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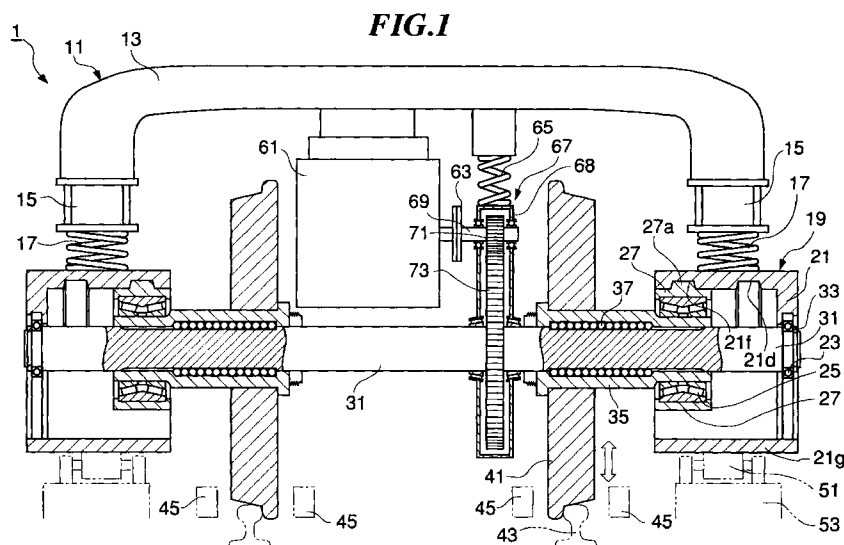
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(54) Variable gauge bogie for rolling stock

(57) The present invention provides a variable gauge bogie for a rolling stock which is capable of suppressing non-suspended weight and maintaining satisfactory steering performance.

A bogie 1 comprises a bogie frame 11, axle springs 17, axle boxes 19, an axle 31, wheels 41, a motor 61, and a speed reducer 67. The axle 31 is so made rotational to be driven for rotation by the Cardan-type drive method. A gauge alternation is carried out such that, the

wheels 41, the outer cylinder 35, and the outer cylinders 25 are transversely slidable on the axle 31. During the alternation operation, the outer cylinders 35 and the wheels 41 are located at a lower position. Fixable grooves 21f and 21d are provided inside the axle box to hold the outer cylinder bearing 25 at two points in right and left directions.



Description

BACKGROUND OF THE INVENTION

This invention relates to a variable gauge bogie for a rolling stock which is capable of running on railways of various types of gauge (the distance between a pair of right and left rails). More particularly, the present invention relates to a variable gauge bogie which is adaptable to a motor bogie, and in which the weight of equipments under axle springs (non-suspended weight) is reduced.

There are several types of gauge of railways (the distance between the insides of right and left railhead of a railway). For example, in Japan, "Shinkansen" runs on a railway track having a standard gauge of 1,435 mm. On the other hand, Japanese conventional railway track is called a narrow gauge of 1,067 mm. Besides, there are a wide gauge of 1,524 mm or 1,688 mm, and a narrower gauge of 1,000 mm.

Especially in Europe, international trains run through on plural types of railways having different gauges, so that a variable gauge railway bogie has been sought.

Only a light weight articulated bogie, the so-called Talgo Train, has practically been in use as a variable gauge bogie. This bogie for the Talgo Train is towed by an electric locomotive and does not have driving power by itself. Namely, it is a carrying bogie.

Several systems have been proposed for a carrying bogie capable of altering its gauge. Fig. 5 shows a front sectional view of the construction around the axle of a variable gauge bogie employing a direct drive mechanism with independent wheels (DDM). In Fig. 5, ground facilities are indicated by two-dot chain lines (as well, hereinafter).

Right and left wheels 141, which are positioned on right and left rails 143, are shown in Fig. 1. Each wheel 141 is attached rotationally to an outer cylinder 135 via a bearing 140. The outer cylinders 135 are fitted on the outside of a non-rotational axle 131. Said outer cylinders are also non-rotational and transversely slidable relative to the axle 131. The right and left outer cylinders 135 are correspondingly provided with the right and left wheels 141, respectively, and independently slidable relative to each other.

The insides of right and left wheels 141 are each provided with a motor 162. The casing 162a and rotor 162b of the motor 162 are fixed to the wheel 141, while a stator 162c of the motor 162 is fixed to the outer cylinder 135. The inside end of the casing 162a is rotationally supported on the outer cylinder 135 by a bearing 162d. The motor 162, contrary to a conventional motor, has the rotor 162b in the circumference of inside of the casing 162a and the stator 162c at its center. By rotationally driving the rotor 162b and casing 162a, the wheel 141 will be rotated.

In a bogie according to the DDM system in Fig. 5, its gauge will be altered by transversely sliding the outer

cylinder 135, together with the wheel 141 and motor 162, on the axle 131. That is, in the process of altering a gauge, while an axle box 119, a bogie frame 111 on the axle box and a vehicle body (not shown) are supported by a support roller 151 and a support base 153 under the axle box 119, the axle 131, the wheel 141, and the motor 162 are all together lowered (the rails 143 go down or the support bases 153 go up). At the same time, a locking block 128 fixed to the end of the outer cylinder 135 lowers, so that a projection 128b on the upper part of the locking block 128 will come off the cavity 121f of the axle box body 121. Under this circumstance, the outer cylinder 135 becomes transversely slidable.

Therefore, when the bogie 101 (along with the vehicle) proceeds in its advancing direction (a perpendicular direction to the sheet of Fig. 5), if the rails 143 and the guide rails 145 are set as to gradually widen outwardly, the outer cylinders 135 and the wheels 141 and the motors 162 move transversely on the axle 131. Thus, the distance between the right and left wheels 141 is increased. When the widening is completed, the wheels 141 are so lifted (the rails 143 are lifted) that the inside projections 128a will fit in the lock cavity 121f and the outer cylinder 135 will be set to the predetermined transverse position. The operation of altering the gauge of the bogie is completed.

Generally, in employing a DDM system by the above-mentioned independent wheels, a variable gauge bogie runs with satisfactory stability at a high speed on straight railway tracks. On the other hand, it is poor in steering performance on a curved track. The reason is as follows. In a usual right-left-wheel joined drive method, the axle is expected to automatically follow the curve in a railway, since the running distance of wheels may vary by a difference between the diameters of the outside and inside wheels at the curve, caused by the centrifugal force and the gradient of a wheel tread.

On the contrary, in a DDM bogie with independent wheels, the right and left wheels thereof are independently driven, so that the same steering performance may not be expected.

Further, the weight under axle springs 117 installed between the axle box 119 and the side beam 115 of the bogie frame 111 (non-suspended weight) is increased by the weight of the motors 162. Accordingly, load put on the railway track (including rails, sleepers, and track bed) may be disadvantageously increased.

SUMMARY OF THE INVENTION

Therefore, it is an object of the invention to provide a variable gauge bogie for a rolling stock which is capable of suppressing non-suspended weight along with satisfactory steering performance.

According to the feature of the invention, a variable gauge bogie for a rolling stock comprises a rotational axle extending in transverse directions of a vehicle

body; a pair of outer cylinders, mounted on the right and left outer circumferences of the axle, which is synchronously rotatable with the axle and transversely slidable relative to the axle; a pair of right and left wheels fixably positioned closer to the center on the outer circumference of each of the outer cylinders; a pair of right and left outer cylinder bearings, positioned closer to the side end on the outer circumference of each of the outer cylinders, for receiving both radial and thrust loads; axle bearings for receiving thrust load of the axle; and a pair of right and left axle boxes, in which the bearings are installed, each of the boxes having a holding portion to hold the outer cylinder bearings at two points in right and left directions, a construction in which the outer cylinder bearings are movable between a plurality of holding portions inside the axle box, and axle bearing grooves to guide the axle bearings upwards and downwards.

In short, an axle is a rotational type one in which the axle is so made to be driven for rotation by a so-called Cardan type driving device, as well as an ordinary carrying bogie. On the rotational axle, the wheels, the outer cylinders, and the outer cylinder bearings are transversely slidable as to carry out an alternation operation of a gauge of a bogie. The weight of the vehicle body and the thrust load born by the wheels are received by the outer cylinder bearings, and transmitted between the outer cylinders and the axle boxes. The axle is supported in a rotational direction by the axle boxes via axle bearings, and in a thrust direction by the axle bearings.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in more detail in conjunction with the accompanying drawings, wherein:

Fig. 1 is a top plan cross-sectional view of the construction around the axle of a variable gauge bogie for a rolling stock according to one embodiment of the present invention;

Fig. 2 is a detailed top plan cross-sectional view of a portion around the axle box of the bogie for a rolling stock according to the embodiment in Fig. 1;

Figs. 3A to 3C show a sequence of top plan sectional views to describe an operation during alternation of the gauge of the bogie according to the embodiment in Fig. 1;

Figs. 4A and 4B are views of ground facilities of a track to carry out the gauge changing operation of a variable gauge bogie for a rolling stock according to this embodiment of the present invention; Fig. 4A is a top plan view and Fig. 4B is a side view taken along line B-B; and

Fig. 5 shows a top plan sectional view of the construction around the axle of a variable gauge bogie for a rolling stock employing the Direct Drive Mechanism with independent wheels (DDM).

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The bogie 1 of this embodiment comprises a bogie frame 11, axle springs 17, axle boxes 19, an axle 31, wheels 41, a motor 61, and a speed reducer 67, referring now to Fig. 1.

The bogie frame 11, which is a principal structural body of the bogie 1, includes side beams 15 at its right and left sides and a cross beam 13 to couple the side beams 15. The bogie frame 11 is supported by four axle boxes 19 which are located at the right and left, the front and rear of the bogie frame 11. In this specification, as well as terminology used in the common technology of railway cars, the lengthwise direction of rails (an advancing direction of a railway car) is named a longitudinal direction, the perpendicular direction to the lengthwise direction of rails on a track is named a transverse direction, and the perpendicular direction to a railway track is named a vertical direction. A railway vehicle body (not shown) is positioned on the bogie frame 11 via a rotation fulcrum (not shown). A tractive apparatus to transmit proceeding power and breaking power to the vehicle body, and a damper which controls relative yawing motion between the bogie and the vehicle body are provided between the bogie and the vehicle body, if necessary (both publicly known and not shown).

The axle box 19 is installed under the side beam 15 through the axle spring 17, which serves to absorb vibration of the wheel 41 and the axle 31. A publicly known axle box support system or damper may be installed between the side beam 15 and the axle box 19 (not shown).

The axle box 19 (an assembly) is a box in which an outer cylinder bearing 25 and an axle bearing 23 are installed. The outer cylinder bearing 25 substantially receives weight and thrust power loaded on the wheel 41 and the axle 31 via the outer cylinder 35. The axle bearing 23 is attached to each end of the axle 31, so that it receives thrust power loaded on the axle 31.

The outer ring of the axle bearing 23, shown in detail in Fig. 2 is retained at the both sides thereof by a groove 21b in an outer side portion 21a of the axle box body 21. At the outer side portion 21a of the axle box body 21, an inverted u-shaped window 21h is open, seen from the line B-B, as shown in Fig. 2B. The groove 21b is formed along the edge of the window 21h, and the outer ring of the axle bearing 23 is vertically slidably fitted in this groove 21b. Further, the upper side of the groove 21b is cut at a deeper position away from the upper outer circumference of the axle bearing 23, so that radial load does not apply to the axle bearing 23. Still further, the window 21h, including a corresponding portion therein, is closed with a cap or bellows (not shown).

The outer ring of the outer cylinder bearing 25 is retained inside the retainer 27. The retainer 27 has a partially separable construction and has substantially a

ring-like shape. The retainer 27 is provided with a locking projection 27a of a trapezoid section, which is formed like a belt extending in the circumferential direction on the upper outer circumference, as shown in Fig. 2C. The locking projection 21 fits in the outer cylinder groove 21f or 21d formed on the ceiling 21c inside the axle box body 21, so that it holds the retainer 27 and outer cylinder bearing 25, as well as the outer cylinder 35 and the wheel 41 in right and left directions. When the retainer locking projection 27a is positioned at the inside groove 21f, the wheel 41 moves towards inside to be positioned at the narrow gauge. When the retainer locking projection 27a at the outside groove 21d, the wheel 41 moves towards outside to be positioned at the standard gauge. Accordingly, the center distance between the grooves 21f and 21d is half the distance of the variable gauge (e.g. 184 mm).

The axle box body 21 has a plane closed construction at the bottom 21g thereof. As shown in Fig. 1, the under surface of the bottom 21g is received by a support roller 51 on a support base 53, which is a part of ground facilities, to support the weight of the bogie and the vehicle body during the operation of altering the gauge of the bogie. The ground facilities (including rails 43 and guide rails 45) will be described later with reference to the Fig. 4.

The outer cylinder 35 is fixably mounted on the axle 31, being non-rational relative to the axle and transversely slidable on the axle. The wheel 41 is fixed to the outer circumference of the outer cylinder 35 in both radial and thrust directions. A sliding-type torque transmission mechanism which comprises a ball spline or spline 37 is provided between the outer cylinder 35 and the wheel 31. The ball spline or spline 37 transmits torque of the rotational direction from the axle 31 to the outer cylinder 35. The inner ring of the outer cylinder bearing 25 is retained at the outer surface of the end of the outer cylinder 35. After lowering along with the axle 31 and the wheel 41 upon the operation of altering the gauge of a bogie 1, the outer cylinder 35 will slide transversely on the axle 31 (referring to Fig. 3). The bellows 40 is so mounted on the end of the outer cylinder that the ball spline 37 will not appear outside, when the outer cylinder 35 moves transversely.

The drive mechanism of a wheel will be further set forth, referring to the Fig. 1.

A motor 61 is firmly fixed to the center of the cross beam 13. A speed reducer 67 which reduces rotation of the motor 61 and delivers the rotation to the axle 31, and which is named as a publicly known Cardan-type speed reducer, is held elastically relative to the cross beam 13. More specifically, the casing 68 of the speed reducer 67, comprising a pinion shaft 69, is supported by the cross beam 13 through a rubber around the pinion shaft 69 and swings correspondingly to movement of the axle 13 at the supported section as a pivotal point.

A coupling 63 connecting the power shaft of the

motor 61 with the pinion shaft 69 of the speed reducer 67 is a universal joint capable of adapting to dislocation of the shaft center. The speed reducer 67 is, in this example, a single reduction gear which comprises a pinion 71 and a gear 73. The gear 73 is firmly fixed to the axle 31 to deliver torque to the axle 31.

Ground facilities of a railway track will be next described, referring to the Fig. 4.

Fig. 4 shows views of the ground facilities for altering the gauge of a variable gauge bogie according to this embodiment of the present invention. Fig. 4A is a top plan view, and Fig. 4B is a side view along line B-B.

Two support bases 53 extend longitudinally at both right and left sides of the railway track, as shown in Fig. 4A. A multiple of support rollers 51 are provided on said support bases 53, not shown.

Rails 43, 43' and 43'', which are positioned between guide rails 45' at the both sides thereof, are provided inside the support bases 53. The guide rails 45' will serve to make the wheels 41 spread (or narrow) transversely during operation of gauge alternation.

The rails 43 are positioned at the narrow gauge (a gauge of 1,067 mm) at the lower part of the Fig. 4. The rails 43' at the middle part has a tapered shape gradually widening at the gauge altering section, and the rails 43'' at the upper portion is the standard gauge (1,435 mm). While a train is passing through this section, an operation of gauge alternation is being carried out.

The support base 53 has the same height at any point of the track, while the height of the rail 43 varies, with the track viewed from the side, as shown in Fig. 4B. That is, relative to the narrow gauge rail 43 and the standard gauge rail 43'' at the both sides, the gauge altering section rail 43' at the center is lower by H indicated in Fig. 4B. An inclined section having a length of L indicated in Fig. 4B is provided between the rails 43 and 43''. This is because when a train passes through the gauge altering section, the wheels 41 and the axle 31 are lowered as to release a transverse lock of each of the wheels 41, and while the wheels 41 are lowered, the right and left spacing of the wheels 41 will be altered by the guide rails 45'.

With reference to Fig. 3, an operation of altering the gauge of a variable gauge bogie according to this embodiment of the present invention will be totally described.

Fig. 3A shows a condition of the narrow gauge mentioned. The outer cylinder 35, the wheel 41, and the outer cylinder bearing 25 are inwardly positioned. The locking projection 27a of the outer cylinder bearing are fitted in the inside groove 21f. While the support roller 51, being positioned under the axle box 19, supports the weight above the axle box 19, the bogie 1 proceeds on the gauge altering section shown in Fig. 4.

Now, referring to Fig. 3B, the axle box 19 being supported by the support roller 51, the wheel 41 and the axle 31 become lower because the rail 43' is at the lower position at the center of the gauge altering sec-

tion, shown in Fig. 4. Consequently, the outer cylinder bearing 25 and the retainer 27 become lower and the locking projection 27a slips off downwards from the narrow gauge groove 21f. Under this condition, the outer cylinder 35 and the wheel 41 are transversely slidable on the axle 31, so that the wheel 41 and others will move transversely on the axle 31 when the wheel 41 is pushed transversely by the guide rails 45 and the flange of the wheel 41. Thus, the gauge of a variable gauge bogie alters from the narrow gauge to the standard one, while the train passes through the gauge altering section, wherein the rails 43 and guide rails 45 are disposed as shown in Fig. 4.

Fig. 3C shows a condition such that the wheel 41, the axle 31, the outer cylinder 35, the outer cylinder bearing 25, and the like are positioned outwardly, and further, the wheel 41, the axle 31, the outer cylinder 35, the outer cylinder bearing 25, the retainer 27, and the like are positioned higher (under the condition of the standard gauge). Under this condition, the locking projection 27a of the retainer 27 fits in the outside standard gauge groove 21d to hold the outer cylinder 35 and the wheel 41 towards a thrust direction. The operation of gauge alternation, from the narrow gauge to the standard one, is now completed. A gauge alternation from the standard gauge to the narrow one is carried out by a reversed operation of the above-mentioned.

The above description apparently shows that the present invention will provide a variable gauge bogie for a rolling stock which is capable of suppressing non-suspended weight and maintaining satisfactory steering performance of the bogie. Besides, the Cardan system, widely used as a driving mechanism, may be employed for a variable gauge bogie for a rolling stock according to the present invention.

Claims

1. A variable gauge bogie for a rolling stock, comprising:
 - a rotational axle extending in transverse directions of a vehicle body;
 - a pair of outer cylinders, mounted on the right and left outer circumferences of said axle, which is synchronously rotatable with said axle and transversely slidable on said axle;
 - a pair of right and left wheels fixably positioned closer to the center at the outer circumference of each of said outer cylinders;
 - a pair of right and left outer cylinder bearings, positioned closer to side end on the outer circumference of each of said outer cylinders, for receiving both radial and thrust loads;
 - axle bearings for receiving thrust load of said axle; and
 - a pair of right and left axle boxes, in which said bearings are installed, each of the boxes hav-

ing a holding portion to hold the outer cylinder bearings at two points in right and left directions, a construction, in which the outer cylinder bearings are movable between a plurality of holding portions inside said axle box, and axle bearing grooves to guide said axle bearings upwards and downwards.

2. The variable gauge bogie for the rolling stock according to claim 1, further comprising:

a driving device for driving said axle for rotation; and

a sliding-type torque transmittance mechanism, mounted between said axle and said outer cylinder, which is transversely slidable and capable of transmitting torque.

3. The variable gauge bogie for the rolling stock according to claim 2, wherein said driving device, which is the so-called Cardan type, comprises a motor or a power generator (referred to "motor") installed in a bogie frame, and a speed reducer held elastically relative to said bogie frame for reducing rotation of said motor and for transmitting said rotation to said axle.

4. The variable gauge bogie for the rolling stock according to claims 1, 2, or 3, wherein its gauge alternation operation is carried out such that:

said axle box is supported from underneath by support strength equivalent to the whole weight of vehicle body;

said outer cylinder bearing is released from the vehicle body weight, and said wheel bearing may descend inside the axle box, while being guided by the wheel bearing groove of said axle box;

by said wheel bearing's descent, the outer cylinder bearing is unlocked relative to the axle box, and then

said outer cylinder bearing transversely moves inside said axle box.

FIG.1

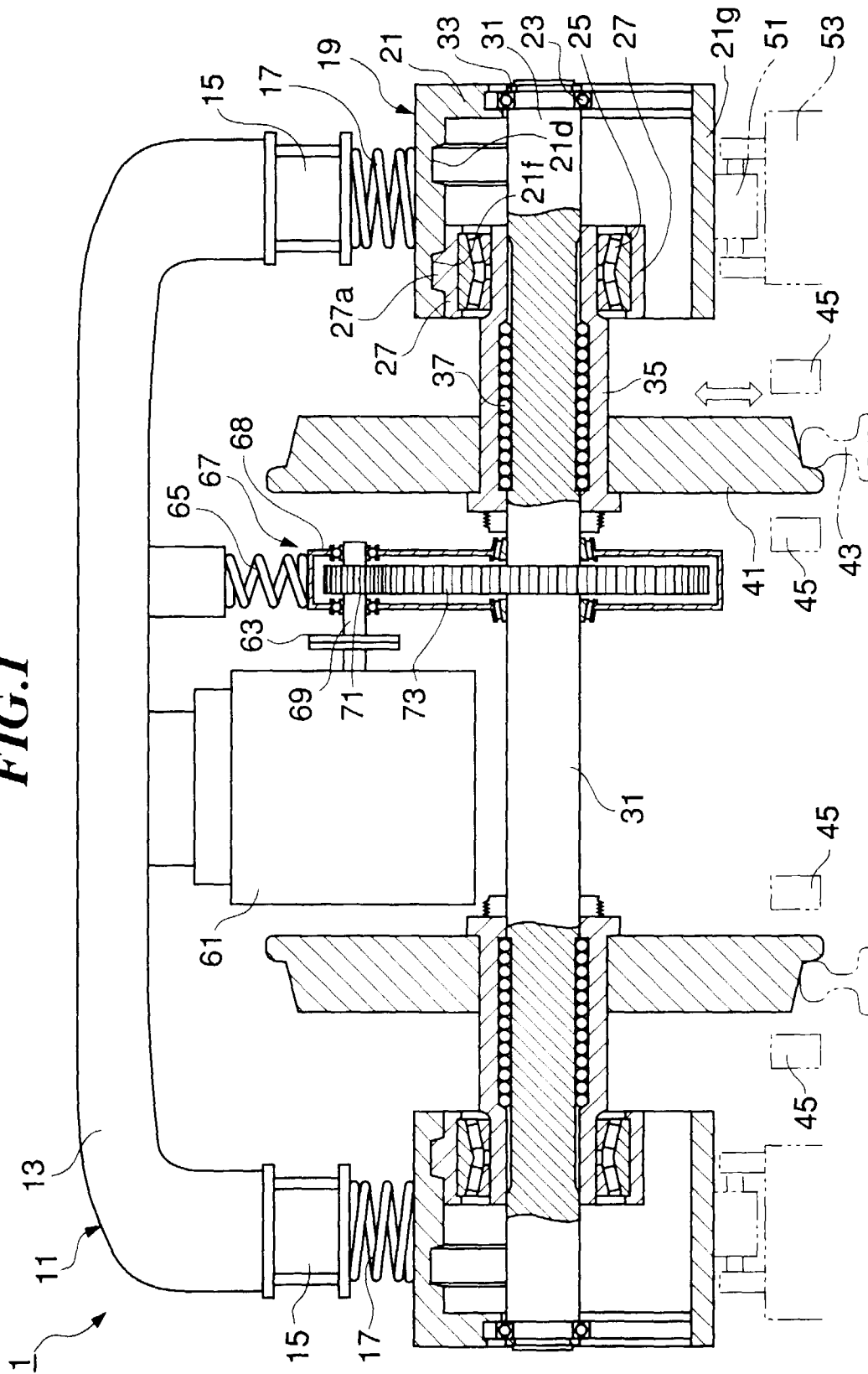


FIG.2A

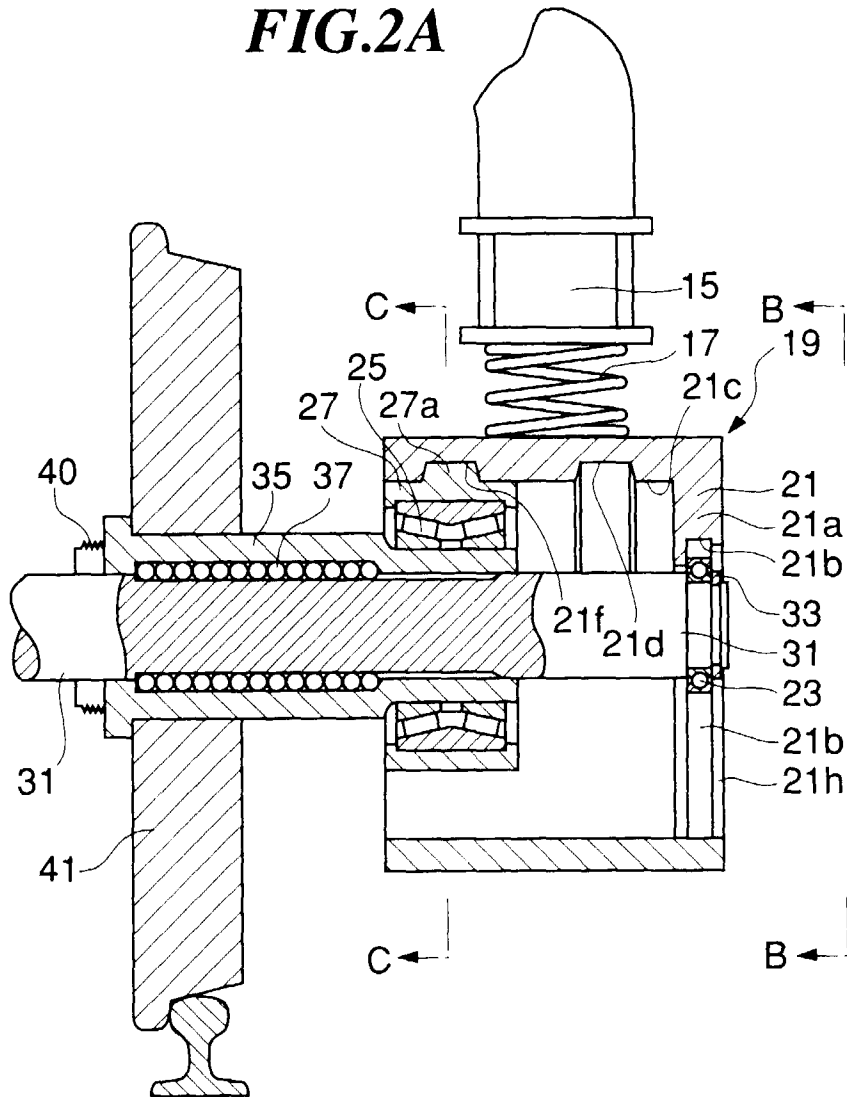


FIG.2B

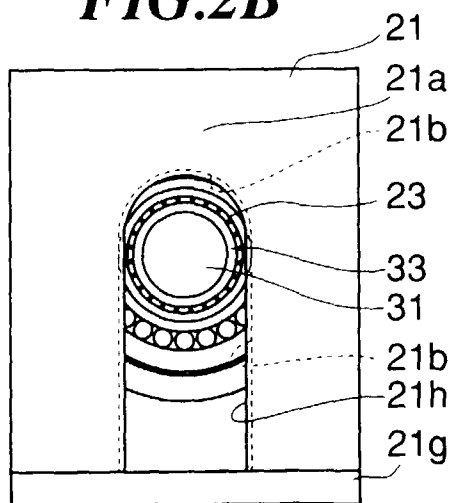
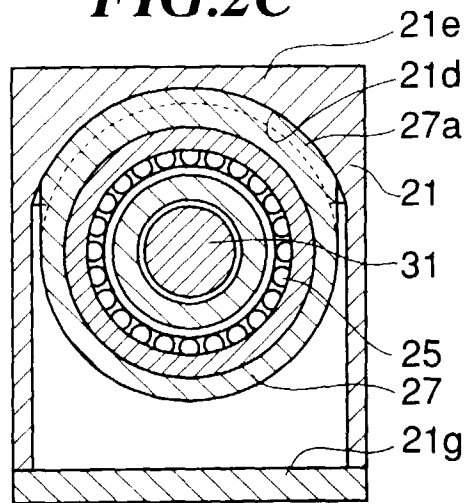


FIG.2C



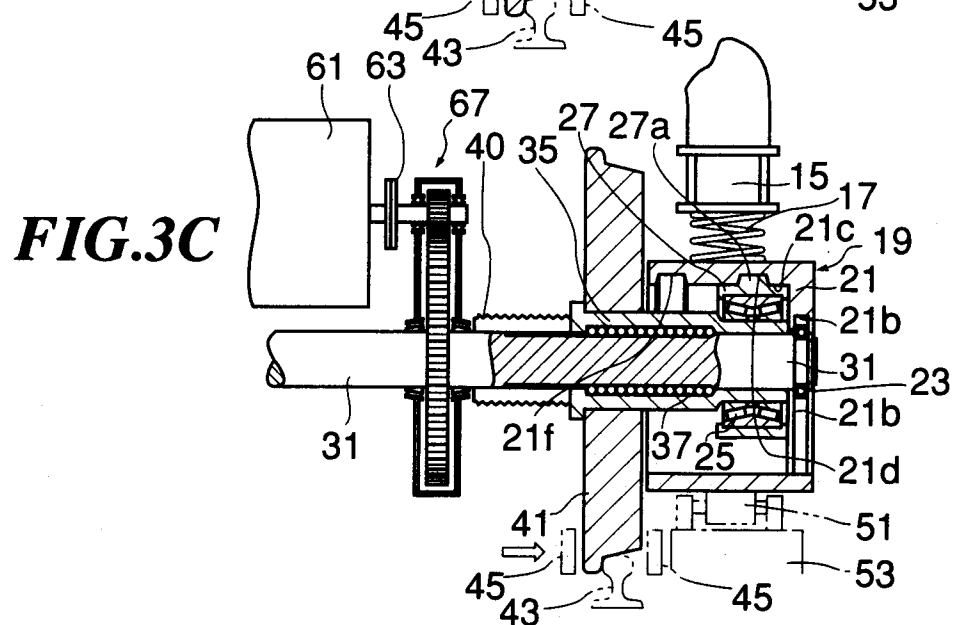
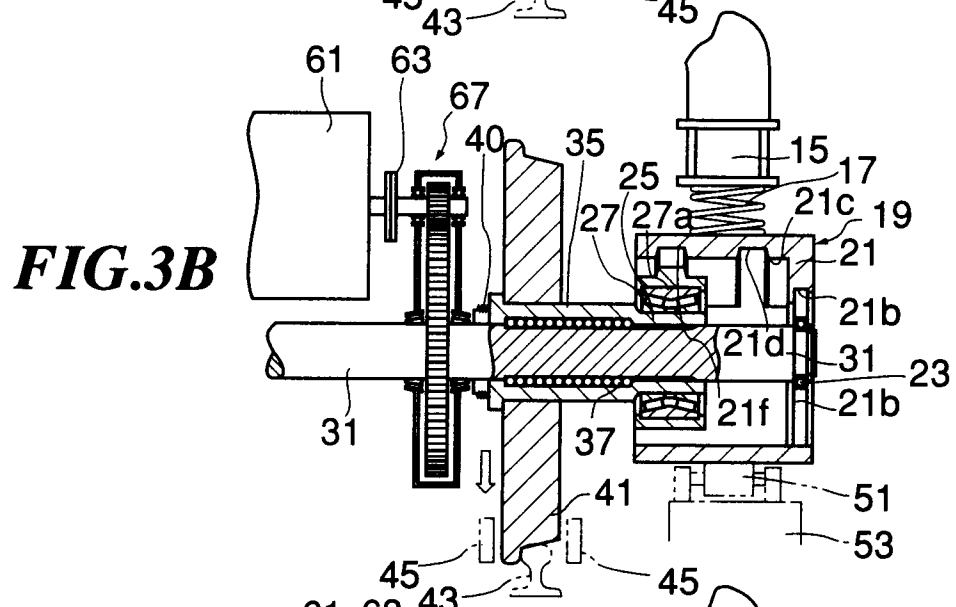
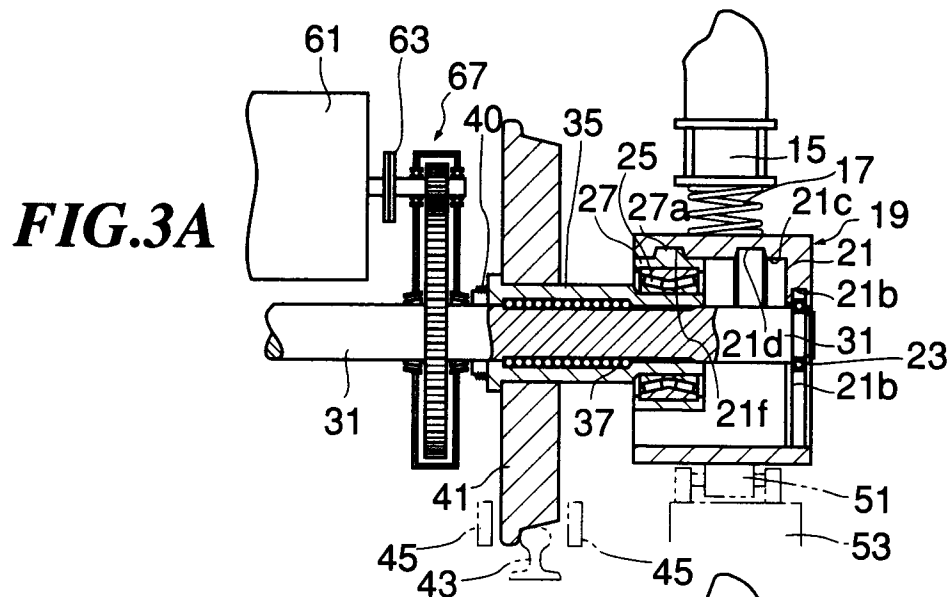


FIG.4A

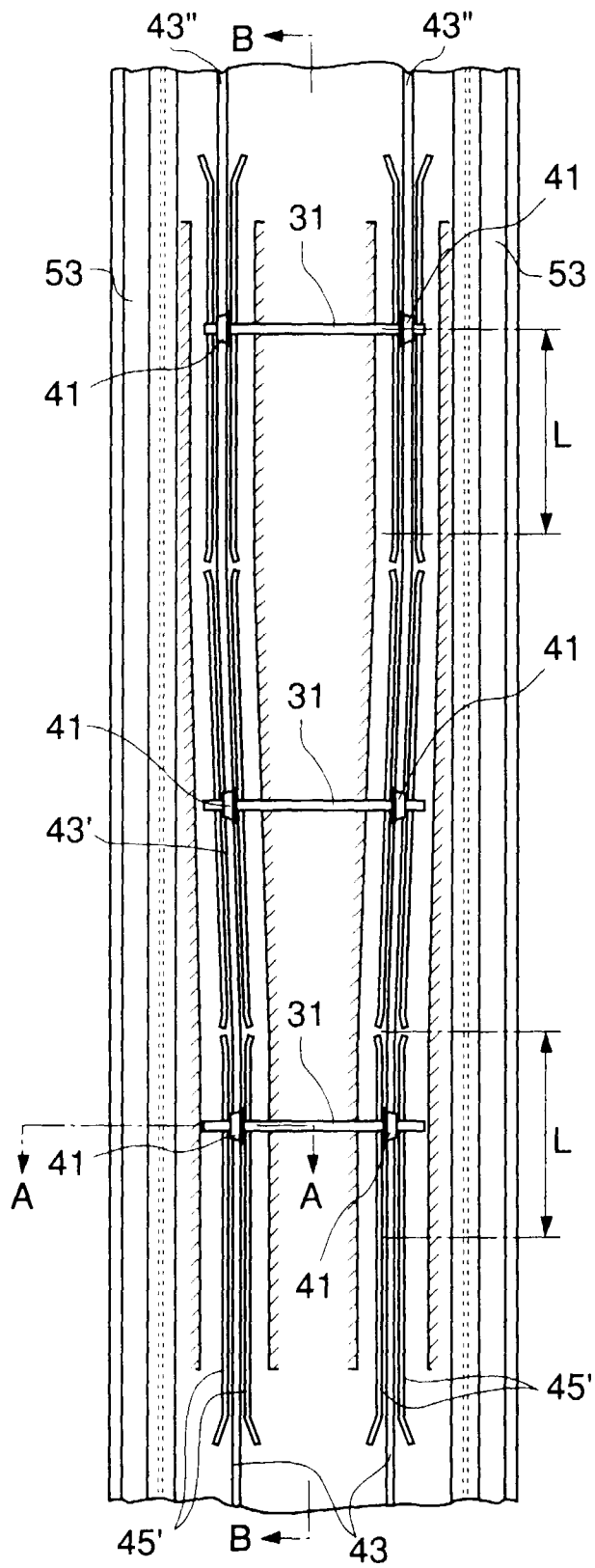


FIG.4B

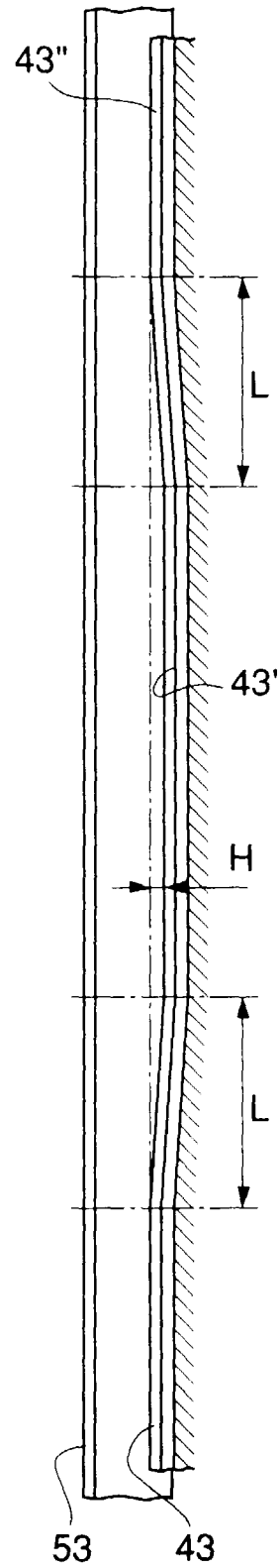


FIG. 5

