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(54) MOTOR ASSEMBLY FOR A RAILWAY AXLE HAVING A CONTINUOUS VARIATION WITH AN ENERGY RECOVERY, AND RAILWAY WAGON

(57) The present invention refers to a motor assembly for a railway axle (1) comprising: one axle (2) exhibiting at least one driving wheel (2a) and configured for rotating around an axis (A), a main wheel (3) fitted to the axle (2), a first actuating wheel (4) constrained to the axle (2) and configured for rotating with respect to this latter around the axis (A) and actuatable by a first motor (8), a connecting wheel (5) fixed to the first actuating wheel (4) and configured for cooperating with the main wheel (3) for enabling the axle (2) to rotate around the axis (A), a second actuating wheel (6) constrained to the axle (2) and configured for rotating with respect to this latter around the axis (A) and actuatable by a second motor (9), a coupling portion (7) fixed and integral with the second actuating wheel (6) - placed at least partially around the connecting wheel (5) - and which exhibits an inner coupling surface (7a) engaged with the connecting wheel so that this latter is interposed between the main wheel (3) and said inner coupling surface (7a). Moreover, the present invention refers to a railway wagon.

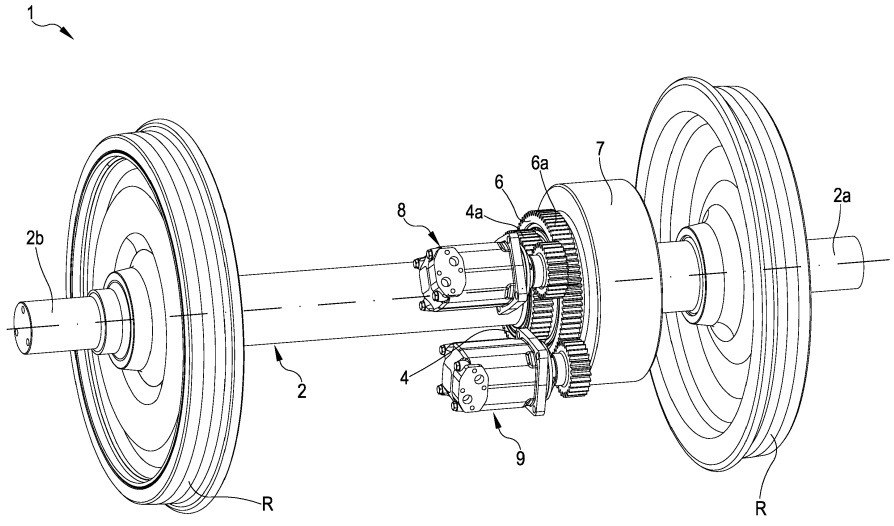

FIG.1

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Description

FIELD OF THE INVENTION

[0001] The object of the present invention is a motor assembly for a railway axle advantageously useable in the field of the railway vehicles, and a respective railway wagon using said motor assembly.

STATE OF THE ART

[0002] Nowadays, there are known machines or vehicles delivering high values of power - such as for example railway wagons and operative machines - which use an endothermic traction wherein, between the endothermic motor and the driven shaft connected to the wheels, there is a geared transmission. The purpose of the transmission is to provide a reduction ratio between the number of rounds of the motor and the number of rounds of the driven shaft for causing the motor to function at an operative state which is as nearest as possible to the optimal operative one independently from the speed of the machine itself. This is due to the fact that the more the number of rounds of the motor differs from the optimal one, the more will decrease the thermodynamic efficiency of the endothermic motor.

[0003] The known transmissions are adapted to generate a predetermined number of reduction ratios, tied to corresponding combinations of geared wheels present in the transmission itself. Such type of transmission requires to reciprocally engage the geared wheels which - in order to be capable to be engaged and disengaged from each other - require to be temporarily disconnected from the normal flow of the mechanical power in order to prevent the wheels themselves from being hit and irreversibly damaged. For this reason, mechanical clutches are used which, however, disadvantageously dissipate part of the power transmitted by them under the engagement and disengagement transient conditions. Moreover, the mechanical clutches are characterized by a performance which gets lower as the transmitted powers get higher, so that they are not very suited for machines and vehicles with high values of the delivered power. It is noted that - referring again to applications in which the exchanged power is high as in the railway field - the mechanical clutches exhibit a short life and an insufficient reliability.

[0004] Moreover, it is observed that the geared transmissions are often commanded by a manual actuation, through known "speed gearboxes". If such manual actuation is not cleverly performed, the machine would be caused to operate in a suboptimal operative state, in other words in a too low or too high state, and therefore the overall efficiency of the machine will be reduced.

[0005] Moreover, it is known to use semi-hydrostatic type transmissions, wherein the endothermic motor is mechanically connected, by a reduction group, to a driven shaft, which is, for example, connected to driving wheels. The reduction group has a transmission ratio which can be continuously changed along a portion of the operative range of the machine, in other words a portion of the overall speed range of the machine itself. The transmission ratio is changed by a hydrostatic actuation which acts on the reduction group. Disadvantageously, such semi-hydrostatic type transmission requires anyway to use a mechanical engagement geared transmission, generally mounted downstream the reduction group, at least for switching between a "low gear", typical of an operation under heavy loads and at low speeds, and a "high gear", typical of an operation without loads or with light loads and at high speeds. This is caused by the limited flexibility of the endothermic motor, which is directly and mechanically connected to the reduction group and which, since is a Diesel motor, has a very limited optimal range of the operative conditions. Without the engagement geared transmission, the performance of the machine would be jeopardized, particularly the speed would be limited and the supplied power would not be optimized. Moreover, the cited switching between the low gear and high gear would require to adopt a mechanical clutch which would cause the above described disadvantages. In the same way, if the vehicle is switched when is still, e.g., for inserting the high gear, the vehicle breakaway performance would be substantially jeopardized, because the vehicle, since must stop for engaging the high gear, would be compelled to start to move from still with a more disadvantageous transmission ratio, since this latter is associated to an use optimal at high speeds but which is certainly unsuited for starting from still, particularly under high loads. Moreover, the known semi-hydrostatic transmissions exhibit another disadvantage which consists of requiring complicated constructive arrangements for reversing the motion direction, particularly tied to the necessity of providing complicated reversing members adapted to reverse the rotation direction of the driven shaft.

[0006] A further solution is described in the patent application EP1988309A2 which refers to a transmission system for endothermic traction machines. The system comprises a first and second hydraulic motors connectable by respective pumps to an endothermic motor; each motor is mechanically connected to a reduction group which is connected - oppositely to the hydraulic motors - to a driven shaft. The driven shaft is connected to a motion transmission shaft provided with a pair of driving wheels of the machine. The reduction group is distanced and distinct from the motion transmission shaft by the driven shaft which is interposed between the reduction group and the transmission shaft.

[0007] The reduction group is configured for continuously changing, along an overall operative range of the machine, the transmission ratio between the number of rounds of the endothermic motor and the number of rounds of said driving wheels. Moreover, the system comprises adjusting means acting on the reduction group for continuously changing the transmission ratio in the

overall operative range of the traction machine.

[0008] This latter solution, in comparison with the above described state of the art, enables to continuously switch between the low gear and high gear without mechanical clutches and without stopping the vehicle. While the solution described in the patent application EP1988309A2 is better than the previous state of the art, the Applicant has found that also this latter approach is not devoid of limitations and disadvantages. De facto, the transmission system described in the application EP1988309A2 exhibits a cumbersome and complicated structure which makes complex the steps of installing, servicing and possibly substituting the same. Moreover, it is observed that the complicated structure substantially impacts on the overall mechanical efficiency of the transmission so that the mechanical power transferrable from the endothermic motor to the driving wheels is reduced.

OBJECT OF THE INVENTION

[0009] Therefore, it is an object of the present invention to substantially solve at least one of the inconveniences and/or limitations of the previous solutions.

[0010] A first object of the present invention consists of providing a motor assembly for a railway axle for railway wagons, which exhibits a high overall efficiency and at the same exhibits a high reliability.

[0011] Moreover, it is an object of the present invention to provide a motor assembly for railway wagons which is structurally simple and economical; particularly, it is an object of the invention to provide a motor assembly exhibiting a reduced size which can make easier to install and possibly service the motor assembly itself.

[0012] Then, it is an object of the present invention to provide a motor assembly for railway wagons which exhibits a high operative flexibility, particularly when is used in a wide range of operative speeds; particularly, it is an object of the invention to provide a motor assembly which is capable of substantially autonomously causing the motor - for example of the railway wagon - to operate at a state and under a load proximate to the optimal values.

[0013] These objects and others, which will be better shown in the following description, are substantially met by a motor assembly for a railway axle and by a respective railway wagon according to what is disclosed in one or more of the attached claims and/or in the following aspects, considered alone or in any combination with each other or in a combination with anyone of the attached claims and/or in a combination with anyone of the further aspects or characteristics described in the following.

SUMMARY

[0014] Aspects of the invention are described in the following.

[0015] In a 1st aspect, it is provided a motor assembly for a railway axle (1) comprising:

- at least one axle (2) comprising at least one driving wheel (2a), said axle (2) with said driving wheel being configured for rotating around an axis (A),
- at least one main wheel (3) fitted to the axle (2) and adapted to rotate together with this latter around the same axis (A),
- at least one first actuating wheel (4) constrained to the axle (2) and configured for rotating with respect to this latter around the axis (A), said first actuating wheel (4) exhibiting an outer coupling surface (4a) actuatable by a first motor (8) configured for putting in rotation said first actuating wheel (4),
- at least one connecting wheel (5) fixed to the first actuating wheel (4) and configured for cooperating with the main wheel (3) for enabling the axle (2) to rotate around the axis (A), said connecting wheel (5) being configured for rotating at least around the main wheel (4),
- at least one second actuating wheel (6) - distinct from the first actuating wheel (4) - constrained to the axle (2) and configured for rotating with respect to this latter around the axis (A), the second actuating wheel (6) exhibiting an outer coupling surface (6a) actuatable by a second motor (9) configured for putting in rotation said second actuating wheel (6),
- at least one coupling portion (7) fixed and integral with the second actuating wheel (6) - placed at least partially around the connecting wheel (5) - and which exhibits an inner coupling surface (7a) engaged with the connecting wheel so that this latter is interposed between the main wheel (3) and said inner coupling surface (7a).

[0016] In a 2nd aspect according to the aspect 1, the first actuating wheel (4) is constrained to the axle (2) by means of at least one radial bearing.

[0017] In a 3rd aspect according to anyone of the preceding aspects, the second actuating wheel (6) is rotatively movable with respect to the main wheel (3) and to the first actuating wheel (4).

[0018] In a 4th aspect according to anyone of the preceding aspects, the second actuating wheel (6) is constrained to the axle (2) by means of at least one radial bearing.

[0019] In a 5th aspect according to anyone of the preceding aspects, the motor assembly (1) comprises at least one connecting element (10) fixed to the first actuating wheel (4) and fixed to the connecting wheel (5), the connecting element (10) being interposed and connecting the first actuating wheel (4) to the connecting wheel (5), the connecting element (10) comprising an abutment portion (10a) comprising an outer surface (10b) having a circular cross-section around which the second actuating wheel (6) is engaged.

[0020] In a 6th aspect according to the preceding aspect, the second actuating wheel (6) is constrained to the axle (2) by interposing the connecting element (10).

[0021] In a 7th aspect according to the aspect 5 or 6,

the second actuating wheel (6) is constrained to the connecting element by means of at least one radial bearing acting, on a side, on the outer surface (10b) of the abutment portion and, on the other side, on an inner reciprocal coupling surface (6b) of the second actuating wheel (6).

[0022] In an 8th aspect according to anyone of the preceding aspects, the first actuating wheel (4) - according to a view directed along the axis (A) - is concentric with the second actuating wheel (6), particularly wherein the first and second actuating wheels rotate around the same axis (A) of the axle (2).

[0023] In a 9th aspect according to anyone of the preceding aspects, the first and second actuating wheels (4, 6) are distanced from each other along the axis (A).

[0024] In a 10th aspect according to anyone of the preceding aspects, the first and second actuating wheels (4, 6) - according to a view directed along the axis (A) - are disposed concentrically with respect to the main wheel (3).

[0025] In an 11th aspect according to anyone of the preceding aspects, the first and second actuating wheels (4, 6) are axially distanced from said main wheel (3).

[0026] In a 12th aspect according to anyone of the preceding aspects, the connecting wheel (5) exhibits a center distanced from the axis (A), particularly the connecting wheel (5) being offset from the axle (2).

[0027] In a 13th aspect according to anyone of the preceding aspects, the connecting wheel (5) is directly constrained, on one side, to the main wheel (3) and, on the other side, to the inner coupling surface (7a) of the coupling portion (7), particularly wherein said inner coupling surface (7a) being connected to the main wheel (3) only by interposing the connecting wheel (5).

[0028] In a 14th aspect according to anyone of the preceding aspect, the first actuating wheel (4) comprises at least one selected in the group of: a geared wheel, a friction gear.

[0029] In a 15th aspect according to anyone of the preceding aspects, the second actuating wheel (6) comprises at least one selected in the group of: a geared wheel, a friction gear.

[0030] In a 16th aspect according to anyone of the preceding aspects, the main wheel (3) comprises at least one selected in the group of: a geared wheel, a friction wheel.

[0031] In a 17th aspect according to anyone of the preceding aspects, the connecting wheel (5) comprises at least one selected in the group of: a geared wheel, a friction wheel.

[0032] In an 18th aspect according to anyone of the preceding aspects, the inner coupling surface (7a) defines an inner geared wheel.

[0033] In a 19th aspect according to anyone of the preceding aspects, the main wheel (3), connecting wheel (5) comprise respectively a geared wheel, for example one with straight teeth, the geared wheel of the main wheel (3) exhibiting a rotation axis parallel to an axis of the connecting wheel (5), the geared wheel of the connecting wheel (5) being active and operating in contact with an inner geared wheel defined by the inner coupling surface (7a), the geared wheel of the connecting wheel (5) exhibiting a rotation axis parallel to a rotation axis of the inner geared wheel, for example one with straight teeth, defined by the inner coupling surface (7a).

[0034] In a 20th aspect according to anyone of the preceding aspects, the motor assembly comprises at least one first motor (8) exhibiting a transmission shaft (8a) to which a transmission wheel (8b) is fitted, configured for putting in rotation - by an action of the first motor (8) - the first actuating wheel (4).

[0035] In a 21st aspect according to the preceding aspect, the transmission wheel (8b), fitted to the shaft of the first motor (8), comprises a geared wheel for example one with straight teeth, optionally the geared wheel of the transmission wheel fitted to the shaft of the first motor (8) directly contacts and is directly active on the first actuating wheel (4), particularly the geared wheel of the transmission wheel fitted to the shaft of the first motor (8) exhibits a rotation axis parallel to the rotation axis of the first actuating wheel (4).

[0036] In a 22nd aspect according to the aspect 20 or 21, the first motor comprises an electric motor.

[0037] In a 23rd aspect according to anyone of the preceding aspects, the motor assembly (1) comprises at least one second motor (9) exhibiting a transmission shaft (9a) on which is fitted a transmission wheel (9b) configured for putting in rotation - by an action of the second motor (9) - the second actuating wheel (6).

[0038] In a 24th aspect according to the preceding aspect, the transmission wheel (9b), fitted to the shaft of the second motor (9), comprises a geared wheel, for example one with straight teeth, optionally wherein the geared wheel of the transmission wheel fitted to the shaft of the second motor (9) directly contacts and is directly active on the second actuating wheel (6), particularly wherein the geared wheel of the transmission wheel fitted to the shaft of the second motor (9) exhibits a rotation axis parallel to the rotation axis of the second actuating wheel (6).

[0039] In a 25th aspect according to the aspect 23 or 24, the second motor comprises an electric motor.

[0040] In a 26th aspect according to the aspect 23 or 24, the second motor comprises a hydraulic motor supplied by an endothermic motor, for example a Diesel motor.

[0041] In a 27th aspect according to anyone of the preceding aspects, the motor assembly (1) comprising a plurality of connecting wheels (5) active on and directly contacting the main wheel (3), particularly interposed between the main wheel (3) and the inner coupling surface (7a) of the coupling portion (7).

[0042] In a 28th aspect according to the preceding aspect, the motor assembly (1) comprises a number of connecting wheels (5) equal to or greater than 2, particularly comprised between 2 and 6, still more particularly equal to or comprised between 3 and 5.

[0043] In a 29th aspect according to the aspect 27 or 28, the connecting wheels are equidistant from each other.

[0044] In a 30th aspect according to anyone of the aspects from 27 to 29, each connecting wheel (5) comprises a straight geared wheel identical to each other by shape and size.

[0045] In a 31st aspect according to anyone of the aspects from 27 to 30, the connecting wheels (5) exhibit parallel symmetry axes, particularly parallel to a symmetry axis of the main wheel (3).

[0046] In a 32nd aspect according to anyone of the aspects from 23 to 31, the motor assembly comprises at least one battery or an electric generator (11) connected to the first and second electric motors and configured for supplying these latter.

[0047] In a 33rd aspect according to anyone of the preceding aspects, the axle (2) - respectively at a first and second longitudinal end portions opposite to each other - comprises at least one first and one second driving wheels (2a, 2b), said axle (2) - together with said first and second driving wheels - being configured for rotating around an axis (A).

[0048] In a 34th aspect, it is provided a railway wagon (100) comprising:

- at least one motor assembly for a railway axle (1) according to anyone of the preceding aspects, the driving wheel of the motor assembly (1) being configured for abutting on at least one railway rail,
- at least one frame (101) engaged with the motor assembly (1) for a railway axle, adapted to define the load and support structure of the railway wagon.

[0049] In a 35th aspect according to the preceding aspect, the railway wagon comprises at least two motor assemblies (1) for a railway axle, constrained to the frame and distanced one with respect to the other from the same frame (101) along a longitudinal development direction of the railway wagon (100).

[0050] In a 36th aspect according to the preceding aspect, the motor assemblies for a railway axle are connected to each other from the frame (101), the frame (101) being configured for holding the group assemblies (1) at a predetermined and fixed distance from each other when the railway wagon slides on the rail, particularly on tracks.

BRIEF DESCRIPTION OF THE DRAWINGS

[0051] Some embodiments and some aspects of the invention will be described in the following with reference to the attached drawings, given only in an indicative and therefore non-limiting way, wherein:

- Figure 1 is a perspective view of a motor assembly for a railway axle according to the present invention;
- Figure 2 is a perspective detailed view of the motor assembly for a railway axle according to the present invention;
- Figure 3 is a longitudinal cross-section detailed view of the motor assembly for a railway axle according to the present invention;
- Figure 4 is an exploded schematic view of components of the motor assembly for a railway axle according to the present invention;
- Figures from 5 to 7 are respective outlines of different embodiments of motor assemblies for a railway axle according to the present invention;
- Figure 8 is a perspective view of a railway wagon comprising at least one motor assembly for a railway axle according to the present invention.

DEFINITIONS AND CONVENTIONS

[0052] It is observed that in the present detailed description, corresponding parts illustrated in the several figures are indicated by the same numeral references. The figures could therefore illustrate the object of the invention by means of not-in-scale representations; therefore, parts and components illustrated in the figures regarding the object of the invention could refer only to schematic representations.

[0053] The term hydraulic-type actuation means an actuation which translates a mechanical action, for example generatable by an endothermic motor, in a pressure value associable to a working fluid.

[0054] The term working fluid means any fluid adapted to transmit high pressures, typically the ones used in power actuations such as the actuations in the traction field. Preferably, such working fluid is oil.

DETAILED DESCRIPTION

Motor assembly for a railway axle

[0055] 1 generally indicates a motor assembly for a railway axle advantageously useable in the field of railway wagons. The attached figures schematically show - in a non-limiting way - an embodiment of the motor assembly 1 associated to an axle 2 of a railway wagon 100 (see Figure 8, for example).

[0056] As it is visible in Figure 1, the motor assembly 1 comprises an axle 2 extending along a development direction between a first and second longitudinal end portions 2a, 2b at which, the axle 2 respectively stably supports, in a non-limiting way, a first and second driving wheels (these elements are indicated by reference R in Figure 1). The axle 2 and driving wheels are configured for rotating around an axis A (Figure 1); the axle and driving wheels exhibit a circular cross-section and are located concentrically with each other: the axle and driving wheels exhibit a common symmetry axis which coincides with the axis A. In an embodiment variant not illustrated in the attached figures, the axle 2 can comprise also one driving wheel: such embodiment variant is

adapted for the railway transport systems known as monorail.

[0057] As it is visible in the attached figures, the motor assembly comprises a main wheel 3 fitted to the axle 2 and adapted to rotate together with this latter around the same axis A: the main wheel 3 is stably fixed to the wheel for example by a joint or key system. The attached figures illustrate a preferred but non-limiting embodiment of the invention wherein the main wheel 3 is disposed in proximity of the driving wheel R placed at the first longitudinal end portion 2a. De facto, the main wheel 3 is not located at a midline portion of the axle 2 but is proximate to a driving wheel R with respect to the other.

[0058] In a preferred but non-limiting embodiment of the invention, the main wheel 3 comprises a geared wheel, for example one with straight teeth, whose axis substantially coincides with the axis A. As an alternative, the main wheel can comprise a friction wheel.

[0059] As it is visible in Figures from 1 to 4 for example, the motor assembly 1 comprises an actuating wheel 4 constrained to the axle 2 and movable around the axis A with respect to the axle 2 itself, consequently movable with respect to the main wheel 3. The first actuating wheel 4 is concentric with the axle 2: the first actuating wheel 4 comprises an axis coincident with the axis A. More particularly, the wheel 4 exhibits a center which is located on the rotation axis A. The first actuating wheel is axially distanced from the main wheel 3: the main wheel 3 and first actuating wheel 4 are both engaged with the axle 2 but are distanced along the development direction of this latter.

[0060] The first actuating wheel 4 is constrained to the axle 2 by means of at least one radial bearing interposed between this latter and the wheel 4: the bearing is adapted to enable a rotative relative motion between the wheel 4 and axle 2. The first actuating wheel 4 exhibits an outer coupling surface 4a actuatable by a first motor 8 configured for putting in rotation the first actuating wheel 4. In a preferred but non-limiting embodiment of the invention, the first actuating wheel 4 comprises a geared wheel, for example one with straight teeth, whose axis substantially coincides with the axis A. As an alternative, the first wheel 4 can comprise a friction wheel.

[0061] As it is visible in the attached figures, the motor assembly 1 can comprise a connecting element 10 attached to the first actuating wheel 4 and extending towards the main wheel 3 (Figure 3). More particularly and as it is visible in Figure 4 for example, the connecting element 10 comprises an abutment portion 10a substantially comprising a tubular body - a kind of sleeve - having a circular cross-section integrally joined to the first actuating wheel 4. The abutment portion 10a is delimited in thickness by an inner surface facing the axle 2 and distanced from this latter and an outer surface 10b - opposite to the inner surface of the same abutment portion - whose function will be fully described in the following.

[0062] Moreover, the connecting element 10 comprises a spacing portion 10c integrally joined to the abutment portion 10a and disposed oppositely to the first actuating wheel 4: the abutment portion 10a is interposed between the first actuating wheel 4 and spacing portion 10c. As it is visible in Figure 4 for example, the spacing portion 10c emerges from the abutment portion away from the axle 2. More particularly, the facing portion 10c comprises a plate extending all around the sleeve of the abutment portion and therefore all around the axle 2. The first actuating wheel 4, abutment portion 10a and spacing portion are integrally joined in order to define a single solid body.

[0063] As it is visible in the attached figures, the motor assembly 1 further comprises at least one connecting wheel 5 fixed to the first connecting wheel 4 and configured for cooperating with the main wheel 3 for enabling the axle 2 to rotate around the axis A. The connecting wheel 5 is configured for rotating around the main wheel 3. Particularly, the connecting wheel 5 is attached - for example by a joint or by means of a key system - to the spacing portion 10c of the connecting element 10 oppositely to the abutment portion 10a: the connecting element 10 is interposed and connects the first actuating wheel 4 to the connecting wheel 5 (Figure 4 is an exploded view of the motor assembly 1 even though is not shown how the connecting wheel is fixed to the spacing portion 10c).

[0064] The connecting wheel 5 exhibits a center distanced from the axis A and therefore is offset with respect to the axis 2. The connecting wheel 5 is rotatively supported by the connecting element 10 - fixed to the first actuating wheel 4 - around the axle 2. The spacing portion 10c is adapted to arrange the connecting wheel 5 around and in contact with the main wheel 3: indeed, the connecting wheel directly contacts the main wheel 3. More particularly, the connecting wheel 5 is aligned with the main wheel 3 along a direction perpendicular to the axis A: the connecting wheel 5 therefore is distanced - along the axis A - with respect to the first actuating wheel 4.

[0065] In a preferred but non-limiting embodiment of the invention, the connecting wheel 5 comprises a geared wheel, for example one with straight teeth, having the axis parallel to the axis A and therefore to the axis of the main wheel 3. As an alternative, the connecting wheel 5 can comprise a friction wheel. As hereinbefore described, the main wheel 3 can also comprise a geared wheel or a friction wheel; the connecting wheel 5 - being adapted to cooperate with the main wheel 3 - comprises a type of wheel identical to this latter: the main wheel and connecting wheel both comprise a geared wheel or a friction wheel.

[0066] Advantageously, the motor assembly 1 comprises a plurality of connecting wheels 5 active on and directly contacting the main wheel 3. More specifically, the motor assembly 1 can comprise a number of connecting wheels 5 equal to or greater than 2, particularly comprised between 2 and 6, still more particularly equal to or comprised between 3 and 5. Advantageously, the connecting wheels 5 are equidistant to each other, par-

ticularly exhibit the same distance from the axle 2. Advantageously, each connecting wheel 5 comprises a geared wheel with straight teeth, identical to each other by shape and size; particularly the connecting wheels 5 exhibit parallel symmetry axes, particularly parallel to a symmetry axis of the main wheel 3. In this way, the connecting wheels 5 can operate by pushing on the main wheel 3 in a uniform way in order to ensure a uniform thrust and a suitable distribution of the stresses on the wheel 3.

[0067] As it is visible in Figures from 1 to 4 for example, the motor assembly 1 comprises a second actuating wheel 6 - distinct from the first actuating wheel 4 - constrained to the axle 2 and configured for rotating with respect to this latter around the axis A, consequently movable with respect to the main wheel 3. The second actuating wheel 6 is concentric with the axis 2 and therefore concentric with the first actuating wheel 4: the second actuating wheel 6 comprises an axis coincident with the axis A.

[0068] More particularly, the wheel 6 exhibits a center which is located on the rotation axis A. The second actuating wheel 6 is axially distanced from the main wheel 3 and distanced from the first actuating wheel 4: the second actuating wheel 6 is axially interposed between the first actuating wheel 4 and main wheel 3 (Figure 3). De facto, the first actuating wheel 4, second actuating wheel 6 and main wheel 3 - besides all rotating around the axis - are aligned and distanced along said axis A.

[0069] More specifically, the second actuating wheel 6 is constrained by means of at least one radial bearing to the abutment portion 10b of the connecting element 10: in this way, the second actuating wheel 6 is rotatively movable both with respect to the first actuating wheel 4 and main wheel 3. Still more particularly, the second actuating wheel 6 is constrained to the axle 2 by interposing the connecting element 10; the second actuating wheel 6 is constrained to the connecting element by means of a radial bearing acting, on one side, on the outer surface 10b of the abutment portion 10a and, on the other side, on the reciprocal coupling inner surface 6b of the second actuating wheel 6 (Figure 3).

[0070] The second actuating wheel 6 exhibits an outer coupling surface 6a actuatable by a second motor 9 configured for putting in rotation the second actuating wheel 6. In a preferred but non-limiting embodiment of the invention, the second actuating wheel 6 comprises a geared wheel, for example one with straight teeth, whose axis substantially coincides with the axis A. As an alternative, the second wheel 6 can comprise a friction wheel.

[0071] As it is visible in Figures 3 and 4 for example, moreover the motor assembly 1 comprises at least one coupling portion 7 attached to and integral with the second actuating wheel 6. The coupling portion 7 is placed at least partially around the connecting wheel 5 and exhibits an inner coupling surface 7a engaged with the connecting wheel 5 so that this latter is interposed between the main wheel 3 and said inner coupling surface 7a. De facto, the coupling portion 7 comprises a cross-section tubular body - integrally joined to the second actuating wheel 6 - exhibiting an inner surface delimiting the coupling surface which is directly constrained to one or more connecting wheels 5. The coupling portion 7a exhibits a circular development, the center thereof being coincident with the axis A. De facto, the coupling portion 7 is concentric with the axle and therefore with the respective wheels 3, 4 and 6 (the actuating wheels 4, 6 and main wheel 3).

[0072] Each connecting wheel 5 is directly constrained, on one side, to the main wheel 3 and, on the other side, directly constrained to the inner coupling surface 7a of the coupling portion 7: the inner coupling surface 7a is connected to the main wheel 3 only by interposing the connecting wheel 5.

[0073] In a preferred but non-limiting embodiment of the invention, the inner coupling surface 7a defines an inner geared wheel adapted to directly cooperate with the geared wheel of the connecting wheel 5. More particularly, the geared wheel of the connecting wheel 5 is active on and operates in contact with an inner geared wheel defined by the inner coupling surface 7a; the geared wheel of the connecting wheel 5 exhibits a rotation axis parallel to a rotation axis of the inner geared wheel, for example one with straight gear, defined by the inner coupling surface 7a.

[0074] As hereinbefore briefly described, the first and second actuating wheels 4, 6 are actuatable by a motor. Indeed, the motor assembly 1 can comprise at least one first motor 8 active on the first actuating wheel 4 and configured for rotating this latter around the axis A. As it is visible in Figures 2 and 4 for example, the first motor comprises at least one transmission shaft 8a on which is fitted a transmission wheel 8b configured for putting in rotation - by the action of the first motor 8 - the first actuating wheel 4. In a preferred but non-limiting embodiment of the invention, the transmission wheel 8b comprises a geared wheel, for example one with straight teeth, which directly contacts and is directly active on the outer surface 4a of the first actuating wheel 4. The geared wheel of the transmission wheel 8b exhibits a rotation axis parallel to and distanced from the rotation axis of the first actuating wheel 4 and therefore parallel to the axis A. In a preferred embodiment of the invention, the first motor 8 comprises an electric motor connected to and supplied by a battery or current generator 11.

[0075] Moreover, the motor assembly 1 can comprise at least one second motor 9 active on the second actuating wheel 6 and configured for rotating this latter around the axis A. As it is visible in Figures from 2 to 4 for example, the second motor comprises at least one transmission shaft 9a to which is fitted a transmission wheel 9b configured for putting in rotation - by the action of the second motor 9 - the second actuating wheel 6. In a preferred but non-limiting embodiment of the invention, the transmission wheel 9b comprises a geared wheel, for example one with straight teeth, which directly contacts

and is directly active on the outer surface 6a of the second actuating wheel 6. The geared wheel of the transmission wheel 9b exhibits a rotation axis parallel to and distanced from the rotation axis of the second actuating wheel 6 and therefore parallel to the axis A. In a preferred embodiment of the invention, the second motor 9 comprises an electric motor connected to and supplied by a battery or current generator 11.

[0076] In a preferred but non-limiting embodiment of the invention illustrated in Figure 5, the first and second motors comprise respectively an electric motor: each motor is supplied by the battery or current generator 11. Advantageously, moreover the motor assembly 1 comprises a control unit 12 connected to the battery or current generator 11, and configured for commanding this latter (the element 11) to supply electric energy to the respective motors for enabling the operation. Further, the control unit 12 is advantageously connected to each electric motor 8, 9 and is configured for:

- detecting the operative condition of each motor, in other words detecting if each motor is in a still state (the rotation shaft is still) or if each motor is in an active state wherein the transmission shaft - and therefore the transmission wheel - is moving,
- detecting, for each motor, an angular speed of the transmission shaft and therefore the angular speed of the respective transmission wheel,
- controlling, for each motor, said angular speed in order to control the angular speed of the actuating wheels 4, 6 and therefore the rotation speed of the axle around the axis A.

[0077] Figure 7 illustrates an embodiment variant of the invention wherein the motor assembly 1 comprises a first portion 18 directly associable to an endothermic motor 13, particularly a Diesel motor, and connected, as it will be better described in the following, to at least one hydraulic motor which is directly active on the first or second actuating wheels 4, 6.

[0078] More particularly, the first portion 18 comprises a first hydraulic pump 14 mechanically connected to the endothermic motor 13, for receiving a mechanical power from the same and transferring at least part of such power to a working fluid. Preferably, the first hydraulic pump 14 is directly connected to the endothermic motor, and still more preferably, is stably connected to the endothermic motor itself, for example to flanged portions suitably made on the endothermic motor. In the particular case of an application on a railway machine, the first portion 18 of the apparatus 1 is mounted to the case of the machine itself, to which is also housed the endothermic motor 13. The motor assembly 1 (the embodiment variant in Figure 7) comprises a hydraulic-type actuating group, preferably a hydrostatic one, which is mechanically connected to the endothermic motor 13 for receiving power from this latter and transmitting at least part of such power to one or more of the cited actuating wheels. Particularly, the hydraulic actuating group comprises a first hydraulic-type motor 8, fluidically communicating with the cited first hydraulic pump 14 for receiving, at the inlet, a motive power from the cited working fluid and for transferring part of such motive power to the first actuating wheel 4 and consequently to the driving wheels. According to what was cited before, the fluid communication between the first hydraulic pump 14 and first hydraulic motor 8 is performed by one or more first conduits 19 of a type adapted to convey a pressurized fluid. More preferably, the first hydraulic pump 14 and first hydraulic motor 8 are connected only by means of such fluid communication. The first hydraulic pump 14 is preferably of a piston type, and more preferably of a variable displacement type. This latter condition means the possibility of varying in a regulated way at least the flow rate of the working fluid from the hydraulic pump 14 itself, in order to be capable of varying a power transmitted to the corresponding first hydraulic motor 8 and, therefore, to the driving wheels. Preferably, also the first hydraulic motor 8 is of a piston type, and more preferably of a variable displacement type. As it is visible again in Figure 7, the motor assembly 1 comprises a second hydraulic pump 15 and a second hydraulic-type motor 9: the second hydraulic motor 9 is directly active on the second actuating wheel by means of a geared wheel. Preferably, both the second hydraulic pump 15 and second hydraulic motor 9 are of a piston type, and at least one them, preferably the second hydraulic pump 15, has a displacement varying as a function of a power to be transmitted by means of the second hydraulic pump 15 itself. Moreover, preferably the second hydraulic pump 15 is directly connected to the endothermic motor 13, particularly to the above mentioned flanged portions of the endothermic motor itself. According to Figure 7, the second hydraulic pump 15 is integrally joined to the first portion 18, and when is applied on a railway machine, the second hydraulic pump 15 is therefore supported on the case of the railway machine. On the contrary, preferably the second hydraulic motor 9 is mechanically and directly fixed at the axle 2 so that the same motor can be directly active on the second actuating wheel 6. The operative connection between the second hydraulic pump 15 and second hydraulic motor 9, in other words the power exchange between the same, is obtained only by a fluid communication, and particularly by one or more second conduits 20 of a type adapted to circulate a fluid at high pressures. In the embodiment in Figure 7, the electric motors 8 and 9 are implemented by hydraulic motors 8 and 9; each hydraulic motor comprises the above described shaft and transmission wheel for the electric motors and are directly connected (active) on the respective actuating wheels 4, 6: there are no interposing elements between the transmission wheels 8b, 9b of the motor and the actuating wheels 4, 6. In a further embodiment variant illustrated in Figure 6, the motor assembly 1 comprises a first hydraulic motor 8 connected, as hereinbefore described, to an endothermic motor 13 and to the first actuating wheel 4. The second motor 9 is

of an electric type and is connected, on one side, to the battery 11 and, to the other side, is directly connected to the second actuating wheel 6.

Railway wagon

[0079] Moreover, it is an object of the present invention a railway wagon 100 comprising at least one motor assembly 1 according to the hereinbefore given description and/or according to anyone of the attached claims. Particularly, and as it is visible in Figure 8, the wagon 100 comprises at least one frame 101 engaged with the motor assembly 1 adapted to define the load and support structure of the wagon. De facto, the frame 101 is constrained - under an operative condition of the wagon 100 - on the motor assembly 1.

[0080] Advantageously but in a non-limiting way, the wagon comprises at least two motion systems 1 both constrained to the frame 101 and distanced one from the other from the same frame 101 along a longitudinal development direction of the wagon 100 (see in an exemplifying way Figure 8); in other words, the motor assemblies 1 are connected to each other by the frame 101: the frame 101 is configured for holding the motion systems 1 at a predetermined and fixed distance from each other when the wagon slides on the tracks. Figure 8 schematically shows a railway wagon 100 exhibiting four axles wherein two of them comprise the motor assembly 1; however it is not excluded the possibility of assembling a wagon exhibiting only two axles or a number of axles greater than four. Moreover, it is not excluded the possibility of assembling a wagon wherein each axle comprises the motor assembly 1 (all the axles are motorized) or of assembling a wagon 100 exhibiting only one motor assembly 1 (having only one motorized axle).

ADVANTAGES OF THE INVENTION

[0081] The present invention meets the provided objects, because it overcomes the disadvantages described with reference to the prior art. The presence of a motor assembly 1 devoid of mechanical engagement members such as mechanical clutches and gear clutches is extremely reliable particularly due to the absence of mechanical clutches, indeed these latter, when used with high powers, are not cost-effective. The absence of mechanical clutches and gear clutches enables to improve the overall efficiency of the machine, because by its own nature the clutch is a source of a substantial dissipation of energy during the engagement, disengagement and starting steps. Moreover, it is noted that the members adapted to transmit the mechanical power of the motors to the driving wheels R are directly constrained to the axle; this arrangement enables to obtain a motor assembly 1 which is extremely compact and easy to install and which further enables to maximize the mechanical efficiencies when it transmits power.

[0082] In addition, the presence of a reduction group adapted to generate a transmission ratio continuously varying along the overall operative range of the machine, makes possible to eliminate the gearboxes and the cited mechanical clutches.

Claims

1. Motor assembly for a railway axle (1) comprising:

- at least one axle (2) comprising at least one driving wheel (2a), said axle (2) together with said driving wheel being configured for rotating around an axis (A),
- at least one main wheel (3) fixed to the axle (2) and adapted to rotate with this latter around the same axis (A),

characterized by the fact that said Motor assembly for a railway axle (1) further comprises:

- at least one first actuating wheel (4) constrained to the axle (2) and configured for rotating with respect to this latter around the axis (A), said first actuating wheel (4) exhibiting an outer coupling surface (4a) actuatable by a first motor (8) configured for putting in rotation said first actuating wheel (4),
- at least one connecting wheel (5) fitted to the first actuating wheel (4) and configured for cooperating with the main wheel (3) for enabling to rotate the axle (2) around the axis (A), said connecting wheel (5) being configured for rotating at least around the main wheel (3),
- at least one second actuating wheel (6) - distinct from the first actuating wheel (4) - constrained to the axle (2) and configured for rotating with respect to this latter around the axis (A), the second actuating wheel (6) exhibiting an outer coupling surface (6a) actuatable by a second motor (9) configured for putting in rotation said second actuating wheel (6),
- at least one coupling portion (7) fixed and integral with the second actuating wheel (6) - placed at least partially around the connecting wheel (5) - and which exhibits an inner coupling surface (7a) engaged with the connecting wheel so that this latter is interposed between the main wheel (3) and said inner coupling surface (7a).

2. Motor assembly according to the preceding claim, wherein the second actuating wheel (6) is rotatively movable with respect to the main wheel (3) and to the first actuating wheel (4), optionally the second wheel (6) is constrained to the axle (2) by means of at least one radial bearing.

3. Motor assembly according to anyone of the preced-

ing claims, comprising at least one connecting element (10) fixed to the first actuating wheel (4) and fixed to the connecting wheel (5), the connecting element (10) being interposed and connecting the first actuating wheel (4) to the connecting wheel (5), the connecting element (10) comprising an abutment portion (10a) comprising an outer surface (10b) having a circular cross-section which the second actuating wheel (6) is engaged around,
wherein the second actuating wheel (6) is constrained to the axle (2) by interposing the connecting element (10), optionally the second actuating wheel (6) is constrained to the connecting element by means of at least one radial bearing acting, on one side, on the outer surface (10b) of the abutment portion and, on the other side, on an inner reciprocal coupling surface (6b) of the second actuating wheel (6).

4. Motor assembly according to anyone of the preceding claims, wherein the first actuating wheel (4) - according to a view along the axis (A) - is concentric with the second actuating wheel (6), particularly the first and second actuating wheels rotate around the same axis (A) of the axle (2), optionally the first and second actuating wheels (4, 6) are spaced from each other along the axis (A).

5. Motor assembly according to anyone of the preceding claims, wherein the connecting wheel (5) exhibits a center spaced from the axis (A), particularly the connecting wheel (5) being offset from the axle (2), wherein the connecting wheel (5) is directly constrained, on one side, to the main wheel (3) and, on the other side, to the inner coupling surface (7a) of the coupling portion (7), particularly the inner coupling surface (7a) is connected to the main wheel (3) exclusively by interposing the connecting wheel (5).

6. Motor assembly according to anyone of the preceding claims, wherein the main wheel (3) and the connecting wheel (5) comprise respectively a geared wheel, for example a straight teeth one, the geared wheel of the main wheel (3) exhibiting a rotation axis parallel to an axis of the connecting wheel (5),
the geared wheel of the connecting wheel (5) being active and operates in contact with an inner geared wheel defined by the inner coupling surface (7a), the geared wheel of the connecting wheel (5) exhibiting a rotation axis parallel to a rotation axis of the inner geared wheel, for example a straight teeth one, defined by the inner coupling surface (7a).

7. Motor assembly according to anyone of the preceding claims, comprising at least one first motor (8) exhibiting a drive shaft (8a) on which a drive wheel (8b) is fitted, said drive wheel (8b) being configured for putting in rotation - by the action of the first motor (8) - the first actuating wheel (4),
wherein the first motor comprises an electric motor;
wherein the motor assembly comprises at least one second motor (9) exhibiting a drive shaft (9a) on which a drive wheel (9b) is fitted, said drive wheel (9b) being configured for putting in rotation - by the action of the second motor (9) - the second actuating wheel (6); wherein the second motor comprises an electric motor or comprises a hydraulic motor supplied by an endothermic engine, for example a Diesel engine.

8. Motor assembly according to anyone of the preceding claims, comprising a plurality of connecting wheels (5) active and in direct contact with the main wheel (3), particularly interposed between the main wheel (3) and the inner coupling surface (7a) of the coupling portion (7), optionally the connecting wheels are equidistant from each other.

9. Motor assembly according to the preceding claim, wherein each connecting wheel (5) comprises a straight teeth geared wheel identical to each other by shape and size;
wherein the connecting wheels exhibit symmetry axes parallel, particularly parallel to a symmetry axis of the main wheel (3).

10. Railway wagon (100) comprising:

- at least one motor assembly for a railway axle (1) according to anyone of the preceding claims, the driving wheel of the motor assembly (1) being configured for abutting at least on a railway rail,
- at least one frame (101) engaged with the motor assembly (1), adapted to define the load and support structure of the railway wagon.

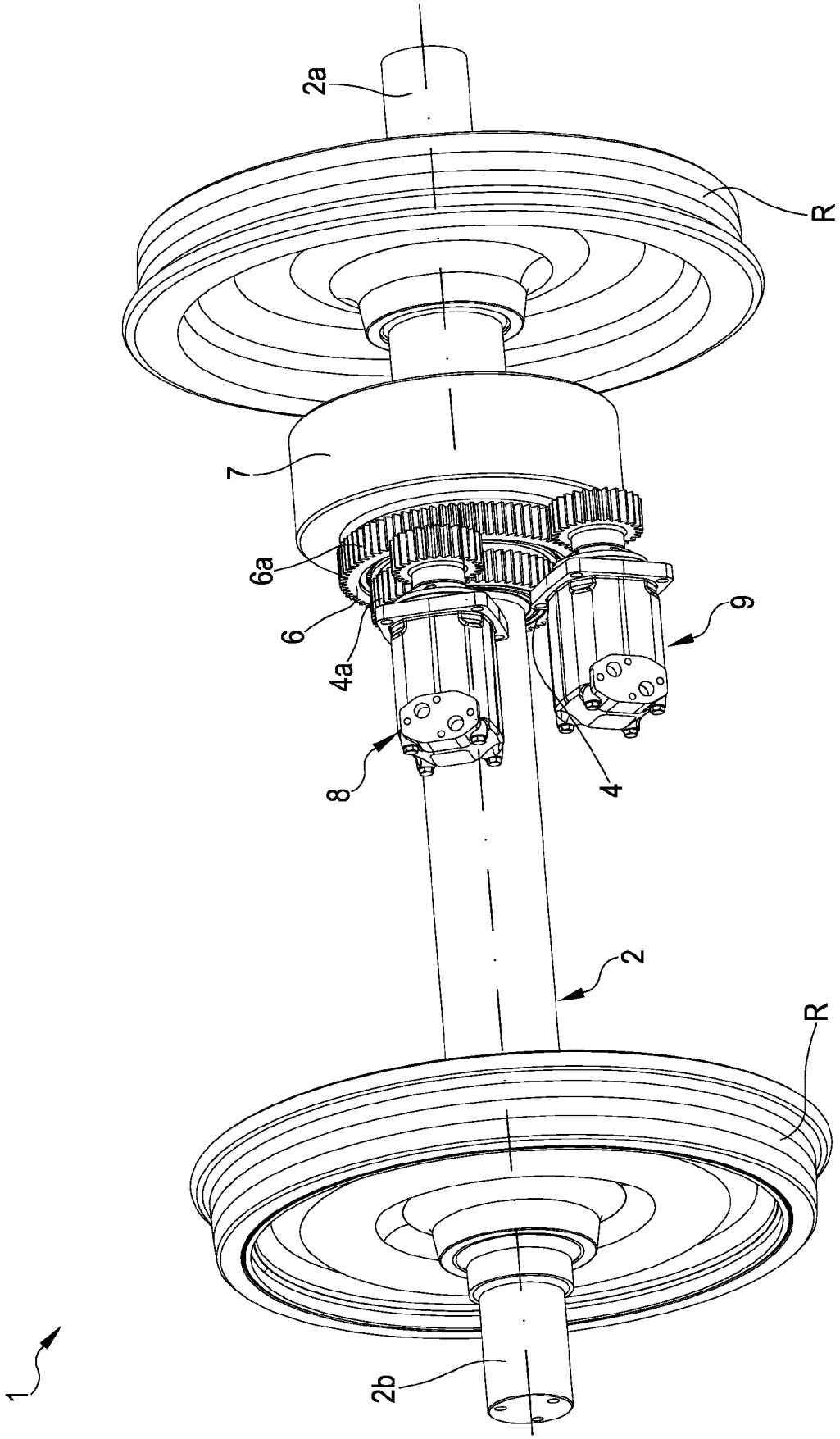


FIG.1

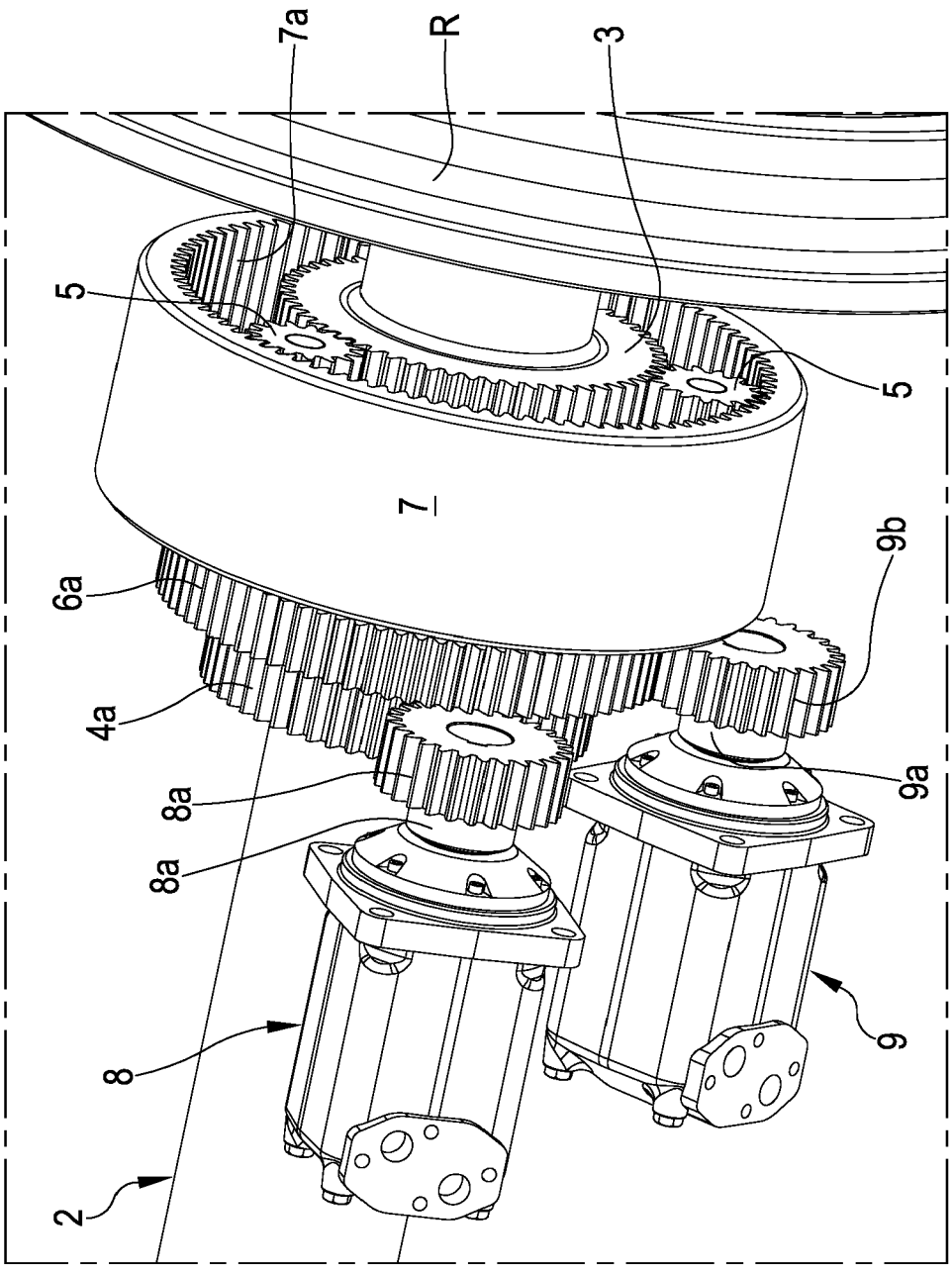


FIG.2

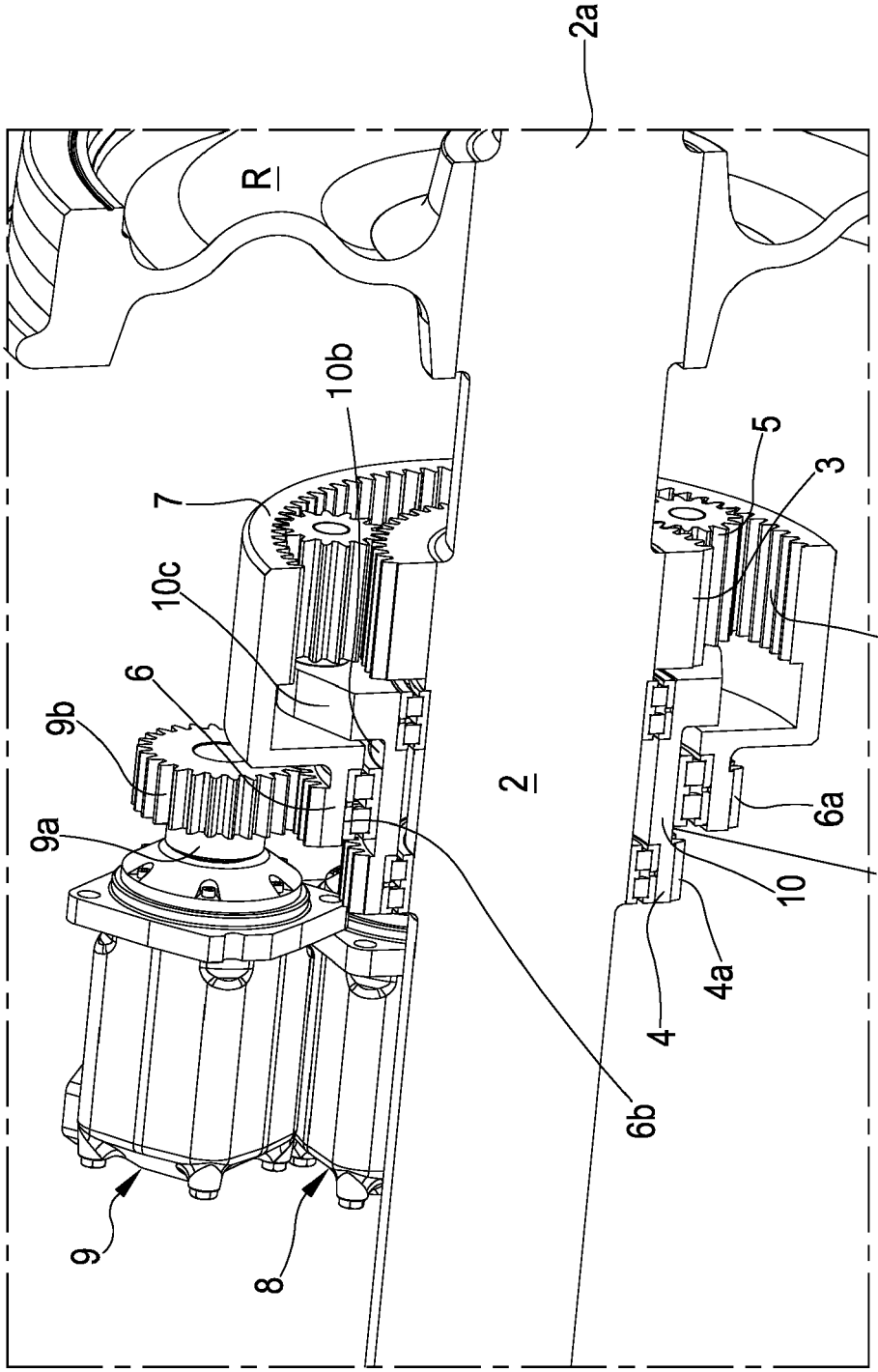


FIG.3

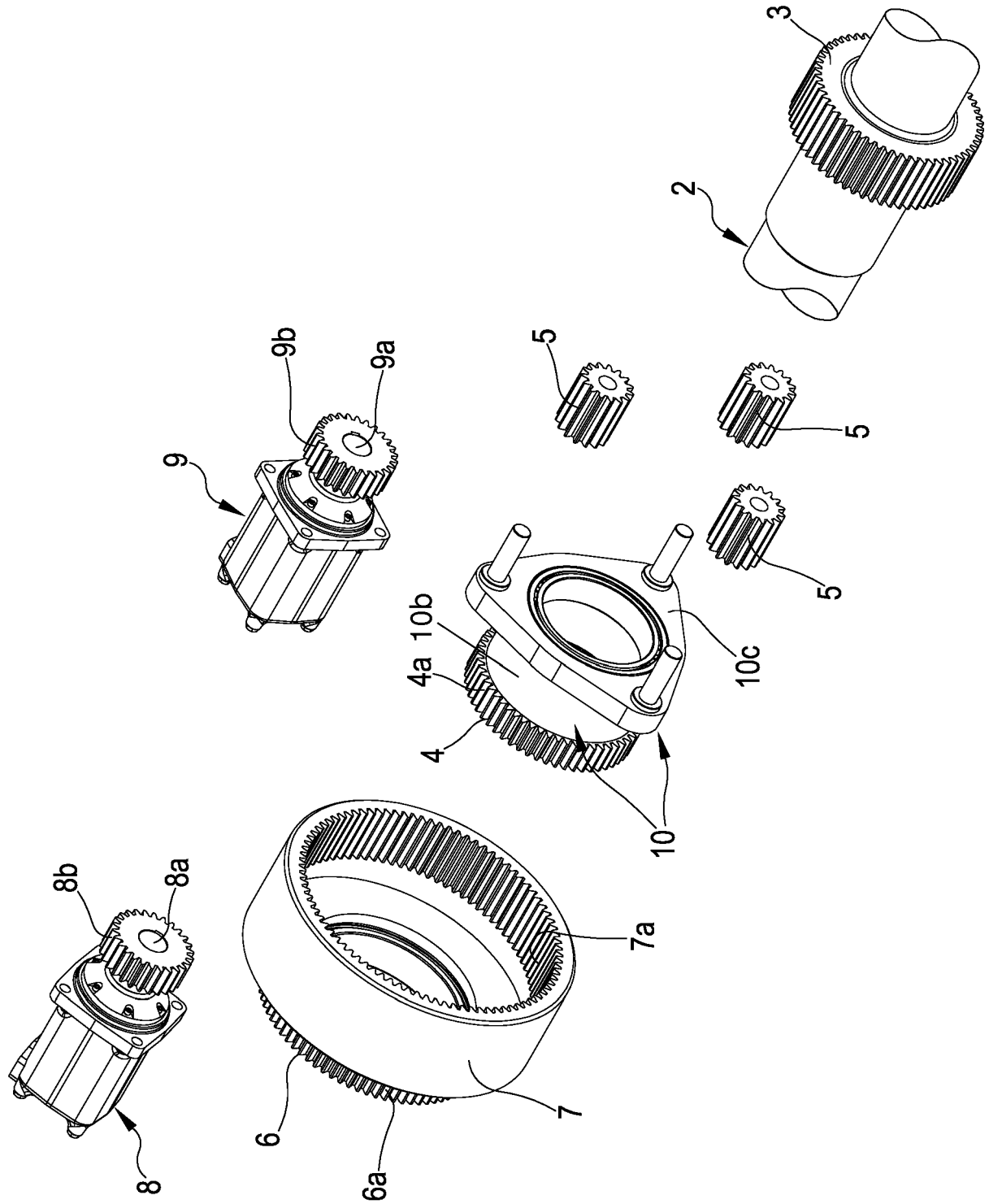


FIG.4

FIG.5

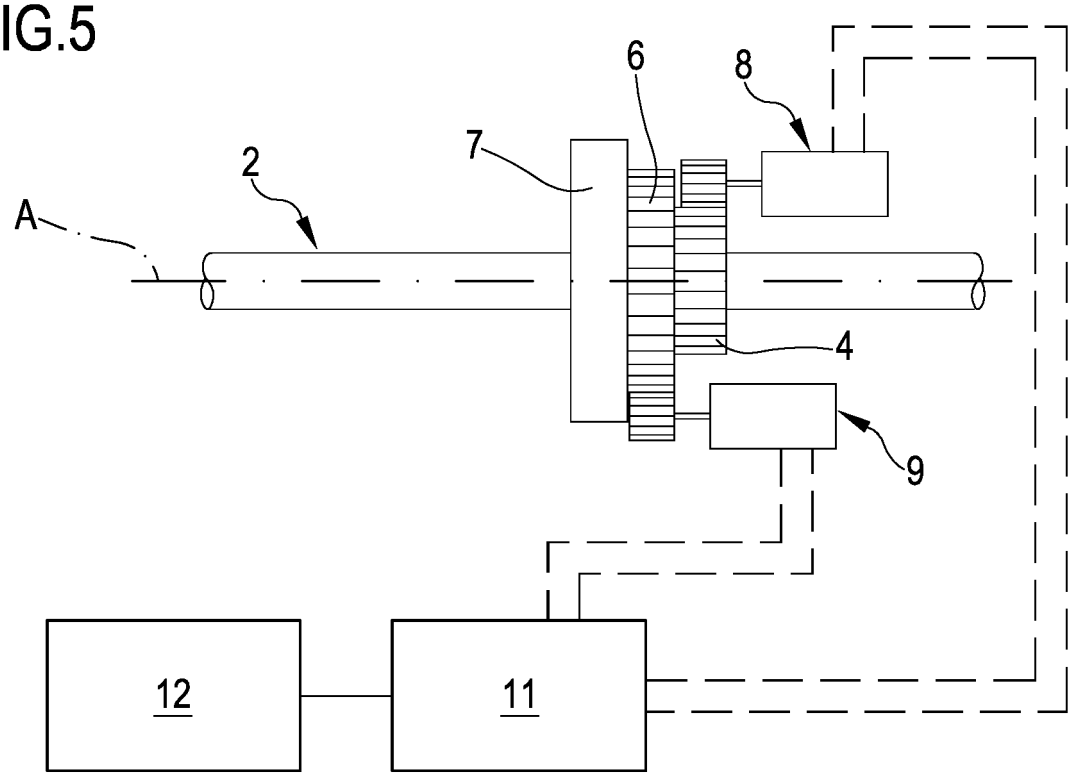
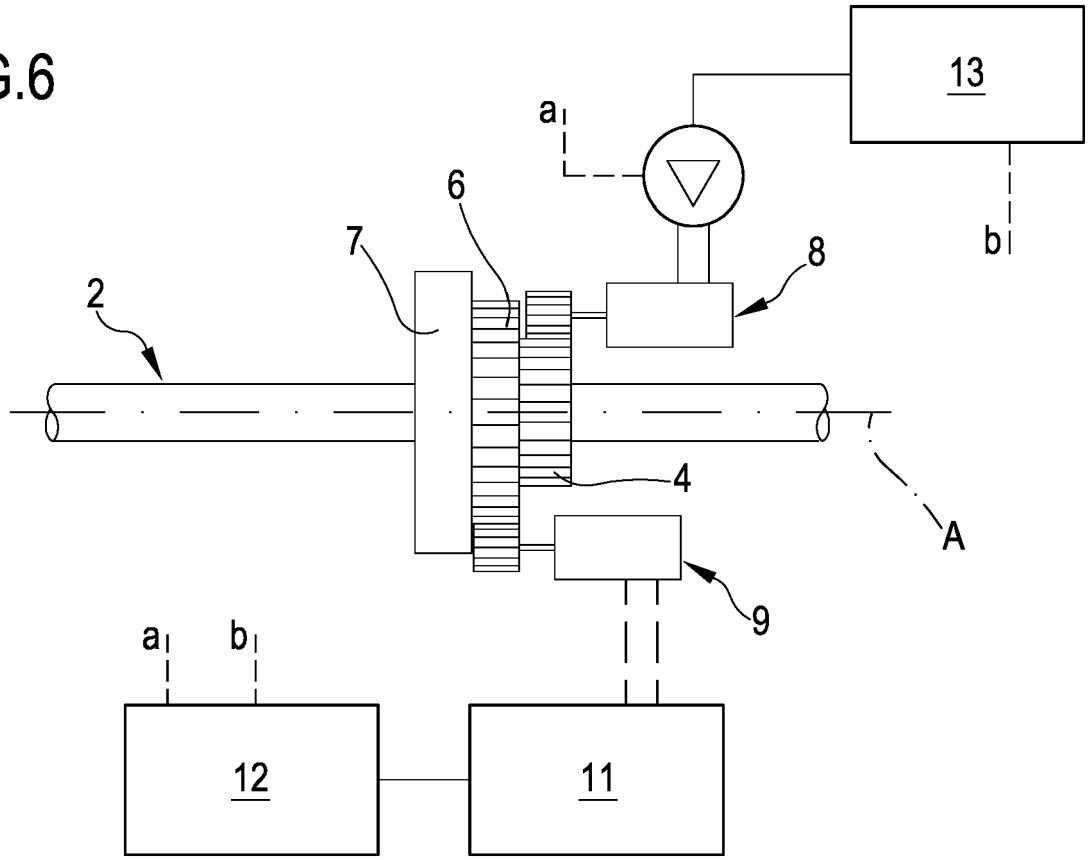


FIG.6



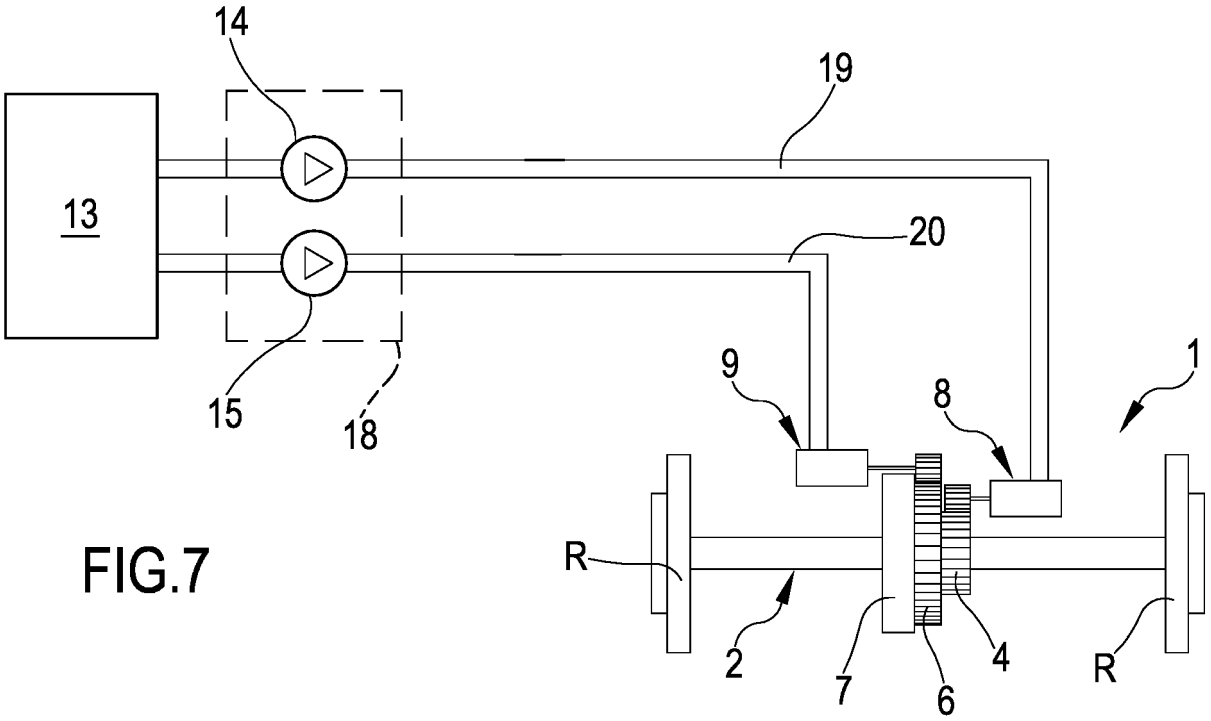


FIG.7

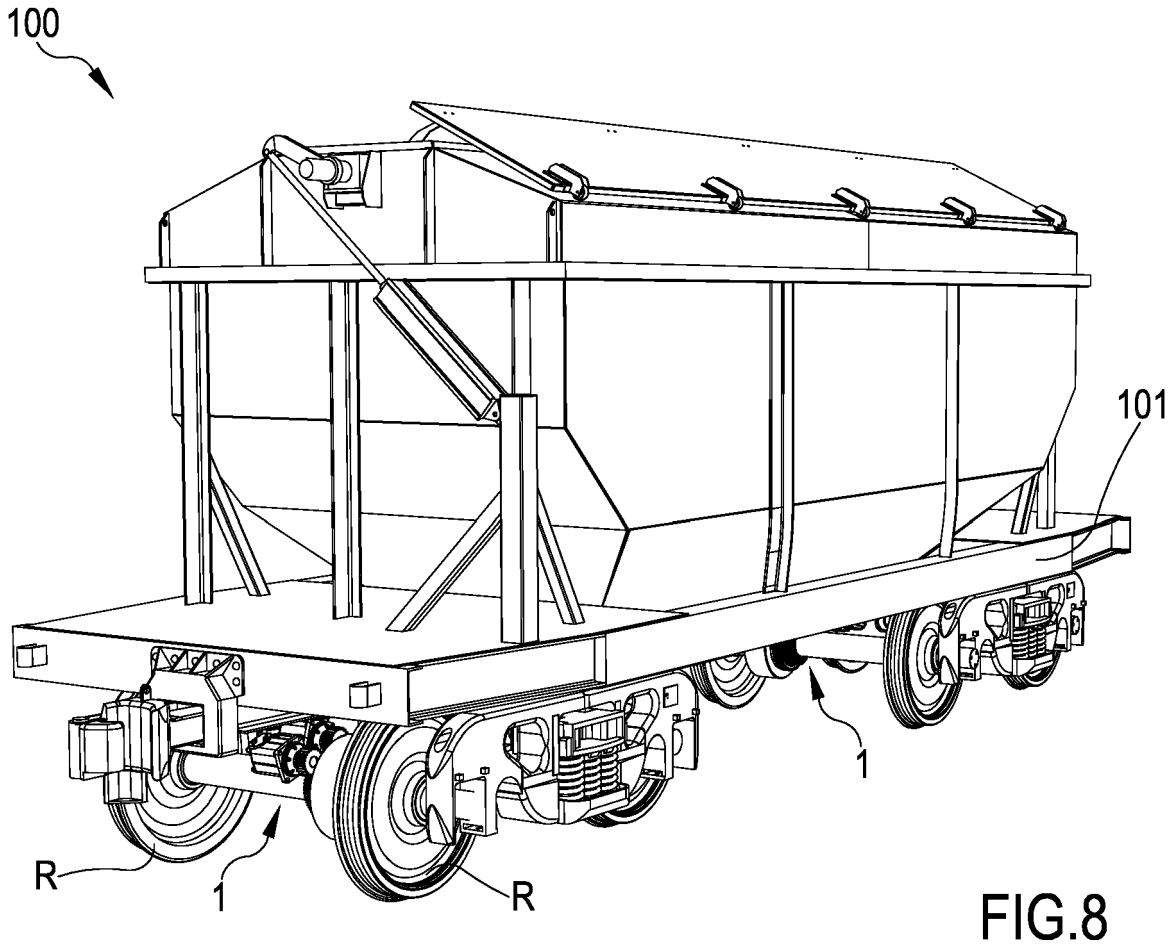


FIG.8

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EUROPEAN SEARCH REPORT

Application Number
EP 17 18 4784

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	DE 22 08 036 A1 (SIEMENS AG) 30 August 1972 (1972-08-30) * figure 1 *	1	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 November 2017	Lorandi, Lorenzo

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