(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 177 459**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 85830238.3

(22) Date of filing: 24.09.85

(51) Int. Cl.[4]: **B 61 F 5/52**
B 61 F 5/06, B 61 F 5/12

(30) Priority: 01.10.84 IT 6797584

(43) Date of publication of application: 09.04.86 Bulletin 86/15

(84) Designated Contracting States: AT BE CH DE FR GB IT LI LU NL SE

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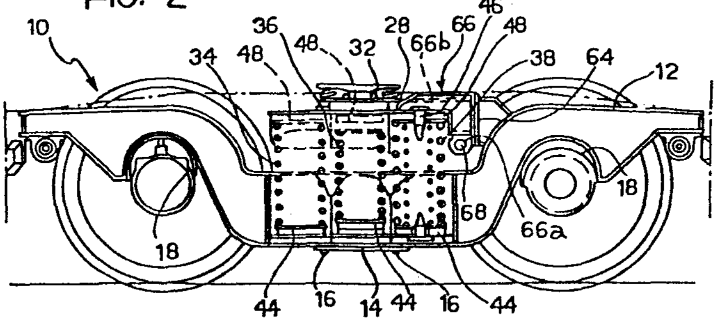
(54) Bogie for wagons of high-speed freight trains.

(57) A bogie for wagons of high-speed freight trains includes a frame (10) formed by two side members (12) interconnected centrally by means (14) for allowing relative angular movements only in substantially vertical planes, and a load-bearing beam (28) supported by the frame with the interposition of two lateral groups of vertical-axis helical suspension springs (26) which operate progressively in dependence on the load bearing on the bogie. Between the frame and the load-bearing beam are also interposed resilient lateral buffer means (50, 52, 58) which operate progressively, and friction damping means (64, 66) for the vertical and transverse movements.

FIG. 2



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Bogie for wagons of high-speed freight trains

The present invention relates to bogies for wagons of freight trains, of the type including a frame bearing on two axles and a load-bearing cross beam supported by the frame with the interposition of vertical and transverse resilient suspension means.

The conventionally structured bogies for freight wagons in use at present are subject to very restricted speed limits which greatly afflict the running of the trains. These limits are due to the unsatisfactory dynamic behaviour of such conventionally structured bogies, which leads to serious limitations on traffic safety and considerable rail-aggressiveness.

The need to speed up the running of freight trains on the main lines of railway networks derives from two factors in particular: the saturated conditions suffered by almost all lines which carry trains of very different natures and speeds (freight, slower or faster passenger trains); the resulting need to bring the traffic as close as possible to the same speed since, faced with the drive to increase the speed of passenger trains, the movement of freight trains is ever more sacrificed, particularly because of the increase in the speed difference.

There is thus a compelling need to overcome the speed limits for freight wagon bogies currently in use by resolving a series of problems connected with the operating needs of such bogies, the most important of which lies in the very considerable weight variations to which freight wagons are subject (on average, from a tare of about 20-25 tons to a maximum load of at least 80 tons).

The object of the present invention, therefore, is to provide a bogie for freight train wagons which, despite the considerable weight variations during use, is able to maintain characteristics of vertical and transverse suspension such as to ensure stability and low forces between the wheels and the rails up to speeds of the order of 140-150 km per hour.

A further object of the invention is to provide a bogie which can be manufactured by simple and economical tecnhiques and which has a configuration such as to ensure that its characteristics are constant in time and require minimum maintenance.

In order to achieve these objects, the present invention provides a bogie for wagons of high-speed freight trains, of the type defined at the beginning, characterised in that:

- the frame includes two side members interconnected centrally by means for allowing relative angular movements only in substantially vertical planes;
- the resilient suspension means for the load-bearing crossbeam comprise two lateral groups of vertical-axis helical springs which operate progressively in dependence on the load bearing on the bogie in use, so as to increase the rigidity of the vertical and transverse suspension upon an increase in load;
- between the frame and the load-bearing beams are interposed resilient lateral buffer means which operate gradually in dependence on the load bearing on the bogie in use to limit relative transverse movements between the frame and the load-bearing beam, and friction damping means for the relative vertical and transverse movements between the load-bearing beam and the frame.

According to the invention, the helical springs of each group have lower ends bearing permanently on corresponding bases supported by the respective side members and upper ends located at decreasing levels and connected to the load-bearing crossbeam by guide means, whereby the springs are uncoupled axially and transversely from the load-bearing beam as long as it is not in contact with the upper end of the springs.

The springs of each group normally include two series of springs aligned respectively in longitudinal and transverse directions. Conveniently, there are three springs in the longitudinal series, the first and third bearing permanently on the load-bearing crossbeam, and there are two springs in the transverse series alongside the second spring of the longitudinal series, the upper ends of which lie at progressively lower levels relative to the load-bearing beam.

With this solution, the load-bearing crossbeam, at tare and up to a certain weight carried, rests only on the first and third springs of the longitudinal series of the two groups, while the other springs act neither vertically nor laterally. As the load bearing on the bogie increases, the load-bearing crossbeam is depressed towards the remaining springs, causing their intervention and, by definition, increasing the rigidity of the suspension in both the vertical and transverse senses.

According to the invention, the resilient lateral buffer means include a compression spring which has its axis parallel to the transverse axis of the bogie and is rigid with the load-bearing beam, and which has its ends arranged to bear against respective stops carried by the frame at distances that decrease upon an increase in the load bearing on the bogie in use. As will be seen, the adjustment of this distance is entrusted to wedge-shaped elements.

The friction dampers for the vertical and transverse movements are formed by two cranked levers arranged, one on each side, at the ends of the load-bearing crossbeam. These levers have two arms, vertical and horizontal respectively, of which the first slides against a guide on the load-bearing crossbeam and the second acts as an upper bearing for a suspension spring. A horizontal pin with its axis parallel to the transverse axis of the bogie connects each cranked lever to the end of the crossbeam.

The invention will now be described in detail with reference to the appended drawings provided purely by way of non-limiting example, in which:

Figure 1 is a partially-sectioned plan view from above of a freight wagon bogie according to the invention,

Figure 2 is a partially-sectioned side elevational view of Figure 1,

Figure 3 is a partial sectional view taken on the line III-III of Figure 1, and

Figure 4 is a partially-sectioned front elevational view of Figure 1.

The bogie for freight train wagons illustrated in the drawings comprises essentially a frame 10 constituted by two identical welded steel side members 12 connected underneath by a spring steel cross plate 14. The plate 14 is fixed beneath the central zones of the two side members 12 by screw fixing members 16.

According to a variant not illustrated, the two side members may be connected together centrally by means of a ball joint with male and female members carried by internal extensions of the two side members and shaped so as to allow relative angular movements of the two side members only in substantially vertical planes.

Close to their ends the two side members 12 are shaped to fit over bushes 18 which rotatably support the ends of two conventional axles 20.

As will become more apparent below, the two side members 12 have the function of receiving the weight of the wagon body intended to be fitted to the bogie, and of transmitting it to the bushes 18 and hence to the axles 20. The plate 14 (or the ball joint in the variant not illustrated) prevents relative movements (longitudinal sliding, rotation, etc.) of the two side members 12 in the horizontal plane but allows the relative rotations in vertical planes necessary for the bogie to adapt to crooked tracks.

Beneath their centres the two side members 12 have respective outer and inner brackets 22 and 24 for the bearing of two vertical and transverse suspension groups 26 of the bogie. A load-bearing beam or pivoting beam 28, through which the bogie is connected to the body of the railway wagon, bears on the suspension groups 26.

The connection is achieved in a conventional manner by a central plate 30 and two resilient lateral shoes 32. The conformation and position of these members of the load-bearing beam 28 are exactly the same as those of standard freight wagons, so that the bogie according to the invention is perfectly interchangeable with those with which most of the wagons presently in use are equipped.

The two groups of suspension springs are arranged to transmit vertical and transverse forces between the load-bearing beam 28 and the side members 12 of the frame 10 of the bogie. The configuration of the two groups 26 is such as to give an increase in the rigidity of the vertical and transverse suspension proportional to the increase in the load bearing on the bogie. In effect, each group 26 includes a series of three vertical-axis helical springs 34, 36 and 38 disposed in a line in a direction parallel to the longitudinal axis of the bogie, and a series of two vertical-axis helical springs 40, 42 side by side with the spring 36 and aligned in a direction parallel to the transverse axis of the bogie. The springs 34, 36 and 38 bear at their lower ends on the brackets 22 of the side members 12, while the lower ends of the springs 40 bear on the brackets 24. Between the lower end of each spring and the respective bracket is at least one resilient bearing member 44 of elastomeric material.

As is clearly seen in Figures 2 and 3, the springs of the two groups 26 are shaped and located so that, in the rest position of the bogie, their upper ends are located at different levels. In particular, the springs 34 and 38 extend upwardly to the level of the load-carrying beam 28 the ends of which bear permanently on these springs 34 and 38 in the manner explained below. The upper ends of the intermediate springs 36 are located at a level below that of the corresponding ends of the springs 34 and 38, the upper ends of the springs 40 at a level below the level of the springs 36, and the springs 42 at a lower level still. In practice, therefore, in the conditions illustrated in the drawings, the springs 36, 40 and 42 are spaced from the load-carrying beam 28 at their upper ends and are thus completely unloaded.

The connection between the springs of each group 26 and the load-bearing crossbeam 28 is achieved by rods or vertical guide pins 46 fixed to the beam 28 and inserted with axial and radial clearance through corresponding resilient bearing plates 48 fixed to the top of the springs themselves. This connection means that springs 36, 40 and 42 are uncoupled axially and transversely from the load-bearing beam 28, while coupling is achieved by the effect of the lowering of the beam 28 under load and its resting on these springs, as will be explained below. It will become apparent that the springs of the two groups 26 operate progressively in dependence on the load bearing on the bogie in use, so as to increase the rigidity of its vertical and transverse suspension upon an increase of the load.

The need to keep down the rigidity of the transverse connection between the bogie and its wagon body, so as to have a hypercritical suspension with respect to the rocking bogie-rocking body coupling from the lowest possible speed, imposes the provision of resilient means for limiting the transverse movement between the load-bearing beam and the frame on curves. Since the forces which give rise to these movements vary considerably, in dependence on both the speed and the variation in weight of the vehicle, the invention provides for the use of transverse limiting means with characteristics which vary in dependence on the weight itself.

As clearly seen in Figure 3, this is achieved by means of a compression spring 50 carried by the load-bearing beam 28 with its axis parallel to the transverse axis of the bogie and its ends cooperating with two inclined lateral stops 52 carried by the side members 12 and whose distance relative to the ends of the spring 50 in the rest condition decreases upon an increase in the load bearing on the bogie. In practice, the spring 50, which may be a helical metal spring or a body of elastomeric material, is inserted in a holder 54 fixed beneath the beam 28 and is interposed between two buffers 56 which project slidably from the ends of the holder 54 and bear against two corresponding wedge-shaped elements 58 carried by two connecting rods 60 freely articulated relative to the beam 28 about two pins 62 parallel to the transverse axis of the bogie. It is clear that the more the load-bearing beam 28 is depressed as a result of the load bearing thereon, the more the distance between the buffers 56 of the wedge-shaped elements 58 and the stop surfaces 52 is reduced, limiting the transverse movements between the beam 28 and the frame 10 of the bogie in the manner explained below.

The relative longitudinal movements between the load-bearing beam 28 and the frame of the bogie are prevented by two pairs of vertical guides (only one of which is indicated 64 in Figures 1 and 2) carried by the side members 12 and facing opposite sides at the ends of the load-bearing beam 28. The guides 64 also form part of a friction damping system having the function of damping the vertical and transverse relative movements between the load-bearing beam 28 and the frame 10 of the bogie. Since this damping must be proportional to the energy in play, that is, to the weight of the wagon in practice, the damping system must give rise to forces which also vary proportionally with the weight of the wagon bearing on the bogie.

According to the invention, two cranked levers are used, one of which is indicated 66 in Figures 1 and 2, each of which has a vertical arm 66a facing a corresponding guide 64 and articulated at its lower end to a transverse pin 68 carried by the load-bearing beam 28, and a horizontal arm 66b which carries the guide pin 46 of one of the springs 34 or 38 of the two suspension groups 26. It will be clear that the reaction force transmitted by the spring 34 or 38 to the respective lever 66 tends to cause it to rotate upwardly, bringing the arm 66a against the respective guide 64 so as to damp the force which has caused this reaction.

Two transverse bars, indicated 70, interconnect the ends of the two side members 12. The bars 70 are connected to the side members 12 by respective ball joints 72 and, acting as tension-compression members, cancel any possible relative horizontal movement between the side members 12, while allowing the necessary angular movements in vertical planes.

The bogie according to the invention may be equipped with a tyre braking system with blocks, the operating cylinders of which may be arranged on the body of the wagon or on the bogie itself. It is also possible to equip the bogie with disc brakes (two discs per axle).

There will now be briefly described the behaviour of the bogie according to the invention during use, by virtue of which the necessary stability and low forces between the wheels and the rails at high speeds of the order of 140-150 km per hour are obtained, notwithstanding the very considerable variations in load to which the bogie may be subject.

At tare and up to a predetermined weight carried, the load-bearing crossbeam 28 bears only on the springs 34 and 38 of the two suspension groups 26. The upper ends of the remaining springs 36, 40 and 42 are uncoupled from the load-bearing beam 28 and hence do not act. In fact, the springs on whose upper ends the load-bearing crossbeam 28 does not rest neither transmit weight nor generate lateral return forces, since, although they are guided in a transverse sense by their pins 46, their bases are free to rotate. Only when this freedom is removed by the gradual contact between the load-bearing beam 28 and the upper ends 48 of the springs 36-42, the latter resisting their lateral deformation, does the rigidity of the lateral suspension gradually increase and thus become isofrequential. In practice then the springs of the two groups 26 operate progressively upon an increase in the load bearing on the bogie, thus increasing the rigidity of the suspension in both the vertical and transverse senses.

Similarly, the transverse limiting system described above has characteristics which vary proportionally with the weight bearing on the bogie. The buffers 56 urged by the spring 50 may come into contact with the lateral stop surfaces 52 through the wedge-shaped elements 58 when a certain movement (± about 10-20 mm), during which only the vertical springs of the two suspension groups act, is exceeded. The value of this movement, beyond which the lateral buffering operates, is variable due to the presence of the wedge-shaped elements 58 and the conformation of the surfaces 52. As the weight bearing on the bogie increases, these members reduce the amplitude of the possible lateral movements of the load-bearing beam and frame under the sole control of the springs of the suspension groups 26, gradually advancing the intervention of the buffering spring 50, so that after the permitted transverse movements (about ± 30 mm) the total force exerted between the body and the bogie is greater the greater the load on the wagon.

The above-described system for damping the relative vertical and transverse movements between the load-bearing beams 28 and the frame 10 of the bogie also has an action which varies proportionally with the weight bearing on the bogie. In fact, when the force transmitted by the or each spring 34 and 38 of the two groups 26 tends to make the or each cranked lever 66 rotate in the manner described above, the mutual force exerted between the or each vertical guide 64 and the corresponding vertical arm 66a of the respective lever 66 is proportional to the weight bearing on the bogie. Clearly, this applies equally for the frictional forces which arise. These forces have a direction such as to oppose the motion which is generated: thus, they will be vertical for vertical movements and horizontal for horizontal movements.

Naturally, the principle of the invention remaining the same, the constructional details and forms of embodiment may be varied widely with respect to those described and illustrated, without thereby departing from the scope of the present invention.

CLAIMS

1. Bogie for wagons of high-speed freight trains, including a frame (10) carrying two axles (20) and a load-bearing crossbeam (28) supported by the frame (10) with the interposition of vertical and transverse resilient suspension means, characterised in that:

- the frame (10) includes two side members (12) interconnected centrally by means (14) for allowing relative angular movements only in substantially vertical planes;
- the resilient suspension means comprise two lateral groups of vertical-axis helical springs (26) which operate progressively in dependence on the load bearing on the bogie in use, so as to increase the rigidity of the vertical and transverse suspension upon an increase in the load, and
- between the frame (10) and the load-bearing beam (28) are interposed resilient lateral buffer means (50, 52, 58) which operate gradually in dependence on the load bearing on the bogie in use to limit relative transverse movements between the frame (10) and the load-bearing beam (28), and friction damping means (64, 66) for the relative vertical and transverse movements between the load-bearing beam (28) and the frame (10).

2. Bogie according to Claim 1, characterised in that the means for allowing relative angular movments of the two side members in substantially vertical planes are constituted by a cross member in the form of a resiliently deformable plate (14).

3. Bogie according to Claim 1, characterised in that the helical springs of each group (26) have lower ends (44) bearing permanently on corresponding bases (22, 24) carried by the respective side member (12) and upper

ends (48) located at decreasing levels and connected to the load-bearing crossbeam (28) by guide means (46), whereby the springs are uncoupled axially and transversely from the load-bearing beam (28) as long as it is not in contact with the upper ends (48) of the springs.

4. Bogie according to Claim 3, characterised in that the guide means are constituted by vertical guide pins (46) carried by the load-bearing beam (28) and engaged with clearance in corresponding axial apertures in plates (48) carried by the suspension springs.

5. Bogie according to Claim 3 or Claim 4, characterised in that the springs of each group (26) include two series of springs (34, 36, 38; 40, 42) aligned respectively in the longitudinal direction and the transverse direction relative to the bogie.

6. Bogie according to Claim 5, characterised in that the springs (34-42) are provided at respective ends with resilient bearings (44, 48) of elastomeric material.

7. Bogie according to Claim 1, characterised in that the resilient lateral buffer means include a compression spring (50) which has its axis parallel to the transverse axis of the bogie and is fixed to the load-bearing beam (38), and which has its ends (56) arranged to bear against respective stops (52) carried by the frame (10), the distances of which from the spring (50) decrease upon an increase in the load bearing on the bogie in use.

8. Bogie according to Claim 7, characterised in that

the spring (50) is interposed between two wedge-shaped elements (58) carried by two connecting rods (60) articulated to the load-bearing beam (28) about respective axes (62) parallel to the longitudinal axis of the bogie and facing corresponding complementary stop surfaces (52) carried by the side members (12) of the bogie.

9. Bogie according to Claims 1 to 5, characterised in that the friction damping means include two pairs of vertical guides (64) carried by the side members (12) and facing opposite sides at the ends of the load-bearing beam to prevent longitudinal relative movement between the latter and the frame (10), a cranked lever (66) being associated with one guide (64) of each pair and having a vertical arm (66a) facing the guide (64) and articulated at its lower end to the load-bearing beam (28) about an axis (68) parallel to the transverse axis of the bogie, and a horizontal arm (66b) carrying the respective guide pin (46) of one of the first or third springs (34, 38) of the longitudinal series of the corresponding group of suspension springs (26).

10. Bogie according to Claim 1, characterised in that the side members (12) are interconnected at their ends by two transverse bars (70) articulated to the side members (12) by respective ball joints (72).

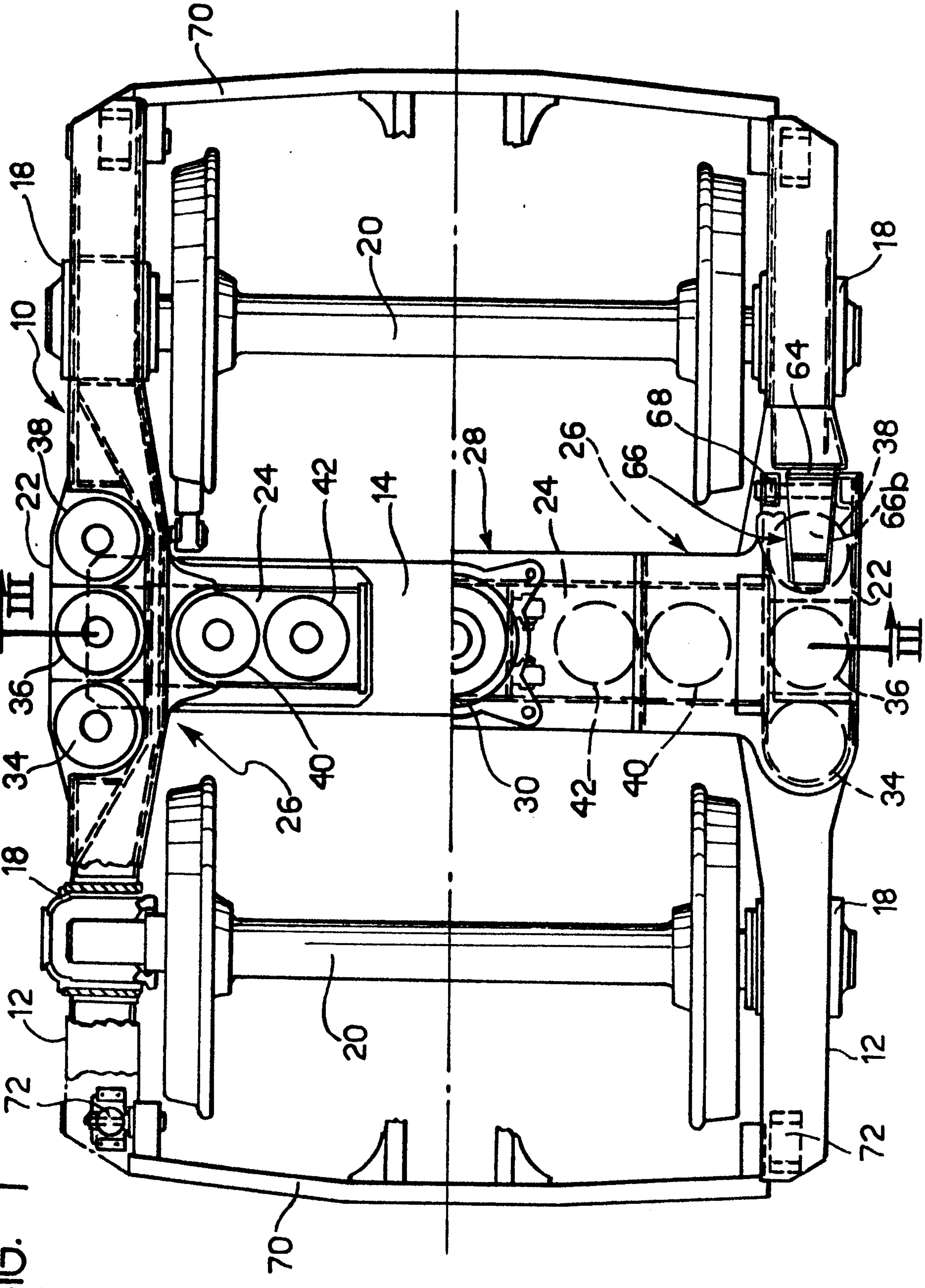
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FIG. 1

FIG. 2

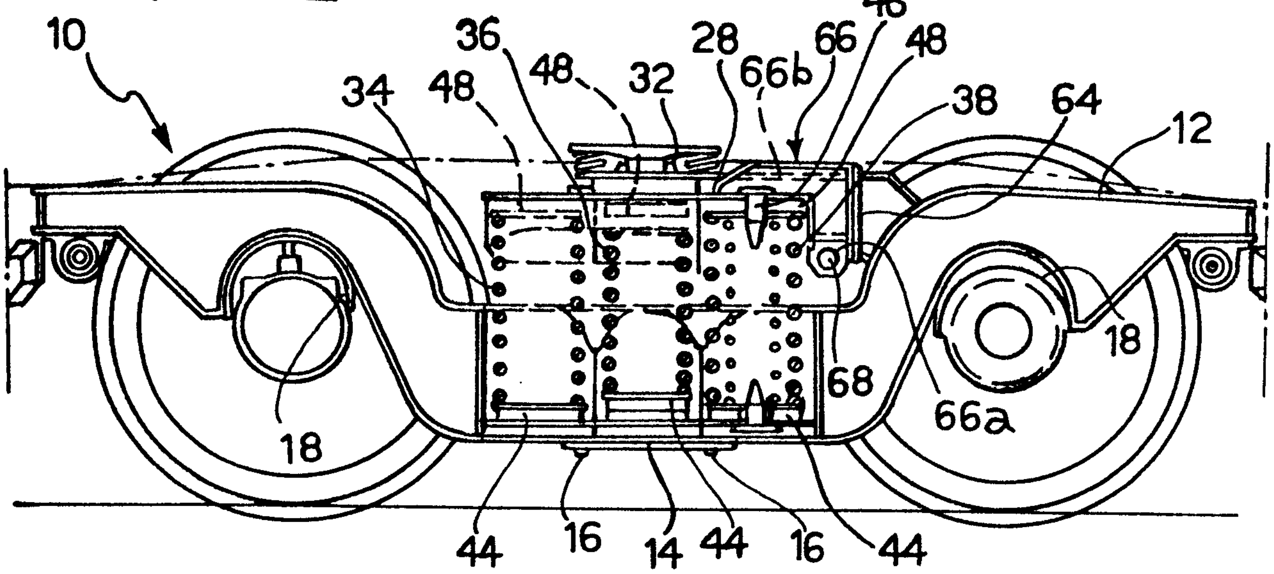

FIG. 3

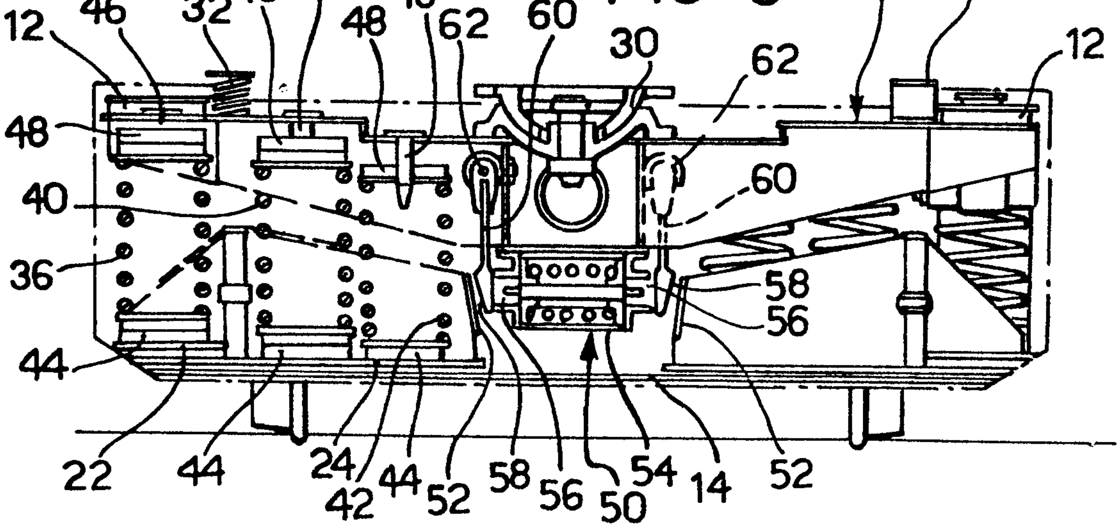

FIG. 4