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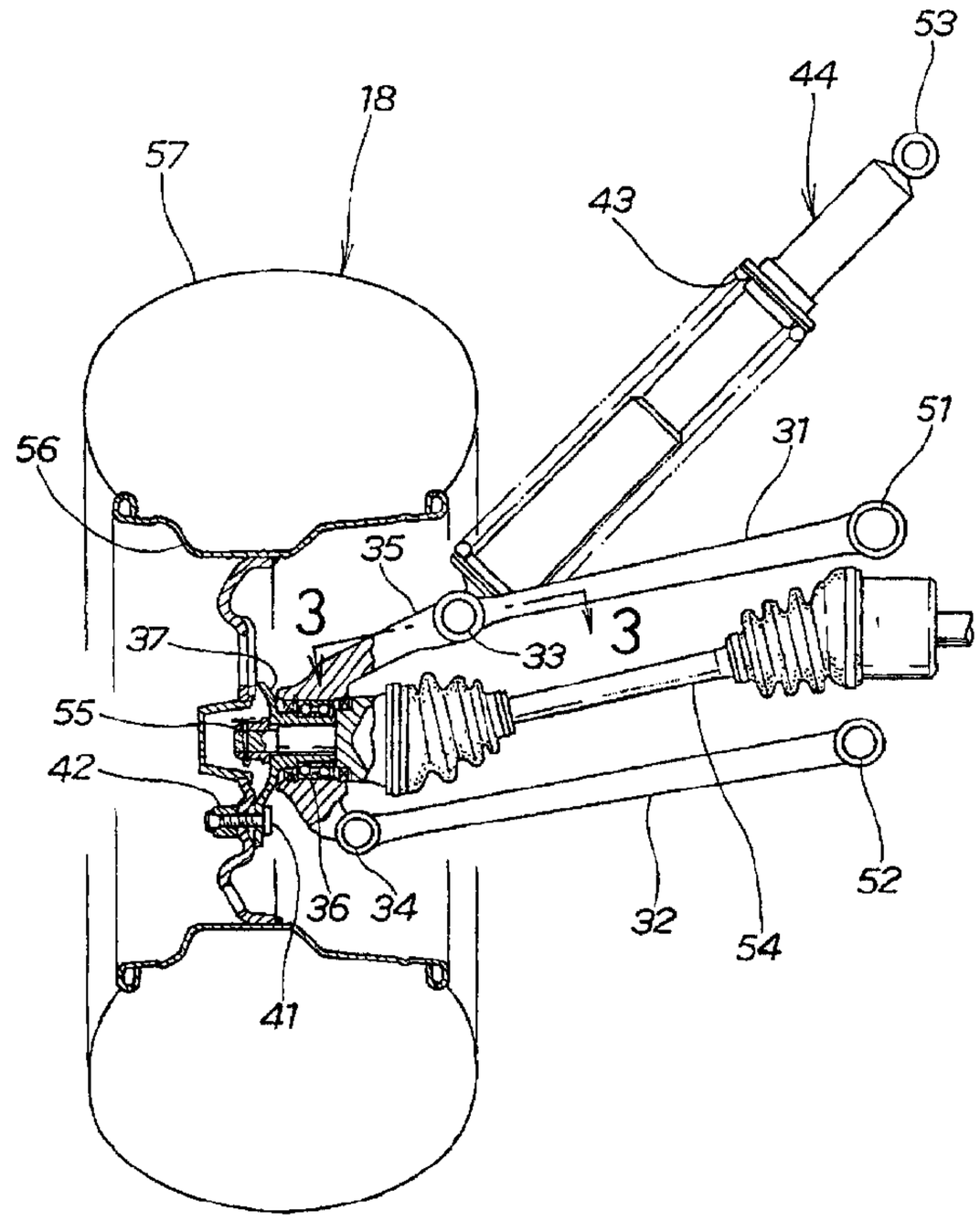
(54) Title: SUSPENSION STRUCTURE



(57) Abrégé/Abstract:
A damper coupling part 67 at one end of a damper 44 is coupled to either of a coupling shaft 33 or 34 for coupling an upper arm 31 or a lower arm 32 and a knuckle 35. As impact from a wheel is not applied to an intermediate part of an arm and no bending moment acts upon the arm, the arm is not required to be reinforced and can be lightened. Also, a damper attachment for attaching a damper to the arm is not required to be provided, the number of parts can be reduced and the manufacturing cost of the arm can be reduced.

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ABSTRACT OF THE DISCLOSURE

A damper coupling part 67 at one end of a damper 44 is coupled to either of a coupling shaft 33 or 34 for coupling an upper arm 31 or a lower arm 32 and a knuckle 35. As impact from a wheel is not applied to an intermediate part of an arm and no bending moment acts upon the arm, the arm is not required to be reinforced and can be lightened. Also, a damper attachment for attaching a damper to the arm is not required to be provided, the number of parts can be reduced and the manufacturing cost of the arm can be reduced.

TITLE: SUSPENSION STRUCTURE

FIELD OF THE INVENTION

The present invention relates to suspension structure favorable for lightening suspension and reducing the cost.

BACKGROUND OF THE INVENTION

For vehicular suspension structure, for example, Japanese utility model publication No. Sho 63-48690, "Double wishbone type suspension" is known.

In Fig. 2 of the above-mentioned publication, suspension wherein a suspension arm composed of an upper arm and a lower arm is attached to a body frame, a cross member as a reinforcement is attached to the upper arm, a push-pull rod is extended from a lower part of the cross member, the end of the push-pull rod is coupled to a cushion arm via a link arm, the cushion arm is coupled to one end of a cushion unit via a link arm and the other end of the cushion unit is attached to the body frame is shown.

In the above-mentioned suspension, the vertical motion of the upper arm is converted to the elastic motion of the cushion unit.

In the above-mentioned art, as a large bending moment acts upon the upper arm when external force is applied to the cushion unit via the upper arm from a front wheel because the push-pull rod is attached to an intermediate part of the upper arm, the cross member as a reinforcement is required to stand the bending moment. The cross member also functions as a coupling member for coupling the upper arm to the cushion unit and in addition, the push-pull rod, the link arm, the cushion arm and the link arm 8 are required to couple the upper arm and the cushion unit.

As described above, as the reinforcement of the upper arm is required to couple one end of the cushion unit to the intermediate part of the upper arm and multiple parts are required to attach the upper arm, the weight is increased and the cost is also increased.

Then, an object of the invention is to lighten suspension and reduce the cost by improving suspension structure.

SUMMARY OF THE INVENTION

To achieve the object, the present invention provides a double wishbone type suspension structure wherein a pair of upper and lower arms are attached to the body side so that they can be vertically swung, a knuckle on the side of a wheel is respectively coupled to each end of these arms via a coupling shaft and a damper for damping impact transmitted from the wheel to the body ranges from the body side to the side of the arm and is characterized in that one end of the damper is coupled to one coupling shaft.

As impact from the wheel is not applied to an intermediate part of the arm because one end of the damper is coupled to one coupling shaft and no bending moment acts upon the arm, the arm is not required to be reinforced and can be lightened. A damper attachment for attaching the damper to the arm is not required to be provided, the number of parts can be reduced and the manufacturing cost of the arm can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are shown in the drawings, wherein:

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Fig. 1 is a perspective view showing a vehicle adopting suspension structure according to the invention;

Fig. 2 is a sectional view viewed along a line 2-2 in Fig. 1;

Fig. 3 is a sectional view viewed along a line 3-3 in Fig. 2;

Fig. 4 is an explanatory drawing for explaining the action of the suspension structure according to the invention;

Fig. 5 is a front view showing a comparative example of the suspension structure; and

Fig. 6 is a sectional view showing a transformed example of the suspension structure according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to attached drawings, embodiments of the invention will be described below. The orientation of a reference number shows that of the drawing.

Fig. 1 is a perspective view showing a vehicle adopting suspension structure according to the invention, and a vehicle 10 is composed of a handlebar 12 attached to a body frame 11 on the body side so that the handlebar can be turned, front wheels 13, 14 (the reference number 13 denotes a left front wheel and 14 denotes a right front wheel) coupled to the handlebar 12 via a steering system not shown so that the front wheel can be steered and attached to the body frame 11 via an arm described later so that the front wheel can be turned, a seat 15 attached on the body frame 11 and rear wheels 17, 18 (the reference number 17 denotes a left rear wheel and 18 denotes a right rear wheel) arranged below the seat 15 and driven together with the front wheels 13, 14 by a

power unit including an engine and a transmission respectively not shown.

A reference number 21 denotes differential gears, 22 denotes a front bumper, 23 denotes an undercover, 24 denotes a front fender, 25 denotes a head lamp and 26 denotes a rear fender.

Fig. 2 is a sectional view viewed along a line 2-2 in Fig. 1 and shows double wishbone type suspension wherein each one end of an upper arm 31 and a lower arm 32 respectively as a pair of upper and lower arms is attached to the body frame 11 so that the upper and lower arms can be vertically swung, a knuckle 35 is attached to respective other ends of these upper arm 31 and lower arm 32 via a socket bolt 33 as a coupling shaft and a coupling shaft 34 so that the knuckle can be vertically moved, a hub 37 is attached to the knuckle 35 via a bearing 36 so that the hub can be turned, the right rear wheel 18 is attached to the hub 37 by plural bolts 41 and nuts 42(only one is respectively shown) and one end of a damper 44 integrated with a suspension spring 43 for damping impact so that the impact is not transmitted from the right rear wheel 18 to the side of the body frame 11 is coupled to the socket bolt 33 as one coupling shaft.

Reference numbers 51 and 52 denote swing shafts on the side of the body frame 11 of the upper arm 31 and the lower arm 32, 53 denotes an attachment for attaching the damper 44 to the body frame 11, 54 denotes a drive shaft one end of which is coupled to the power unit and the other end of which is coupled to the hub 37, 55 denotes a nut for fixing the other end of the drive shaft 54 to the hub 37, and 56 and 57 denote a wheel and a tire composing the right rear wheel 18.

As suspension on the side of the left rear wheel 17 has the identical configuration to the suspension on the side of the right rear wheel 18, the

description is omitted and hereinafter, only the side of the right rear wheel 18 will be described.

Fig. 3 is a sectional view viewed along a line 3-3 in Fig. 2 and shows that the knuckle 35 is coupled to the upper arm 31 via the socket bolt 33 and the damper 44 is coupled to the socket bolt 33.

That is, Fig. 3 shows that knuckle coupling holes 62, 62 are respectively made in two coupling parts 61, 61 provided at the end of the knuckle 35, flanged bushes 63, 63 are respectively fitted into these knuckle coupling holes 62, 62, dust seals 64, 64 are respectively installed, in the meantime, a damper coupling hole 68 is made in a damper coupling part 67 provided at one end of the damper 44, a bush 71 is fitted into the damper coupling hole 68 and dust seals 72, 72 are installed on both sides of the bush 71.

Fig. 3 also shows that a cylindrical collar 74 is inserted inside one bush 63 of the knuckle 35, the bush 71 of the damper 44 and the other bush 63 in a state that the damper coupling part 67 of the damper 44 is arranged between the coupling parts 61, 61 of the knuckle 35, dust seals 76, 76 are installed at each end outside the coupling parts 61, 61 of the knuckle 35, and the knuckle 35 and the damper 44 are coupled by respectively covering these dust seals 76, 76, the end of each bush 63 and both ends of the collar 74 with end covers 77, 77.

Further, Fig. 3 shows that arm coupling holes 83, 84 are respectively made in two arm coupling parts 81, 82 provided at the end of the upper arm 31, each coupling part of the knuckle 35 and the damper 44 is arranged between the arm coupling parts 81, 82, a socket bolt 33 is inserted into the arm coupling hole 83, the collar 74 and the arm coupling hole 84 from the side of the arm coupling part 81 of the upper arm 31, and the knuckle 35 and the damper 44 are coupled to the upper arm

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31 by screwing a nut 86 on a male screw provided at the end of the socket bolt 33.

As the socket bolt 33 is provided with a head 88 inserted into the arm coupling hole 83, the socket bolt 33 and the nut 86 clamp the knuckle 35 between the end covers 77, 77 and the arm coupling part 82, the knuckle 35 is vertically moved, being slid between the collar 74 and the bush 63, the damper 44 is swung and is extended or contracted, being slid between the collar 74 and the bush 71. A reference number 91 denotes a hexagon socket provided to the head 88.

The bushes 63, 63, the dust seals 64, 64, the collar 74, the dust seals 76, 76, the end covers 77, 77, the socket bolt 33 and the nut 86 are parts composing a coupling mechanism 93 for coupling the upper arm 31 and the knuckle 35 and the invention is characterized in that the damper 44 is coupled to the socket bolt 33 and the collar 74 forming the coupling mechanism 93 via the bush 71 and the dust seals 72, 72, utilizing the coupling mechanism 93.

Next, the action of the above-mentioned suspension structure will be described.

Fig. 4 is an explanatory drawing for explaining the action of the suspension structure according to the invention.

For example, when the right rear wheel 18 is lifted for the body frame or the body frame sinks for the right rear wheel 18, the upper arm 31 and the lower arm 32 are respectively swung upward with swing shafts 51, 52 respectively in the center as shown by arrows □ and □.

As a result, the damper 44 is contracted in a direction shown by an arrow □. At this time, tensile force acts upon the upper arm 31 in a direction shown by an arrow □.

In a case that the upper arm 31 is swung downward with the swing shaft 51 in the center reverse to the above-mentioned case, compressive force acts upon the upper arm 31 in a direction reverse to the direction shown by the arrow.

Fig. 5 is a front view showing a comparative example of the suspension structure and shows a state in which each one end of an upper arm 201 and a lower arm 202 is attached to a body frame 200 so that they can be swung, a knuckle 203 is attached to each other end of these upper arm 201 and lower arm 202 so that the knuckle can be vertically moved, a hub 204 is attached to the knuckle 203 so that the hub can be turned, a wheel 205 is attached to the hub 204, one end of a damper 206 is attached to an intermediate part of the lower arm 202 and the other end of the damper 206 is attached to the body frame 200.

The lower arm 202 is composed of an arm body 207 and a tube for reinforcement 208 covered on the arm body 207 to reinforce the arm body 207 and a damper attachment 209 for attaching one end of the damper 206 is provided to the tube for reinforcement 208.

As the damper 206 is attached to the intermediate part of the lower arm 202 as described above, the lower arm 202 is required to be reinforced by the tube for reinforcement 208 so that the lower arm can bear a large bending moment generated in the lower arm 202 and also requires the damper attachment 209 for attaching the damper 206 to the lower arm 202.

In the meantime, in the embodiment of the invention, as described in relation to Fig. 4, force in a longitudinal direction such as tensile force and compressive force acts upon the upper arm 31 because the upper arm 31 is vertically swung, however, the bending moment in the comparative example does not act.

Therefore, as the upper arm 31 is not required to be reinforced, it can be lightened.

Also, in the embodiment of the invention, as the socket bolt 33 and the collar 74 which couple the upper arm 31 and the knuckle 35 also function as an attachment of the damper 44, the damper attachment in the comparative example is not required to be specially provided.

As described in relation to Figs. 2 and 3, the invention is based upon double wishbone type suspension structure in which a pair of the upper arm 31 and the lower arm 32 are attached to the body frame 11 so that the arms can be vertically swung, the knuckle 35 on side of the right rear wheel 18 is coupled to each end of these upper arm 31 and lower arm 32 respectively via the coupling shafts 33, 34 and the damper 44 for damping impact transmitted from the right rear wheel 18 to the body frame 11 ranges from the body frame 11 to the side of the upper arm 31 (or the lower arm 32) and is characterized in that the damper coupling part 67 at one end of the damper 44 is coupled to either of the coupling shaft 33 or 34.

As impact from the right rear wheel 18 is not applied to the intermediate part of the upper arm 31 (or the lower arm 32) because the damper coupling part 67 of the damper 44 is coupled to either of the coupling shaft 33 or 34, no bending moment acts upon the upper arm 31 (or the lower arm 32) and the upper arm 31 (or the lower arm 32) is not required to be reinforced. Therefore, the upper arm 31 (or the lower arm 32) can be lightened.

Also, the damper attachment for attaching the damper 44 is not required to be provided to the intermediate part of the upper arm 31 (or the lower arm 32), the number of parts can be reduced and the

manufacturing cost of the upper arm 31 (or the lower arm 32) can be reduced.

Fig. 6 is a sectional view showing a transformed example of the suspension structure according to the invention, the same reference number is allocated to the same configuration as that in the embodiment shown in Figs. 2 and 3 and the detailed description is omitted.

The transformed example of the suspension structure according to the invention is characterized in that a knuckle 102 is coupled to an upper arm (or a lower arm) 101 via a coupling mechanism 93 (also see Fig. 3).

That is, the transformed example shows structure that arm coupling holes 105, 105 are made in an arm coupling part 104 provided to the end of the upper arm (or the lower arm) 101, dust seals 64, 64 are respectively installed in these arm coupling holes 105, 105, flanged bushes 63, 63 are respectively fitted into these arm coupling holes, a collar 74 is inserted inside these bushes 63, 63, dust seals 76, 76 are respectively installed at both ends of the arm coupling part 104, these dust seals 76, 76, the end of each bush 63 and both ends of the collar 74 are covered with end covers 77, 77, in this state, the arm coupling part 104 is arranged between two knuckle coupling parts 107, 107 provided to the knuckle 102, a socket bolt 33 is inserted into knuckle coupling holes 108, 111 made in each knuckle coupling part 107 in the order of the knuckle coupling hole 108, the collar 74 and the knuckle coupling hole 111 from the side of the knuckle coupling hole 108 and a nut 86 is screwed on a male screw at the end of the socket bolt 33.

Such structure may be also used for coupling the lower arm 32 and the knuckle 35 in the embodiment shown in Fig. 2.

The suspension structure according to the invention may be also adopted in double wishbone type suspension for a front wheel and may be also adopted in a part for coupling each link and a knuckle in so-called multi-link double wishbone type suspension that supports the knuckle by plural links to the body side.

The invention produces the following effect by the above-mentioned configuration.

In the suspension structure according to Claim 1, as one end of the damper is coupled to either of the coupling shafts for coupling a pair of upper and lower arms and each knuckle, impact from the wheel is not applied to the intermediate part of the arm, no bending moment acts upon the arm, as a result, the arm is not required to be reinforced and the arm can be lightened. Also, the damper attachment for attaching the damper to the arm is not required to be provided, the number of parts can be reduced and the manufacturing cost of the arm can be reduced.

Although various preferred embodiments of the present invention have been described herein in detail, it will be appreciated by those skilled in the art, that variations may be made thereto without departing from the spirit of the invention or the scope of the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A double wishbone suspension structure comprising:

a wheel side and a vehicle body side;

a pair of upper arms and a pair of lower arms vertically swingably connected to the body side of the suspension structure, said upper and lower arms each having a first end and a second end, wherein said second ends are positioned on said vehicle body side of said suspension structure;

an upper coupling shaft and a lower coupling shaft operatively connected to said respective first ends of said upper and lower arms;

a knuckle on the wheel side being coupled to the respective first ends of the upper and lower arms via the respective upper and lower coupling shafts;

a damper for dampening an impact transmitted from the wheel side to the vehicle body side; and

a first end of the damper being coupled to either of the upper coupling shaft or the lower coupling shaft, wherein the first end of the damper coupled to the upper coupling shaft or the lower coupling shaft is coaxial with a central axis of the damper.

2. A double wishbone suspension structure comprising:

a wheel side and a vehicle body side;

a pair of upper arms and a pair of lower arms vertically swingably connected to the body side of the suspension structure, said upper and lower arms each having a first end and a second end, wherein said second ends are positioned on said vehicle body side of said suspension structure;

an upper coupling shaft and a lower coupling shaft

operatively connected to said respective first ends of said upper and lower arms;

a knuckle on the wheel side being coupled to the respective first ends of the upper and lower arms via the respective upper and lower coupling shafts;

a damper for dampening an impact transmitted from the wheel side to the vehicle body side; and

a first end of the damper being coupled to the lower coupling shaft.

3. The double wishbone suspension structure according to claim 1, wherein the first end of the damper is coupled to the upper coupling shaft.

4. The double wishbone suspension structure according to claim 1, wherein said suspension structure is a multi-link double wishbone suspension.

5. The double wishbone suspension structure according to claim 1, wherein said coupling shaft is a socket bolt secured to said knuckle with a nut.

6. The double wishbone suspension structure according to claim 1, said first end of the damper being coupled to said socket bolt.

7. The double wishbone suspension structure according to claim 1, further comprising a coupling mechanism, said coupling mechanism operatively connecting said knuckle and said respective upper and lower arm via a respective upper and lower coupling shaft.

8. The double wishbone suspension structure according to claim 7, said coupling mechanism including

a pair of coupling parts provided in a position where said knuckle is operatively connected to said respective upper and lower coupling shaft;

a knuckle coupling hole within each of said coupling parts;

a flanged bushing fitted within each of said knuckle coupling holes; and

a socket bolt and nut, said socket bolt passing through said flanged bushings, said knuckle coupling holes and said coupling parts.

9. The double wishbone suspension structure according to claim 8, further comprising dust seals within said coupling mechanism.

10. The double wishbone suspension structure according to claim 7, said coupling mechanism including

a damper coupling hole within a damper coupling part provided at the first end of the damper; and

a bushing having a pair of sides fitted within the damper coupling hole.

11. The double wishbone suspension structure according to claim 10, further comprising dust seals engaging both sides of the bushing.

12. A double wishbone suspension structure comprising:

a wheel side and a vehicle body side;

a pair of upper arms and a pair of lower arms vertically swingably connected to the body side of the suspension structure, said upper and lower arms each having a first end and a second end, wherein said second ends are positioned on said vehicle body side of said suspension structure;

an upper coupling shaft and a lower coupling shaft operatively connected to said respective first ends of said upper and lower arms;

a knuckle on the wheel side being coupled to the respective first ends of the upper and lower arms via the respective upper and lower coupling shafts;

a damper for dampening an impact transmitted from the wheel side to the vehicle body side;

a first end of the damper being coupled to the lower coupling shaft; and

a coupling mechanism, said coupling mechanism operatively connecting said knuckle and said respective upper and lower arm via a respective upper and lower coupling shaft said coupling mechanism including

a pair of coupling parts provided in a position where said knuckle is operatively connected to said respective upper and lower coupling shaft;

a knuckle coupling hole within each of said coupling parts;

a flanged bushing fitted within each of said knuckle coupling holes; and

a socket bolt and nut, said socket bolt passing through said flanged bushings, said knuckle coupling holes and said coupling parts;

a damper coupling hole within a damper coupling part provided at the first end of the damper; and

a bushing having a pair of sides fitted within the damper coupling hole, said socket bolt operatively engaging said damper coupling hole and said bushing.

13. The double wishbone suspension structure according to claim 12, further comprising a cylindrical collar being inserted between said flanged bushings of the knuckle and the bushing of the damper, and said damper coupling part

being arranged between the coupling parts of the knuckle.

14. The double wishbone suspension structure according to claim 8, further comprising:

an arm coupling part at an end of each upper and lower arm; and

an arm coupling hole within each of said arm coupling parts, said coupling shaft operatively engaging said knuckle, said damper and said arm coupling holes.

15. The double wishbone suspension structure according to claim 13, further comprising:

an arm coupling part at an end of each upper and lower arm; and

an arm coupling hole within each of said arm coupling parts, said socket bolt operatively engaging said knuckle, said damper and said arm coupling holes.

16. A double wishbone suspension structure comprising:

a wheel side and a vehicle body side;

a pair of upper arms and a pair of lower arms vertically swingably connected to the body side of the suspension structure, said upper and lower arms each having a first end and a second end, wherein said second ends are positioned on said vehicle body side of said suspension structure;

a coupling shaft operatively connected to at least one of said first ends;

a knuckle on the wheel side being coupled to the at least one first end coupled with the coupling shaft;

a damper for dampening an impact transmitted from the wheel side to the vehicle body side; and

a first end of the damper being coupled to the coupling shaft, wherein the first end of the damper coupled

to the coupling shaft is coaxial with a central axis of the damper.

17. A double wishbone suspension structure comprising:

a wheel side and a vehicle body side;

a pair of upper arms and a pair of lower arms vertically swingably connected to the body side of the suspension structure, said upper and lower arms each having a first end and a second end, wherein said second ends are positioned on said vehicle body side of said suspension structure;

a coupling shaft operatively connected to at least one of said first ends;

a knuckle having a pair of knuckle coupling parts on the wheel side being coupled to the at least one first end of the arm coupled with the coupling shaft;

a damper for dampening an impact transmitted from the wheel side to the vehicle body side; and

a first end of the damper being coupled to the coupling shaft, wherein the first end of the damper coupled to the coupling shaft is coaxial with a central axis of the damper.

18. The double wishbone suspension structure according to claim 17, further comprising:

an arm coupling part provided at the first end of the arm between the knuckle coupling parts;

arm coupling holes within the arm coupling part;

dust seals respectively installed within the arm coupling holes;

flanged bushings respectively fitted into the arm coupling holes;

a collar inserted within the bushings; and

a socket bolt inserted into knuckle coupling holes

provided within each knuckle coupling part, the arm coupling holes and the collar, wherein said coupling shaft is formed by said socket bolt.

19. A double wishbone suspension structure as claimed in any of claims 1 through 18 wherein a second end of said damper is connected to said vehicle body at a position inwardly of the position of said second ends of said upper and lower arms.

20. A double wishbone suspension as claimed in any of claims 1 through 19 wherein said damper is of a length and connected at said first and second ends to have an orientation with a horizontal component greater than a vertical component thereof.

Fig. 1

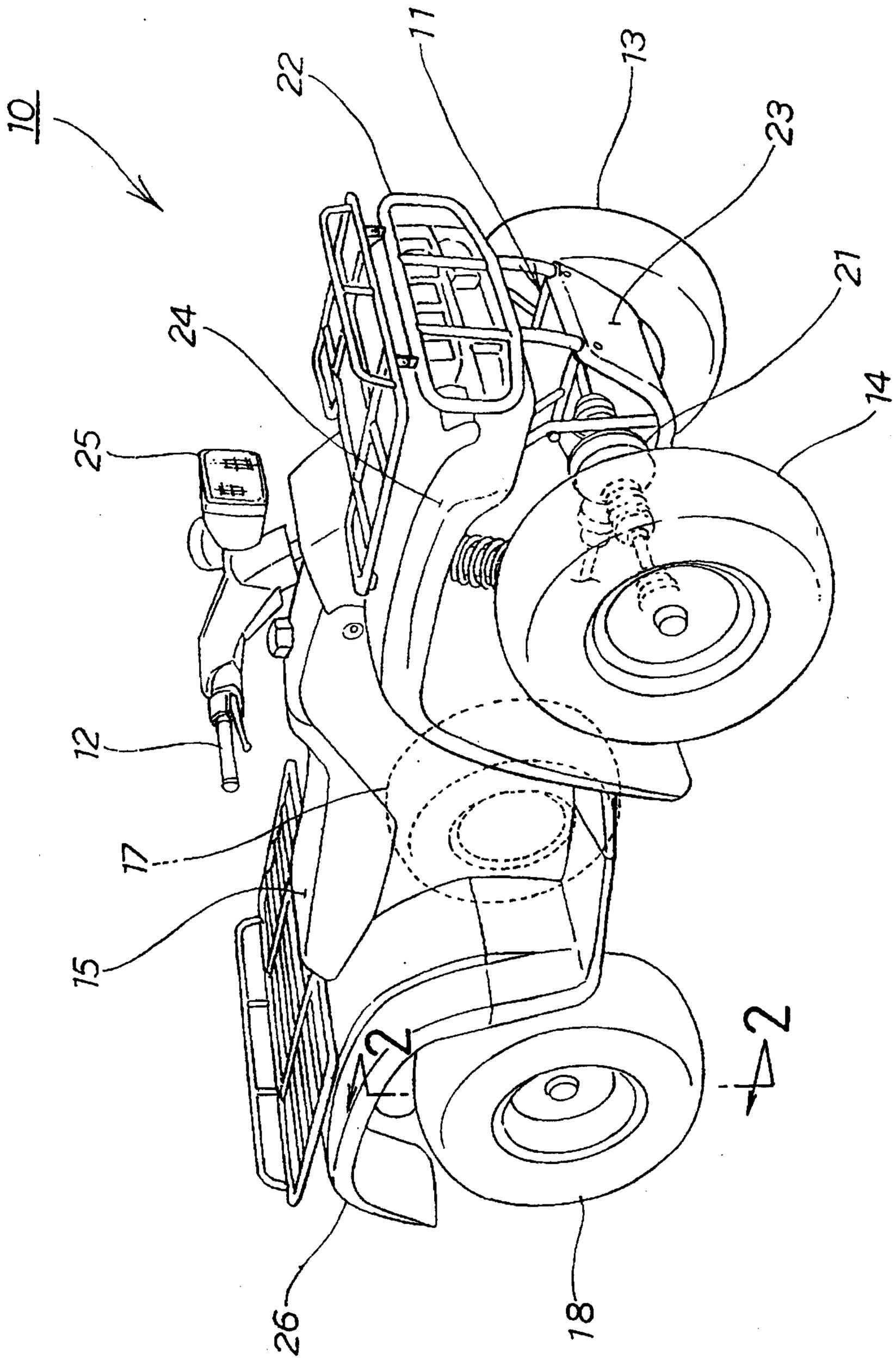

Fig. 2

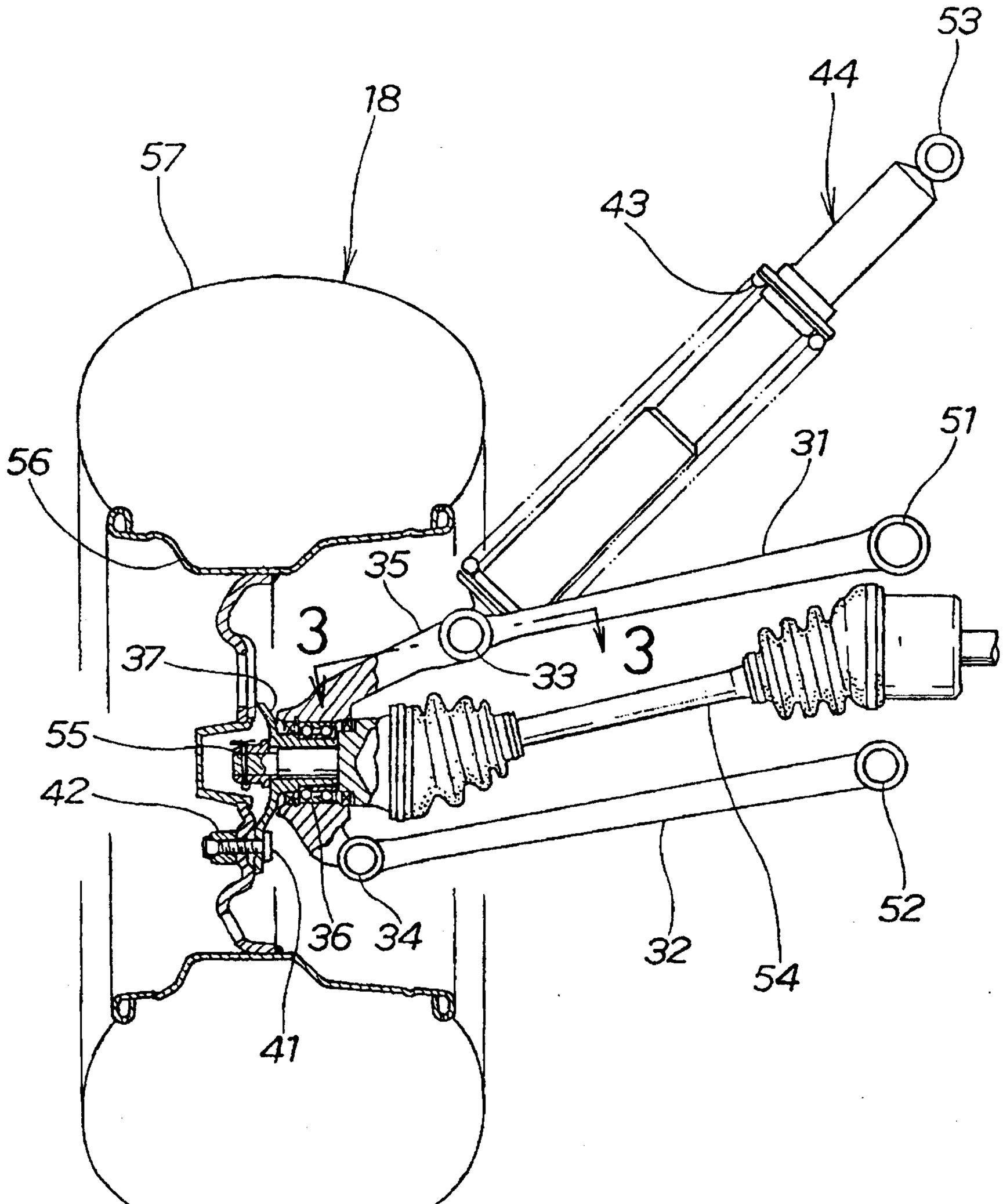

Fig. 3

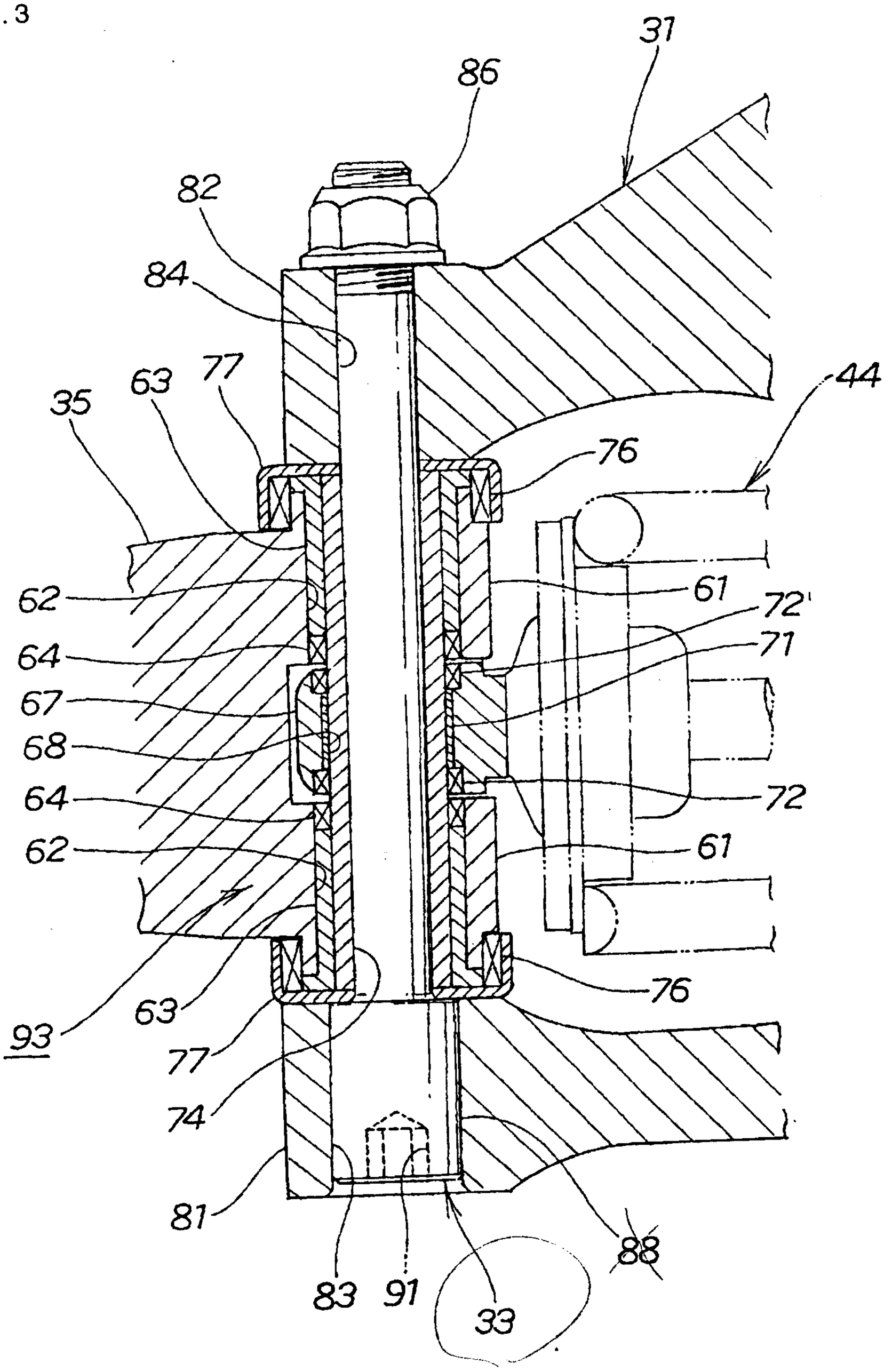
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Fig. 4

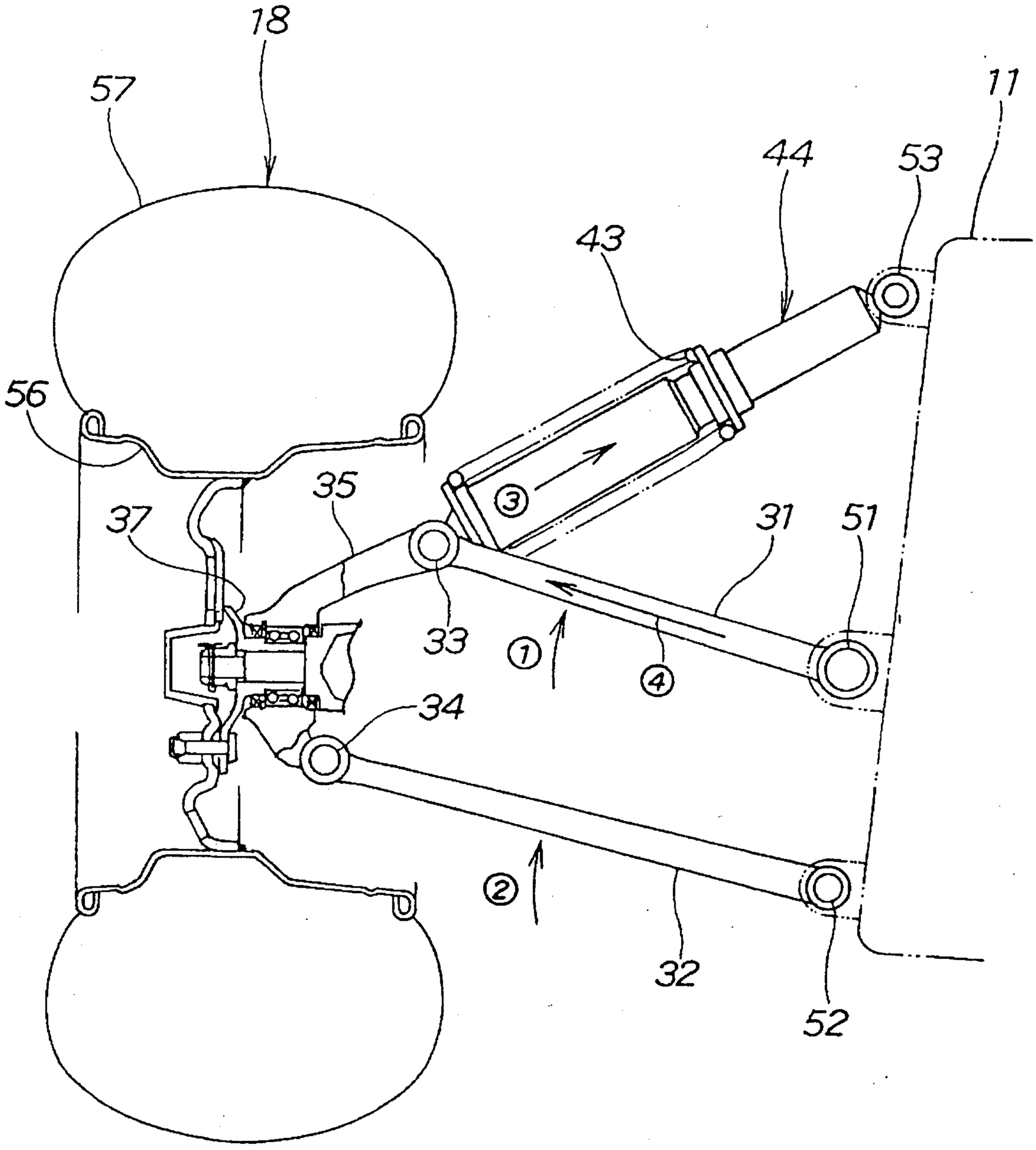

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Fig. 5

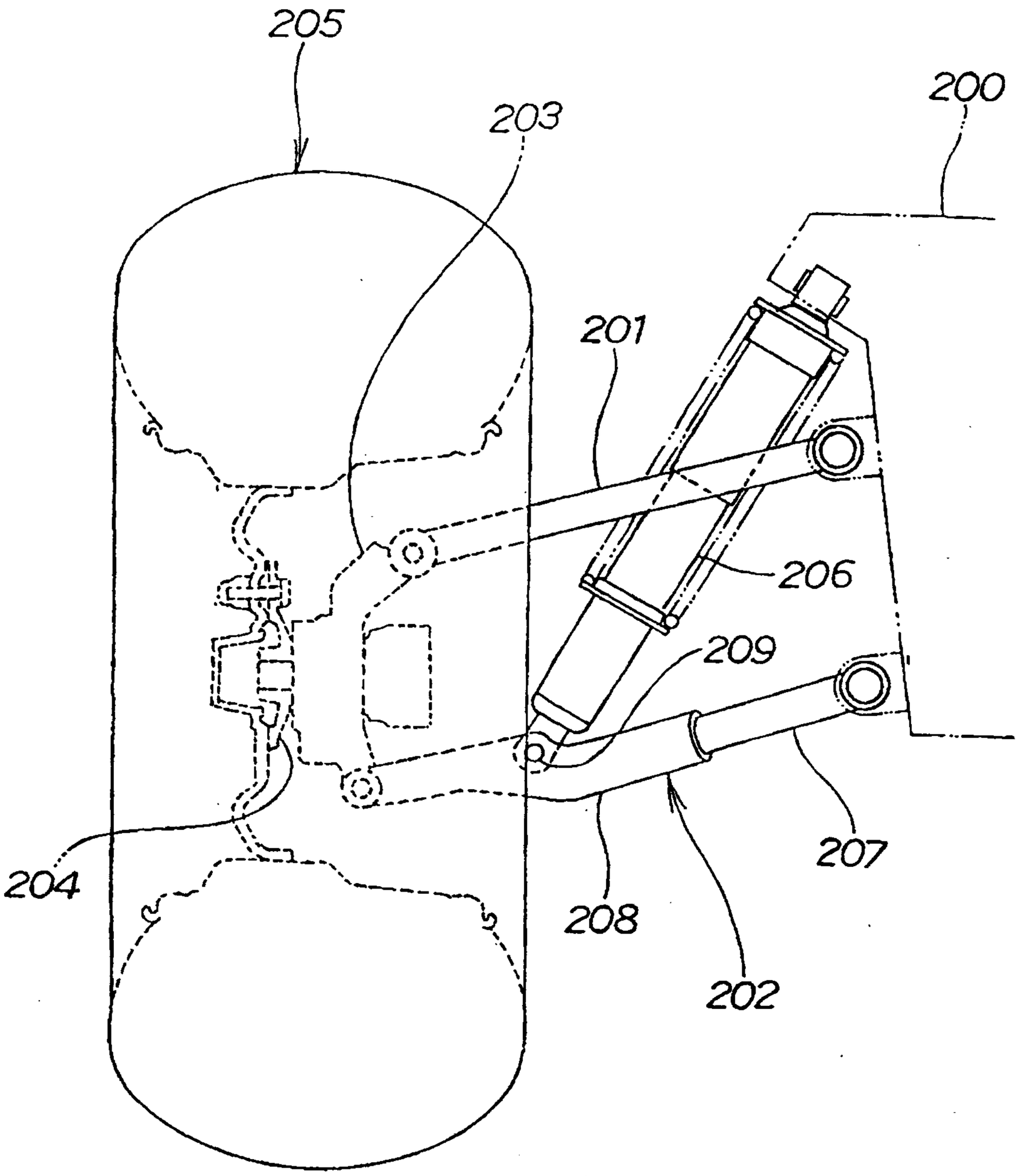
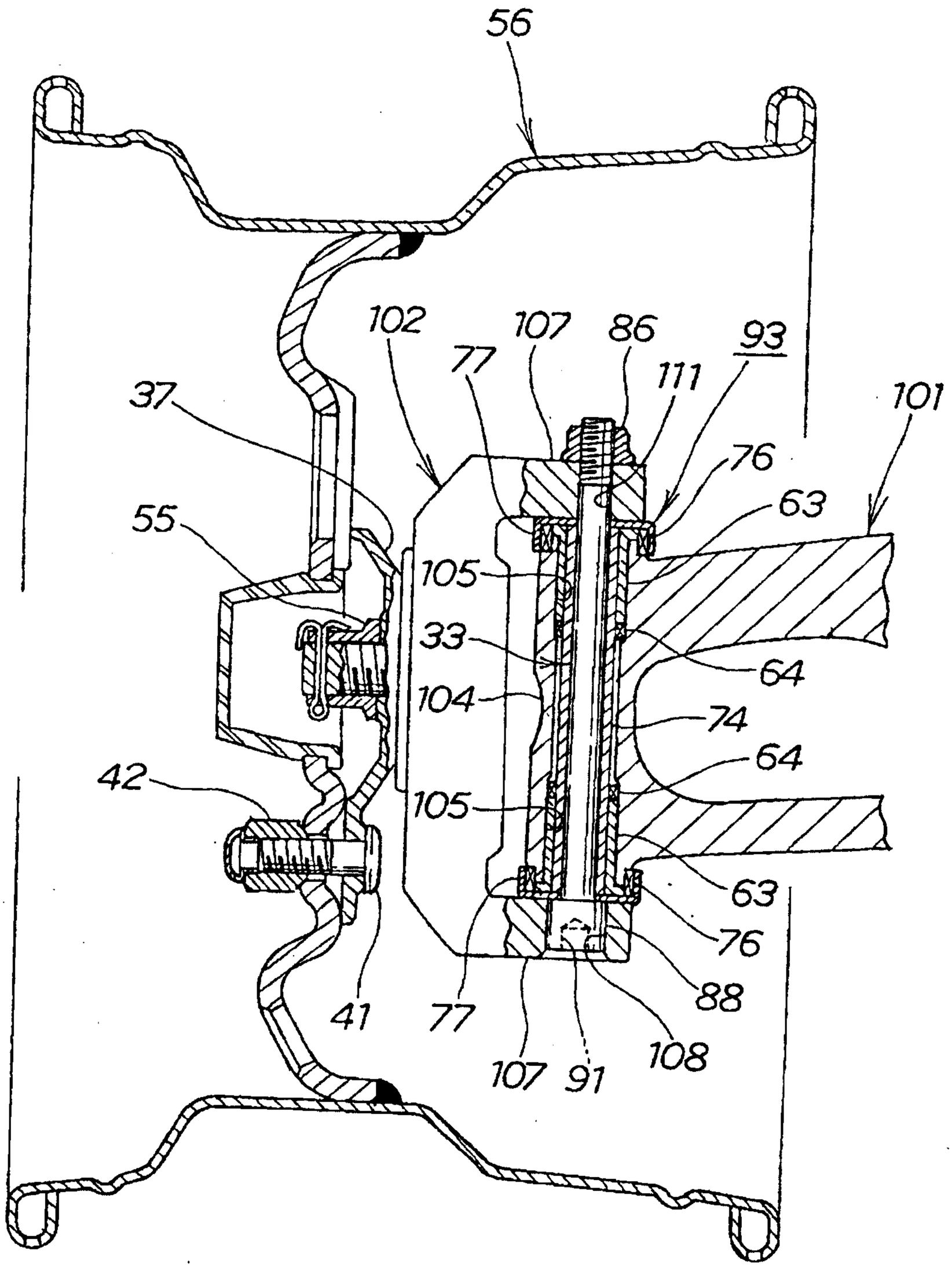


Fig. 6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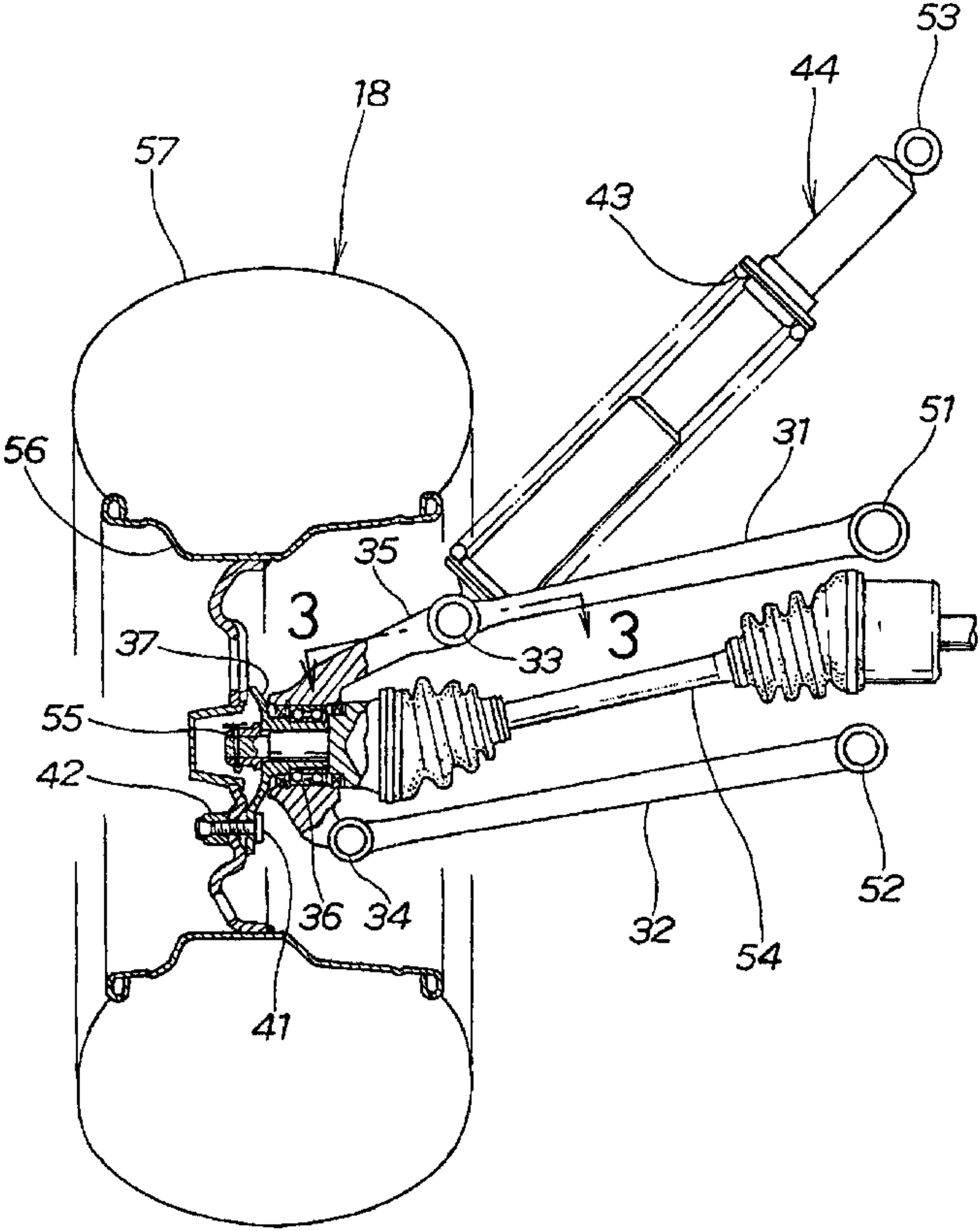
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