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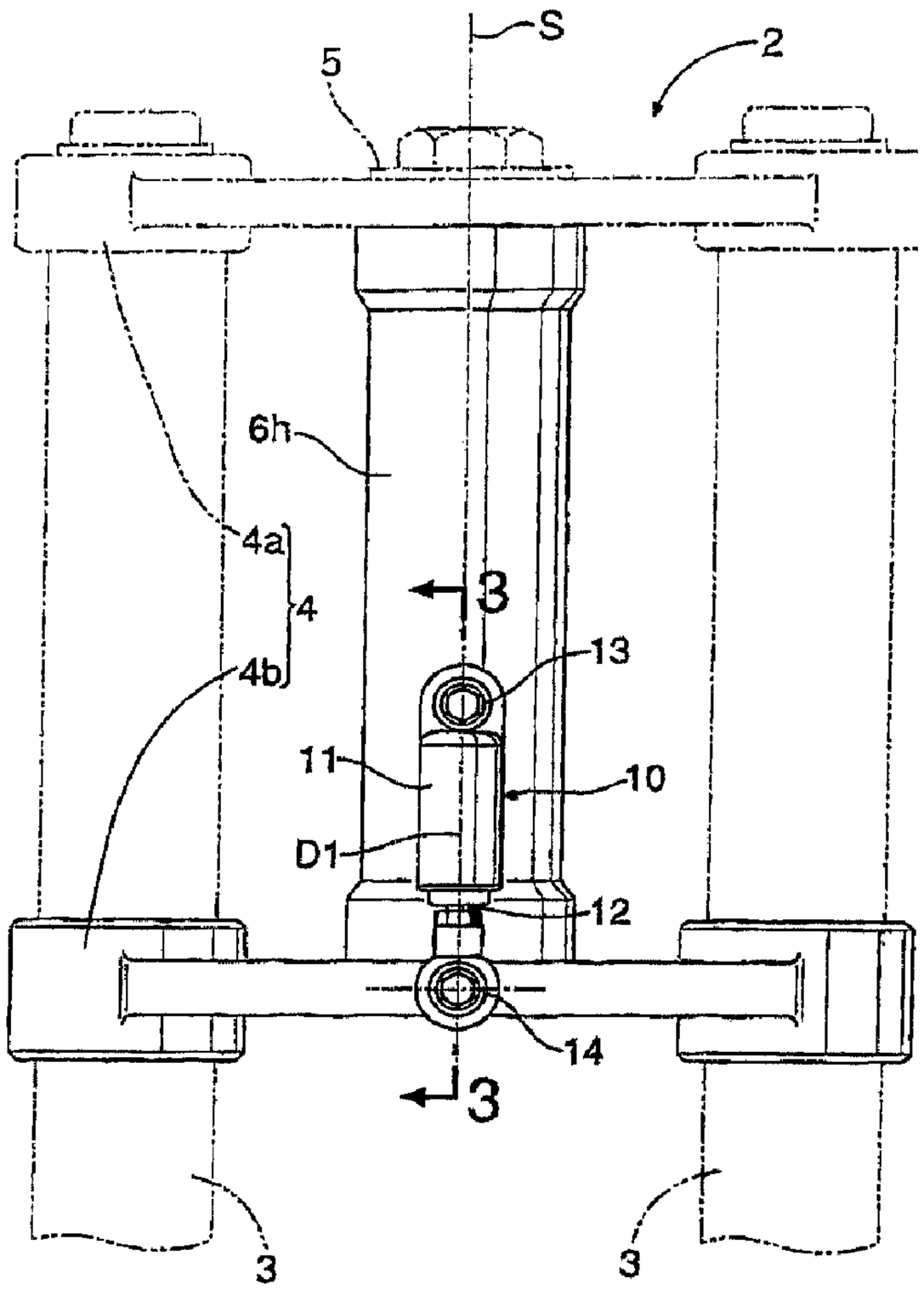

(57) Abrégé/Abstract:
To provide a steering damper device having a desired damping characteristic in which a gradually increasing damping force is generated according to the turned angle when a handle is turned, and the damping force is not generated when the handle is

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(57) Abrégé(suite)/Abstract(continued):
returned using an inexpensive cylindrical damper of a simple structure. A cylindrical damper is disposed between a head pipe for rotatably supporting a steering stem and a fork bridge of a front fork so as to be the shortest when the handle is at a neutral position. The cylindrical damper is connected to the head pipe and the fork bridge via spherical joints. The cylindrical damper generates the damping force when being expanded. Since the cylindrical damper is expanded when the handle is turned either directions, left or right, a damping force is generated.

ABSTRACT OF THE DISCLOSURE

To provide a steering damper device having a desired damping characteristic in which a gradually increasing damping force is generated according to the turned angle when a handle is turned, and the damping force is not generated when the handle is returned using an inexpensive cylindrical damper of a simple structure. A cylindrical damper is disposed between a head pipe for rotatably supporting a steering stem and a fork bridge of a front fork so as to be the shortest when the handle is at a neutral position. The cylindrical damper is connected to the head pipe and the fork bridge via spherical joints. The cylindrical damper generates the damping force when being expanded. Since the cylindrical damper is expanded when the handle is turned either directions, left or right, a damping force is generated.

STEERING DAMPER DEVICE

FIELD OF THE INVENTION

The present invention relates to a steering damper device used for a small vehicle such as a motorcycle.

BACKGROUND OF THE INVENTION

In a motorcycle, steering is performed by operating a handle so as to rotate a front fork, which supports a front wheel, about a steering stem rotatably inserted into a head pipe at the front end of a vehicle body frame. Such a motorcycle may be provided with a steering damper device between the steering-side member which rotates when the handle is operated and the vehicle-body-side member which does not rotate even when the handle is operated. In such a case, the steering damper device is required to generate little damping moment during normal traveling in which the turned angle of the handle is small and the angular speed is low and generate a high damping moment in the range in which the turned angle of the handle is large and the angular speed is high, to restrain a burden of the handle operation as much as possible by setting the damping moment in the low-speed range to a small value in a situation in which the speed is low and small turns occur continuously and the turned angle of the handle is relatively large, to control the damping moment so as to be generated little when the steered steering is returned, and so on. Therefore, in the related art, there is a steering damper device for a motorcycle in which the above-described requirements is satisfied by using a swing-type damper and providing a bypass for varying a damping force in a complex manner.

However, the steering damper device employing such a swing-type damper is complex in structure and expensive, and in addition, bulky and heavy. Therefore, it may constrain the arrangement of other parts.

There is also a steering damper device for a motorcycle which is configured by a cylindrical damper which has a simple structure and is inexpensive, which is well known since long time ago (For example, JP-UM-B-64-4633). The steering damper device includes a cylindrical damper having a damper case and a damper rod sliding in the damper case, the damper case being rotatably connected to a head pipe on the vehicle body side and one of fork bridges on the steering side, and the damper rod being rotatably connected to the other one of those. In such a case, a connecting point on the fork bridge side is a position closer to either one of left and right ends of the fork bridge.

According to the steering damper device as described above, since the cylindrical damper is contracted when the handle is turned to the right, and expanded when turned to the left, a damping effect may be generated on either sides. Accordingly, the damping force can be generated at the limits of rotation.

Generally, the cylindrical damper generates a uniform damping force in a contracting stroke or an expansion stroke of the damper. Therefore, the device configured such that the cylindrical damper is contracted on one side and expanded on the other side depending on the turning direction of the handle as stated in JP-UM-B-64-4633 described above may have the same characteristics when the handle is turned in either directions of right or left from the steered angle of 0°, but it is difficult to configure the device so as to generate different values of the damping force when the handle is turned from the steered angle of 0° when the handle is turned to the steered angle of 0°. It is also difficult to provide an angle-dependent characteristic to the steered angle of the handle. Furthermore, in the device stated in JP-UM-B-64-4633 described above, a long damper stroke is structurally required, and hence a compact layout cannot be achieved.

In view of such circumstances, it is an object of the present invention to provide a steering damper device which can provide a desired

characteristic while using a normal cylindrical damper of a simple structure.

SUMMARY OF THE INVENTION

The present invention is directed to a steering damper device including a cylindrical damper having a damper rod, the damper rod sliding in a damper case, the cylindrical damper disposed between a steering-side member, which rotates about a steering stem when a handle is operated, and a vehicle-body-side member, which does not rotate even when the handle is operated, characterized in that the cylindrical damper is mounted in such a manner that the damper rod takes a longest position or a shortest position when the steered angle of the handle is in the vicinity of 0°.

An aspect of the invention is characterized in that the cylindrical damper is provided in front of a head pipe, which rotatably supports the steering stem, substantially along the length of the head pipe so that the damper rod takes the shortest position when the steered angle of the handle is in the vicinity of 0°.

Another aspect of the invention is characterized in that the cylindrical damper is provided in the fore-and-aft direction between a fork bridge positioned forwardly of the steering stem and a vehicle body frame positioned rearwardly of the steering stem so that the damper rod takes the longest position when the steered angle of the handle is in the vicinity of 0°.

A further aspect of the invention is directed to a steering damper device including a cylindrical damper having a damper rod, the damper rod sliding in a damper case, the cylindrical damper disposed between a steering-side member, which rotates about a steering stem when a handle is operated, and a vehicle-body-side member, which does not rotate even when the handle is operated, characterized in that the cylindrical damper is disposed so that a center axis of the cylindrical damper is positioned substantially on a plane including a center axis of the steering stem when the steered angle of the handle is in the vicinity of 0°.

Yet another aspect of the invention is characterized in that the cylindrical damper is disposed so that the center axis of the cylindrical damper lies substantially along a center plane of the vehicle body extending in the fore-and-aft direction of the vehicle body when the steered angle of the handle is in the vicinity of 0°.

A further aspect of the present invention is directed to a steering damper comprising a cylindrical damper having a damper rod the damper rod sliding in a damper case, the cylindrical damper being disposed between a steering side member, which rotates about a steering stem when the handle is operated, and a vehicle-body-side member, which does not rotate even when the handle is operated, characterized in that the cylindrical damper is mounted so that the damper rod slides in the damper case in the same direction in either cases where the cylindrical damper is steered leftward or rightward from the position at which the steered angle of the handle is 0°.

Another aspect of the invention is characterized in that the cylindrical damper is provided in front of a head pipe, which rotatably supports the steering stem, substantially along the length of the head pipe so that the damper rod takes the shortest position when the steered angle of the handle is in the vicinity of 0°.

A further aspect of the invention is characterized in that the cylindrical damper is provided in the fore-and-aft direction between the fork bridge positioned forwardly of the steering stem and the vehicle body frame positioned rearwardly of the steering stem so that the damper rod takes the longest position when the steered angle of the handle is in the vicinity of 0°.

A further aspect of the invention is characterized in that the amount of sliding movement of the damper rod with respect to the steered angle of the handle is small when the steered angle of the handle is in the vicinity of 0°, and increases as the steered angle of the handle goes away from 0°.

Another aspect of the invention is characterized in that a damping force acting on the steering-side member from the cylindrical damper is small

when the steered angle of the handle is in the vicinity of 0°, and increases as the steered angle of the handle goes away from 0°.

Yet another aspect of the invention is directed to a steering damper device including a cylindrical damper having a damper rod, the damper rod sliding in a damper case, the cylindrical damper disposed between a steering-side member, which rotates about a steering stem when a handle is operated, and a vehicle-body-side member, which does not rotate even when the handle is operated, characterized in that the cylindrical damper is connected to the steering-side member via a link lever rotatably supported by the vehicle-body-side member and a link rod connected to the link lever, in that, the link rod is disposed so that a straight line connecting the joint portions at both ends of the link rod is positioned substantially on a plane including a center axis of the steering stem when the steered angle of the handle is in the vicinity of 0°.

A further aspect of the invention is characterized in that the link rod is disposed so that the straight line connecting the joint portions at the both ends of the link rod lies substantially along the center plane of the vehicle body extending in the fore-and-aft direction of the vehicle body when the steered angle of the handle is in the vicinity of 0°.

BRIEF DESCRIPTION OF THE DRAWINGS

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

Fig. 1 is a side view showing a principal portion of a motorcycle provided with the steering damper device according to a first embodiment of the present invention.

Fig. 2 is a front view of a front fork portion viewed in the direction indicated by an arrow 2 in Fig. 1.

Fig. 3 is a cross-sectional view of a cylindrical damper portion taken along the line 3-3 in Fig. 2.

Fig. 4 is an explanatory enlarged view of the cylindrical damper showing a portion indicated by an arrow 4 in Fig. 3.

Fig. 5 is an explanatory enlarged view of the cylindrical damper similar to Fig. 4.

Fig. 6 is a front view, which is similar to Fig. 2, showing a state in which a handle is turned to the left.

Fig. 7 is a cross-sectional view taken along the line 7-7 in Fig. 6.

Fig. 8 is a characteristic curve of the steering damper device.

Fig. 9 is a side view showing a principal portion of a motorcycle provided with the steering damper device of a second embodiment of the present invention.

Fig. 10 is a plan view of a front fork portion viewed in the direction indicated by an arrow 10 in Fig. 9.

Fig. 11 is a cross-sectional view taken along the line 11-11 in Fig. 10.

Fig. 12 is a plan view similar to Fig. 10, showing a state in which the handle is turned leftward.

Fig. 13 is a cross-sectional view taken along the line 13-13 in Fig. 12.

Fig. 14 is a plan view of the front fork portion of the motorcycle provided with the steering damper device according to a third embodiment of the present invention.

Fig. 15 is a side view viewed in the direction indicated by an arrow 15 in Fig. 14.

Fig. 16 is a side view of a fork bridge portion of the front fork of a motorcycle provided with a steering damper device according to a fourth embodiment of the present invention.

Fig. 17 is a front view viewed in the direction indicated by an arrow 17 in Fig. 16.

Fig. 18 is a plan view of the front fork portion of the motorcycle provided with the steering damper device according to a fifth embodiment of the present invention.

Fig. 19 is a plan view of a front fork portion of the motorcycle provided with the steering damper device according to a sixth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will be described based on preferred embodiments of the present invention shown in the attached drawings.

Fig. 1 to Fig. 8 out of the drawings shows a first embodiment of a steering damper device according to the present invention. Fig. 1 is a side view showing a principal portion of a motorcycle provided with the steering damper device; Fig. 2 is a front view of a front fork portion viewed in the direction indicated by an arrow 2 in Fig. 1; Fig. 3 is a cross-sectional view of a cylindrical damper portion taken along the line 3-3 in Fig. 2; Fig. 4 and Fig. 5 are explanatory enlarged views of the cylindrical damper; Fig. 6 is a front view, which is similar to Fig. 2, showing a state in which a handle is turned to the left; Fig. 7 is a cross-sectional view taken along the line 7-7 in Fig. 6; and Fig. 8 is a characteristic curve of the steering damper device.

As shown in Fig. 1 and Fig. 2, a front fork 2 supporting a front wheel 1 of a motorcycle includes left and right fork pipes 3, 3, and a fork bridge 4 for connecting the upper ends thereof. The fork bridge 4 includes a top bridge 4a and a bottom bridge 4b disposed in parallel and at a distance in the vertical direction, and a steering stem 5 is arranged between the lateral centers of the respective bridges 4a, 4b so as to connect them integrally. The steering stem 5 is rotatably inserted into a head pipe 6h provided at the front end of a vehicle body frame 6. A handle 7 for steering is attached to the top bridge 4a. In this manner, the front fork 2 rotates leftward and

rightward about the steering stem 5 when the handle 7 is operated, and the front wheel 1 supported by the front fork rotates therewith, so that steering of the motorcycle is achieved.

The head pipe 6h is provided at a position closer to the lower end thereof with a forwardly projecting stay 8. The stay 8 is disposed on the centerline in the fore-and-aft direction of the vehicle body. The bottom bridge 4b is also provided with a forwardly projecting stay 9 at the lateral center thereof. A cylindrical damper 10 is disposed between the stays 8, 9. In other words, the cylindrical damper 10 is disposed in front of the head pipe 6h so as to lie substantially along the length of the head pipe 6h.

As shown in Fig. 3, the cylindrical damper 10 includes a damper case 11, and a damper rod 12 sliding in the damper case 11. The damper case 11 is rotatably connected to the head pipe 6h side, that is, to the stay 8 on the vehicle body side, via a spherical joint 13, and the damper rod 12 is rotatably connected to the bottom bridge 4b side, that is, to the stay 9 on the steering side via a spherical joint 14. It is also adapted in such a manner that the center axis of the damper rod 12 which slides in the damper case 11, that is, the center axis D1 of the cylindrical damper 10 passes through the centers of the spherical joints 13, 14. In this manner, the cylindrical damper 10 is attached between the vehicle body frame 6 which does not rotate during operation of the handle 7, and the front fork 2 which rotates with the operation of the handle 7. As shown in Fig. 2, the cylindrical damper 10 takes the most contracted state, that is, the damper rod 12 takes the shortest position when the handle 7 is at a neutral position, that is, when a steered angle of the handle is 0°. In addition, the center axis D1 of the cylindrical damper 10 is adapted to lie in parallel with the center axis S of the steering stem 5 and of the head pipe 6h. Therefore, at this time, the center axis D1 of the cylindrical damper 10 is positioned on a plane including the center axis S of the steering stem 5 and extending in the fore-and-aft direction of the vehicle body, that is, on the center plane of the vehicle body extending in the fore-and-aft direction of the vehicle body. The damper case 11 of the cylindrical damper 10 includes, as shown in Fig. 3, a damper chamber 15, and a reservoir chamber 17 in communication with the damper chamber 15 via a oil channel 16. Oil is encapsulated in the damper chamber 15 and the reservoir chamber 17. The lower surface

of the reservoir chamber 17 is defined by a piston 18, and the piston 18 is pressed and urged upward by compression gas 19 encapsulated in the gas chamber provided below. The damper chamber 15 is divided into two upper and lower chambers 15a, 15b by a piston 20 attached at the extremity of the damper rod 12. The piston 20 is provided with a plurality of vertically penetrating openings 21, 21... and a valve 22 for opening and closing the lower ends of the openings 21. As shown in Fig. 4 and Fig. 5, the valve 22 includes a valve plate 23 having a valve hole 23a which is relatively small in diameter, a rubber plate 24 for opening and closing the valve hole 23a, and a leaf spring 25 for urging the valve plate 23 toward the closed position of the openings 21. In addition, the piston 20 is provided with an orifice 26 for allowing the openings 21 and the lower chamber 15b of the damper chamber 15 to be constantly in communication with each other.

In the cylindrical damper 10 thus configured, when expanding, the pressure in the lower chamber 15b of the damper chamber 15 increases as the piston 20 mounted at the extremity of the damper rod 12 slides downward in the damper chamber 15. Therefore, as shown in Fig. 4 by an arrow, oil in the lower chamber 15b flows into the upper chamber 15a via the valve hole 23a, then via the openings 21. Then, a damping force is generated due to a resistance when oil passes through the valve hole 23a. When contracting, since the pressure in the upper chamber 15a of the damper chamber 15 increases, as shown in Fig. 5 by an imaginary line, the valve plate 23 is deformed downward against an urging force of the leaf spring 25. As a consequence, the openings 21 open, and oil in the upper chamber 15a flows through the openings 21 into the lower chamber 15b. Therefore, at this time, the damping force is hardly generated.

The operation of the steering damper device thus configured will be described.

As described above, when the handle 7 is at the neutral position, that is, when the steered angle of the handle is 0°, the cylindrical damper 10 is contracted to the maximum and takes the shortest state. When the handle 7 is turned in this state, for example, to the left, the front fork 2 rotates leftward about the steering stem 5, which is rotatably inserted into the

head pipe 6h of the vehicle body frame 6, as shown in Fig. 6. Therefore, the bottom bridge 4b constituting the fork bridge 4 of the front fork 2 also rotates, and the spherical joint 14 connecting the stay 9 provided at the lateral center thereof and the damper rod 12 of the cylindrical damper 10 is deviated from the centerline in the fore-and-aft direction of the vehicle body. On the other hand, the spherical joint 13 connecting the stay 8, which is provided on the head pipe 6h, and the damper case 11 of the cylindrical damper 10, remains at its original position, that is, on the centerline in the fore-and-aft direction of the vehicle body since the head pipe 6h does not rotate even when the handle 7 is rotated. As a consequence, the cylindrical damper 10 is expanded and the damper rod 12 slides in the damper case 11 downward in Fig. 3, and hence the damping force is generated.

Also, when the handle 7 is turned toward the right as well, the cylindrical damper 10 is expanded and the damper rod 12 slides in the damper case 11 downward in Fig. 3. Therefore, the damping force is generated. In this manner, the cylindrical damper 10 is provided such that the damper rod 12 slides in the damper case 11 in the same direction in either cases where the handle 7 is steered leftward or rightward from the position where the steered angle of the handle is 0°.

In addition, when the handle 7 is turned in either directions of left or right, as long as the turned angle of the handle 7, that is, as long as the steered angle is the same, the amount of expansion of the cylindrical damper 10 is the same. Therefore, the damping force characteristic is symmetry as shown in Fig. 8.

When returning the handle 7 which is turned rightward or leftward to its neutral position, the cylindrical damper 10 contracts and the damper rod 12 slides in the damper case 11 upward in Fig. 3 in either cases. As described above, the cylindrical damper 10 is adapted not to generate the damping force during contraction. Therefore, when returning the steered steering, the damping force is hardly generated. In this manner, the steering damper device may be configured so that the damping force is generated in both cases where the handle 7 is turned rightward and where

it is turned leftward from the steered angle 0°, and the damping force is reduced when returning the handle 7 to the steered angle of 0°.

Fig. 8 shows a calculated damping moment to be generated when the cylindrical damper 10 is mounted to a certain position and the handle 7 is steered leftward and rightward at a certain constant speed. The damping force of the damper 10 has a characteristic in which the damping force increases at a constant rate with respect to the expansion speed of the damper 10.

As shown in Fig. 8, according to the steering damper device, a generated damping moment is small where the turned angle of the handle 7 is small, and a generated damping moment increases with increase in turned angle. In other words, the damping force acting on the front fork 2, which is the steering-side member, from the cylindrical damper 10 is small when the steered angle of the handle is in the vicinity of 0°, and increases as the steered angle of the handle goes away from 0°. In addition, during that time, generation of the damping moment continues smoothly.

As described above, the reason why the damping moment is hardly generated in the initial stage when the handle 7 is steered from the neutral position is that the amount of expansion of the cylindrical damper 10 is small in the vicinity of the neutral position of the handle 7. Then, in the middle stage, since the damper stroke increases gradually with respect to the turned angle of the handle 7, the damping force increases gradually as well. In other words, in this steering damper device, the amount of sliding movement of the damper rod 12 with respect to the steered angle of the handle is small when the steered angle of the handle is in the vicinity of 0°, and increases as the steered angle of the handle goes away from 0°. In the late stage, since the moment arm about the steering axis is significantly reduced, increase in damping moment becomes sluggish.

In such a manner, with this steering damper device, the above-described requirements required for the steering damper device for a motorcycle may be satisfied.

Since the relatively short cylindrical damper 10 must simply be attached to the head pipe 6h at the front thereof, it can be configured to be compact and light-weight, and the possibility of impairment of the design or the like is also eliminated. Furthermore, since the productivity of the cylindrical damper 10 is high, the cost reduction is also achieved.

Fig. 9 to Fig. 13 shows a second embodiment of the steering damper device according to the present invention. Fig. 9 is a side view showing a principal portion of the motorcycle provided with the steering damper device; Fig. 10 is a plan view of a front fork portion viewed in the direction indicated by an arrow 10 in Fig. 9; Fig. 11 is a cross-sectional view of the cylindrical damper taken along the line 11-11 in Fig. 10; Fig. 12 is a plan view similar to Fig. 10, showing a state in which the handle is turned leftward; and Fig. 13 is a cross-sectional view taken along the line 13-13 in Fig. 12.

In the second embodiment, the parts corresponding to the first embodiment are represented by the same reference numerals and duplicated description is omitted.

As shown in Fig. 9 and Fig. 10, in the case of the second embodiment, an upwardly projecting stay 28 is provided at the center of the upper surface of the top bridge 4a, which corresponds to the upper portion of the fork bridge 4, at the position forwardly of the steering stem 5. Provided on the head pipe 6h of the vehicle body frame 6 is an extending portion 6j extending rearward from the upper end thereof, and an upwardly projecting stay 29 is provided on the upper surface of the extending portion 6j. A cylindrical damper 30 is disposed between the stays 28, 29. As shown in Fig. 11, the cylindrical damper 30 includes a damper case 31 and a damper rod 32 sliding in the damper case 31. The damper case 31 is rotatably connected to the stay 28 on the top bridge 4a side, which corresponds to the steering-side member, via a spherical joint 33, and the damper rod 32 is rotatably connected to the stay 29 on the head pipe 6h side which corresponds to the vehicle-body-side member via a spherical joint 34. In addition, the center axis of the damper rod 32, that is, the center axis D2 of the cylindrical damper 30 passes the centers of the spherical joints 33, 34. In this manner, the cylindrical damper 30 is attached between the

vehicle body frame 6 which does not rotate during operation of the handle 7, and the front fork 2 which rotates with the operation of the handle 7. As shown in Fig. 10, the cylindrical damper 10 takes the most expanded state, that is, the damper rod 32 takes the longest position when the handle 7 is at a neutral position, that is, when the steered angle of the handle is 0°. In addition, it is adapted so as to be positioned on the center plane in the fore-and-aft direction of the vehicle body across the steering stem 5 and the head pipe 6h. Therefore, at that time, the center axis D2 of the cylindrical damper 30 is positioned on the plane including the center axis S of the steering stem 5 and extending in the fore-and-aft direction, that is, on the center plane of the vehicle body extending in the fore-and-aft of the vehicle body.

Since the structure of the cylindrical damper 30 is almost the same as the cylindrical damper 10 in the first embodiment except that a valve 35 generates a damping force when the cylindrical damper 30 is contracted, and the damping force is hardly generated when the cylindrical damper 30 is expanded, the detailed description is omitted. The construction of other parts is also the same as the first embodiment.

In the steering damper device configured as described above, when the handle 7 is at the neutral position, the cylindrical damper 30 is in the most expanded longest state as described above. When the handle 7 is turned leftward from this state, as shown in Fig. 12, the front fork 2 rotates leftward about the steering stem 5 rotatably inserted into the head pipe 6h of the vehicle body frame 6. Therefore, the top bridge 4a which constitutes the fork bridge 4 of the front fork 2 also rotates, and the spherical joint 33 connecting the stay 28 provided at the lateral center thereof and the damper case 31 of the cylindrical damper 30 is deviated from the center plane of the vehicle body in the fore-and-aft direction of the vehicle body. On the other hand, the spherical joint 34 connecting the stay 29 provided on the extending portion 6j of the head pipe 6h and the damper rod 32 of the cylindrical damper 30 remains at its original position, that is, on the center plane of the vehicle body in the fore-and-aft direction of the vehicle body since the head pipe 6h does not rotate even when the handle 7 is operated. As a consequence, the cylindrical damper 30 is contracted, and the damper rod 32 slides in the damper case 31 leftward in Fig. 11, and hence the damping force is generated. Also, when the handle 7 is turned

rightward, the cylindrical damper 30 is also contracted and the damper rod 32 slides in the damper case 31 leftward in Fig. 11. Therefore, the damping force is generated. In this manner, the cylindrical damper 30 is provided such that the damper rod 32 slides in the damper case 31 in the same direction in either cases where the handle 7 is steered leftward and rightward from the position where the steered angle of the handle is 0°.

In addition, when the handle 7 is turned in either directions of right or left, the amount of expansion of the cylindrical damper 30 is the same as long as the turned angle of the handle 7, that is, the steered angle is the same. Therefore, the damping force characteristic is symmetry.

When returning the handle 7 which is turned rightward or leftward to the neutral position, the cylindrical damper 30 is expanded and the damper rod 32 slides in the damper case 31 rightward in Fig. 11 in either cases. As described above, the cylindrical damper 30 is adapted to hardly generate the damping force when being expanded. Therefore, when returning the steered steering back to the original position, the damping force is hardly generated. In this manner, with the steering damper device according to the second embodiment, it can be adapted in such a manner that the damping force is generated when the handle 7 is turned, and the damping force is decreased when the handle 7 is returned. In addition, in this steering damper device as well, the amount of sliding movement of the damper rod 32 with respect to the steered angle of the handle is small when the steered angle of the handle is in the vicinity of 0° and increases as the steered angle of the angle goes away from 0°. Also, the damping force acting from the cylindrical damper 30 on the front fork 2 which is the steering-side member is small when the steered angle of the handle is in the vicinity of 0°, and increases as the steered angle of the handle goes away from 0°. Therefore, the above-described requirements required for the steering damper device of the motorcycle can be satisfied by this steering damper device.

Since the cylindrical damper 30 is provided in the fore-and-aft direction, the steering damper device is arranged so as to lie substantially along the vehicle body frame 6, and hence restraint putted on the layout of other parts by the steering damper device may be reduced.

Fig. 14 and Fig. 15 show a third embodiment of the steering damper device according to the present invention. Fig. 14 is a plan view of the front fork portion of the motorcycle provided with the steering damper device, and Fig. 15 is a side view viewed in the direction indicated by an arrow 15 in Fig. 14.

In the third embodiment, the parts corresponding to the second embodiment are represented by the same reference numerals and duplicated description is omitted.

As shown in Fig. 14 and Fig. 15, in the third embodiment, the top of the head pipe 6h is rotatably supported via a horizontal shaft 39. Then, a cylindrical damper 40 is provided between a link lever 38 and a down tube 6d between left and right main frames 6m, 6m which constitute the vehicle body frame 6 together with the head pipe 6h. The cylindrical damper 40 includes a damper case 41 and a damper rod 42 which slides in the damper case 41. The damper case 41 is rotatably connected to the rear end of the link lever 38 via a horizontal shaft 43, and the damper rod 42 is rotatably connected to the upper end surface of the down tube 6d via a horizontal shaft 44. On the other hand, a link rod 45 is rotatably connected to the upper surface of the front end of the link lever 38via the spherical joint 46, and the other end of the link rod 45 is rotatably connected to the center of the upper surface of the top bridge 4a, which corresponds to the upper portion of the fork bridge 4, at the position forwardly of the steering stem 5 via a spherical joint 47.

In this manner, the cylindrical damper 40 is connected to the fork bridge 4, which corresponds to the steering-side member rotating about the steering stem 5 when the handle is operated, and is connected to the vehicle body frame 6 which does not rotate even when the handle is operated via the link lever 38 and the link rod 45. The link rod 45 is disposed in such a manner that a straight line L1 connecting the centers of the spherical joints 46, 47, which are joint portions at both ends of the link rod 45, is positioned on the center plane of the vehicle body including the center axis S of the steering stem 5 and extending in the fore-and-aft direction of

the vehicle body when the handle 7 is at the neutral position, that is, when the steered angle of the handle is 0°.

The cylindrical damper 40 is adapted to generate a damping force when being contracted, and to generate little damping force when being expanded.

The construction of other parts is also the same as the second embodiment.

In the steering damper device thus configured, when the handle 7 is turned leftward for example, the front fork 2 rotates leftward about the center axis S of the steering stem 5 and the top bridge 4a is tuned to the position indicated by an alternate long and two short dashed line in Fig. 14. Therefore, the spherical joint 47 connected to the center of the front portion of the top bridge 4a moves as indicated by an arrow in Fig. 14. Consequently, the spherical joint 46 connected to the link lever 38 is pressed rearward by the link rod 45 connected to the spherical joint 47, and hence the link lever 38 rotates about the horizontal shaft 39 as shown in an arrow in Fig. 15. Therefore, the cylindrical damper 40 is contracted, and the damping force is applied on the top bridge 4a, which corresponds to the steering-side member, from the cylindrical damper 40. Also, when the handle 7 is turned rightward as well, since the spherical joint 46 on the link-lever 38 side is pressed rearward, the cylindrical damper 40 is also contracted in the same manner and the damping force is generated.

When the handle 7 which is turned rightward or leftward is returned to the neutral position, the cylindrical damper 40 is expanded in either cases, and hence the attenuation force can hardly be generated.

In this manner, the steering damper device according to the third embodiment can also be configured to generate a damping force when being steered and to generate little damping force when the steered steering is returned. In the case of this steering damper device, the movement of the steering-side member is transmitted to the cylindrical damper 40 via the link rod 45 and the link lever 38, and hence the cylindrical damper 40 can be disposed away from the steering-side member

and, in addition, in the given direction, so that the cylindrical damper 40 can be arranged utilizing a dead space between the main frames 6m, 6m as in the above-described embodiment.

Fig. 16 and Fig. 17 show a fourth embodiment of the steering damper device according to the present invention. Fig. 16 is a side view of a fork bridge portion of the front fork of a motorcycle provided with a steering damper device according to a fourth embodiment of the present invention, and Fig. 17 is a front view viewed in the direction indicated by an arrow 17 in Fig. 16.

In the fourth embodiment, the parts corresponding to the first embodiment are represented by the same reference numerals and duplicated description is omitted.

As shown in Fig. 16 and Fig. 17, in the case of the fourth embodiment, a substantially triangular link lever 48 is rotatably supported at the front end of a forwardly projecting stay 8a from the vertical center of the head pipe 6h via a horizontal shaft 49. Then, a cylindrical damper 50 is disposed between the link lever 48 and the upper end of the head pipe 6h. The cylindrical damper 50 includes a damper case 51 and a damper rod 52 sliding in the damper case 51, the damper case 51 is rotatably connected to the front surface of the upper end of the head pipe 6h via a horizontal shaft 53, and the damper rod 52 is rotatably connected to the front end of the link lever 48 via a horizontal shaft 54. On the other hand, a rink rod 55 is rotatably connected to the front surface of the lower end of the link lever 48 via a spherical joint 56 and the other end of the link rod 55 is rotatably connected to the front surface of the lateral center of the bottom bridge 4b which corresponds to the lower portion of the fork bridge 4, via a spherical joint 57.

In this manner, the cylindrical damper 50 is connected to the vehicle body frame 6 which does not rotate even when the handle is operated, and is connected to the fork bridge 4 which corresponds to the steering-side member rotating about the steering stem 5 when the handle is operated via the link lever 48 and the link rod 55. The link rod 55 is disposed in such a manner that a straight line L2 connecting the centers of the

spherical joints 56, 57 which are the joint portions at both ends of the link rod 55 is positioned on the center plane of the vehicle body including the center axis S of the steering stem 5 and extending in the fore-and-aft direction of the vehicle body when the handle 7 is at the neutral position, that is, when the steered angle of the handle is 0°.

The cylindrical damper 50 generates a damping force when being expanded, and generates little damping force when being contracted.

The construction of other parts is also the same as the first embodiment.

In the steering damper device thus configured, when the handle 7 is turned leftward for example, the front fork 2 rotates leftward about the center axis S of the steering stem 5, and the bottom bridge 4b rotates as well. Therefore, the spherical joint 57 connected to the center of the front portion of the bottom bridge 4b moves to the position indicated by an alternate long and two short dashes line in Fig. 17. Consequently, the spherical joint 56 connected to the link lever 48 is pulled downward by the link rod 55 connected to the spherical joint 57, and the link lever 48 rotates about the horizontal axis 49 as indicated by an arrow in Fig. 16. Therefore, the cylindrical damper 50 is expanded, and a damping force is applied from the cylindrical damper 50 to the bottom bridge 4b, which corresponds to the steering-side member. Also, when the handle 7 is turned rightward as well, the spherical joint 56 on the link lever 48 side is pulled downward, and hence the cylindrical damper 50 is expanded in the same manner and the damping force is generated. When the handle 7 which is turned rightward or leftward is returned to the neutral position, the cylindrical damper 50 is contracted in either cases and thus little damping force is generated.

In this manner, the steering damper device according to the fourth embodiment can be adapted to generate the damping force when steered, and to generate little damping force when returning the steered steering. Also, with this steering damper device, since the movement of the steering-side member is transmitted to the cylindrical damper 50 via the link rod 55 and the link lever 48, the cylindrical damper 50 can be disposed at a distance from the steering-side member and, in addition, in the given

direction. Therefore, flexibility of the layout of the cylindrical damper 50 can be further increased.

Fig. 18 shows a fifth embodiment of the steering damper device according to the present invention and is a plan view of the front fork portion of the motorcycle provided with the steering damper device.

The fifth embodiment is a modification in which the position where the cylindrical damper 30 is arranged in the second embodiment described above is simply changed and most of the structure is the same as the second embodiment. Therefore, the parts corresponding to the second embodiment are represented by the same reference numerals, and duplicated description is omitted.

As shown in Fig. 18, in the case of the fifth embodiment, a stay (not shown) to which the spherical joint 33 is mounted at the upper end thereof is disposed at the position deviated from the lateral center toward the left on the upper surface of the top bridge 4a of the fork bridge 4, as the stay 28 in the second embodiment. Then, the damper case 31 of the cylindrical damper 30 is rotatably connected and supported by the spherical joint 33 via the rod 58. On the other hand, the vehicle body frame 6 is provided with an extending portion 6k extending from the right side surface thereof toward the right, and the upper surface of the extending portion 6k is provided with a upwardly projecting stay (not shown) as the stay 29 in the second embodiment. Then, the damper rod 32 of the cylindrical damper 30 is rotatably connected to the stay via the spherical joint 34.

In this manner, in the case of the embodiment, the cylindrical damper 30 is disposed so that the center axis D2 of the cylindrical damper 30 forms an angle with respect to the center plane of the vehicle body even when the steered angle of the handle is 0°. In this case as well, the center axis D2 of the cylindrical damper 30 intersects the center axis S of the steering stem 5. In other words, when the steered angle of the handle is 0°, the center axis D2 of the cylindrical damper 30 and the center axis S of the steering stem 5 are positioned on the identical plane.

In the steering damper device in which the cylindrical damper 30 is disposed as described above as well, when the handle 7 is turned, for example, leftward from the state in which the steered angle of the handle is 0°, the top bridge 4a on the steering side rotates leftward about the center axis S of the steering stem 5 into the state shown by an alternate long and two short dashed line in Fig. 18, and hence the spherical joint 33 moves rearwardly of the vehicle body as shown by an arrow. Therefore, the cylindrical damper 30 is contracted as well and a damping force is generated. Also, when returning the handle 7 steered to rightward, the damping force is generated since the cylindrical damper 30 is similarly expanded. Then, when returning the handle 7 steered to rightward or leftward to the neutral position, the cylindrical damper 30 is expanded in either cases so that little damping force is generated.

In this manner, in the case of the steering damper device as described in the second embodiment, the cylindrical damper 30 is not necessarily required to be disposed on the center plane of the vehicle body in the fore-and-aft direction when the handle 7 is at the neutral position, and it is also possible to dispose it at the position deviated from the center plane of the vehicle body in the fore-and-aft direction to some extent.
In addition, the cylindrical damper 30 can be provided between the lower surface of the bottom bridge 4b of the fork bridge 4 and the vehicle body frame 6.

Fig. 19 shows a sixth embodiment of the steering damper device according to the present invention, and is a front view of a front fork portion of the motorcycle provided with the steering damper device.

The sixth embodiment is a modification in which the position where the cylindrical damper 10 is arranged in the first embodiment described above is simply changed and most of the structure is the same as the first embodiment. Therefore, the parts corresponding to the first embodiment are represented by the same reference numerals, and duplicated description is omitted.

As shown in Fig. 19, in the case of the sixth embodiment, a leftwardly projecting stay 59 is provided on the left side surface of the head pipe 6h so

as to project leftward. A upwardly projecting stay 60 is provided on the upper surface of the bottom bridge 4b at the position deviated leftward from the lateral center thereof. Then, the damper case 11 of the cylindrical damper 10 is rotatably connected to the stay 59 on the side of the head pipe 6h via the spherical joint 13, and the damper rod 12 of the cylindrical damper 10 is rotatably connected to the stay 60 on the side of the bottom bridge 4b via the spherical joint 14. The cylindrical damper 10 is disposed in such a manner that the center axis D1 of the cylindrical damper 10 and the center axis S of the steering stem 5 are on the identical plane when the steered angle of the handle is in the vicinity of 0° by arranging the cylindrical damper 10 in such a manner that the center axis D1 thereof lies in parallel with the center axis S of the steering stem 5.

In the steering damper device having the cylindrical damper 10 arranged as described above, the damper 10 is always expanded when the handle 7 is turned to either the left or the right from the steered angle of 0°. Then, when returning the handle 7 turned to the right or the left to the neutral position, the cylindrical damper 10 is contracted in either cases. Therefore, the device can be adapted to generate the damping force when turning the handle 7, and generate little damping force when returning the handle 7. In this manner, with the steering damper device in which the cylindrical damper 10 is disposed at a distance from the center plane of the vehicle body, the same effect as the basic effect of the first embodiment can be obtained. In other words, the cylindrical damper 10 may be deviated from the center plane of the vehicle body extending in the-fore-and aft direction as long as the center axis D1 of the cylindrical damper 10 and the center axis S of the steering stem 5 are positioned on the same plane when the steered angle of the handle is in the vicinity of 0°.

In addition, the cylindrical damper 10 may be provided between the top bridge 4a of the fork bridge 4 and the vehicle body frame 6.

The cylindrical dampers 10, 30 may be those of a double-tube type having a reservoir chamber along the outer periphery of the damper chamber in addition to that having the reservoir chamber 17 on one side of the damper chamber 15 as in the above-described embodiments. Also, instead of compression gas 19 for urging the piston 18 provided on the reservoir

chamber 17 side, a compression spring may be employed, or both of them may be employed. In addition, the present invention may also be applied to other vehicles such as a four-wheel buggy in addition to the motorcycle as in the above described embodiments.

According to the present invention, since the cylindrical damper either contracts or expands when the handle is turned in either directions of right or left from the steered angle of 0°, the symmetrical characteristic may be provided. Although it will be reverse when bringing the handle back, since the cylindrical damper can be set so that different damping force characteristics are effected between the contract stroke and the expansion stroke, it can be adapted so as to generates a damping moment when turning the handle and to reduce the damping moment when returning the handle. Therefore, the requirements described above which is required for the steering damper device of a motorcycle or the like can be satisfied.

According to an embodiment of the present invention, since the cylindrical damper is provided substantially along the length of the head pipe, impairment of design of the vehicle by the steering damper device can be alleviated.

According to another embodiment of the present invention, since the cylindrical damper is provided in the fore-and-aft direction, the steering damper device is disposed so as to lie substantially along the vehicle body frame, and hence restraint putted on the layout of other parts by the steering damper device may be reduced.

According to another embodiment of the present invention, by disposing the cylindrical damper in such a manner that the center axis of the cylindrical damper is positioned on a plane including the center axis of the steering stem, the cylindrical damper expands and contracts symmetrically when the handle is turned to the right and to the left from the steered angle of 0°, so that the symmetrical characteristic is provided to the steering damper device.

In addition, according to another embodiment of the present invention, since the cylindrical damper is provided substantially along the center plane in the fore-and-aft direction of the vehicle body, the steering damper device is prevented from protruding significantly from the vehicle body toward the left and the right, and hence the entire steering damper device can be disposed compactly.

According to another embodiment of the present invention, in either cases where the handle is turned rightward or leftward from the steered angle of 0°, the cylindrical damper is either contracted or expanded, and hence the same effect as the effect of the present invention according to Claim 1 described above can be achieved.

In addition, according to another embodiment of the present invention, since the amount of sliding movement of the damper rod with respect to the steered angle of the handle increases as the steered angle of the handle goes away from 0°, a high damping moment can be generated in the range in which the turned angle of the handle is large and an angular speed is high, and hence the above-described requirement which is required for the steering damper device for a motorcycle or the like can be satisfied.

In addition, according to another embodiment of the present invention, since a damping force acting on the steering-side member from the cylindrical damper is small when the steered angle of the handle is in the vicinity of 0°, and increases as the steered angle of the handle goes away from 0°, the device can be adapted in such a manner that the damping force is hardly generated in the range in which the turned angle of the handle is small and a large damping force is generated in the range in which the turned angle of the handle is large. Therefore, the above-described requirements required for the steering damper device for a motorcycle or the like can be satisfied.

According to another embodiment of the present invention, by the cylindrical damper connected to the steering-side member via the link mechanism, since the movement of the steering-side member can be transmitted to the cylindrical damper even when the cylindrical damper is

disposed at a distance, flexibility of the layout of the cylindrical damper can be further increased.

According to another embodiment of the present invention, since the elongated link rod, which constitutes the link mechanism, is provided substantially along the center plane extending in the fore-and-aft direction of the vehicle body, the steering damper device can be prevented from protruding significantly to the left and the right from the vehicle body although the link mechanism is employed.

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 steering damper device comprising: a cylindrical damper having a damper rod, the damper rod sliding in a damper case, the cylindrical damper disposed between a steering-side member, which rotates about a steering stem when a handle is operated, and a vehicle-body-side member, which does not rotate even when the handle is operated, characterized in that the cylindrical damper is mounted in such a manner that the damper rod takes a longest position or a shortest position when the steered angle of the handle is in the vicinity of 0°.

2. A steering damper device according to Claim 1, characterized in that the cylindrical damper is provided in front of a head pipe, which rotatably supports the steering stem, substantially along the length of the head pipe so that the damper rod takes the shortest position when the steered angle of the handle is in the vicinity of 0°.

3. A steering damper device according to Claim 1, characterized in that the cylindrical damper is provided in the fore-and-aft direction between a fork bridge positioned forwardly of the steering stem and a vehicle body frame positioned rearwardly of the steering stem so that the damper rod takes the longest position when the steered angle of the handle is in the vicinity of 0°.

4. A steering damper device comprising a cylindrical damper having a damper rod, the damper rod sliding in a damper case, the cylindrical damper disposed between a steering-side member, which rotates about a steering stem when a handle is operated, and a vehicle-body-side member, which does not rotate even when the handle is operated, characterized in that the cylindrical damper is disposed so that a center axis of the cylindrical damper is positioned substantially on a plane including a center axis of the steering stem when the steered angle of the handle is in the vicinity of 0°.

5. A steering damper device according to Claim 4, characterized in that the cylindrical damper is disposed so that the center axis of the cylindrical damper lies substantially along a center plane of the vehicle body extending in the fore-and-aft direction of the vehicle body when the steered angle of the handle is in the vicinity of 0°.

6. A steering damper comprising a cylindrical damper having a damper rod, the damper rod sliding in a damper case, the cylindrical damper being disposed between a steering side member, which rotates about a steering stem when a handle is operated, and a vehicle-body-side member, which does not rotate even when the handle is operated, characterized in that the cylindrical damper is mounted so that the damper rod slides in the damper case in the same direction in either cases where the cylindrical damper is steered leftward or rightward from the position at which the steered angle of the handle is 0°.

7. A steering damper device according to Claim 6, characterized in that the cylindrical damper is provided in front of a head pipe, which rotatably supports the steering stem, substantially along the length of the head pipe so that the damper rod takes the shortest position when the steered angle of the handle is in the vicinity of 0°.

8. A steering damper device according to Claim 6, characterized in that the cylindrical damper is provided in the fore-and-aft direction between a fork bridge positioned forwardly of the steering stem and the vehicle body frame positioned rearwardly of the steering stem so that the damper rod takes the longest position when the steered angle of the handle is in the vicinity of 0°.

9. A steering damper device according to Claim 6, characterized in that the amount of sliding movement of the damper rod with respect to the steered angle of the handle is small when the steered angle of the handle is in the vicinity of 0°, and increases as the steered angle of the handle goes away from 0°.

10. A steering damper device according to Claim 6, characterized in that a damping force acting on the steering-side member from the cylindrical damper is small when the steered angle of the handle is in the vicinity of 0°, and increases as the steered angle of the handle goes away from 0°.

11. A steering damper device comprising a cylindrical damper having a damper rod, the damper rod sliding in a damper case, the cylindrical damper disposed between a steering-side member, which rotates about a steering stem when a handle is operated, and a vehicle-body-side member, which does not rotate even when the handle is operated, characterized in that the cylindrical damper is connected to the steering-side member via a link lever rotatably supported by the vehicle-body-side member and a link rod connected to the link lever, in that,

the link rod is disposed so that a straight line connecting the joint portions at both ends of the link rod is positioned substantially on a plane including a center axis (s) of the steering stem when the steered angle of the handle is in the vicinity of 0°.

12. A steering damper device according to Claim 11, characterized in that the link rod is disposed so that tile straight line connecting the joint portions at the both ends of the link rod lies substantially along the center plane of the vehicle body extending in the fore-and-aft direction of the vehicle body when the steered angle of the handle is in the vicinity of 0°.

13. A steering damper apparatus according to claim 11 or 12, characterized in that the cylindrical damper is provided in the fore-and-aft direction between a fork bridge positioned forwardly of the steering stem and the vehicle body frame positioned rearwardly of the steering stem so that the damper rod takes the longest position when the steered angle of the handlebar is in the vicinity of zero degrees.

14. A steering damper apparatus according to claim 11, 12 or 13, characterized in that the amount of sliding movement of the damper rod with respect to the steered angle of the handlebar is small when the steered angle of the handlebar is in the vicinity of zero degrees, and increases as the steered angle of the handlebar goes away from zero degrees.

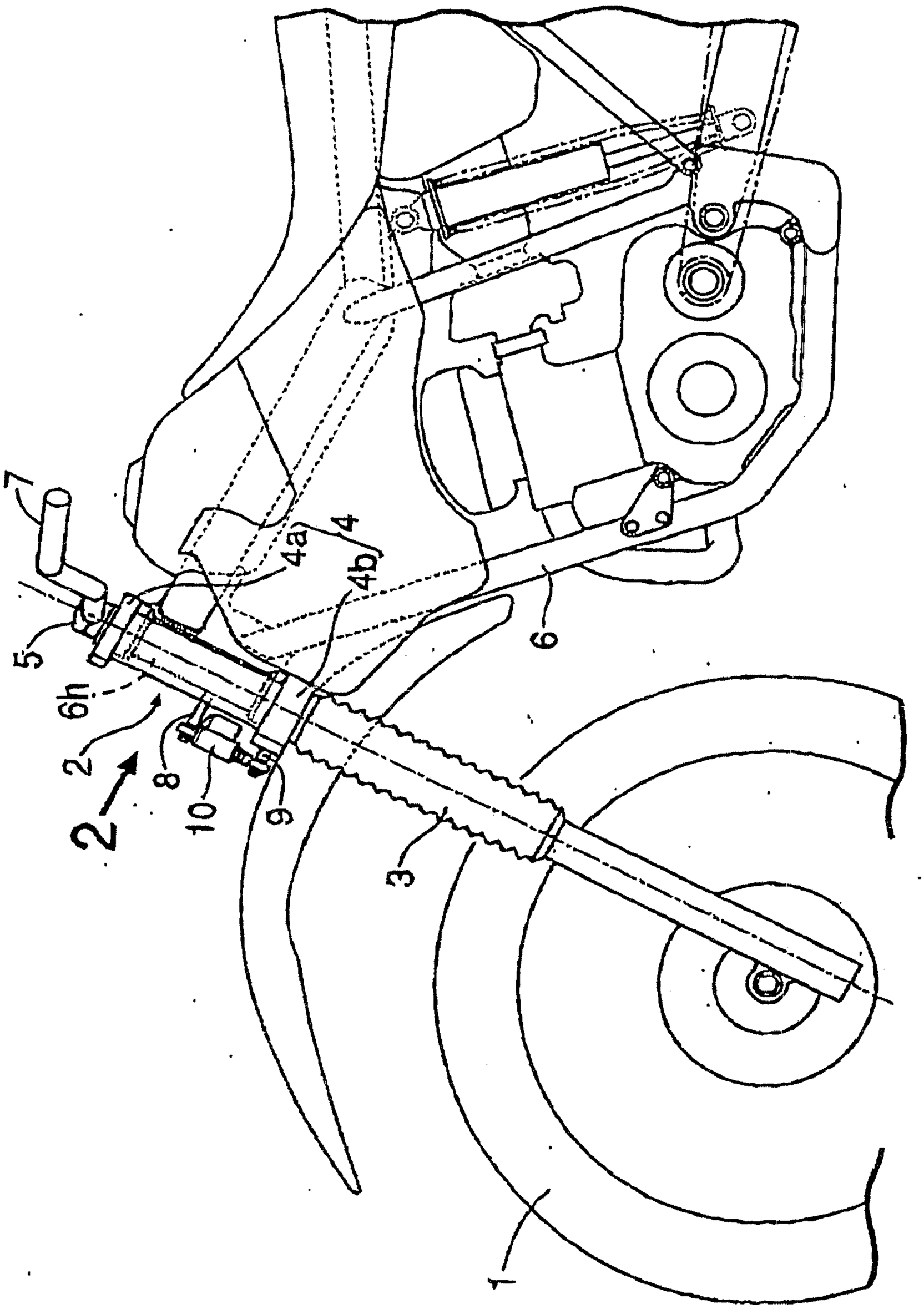
15. A steering damper apparatus according to claim 11, 12, 13 or 14, characterized in that a damping force acting on the steering-side member from the cylindrical damper is small when the steered angle of the handlebar is in the vicinity of zero degrees, and increases as the steered angle of the handlebar goes away from zero degrees.

16. A steering damper apparatus of claim 11, 12, 13, 14 or 15, wherein the steering damper comprises a first spherical joint proximate a first end thereof, and a second spherical joint proximate a second end thereof.

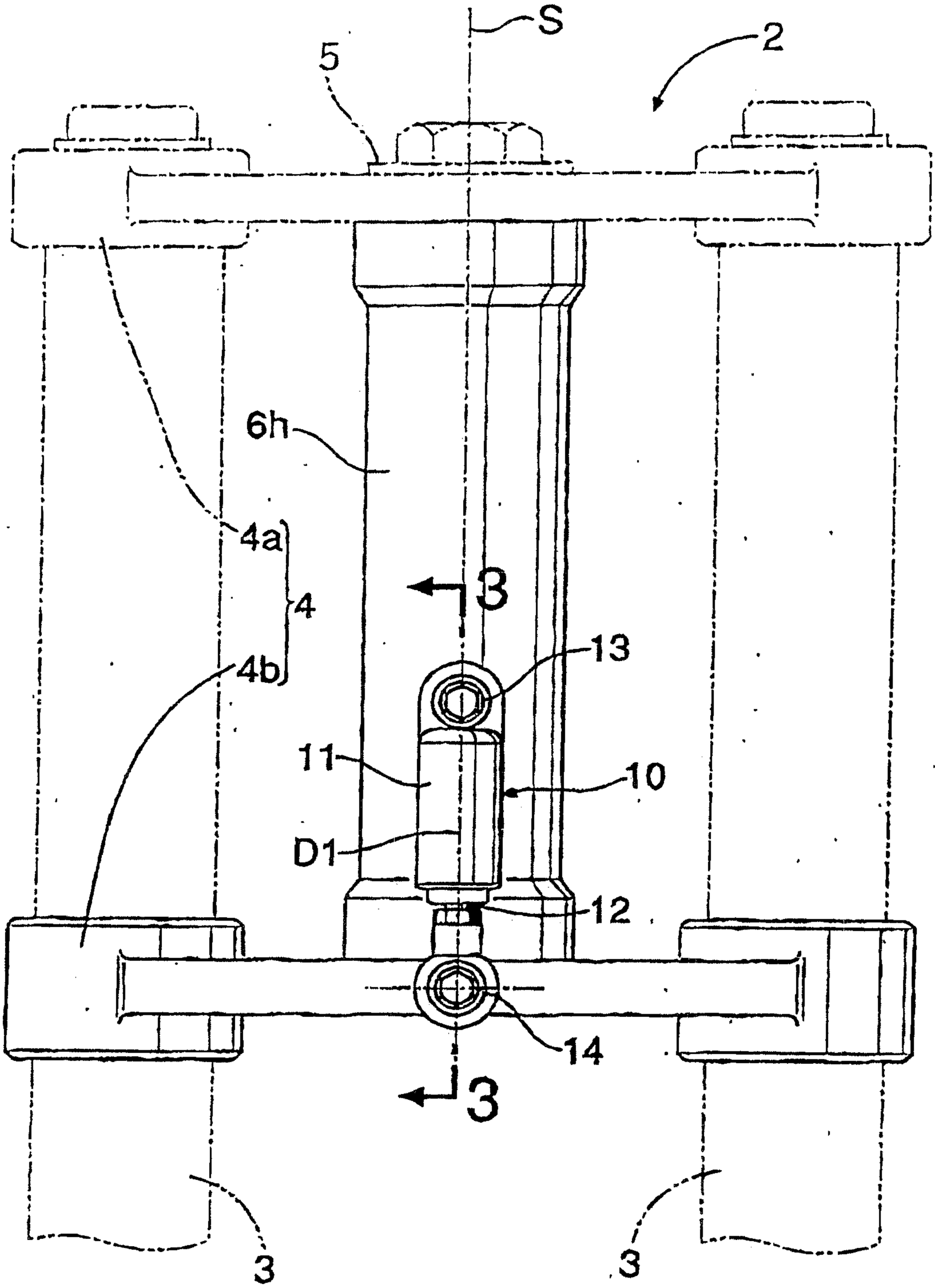
17. A steering damper apparatus according to any one claim of claims 1 to 17 wherein said steering damper apparatus is in combination with a motorcycle vehicle.

[Name of Document] Drawings

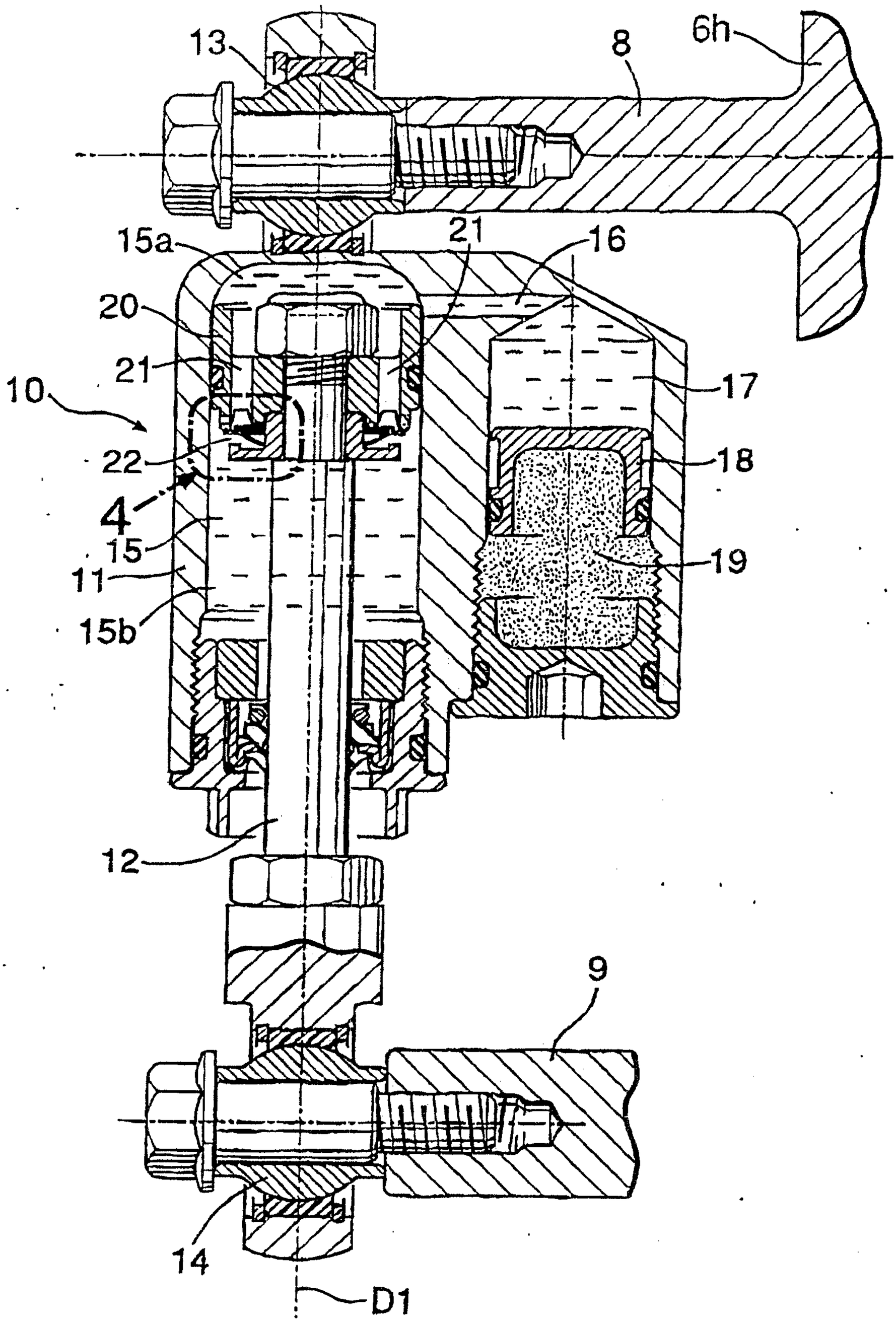
[Fig.1]



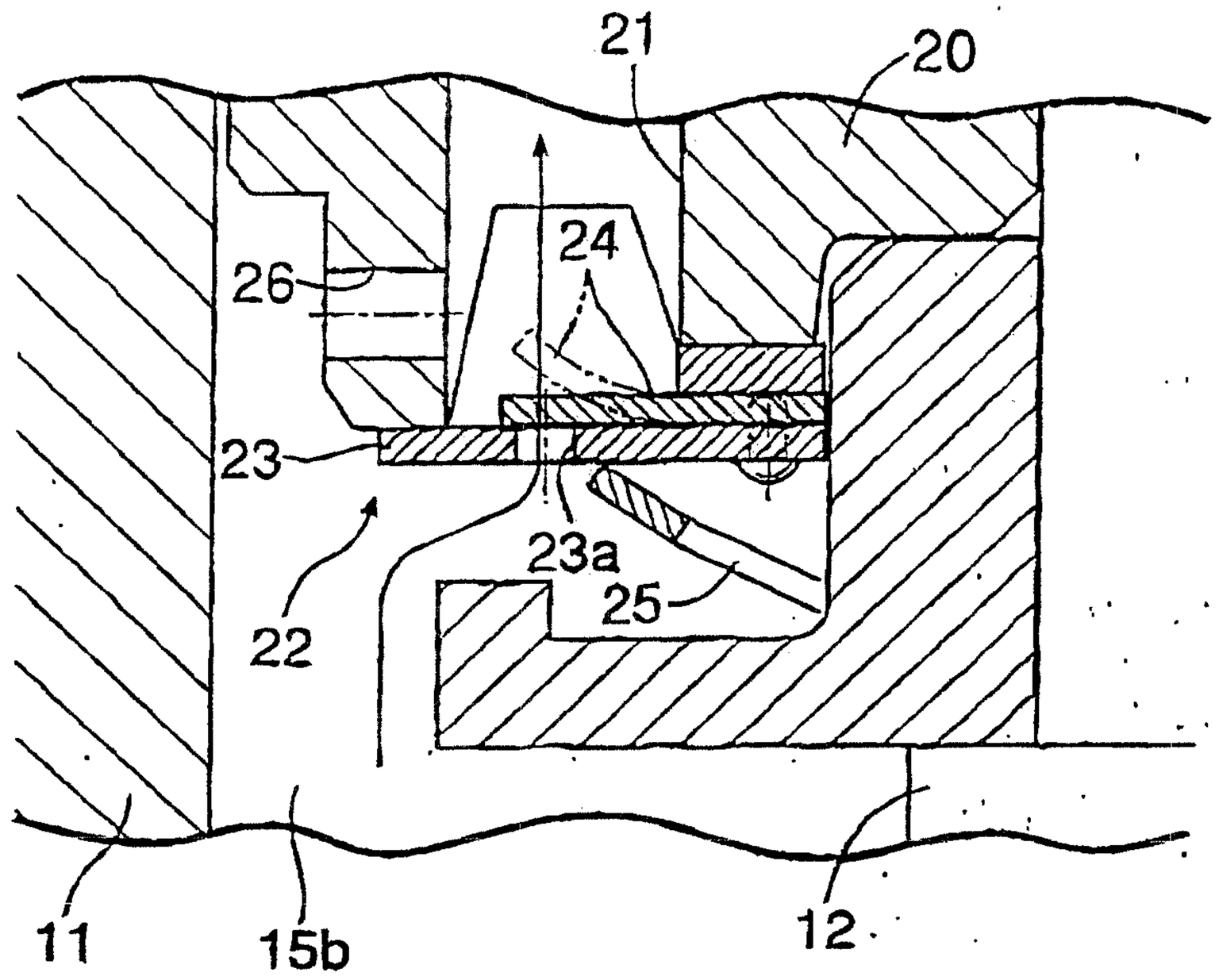
[Fig.2]



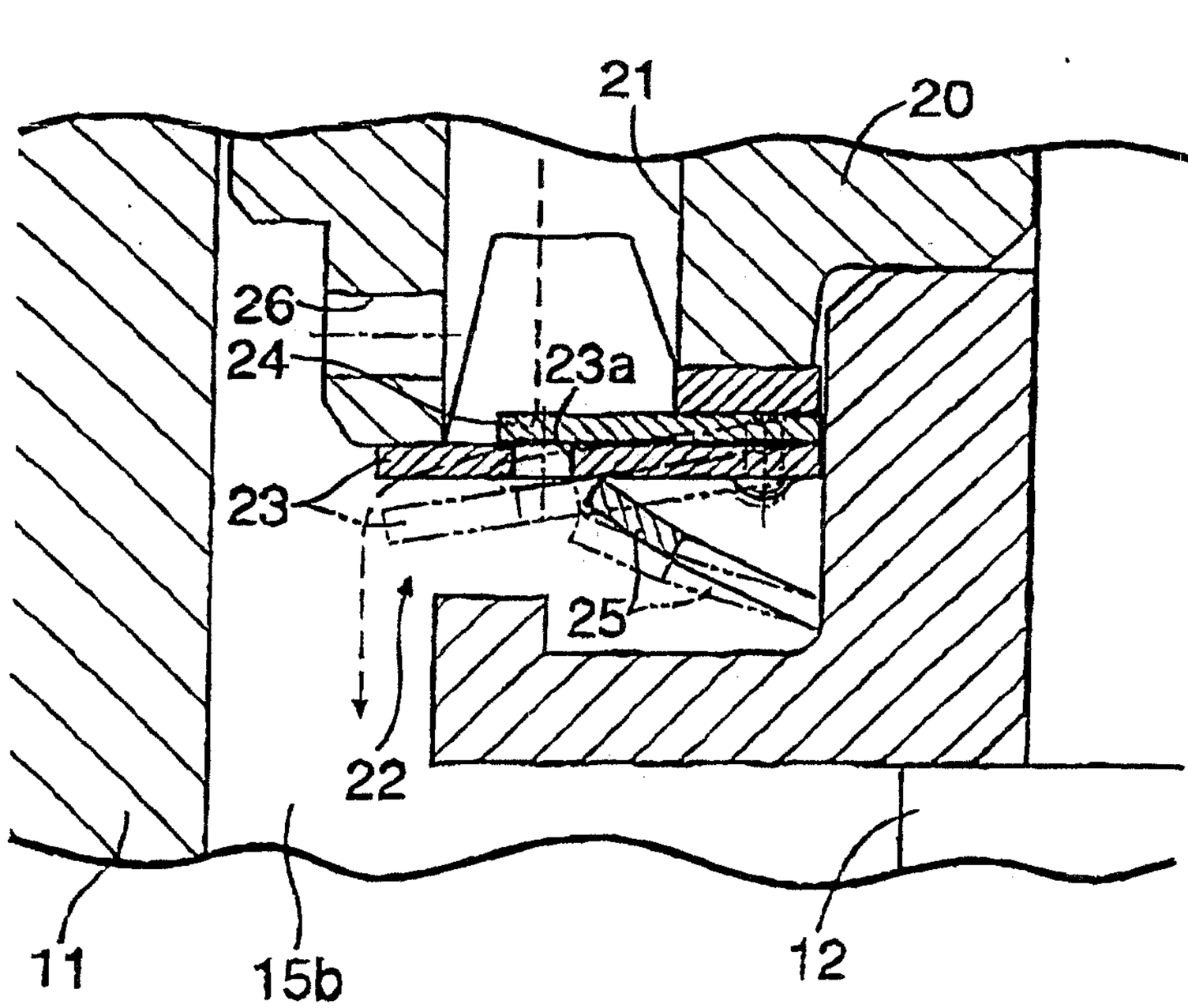
[Fig.3]



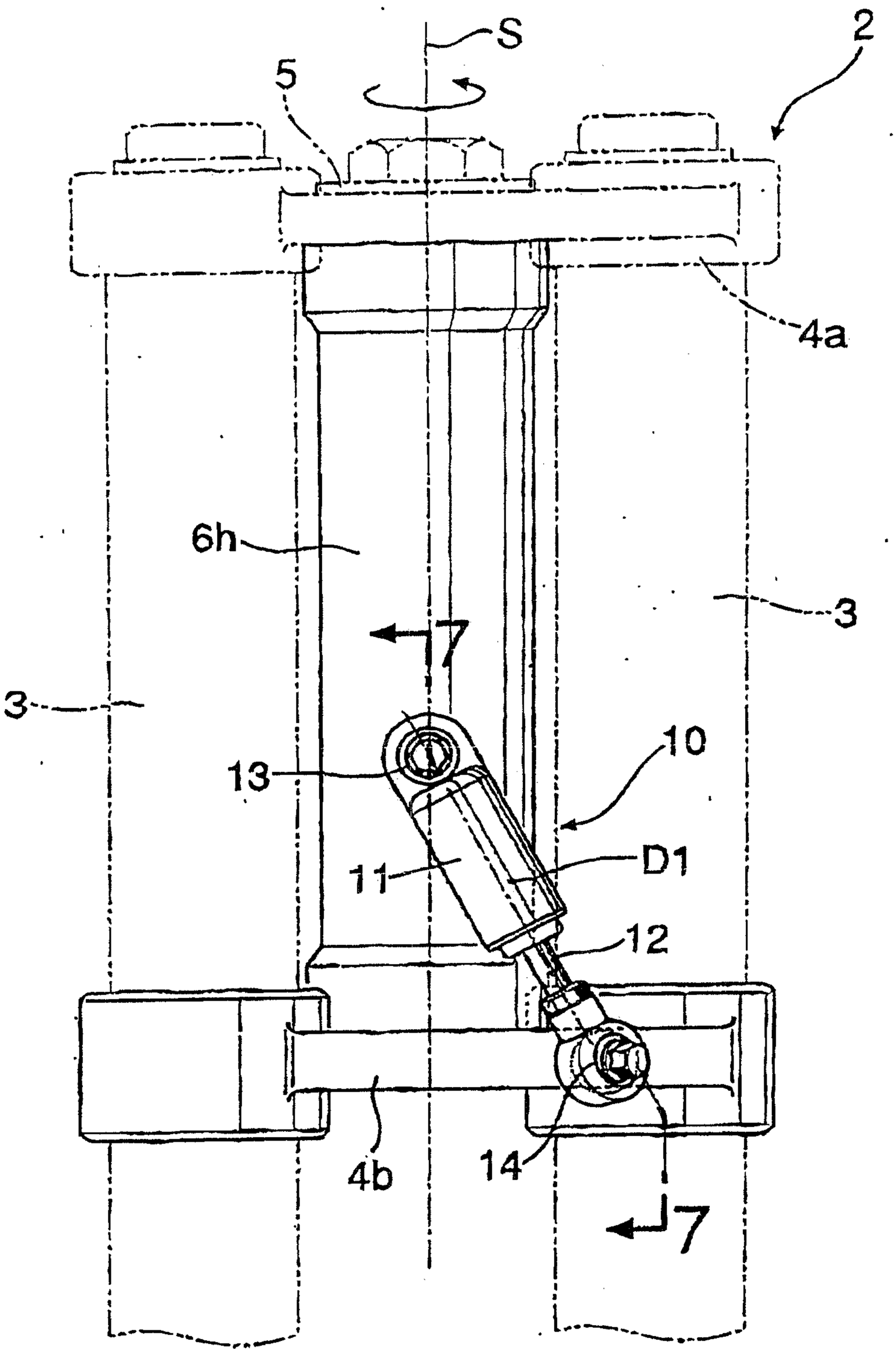
[Fig.4]



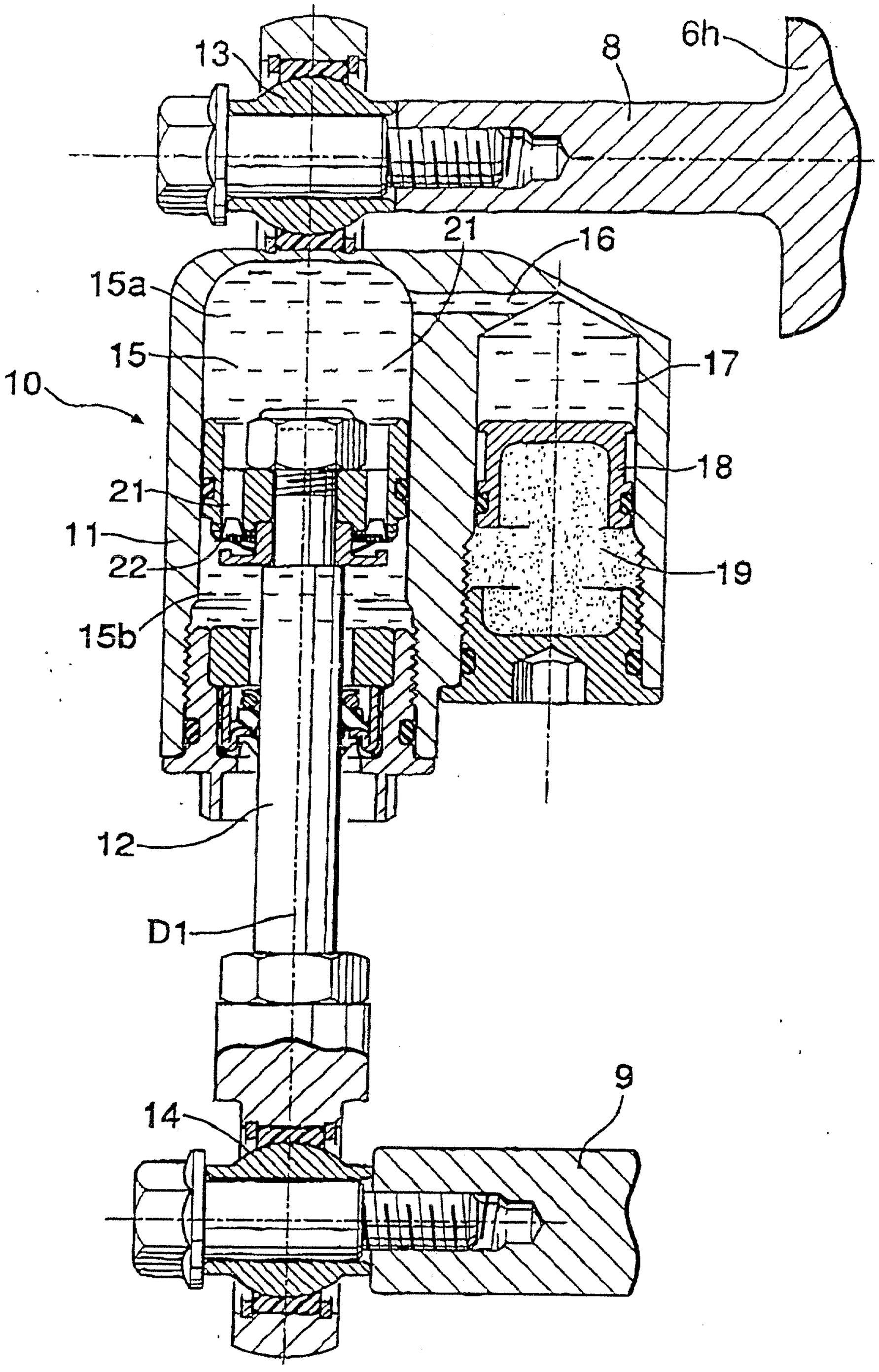
[Fig.5]



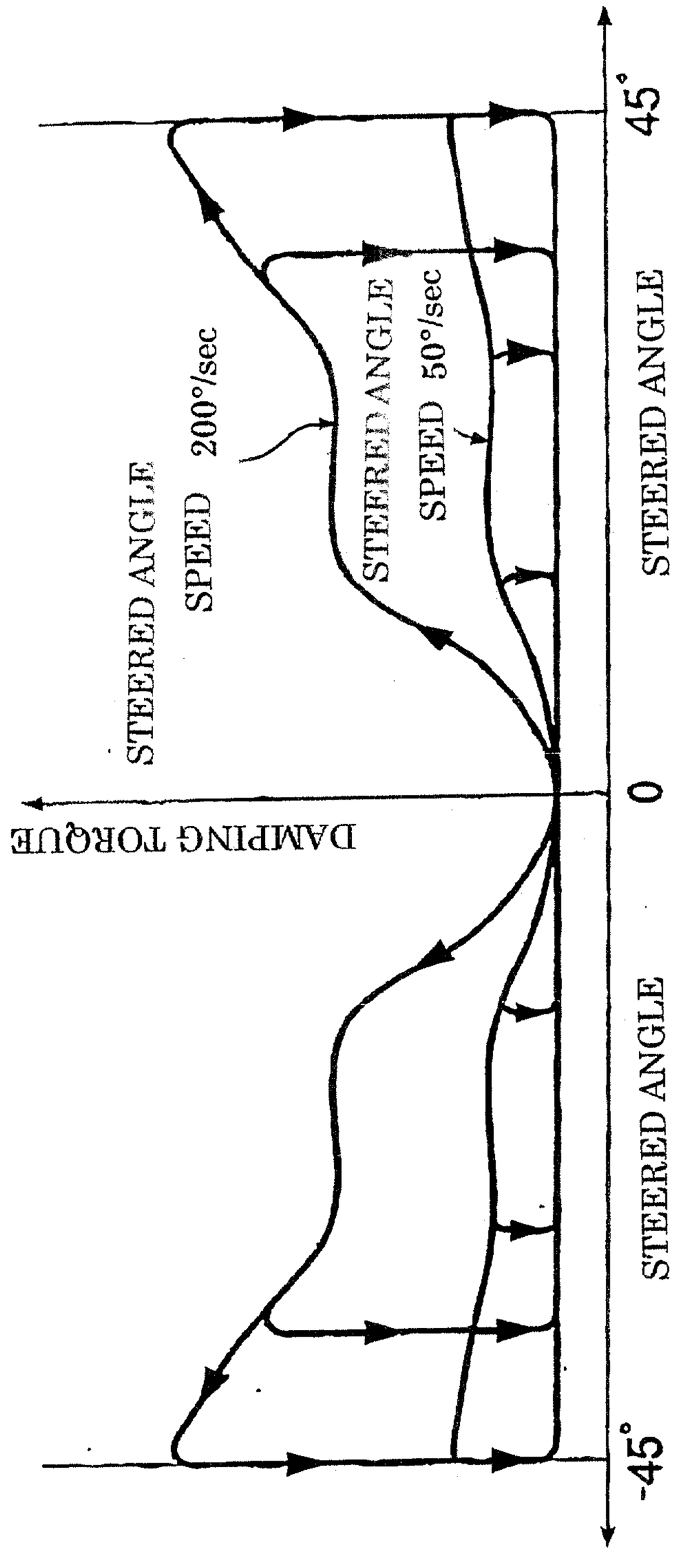
[Fig.6]



[Fig.7]



[Fig.8]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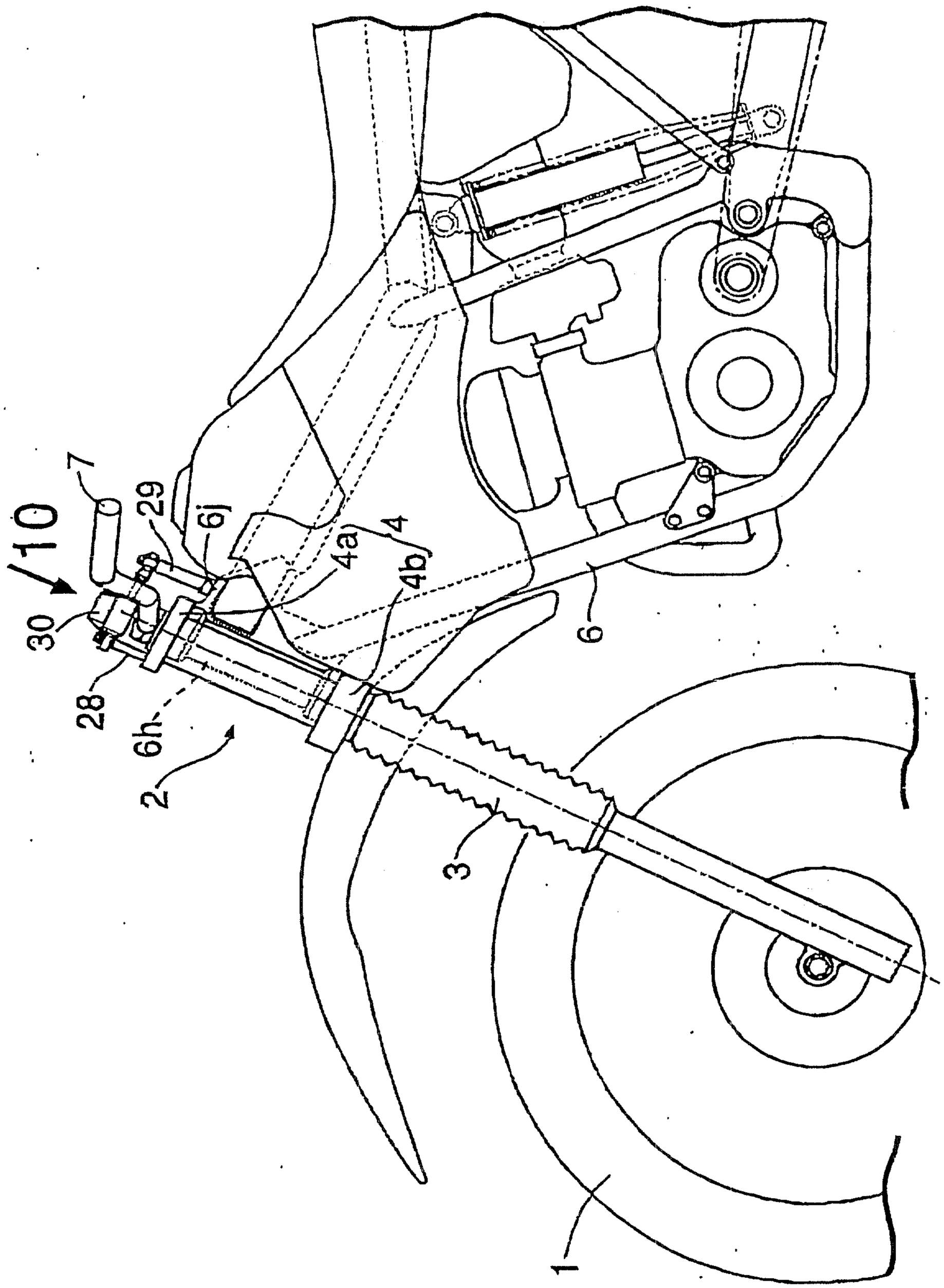
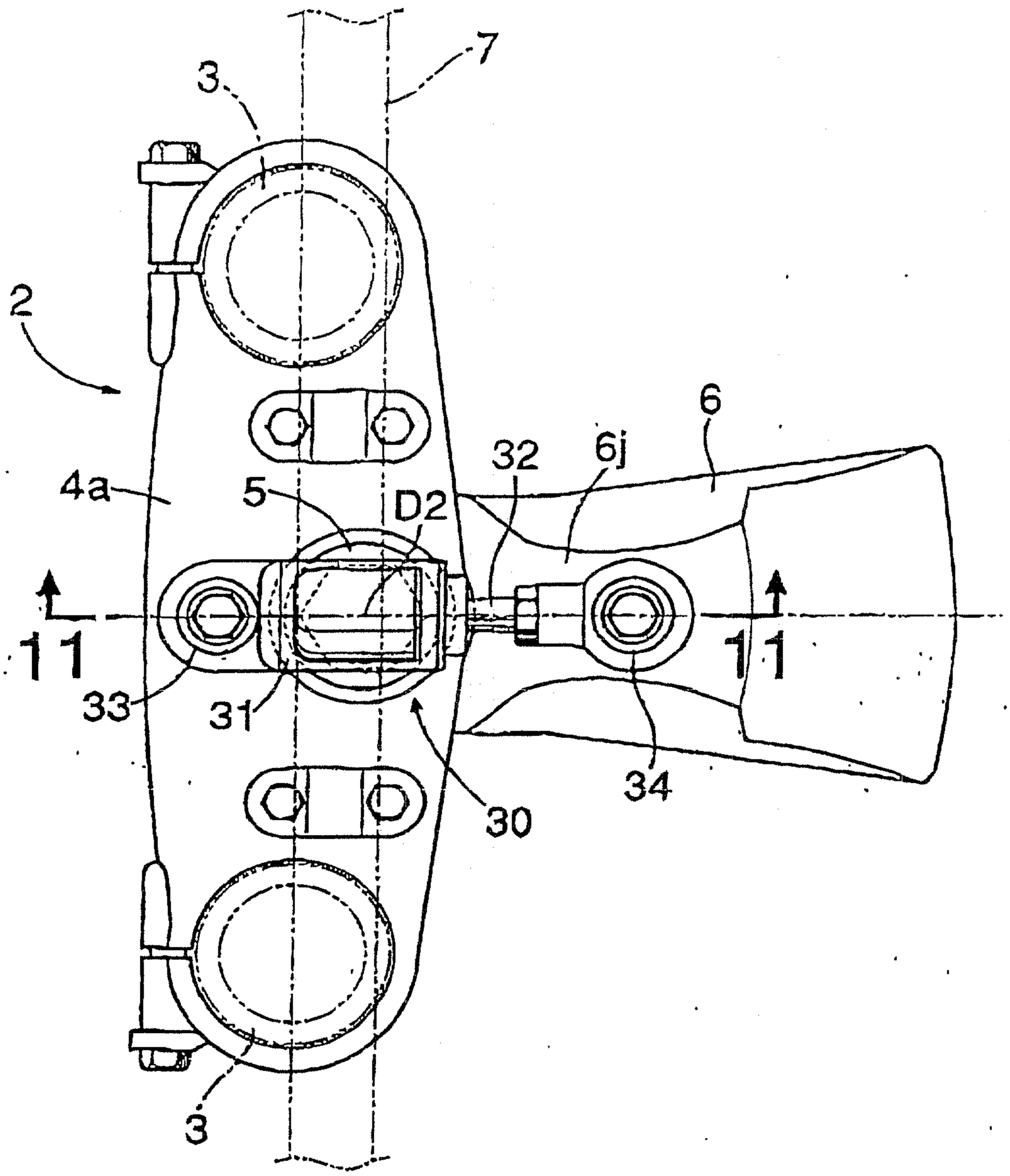
STEERED ANGLE
SPEED 200°/sec
STEERED ANGLE
SPEED 50°/sec
DAMPING TORQUE
0
STEERED ANGLE
-45°
STEERED ANGLE

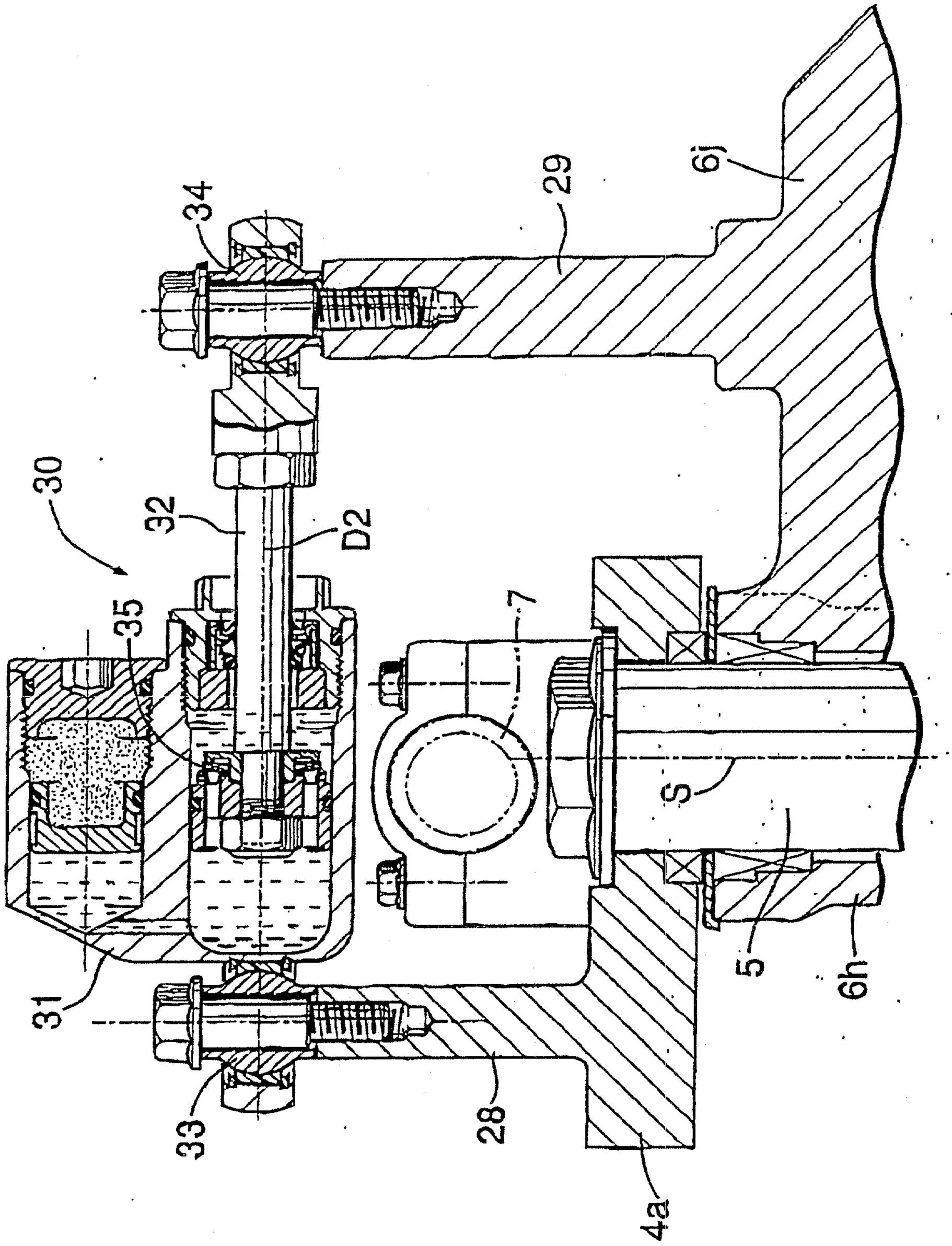
[Fig.9]



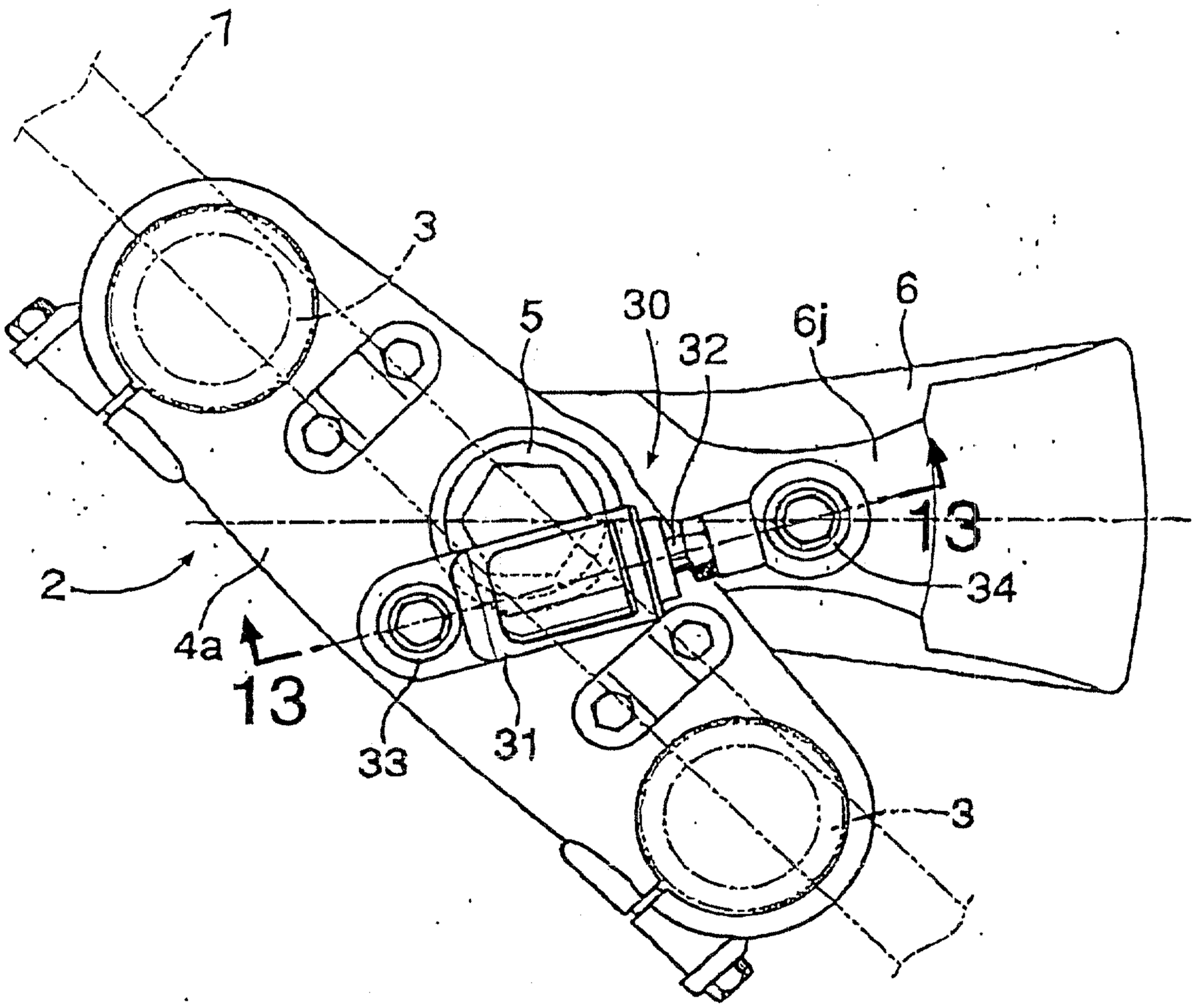
[Fig.10]



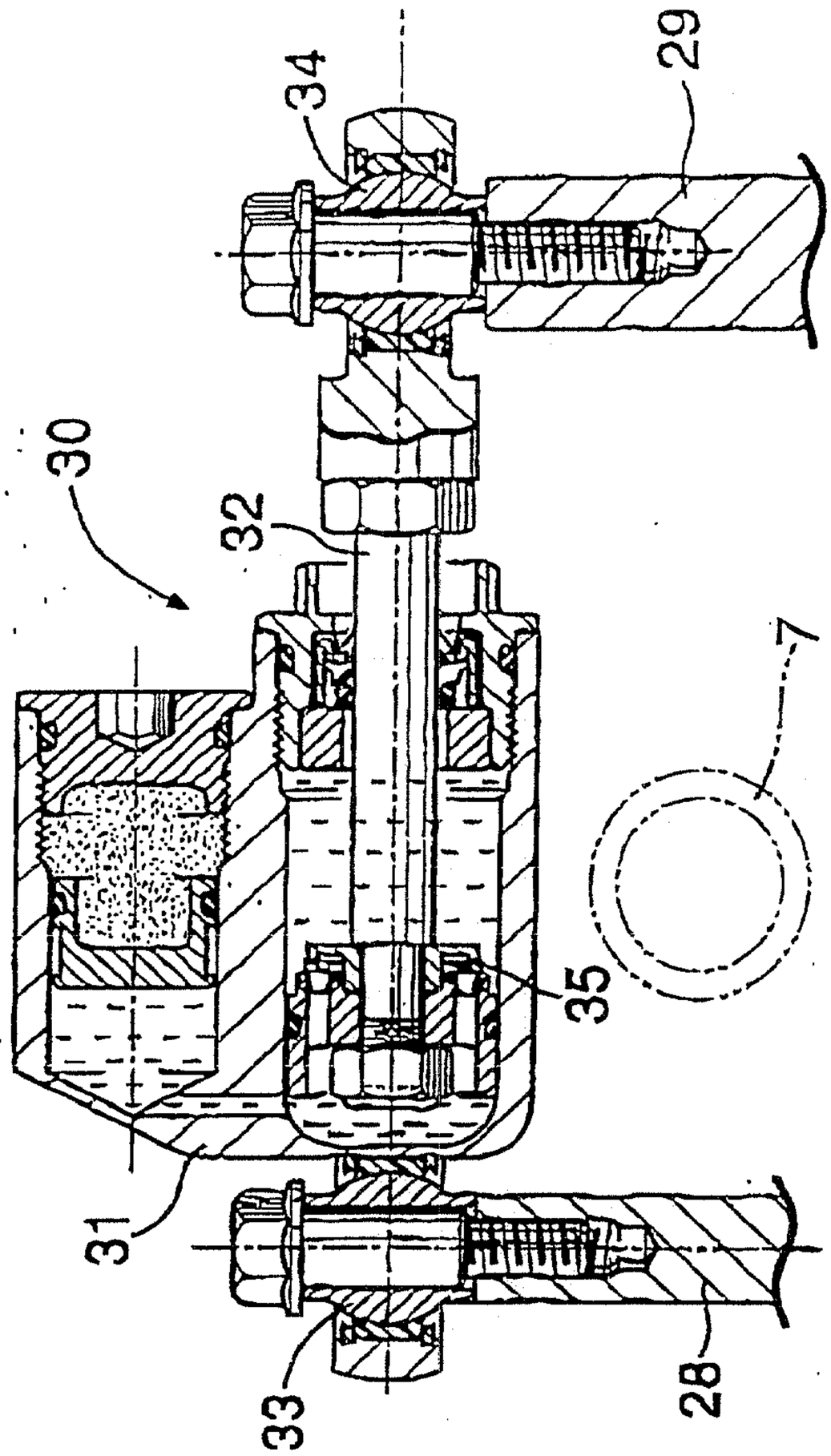
[Fig.11]



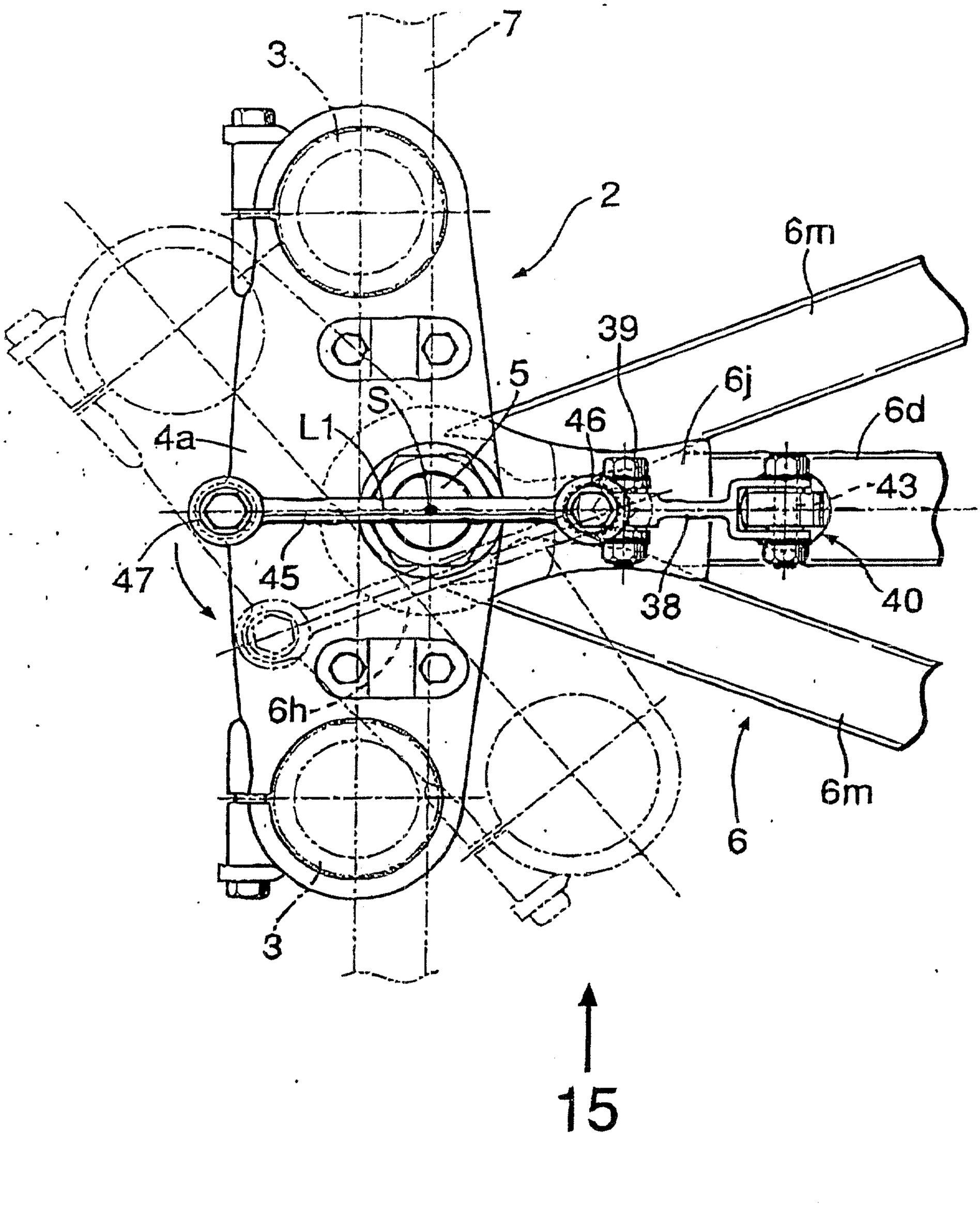
[Fig.12]



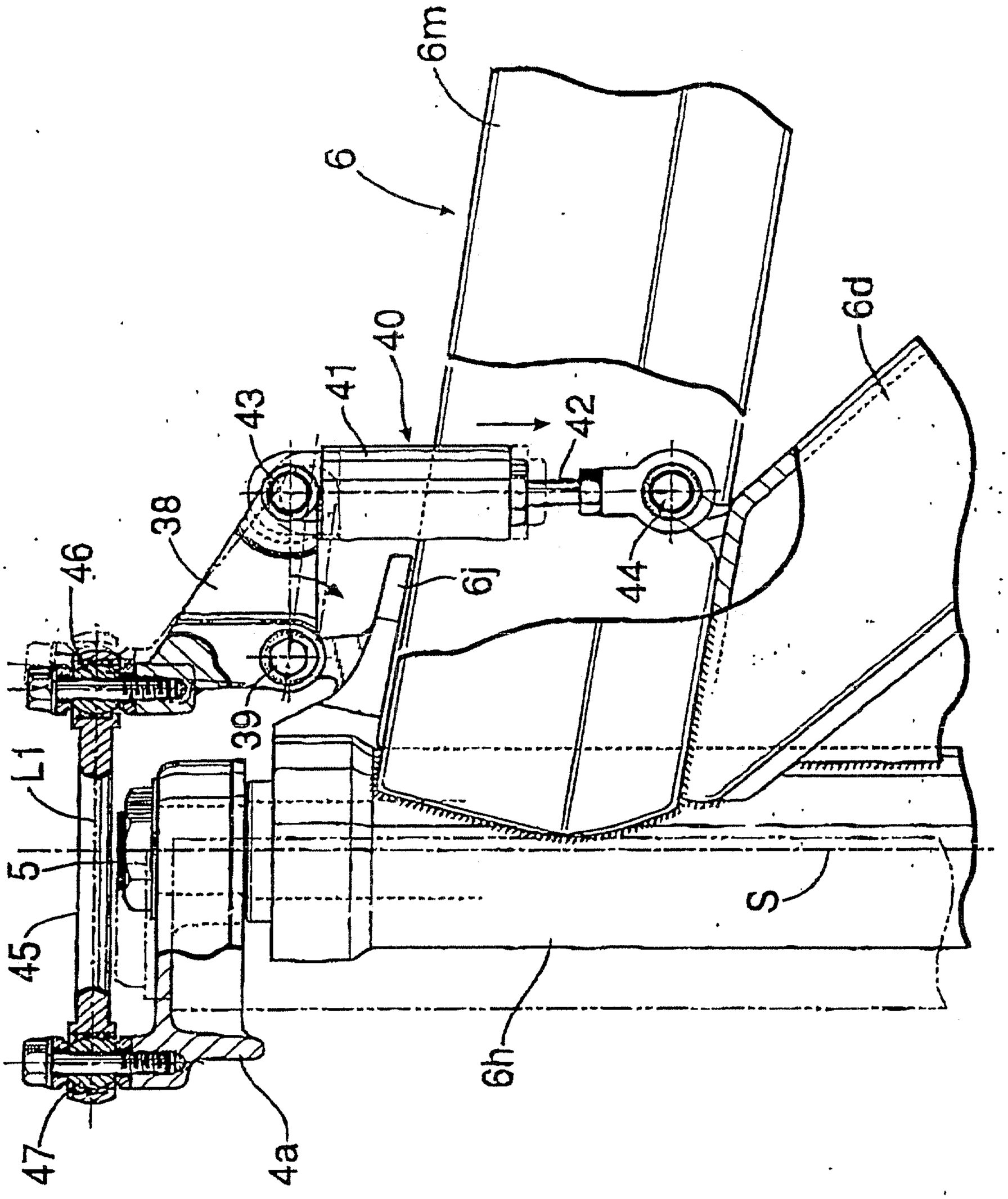
[Fig.13]



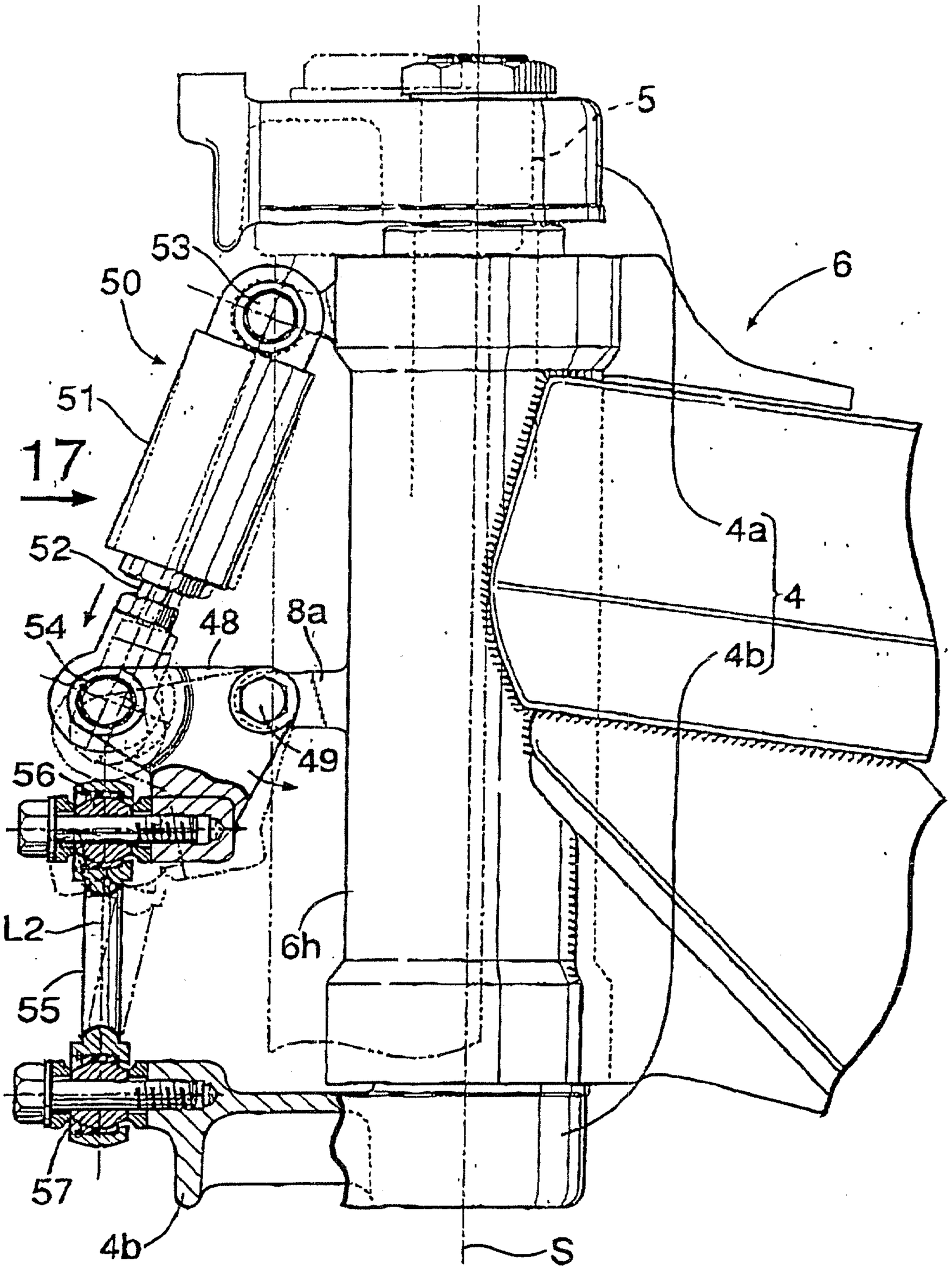
[Fig.14]



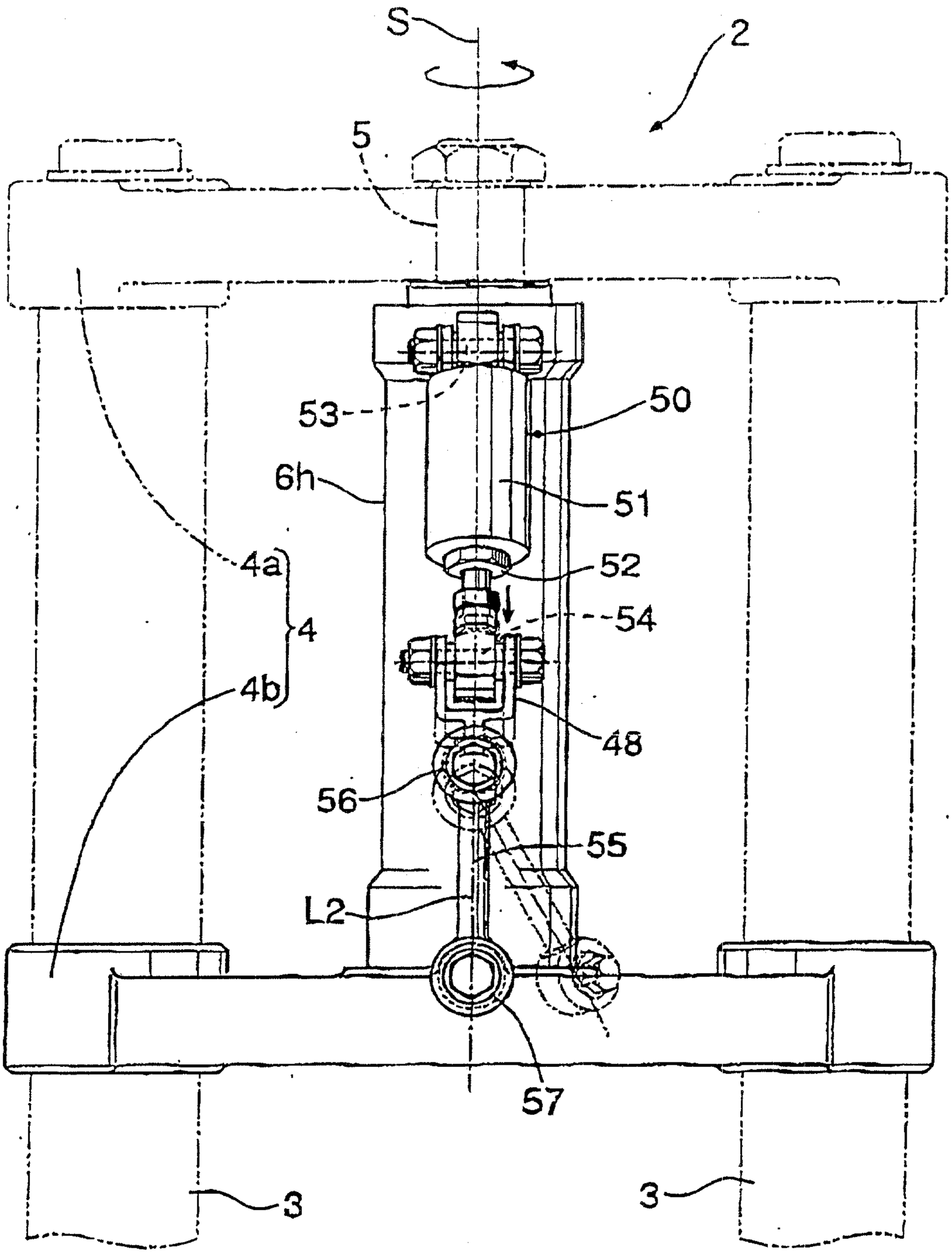
[Fig.15]



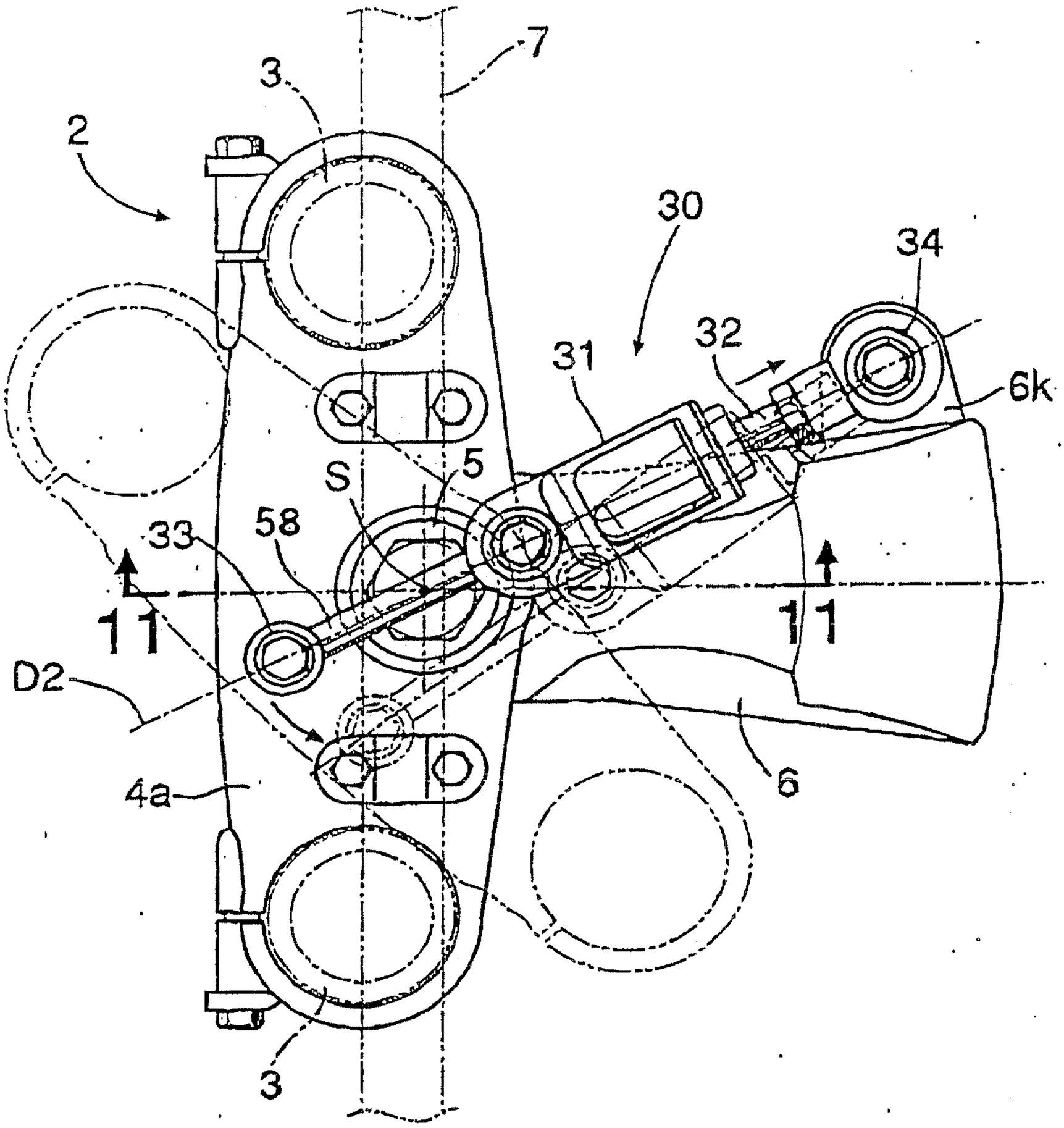
[Fig.16]



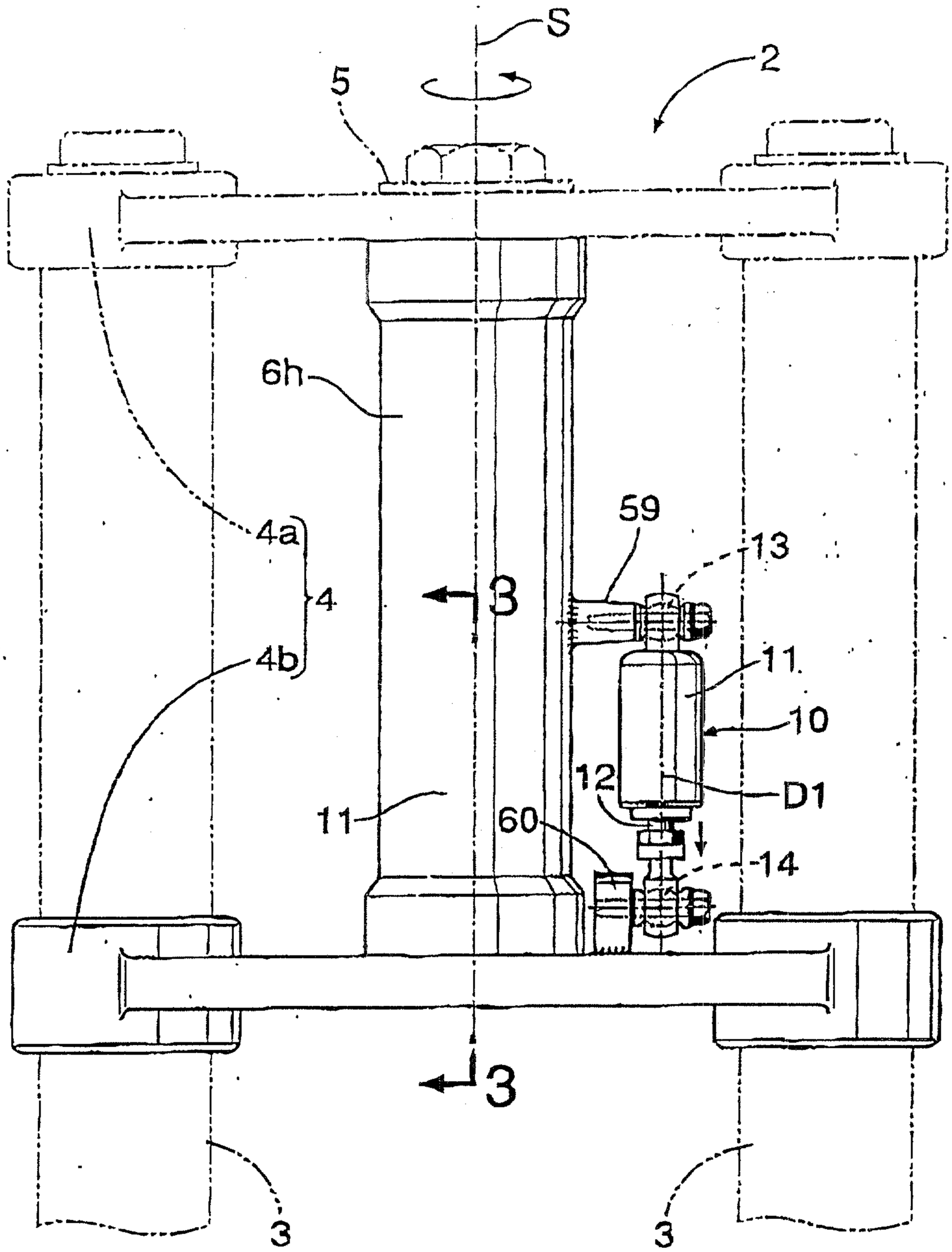
[Fig.17]

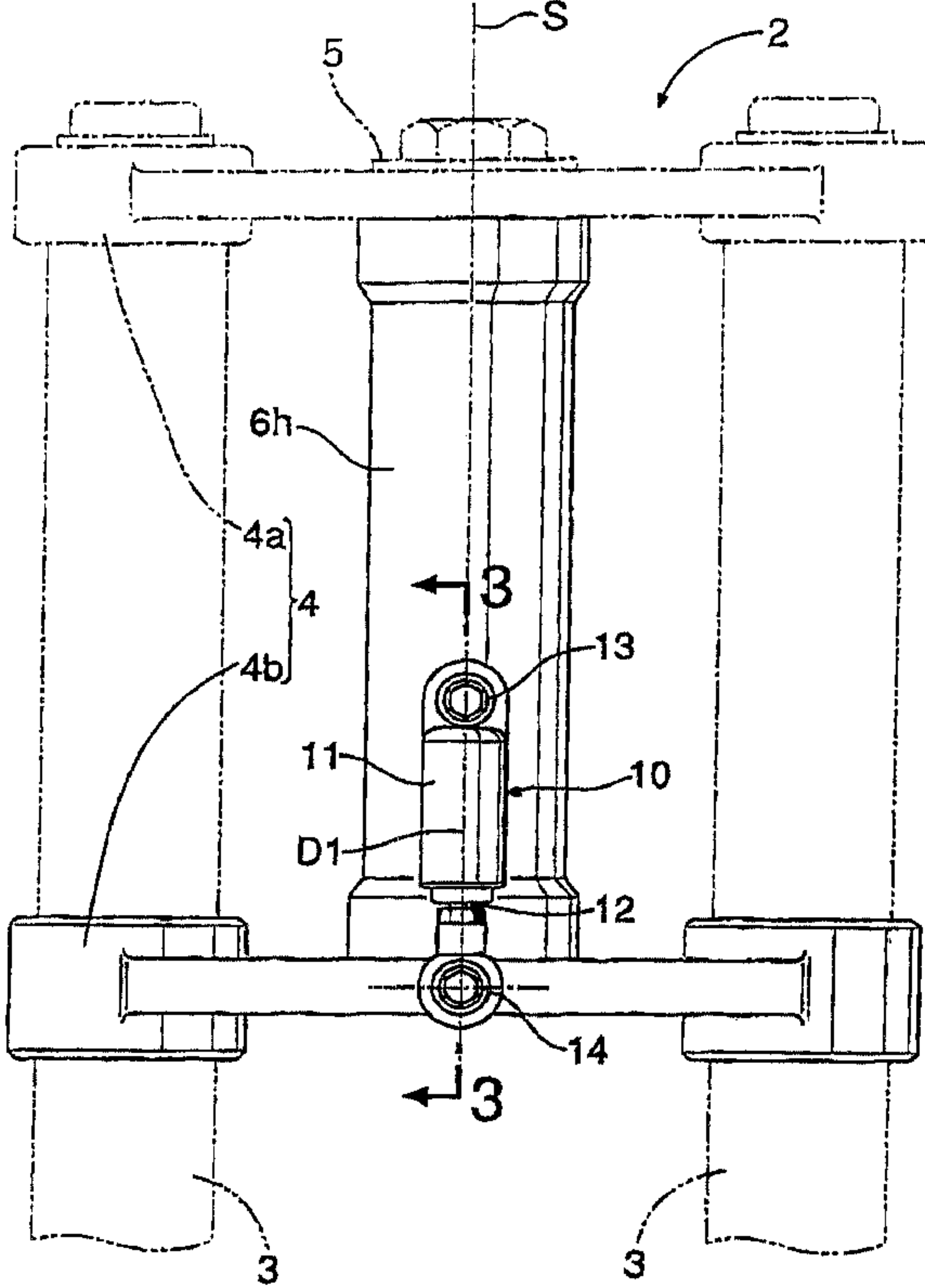


[Fig.18]



[Fig.19]




S
5
2
6h
4a
4
4b
3
13
11
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D1
12
14
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3