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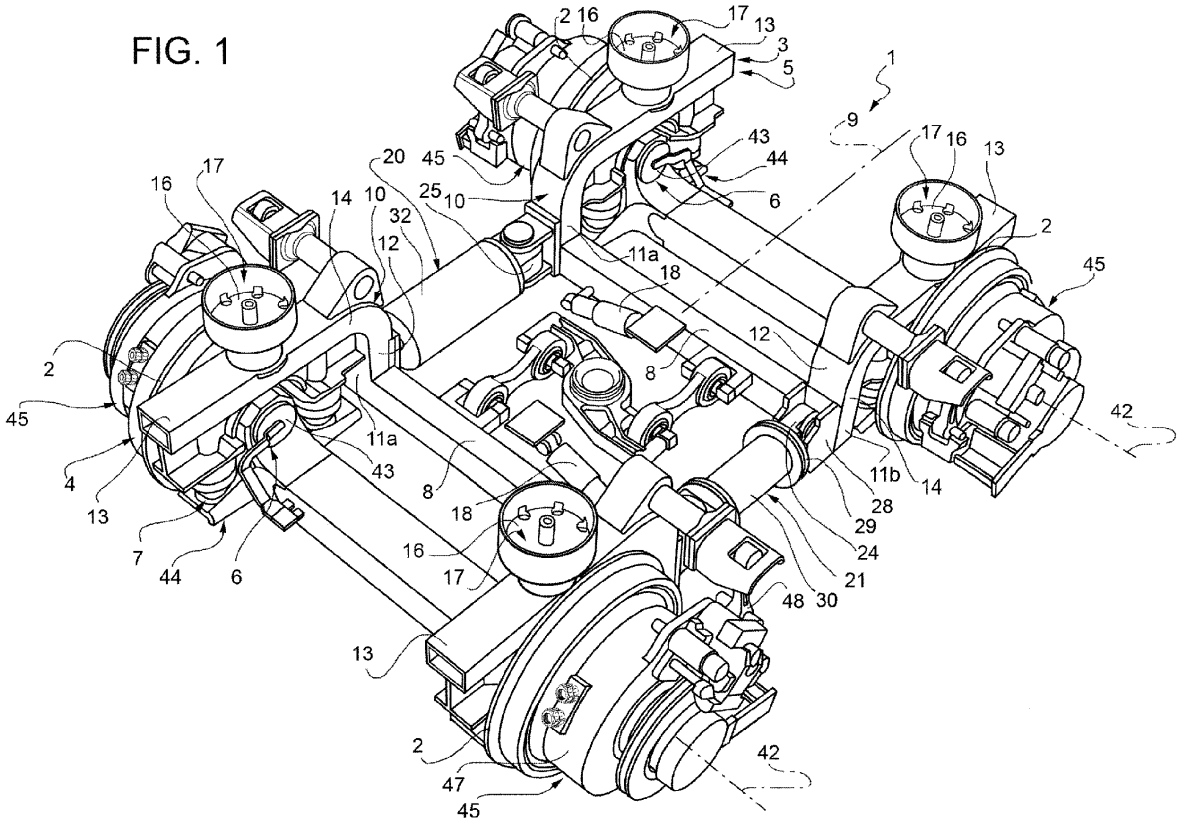
(54) **Steering bogie, particularly for a tram carriage**

(57) A steering bogie (1), particularly for a tram carriage, has a frame (3) comprising support means (16) for a secondary suspension adapted to couple the frame (3) to a bogie; the frame comprises two half-frames (4,5) coupled to respective axles (6) by way of a primary suspension (7); the frame (3) is provided with two side members (20,21) secured at the ends thereof to the half-frames (4,5) and having respective joints (24,25) that allow a relative rotation between said half-frames (4,5) about a vertical hinge axis (33); one of the side members (20) has variable length.

FIG. 1



EP 2 551 166 A1

Description

[0001] The present invention relates to a steering bogie, particularly for a tram carriage.

[0002] In the field of trains and trams, it is known to use steering bogies to reduce the wear on the wheels when the latter travel along curving rails. The steering can be set automatically by mechanical transmissions in response to the entering of the bogie into a curve, as in the Italian patent IT1224491 for example; or it can be set by way of actuators operated by active control electronic systems, which are provided with sensors adapted to detect the presence or the approach of a curve, as for example in U.S. patent US4982671 or in French patent FR2874883, which corresponds to the preamble of claim 1.

[0003] The solutions described in the prior art indicated above are rather unsatisfactory, as they are relatively complex and have a relatively large number of components.

[0004] Furthermore, the patent IT1224491 provides a single stage of suspension, which typically is unsatisfactory to ensure adequate comfort to passengers. With regard to the suspension, however, the solution described in the patent US4982671 comprises two stages, namely a primary suspension and a secondary suspension. In particular, this solution comprises two axles supported by respective structures, which are hinged to one another by way of a central joint and are coupled by way of the primary suspension to an upper frame. The upper frame, in turn, is coupled by way of the secondary suspension to the carriage.

[0005] The axles are steered with respect to the upper frame by one or more actuators. The primary suspension consists of two pairs of springs that, during steering, are deformed by the relative horizontal displacement between the upper frame and the structures that support the axles.

[0006] This solution is better in terms of comfort, but is not applicable to trams, which must travel along relatively small steering radii on city roadways. In fact, in general, the springs of the primary suspension do not have the ability to deform enough in the horizontal direction to ensure small curvature radii.

[0007] The aim of the present invention is to provide a steering bogie, particularly for a tram carriage, which allows to solve the problems outlined above in a simple and economic way.

[0008] According to the present invention a steering bogie is provided, particularly for a tram carriage, as defined by claim 1.

[0009] The invention will now be described with reference to the accompanying drawings, which illustrate a non-limiting embodiment, wherein:

- Figure 1 is a perspective view of a preferred embodiment of the steering bogie, particularly for a tram carriage, according to the present invention;
- Figure 2 is a plan view of the steering bogie of Figure 1;
- Figure 3 is a different perspective that shows, on an enlarged scale, a detail of Figure 1.

[0010] In figure 1, with 1 is indicated a bogie for a tram carriage (not shown).

[0011] The bogie 1 comprises four wheels 2 which travel along a pair of rails (not shown) defining a path comprising curves. The bogie 1 comprises an upper frame 3, in turn comprising two equal half-frames 4,5, a front one and a rear one. The half-frames 4,5 are coupled to the axles 6 of the wheels 2 through a primary suspension 7, and to the body of the carriage by way of a secondary suspension (not shown), and can lightly slant relative to one another, as will be better described below. The half-frames 4 and 5 comprise respective cross members 8, which are rectilinear, substantially horizontal, and orthogonal to a forward movement direction 9 coinciding with the path of the bogie 1. Each half-frame 4,5 comprises a pair of arms 10, which are arranged above the cross member 8 and comprise respective vertical portions 12, fixed to the ends 11a, 11b of the cross members 8. The arms 10 of each half-frame 4,5 end with respective horizontal portions 13, which are parallel to the forward movement direction 9, are connected to the corresponding portions 12 by way of intermediate curved portions 14, and extend cantilevered in the opposite direction to the portions 13 of the other half-frame 4,5. In this way, the half-frames 4 and 5 have, in plan, a U-shape.

[0012] The secondary suspension mentioned above comprises four springs (not shown), for example, four steel helical springs, whose lower ends are supported on respective support members 16 arranged on the portions 13 and fixed to the portions 13 themselves in a manner not shown. In particular, the support members 16 define respective upper seats 17 housing the lower ends of the springs of the secondary suspension.

[0013] The half-frames 4 and 5 are coupled to the body of the carriage also by way of respective dampers 18. The ends of the dampers 18 are defined by ball joints, inferiorly coupled, to the cross members 8 and above, to the carriage body.

[0014] The frame 3 also comprises a side member 20 fixed to the ends 11a, and a side member 21 fixed to the ends 11b. The side members 20,21 are of articulated type, in order to make the frame 3 articulated. In particular, the side member 21 comprises a spherical joint 23 and a vertical axis joint 24, which are arranged near the ends of the side member 21. The side member 20, instead, comprises only a ball joint 25, which is diametrically opposed to the joint 23, with respect to the center of the frame 3, and is aligned with the joint 24 in the horizontal direction orthogonal to the forward movement direction 9. Preferably, the joint 24 is made by the assemblage of two ball joints mutually vertically aligned. The two ball joints, which form the joint 25 are bound, on the one side, to a fork 28 fixed to the end 11b of the half-

frame 5 and, on the other side, to a flange 29 fixed to an intermediate portion 30 of the side member 21.

[0015] With reference to Figure 2, the pair of joints 23 and 25 define a hinge axis 31 inclined with respect to the forward movement direction 9: the half-frames 4,5 slant relative to one another about the axis 31 to help the primary suspension 7 to compensate for any momentary difference in height of a wheel 2 with respect to the others on the rails, i.e. to compensate for the so-called "uneven tracks".

[0016] At the same time, the side member 20 has a variable length, and together with the joints 24 and 25, renders the bogie 1 steerable. As "length" is intended the distance between the cross members 8 along a broken line defined by the axes of the components which form the side member and which are coupled one to the other in an articulated way. In particular, the side member 20 comprises an intermediate element 32 of variable length, which is fixed, on the one side, to the joint 25 and, on the other side, to the end 11a of the half-frame 4, while the portion 30 of the side member 21 has a fixed length.

[0017] The element 32 may be a passive element, that adapts its length automatically in response to the forces that are transmitted by the rails to the wheels 2 while curving. For example, the element 32 comprises a spring (not shown) and a damper (not shown), whose damping characteristic can be possibly varied by an external control system.

[0018] Alternatively, the element 32 may be an active element, namely an actuator of hydraulic, electrical or pneumatic type, which is activated by an electronic control unit (not shown) in response to signals originating from sensors mounted on the carriage (magnetic sensors, optical sensors, etc...) or by localization systems arranged outside the carriage (for example: GPS, underground lines, etc...) and indicating information relating to the curves of the track (start and end of the curve, curvature radius, etc ...).

[0019] Depending on the length of the element 32, the two half-frames 4,5 rotate with respect to each other about a vertical axis 33, which coincides with the axis of the joint 24, to perform a steering angle.

[0020] The frame 3 also comprises a Watt parallelogram 35, which connects together the cross members 8 of the half-frames 4,5. The Watt parallelogram 35 comprises two longitudinal connecting rods 36, substantially parallel to the forward movement direction 9, and a transverse lever 37 arranged substantially at the center of the bogie 1. The ends of the longitudinal rods 36 are coupled by way of ball joints to the arms 38 of the transverse lever 37, on one side, and to the cross members 8, on the other side. The transverse lever 37 comprises a central portion 39, which defines a connection point for hinging the bogie 1 at the body of the carriage about a vertical axis 40. In particular, the connection is defined by a vertical shaft (not shown) which engages the portion 39. In this way, the Watt parallelogram 35 transmits the forces along the forward movement direction 9 between the frame 3 and the carriage, leaving freedom of relative movement in the other directions.

[0021] Again with reference to Figure 1, the four wheels 2 are coupled by way of bearings to the two axles 6, so as to rotate about respective axes 42. Each axle 6 is constituted by two spindles, i.e. by two distinct coaxial shafts 43, fixed to a relative structure 44. In the preferred embodiment illustrated, the wheels 2 are motorized and form part of respective motor-wheel groups 45, without mechanical transmissions. In particular, the configuration of the motor-wheel groups 45 and the mounting thereof on the shafts 43 are similar to what is shown in the international patent application WO2008015282A1 (on behalf of the same applicant), which is herein fully incorporated for completeness of description. In particular, the casing 47 and the stator of the electric motor are connected to the corresponding arm 10 by way of a connecting rod 48 substantially vertical, which transmits the reaction of the electric motor to the corresponding half-frame 4,5. The ends of the connecting rod 48 define respective hinges provided with damping elements of silent-block type, whereby the casing 47 of the motor can slightly oscillate about the axis 42.

[0022] With reference to Figure 3, each structure 44 comprises a beam 50, generally referred to as "false axle", parallel to axis 42, and fixed at the ends thereof to two supporting bodies 52 having respective holes 53 engaged by the shafts 43.

[0023] Each body 52 comprises a pair of plates 54, which project in opposite directions and support the lower ends of respective elastic elements 55. The elastic elements 55 define the primary suspension 7 and are made, preferably, of elastomeric material. For each wheel 2, the two elastic elements 55 are arranged on opposite sides of the shaft 43 and are fixed, at their upper ends, to a bracket 56, in turn fixed below the portion 13.

[0024] From the above it is evident that it is possible to tilt the axles 6 with respect to each other about a vertical axis for steering the bogie 1. In fact, as explained above, the element 32 can lengthen and shorten compared to a configuration in which the axles 6 are parallel, so as to vary the length of the side member 20, while the length of the side member 21 remains constant. When the side member 20 lengthens or shortens, the side members 20,21 bend about respective vertical axes defined by the joints 24 and 25.

[0025] During the relative rotation about the axis 33, there is a relative horizontal movement between at least one of the half-frames 4,5 and the body of the carriage: said relative movement causes a deformation of the springs of the secondary suspension in horizontal direction. At the same time, as mentioned above, the Watt parallelogram 35 transmits the forces along the forward movement direction 9 independently to said relative movement and to all possible changes in shape of the frame 3 along the line. The elastic elements 55 of the primary suspension 7, instead, do not undergo deformation in the horizontal direction, as there is no relative

movement between the half-frames 4,5 and axles 6.

[0026] The articulated joint 24 allows only a rotation about a vertical axis, i.e. the axis 33, without leaving freedom of rotation about other directions: thanks to this feature, the frame 3 has a degree of constraint that maintains substantially horizontal the side members 20 and 21.

[0027] It is evident then that the bogie 1 is extremely simple compared to other solutions of the prior art, as it has a relatively small number of components. At the same time, the bogie 1 provides two stages of suspension, i.e. the primary suspension 7 defined by the elastic elements 55, and the secondary suspension defined by the springs (not shown) resting on the support members 16.

[0028] At the same time, the bogie 1 can also be used along lines having curves with a relatively small curvature radius, since the springs currently in commerce for the secondary suspension are able to deform in the horizontal direction to compensate for a relative movement relatively high between the carriage body and the half-frames 4,5.

[0029] From the above it is, finally, clear that the bogie 1 described can be subject to modifications and variants which do not depart from the scope of protection of the present invention, as defined in the appended claims.

[0030] In particular, the joints 23 and 24 could be part of the side member 20, and the joint 25 be part of the side member 21; or the joint 23 could be absent, and the joint 25 be optionally substituted by one vertical axis joint, although in this case the frame 3 does not assist the suspensions to compensate for the "uneven tracks".

[0031] Furthermore, the axles 6 could be free of motors; and/or the wheels 2 could be arranged within the half-frames 4,5 (without the beams 50); and/or each axle 6 could be defined by a single shaft.

[0032] Finally, the half-frames 4,5 may have a shape different from that indicated by way of example.

Claims

1. A steering bogie (1), particularly for a tram carriage, comprising:

   - a frame (3) comprising support means (16) for a secondary suspension adapted to couple said frame to a bogie;
   - two axles (6), each supporting two wheels (2) rotatable about an rotation axis (42);
   - a primary suspension (7) which couples said axles (6) to said frame (3);

   said frame (3) comprising:

   - two half-frames (4,5) respectively coupled to said axles (6) ;
   - a first and a second side member (20,21) secured at the ends thereof to said half-frames (4,5) and comprising joint means (24,25) defining a vertical rotation axis (33) to allow said half-frames (4,5) to rotate with respect to each other about said vertical rotation axis (33);

   characterized in that said first side member (20) has a variable length and said second side member (21) has a constant length.

2. The bogie according to claim 1, **characterized in that** said first side member (20) comprises a variable length element (32) comprising a spring and a damper.

3. The bogie according to claim 1, **characterized in that** said first side member (20) comprises a variable length element (32) comprising an actuator.

4. The bogie according to any one of the preceding claims, **characterized in that** said joint means comprise a first and a second joint (24,25) which are respectively part of said first and second side member and are aligned one to the other along a direction orthogonal to a forward movement direction (9) of the bogie (1).

5. The bogie according to claim 4, **characterized in that** one of said first and second joint is defined by a joint having only a vertical rotation axis (24), and the other of said first and second joint is defined by a ball joint (25).

6. The bogie according to claim 5, **characterized in that** said joint means comprise a further ball joint (23), which is part of the same side member of the joint having only a vertical rotation axis (24).

7. The bogie according to claim 6, **characterized in that** said ball joint (25) and said further ball joint (23) are arranged in diametrically opposite positions with respect to the center of the bogie (1).

8. The bogie according to any one of the preceding claims, **characterized by** comprising a Watt parallelogram (35), which connects said half-frames (4,5) and comprises two longitudinal connecting rods (36) and one transverse lever (37); said transverse lever (37) being arranged substantially at the center of the bogie (1) and having coupling means (39) to be hinged to said carriage about a vertical axis.

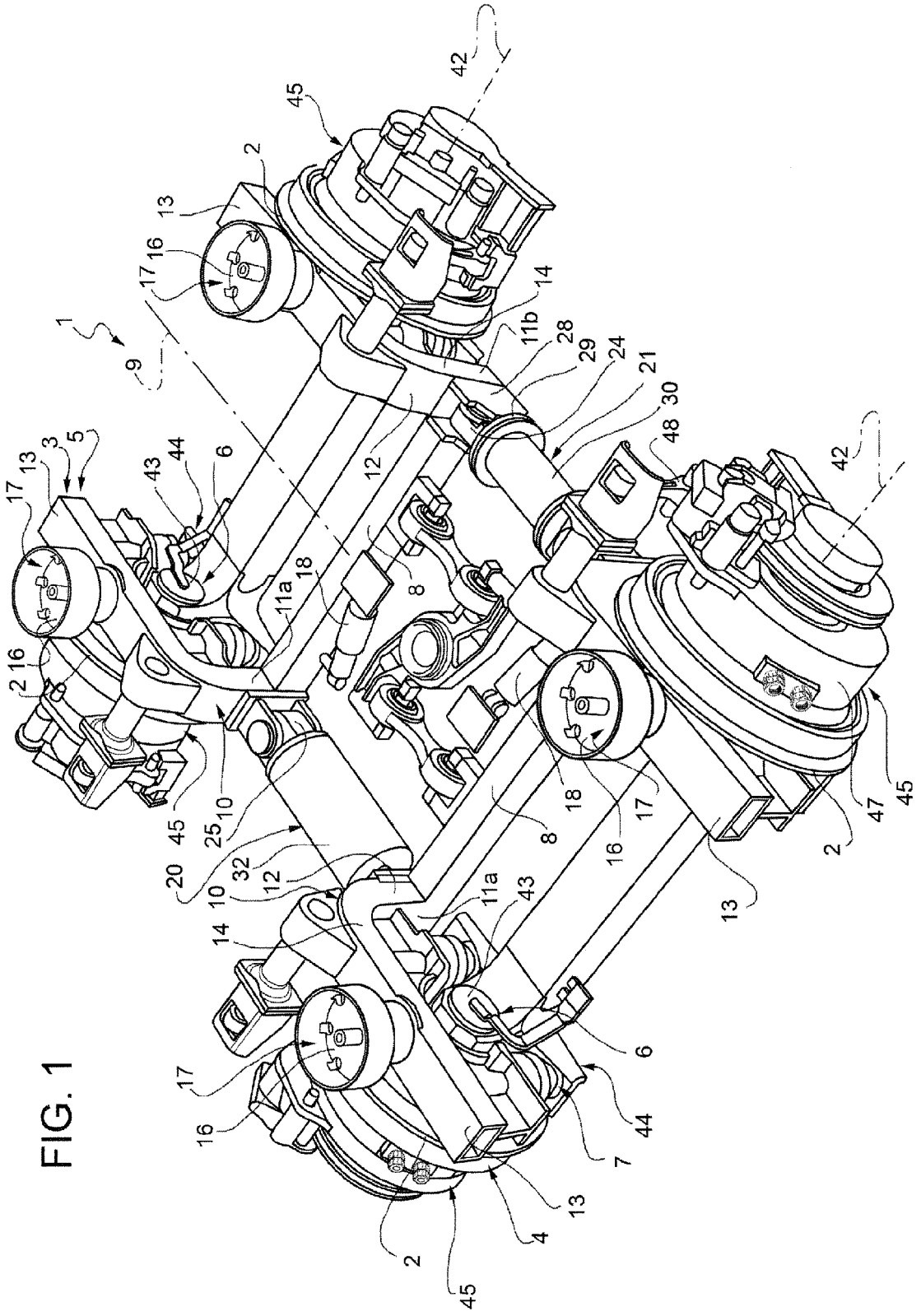

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FIG. 1

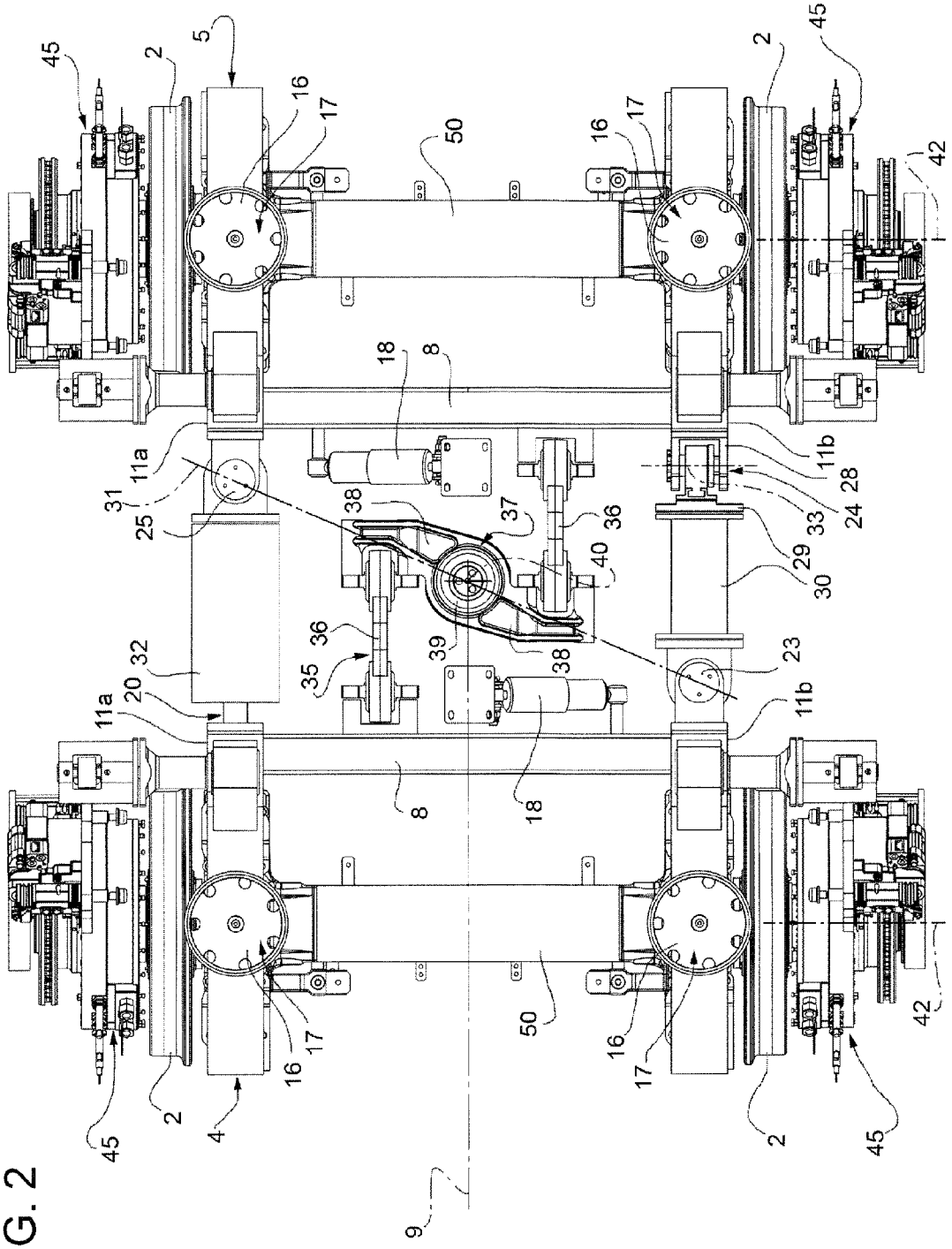
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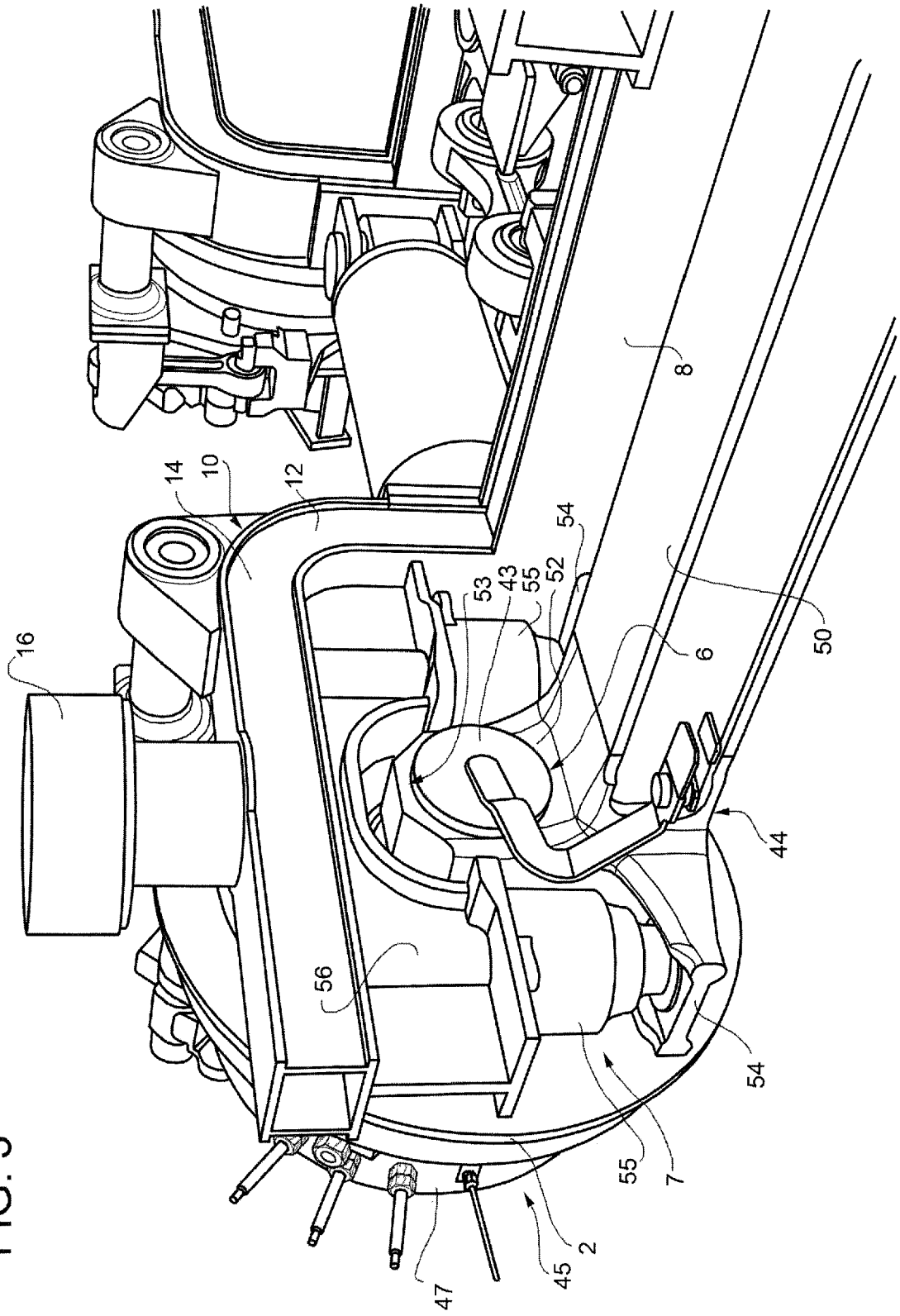
FIG. 2

FIG. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 12 17 7914

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	FR 2 874 883 A1 (GUILLEMAUT HENRI [FR]) 10 March 2006 (2006-03-10) * page 3, line 22 - page 4, line 35 * * page 5, line 34 - page 6, line 21; figures 1-5 *	1,3,4	INV. B61F3/08 B61F5/38 B61F5/52
A	US 983 478 A (CLARK ALBERT M [US]) 7 February 1911 (1911-02-07) * page 1, line 68 - line 89 * * page 2, line 61 - page 3, line 9; figures 1-5 *	1	
A	DE 31 19 163 A1 (MASCHF AUGSBURG NUERNBERG AG [DE]) 2 December 1982 (1982-12-02) * page 7, paragraph 2 - page 8, paragraph 3; figure 3 *	1	

TECHNICAL FIELDS SEARCHED (IPC)

B61F
B61D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	1 November 2012	Chlosta, Peter

CATEGORY OF CITED DOCUMENTS

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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- US 4982671 A **[0002] [0004]**
- FR 2874883 **[0002]**
- WO 2008015282 A1 **[0021]**