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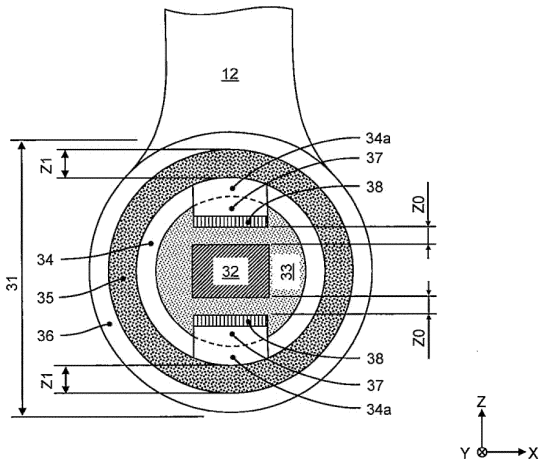
(54) RAILWAY VEHICLE

(57) A railroad vehicle is provided with a vehicle body, a truck frame constituting a truck supporting the vehicle body, an anti-rolling device provided stretching between the vehicle body and the truck frame to suppress a relative roll displacement of the vehicle body, a torsion bar provided extending in the width direction of the vehicle body in the anti-rolling device, an arm extending in the longitudinal direction of the vehicle body from each end of the torsion bar, a rod extending in the vertical direction of the vehicle body from the tip of the arm, and a joint section provided at a tip of the rod, an annular member provided in the joint section and connected to the rod, a first elastic body filling the inside of the annular member, a coupling bar extending along the axis of the annular member and supported by the first elastic body, and a control member for controlling the displacement of the coupling bar in the height direction.

[FIG. 5]



C-C CROSS SECTION IN FIG. 3

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Description

Technical Field

[0001] The present invention relates to a railroad vehicle provided with an anti-rolling device that suppresses roll oscillation of a vehicle body to improve riding quality when the vehicle passes through a curve section of a track. For example, the present invention relates to a railroad vehicle in which an anti-rolling device is disposed together with a vehicle body tilting device which inclines the vehicle body to the inner rail side in order to pass a curve section of a track at high speed.

Background Art

[0002] When the railroad vehicle passes through a curve section of a track, since centrifugal force acts on the vehicle body of the railroad vehicle, the railroad vehicle is inclined to the outer rail side. Normally, the centrifugal force is canceled by gravity by providing a cant on the railroad surface so that the track on the outer rail side is higher than that on the inner rail side to prevent the vehicle body from leaning to the outer rail side when the railroad vehicle passes through the curve section of the track. When the cant amount is set appropriately for the curve passing speed of the railroad vehicle, the components of centrifugal force and gravity cancel each other, and no centrifugal force acts on the passengers in the railroad vehicle in appearance.

[0003] On the other hand, if the railroad vehicle travels through the curve section of the track at a speed exceeding the balancing speed at which the components of centrifugal force and gravity can cancel each other, the excess centrifugal force that cannot be cancelled by the cant acts on the railroad vehicle so that the passengers have a feeling of being swung outside the curve and feel an uncomfortable ride. In order to suppress the deterioration of the ride quality caused by the excess centrifugal force, the railroad vehicle is provided with a vehicle body tilting device that positively inclines the railroad vehicle to the inner rail side of the curve more than the cant amount.

[0004] On the other hand, when the railroad vehicle travels on the track at high speed, track irregularities or the like may cause roll oscillation in which the railroad vehicle oscillates around an axis along the rail direction. For this reason, a railroad vehicle may be equipped with an anti-rolling device which suppresses this roll oscillation.

[0005] The anti-rolling device acts as a spring element for relative displacement in the roll direction between the vehicle body and the truck. For this reason, when the vehicle body tilting device attempts to incline the railroad vehicle to the curved inner rail side of the curve section of the track, the anti-rolling device generates a moment in the opposite direction to the direction in which the vehicle body is desired to be inclined. Patent Literature 1 discloses a railroad vehicle provided with an anti-rolling device having a torsion bar.

Prior Art Document

Patent Document

[0006] Patent Document 1: JP-2005-238858-A

Summary of the Invention

Problem to be Solved by the Invention

[0007] A railroad vehicle is provided with a vehicle body tilting device which inclines the railroad vehicle to the inner rail side of the track when the vehicle passes through a curve section of the track. In the case where an anti-rolling device for suppressing the roll oscillation of the railroad vehicle is disposed on the railroad vehicle, when the vehicle body tilting device attempts to tilt the railroad vehicle, the anti-rolling device acts in a direction to interfere with the tilt. For this reason, there is a problem that it is difficult to utilize both the functions of the vehicle body tilting device and the anti-rolling device in a railroad vehicle in which the vehicle body tilting device and the anti-rolling device are provided together.

[0008] The present invention has been made in consideration of the above points, and an object thereof is to propose a railroad vehicle provided with an anti-rolling device which does not inhibit the function of the vehicle body tilting device.

Means for Solving the Problem

[0009] In order to solve such a problem, in the present invention, a railroad vehicle is provided with a vehicle body, a truck frame constituting a truck supporting the vehicle body, an anti-rolling device provided stretching between the vehicle body and the truck frame to suppress a relative roll displacement of the vehicle body, a torsion bar provided extending in the width direction of the vehicle body in the anti-rolling device, an arm extending in the longitudinal direction of the vehicle body from each end of the torsion bar, a rod extending in the vertical direction of the vehicle body from the tip of the arm, a joint section provided at the tip of the rod, an annular member provided at the joint section and connected to the rod, a first elastic body filling the inside of the annular member, and a coupling bar extending along the axis of the annular member and supported by the first elastic body, and a control member for controlling displacement of the coupling bar in the height direction.

Effect of the Invention

[0010] According to the present invention, the railroad vehicle provided with the anti-rolling device which does not inhibit the function of a vehicle body tilting device can

be achieved.

Brief Description of the Drawings

[0011]

FIG. 1 is a side view of a railroad vehicle provided with an anti-rolling device according to first, second and third embodiments.
FIG. 2 is a top view of the railroad vehicle provided with the anti-rolling device according to the first, second and third embodiments (view taken along line A-A in FIG. 1).
FIG. 3 is a front view of a lower joint section connecting a lower end of a rod of the anti-rolling device and a truck frame according to the first, second and third embodiments.
FIG. 4 is a cross-sectional view at the center of the lower joint section connecting the lower end of the rod of the anti-rolling device and the truck frame according to the first embodiment (cross-sectional view taken along line B-B in FIG. 3).
FIG. 5 is a cross-sectional view of the lower joint section connecting the lower end of the rod of the anti-rolling device and the truck frame according to the first embodiment when viewed from a point apart from the center (cross-sectional view taken along line C-C in FIG. 3).
FIG. 6 is a schematic view showing a change in spring stiffness of the lower joint section in the height direction corresponding to the amount of displacement in the height direction of the vehicle body.
FIG. 7 is a schematic view showing an operation of the anti-rolling device according to the first embodiment when a small roll displacement occurs.
FIG. 8 is a schematic view showing a state of displacement of one lower joint section (A side) constituting the anti-rolling device according to the first embodiment when a small roll displacement occurs.
FIG. 9 is a schematic view showing a state of displacement of the other lower joint section (B side) constituting the anti-rolling device according to the first embodiment when a small roll displacement occurs.
FIG. 10 is a schematic view showing an operation of the anti-rolling device according to the first embodiment when a large roll displacement occurs.
FIG. 11 is a schematic view showing a state of displacement of one lower joint section (A side) constituting the anti-rolling device according to the first embodiment when a large roll displacement occurs.
FIG. 12 is a schematic view showing a state of displacement of the other lower joint section (B side) constituting the anti-rolling device according to the first embodiment when a large roll displacement occurs.
FIG. 13 is a side view of the lower joint section of the anti-rolling device according to a second embodiment.
FIG. 14 is a side view of the lower joint section of the anti-rolling device according to a third embodiment.

Modes for Carrying Out the Invention

[0012] Hereinafter, an embodiment of the present invention will be described in detail with reference to the drawings. First, each direction to be used for the description is defined. The longitudinal direction of the railroad vehicle (rail direction) is defined as X direction, the width direction of the railroad vehicle (crosstie direction) is defined as Y direction, and the height direction of the railroad vehicle is defined as Z direction. Hereinafter, the X direction, Y direction, and Z direction may be simply referred to.

(1) First Embodiment

[0013] FIG. 1 is a side view of a railroad vehicle provided with an anti-rolling device 3 according to the present embodiment, and FIG. 2 is a top view of the railroad vehicle provided with the anti-rolling device 3 according to the present embodiment (view taken along line A-A in FIG. 1). The both ends in X direction of a vehicle body 1 of the railroad vehicle are supported, through air springs 2, by a truck including a truck frame 4, wheel axle 6, journal box body 7, and journal box supporting device 5 for connecting the journal box body 7 to the truck frame 4.

[0014] The anti-rolling device 3 is constituted by a torsion bar 9 provided extending in the X direction on the lower surface of the vehicle body 1, arms 11 extending in the Y direction from both ends of the torsion bar 9, and rods 12 hanging down in the Z direction from the ends of the arms 11 in the X direction.

[0015] At both ends of the torsion bar 9, a pair of holders 10 fixed to be spaced at both ends in the X direction of the lower surface of the vehicle body 1 are provided rotatably around the shaft of the torsion bar 9. Each end of the torsion bar 9 is connected to one end of the arm 11 by press fitting or the like. The other end of the arm 11 and the rod 12 are rotatably connected via a spherical bearing or the like. A coupling bar 32 constituting a lower joint section 31 provided at the lower end of the rod 12 is fixed to a joint section support 15 provided on the side surface of the truck frame 4.

[0016] In the case where a relatively large relative roll displacement occurs between the vehicle body 1 and the truck frame 4, the torsion bar 9 is torsionally deformed when one rod 12 ascends in the Z direction to lift up the other end of the arm 11 and the other rod 12 descends in the Z direction to push down the other end of the arm 11 at the same time in the anti-rolling device 3. The action against the torsional deformation of the torsion bar 9 suppresses the upward and downward movements of the pair of right and left rods 12 and produces an anti-rolling action for reducing the relative roll displacement between

the vehicle body 1 and the truck frame 4.

[0017] FIG. 3 is a front view of the lower joint section 31 connecting the lower end of the rod 12 of the anti-rolling device 3 and the truck frame 4. FIG. 4 is a cross-sectional view at the center of the lower joint section 31 connecting the lower end of the rod 12 of the anti-rolling device 3 and the truck frame 4 (cross-sectional view taken along line B-B in FIG. 3), and FIG. 5 is a cross-sectional view of the lower joint section 31 connecting the lower end of the rod 12 of the anti-rolling device 3 and the truck frame 4 when viewed from a point apart from the center (cross-sectional view taken along line C-C in FIG. 3).

[0018] The lower joint section 31 is composed of an outer annular member 36 connected to the lower end of the rod 12 by welding or the like and being pipe-shaped having an axis in the Y direction, and an second elastic body 35 that is annular and provided inside the outer annular member 36, an inner annular member 34 provided inside the second elastic body 35, and a first elastic body 33 provided inside the inner annular member 34. The coupling bar 32 that is prismatic is provided at the center of the first elastic body 33.

[0019] The size of the coupling bar 32 in the Y direction is larger than the size of the lower joint section 31 in the Y direction, and both ends of the coupling bar 32 in the Y direction project from both end surfaces of the lower joint section 31 in the Y direction.

[0020] An extending portions 34a are connected in such a manner as to project in the Y direction (the axial direction of the inner annular member 34) from both ends of the inner annular member 34 in the Z direction and a stopper rubber mounting portion 37 on which a stopper rubber 38 is mounted is provided on the surface of the extending portion 34a facing the coupling bar 32. The extending portion 34a and the stopper rubber mounting portion 37 may be carved integrally out of the inner annular member 34 by machining or may be fixed to the inner annular member 34 by welding or the like after being prepared as a component separate from the inner annular member 34.

[0021] Both ends of the coupling bar 32 in the Y direction are fixed with bolts 50 to the upper surfaces of both ends in the Y direction of the joint section support 15 fixed to the side surface of the truck frame 4. Due to fixing in this manner, the lower end of the rod 12 constituting the anti-rolling device 3 is fixed to the truck frame 4.

[0022] When a relative roll displacement of the vehicle body 1 occurs relative to the truck, the first elastic body 33 is deformed first so that the coupling bar 32 comes in contact with the stopper rubber 38 held on the extending portion 34a via the stopper rubber mounting portion 37. Furthermore, when the relative roll displacement increases, the second elastic body 35 is deformed while absorbing the impact caused when the coupling bar 32 comes in contact with the stopper rubber 38.

[0023] Since the stopper rubber 38 is provided to inhibit the reliability of the first elastic body 33 from being significantly impaired due to deformation of the first elastic body 33 exceeding an allowable amount, the stopper rubber 38 does not have to be an elastic body such as a rubber, and may be a Teflon (registered trademark) plate or the like.

[0024] A clearance of Z direction dimension Z0 is provided between the upper surface (lower surface) of the coupling bar 32 and the stopper rubber 38. Since the coupling bar 32 and the stopper rubber 38 comes in contact with each other when the coupling bar 32 is displaced by the dimension Z0 in the Z direction, the dimension Z0 is desirably equal to or larger than the dimension (θT/W) obtained by dividing the target inclination angle θT of the vehicle body tilting device by the W dimension (see FIG. 2) .

[0025] FIG. 6 is a schematic view showing a change in spring stiffness in the height direction of the lower joint section corresponding to the displacement amount in the height direction of the vehicle body. In the case where the lower joint section 31 having the above-described configuration is displaced in the Z direction, when the amount of displacement in the Z direction from the upper surface or lower surface of the coupling bar 32 is smaller than the Z0 size, the spring stiffness of the lower joint section 31 is the stiffness of the first elastic body 33 because mainly the first elastic body 33 is deformed.

[0026] On the other hand, when the displacement in the Z direction from the upper surface or the lower surface of the coupling bar 32 is larger than the Z0 size, the coupling bar 32 is displaced in the Z direction integrally with the inner annular member 34 while being in contact with the stopper rubber 38. For this reason, since mainly the second elastic body 35 is deformed, the spring stiffness of the lower joint section 31 is the spring stiffness of the second elastic body 35.

[0027] In other words, since the lower joint section 31 includes the first elastic body 33 having small stiffness and the second elastic body 35 having large stiffness, when the displacement of the coupling bar 32 in the Z direction is smaller than Z0, the coupling bar 32 is easily displaced in the Z direction, but when the displacement of the coupling bar 32 in the Z direction is greater than Z0, the coupling bar 32 has the property of being less easily displaced in the Z direction.

[0028] In addition, the first elastic body 33 and second elastic body 35 that are two types having different stiffness are provided. Therefore, even in the case where the first elastic body 33 with small stiffness is easily displaced and the coupling bar 32 vigorously comes in contact with the stopper rubber 38, the second elastic body 35 can absorb the impact caused by the coupling bar 32 coming in contact with the stopper rubber 38. As described above, since the second elastic body 35 absorbs the impact when the coupling bar 32 and the stopper rubber 38 come in contact with each other, the reliability of the anti-rolling device 3 is not impaired.

[0029] FIG. 7 is a schematic view showing the operation of the anti-rolling device 3 when a small roll displace-

ment occurs. FIG. 8 is a schematic view showing the state of displacement of one lower joint section 31 (side A) constituting the anti-rolling device 3 when a small roll displacement occurs, and FIG. 9 is a schematic view showing the state of displacement of the other lower joint section 31 (B side) constituting the anti-rolling device 3 when a small roll displacement occurs.

[0030] A case is considered where the vehicle body 1 rotates around an axis extending along the X direction at a roll angle θ (a relative roll angle θ is generated between the vehicle body 1 and the truck frame 4). The coupling bar 32 located on one side (A side) of the truck frame 4 in the Y direction is located at a distance of W dimension from the above-described axis in the +Y direction, and the coupling bar 32 located on the other side (B side) of the truck frame 4 in the Y direction is located at a distance of W dimension from the above-mentioned axis in the -Y direction (see FIG. 2).

[0031] Therefore, the coupling bar 32 on the A side is displaced upward in the Z direction by a displacement amount ($W \times \theta$) obtained by multiplying the W dimension by the roll angle θ (see FIG. 8). Similarly, the coupling bar 32 on the B side is displaced downward in the Z direction by a displacement amount ($W \times \theta$) obtained by multiplying the W dimension by the roll angle θ (see FIG. 9).

[0032] For example, the vehicle body tilting device is a device that adjusts the internal pressure of the pair of air springs 2 mounted on the upper surface of the truck frame 4 to gives a small relative roll angle θ of the vehicle body 1 relative to the truck frame 4 when the railroad vehicle passes through a curve section of the track.

[0033] FIG. 10 is a schematic view showing the operation of the anti-rolling device 3 when a large roll displacement occurs. FIG. 11 is a schematic view showing the state of displacement of one lower joint section 31 (side A) constituting the anti-rolling device 3 when a large roll displacement occurs, and FIG. 12 is a schematic view showing the state of displacement of the other lower joint section 31 (B side) constituting the anti-rolling device 3 when a large roll displacement occurs.

[0034] A case is considered where the vehicle body 1 rotates around an axis extending along the X direction at a roll angle 2θ. The coupling bar 32 located on one side (A side) of the truck frame 4 in the Y direction is located at a distance of W dimension from the above-described axis in the +Y direction, and the coupling bar 32 located on the other side (B side) of the truck frame 4 in the Y direction is located at a distance of W dimension from the above-mentioned axis in the -Y direction.

[0035] Therefore, the coupling bar 32 on the A side is displaced upward in the Z direction by a displacement amount ($W \times 2\theta$) obtained by multiplying the W dimension by the roll angle θ (see FIG. 11). Similarly, the coupling bar 32 on the B side is displaced downward in the Z direction by a displacement amount ($W \times 2\theta$) obtained by multiplying the W dimension by the roll angle θ (see FIG. 12).

[0036] The displacement amount $W \times 2\theta$ in the Z direction of the coupling bar 32 is larger than the Z direction dimension Z0 (see FIG. 5) from the upper surface and the lower surface of the coupling bar 32 at the initial (relative displacement angle 0°) position to the stopper rubber 38. Therefore, when the relative roll angle exceeds Z0/W, the coupling bar 32 deforms the first elastic body 33 and comes in contact with the stopper rubber 38. Further, the coupling bar 32 is displaced together with the inner annular member 34 supporting the stopper rubber 38 from the initial position (position of relative roll angle 0°) to the position at a distance of $W \times 2\theta$ in the Z direction while deforming the second elastic body 35.

[0037] Since the stiffness of the second elastic body 35 is set sufficiently large compared to the stiffness of the first elastic body 33, the second elastic body 35 is not easily deformed in the Z direction. Due to this property (the property of not being easily deformed) of the second elastic body 35, one rod 12 connected to the lower joint section 31 ascends in the Z direction and the other rod 12 descends in the Z direction at the same time.

[0038] Since the other end of the arm 11 is connected to the upper end of the rod 12, one end (A side) of the torsion bar 9 is twisted clockwise by the arm 11 and the other end (B side) of the torsion bar 9 is twisted counterclockwise by the arm 11. Due to this twisting, a large anti-rolling function of the anti-rolling device 3 works in the direction in which the relative roll angle between the vehicle body 1 and the truck frame 4 is not generated.

[0039] In the anti-rolling device 3 according to the present invention, since the stiffness of the first elastic body 33 constituting the lower joint section 31 is set small, the first elastic body 33 is easily deformed and the anti-rolling action of the anti-rolling device 3 is not generated while the displacement of the coupling bar 32 in the Z direction is allowed when the relative roll angle θ is small, and therefore, the anti-rolling device 3 does not interfere with the operation of the vehicle body tilting device.

[0040] Further, when the relative roll displacement amount between the vehicle body 1 and the truck frame 4 reaches a relative roll displacement amount larger than that of the vehicle body tilting operation by the vehicle body tilting device, the pair of coupling bars 32 are displaced in the opposite direction from each other in the Z direction and causes the torsion bar 9 to be twisted via the arms 11. For this reason, a strong anti-rolling action works, and an increase in the relative roll displacement can be suppressed between the vehicle body 1 and the truck frame 4. Therefore, a railroad vehicle provided with the anti-rolling device 3 which does not inhibit the function of the vehicle body tilting device can be provided.

[0041] The stopper rubber 38 held by the extending portion 34a supported by the inner annular member 34 restricts the movement of the coupling bar 32. Due to this restriction, following the first stage stiffness of the first elastic body 33 having small stiffness, the second stage stiffness generated by the second elastic body 35 having large stiffness and the torsional stiffness of the torsion

bar 9 can be achieved. As described above, the anti-rolling device 3 has a first-stage stiffness region that does not interfere with the action of the vehicle body tilting device and a second-stage stiffness region that can suppress an excessive relative roll displacement between the vehicle body and the truck frame. Therefore, according to the present embodiment, a railroad vehicle provided with the anti-rolling device 3 which does not inhibit the function of the vehicle body tilting device can be provided.

[0042] In the present embodiment, an example is shown in which the lower end of the rod 12 connected to the arm 11 couples with the torsion bar 9 is fixed to the truck frame 4 while the torsion bar 9 is rotatably held in the holders 10 fixed to the lower surface of the vehicle body 1. The present embodiment is not limited to this example, and the same effect can be obtained even if the upper end portion of the rod 12 connected to the arm 11 couples with the torsion bar 9 is fixed to the floor surface of the vehicle body 1 while the torsion bar is rotatably held in the holders provided on the upper surface of the truck frame (the same goes for also the second and third embodiments).

(2) Second Embodiment

[0043] FIG. 13 is a side view of the lower joint section of an anti-rolling device 40 according to a second embodiment. In order to reduce the number of design and manufacturing steps, the inner annular member 34 is omitted and only one type of elastic body (first elastic body 33) having a relatively small stiffness is adopted to simplify the structure.

[0044] In order to obtain the two-stage spring characteristics in the Z direction described with reference to FIG. 6, extending portions 36a extending in the Y direction from both ends of the outer annular member 36 in the Z direction are provided, and the stopper rubber 38 is fixed to the stopper rubber mounting portion 37 while the stopper rubber mounting portion 37 is fixed to the extending portion 36a.

[0045] With this configuration, a first-stage elastic region in which the first elastic body 33 is elastically deformed until the coupling bar 32 comes in contact with the stopper rubber 38 is obtained. Further, after the coupling bar 32 comes in contact with the stopper rubber 38, a second stage elastic region can be obtained by the torsional stiffness of the torsion bar 9 through the rod 12 and the arm 11.

[0046] Since the support stiffness for the coupling bar 32 by the first elastic body 33 in the first stage elastic region is small, the anti-rolling device 40 does not inhibit the function of the vehicle body tilting device. In the second stage elastic region, the torsional stiffness of the torsion bar 9 constituting the anti-rolling device 40 suppresses the excessive relative roll displacement between the vehicle body 1 and the truck frame 4. For this reason, a railroad vehicle provided with the anti-rolling device 40 that does not inhibit the function of the vehicle body tilting device can be provided.

[0047] Furthermore, in addition to the effects described above, since fewer types of elastic bodies and annular members are used for constituting a lower joint section 41, a railroad vehicle provided with the anti-rolling device 40 with a small number of design and manufacturing steps can be provided.

(3) Third Embodiment

[0048] FIG. 14 is a side view of the lower joint section of an anti-rolling device 45 according to a further third embodiment. The configuration of a lower joint section 46 according to the present embodiment is basically the same as that of the lower joint section 31 according to the first embodiment. The lower joint section 46 according to the present embodiment is provided with a pair of inner walls 34b extending in the Z direction inside the inner annular member 34. The clearance size of the inner wall 34b in the X direction is set to be slightly larger than the size of the coupling bar 32 in the X direction, thereby characteristically allowing the displacement of the coupling bar 32 in the Z direction while restricting the displacement of the coupling bar 32 in the X direction.

[0049] With this configuration, when the truck frame 4 turns while the vehicle body 1 passes through a section such as a curved track, the coupling bar 32 is inhibited from being largely displaced in the X direction or having minute rotation in the X-Z plane. The stiffness of the first elastic body 33 holding the coupling bar 32 is set smaller than the stiffness of the second elastic body 35. Therefore, when the coupling bar 32 is largely displaced in the X direction or rotated in the X-Z plane, the first elastic member 33 having small stiffness is largely deformed and the deterioration thereof rapidly progresses, which causes a concern that reliability of the lower joint section 46 may be degraded.

[0050] In order to eliminate this concern, in the present embodiment, the inner annular member 34 is provided with the pair of inner walls 34b extending in the Z direction, and the coupling bar 32 that is allowed to be displaced in the Z direction is disposed inside the inner walls 34b facing each other, in addition. With this configuration, only the displacement in the Z direction can be permitted for the first elastic body 33, and the minute rotation in the X-Z plane generated in the coupling bar 32 can be dealt with by the displacement of the second elastic body 35.

[0051] Therefore, according to the present embodiment, a railroad vehicle having the anti-rolling device 45 which does not inhibit the function of the vehicle body tilting device can be provided. In addition to this, according to the present embodiment, even when the truck frame 4 turns when the vehicle body 1 passes through a curve section of the track, the rapid deterioration of the first elastic body 33 is suppressed and the decrease in the reliability of the lower joint section 46 can be restricted.

Description of Reference Characters

[0052]

1:	Vehicle body
2:	Air spring,
3, 40, 45:	Anti-rolling device
4:	Truck frame
5:	Journal box support device
6:	Wheel axle
7:	Journal box body
9:	Torsion bar
10:	Holder
11:	Arm
12:	Rod
13:	Upper joint section
15:	Joint section support (truck)
16:	Axle spring
31, 41, 46:	Lower joint section
32:	Coupling bar
33:	First elastic body
34:	Inner annular member
34a:	Extending portion
34b:	Inner wall
35:	Second elastic body
36:	Outer annular member
36a:	Extending portion
37:	Stopper rubber mounting portion
38:	Stopper rubber
50:	Bolt

Claims

1. A railroad vehicle comprising:

a vehicle body;
a truck frame constituting a truck for supporting the vehicle body;
an anti-rolling device provided stretching between the vehicle body and the truck frame for suppressing a relative roll displacement of the vehicle body;
a torsion bar provided extending in a width direction of the vehicle body in the anti-rolling device;
an arm extending in a longitudinal direction of the vehicle body from each end of the torsion bar;
a rod extending in a vertical direction of the vehicle body from a tip of the arm;
a joint section provided at a tip of the rod;
an annular member provided at the joint section and connected to the rod;
a first elastic body filling an inside of the annular member;
a coupling bar extending along an axis of the annular member and supported by the first elastic body; and
a control member for controlling displacement of the coupling bar in a height direction.

2. The railroad vehicle according to claim 1, wherein
the control member is a stopper rubber provided on an extending portion extending in an axial direction of the annular member from each end of the annular member in a height direction, and
the stopper rubber controls displacement of the coupling bar in the height direction accompanied by deformation of the first elastic body when a relative roll displacement occurs.

3. The railroad vehicle according to claim 1, wherein
the annular member includes:

an outer annular member connected to the rod and filled with the first elastic body; and
an inner annular member supported by the first elastic body and filled with a second elastic body,
the coupling bar is supported by the second elastic body filling the inner annular member, and
the control member is a stopper rubber disposed on an extending portion extending in an axial direction of the inner annular member from each end of the inner annular member in a height direction.

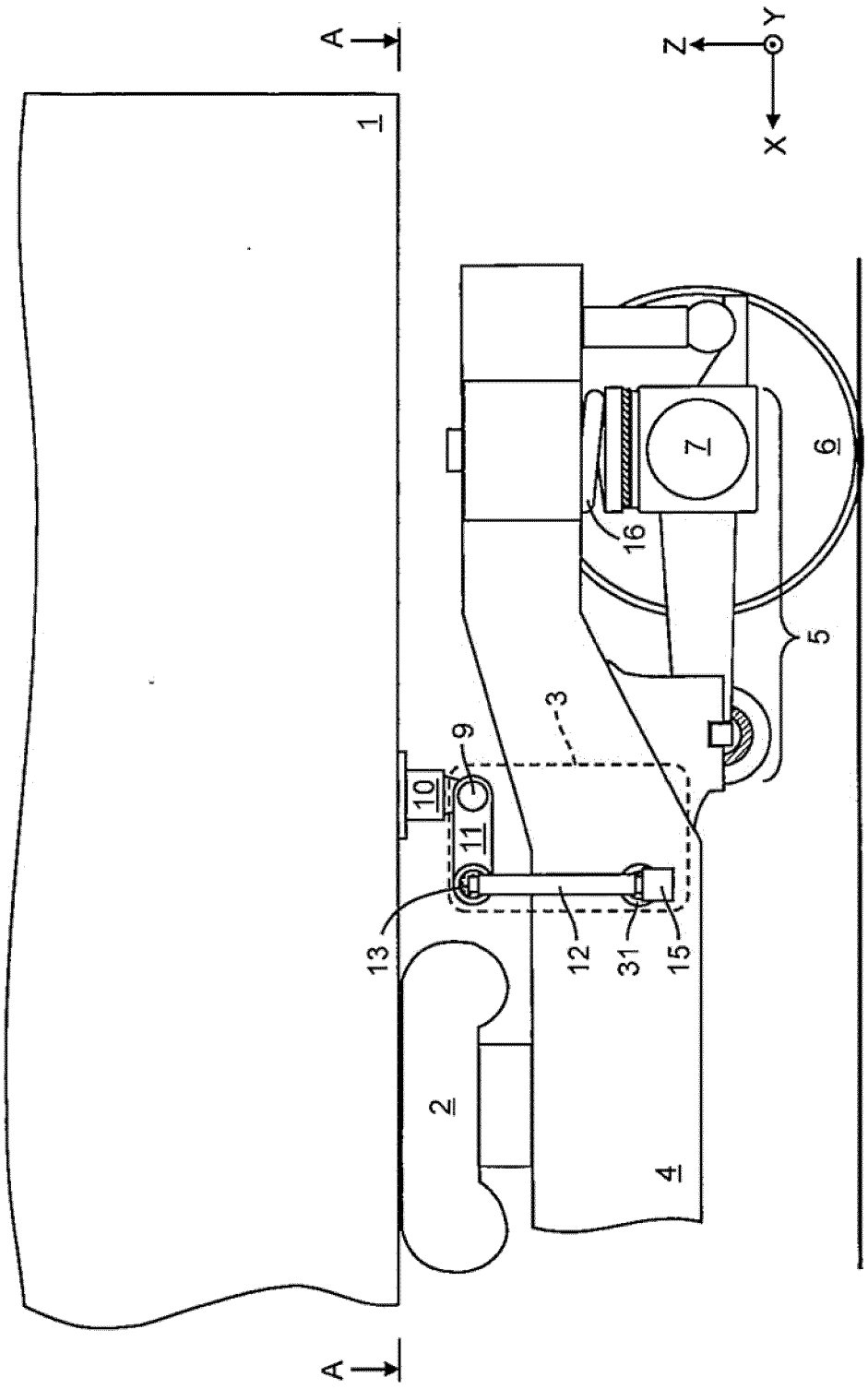
4. The railroad vehicle according to claim 3, wherein
stiffness of the first elastic body is greater than stiffness of the second elastic body.

5. The railroad vehicle according to claim 4, wherein
the inner annular member has a pair of inner walls therein that extends in a vertical direction and faces each other, and
the coupling bar is displaced in a height direction along the inner walls.

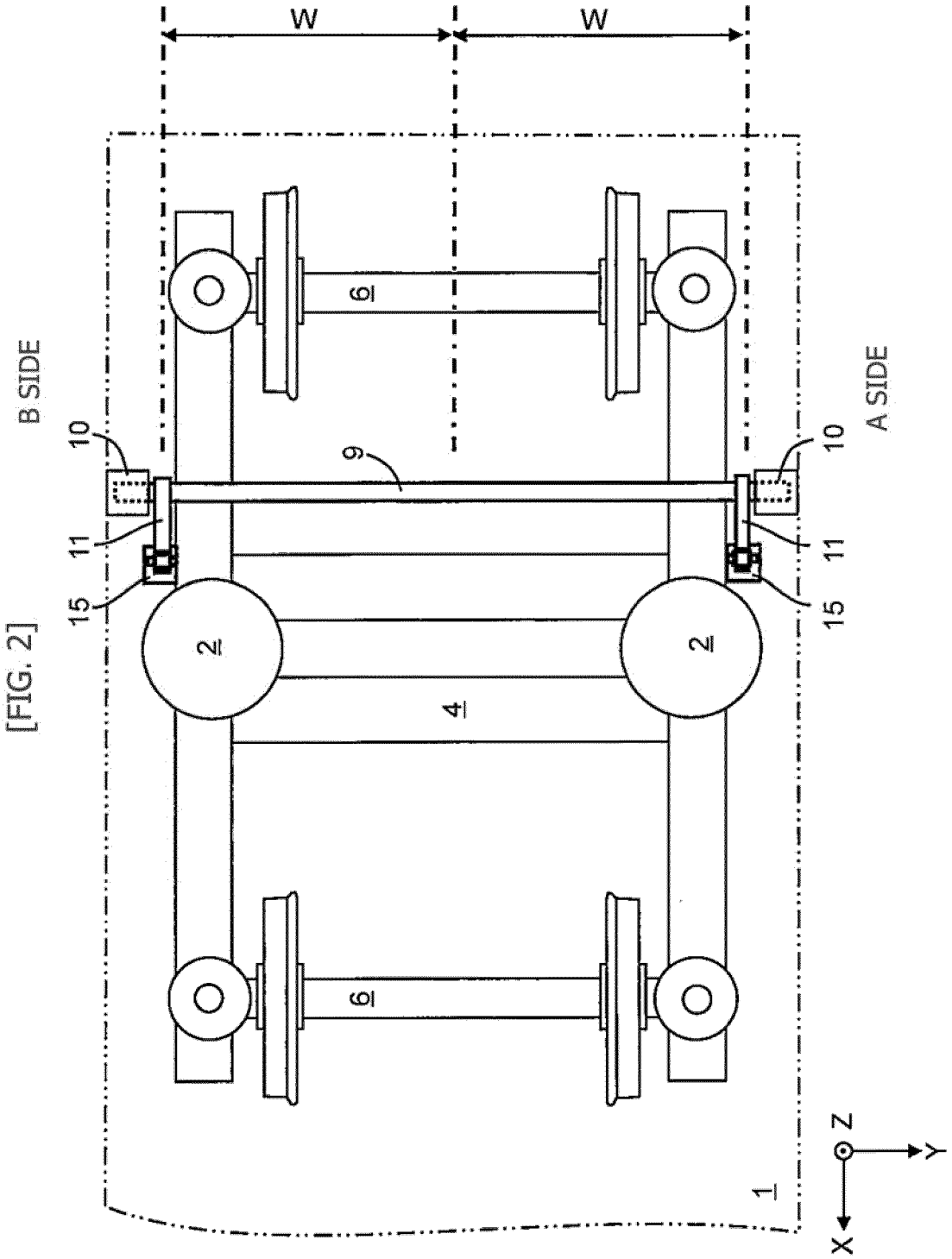
6. The railroad vehicle according to any one of claims 1 to 5, wherein
each end of the torsion bar is rotatably held on a lower surface of each end of the vehicle body in a width direction, and
each end of the coupling bar is fixed to the truck frame.

7. The railroad vehicle according to any one of claims 1 to 5, wherein
each end of the torsion bar is rotatably held on an upper surface in a width direction of the truck frame, and
each end of the coupling bar is fixed to a lower surface in a width direction of the vehicle body.

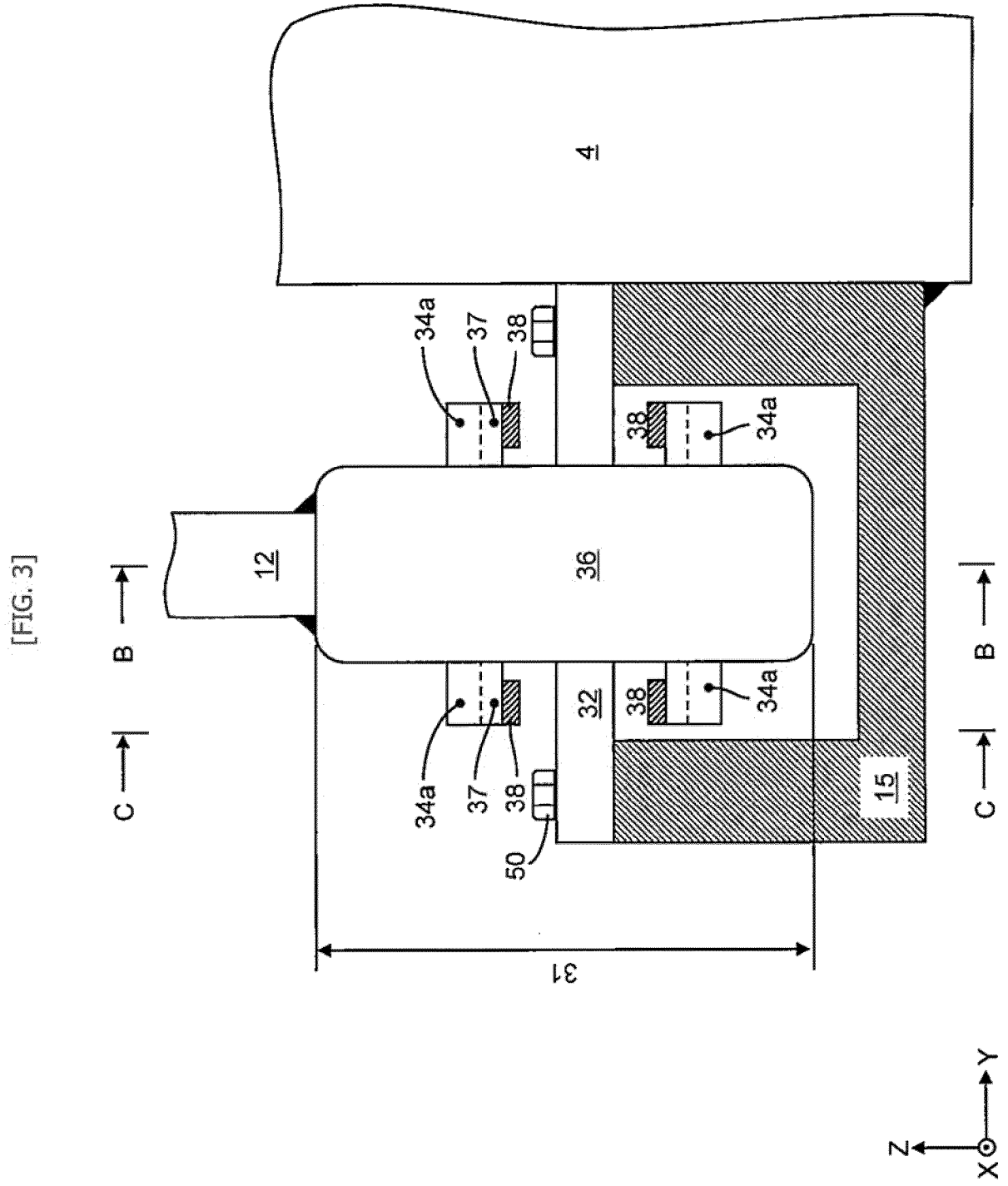
[FIG. 1]



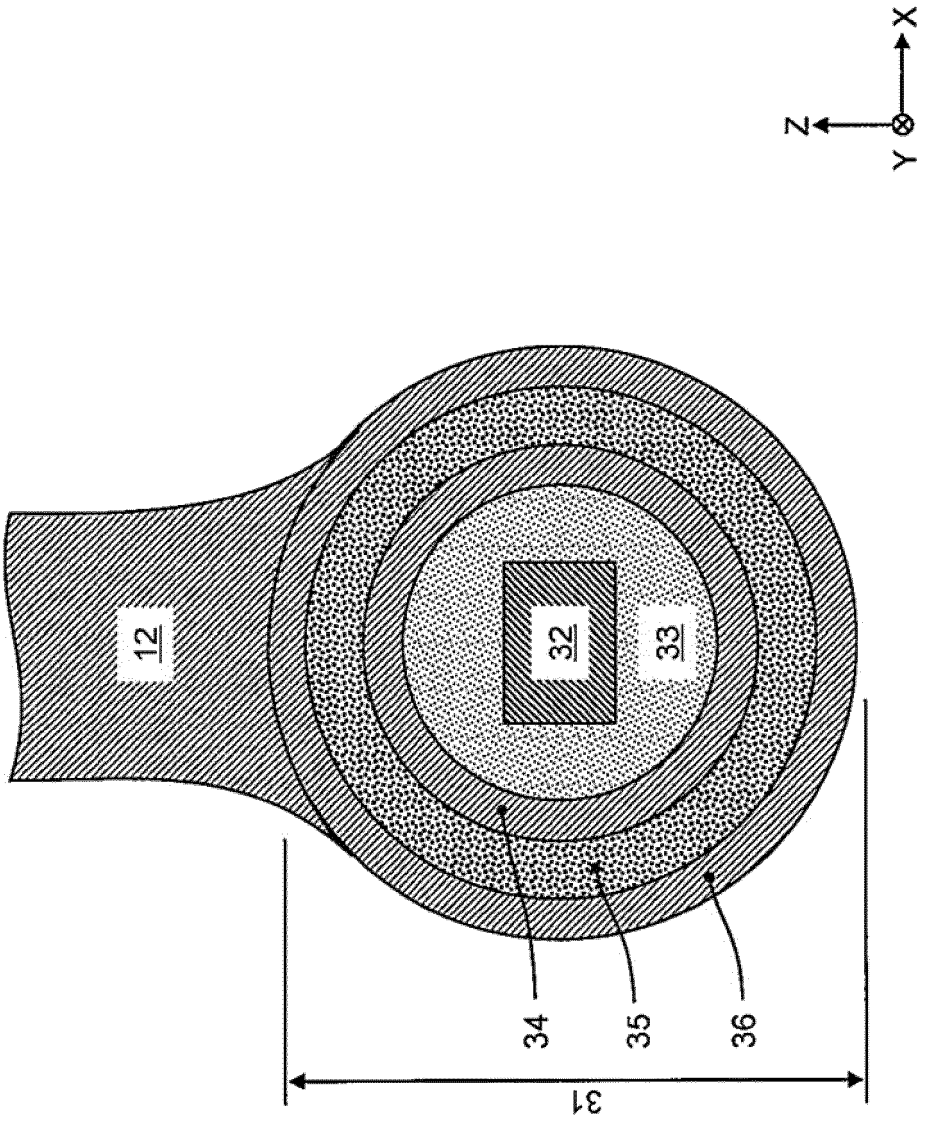
[FIG. 2]



[FIG. 3]

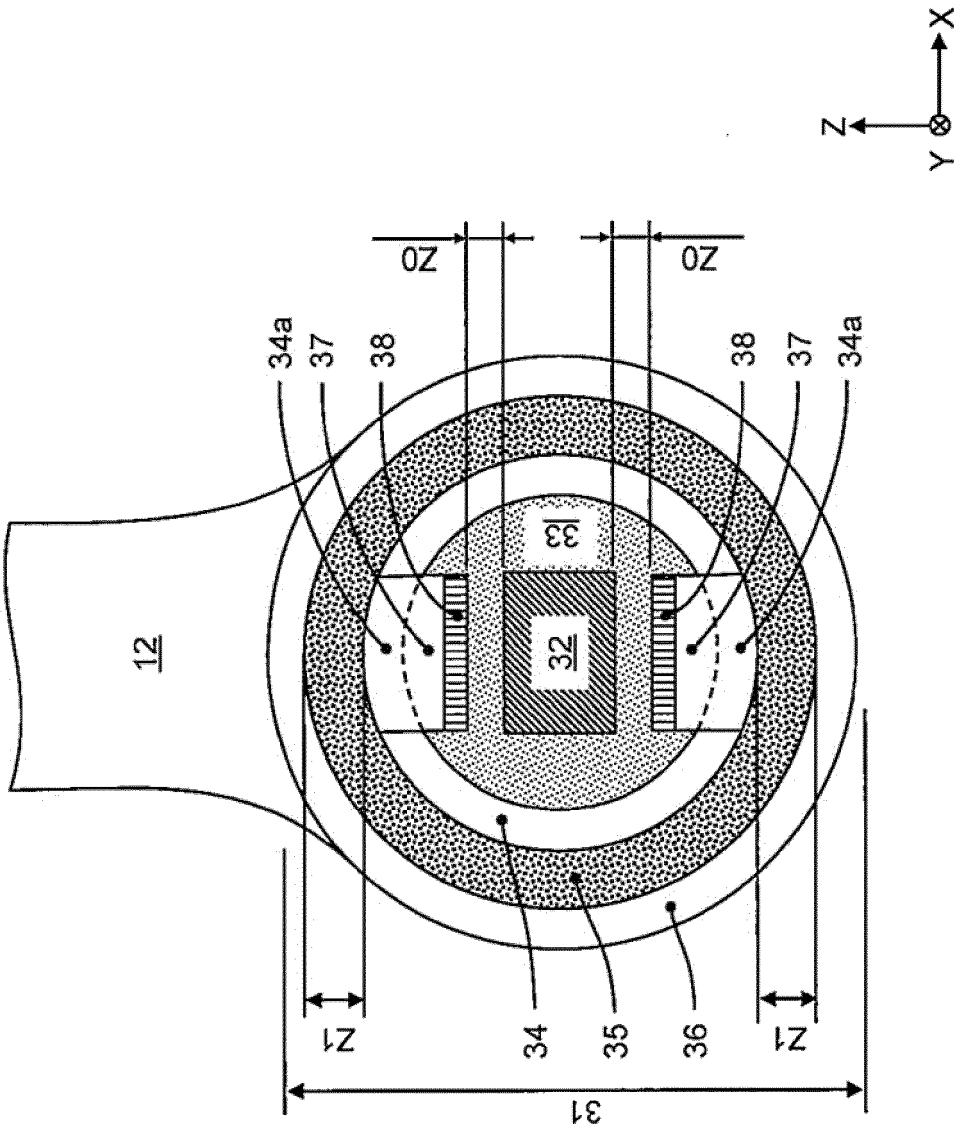


[FIG. 4]



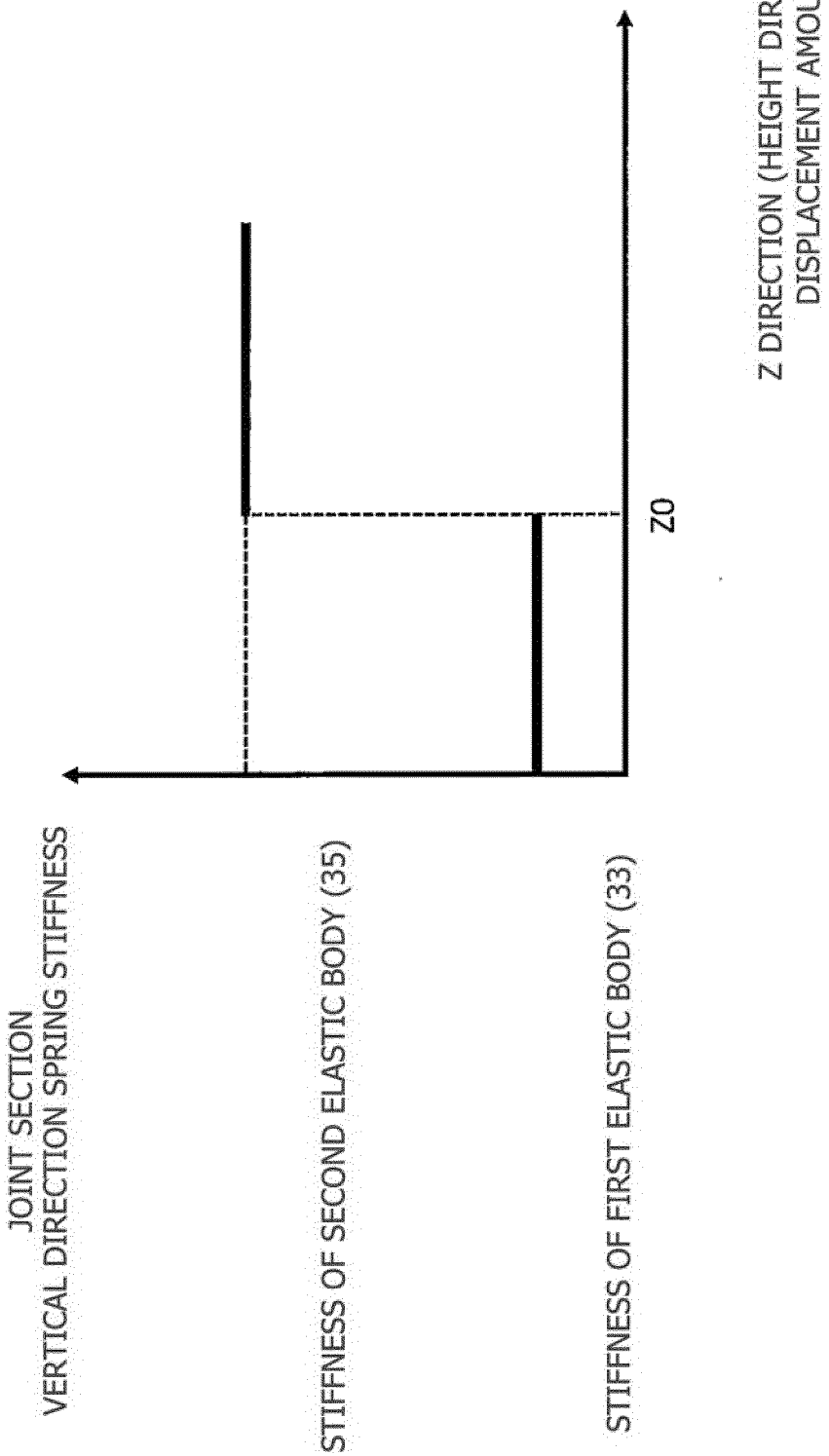
B-B CROSS SECTION IN FIG. 3

[FIG. 5]

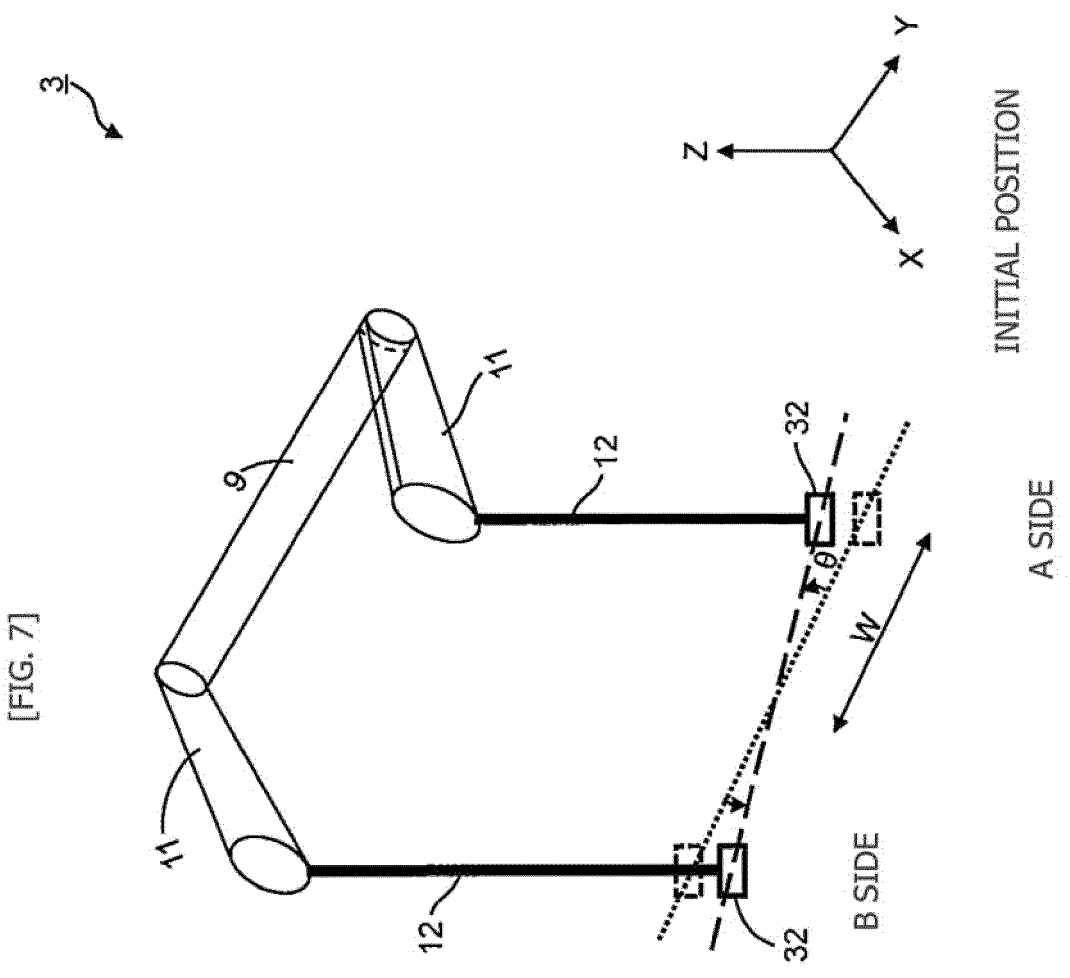


C-C CROSS SECTION IN FIG. 3

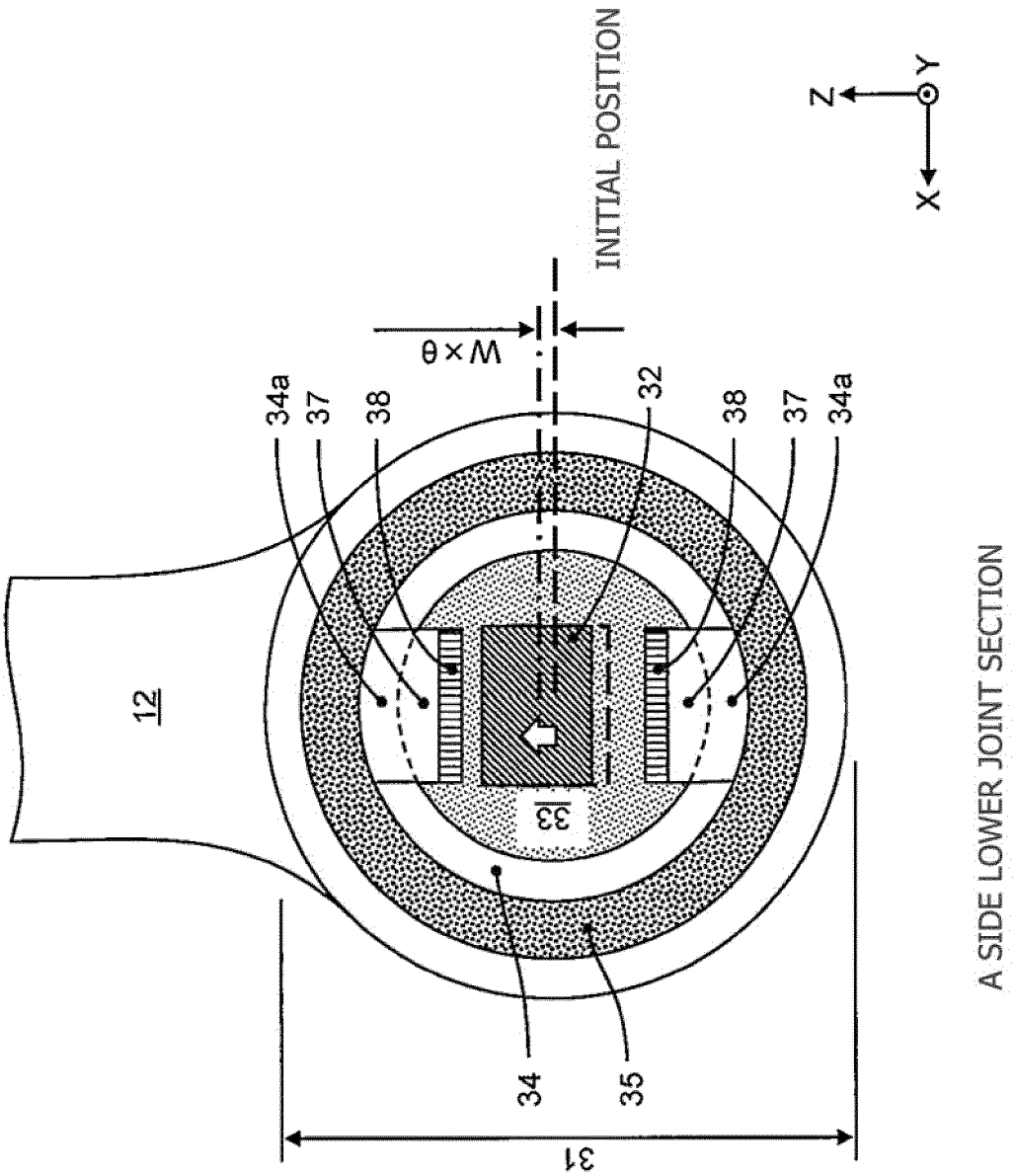
[FIG. 6]


JOINT SECTION
VERTICAL DIRECTION SPRING STIFFNESS
STIFFNESS OF SECOND ELASTIC BODY (35)
STIFFNESS OF FIRST ELASTIC BODY (33)
Z0
Z DIRECTION (HEIGHT DIRECTION)
DISPLACEMENT AMOUNT

[FIG. 7]

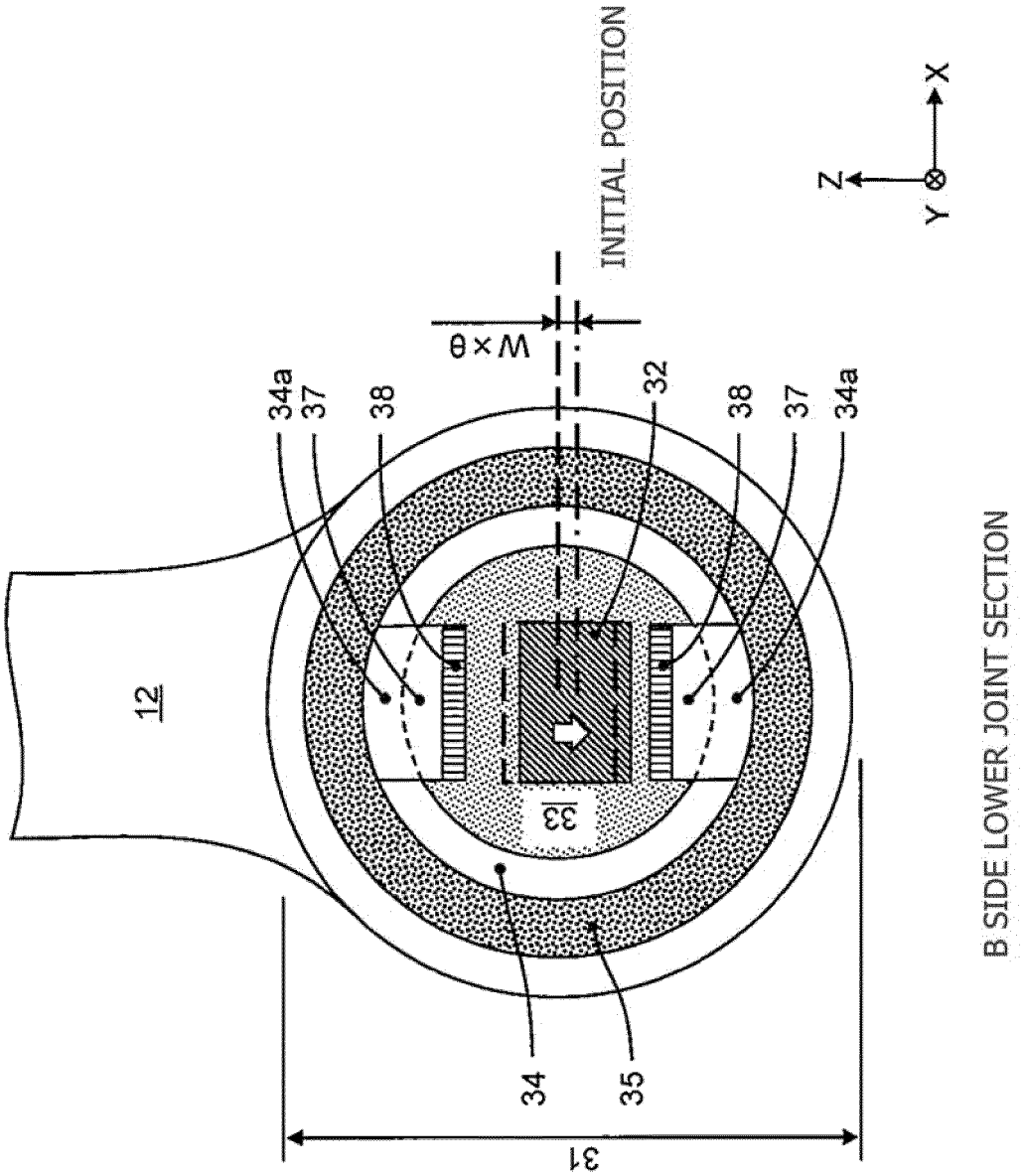


[FIG. 8]

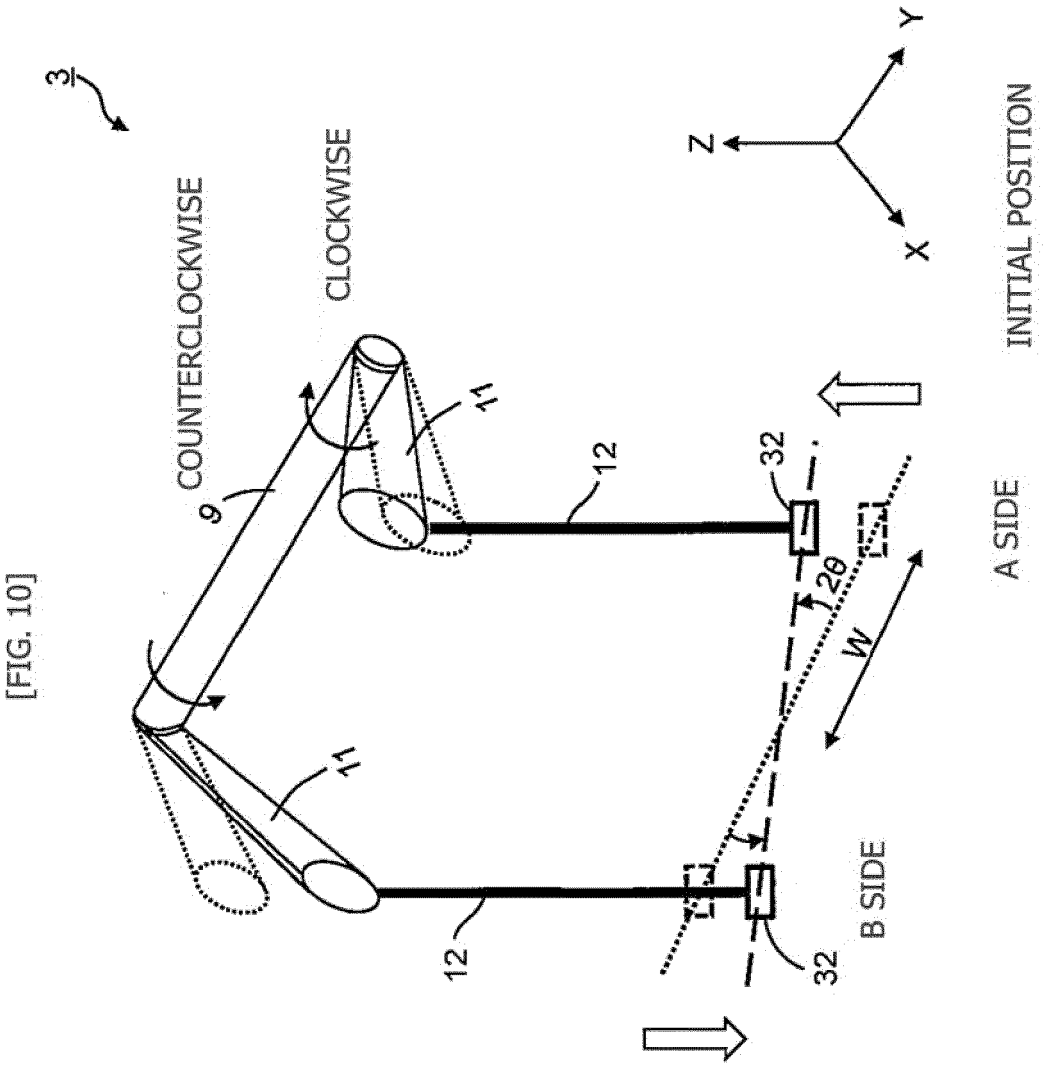


A SIDE LOWER JOINT SECTION

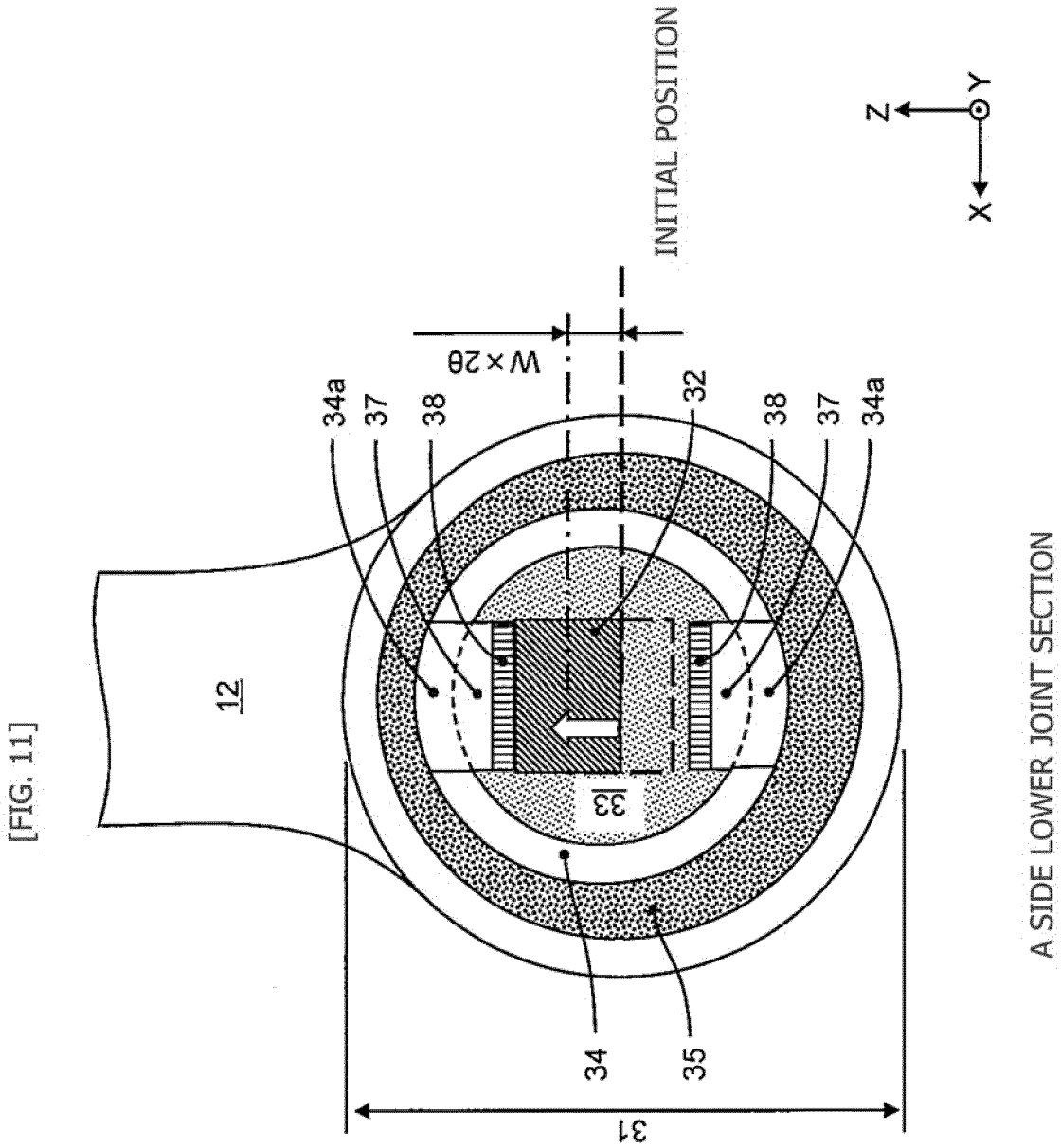
[FIG. 9]


B SIDE LOWER JOINT SECTION
INITIAL POSITION
W×θ
X
Z
Y
12
31
33
34
35
32
34a
37
38

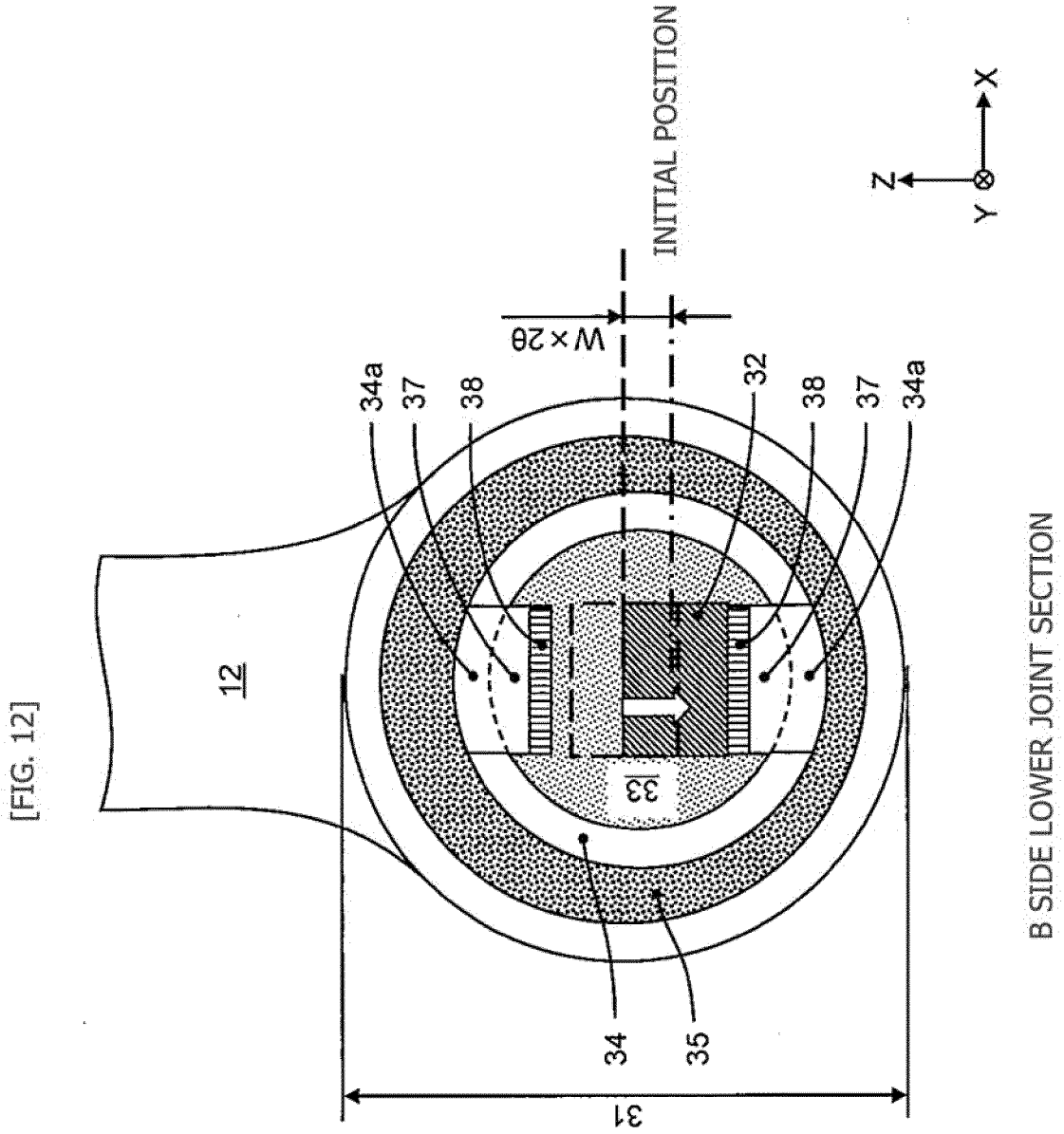
[FIG. 10]


3
COUNTERCLOCKWISE
CLOCKWISE
9
11
12
32
Z
Y
X
INITIAL POSITION
A SIDE
B SIDE
2θ
W

[FIG. 11]


A SIDE LOWER JOINT SECTION
INITIAL POSITION
W×2θ
Z
Y
X
12
31
33
34
35
32
34a
37
38

[FIG. 12]


12
34a
37
38
32
38
37
34a
W×2θ
INITIAL POSITION
Z
X
Y
33
34
35
31
B SIDE LOWER JOINT SECTION

[FIG. 13]

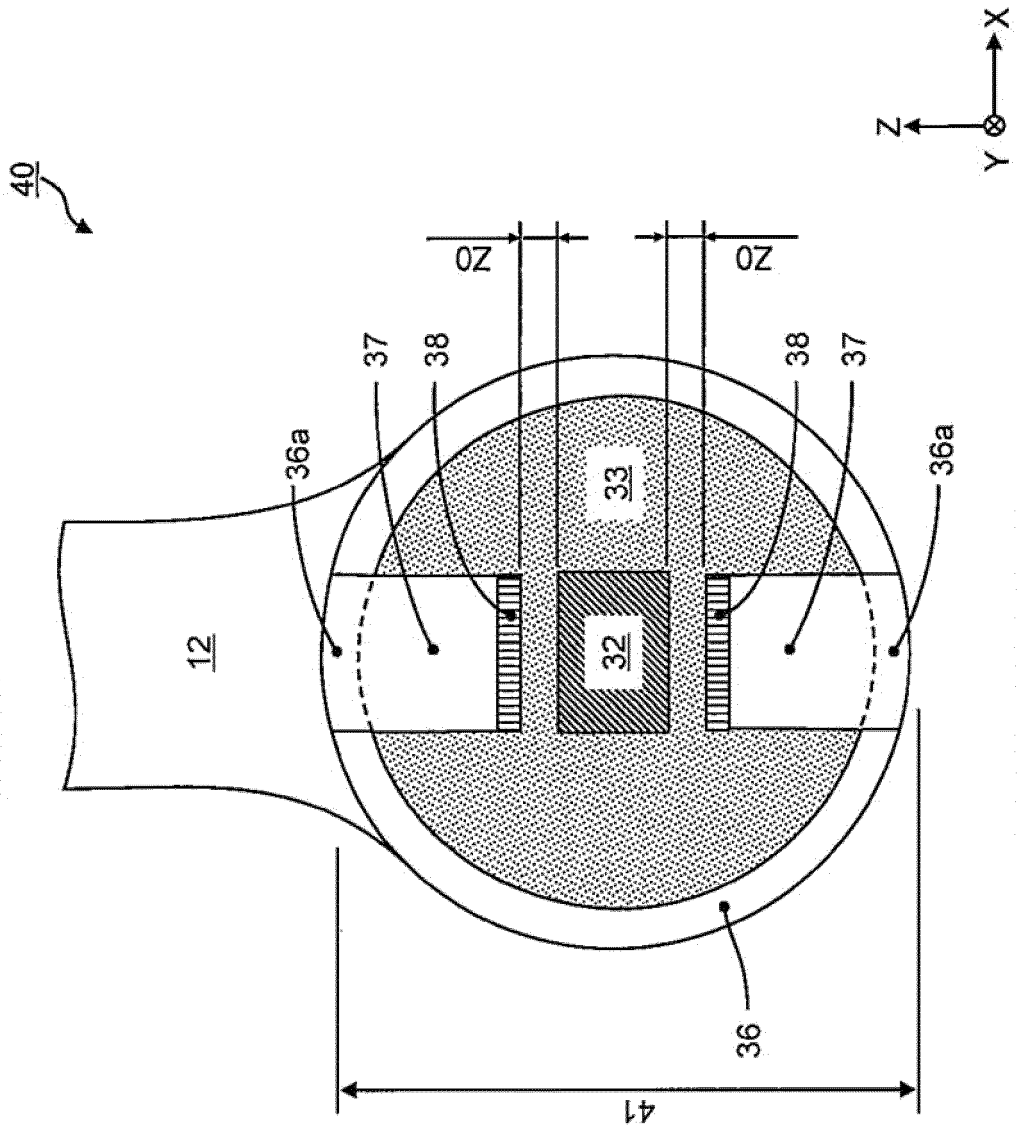
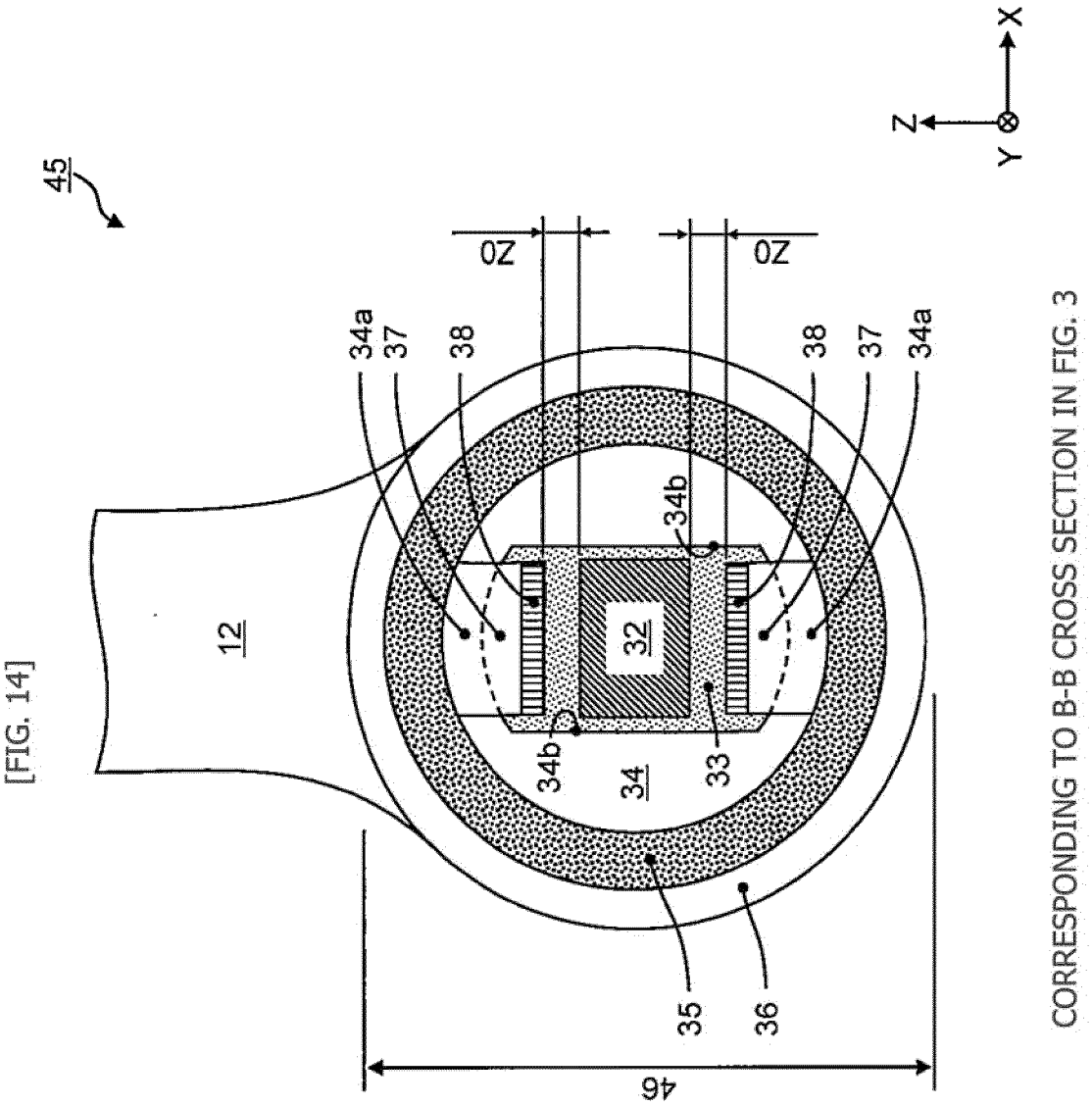


DIAGRAM CORRESPONDING TO B-B CROSS SECTION IN FIG. 3

[FIG. 14]



CORRESPONDING TO B-B CROSS SECTION IN FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/016397

A. CLASSIFICATION OF SUBJECT MATTER
B61F5/24(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B61F5/24, B61F5/38-B61F5/48

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017
Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-289286 A (Sumitomo Metal Industries, Ltd.), 20 October 2005 (20.10.2005), (Family: none)	1-7
A	WO 2016/063382 A1 (Hitachi, Ltd.), 28 April 2016 (28.04.2016), (Family: none)	1-7
A	JP 2005-238858 A (Sumitomo Metal Industries, Ltd.), 08 September 2005 (08.09.2005), (Family: none)	1-7

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

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Date of the actual completion of the international search	Date of mailing of the international search report
14 July 2017 (14.07.17)	25 July 2017 (25.07.17)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/016397

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2008-290671 A (Sumitomo Metal Industries, Ltd.), 04 December 2008 (04.12.2008), (Family: none)	1-7
A	JP 2013-78974 A (Sumitomo Electric Industries, Ltd.), 02 May 2013 (02.05.2013), & CN 102490750 A & CN 202449004 U	1-7

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2005238858 A **[0006]**