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(54) BEARING AND EXPANSION JOINT SYSTEM INCLUDING SAME

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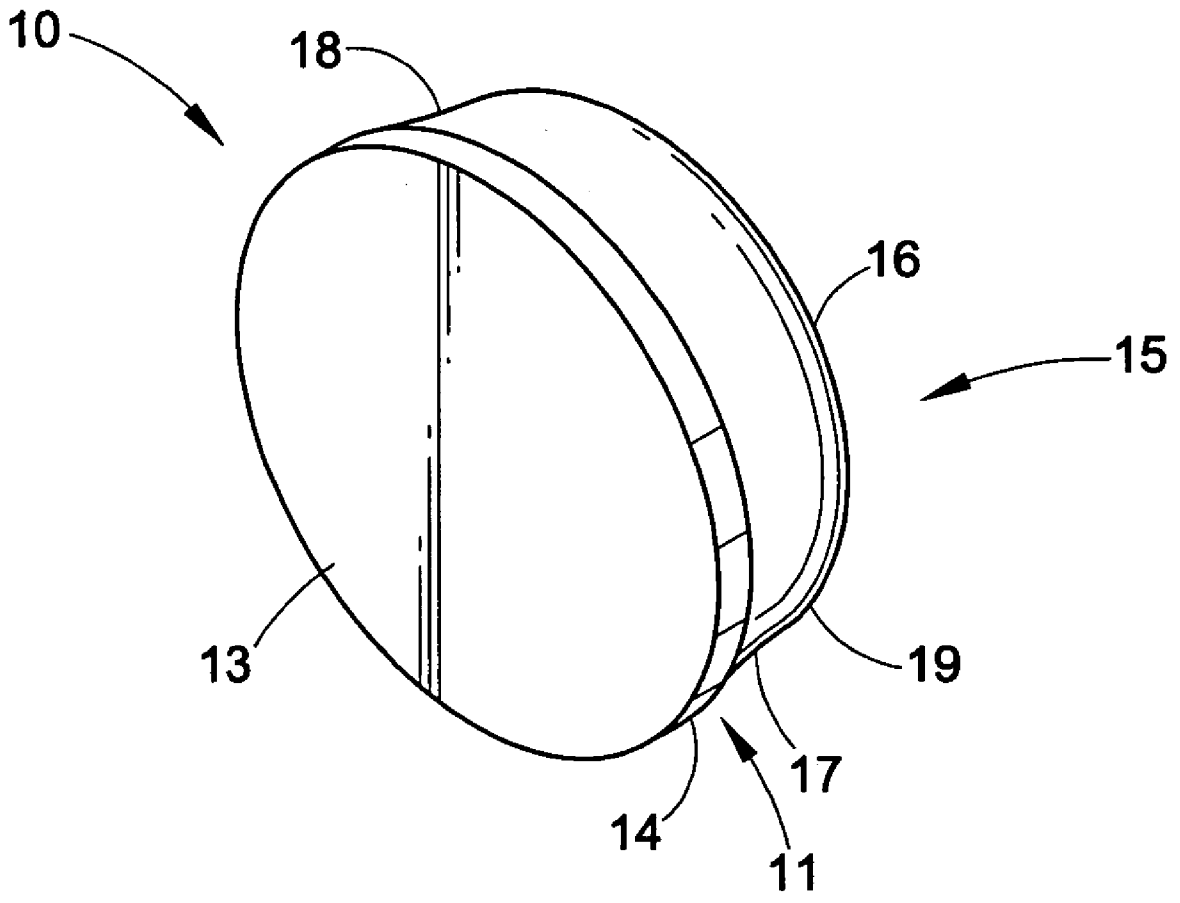
(57) **ABSTRACT**

A bearing is provided for use in connection with expansion joint systems. The structure of the bearing permits improved motion of, and provides improved support for, the components of the expansion joint system that are supported on or engaged with the bearing. The bearing is particularly useful for expansion joint systems in roadway constructions, bridge constructions, and architectural structures.



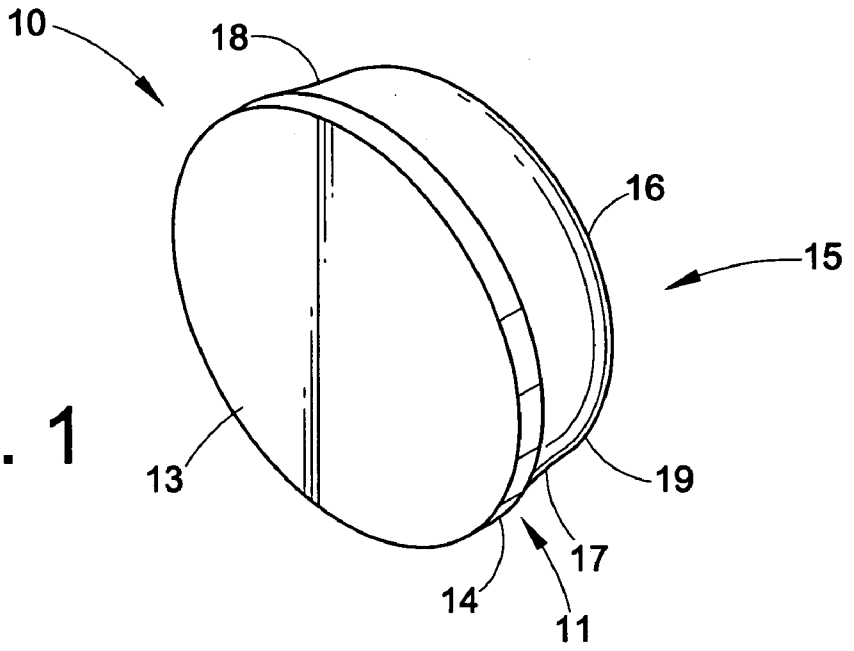


FIG. 1

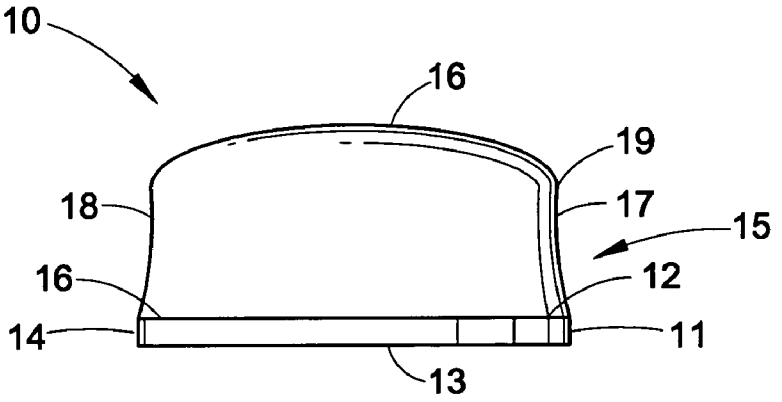


FIG. 2

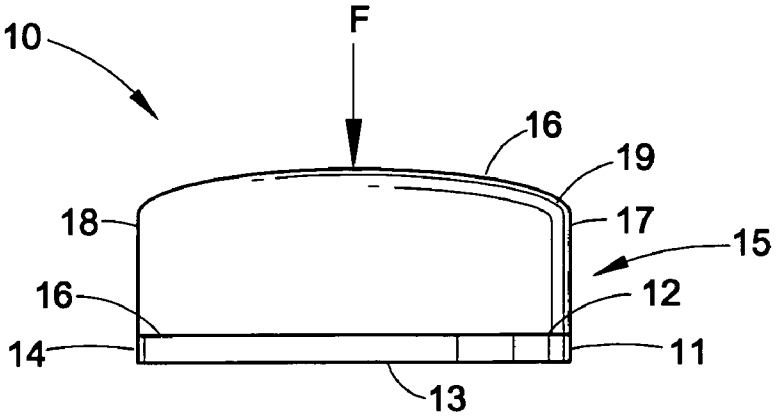


FIG. 3

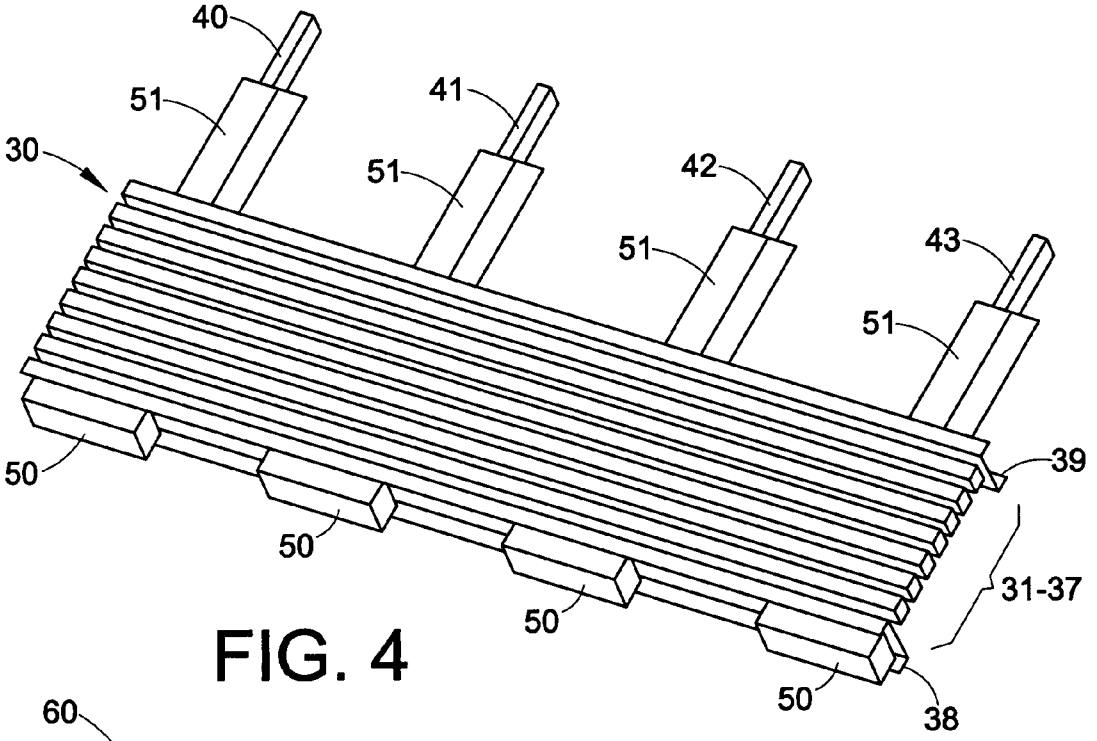


FIG. 4

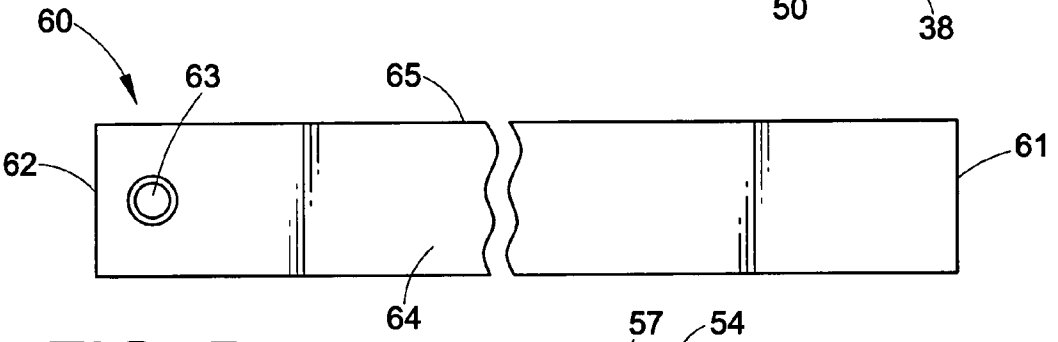


FIG. 5

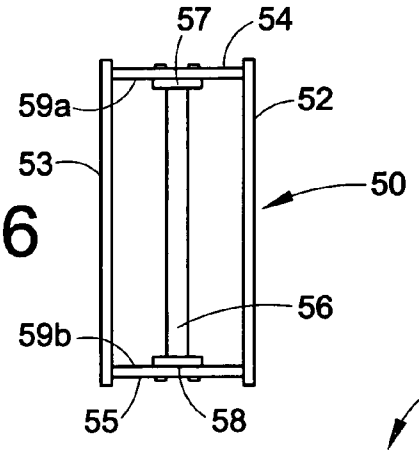


FIG. 6

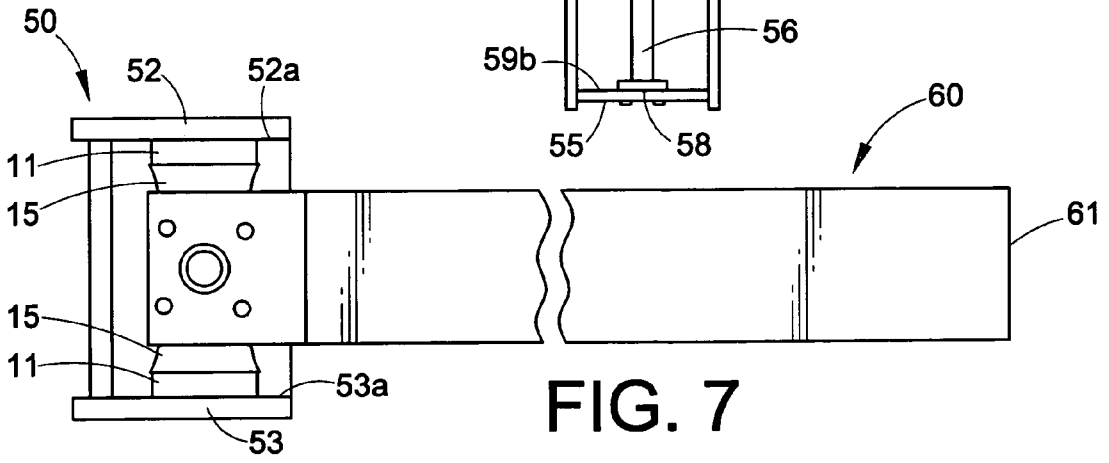


FIG. 7

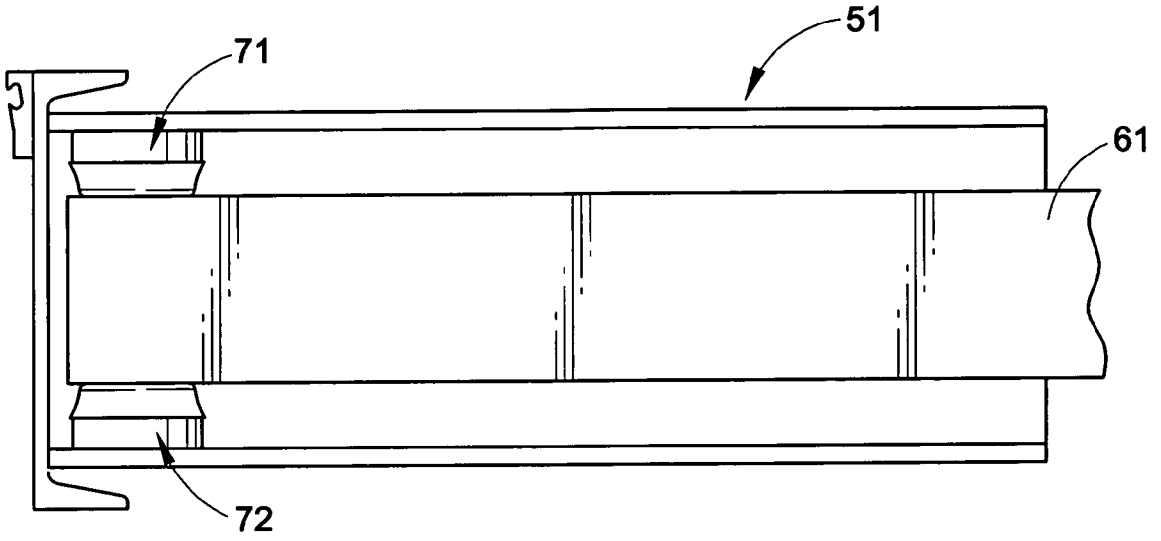


FIG. 8A

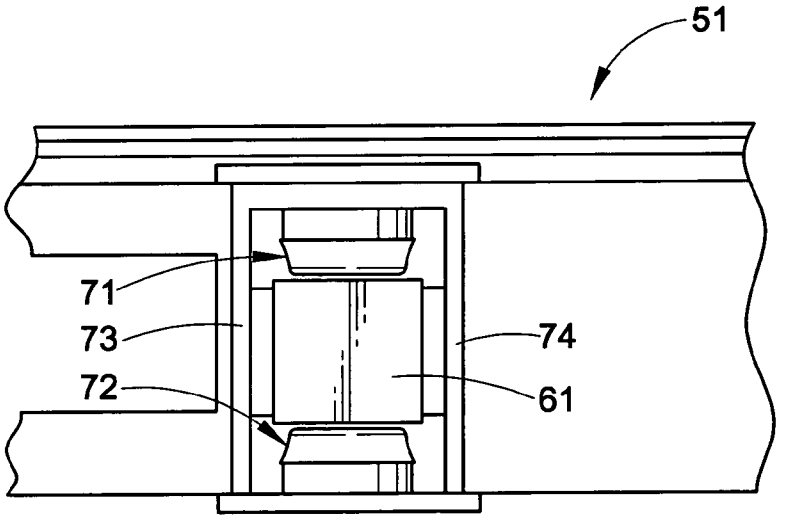


FIG. 8B

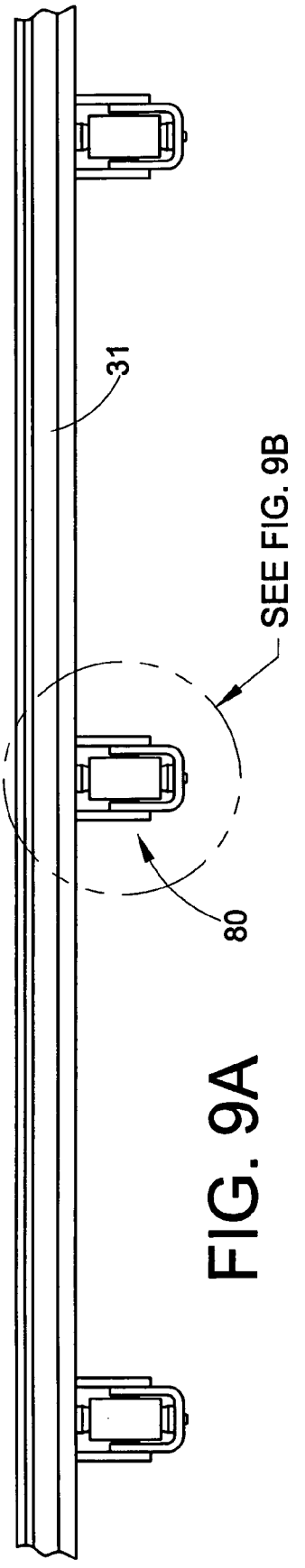


FIG. 9A

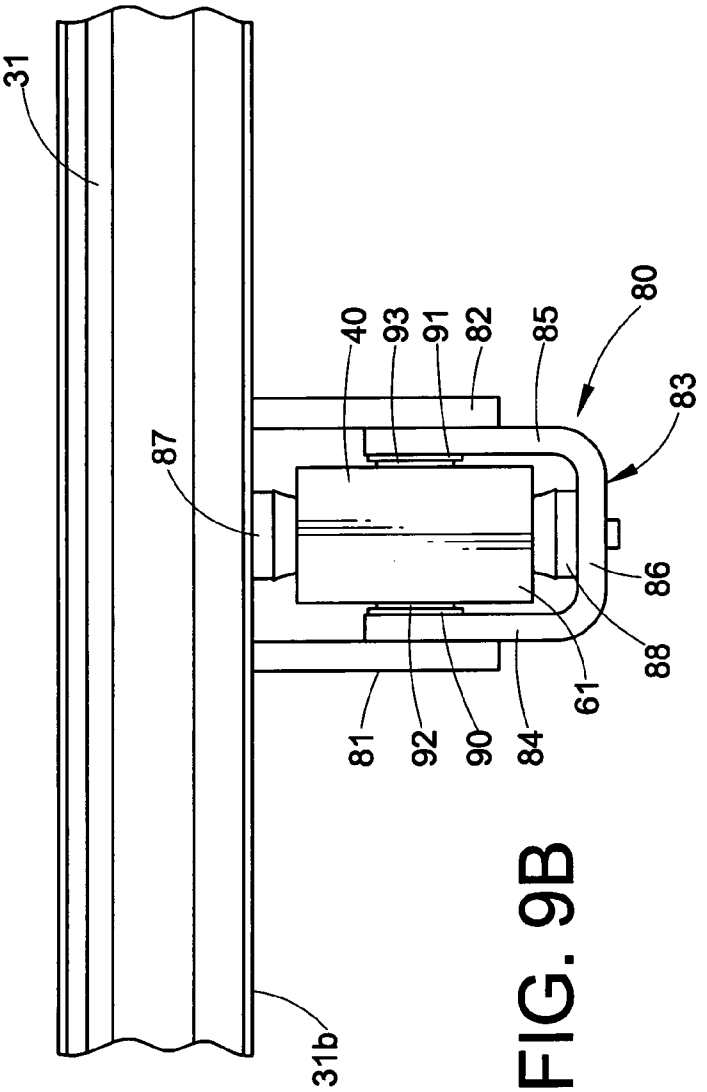


FIG. 9B

BEARING AND EXPANSION JOINT SYSTEM INCLUDING SAME

BACKGROUND

[0001] The present invention relates to a bearing structure. The present invention more particularly relates to a bearing structure for an expansion joint system and an expansion joint system including the bearing structure.

[0002] An opening or gap is purposely provided between adjacent concrete structures for accommodating dimensional changes within the gap occurring as expansion and contraction due to temperature changes, shortening and creep of the concrete caused by prestressing, seismic cycling and vibration, deflections caused by live loads, and longitudinal forces caused by vehicular traffic. An expansion joint system is conventionally utilized to accommodate these movements in the vicinity of the gap.

[0003] Bridge constructions are also subject to relative movement in response to occurrence of thermal changes, seismic events, and vehicle loads. This raises particular problems, because the movements occurring during such events are not predictable either with respect to the magnitude of the movements or with respect to the direction of the movements. Gaps or openings in the bridge deck are provided for accommodating these movements, and expansion joint systems are often installed in the gap. In many instances, bridges have become unusable for significant periods of time, due to the fact that traffic cannot travel across damaged expansion joints.

[0004] Prior art expansion joint systems include various types of bearings for absorbing loads applied to the expansion joint system and for supporting the various expansion joint system components. However, many of the bearings used in expansion joint systems cannot absorb the increased loads and rotations that are demanded by the roadway and bridge designs. Therefore, a need still exists in the art for an improved bearing structure that can accommodate increased loads and an expansion joint system including an improved bearing that can accommodate movements that occur in the vicinity of a gap having an expansion joint between two adjacent roadway sections, for example, movements that occur in longitudinal and transverse directions relative to the flow of traffic, and which are a result of thermal changes, seismic events, and deflections caused by vehicular loads.

SUMMARY

[0005] A bearing structure is provided, said bearing structure comprising a bearing substrate and an upper bearing portion disposed on a portion of said bearing substrate, said upper bearing portion including concavely curved side walls.

[0006] According to certain embodiments, the upper bearing portion includes curved side walls, a substantially curved upper bearing surface, and a flat seat region.

[0007] An expansion joint system is further provided for a roadway construction wherein a gap is defined between adjacent first and second roadway sections, said expansion joint system extending across said gap to permit vehicular traffic, said expansion joint system comprising transversely extending, spaced-apart, vehicular load bearing members, elongated support members having opposite ends positioned below said transversely extending load bearing members and extending longitudinally across said expansion joint gap, first means for accepting ends of said longitudinally extending elongated support members for controlling the movement of said ends of said support members within said first means for accepting longitudinally extending elongated support members, second means for accepting opposite ends of said longitudinally extending elongated support members for controlling the movement of said opposite ends of said support members within said second means for accepting longitudinally extending elongated support members, and bearing means disposed between said ends of said longitudinally extending elongated support members and said first and second means for accepting ends of said longitudinally extending elongated support members, said bearing means comprising a bearing substrate and an upper bearing portion disposed on said bearing substrate, said upper bearing portion including concavely curved side walls.

[0008] According to certain embodiments, the bearing includes an upper bearing portion having curved side walls, a substantially curved upper bearing surface, and a flat seat region.

[0009] In another embodiment, an expansion joint system is provided for a roadway construction wherein a gap is defined between adjacent first and second roadway sections, said expansion joint system extending across said gap to permit vehicular traffic, said expansion joint system comprising transversely extending, spaced-apart, vehicular load bearing members, elongated support members having opposite ends positioned below said transversely extending load bearing members and extending longitudinally across said expansion joint, means for movably engaging said longitudinally extending, elongated support members with at least one of said transversely extending, spaced-apart load bearing members, and bearing means disposed between lateral sides of said longitudinally extending elongated support members and surfaces of said means for movably engaging at least one of said longitudinally extending, elongated support members with said transversely extending, spaced-apart load bearing members, said bearing means comprising a bearing substrate and an upper bearing portion disposed on said bearing substrate, said upper bearing portion including concavely curved side walls.

[0010] According to certain embodiments, the bearing includes an upper bearing portion having curved side walls, a substantially curved upper bearing surface, and a flat seat region.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] **FIG. 1** is an exploded perspective view of the bearing structure.

[0012] **FIG. 2** is a side view of the bearing structure in an uncompressed state in the absence of a load.

[0013] **FIG. 3** is a side view of the bearing structure in a compressed state in response to the application of a load to the bearing.

[0014] **FIG. 4** shows a top perspective view of the expansion joint system including the bearing structure

[0015] **FIG. 5** is a side view of an illustrative support bar member.

[0016] **FIG. 6** is a rear view of the means for permitting transverse movement of the support bar members.

[0017] **FIG. 7** is a side view of an illustrative support bar member inserted into means for permitting transverse movement of the support bar member.

[0018] **FIG. 8A** is a side view of the means for permitting longitudinal and vertical movement of the support bar member.

[0019] **FIG. 8B** is an end view of the means for permitting longitudinal and vertical movement of the support bar member.

[0020] **FIG. 9A** is a side view of a portion of the expansion joint system including an end view of the yoke assembly for maintaining the support bar member in proximity to the bottom surfaces of the load bearing beams of the expansion joint system.

[0021] **FIG. 9B** is an enlarged fragmentary side view of a portion of the expansion joint system including an end view of the yoke assembly for maintaining the support bar member in proximity to the bottom surfaces of the load bearing beams of the expansion joint system.

DETAILED DESCRIPTION

[0022] An improved bearing structure is provided. Without limitation, the bearing can be utilized in connection with an expansion joint system in roadway constructions, bridge constructions, tunnel constructions, and other constructions where gaps are formed between spaced-apart, adjacent concrete sections. The expansion joint system may be utilized where it is desirable to absorb loads applied to the expansion joint systems, and to accommodate movements that occur in the vicinity of the expansion joint gap in response to the application of the applied loads to the expansion joint system.

[0023] The bearing structure includes a bearing substrate and an upper bearing portion that is disposed on, or otherwise fitted over, a portion of the bearing substrate. The upper bearing portion of the bearing includes curved side walls and a curved upper bearing surface.

[0024] The bearing structure will now be described in greater detail with reference to the FIGURES. It should be noted that the bearing structure is not intended to be limited to the illustrative embodiments shown in the FIGURES.

[0025] **FIG. 1** shows an exploded side view of one embodiment of the bearing structure **10**. Bearing structure **10** comprises a substrate **11** that is manufactured from a resilient material. According to the embodiment shown in **FIG. 1**, bearing substrate **11** is shown having a substantially cylindrical shape. The bearing substrate **11** includes a top surface **12**, bottom surface **13**, and side walls **14** that extend between top surface **12** and bottom surface **13**.

[0026] Bearing structure **10** also includes an upper bearing portion **15**. Upper bearing portion **15** includes a top bearing surface **16** and side walls **17** extending downwardly away from top bearing surface **16**. The side walls **17** of upper bearing portion **15** include oppositely facing inner **18** and outer **19** surfaces. The top bearing surface **16** and curved side walls **17**, together, form a cap-like structure having an inner volume **20**.

[0027] Now turning to **FIG. 2**, the bearing structure **10** is shown with upper bearing portion **15** engaged with the bearing substrate **11**. Upper bearing portion **15** is engaged with bearing substrate **11** by disposing or otherwise fitting upper bearing portion **15** over a portion of bearing substrate **11**. The upper bearing portion **15** is fitted over the top surface **12** of bearing substrate **11**, and the side walls **17** of upper bearing portion **15** extend over a portion of the side walls **14** of the bearing substrate **11**.

[0028] According to **FIG. 2**, the bearing structure **10** is shown under conditions where no force or load is applied to the top bearing surface **16** of the upper bearing portion **15** of the bearing **10**. The side walls **17** of the upper bearing portion **15** are constructed such that in the absence of a force or load on the upper bearing portion **15** the sides walls **17** of upper bearing portion **15** have a curved shape. That is, the side walls **17** of upper bearing portion **15** remain concavely curved and "bow in" toward the center of the upper bearing portion **15**. A portion of the upper bearing surface **16** includes a flat seat region. The flat seat region of upper bearing surface **16** may be centrally located.

[0029] Turning to **FIG. 3**, the bearing structure **10** is shown under conditions where a force or load (F) is applied to the top bearing surface **16** of the upper bearing portion **15**. Under conditions where a force or load is applied to the upper bearing surface **16** of the bearing **10**, the side walls **17** of upper bearing portion **16** are urged downwardly along the outer surfaces of side walls **14** of bearing substrate **11** and upper bearing portion **16** moves into closer proximity with bearing substrate **11**. As upper bearing portion **15** is urged in a downward direction toward bearing substrate **11**, the shape of the side walls **17** of upper bearing portion **15** undergo a transition from being concavely curved toward the center of the upper bearing portion **15** to a vertical configuration. That is, as top bearing portion **15** is urged downwardly the side walls **17** change configuration from the concavely shaped side walls to a position that is perpendicular to the upper bearing surface **16** of upper bearing portion **15** and top surface **12** of bearing substrate **11**. When an out of level force or load is applied to upper bearing surface **16** at an angle, the upper bearing portion **15** of structural bearing **10** is able to transmit the vertical load such that the bottom surface of the bearing "feels" very minimal eccentricity.

[0030] Distortional stresses in response to the application of a load to a traditional bearing structure often caused damage to the bearing structure. The use of the bearing structure **10** having concavely curved side walls **17** minimizes the distortional stresses below the bearing surface in response to the application of a force or load. The optimized geometric combination of curved side walls, curved top bearing surface, and flat seat region reduces local distortional stresses directly below the applied load, and moves the maximum distortional stress region to below the surface, based on the accepted principles of elasticity.

[0031] It is known that prior art bearing structure stiffness remains nearly constant over the range of applications, as they are compressed in response to the application of a load to the bearing. The use of the bearing structure **10** having an upper bearing portion **15** with concavely curved side walls **17** provides an increasing force versus deflection spring rate. Utilizing the bearing structure **10** having an upper bearing portion **15** with curved side walls **17** permits the bearing

structure to be precompressed to a significant degree, thereby mitigating bearing vibration when large vehicular impact loads are applied to the bearing. Additionally, the use of the bearing structure **10** having an upper bearing portion **15** with curved side walls **17** stabilizes large displacements in response to loads applied to the bearing **10**.

[**0032**] In general, the top bearing surfaces of prior art bearings expand and contract against the support bar of the expansion joint systems in response to an application of a load, which causes significant rubbing and friction between the top bearing surfaces of the bearings and the surfaces of the support bar of the expansion joint systems. In contrast, upper bearing portion **15** of the bearing structure **10** expands upward to contact the surface of the support bar of the expansion joint systems. Under these conditions, less surface rubbing and friction occur between the top bearing surface **16** and the surface of the support bars of the expansion joint system. Because there is less friction between the top bearing surface **16** of the bearing **10** and the surfaces of the support bars, there is a significant decrease in the surface wear of the bearing **10**. Thus, the overall life of the bearing is increased.

[**0033**] The side walls of the prior art bearings bulge outwardly upon an application of a load to the top bearing surface. These bearings, sometimes referred to as parabolic bulge bearings, are bonded on the top and bottom surfaces, and are free to bulge on their sides. These bearings produce very large surface shears at the point where the free edge of the bearing meets the bonded surfaces. In contrast to prior art parabolic bulge bearings, the side walls **17** of bearing **10** are constructed in such a manner that upon maximum compression by a load applied to the bearing, the side walls **17** of upper bearing portion **15** are vertical. This is a significant improvement over prior art parabolic bulge bearings, as shear strains at the point of the bond of the free edge to the bonded edge is minimized.

[**0034**] An expansion joint system incorporating the improved structural bearing **10** is further provided. The expansion joint system may be utilized in a roadway construction wherein a gap is defined between adjacent first and second roadway sections. The expansion joint system extends across the gap between adjacent concrete roadway sections to permit vehicular traffic. The expansion joint system comprises transversely extending, spaced-apart, vehicular load bearing members. Elongated support members having opposite ends are positioned below the transversely extending load bearing members and extend longitudinally across the gap in the expansion joint from a first concrete roadway section to a second concrete roadway section. According to certain embodiments, the expansion joint system also includes first means for accepting first ends of the longitudinally extending elongated support members for controlling the movement of the ends of the support members within the first means for accepting longitudinally extending elongated support members, and second means for accepting opposite ends of the longitudinally extending elongated support members for controlling the movement of the opposite ends of said support members within the second means for accepting longitudinally extending elongated support members. Bearing structures **10** are disposed between sides surfaces of the opposite first and second ends of the longitudinally extending elongated support members and inner surfaces of the first and second means for accepting ends of the longitudinally extending elongated support members to absorb loads applied to the expansion joint system. The bearing structure includes a substrate and an upper bearing portion that is disposed on, or otherwise fitted over, the substrate. The upper bearing portion of the bearing comprises curved side walls and a curved upper bearing surface.

[**0035**] According to other embodiments, the expansion joint system includes transversely extending, spaced-apart, vehicular load bearing members, elongated support members having opposite ends positioned below the transversely extending load bearing members and extending longitudinally across the expansion joint, and means for movably engaging the longitudinally extending, elongated support members with the transversely extending, spaced-apart load bearing members. Bearings **10** are disposed between surfaces of lateral sides of the longitudinally extending elongated support bar members and surfaces of the means for movably engaging the longitudinally extending, elongated support bar members with the transversely extending, spaced-apart load bearing members. The bearing structure **10** includes a substrate and an upper bearing portion that is disposed on, or otherwise fitted over, the substrate. The upper bearing portion of the bearing comprises curved side walls and a curved upper bearing surface.

[**0036**] Now referring to illustrative **FIG. 4**, expansion joint system **30** includes a plurality of vehicular load bearing members **31-37**. The vehicular load bearing members **31-37** of expansion joint system **30** are positioned in the gap between the adjacent roadway sections (not shown). The vehicle load bearing members are often referred to in the art as "center beams." While illustrative **FIG. 4** shows seven transversely extending load bearing members **31-37**, it should be noted that the expansion joint system **30** may include any number of transversely extending load bearing members, depending on the size of the gap of the particular construction. According to certain embodiments, the load bearing members have a generally square or rectangular cross section. Nevertheless, the load bearing members **31-37** are not limited to members having approximately square or rectangular cross sections, but, rather, the load bearing beam members **31-37** may comprise any number of cross sectional configurations or shapes. The shape of the cross section of load bearing beam members **31-37** is only limited in that the load bearing beams **31-37** must be capable of permitting relatively smooth and unimpeded vehicular traffic across the top surfaces of the load bearing beam members, and the load bearing beam members must have the ability to support engaging means that are engaged to the bottom surfaces of the load bearing beam members to engage the longitudinally extending elongated support members. According to certain embodiments, the top surfaces of the load bearing beam members may, for example, also be contoured to facilitate the removal of debris and liquids, such as rainwater runoff.

[**0037**] The load bearing beam members **31-37** are positioned in a spaced apart, side-by-side relationship and extend transversely in the expansion joint gap relative to the direction of vehicle travel. That is, the load bearing members **31-37** extend substantially perpendicular, relative to the direction of vehicle travel across the expansion joint system **30**. The top surfaces of the load bearing beam members are adapted to support vehicle tires as a vehicle passes over the expansion joint. Compressible seals (not shown in **FIG. 1**,

but shown in **FIG. 9**) may be placed and extend transversely between the positioned vehicular load bearing beam members **31-37** adjacent the top surfaces of the beam members **31-37** to fill the spaces between the beam members **31-37**. The seals may also be placed and extend in the space between end beam member **31** and edge plate **38** and to extend between end beam member **37** and edge plate **39**. The seals are flexible and compressible and, therefore, can stretch and contract in response to movement of the load bearing beams within the expansion joint. The seals are preferably made from a durable and abrasion resistant elastomeric material. The seal members are not limited to any particular type of seal. Suitable sealing members that can be used include, but are not limited to, strip seals, glandular seals, and membrane seals.

[**0038**] Still referring to **FIG. 4**, the expansion joint system **30** includes elongated support bar members **40-43**. Support bar members **40-43** are positioned in a spaced-apart, side-by-side relationship and extend longitudinally across the gap of the expansion joint, relative to the direction of the flow of vehicular traffic. That is, the support bar members **40-43** extend substantially parallel relative to the direction of vehicle travel across the expansion joint system **30**. The support bar members **40-43** provide support to the vehicle load bearing beams **31-37** as vehicular traffic passes over the expansion joint system **30**. Support bar members **40-43** also accommodate transverse, longitudinal and vertical movement of the expansion joint system **30** within the gap.

[**0039**] Opposite ends of the support bar members **40-43** are received into suitable means for accepting the ends of the support bar members, and several means for accepting the support bar members are disposed, or embedded in portions of respective adjacent roadway sections in the roadway construction. The expansion joint system **30** can be affixed within the "block-out" areas between two adjacent roadway sections by disposing the system **30** into the gap between the roadway sections and pouring concrete into the block-out portions or by mechanically affixing the expansion joint system **30** in the gap to underlying structural support. Mechanical attachment may be accomplished, for example, by bolting or welding the expansion joint system **30** to the underlying structural support.

[**0040**] In accordance with the invention, provision is made for particular types of movement of the support bar members **40-43** within the separate means for accepting the ends of the support bar members. In one embodiment, the means for accepting the ends of the support bar members comprise box-like structures. It should be noted, however, that the means for accepting the ends of the support bar members may include any structure such as, for example, receptacles, chambers, housings, containers, enclosures, channels, tracks, slots, grooves or passages, that includes a suitable cavity for accepting opposite end portions of the support bar members **40-43**.

[**0041**] Still referring to **FIG. 4**, the expansion joint system **30** includes first means **50** for confining the first ends of the support bars **40-43** against longitudinal movement within the first means **50** for accepting, but permitting transverse movement of the first ends within the first means **50** for accepting. Therefore, the expansion joint system **30** includes first means for accepting first ends of the longitudinally extending elongated support members which include means for substantially restricting longitudinal movement within the first means for accepting, but permitting transverse and vertical movement within said first means for accepting.

[**0042**] The expansion joint system **30** includes second means **51** for accepting opposite ends of the support members **40-43** for confining the opposite ends of the support bars **40-43** against transverse movement within the second means **51** for accepting, but permitting longitudinal movement and vertical movement within the second means **51** for accepting. Therefore, the expansion joint system **30** includes second means for accepting ends of said longitudinally extending elongated support members which includes means for substantially restricting transverse movement within said second means for accepting, but permitting longitudinal movement within said second means for accepting.

[**0043**] **FIG. 5** shows an illustrative support member **60** of the expansion joint system **30**. The support member **60** is shown as an elongated bar-like member having a square cross section. It should be noted, however, that the support member **60** is not limited to elongated bar members having square cross sections, but, rather, the support member **60** may comprise an elongated bar member having a number of different cross sectional shapes such as, for example, round, oval, oblong and rectangular. The support bar **60** includes opposite ends **61**, **62**. Illustrative support bar **60** includes a hole **63** communicating from one side **64** of the support bar **60** to the other side **65**. According to this embodiment, the hole **63** is adapted to receive a securing means. End **62** of the support bar **60** having the hole **63** therein is adapted to be inserted into first means **50** for permitting transverse and vertical movement, but substantially restricting longitudinal movement of the support member **60** of the expansion joint system **30** within the means **50**.

[**0044**] **FIG. 6** shows a side view of means **50**, which according to the embodiment shown is a substantially rectangular box structure, and which permits transverse and vertical movement of support bars **40-43** of the expansion joint system **30** in response to movement within the expansion joint. The transverse and vertical movement box **50** includes top **52** and bottom **53** plates, side plates **54**, **55** and back plate (not shown). According to this embodiment, the securing means **56** is an elongated, substantially cylindrical guide rod to which a support bar **40-43** is engaged. The securing means **56** is substantially centrally disposed within box **50** may extend across box **50** from side plate **54** to side plate **55**. The securing means **56** may be held in place by holding plates **57**, **58**, which are attached to the inside wall surfaces **59***a*, **59***b* of side plate **54** and side plate **55**, respectively. The securing means **56** is inserted into the hole **63** in order to secure the support bar **40-43** within means **50**. The securement means **56** can be any means which permits pivotable movement of end **62** of the support bar in the vertical direction within means **50**, while further permitting transverse movement of end **62** of the support bar along the axis of the securement means. Thus, the securing means **56** substantially restricts longitudinal movement of the support bars **40-43**, but permits transverse and vertical movement. While the securing means **56** is shown in **FIG. 6** as a cylindrical guide rod, it may, for example, include differently shaped rods, bars, pegs, pins, bolts, and the like.

[**0045**] **FIG. 7** shows one end **62** of the support bar **60** inserted into means **50**. Bearing means **10** are disposed between the top surface of support bar member **60** and the inner surface **52***a* of top plate **52** of box **50** and between the bottom surface of the support bar member **60** and the inner surface **53***a* of bottom plate **53**. The rigid bearing substrate **11** of bearing structure is positioned adjacent to inside surface **52***a* of top plate **52** and top bearing surface **16** of

upper bearing portion **15** may contact top surface of support bar member **60**. A second bearing means **10** is positioned within box **50**. The rigid bearing substrate **11** of the second bearing structure is positioned adjacent to inside surface **53***a* of bottom plate **53** and top bearing surface **16** of upper bearing portion **15** may contact bottom surface **64** of support bar member **60**.

[**0046**] **FIGS. 8A and 8B** shows longitudinal movement support box **51**. Box **51** includes means for permitting longitudinal and vertical movement of the support bars **40-43** within box **51**, and means for substantially preventing transverse movement of support bars **40-43** within the box **51**. Preferably, the upper **71** and lower **72** bearing means maintain the vertical load on the support bars perpendicular to the axis of the support bars and, permits slidable movement of the support bars in the direction of vehicular traffic flow (longitudinal movement). Upper and lower bearing means **71**,**72** are the constructed like bearing structure **10** described in **FIGS. 1-3**. As shown in **FIG. 8B**, side bearing means **73**, **74** substantially prevent transverse movement of support bars **40-43** within box **51**, while not inhibiting or otherwise preventing longitudinal and vertical movement. According to the embodiment shown, side bearing means **73**, **74** are provided in the form of bearing plates that are disposed adjacent the inner surfaces of box **51**.

[**0047**] The use of the upper **71** and lower **72** bearings maintain the vertical load on the bearings perpendicular to the sliding surfaces. The upper and lower bearings are capable of absorbing impact from vehicular traffic moving across the expansion joint system.

[**0048**] The transverse movement box for receiving one end of the support bars is designed to permit transverse and vertical movement of the support bars within the boxes in response to changes in temperature changes, seismic movement or deflections caused by vehicular traffic, while restricting longitudinal movement. Longitudinal boxes for receiving the opposite ends of the support bars are designed to permit relative longitudinal and vertical movement of the support bar within the boxes, while confining the bars against relative transverse movement.

[**0049**] Means are provided to maintain the position of support bars **40-43** relative to the bottom surfaces of the load bearing beams members **31-37**. Also, the means permit longitudinal and limited vertical movement of the support bars **40-43** within the means. **FIGS. 9A and 9B** show one embodiment of the means, which comprises a yoke or stirrup assembly **80** for retaining the position of the support bars **40-43** relative to the bottom surfaces of the load bearing beams **31-37** of the expansion joint system **30**. As shown in **FIG. 9B**, the yoke assembly **80** includes spaced-apart yoke side plates **81**, **82** that are attached to and extend away from the bottom surface of the vehicular load bearing beam **31**. Bent yoke plate **83** includes leg portions **84**, **85** and spanning portion **86** that extends between legs **84**, **85**. The yoke assembly **80** also includes upper yoke bearing **87** and lower yoke bearing **88**. The yoke assembly **80** utilizes upper **87** and lower **88** yoke bearings to minimize yoke tilt and optimizes the ability of the expansion joint system **30** to absorb vehicular impact from traffic moving across the expansion joint system **30**. While the one embodiment is shown utilizing a yoke or stirrup assembly to maintain the positioning of the support bars **40-43**, any restraining device or the like that can maintain the position of the support bars **40-43** relative to the load bearing beams **31-37** may be utilized.

[**0050**] Yoke assembly **80** may further include yoke retaining rings **90**, **91** and yoke discs **92**, **93**, which are located on the inner surfaces of bent yoke legs **74**, **75**. The yoke retaining rings **81**, **82** and yoke discs **83**, **84** are provided to allow limited vertical and longitudinal movement of the support bars **40-43**. Furthermore, the yoke side plates **81**, **82** are spaced apart at a distance sufficient to permit bent yoke plate **83** to be inserted in the space defined by the inner surfaces of yoke side plates **81**, **82**.

[**0051**] The expansion joint system **30** may also include means for controlling the spacing between the transversely extending load bearing beam members **31-37** in response to movement in the vicinity of the expansion joint. In one embodiment, the means for controlling the spacing between beam members **31-37** maintains a substantially equal distance between the spaced-apart, traffic load bearing beams **31-37** that are transversely positioned within the gap in an expansion joint, in response to movements caused by thermal or seismic cycling and vehicle deflections.

[**0052**] The expansion joint system of the invention is used in the gap between adjacent concrete roadway sections. The concrete is typically poured into the blockout portions of adjacent roadway sections. The gap is provided between first and second roadway sections to accommodate expansion and contraction due to thermal fluctuations and seismic cycling. The expansion joint system can be affixed within the block-out portions between two roadway sections by disposing the system into the gap between the roadway sections and pouring concrete into the block-out portions or by mechanically affixing the expansion joint system in the gap to underlying structural support. Mechanical attachment may be accomplished, for example, by bolting or welding the expansion joint system to the underlying structural support.

[**0053**] While the present invention has been described above in connection with the preferred embodiments, as shown in the various figures, it is to be understood that other similar embodiments may be used or modifications and additions may be made to the described embodiments for performing the same function of the present invention without deviating therefrom. Further, all embodiments disclosed are not necessarily in the alternative, as various embodiments of the invention may be combined to provide the desired characteristics. Variations can be made by one having ordinary skill in the art without departing from the spirit and scope of the invention. Therefore, the present invention should not be limited to any single embodiment, but rather construed in breadth and scope in accordance with the recitation of the attached claims.

I claim:

1. A bearing comprising:

a bearing substrate; and

an upper bearing portion disposed on said bearing substrate, said upper bearing portion including curved side walls and a curved upper bearing surface, concavely curved side walls and a flat seat region.

2. The bearing of claim 1, wherein said upper bearing portion further comprises a curved upper bearing surface with a flat seat region.

3. The bearing of claim 1, wherein said curved side walls of said upper bearing portion are concavely curved toward the center of said upper bearing portion.

4. The bearing of claim 1, wherein said bearing substrate is substantially cylindrical.

5. The bearing of claim 1, wherein said side walls of said upper bearing portion are bonded over at least a portion of said bearing substrate.

6. The bearing of claim 1, wherein said substrate comprises a material that substantially resists a conformational change in response to the application of a load.

7. The bearing of claim 1, wherein said upper bearing portion comprises a material that is capable of undergoing a conformational change in response to the application of a load to said bearing.

8. The bearing of claim 7, wherein said upper bearing portion is capable of undergoing a conformational change in response to the application of a maximum load to said bearing, whereby said side walls of said upper bearing portion change conformation from being concavely curved to a conformation that is substantially perpendicular to said upper surface of said bearing substrate of said bearing.

9. The bearing of claim 1, wherein said substrate comprises a material selected from the group consisting of polymers, composites, and metal alloys.

10. The bearing of claim 9, wherein said composite comprises a fiber reinforced polymer.

11. The bearing of claim 9, wherein said polymer is selected from the group consisting of urethane, polytetrafluoroethylene, polyethylene, phenolic, and nylon polymers.

12. The bearing of claim 11, wherein said polymer is a phenolic polymer.

13. The bearing of claim 9, wherein said metal alloy is selected from the group consisting of bronze and steel.

14. The bearing of claim 1, wherein said upper bearing portion comprises an elastomeric material.

15. The bearing of claim 14, wherein said elastomeric material is selected from the group consisting of polyurethane, polychloroprene, isoprene, styrene butadiene rubber, and natural rubber.

16. The bearing of claim 15, wherein said elastomeric material is a urethane material.

17. An expansion joint system for roadway construction wherein a gap is defined between adjacent first and second roadway sections, said expansion joint system extending across said gap to permit vehicular traffic, said expansion joint system comprising:

transversely extending, spaced-apart, vehicular load bearing members;

elongated support members having opposite ends positioned below said transversely extending load bearing members and extending longitudinally across said expansion joint;

first means for accepting ends of said longitudinally extending elongated support members for controlling the movement of said ends of said support members within said first means for accepting longitudinally extending elongated support members;

second means for accepting opposite ends of said longitudinally extending elongated support members for controlling the movement of said opposite ends of said support members within said second means for accepting longitudinally extending elongated support members; and

bearing means disposed between surfaces of said longitudinally extending elongated support members and inner surfaces of at least one of said first and second means for accepting ends of said longitudinally extending elongated support members, said bearing means comprising a bearing substrate and an upper bearing portion disposed on said bearing substrate, said upper bearing portion including concavely curved side walls.

18. The expansion joint system of claim 17, wherein said upper bearing portion further comprises a curved upper bearing surface with a flat seat region.

19. The expansion joint system of claim 17, further comprising means for controlling the spacing of said transversely extending, spaced-apart, load bearing members relative to one another.

20. The expansion joint system of claim 17, wherein said longitudinally extending load bearing members extend across said expansion joint gap from said first roadway section to said second roadway section.

21. The expansion joint system of claim 17, wherein said first and second means for accepting said ends of said longitudinally extending elongated support members are structures selected from the group consisting of boxes, receptacles, chambers, housings, containers, enclosures, channels, tracks, slots, grooves, and passages.

22. The expansion joint system of claim 17, wherein said first means for accepting said opposite ends of said longitudinally extending elongated support members substantially restricts longitudinal movement of said longitudinally extending elongated support members within said first means for accepting, but permits transverse and vertical movement of said longitudinally extending elongated support members within said first means for accepting; and

wherein said second means for accepting ends of said longitudinally extending elongated support members substantially restricts transverse movement of said longitudinally extending elongated support members within said second means for accepting, but permits longitudinal movement of said longitudinally extending elongated support members within said second means for accepting.

23. The expansion joint system of claim 17, further comprising means for movably engaging said longitudinally extending, elongated support members with said transversely extending, spaced-apart load bearing members.

24. The expansion joint system of claim 23, wherein said means for movably engaging said longitudinally extending, elongated support members with said transversely extending, spaced-apart load bearing members comprises a yoke assembly.

25. The expansion joint system of claim 24, wherein said yoke assembly comprises spaced-apart yoke side plates and a bent yoke plate spanning the gap between said spaced-apart yoke side plates.

26. The expansion joint system of claim 25, wherein said yoke assembly slidably engages said longitudinally extending, elongated support members with at least one of said transversely extending, spaced-apart load bearing members.

27. The expansion joint system of claim 17, wherein said curved side walls of said upper bearing portion are concavely curved toward the center of said upper bearing portion.

28. The expansion joint system of claim 17, wherein said bearing substrate is substantially cylindrical.

29. The expansion joint system of claim 17, wherein said side walls of said upper bearing portion are bonded over at least a portion of said bearing substrate.

30. The expansion joint system of claim 17, wherein said substrate comprises a material that substantially resists a conformational change in response to the application of a load.

31. The expansion joint system of claim 17, wherein said upper bearing portion comprises a material that is capable of undergoing a conformational change in response to the application of a load to said bearing.

32. The expansion joint systems of claim 31, wherein said upper bearing portion is capable of undergoing a conformational change in response to the application of a maximum load to said bearing, whereby said side walls of said upper bearing portion change conformation from being concavely curved to a conformation that is substantially perpendicular to said upper surface of said upper bearing portion of said bearing.

33. The expansion joint system of claim 17, wherein said substrate comprises a material selected from the group consisting of polymers, composites, and metal alloys.

34. The expansion joint system of claim 33, wherein said composite material comprises fiber reinforced polymers.

35. The expansion joint system of claim 33, wherein said polymer is a polymer selected from the group consisting of urethane, polytetrafluoroethylene, polyethylene, phenolic, and nylon polymers.

36. The expansion joint system of claim 35, wherein said polymer is a phenolic polymer.

37. The expansion joint system of claim 33, wherein said metal alloy is selected from the group consisting of bronze and steel.

38. The expansion joint system of claim 17, wherein said upper bearing portion comprises an elastomeric material.

39. The expansion joint system of claim 38, wherein said elastomeric material is selected from the group consisting of polyurethane, polychloroprene, isoprene, styrene butadiene rubber, and natural rubber.

40. The expansion joint system of claim 39, wherein said elastomeric material is a polyurethane material.

41. The expansion joint system of claim 17, comprising seals extending between said transversely extending, spaced-apart load bearing members.

42. The expansion joint system of claim 17, comprising seals extending between said transversely extending, spaced apart load bearing members, and between said transversely extending, spaced apart load bearing members and edge sections of said first and said second roadway sections.

43. The expansion joint system of claim 42, wherein said seals are flexible and compressible.

44. The expansion joint system of claim 42, wherein said seals comprise an elastomeric material.

45. The expansion joint system of claim 44, wherein said seals are selected from strip seals, glandular seals, and membrane seals.

46. The expansion joint system of claim 45, wherein said seals are strip seals.

47. An expansion joint system for roadway construction wherein a gap is defined between adjacent first and second roadway sections, said expansion joint system extending across said gap to permit vehicular traffic, said expansion joint system comprising:

transversely extending, spaced-apart, vehicular load bearing members;

elongated support members having opposite ends positioned below said transversely extending load bearing members and extending longitudinally across said expansion joint;

means for movably engaging said longitudinally extending, elongated support members with at least one of said transversely extending, spaced-apart load bearing members; and

bearing means disposed between surfaces of said longitudinally extending elongated support members and surfaces of said means for movably engaging at least one of said longitudinally extending, elongated support members with said transversely extending, spaced-apart load bearing members, said bearing means comprising a bearing substrate and an upper bearing portion disposed on at least a portion of said bearing substrate, said upper bearing portion including concavely curved side walls.

48. The expansion joint system of claim 47, wherein said upper bearing portion further comprises a curved upper bearing surface with a flat seat region.

49. The expansion joint system of claim 47, wherein said curved side walls of said upper bearing portion are concavely curved toward the center of said upper bearing portion.

50. The expansion joint system of claim 47, wherein said bearing substrate is substantially cylindrical.

51. The expansion joint system of claim 47, wherein said side walls of said upper bearing portion are bonded over at least a portion said bearing substrate.

52. The expansion joint system of claim 47, wherein said substrate comprises a material that substantially resists a conformational change in response to the application of a load.

53. The expansion joint system of claim 47, wherein said upper bearing portion comprises a material that is capable of undergoing a conformational change in response to the application of a load to said bearing.

54. The expansion joint system of claim 53, wherein said upper bearing portion is capable of undergoing a conformational change in response to the application of a maximum load to said bearing, whereby said side walls of said upper bearing portion change conformation from being concavely curved to a conformation that is substantially perpendicular to said upper surface of said upper bearing portion of said bearing.

55. The expansion joint system of claim 47, wherein said bearing substrate comprises a material selected from the group consisting of polymers, composites, and metal alloys.

56. The expansion joint system of claim 55, wherein said composite material comprises fiber reinforced polymers.

57. The expansion joint system of claim 55, wherein said polymer is selected from the group consisting of urethane, polytetrafluoroethylene, polyethylene, phenolic, and nylon polymers.

58. The expansion joint system of claim 57, wherein said polymer is a phenolic polymer.

59. The expansion joint system of claim 55, wherein said metal alloy is selected from the group consisting of bronze and steel.

60. The expansion joint system of claim 47, wherein said upper bearing portion comprises an elastomeric material.

61. The expansion joint system of claim 60, wherein said elastomeric material is selected from the group consisting of polyurethane, polychloroprene, isoprene, styrene butadiene rubber, and natural rubber.

62. The expansion joint system of claim 61, wherein said elastomeric material is a polyurethane material.

63. The expansion joint system of claim 47, further comprising means for controlling the spacing of said transversely extending, spaced-apart, load bearing members relative to one another.

64. The expansion joint system of claim 47, wherein said means for movably engaging said longitudinally extending, elongated support members with at least one of said transversely extending, spaced-apart load bearing members comprises a yoke assembly.

65. The expansion joint system of claim 47, comprising seals extending between said transversely extending, spaced-apart load bearing members.

66. The expansion joint system of claim 47, comprising seals extending between said transversely extending, spaced apart load bearing members, and between said transversely extending, spaced apart load bearing members and edge sections of said first and said second roadway sections.

67. The expansion joint system of claim 66, wherein said seals are selected from the group consisting of glandular seals, membrane seals, and strip seals.

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