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(54) **Bogie arrangement for a railway vehicle.**

(57) The invention concerns a bogie arrangement for railway vehicles. The object of the invention is to reduce the number of structural components in the bogie and to provide a radial steering of the wheel sets in the bogie. The bogie arrangement comprises at least two bogies (10,10a) provided with wheels, said bogies consisting of two pivotable bogie frame parts (11,11a, 12,12a) that are linked together. The bogies (10,10a) are coupled to each other mechanically and to the railway vehicle by means of the suspension. The first part (11,11a) and the second part (12,12a) of the bogie frame of each bogie (10,10a) are coupled to each other so that they can pivot both relative the longitudinal axis of the bogie and relative the vertical centre axis of the bogie, and the bogie is suspended by means of a single-stage suspension (17,18) directly on the frame of the railway vehicle. The bogies (10,10a) are connected to each other by means of positive steering so that the axles (15,16,15a,16a) of the wheel sets in each bogie (10,10a) are arranged to be steered in curves substantially radially irrespective of the curve radius (R). The bogies (10,10a) are interconnected by means of a connecting rod (40), which is linked to the first parts (11,11a) of the bogie frames directly and to the second parts (12,12a) of the bogie frames by the intermediate of a set of rods with articulated joints (44 to 46, 44a to 46a).

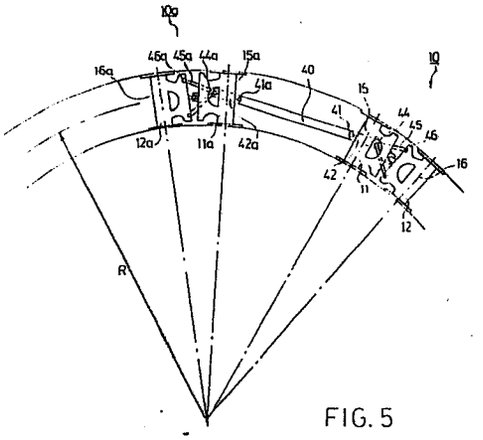

FIG. 5

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Description

Bogie arrangement for a railway vehicle

The invention concerns a bogie arrangement for railway vehicles, which said bogie arrangement comprises at least two bogies provided with wheels, said bogies consisting of two pivotable bogie frame parts that are linked together and said bogies being coupled to each other mechanically and to the railway vehicle by means of the suspension.

The bogie constructions that are used at present under railway vehicles have, almost without exception, such a construction that the bogie frame is rigid and suspended on the frame of the railway vehicle, such as a locomotive, wagon, coach, or equivalent, by means of a two-stage suspension. A rigid bogie frame involves several drawbacks, of which one significant drawback is manifested in particular when running in curves. As the bogie frame is rigid, the wheel sets in the bogie cannot be steered in the curve radially, but the wheels of a wheel set are so to say wedged against the rail, with resulting intensive wear of the wheels and the rails. Owing to such a wedging effect, part of the tractive effort of the locomotive is "lost" in the resistance in the curves. In this connection, two-stage suspension means that the wheel sets of the bogie are first suspended by means of axle suspension on an intermediate frame or cage, which is again suspended by means of a bogie suspension on the frame of the railway vehicle. A significant drawback related to this is the complicated construction, for such a bogie construction includes a very high number of components. This is why the construction is quite expensive. A second difficulty in such a construction is, likewise owing to the complicated construction, how to arrange the coupling of the springs.

In prior art, attempts have been made to solve the drawbacks mentioned above in a number of different ways. For example, the German Patents 3,213,804, 3,221,755, and 3,235,692 and the EP Patent 0,165,752 suggest different bogie constructions, in which the bogie frame is divided in two parts and linked at the middle so that the wheel sets should be able to be steered substantially radially in curves. All of these bogie constructions, however, involve several drawbacks, for which reason the bogie constructions in accordance with the said patents have not become commonly used in railway rolling stock. The construction in accordance with the German Patent 3,213,804 includes a separate bogie bolster, which is suspended on the frame of the vehicle. On the other hand, the wheel sets are suspended individually on the said bogie bolster. Thus, the construction in accordance with the said patent is provided with two-stage suspension. Moreover, the said construction is highly unfavourable in the respect that, owing to the geometry of the construction, the dynamic reaction forces are transmitted substantially directly to the frame of the upper structure, i.e. of the wagon, coach, locomotive,or equivalent. Moreover, owing to the mode of coupling of the suspension, the construction is also quite unstable. In the German Patent 3,221,755, the system of articulated joints in the bogie has been accomplished by using a highly complicated cage in the bogie. The cost of manufacture of such a bogie is very high. On the other hand, in the German Patent 3,235,692, the system of articulated joints in the bogie has been accomplished with the aid of a separate cradle beam and a complicated set of articulated joints. The construction requires an abundance of maintenance and care, because it includes a great number of wearing articulated joints. Therefore, this construction cannot be considered highly usable either. Also, the construction in accordance with the EP Patent 0,165,752 comprises a complicated cage and a very high number of articulated joints that are subject to wear. In all of the above prior-art bogie constructions, along with the systems of articulated joints in the bogie, the bogie construction has also become highly complicated, requiring abundant maintenance, for which reason, in practice, the use of such bogie constructions is not economically sensible.

The object of the present invention is to solve the problems described above and to provide a substantial improvement over the existing bogie constructions and to provide radial steering of the wheel sets in the bogie and to reduce the number of structural components, i.e. to omit the traditional bogie cage. In view of achieving this, the bogie arrangement in accordance with the invention is mainly characterized in that the first part and the second part of the bogie frame of each bogie are coupled to each other so that they can pivot both relative the longitudinal axis of the bogie and relative the vertical centre axis of the bogie, and that the bogie is suspended by means of a single-stage suspension directly on the frame of the railway vehicle, each bogie included in the bogie arrangement being connected to the other bogie or bogies in the arrangement by means of positive steering so that the axles of the wheel sets in each bogie are arranged to be steered in curves substantially radially irrespective of the curve radius.

By means of the present invention, a number of advantages are obtained over prior art, of which, e.g., the following should be mentioned. It has been possible to make the bogie construction belonging to the bogie arrangement in accordance with the invention very simple, because in the bogie a single-stage suspension has been used so that the wheel sets are suspended directly on the frame of the railway vehicle. The bogie construction has a low number of parts and very few wearing articulated joints, because of which the bogie construction requires little maintenance and is highly reliable in operation. The different halves of the bogie are interconnected fully "torsionally loosely", on which account the wheel sets in the bogie can be steered in the curves and, moreover, the wheel sets comply fully with the bankings in curves. Such a solution substantially reduces the wedging of the wheels in the wheel sets against the rails and the slipping of

the wheels on the rails, and consequently also the wear of the wheels and of the rails. In the bogie arrangement, the interconnecting of the bogies and the steering of the wheel sets are arranged with positive control so that in curves the wheel sets are steered fully radially.

In the bogies belonging to the bogie arrangement in accordance with the invention, it has been possible to omit the bogie cage, i.e. a single-stage suspension has been used, owing to the very fact that the wheel sets in each bogie are linked to each other so as to be pivotable around a vertical axis. Thus, here the linkage between the wheel sets carries out the duties of a conventional bogie cage, i.e. the turning of the wheels in curves. In the bogie arrangement in accordance with the invention, the conventional bogie suspension, i.e. the suspension between the bogie cage and the vehicle frame, is substituted for by making the springs communicate with each other at each side. In a conventional bogie construction, the bogie suspension has permitted "pitching" of the bogie relative the frame, which property is needed, e.g., when passing over the top of a hill and, in a corresponding way, in a valley. By means of the communication between the springs in accordance with the invention, the bogie has obtained the same property. The communication between the springs and the linkage between the parts of the bogie frame so that they are pivotable relative the longitudinal centre axis jointly permit adaptation of the wheels in the wheel sets in accordance with the bankings in curves. Thus, the advantages and properties of the invention result from a combination of the bogie linkage and suspension and of a positive steering of wheel sets and interconnection of the bogies.

The invention will be described in the following in more detail by means of an exemplifying embodiment with reference to the figures in the attached drawing.

Figure 1 shows a bogie included in a bogie arrangement in accordance with the invention as a side view and partly in section.

Figure 2 is a top view of a bogie in accordance with Fig. 1.

Figure 3 is a side view partly in section of the interconnection of two bogies in the bogie arrangement in accordance with the invention.

Figure 4 corresponds to Fig. 3 as a top view.

Figure 5 is a fully schematical presentation of the positive steering of the wheel sets of the bogies included in the bogie arrangement when running in curves.

Referring to Figures 1 and 2, the bogie shown in them is denoted generally with the reference numeral 10. In accordance with the invention, the frame of the bogie 10 consists of two parts so that it comprises a first part 11 and a second part 12 of the bogie frame, which said parts are interconnected by means of articulated joints. The parts 11 and 12 of the bogie frame are preferably cast pieces, and these parts 11 and 12 of the bogie frame act as frames for the wheel sets of the bogie 10 so that the first part 11 of the bogie frame includes the first wheel set, provided with the first wheels 13 mounted on the first axle 15, and correspondingly the second part 12 of the bogie frame includes the second wheel set, which is provided with the second wheels 14 mounted on the second axle 16.

The parts 11 and 12 of the bogie frame are connected to each other fully "torsionally loosely" by means of an articulated joint 21 so that the parts 11 and 12 of the bogie frame can pivot relative each other around the longitudinal and horizontal centre axis of the bogie 10 as well as turn relative each other around a vertical centre axis of the bogie. This has been arranged so that the first part 11 of the bogie frame is provided with the first fastening lugs 22 and, on the other hand, the second part 12 of the bogie frame is provided with a second fastening lug 23, the said fastening lugs 22,23 being interconnected by an articulated joint 21. The joint 21 is a joint turnable in all directions, such as a ball joint, rubber joint, or equivalent, whereby the parts 11 and 12 of the bogie frame can also turn in all directions relative each other. By means of the said articulation of the bogie frame parts 11 and 12 relative each other, it has been possible to eliminate any torsional strains in the bogie 10 substantially completely, for which reason cast structures can be advantageously used as the bogie frame parts 11 and 12. When cast structures are used, the fastening lugs 22 and 23 are preferably formed as parts cast integrally with the bogie frame parts 11 and 12.

Since the bogie frame parts 11 and 12 are interconnected in the way described above "torsionally loosely", it has been additionally necessary to interconnect the bogie frame parts 11 and 12 by means of a stabilizer rod system 25, which prevents bending-down or bending-up of the bogie frame parts 11 and 12 relative the articulated joint 21. For the stabilizer rod system 25, the bogie frame parts 11 and 12 are firstly provided with fastening lugs 26 and 27, which are fitted on the centre line of the bogie 10. The stabilizer rod system 25 itself comprises a horizontal rod 28, which is fitted inside a sleeve 29, whereat the said rod 28 and sleeve 29 are supported at their ends on the fastening lugs 26 and 27. The rod 28 receives tensile strains, and it prevents turning of the bogie frame parts 11 and 12 in relation to the horizontal transverse axis around the articulated joint 21 so that the said joint 21 rises during this turning movement. On the other hand, the sleeve 29 is fitted so as to receive compression strains, whereby it again prevents turning of the bogie frame parts 11 and 12 around the articulated joint 21 in the opposite direction. The rod 28 and the sleeve 29 are supported at their ends on the fastening lugs 26 and 27 by the intermediate of elastic pieces 30, whereby the fastening between the stabilizer rod system 25 and the bogie frame parts 11 and 12 is not fully rigid.

The stabilizer rod system 25 may be arranged relatively resilient, because strains derived from traction forces or braking forces are not transmitted to it. This is due to the fact that the bogie 10 has been formed symmetric relative the articulated joint 21, whereby, owing to this symmetry and the dimensioning of the bogie, the strains derived on the bogie frame parts 11 and 12 from traction forces and

braking forces substantially neutralize each other. Another important reason for the resilience of the stabilizer rod system 25 is that, owing to said resilience, any strains and loads caused by impacts are not transferred from one part of the bogie frame to the other. Since it is an essential feature of the bogie 10 that the bogie frame parts 11 and 12 can turn relative each other around the articulated joint 21 fully freely, in stead of a ball joint or rubber joint, it is also possible to use some other sort of a fully freely turnable joint which produces the same effect.

It is a further essential feature of the bogie 10 in accordance with the invention that in the bogie a single-stage suspension is used. Thus, the bogie 10 is suspended directly on the frame of the rail vehicle without a conventional intermediate frame arrangement. For this purpose, the first part 11 of the bogie frame is provided with the first springs 17, and correspondingly the second part 12 of the bogie frame is provided with the second springs 18, which are, thus, directly connected to the frame of the rail vehicle. The springs 17 and 18 are fitted directly above the wheel-set axles 15 and 16, respectively, whereby it has been possible to reduce the bending strains derived from the suspension on the bogie frame parts 11 and 12 substantially, whereby a reduced quantity of material has been adequate in the manufacture of the bogie frame parts 11,12. The springs 17 and 18 are advantageously gas-hydraulic springs, and they communicate with each other in the way shown in Fig. 2, so that the springs 17 and 18 on the bogie frame parts 11 and 12 at each side of the bogie 10 are connected to each other, e.g., by means of hydraulic pipe systems 31 and 32 and necessary throttles 35 or equivalent. Thus, during movements of spring action, the hydraulic fluid in the springs 17 and 18 flows along the said pipe systems 31 and 32 from one spring into the other so that, at each side of the bogie 10, part of the spring force or load is arranged to be passed from the spring 17 or 18 with higher load to the spring 18 or 17 with lower load. In the suspension, it is, of course, also possible to use springs of some other type, whereat their interconnection is, however, taken care of in a corresponding way.

In Figures 1 and 2, the brake devices 19 and 20 are also shown for each wheel set of the bogie 10, the brake devices being herein illustrated only fully schematically, because they do not constitute a part of the present invention.

As was stated above, in the bogie arrangement in accordance with the invention the bogies are coupled and fixed so that, when running in curves, the wheel sets of each bogie 10,10a are steered so that the wheel set axles 15,16,15a,16a are steered in curves fully radially. According to the invention, the steering of the wheel sets is arranged so that, in the bogie arrangement, two subsequent bogies 10,10a are interconnected by means of a connecting rod 40, as is shown in the figures in the drawing. The connecting rod 40 is linked with each bogie 10,10a by means of an articulated joint 41,41a, which connects the connecting rod 40 to the first part 11,11a of the bogie frame of each bogie 10,10a so that the articulated joint 41,41a between the connecting rod 40 and the first part 11,11a of the bogie frame is placed at the side of the connecting rod 40 in relation to the corresponding wheel-set axle 15,15a. The connecting rod 40 is, however, extended beyond the said articulated joint 41,41a to the other side of the wheel-set axle 15,15a, including an extension 42,42a of the connecting rod, which said extension 42,42a is linked by means of an articulated joint 44,44a with support rods 45,45a, which are, at their opposite end, linked with the second part 12,12a of the bogie frame by means of an articulated joint 46,46a.

When the lengths of the connecting rod 40 and of the extension 42,42a of the connecting rod as well as the distances between the articulation points 41,41a; 44,44a are chosen appropriately and when the support rods 45,45a are formed as of appropriate dimensions, when running in curves, the wheel sets of the bogies 10,10a turn so that their axle lines 15,16,15a,16a intersect each other at the centre point of the curve, as is illustrated in Fig. 5, wherein the bogie arrangement in accordance with the invention is shown schematically in a curve whose curve radius is R. As can be seen from the said Fig. 5, when running in a curve, the connecting rod 40 pivots relative the articulated joint 41 between the connecting rod and the first part 11 of the bogie frame so that the extension 42 of the connecting rod 40 and the articulated joint 44 placed at its end turn towards the outside curve and, by the intermediate of the support rods 45, turn the second part 12 of the bogie frame, which is connected to the first part 11 of the bogie frame by the intermediate of the articulated joint 21, relative the first part 11 of the bogie frame so that, with a correct dimensioning of the articulated joints and the rods, the axles 15 and 16 of the wheel sets in the bogie 10 become positioned fully correctly, i.e. fully radially in a curve. The axles 15a and 16a of the wheel sets in the bogie 10a turn in a corresponding way, because they are connected to the connecting rod 40 exactly in the same way as the bogie 10 placed at the opposite end of the rod 40.

The transfer of tractive force and braking forces between the rail vehicle and the bogies 10 and 10a is arranged, e.g., so that the connecting rod 40 is provided with a support member 43, from which the said forces are transferred to the frame of the rail vehicle by means of a separate linkage.

As was already stated in the description given above, the bogie arrangement in accordance with the invention and the bogies included in the bogie arrangement are characterized by the following specific features. Firstly, single-stage suspension of the bogies 10,10a, i.e. the circumstance that the bogies 10,10a are suspended directly on the frame of the rail vehicle without an intermediate frame and a secondary suspension. Secondly, the parts 11 and 12 of the bogie frame are interconnected fully "torsionally loosely", whereat this interconnection of the parts of the bogie frame together with the suspension connection described above permit the wheel sets in the bogies 10,10a to be steered fully freely in the way required by the curve radius and, e.g., by the curve bankings. Thirdly, the bogies

10,10a are interconnected by a connecting rod 40 so that the wheel sets in the bogies are arranged to be positioned in curves fully radially under positive control. The radial control operates in the way described above also when rigid axles are used, but the advantages of the invention are manifested most clearly when the wheels in each wheel set are arranged so as to revolve independently from each other.

Above, the invention has been described by way of example with reference to the figures in the accompanying drawing. This is, however, not supposed to confine the invention to the example shown in the figures only, but many variations are possible within the scope of the inventive idea defined in the following claims.

Claims

1. Bogie arrangement for railway vehicles, which said bogie arrangement comprises at least two bogies (10,10a) provided with wheels (13,14), said bogies consisting of two pivotable bogie frame parts (11,11a, 12,12a) that are linked together and said bogies (10, 10a) being coupled to each other mechanically and to the railway vehicle by means of the suspension (17,18), **characterized** in that the first part (11, 11a) and the second part (12,12a) of the bogie frame of each bogie (10,10a) are coupled to each other so that they can pivot both relative the longitudinal axis of the bogie and relative the vertical centre axis of the bogie, and that the bogie is suspended by means of a single-stage suspension (17,18) directly on the frame of the railway vehicle, each bogie (10,10a) included in the bogie arrangement being connected to the other bogie or bogies in the arrangement by means of positive steering so that the axles (15,16,15a,16a) of the wheel sets in each bogie (10,10a) are arranged to be steered in curves substantially radially irrespective of the curve radius (R).

2. Bogie arrangement as claimed in claim 1, **characterized** in that the bogies (10,10a) included in the bogie arrangement are interconnected by means of a connecting rod (40), which is linked to the first parts (11,11a) of the bogie frames directly and to the second parts (12,12a) of the bogie frames by the intermediate of a set of rods with articulated joints (44 to 46, 44a to 46a).

3. Bogie arrangement as claimed in claim 1 or 2, **characterized** in that the dimensional proportions and the geometry of the connecting rod (40) and of the articulated joints (41,44 and 41a,44a, respectively) between the connecting rod and the bogies (10 and 10a, respectively) connected to both of its ends have been chosen so that both bogies (10 and 10a, respectively) connected to the connecting rod (40) are steered substantially in the same way.

4. Bogie arrangement as claimed in any of the preceding claims, **characterized** in that the connecting rod (40) is provided with a support member (43), through which the traction and braking forces are arranged to be transferred from the bogie arrangement to the frame of the railway vehicle and the other way round, by the intermediate of a system of rods with articulated joints or equivalent.

5. A bogie included in the bogie arrangement as claimed in any of the preceding claims, **characterized** in that the first part (11) and the second part (12) of the bogie frame are connected to each other by means of an articulated joint (21) that can turn in all directions and that a stabilizer rod system (25) is provided additionally, which interconnects the first part (11) and the second part (12) of the bogie frame and which prevents turning of the said articulated joint (21) relative a transverse horizontal axis and permits its turning in the other directions.

6. Bogie as claimed in claim 5, **characterized** in that the suspension of the bogie is interconnected between both parts (11,12) at each side so that, when the parts (11,12) of the bogie frame are pivoted in relation to each other around the longitudinal centre axis, at each side of the bogie, part of the spring force is arranged to be passed from the spring (17 or 18) with higher load to the spring (18 or 17) with lower load.

7. Bogie as claimed in claim 5 or 6, **characterized** in that the springs (17,18) in the bogie are hydropneumatic springs, which are connected to each other by means of a hydraulic pipe system (31 or 32) or in a corresponding way.

8. Bogie as claimed in claim 6 or 7, **characterized** in that the springs (17,18) are fitted above the axles (15,16) of the wheel sets.

9. Bogie as claimed in any of the claims 5 to 8, **characterized** in that the stabilizer rod system (25) is supported on both parts (11,12) of the bogie frame resiliently in the longitudinal direction of the bogie (10).

10. Bogie as claimed in any of the claims 5 to 8, **characterized** in that the first part (11) and the second part (12) of the bogie frame are substantially identical and arranged in such a way that the bogie (10) is substantially symmetric in respect of the articulated joint (21).

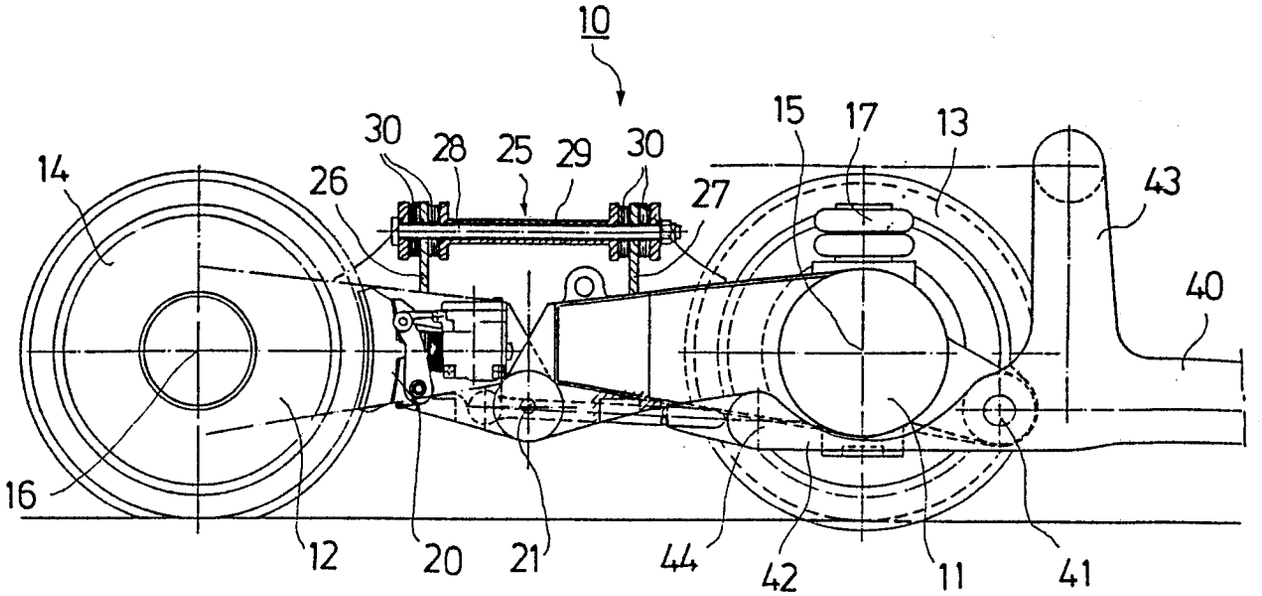
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FIG. 1

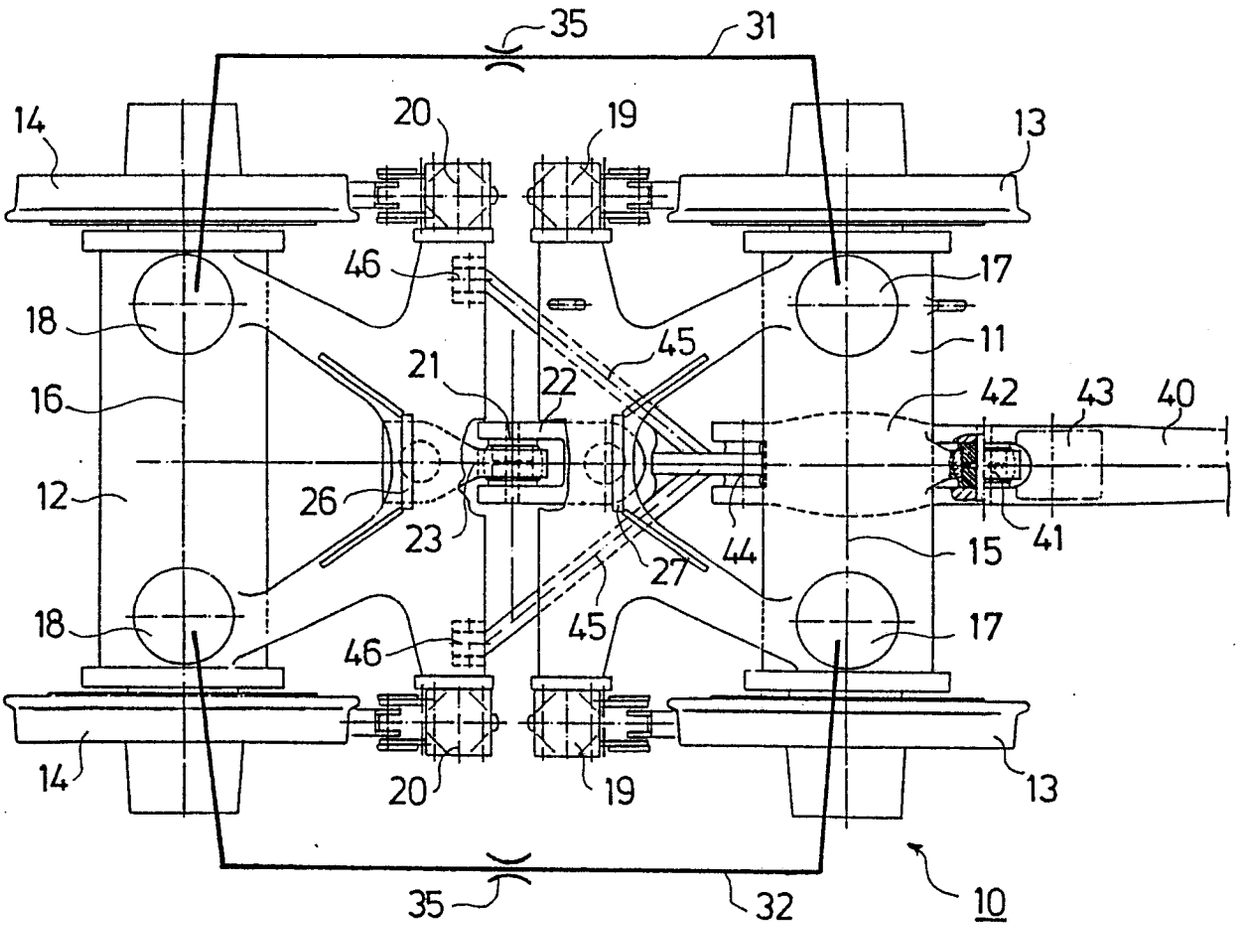
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FIG. 2

FIG. 3

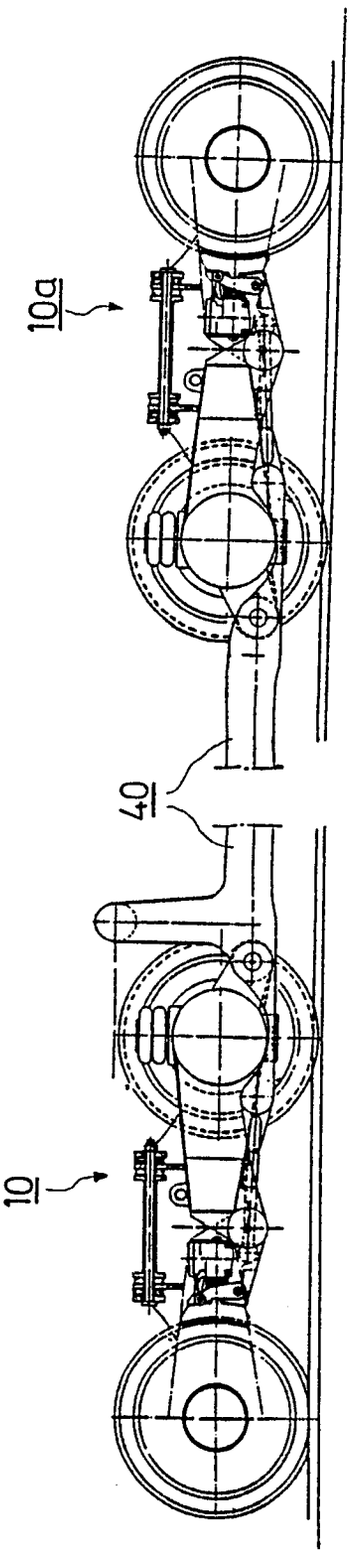
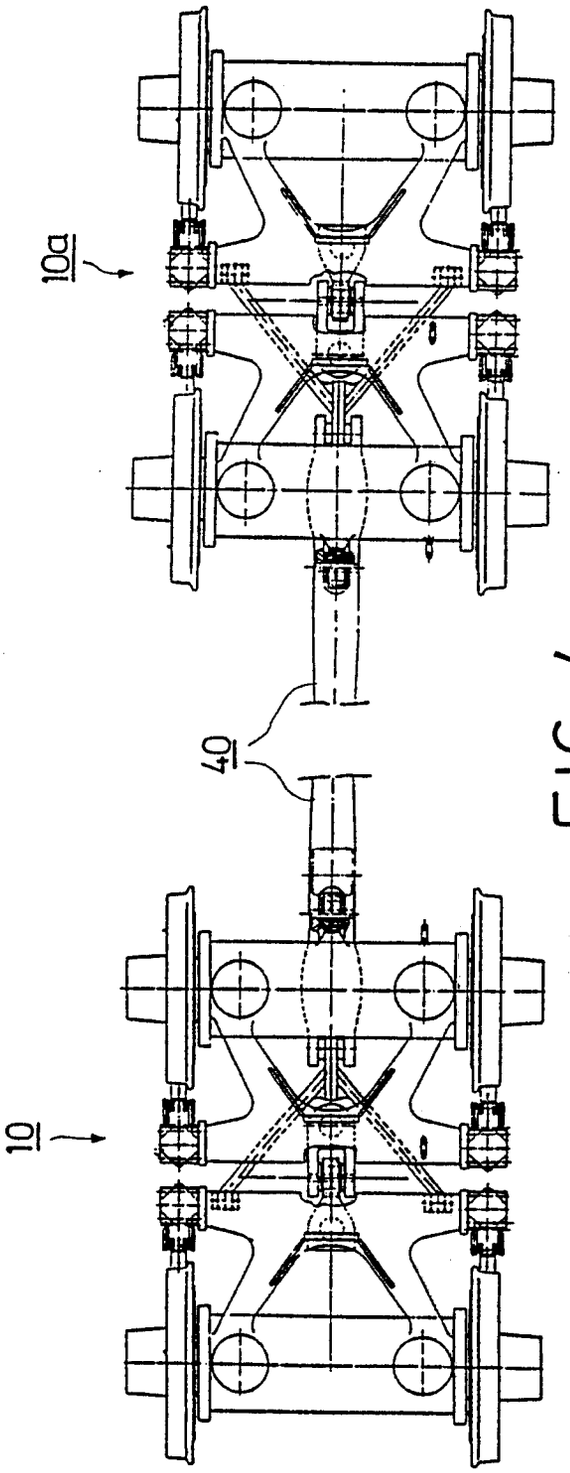


FIG. 4



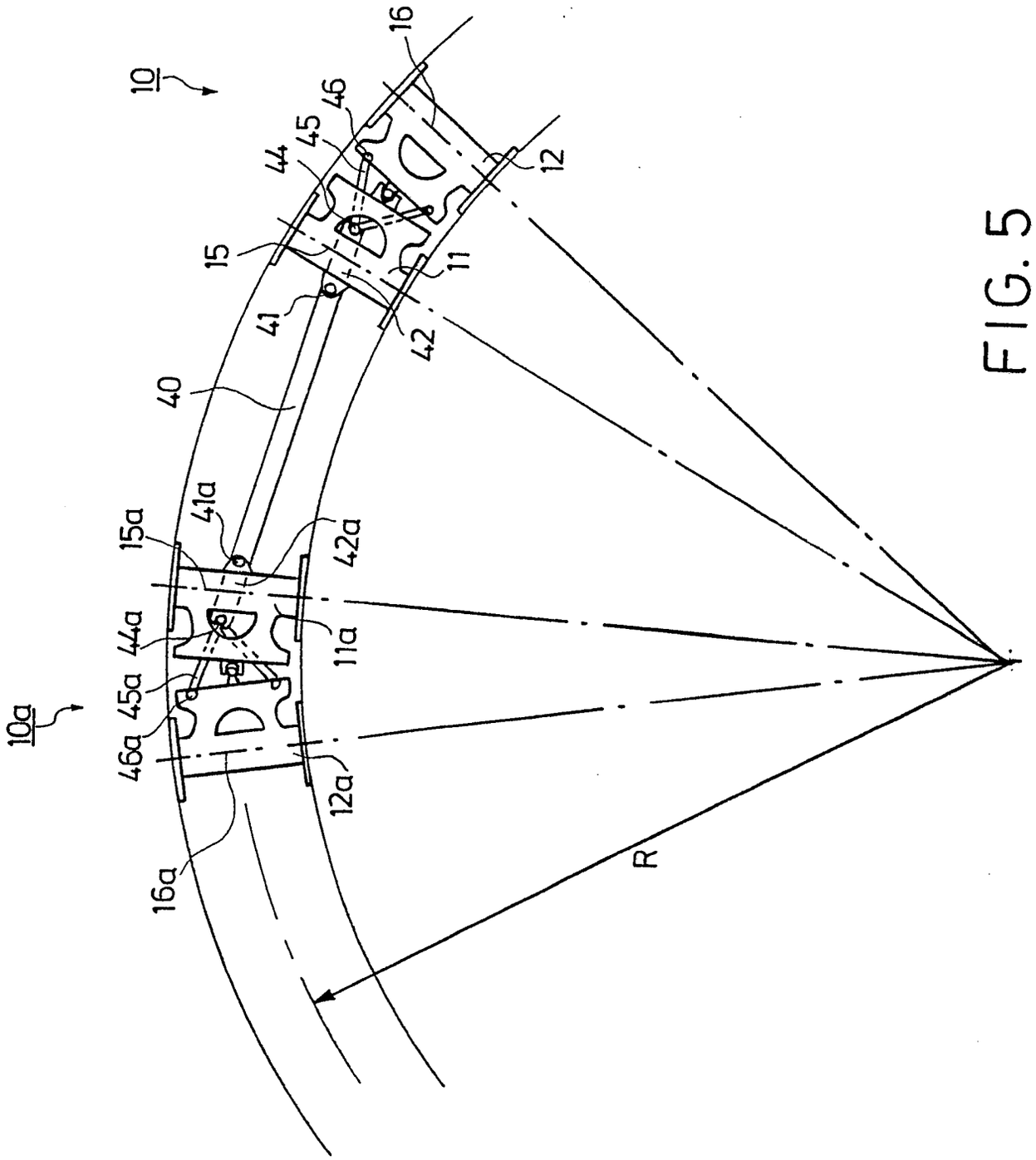

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FIG. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 85 0027

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	DE-B-1 291 352 (ATLAS-MAK MASCHINENBAU GmbH) * Figures 2-4,16,17; column 5, line 37 - column 6, line 23; column 9, lines 58-63 *	1	B 61 F 5/38
A		3,5,8, 10	
Y	US-A-4 235 451 (J.P.M. LERIVEREND) * Figures 1-3; column 2, lines 1-40 *	1	
A	US-A-3 911 830 (C.R. ADAMS) * Figures 1-4,11; column 3, line 46 - column 4, line 18; column 6, line 32 - column 7, line 9 *	1,2,6-8	TECHNICAL FIELDS SEARCHED (Int. Cl.4) B 61 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	02-05-1988	CHLOSTA P.

CATEGORY OF CITED DOCUMENTS

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