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Declarations under Rule 4.17:
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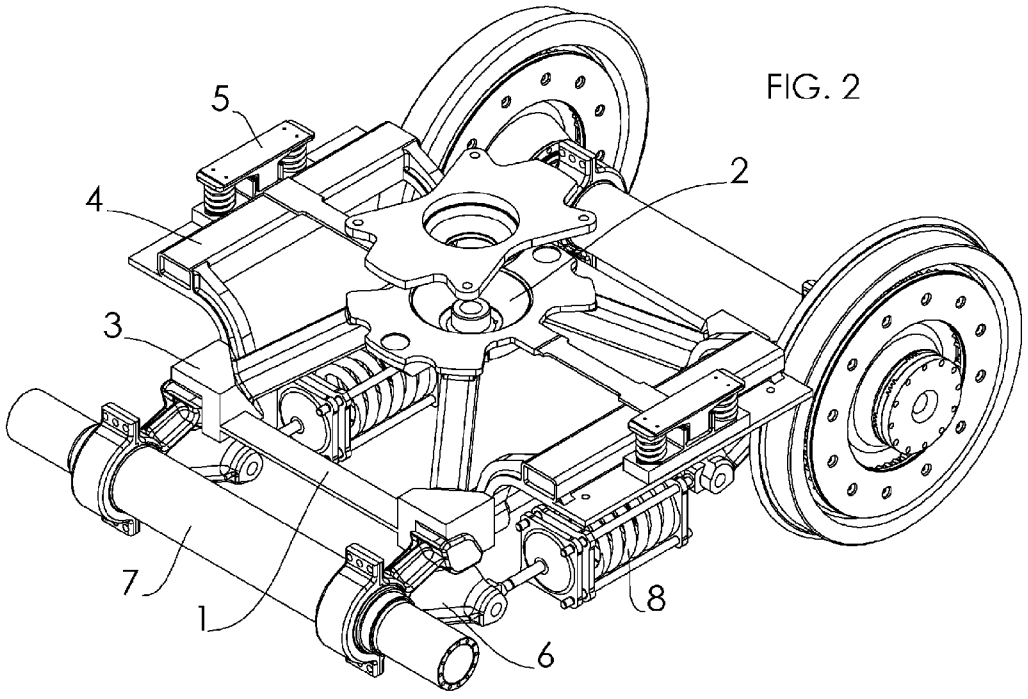
(54) **Title:** TWO-AXLE RAILWAY BOGIE

FIG. 2



(57) **Abstract:** Two-axles railway bogie with inside truss frame connected to wheelsets via pivoting arms, which are connected to progressive springs.

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[Continued on next page]

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DESCRIPTION

Title

TWO-AXLE RAILWAY BOGIE

Technical field

This invention belongs to the sector of railway vehicles and, in particular, to the sector of railway bogies.

The invention is particularly favourable for those vehicles with a high ratio between the laden mass and the tare mass, i.e. freight wagons, but can be implemented on any rail vehicle, such as passenger cars, trams and so on.

State of the art

Freight wagons with four or more axles, used to carry goods, rest on at least two bogies; said bogies, in the case of freight wagons with four axles, are located at both ends of the vehicle. Each bogie includes car body supporting elements that allow the mutual rotation around a vertical axis and that allow the car body to rotate, with some limitations, around the longitudinal axis of the vehicle.

Said supporting elements are usually located on the upper part of the bogie and include a spherical centre bowl and two lateral supports, located near the longitudinal beams of the bogie frame, usually called "side bearers".

Said side bearers are pushed up by preload springs and are designed to contrast lateral unbalance of the car body that mainly happens when a train runs through curves.

Relative car body - bogie movements are possible through the interposition of special friction elements. During rotations around the vertical axis, friction materials covering side bearers also ensure damping of yaw motions.

To allow interchangeability, the majority of freight bogies has supporting elements of the car body with the same shape that match with the bearing elements present in the lower part of the car body.

Widely adopted supporting elements include a coupling with a centre bowl, with a convex half-sphere that extends downwards from the lower part of the car body towards a corresponding concave half-sphere, the latter firmly connected to the upper part of the bogie frame. Suitable friction materials are put between the two half-spheres, of which periodic replacement is scheduled, because of friction that wears them progressively.

The most diffuse bogie for freight wagons includes an outer frame, external to the wheels, that rests on the journals of two wheelsets through rolling bearings of different kind and a single suspension stage with two stiffness levels.

Each axle includes two wheels, while the suspension arrangement on each side includes two pairs of coaxial helical spring, the outer springs offer the first level of stiffness, i.e. the softer one, while the inner springs offer the second level of stiffness, i.e. the stiffer one. In tare condition the latter do not work and the vertical force given by the payload is needed, at least partially, to make them touching the frame.

Generally speaking, railway bogies are very robust devices, without rubber elements and hydraulic dampers, damping of the only vertical suspension stage is demanded to a mechanism based on friction, called "Lenoir link", in which the upper part of the outer spring is linked to a pin, with axis normal to the axle, which holds at the other end a disc that pushes against the lateral surface of the axlebox through a suitable friction material. The clearance of the axlebox is such that, during the pushing action of the pin, also the other surface of the axlebox pushes the bogie frame, thus doubling the number of sliding surfaces. Increasing the load acting on the spring implies a greater lowering of the upper part of the spring, thus generating an increase in the normal load

acting on friction surfaces.

Due to the aforementioned configuration, bogies currently in use are made of numerous metallic components and therefore are expensive to build and to maintain. Moreover, said configuration makes bogies very heavy, with the consequence that they are not very stable at high speeds due to high mass and high moment of inertia around the vertical axis.

Another disadvantage of the heavy mass of the bogie is the corresponding decrease in the payload of the vehicle.

Furthermore, the suspension with coaxial springs requires a high number of springs. A four-wheeled bogie requires eight pairs of springs that work in two different phases, with a highly uncertain dynamic behaviour when the vehicle is only partially loaded.

To improve the behaviour of railway bogies a number of solutions were proposed, e.g. those described in EP1767430A1, but they result as well to be complicated, expensive and heavy.

Objects and summary of the invention

The first object of the present invention is therefore to both design a two-axle bogie for railway vehicles that is lightweight and stable at higher speeds and to increase the payload of a railway vehicle.

A second object of the invention is to design a bogie with a limited number of components in order to make both manufacturing and maintenance easier and less expensive, as the bogie can be assembled by welding semifinished steel profiles and/or casted elements.

Another object of the invention is to improve the behaviour of the suspensions, making them more progressive and reducing the number of springs. Experts in the reference sector know that a progressive suspension makes the vertical bouncing frequency constant for any load, with great advantage on

running dynamics.

Not least object is to build a railway bogie that has the same interface to the car body and that is therefore interchangeable with bogies currently in use.

Other objects and advantages of the invention will be clear to experts in the sector by reading the following text.

Said goals are reached thanks to a bogie frame in which the convex part of the interfacing centre bowl is located in the upper part of a pyramidal reticular frame that is located inside the wheels and within the axles.

The pyramidal frame has a rectangular base. Cylindrical hinges are present at lower vertices to connect it to axlebox arms.

Inclined members of the pyramidal frame favourably converge to the upper part towards the centre of the sphere of the centre bowl. Under the effect of the vertical load of the car body, they are only subjected to compressive loads.

Members connecting the hinges act therefore simply as tie-rods, with bending and torsion effects limited to the load cases of lateral forces and/or track twists. The resulting structure is therefore simple and lightweight. Its structural strength was verified according European standards in force under all combinations of normal and exceptional loads for freight wagons.

It must be highlighted that the architecture of the bogie frame described in this invention allows it to withstand track twists by using frame elasticity only.

Another advantage of the pyramidal frame is a high strength coupled to a high flexibility that makes the frame intrinsically elastic without the need to introduce further elements while keeping unchanged the safety on track twists as each wheel unloading remains below the limits allowed by current standards.

The bogie frame is completed by two side frames that transmit the load acting on the side bearers towards the lower vertices of the frame. Said side frames are at the same time simple, robust and flexible.

The side bearers are preloaded with elastic components to contrast car body roll. They also dampen yaw movements of the bogie frame.

Brake units are connected to the pyramidal frame through the side frames. They can either act on web-mounted brake discs or carry brake blocks in case of the conventional tread braking is used. The fact that the bogie described in this invention can be used either with web-mounted disc brakes or with tread brakes makes it easily adaptable to each specific vehicle.

Axlebox arms are rotationally connected to lower vertices of the pyramidal frame through cylindrical hinges that house elements made of highly wear-resistant materials responsible for friction damping of the vertical motion of the wheelsets. Favourably, this bogie does not use rubber components and/or hydraulic dampers as it uses only wear elements of low cost and easy replacement.

Axlebox arms are not horizontal as described in EP1767430A1 instead, this implies that, when the bogie runs through a curve, the outer wheelbase increases while the inner wheelbase decreases, generating for ordinary speeds a self-steering effect that is highly appreciated in the reference sector.

The suspension system of the bogie described in this invention comprises only two helical springs of the progressive type, that lie in a vertical longitudinal plane with their axis parallel to the longitudinal axis of the bogie.

Each spring is connected, through pivoting axlebox arms, to

the journal of both the wheelsets on one side of the bogie. Known bogies suspensions elements are usually connected on one end at the axlebox body and on the other end to the bogie frame, while in the bogie subject of this invention both the ends of the spring are connected to the journals of the wheelsets trough pivoting axlebox arms.

The bogie comprises a supporting plate, is reversibly connected to the lower surface of the vehicle, from which the convex half-sphere protrudes towards the concave half-sphere of the centre bowl located on the bogie frame.

Wheelsets are functionally interconnected on each side of the bogie being rotationally connected to a respective axlebox arm which in turn is rotationally connected to a respective end of the horizontal cylindrical spring..

According to a particularly efficient and practical design solution, said two horizontal springs are of the continuously progressive stiffness kind, with relevant advantages in terms of operation and of quality of the dynamic behaviour of the suspension.

It is worth underlining that as the bogie frame is inboard, it can house conventional inboard bearings wheelsets as well as innovative wheelsets, with or without torque limiters, with fixed (non-rotating) axlebridge, further increasing both safety and maintenance easiness.

It must be highlighted that the particular kinematic mechanism of the suspensions of this railway bogie always results in the same vertical load per wheel, equalizing therefore the load in any situation.

The fact that, on each side, the horizontal springs have both ends connected to a respective axlebox arm introduces a new degree of freedom around the transversal axis; to restrain bogie pitch, specific anti-pitch bearers are interposed between the supporting plate and the centre bowl.

Said anti-pitch bearers are loaded more heavily during braking while keeping the bogie frame centred when braking is not applied, offering further damping to yaw movements.

This last inventive concept can be applied with two different embodiments according to the possibility that the anti-pitch bearers also work as side bearers.

In a first embodiment, there are four side bearers, two per side, such that the forces they provide to the lower part of the car body generate stabilizing torques in presence of rotations around both a transversal and a longitudinal axis.

In the other embodiment, the configuration of said system is completed by two anti-pitch bearers, aligned along the longitudinal axis of the bogie and located respectively before and after the centre bowl, which contrast the pitch of the car body around the transversal axis of the centre bowl.

Brief description of the drawings

Figure 1 shows the views of the bogie. The drawing does not include the wheels of one of the two wheelsets and the brake units.

The following elements are shown: the pyramidal frame with rectangular basis (1) with the centre bowl (2) on the top, and the hinges (3) of the axlebox arms (6) at the lower vertices. Also the side frames (4), at whose ends side bearers (5) aligned to the centre bowl are located, are visible. Each side bearer is preloaded by two springs, shown in the figure.

In the lower part of the bogie the four axlebox arms (6) are shown, each axlebox arm has centrally a rotational coupling with the cylindrical hinges (3); each axlebox arm (6) is rotationally connected at one end at the end of the horizontal helical springs (8) and at the other end with a wheelset (7). In this embodiment, anti-pitch bearers (9) are

independent from side bearers and are located between the centre bowl (2) and the supporting plate (10), the latter being connected to the lower part of the car body.

In the figure it is shown that anti-pitch bearers (9) are aligned along a longitudinal axis passing through the vertical axis of the centre bowl (2) and are located one in front and one on the rear of the centre bowl (2).

Figure 2 shows an axonometric projection of the same design solution shown in Fig. 1.

Figure 3 shows a different embodiment, in which there are four side bearers (5), two per side of the bogie, located at the corners of a horizontal rectangle whose barycentre is on the vertical axis of the centre bowl. In this solution, each side bearer (5) is preloaded with only one spring and there are no anti-pitch bearers (9).

Figure 4 shows an axonometric projection of the same embodiment shown in Fig. 3.

Detailed description of an embodiment of the invention

With reference to attached drawings and about a particularly complete embodiment of the invention, the bogie object of this invention comprises a truss frame (1) with the shape of a pyramid with rectangular base. The top of the pyramid houses the spherical centre bowl (2), i.e. a concave half-sphere that mates with a corresponding convex half-sphere that protrudes downwards from a supporting plate (10) connected to the lower part of the car body.

The connection of the supporting plate (10) to the lower surface of the car body can be reversible. Typically, it is fixed to the car body through four M24 screws.

According to a particularly favourable embodiment, the half-spheres are made of metal, such that the interpositions of a suitable friction material is required to avoid metal-to-metal sliding.

At each of the lower vertices of the pyramidal frame (1) a cylindrical hinge (3) is located, whose horizontal axis is transversal to the longitudinal axis of the bogie. Each hinge (3) is rotationally connected to the central part of a respective axlebox arm (6). The ends of each axlebox arm are respectively rotationally connected to the end of a progressive spring (8) and to a wheelset (7). The bogie comprises therefore two progressive springs (8), one per side; according to a particularly favourable embodiment, said springs (8) have their axis horizontal, parallel to the longitudinal axis of the bogie.

The pyramidal frame is completed by two side frames (4), which develops transversally, on whose ends side bearers (5) are located. Said side bearers (5) are preloaded by springs such that their upper surface, made of suitable friction material, permanently touches the lower part of the car body. Side bearers (5) contrast car body roll movements and the action of friction elements dampens bogie yaw movements with respect to the car body.

In a preferred version of the invention, progressive helical springs (8) have both variable wire pitch and wire section.

In a first embodiment, anti-pitch bearers (9) covered with suitable friction material are interposed between the lower face of the supporting plate (10) and the upper part of the truss frame (1) to suppress car body / bogie frame relative pitch. To maximize their efficacy, anti-pitch bearers (9) are aligned with the centre bowl (1) along the longitudinal axis of the bogie.

In a second embodiment, side bearers (5) are split and are located at the corners of a horizontal rectangle whose barycentre is located on the vertical axis of the centre bowl (2). In this design each side-bearer (5) is preloaded by one spring only.

In this second embodiment, the fact that side bearers (5) are far from both the transversal axis and the longitudinal axis of the bogie make them capable to prevent both roll and pitch, with the further advantage that during braking the relative forces are reacted by the side bearers (5) and the bogie frame (1) is less subjected to both bending and torsion as the braking torque is no more reacted in the centre bowl (2) area.

CLAIMS

1. Two-axle railway bogie including two wheelsets (7) and a frame (1) that supports the concave portion of a half-spherical centre bowl (2) that mates with a corresponding convex half-sphere that protrudes downwards a supporting plate (10) connected to the lower part of the car body of a railway vehicle, **characterized in that** said frame (1) is functionally connected to said two wheelsets (7) through two pairs of axlebox arms (6) each with a central part with a rotational coupling with transversal axis mating with a respective hinge (3) rotationally connected to said frame (1) along a transversal axis; at each of its ends each axlebox arm (6) is rotationally connected, according to transverse axes, respectively at one end of a progressive cylindrical spring (8), which lies in a vertical longitudinal plane, and at one of said wheelsets (7); said frame (1) comprising two side frames (4) with the outer portions that support at least one side bearer (5) each.

2. Bogie as described in the previous claim **characterized in that** it comprises two anti-pitch bearers (9) interposed between the top of said frame (1) and said supporting plate (10), aligned in front and on the back of said centre bowl (2) along a longitudinal horizontal axis passing through the vertical axis of such centre bowl (2).

3. Bogie as described in previous claim 1 **characterized in that** it comprises two side bearers (5) on each side; all said side bearers (5) are located at the corners of a horizontal rectangle whose barycentre is located on the vertical axis of said centre bowl (2) such that said side bearers (5) also behave as anti-pitch bearers and contrast both pitch and roll of the car body.

4. Bogie as described by one of the previous claims **characterized in that** said frame (1) is a truss frame with

a pyramidal shape with a rectangular base with said centre bowl (2) located at the upper tip and with each of said hinges (3) located at the lower vertices of the pyramid.

5. Bogie as described by one of the previous claims **characterized in that** said progressive helical springs (8) are of the variable wire pitch type.

6. Bogie as described by one of the previous claims **characterized in that** said progressive helical springs (8) are made of a variable section wire.

7. Bogie as described by one of the previous claims **characterized in that** said side bearers (5) are preloaded with suitable elastic components.

8. Bogie as described in previous claim 7 **characterized in that** such elastic components are cylindrical springs.

9. Bogie as described by one of the previous claims **characterized in that** said side bearers (5) and said anti-pitch bearers (9) are covered with friction material.

10. Bogie as described by one of the previous claims **characterized in that** one or more of the rotational coupling of said axlebox arms (6) comprises suitable elements to obtain friction damping.

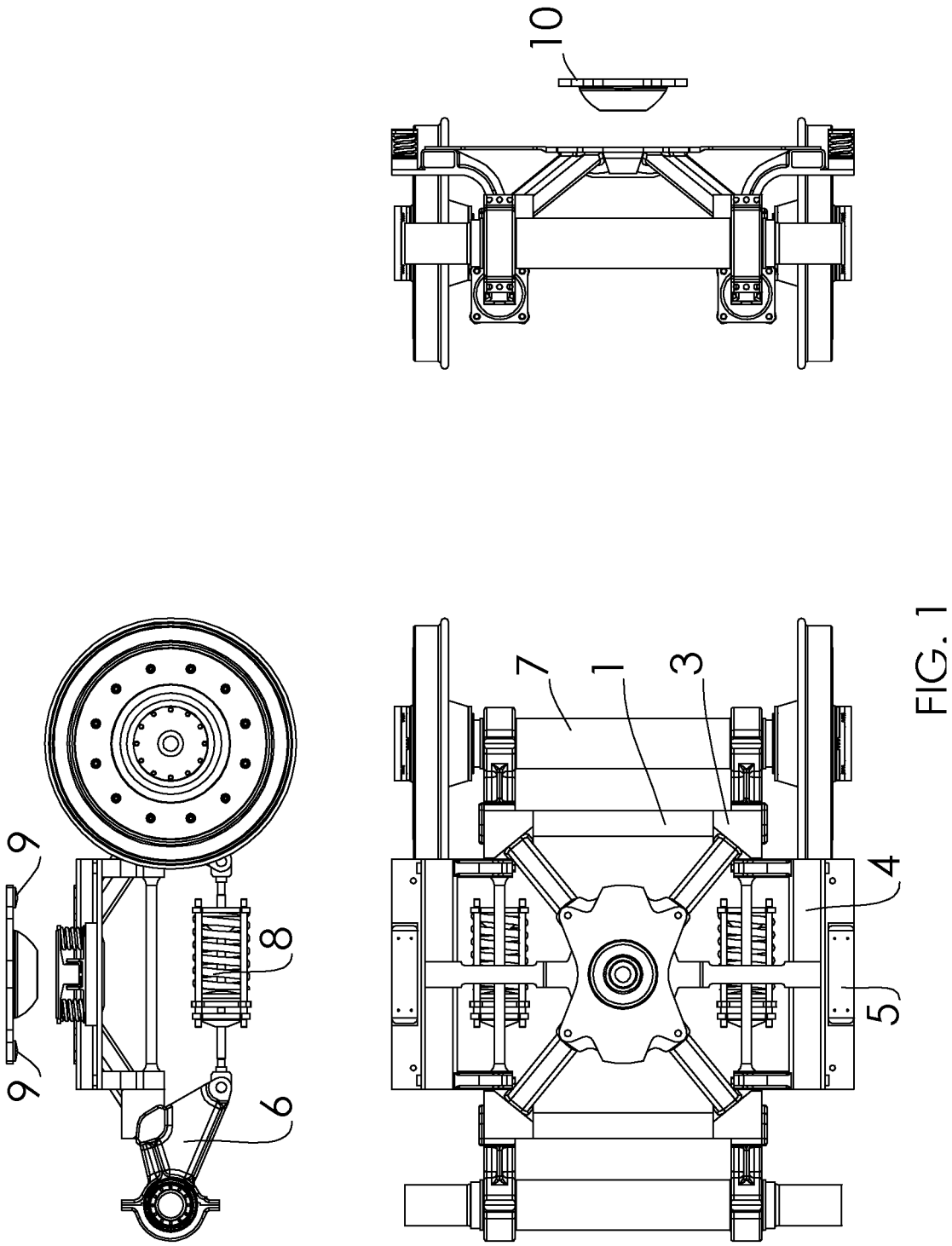

FIG. 1

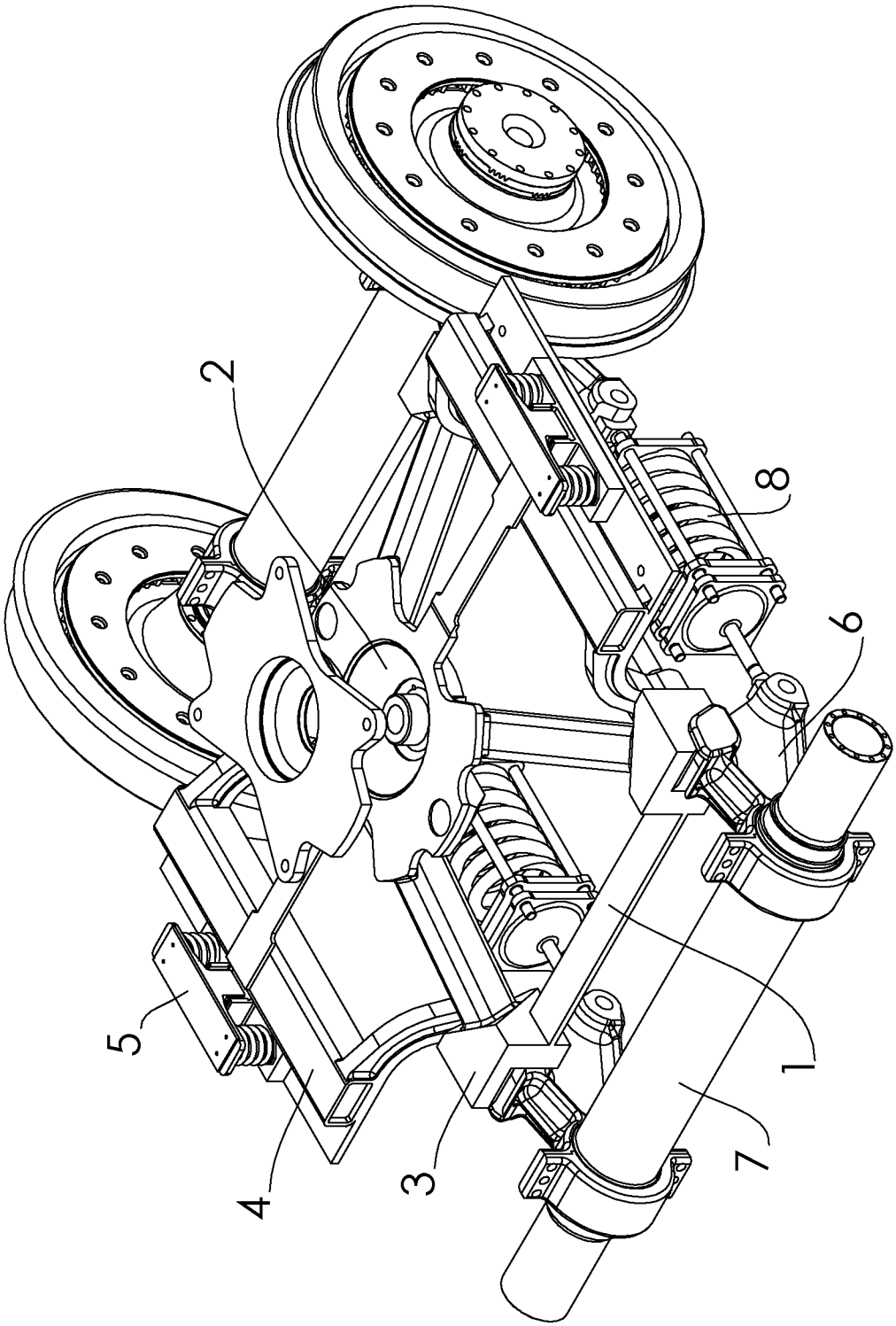

FIG. 2

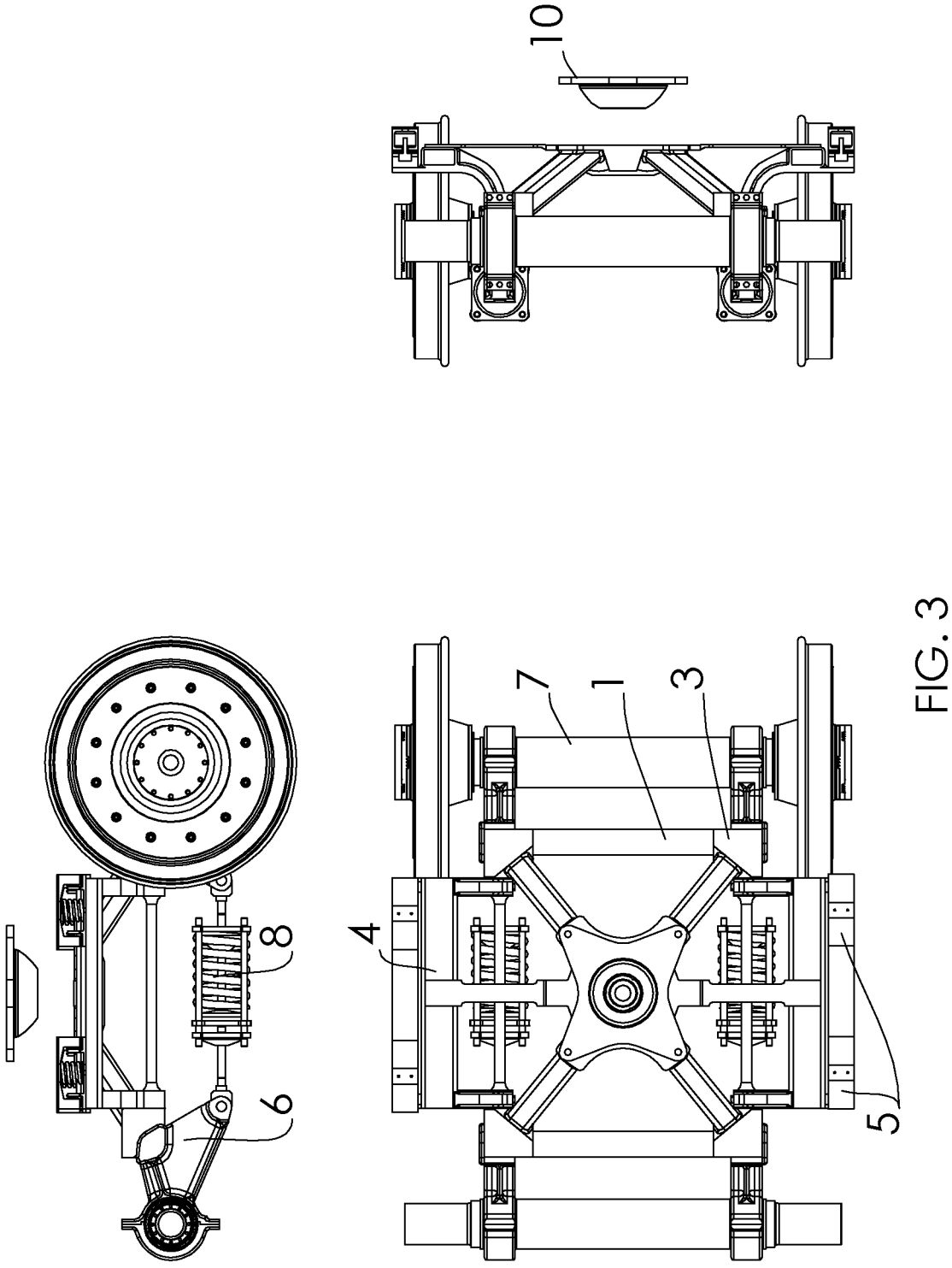

FIG. 3

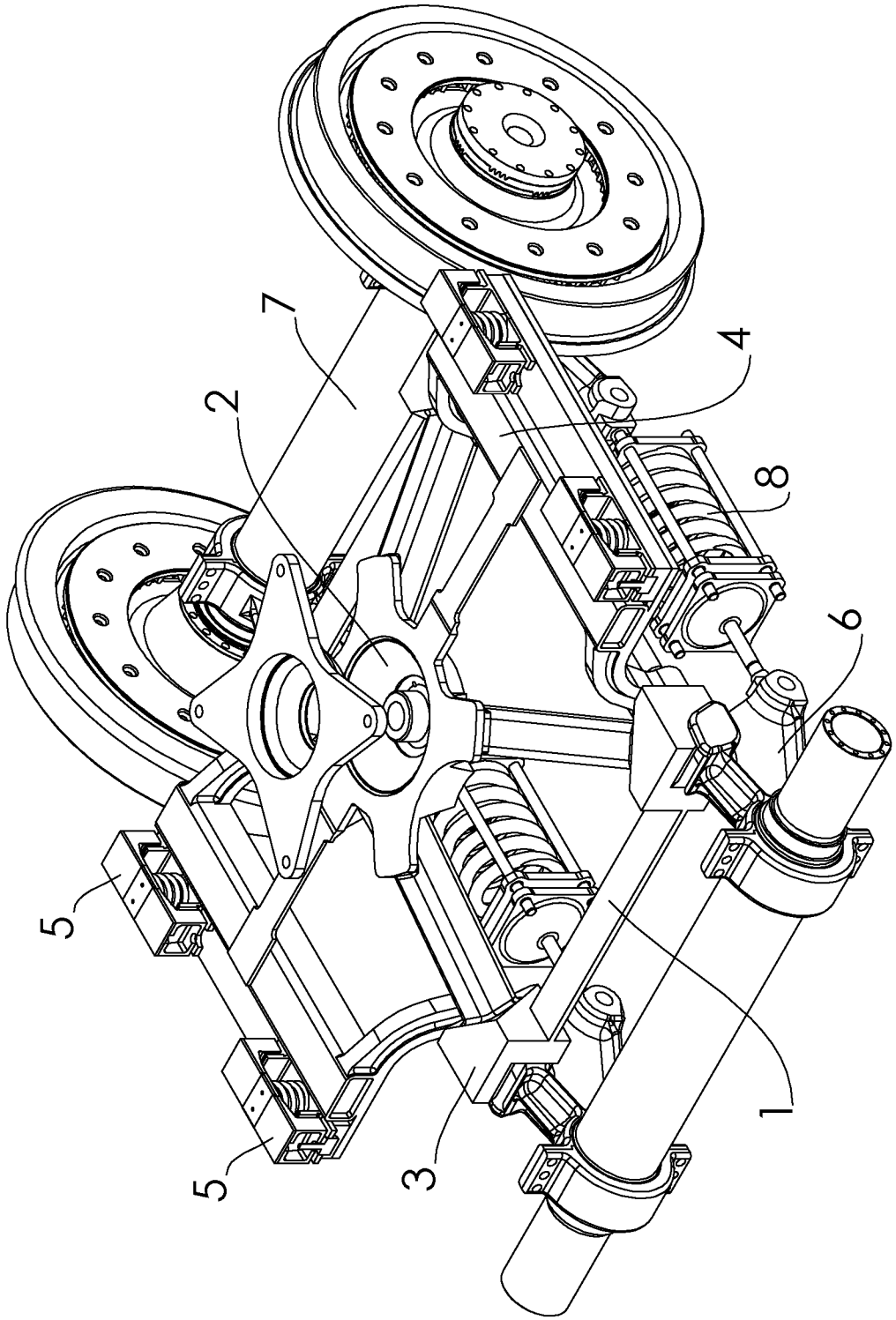

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2019/050240

A. CLASSIFICATION OF SUBJECT MATTER
INV. B61F5/14 B61F5/16 B61F5/30 B61F5/32 B61F5/52
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 2 981 207 A (FELIX PAULSEN JEAN) 25 April 1961 (1961-04-25) the whole document -----	1,3,5-10
A	WO 2007/036234 A1 (THULE SWEDEN AB [SE]; NIELSEN BJARKE [DK] ET AL.) 5 April 2007 (2007-04-05) the whole document -----	1
A	DE 883 292 C (WEGMANN & CO) 16 July 1953 (1953-07-16) the whole document -----	1
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
6 February 2020	24/02/2020

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2019/050240

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 356 775 A (PATON H NEIL ET AL) 2 November 1982 (1982-11-02) figures 1,25 -----	3,10
A	US 2 957 433 A (ROSSELL WILLIAM T) 25 October 1960 (1960-10-25) figures -----	4

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IT2019/050240

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