sides **38** and **39** for slidable accommodation of the flat sides of the inverted U-shape passage **40** of the head portion **41** of the pressure transmitting member **42**. The pressure transmitting member **42** comprises a base **43** having a regular trapezoidal, axial passage **44** of the type

previously described. The passage **44** receives the elastomer pressure transmitting member **32**, which may be of the same type and shape as shown in FIGS. 1 and 2 in the normal state as well as in the compressed state. Upon elastic recovery of the compressed or flattened elastomer body **32**, a downward thrust on the lower wall **45** is exerted when the elastomer body **32** makes its elastic recovery between the bar **35** and the wall **45**. This downward thrust is transmitted through upwardly extending arms **46** having upper, hook segments **47**, the ends **48** of which exert a downward holding thrust against the upper faces of the flange **11**. As shown in FIGS. 4 and 6, four of the pressure transmitting members **42** are employed to secure the rail tightly on the upper face of the tie **14**.

In the embodiment of FIG. 5, the structure and mode of operation is similar to that of FIG. 4 except that the pressure transmitting member **50** has a pair of upwardly extending arms **51** and **52** instead of a single arm. In this embodiment only two pressure transmitting members **50** are employed, one on each side of the tie **14**. A single bar **53** extends transversely through the tie **14**. By use of the dual arms **51** and **52**, a pair of pressure transmitting members **50** may be employed, one on each side of the tie.

FIGS. 7 and 8 illustrate in diagrammatic form the action of the compressed elastomer body in exertion of thrust along lines of force between the substantially parallel faces between which said body is compressed. These lines of force are those which normally result from deflection or compression as distinguished from shear or torsion. For purposes of illustration, the member **60** is a member to be held fixedly relative to member **61**. In relation to the rail holddown systems above described, member **60** corresponds to fixed bars **22**, **35** or **53**, and member **61** corresponds to pressure transmitting members **23–28**, **42** or **50**.

The elastomer member, e.g., a solid elastomer block **62**, has thrust component lines **63** marked on an end face at equal intervals. These lines are at right angles to the opposing parallel faces **64** and **65** between which the block **62** is compressed. When the block **62** is compressed from its normal shape (FIG. 7), the elastomer, being an incompressible solid, flows, whereby its faces **66** and **67** in contact with faces **64** and **65** assume a greater area unless confined by structures precluding such flow (not shown). At the same time, the sides **68** and **69** bulge outwardly to some degree.

Based on these observations, component forces in compressed block **62** exert thrust at substantially right angles to the faces **64** and **65** at various amount of compression of block **62** between parallel faces whereby the elastic recovery forces in the compressed block are working directly against the faces **64** and **65**.

In the embodiment of FIG. 9, the rail holddown member is adapted to be used to hold a rail in a manner similar to the embodiment of FIGS. 4 and 6. The base portion thereof comprises an open end, inverted U-base **70** with flanges **71** projecting from the lower, outer corners thereof. The fixed bar **72** is positioned in the upper part of open portion **73**. A plate **74** fits over the open, lower side of the inverted U-base and is held therein by the engagement of flanges **75** with flanges **71**. The plate **74** has a well **76** to seat the solid elastomer block **77**, which in the assembly is under compressive distortion between the lower face of bar **72** and the bottom wall of well **76**. The elastomer block **77** engages the holddown member downwardly relative to fixed bar **72** and thereby presses the end **78** of the hooked segment **79** downwardly against the base flange of the rail.

The elastomer block **77** may be inserted in the assembly by the compression-freezing technique heretofore described. In the alternative, a power tool may be used on the job site to press plate **74** tightly against the bottom of base **70** with the elastomer block **77** in position. In the course thereof, the block is compressively distorted, and flanges **75** either snap over flanges **71** or the former may be formed by the power tool after the plate **74** is pressed tightly against the bottom of base **70**.

FIG. 10 is a fragmentary cross-section of a holddown member as illustrated in FIGS. 1–3. Like numerals designate like parts. In this embodiment a shim **80** having a tapered, relatively sharp edge **81** is forced between the elastomer member **32** and the upper face **33** of the pressure transmitting member. This narrows the space between opposing faces **33** and **34** and compresses the elastomer member so that it, in the assembly shown, exerts a downward thrust on the pressure transmitting member.

Thus, in its broader concepts the invention herein provides a system for holding one member relative to another by a compressively distorted, solid elastomer body or block. The system embodies a first member and a second member to be held in fixed position relative to the first member. The system embodies substantially parallel, opposed faces against which the compressively distorted elastomer body is positioned with its opposite faces pressing against said opposed faces to give an elastic recovery thrust force urging said faces apart along lines of thrust force at right angles to said faces. This combination utilizes the elastic recovery forces in the compressed elastomer body more effectively than would be the case if the elastomer body were subject to twisting. In the latter case, the torque elastic recovery forces in the twisted elastomer adopt a sine curve-like configuration. Such recovery forces are considerably less effective in terms of amount of elastic recovery thrust forces per unit of distortion or deformation of the elastomer body as compared against the thrust force orientation achieved by this invention.

The elastomer body may exert its thrust force directly against the second member to be held relative to the first member, or, as in the illustrated rail holddown systems, a thrust transmitting member may be provided between the first member and the second member. The opposed parallel faces in such cases are on the first member and the thrust transmitting member, the latter having contact means such as a foot of small area bearing against the second member to hold the latter relative to the first member. The thrust transmitting member preferably is mounted in the system for lineal movement at right angles to the substantially parallel faces.

It is thought that the invention and its numerous attendant advantages will be fully understood from the foregoing description, and it is obvious that numerous changes may be made in the form, construction and arrangement of the several parts without departing from the spirit or scope of the invention, or sacrificing any of its attendant advantages, the form herein disclosed being a preferred embodiment for the purpose of illustrating the invention.

What is claimed is:

**1.** A system for holding one member relative to another by a compressively distorted elastomer body comprising a first member, a second member contiguous thereto to be held in fixed position relative to said first member, a thrust transmitting member having a thrust transmitting segment, opposed, spaced, substantially parallel faces on said first member and said thrust transmitting segment, contact means on said thrust transmitting segment bearing against said second member, and an elastomer body compressively deformed between said opposed faces and having opposite, substantially parallel faces exerting an outward elastic recovery thrust against said opposed, substantially parallel faces with lines of thrust forces in said compressively deformed elastomer body being essentially at right angles to said faces.

**2.** A system as claimed in claim **1**, and means mounting said thrust transmitting member for lineal movement at right angles to said faces.

3. A system as claimed in claim 1, wherein said contact means comprises a foot of small surface area bearing against said second member.

4. A rail holddown system comprising, in combination, a railroad rail having a flange extending along the base thereof, a support beneath said rail, a thrust transmitting holddown member bearing against the upper face of said flange, a fixed member, opposed, spaced, substantially parallel faces on said fixed member and said thrust transmitting holddown member, and a compressively distorted elastomer block having opposite, substantially parallel sides positioned between said opposed faces of said fixed member and said holddown member and exerting via its elastic recovery an elastic recovery thrust against said opposed faces to provide the pressure force pressing said holddown member tightly against said flange.

5. A rail holddown device as claimed in claim 4, wherein said elastomer pressure member comprises an elastomer body which has been compressively distorted from its normal, relaxed shape and immobilized at low temperature in the distorted state prior to positioning thereof between said faces, and, upon warming in said cavity, has recovered toward its normal shape to create and maintain said pressure force.

6. A rail holddown system comprising, in combination, a railroad rail having a flange extending along the base thereof, a support beneath said rail, a holddown member bearing against the upper face of said flange, a fixed member including a fixed, rigid member above said flange, said holddown member including a head portion with a cavity and foot depending therefrom, said fixed member being vertically slidably positioned in the upper portion of said cavity, and a compressively distorted elastomer pressure member being positioned in the lower portion of said cavity beneath said fixed member and exerting via its elastic recovery a pressure force between said fixed member and the bottom of said cavity, thereby pressing said foot downwardly against said flange.

7. A rail holddown system as claimed in claim 6, wherein said support is a concrete tie and said fixed member is a bar fixedly supported above said flange.

8. A rail holddown system comprising, in combination, a railroad rail having a flange extending along the base thereof, a support beneath said rail, a holddown member bearing against the upper face of said flange, a fixed member including a fixed, rigid member below said rail, said holddown member including a head portion with a cavity, a pressure transmitting arm extending upwardly from said head portion, and a downwardly facing hooked end on said arm hooked around said flange with the terminal end of said hooked end bearing against the upper face of said flange, said fixed member being slidably positioned in the upper portion of said cavity, and a compressively distorted elastomer pressure member positioned in the lower portion of said cavity beneath said fixed member and exerting via its elastic recovery a pressure force between said fixed member and the bottom wall of said cavity, thereby pressing said hooked end downwardly against said flange.



9. A rail holddown system as claimed in claim 8, wherein said support is a concrete tie and said fixed member is a bar embedded in and projecting from said tie.

10. A combination embodying a structural member pressing against and holding a second member by lines of thrust force which comprises a fixed structural member having a substantially planar face, a second member having a substantially planar face opposite to and spaced from said first mentioned face, a third member restraining movement of said second member away from said first member, and a solid elastomer block compressively distorted between said faces and exerting a thrust force at right angles to said faces against said face of said second member and pressing the latter against said third member.

11. A system for holding one member relative to another by a compressively distorted elastomer body comprising a first member, a second member contiguous thereto to be held in fixed position relative to said first member, a thrust transmitting member having a cavity therein, said first member being received in said cavity, opposed, spaced, substantially parallel faces on said first member and said thrust transmitting member, contact means on said thrust transmitting member bearing against said second member to hold the later relative to said first member, and a compressively deformed elastomer body in said cavity and having opposite substantially parallel faces exterting an outward elastic recovery thrust against said opposed, substantially parallel faces in said system with lines of thrust forces in said compressively deformed member being essentially at right angles to said faces.

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U.S. Cl. X.R.

238—338, 349, 283