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

(11) **EP 4 242 085 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
13.09.2023 Bulletin 2023/37

(21) Application number: **23160975.1**

(22) Date of filing: **09.03.2023**

(51) International Patent Classification (IPC):
B61F 3/10 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B61F 3/10; B61F 5/38

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **10.03.2022 IT 202200004646**

(71) Applicant: **AAR Ingegneria di Ferrario Roberto & C. S.a.s.**
17024 Finale Ligure (SV) (IT)

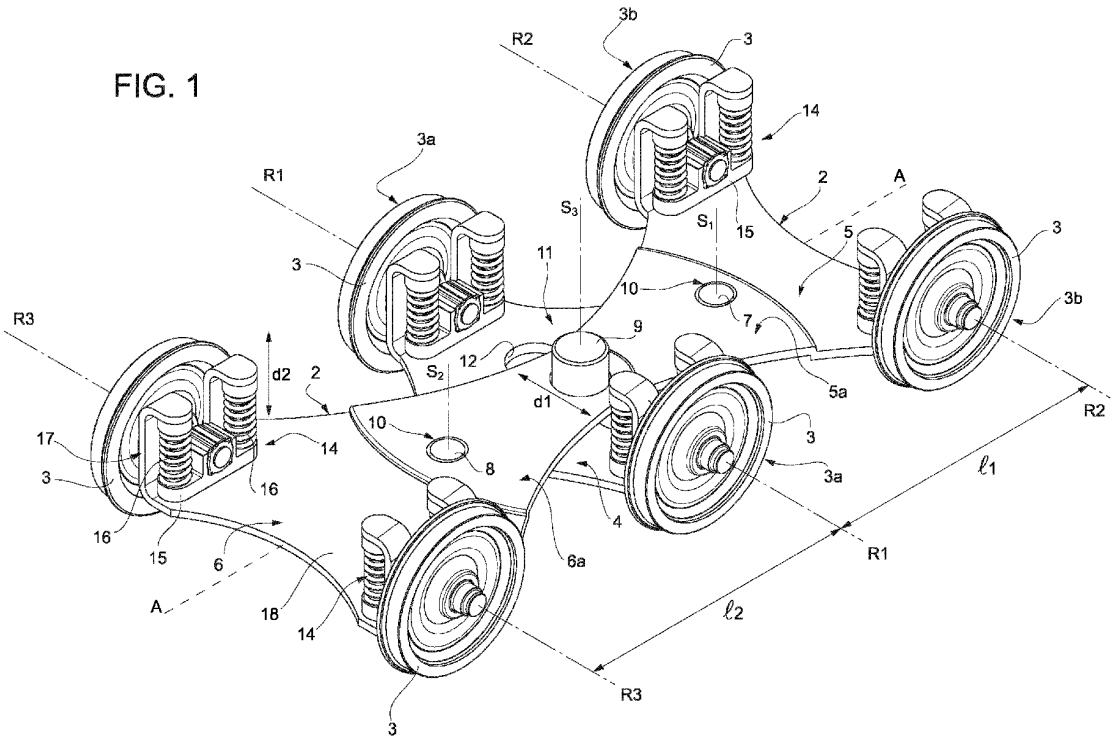
(72) Inventor: **FERRARIO, Roberto**
17024 Finale Ligure (SV) (IT)

(74) Representative: **Studio Torta S.p.A.**
Via Viotti, 9
10121 Torino (IT)

(54) IMPROVED RAILWAY BOGIE AND RAILWAY VEHICLE EQUIPPED WITH SUCH BOGIE

(57) A railway bogie (1) is described, which comprises an articulated frame (2) extending along a longitudinal axis (A) and a plurality of wheels (3) which are carried in a rotatable manner by the articulated frame (2) independently of each other to allow the movement of the railway bogie (1) on a rolling plane (P); the articulated frame (2) comprises a central sub-frame (4) which carries a first pair (3a) of wheels (3), a front sub-frame (5) which carries a second pair (3b) of wheels (3) and is carried in a movable manner by the central sub-frame (4) so as to oscillate about a first rotation axis (S_1) orthogonal to the rolling plane (P), and a rear sub-frame (6) which carries a third pair (3c) of wheels (3) and is carried in a movable manner by the central sub-frame (4) so as to oscillate about a second rotation axis (S_2) orthogonal to the rolling plane (P).

FIG. 1



EP 4 242 085 A1

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims priority from Italian Patent Application no. 102022000004646 filed on March 10, 2022, the entire disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention relates to a railway bogie, in particular a railway bogie with passive steering.

[0003] The following description will make explicit reference to such a use without thereby losing generality.

STATE OF THE PRIOR ART

[0004] As is well known, traditional bogies of a railway vehicle first of all comprise a rigid frame and at least one pair of wheelsets carried by the rigid frame and free to rotate relative to the latter about a rotation axis orthogonal to the vertical mid-plane of the bogie.

[0005] In particular, the wheelsets each comprise a pair of wheels rigidly mutually interconnected by an axle (or wheelset).

[0006] In addition, these wheelsets are mechanically constrained to the rigid frame so that they remain orthogonal to the vertical mid-plane of the railway bogie, i.e., they are not able to rotate about a vertical rotation axis.

[0007] In other words, the wheelsets of traditional railway bogies are not steerable.

[0008] Unfortunately, the railway bogies described above have some technical drawbacks.

[0009] These drawbacks include the fact that the wheels of the railway bogie are not able to arrange themselves parallel to the rails when travelling around a curve.

[0010] As a result, when travelling around a curve, the wheels of the railway bogie slip sideways on the rails, causing a loud screeching noise and speeding up the wear of the rails and wheels of the railway bogie.

[0011] In addition, railway vehicles equipped with the bogies described above are unable to make sharp turns with a bending radius of as little as a few metres, such as, for example, the curves of urban tram or metro lines, with all the problems that this entails.

[0012] Therefore, in this field, there is a need to provide a railway bogie which can overcome the drawbacks mentioned above.

[0013] The object of the present invention is to provide a railway bogie which allows the above-mentioned need to be met in a simple and inexpensive way.

SUMMARY OF THE INVENTION

[0014] Said object is achieved by the present invention, insofar as it relates to a railway bogie according to claim 1.

[0015] Preferred embodiments are described in the directly or indirectly independent claims.

[0016] Moreover, the aforesaid object is achieved by the present invention, insofar as it relates to a railway vehicle according to claim 15.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention will now be described with reference to the accompanying drawings, which illustrate a non-limiting embodiment thereof, wherein:

- Figure 1 is a perspective view of a railway bogie made according to the present invention, with parts removed for clarity,
- Figure 2 is a top view of the railway bogie shown in Figure 1, in a first operating condition and with parts removed for clarity,
- Figure 3 is a top view of the railway bogie shown in Figure 1 in a second operating condition and with parts removed for clarity,
- Figure 4 is a side view of the railway bogie shown in Figure 1, sectioned along the vertical mid-plane and with parts removed for clarity,
- Figure 5 is a front view of the railway bogie shown in Figure 1, with parts removed for clarity, and
- Figure 6 is a partially exploded, perspective view of the railway bogie shown in Figure 1, with parts removed for clarity.

DETAILED DESCRIPTION OF THE INVENTION

[0018] With reference to Figure 1, number 1 indicates, as a whole, a bogie of a railway vehicle, in particular a railway bogie with passive steering.

[0019] Such a railway vehicle can comprise, for example, at least one body (or wagon or carriage) carried by at least one railway bogie 1.

[0020] With reference to Figures 1 to 5, the railway bogie 1 first of all comprises an articulated chassis or frame 2 which extends along a longitudinal axis A, and a plurality of wheels 3 resting on the rails which are carried in a rotatable manner by the articulated frame 2 independently of each other to allow the movement of the railway bogie 1 on a rolling plane (the rail plane) P.

[0021] According to the example shown, the articulated frame 2 comprises a central sub-frame 4 carrying a first pair of wheels 3a.

[0022] The wheels 3a are connected to the central sub-frame 4 on opposite sides of the longitudinal axis A, and rotate about the same rotation axis R_1.

[0023] The rotation axis R_1 is locally orthogonal to the vertical mid-plane of the central sub-frame 4.

[0024] In addition, the articulated frame 2 comprises a front sub-frame 5 which carries a second pair of wheels 3b and is carried in a movable manner by the central sub-frame 4, so that it rotates/oscillates/swings about a rotation axis S_1. In particular, the rotation axis S_1 is orthogonal to the rolling plane P, i.e., it is vertical.

[0025] In greater detail, the front sub-frame 5 is mechanically connected to the central sub-frame 4 via a joint with two degrees of freedom, in particular the rotation about the rotation axis S_1 and the translation along the longitudinal axis A.

[0026] The wheels 3b, instead, are connected to the front sub-frame 5 on opposite sides of the longitudinal axis A and rotate about the same rotation axis R_2.

[0027] The rotation axis R_2 is locally orthogonal to the vertical mid-plane of the front sub-frame 5.

[0028] The rotation axis S_1, on the other hand, is preferably positioned substantially equidistant from the rotation axis R_1 and the rotation axis R_2, i.e., it is positioned approximately in the middle of the wheelbase ℓ_1 between the pair of wheels 3a and the pair of wheels 3b.

[0029] In addition, the articulated frame 2 comprises a rear sub-frame 6 which carries a third pair of wheels 3c and is carried in a movable manner by the central sub-frame 4 so that it rotates/oscillates/swings about a rotation axis S_2 orthogonal to the rolling plane P.

[0030] In greater detail, the rear sub-frame 6 is mechanically connected to the central sub-frame 4 via a joint with two degrees of freedom, in particular the rotation about the rotation axis S_2 and the translation along the longitudinal axis A.

[0031] The wheels 3c are connected to the rear sub-frame 6 on opposite sides of the longitudinal axis A and rotate about the same rotation axis R_3.

[0032] The rotation axis R_3 is locally orthogonal to the vertical mid-plane of the rear sub-frame 6.

[0033] The rotation axis S_2, on the other hand, is preferably positioned substantially equidistant from the rotation axis R_1 and the rotation axis R_3, i.e., it is positioned approximately in the middle of the wheelbase ℓ_2 between the pair of wheels 3a and the pair of wheels 3c.

[0034] Preferably, the front sub-frame 5 and the rear sub-frame 6 are also connected to the central sub-frame 6 on opposite sides along the longitudinal axis A, advantageously in a mirror-like position.

[0035] With reference to the example shown in Figures 1 to 4, in particular, the front sub-frame 5 is carried in a freely rotatable manner by the central sub-frame 4 via a pin 7 coaxial with the rotation axis S_1. The rear sub-frame 6, on the other hand, is carried in a freely rotatable manner by the central sub-frame 4 via a pin 8 coaxial with the rotating axis S_2.

[0036] Preferably, the front sub-frame 5 and the rear sub-frame 6 are also mechanically connected to each other in a rotatable manner, such that they rotate relative to each other about a rotation axis S_3 orthogonal to the rolling plane P.

[0037] In greater detail, the front sub-frame 5 and the rear sub-frame 6 are preferably equipped with corresponding ends 5a and 6a which extend along the longitudinal axis A and locally overlap each other, preferably above the central sub-frame 4.

[0038] Preferably, the ends 5a and 6a are also pivoted to each other through a pin 9 coaxial with the rotation axis S_3.

[0039] In addition, the front 5 and rear 6 sub-frames are mechanically connected in a slidable manner to the central sub-frame 4, so that they can slide in relation to the latter parallel to the longitudinal axis A.

[0040] The pin 7 and the pin 8, in particular, may be lodged in a slidable manner within openings or slots 10 which can be made in the front sub-frame 5 and the rear sub-frame 6, respectively, so as to allow movement/backlash of these sub-frames relative to each other and parallel to the longitudinal axis A.

[0041] In addition, the railway bogie 1 is preferably equipped with an angular backlash limiting device 11, which is configured for limiting the maximum articulation angle of the articulated frame 2, i.e., the maximum rotation angle of the above-mentioned sub-frames relative to each other.

[0042] In greater detail, this limiting device 11 may comprise an oblong-shaped slot 12, which extends in a transverse direction d_1 orthogonal to the vertical mid-plane of the central sub-frame 4 and may be made in the central sub-frame 4, preferably below the ends 5a and 6a of the sub-frames 5 and 6.

[0043] The pin 9 is configured to be lodged in a slidable manner within the oblong slot 12, so that it slides back and forth in the transverse direction d_1 during the rotation of the front 5 and rear 6 sub-frames in relation to the central sub-frame 4.

[0044] It is clear that the size of the oblong slot 12 defines the maximum width of the angular backlash of the articulated frame 2.

[0045] Furthermore, with reference to the example shown in Figures 1, 5 and 6, at least one wheel 3 is mechanically coupled to the articulated frame 2, or rather to the central sub-frame 4, front sub-frame 5 or rear sub-frame 6, via a corresponding suspension assembly 14 (or primary suspension assembly), preferably in a stable but easily removable manner.

[0046] In particular, the suspension assembly 14 comprises a support member 15 which is configured to support the wheel 3 in a freely rotatable manner, and is carried by the articulated frame 2 in a slidable manner, so that it slides in a direction d_2 orthogonal to the rolling plane P in relation to the articulated frame 2, i.e., vertical.

[0047] In addition, the suspension assembly 14 comprises elastic means 16 which are mechanically interposed between the articulated frame 2 and the support member 15, and are adapted to exert forces between them. In other words, the elastic means 16 are configured to dampen the relative movement between the articulated frame 2 and the support member 15. In particular, the elastic means 16 may comprise coil springs.

[0048] With reference to Figures 1 and 5, the articulated frame 2, or rather the central sub-frame 4, the front sub-frame 5 and/or the rear sub-frame 6 comprises at least two lateral shoulders 17 carried by the articulated frame 2 on opposite sides with respect to the longitudinal axis A.

[0049] Preferably, the lateral shoulders 17 are arranged facing each other on opposite sides relative to the longitudinal axis A.

[0050] Each support member 15 is also configured to cooperate in a slidable manner with a corresponding lateral shoulder 17.

[0051] In particular, the support member 15 is preferably T-shaped and carried by the articulated frame 2 so that the horizontal portion of the T faces the rolling plane P.

[0052] In greater detail, the support member 15 preferably comprises a central portion 15a which is configured to carry the wheel 3 in a freely rotatable manner and to cooperate in a slidable manner with the lateral shoulder 17.

[0053] In addition, the support member 15 preferably comprises two lateral portions 15b which extend cantilevered from the central portion 15 in the horizontal direction and are configured to cooperate with the elastic means 16.

[0054] With reference to the example shown in Figures 1 and 5, furthermore, the articulated frame 2, or rather the central sub-frame 4, the front sub-frame 5 and/or the rear sub-frame 6 preferably have an approximately C-shaped cross-section.

[0055] In greater detail, the articulated frame 2 preferably comprises a horizontal base wall 18; the lateral shoulders 17 rise cantilevered from the base wall 18, on opposite sides in relation to the longitudinal axis A.

[0056] Moreover, each lateral shoulder 17 preferably comprises a lateral wall 19 which extends in a vertical direction from the base wall 18, and an upper wall 20 which extends cantilevered in a horizontal direction from the lateral wall 19, spaced above the base wall 18.

[0057] In addition, with reference to the example shown in Figure 6, the lateral shoulders 17, or rather the lateral walls 19, are preferably provided with an opening 21 which extends along the direction d_2 and is configured to lodge in a slidable manner the support member 15. In particular, the opening 21 also extends along the upper walls 20. In other words, the opening 21 is open at the top.

[0058] According to the example shown, the support member 15 is configured to be carried by the articulated frame 2 so that it is free to move along the direction d_2 in the space comprised between the base wall 18 and the upper wall 20.

[0059] In particular, the central portion 15a of the support member 15 is configured to cooperate in a slidable manner with the opening 21, preferably by means of a form-fit coupling.

[0060] In greater detail, one of the axial edges of the opening 21 along the longitudinal axis A and the central portion 15a can comprise a protruding rib 22 which cooperates in a slidable manner with a complementarily shaped groove 23 realized on the other of the axial edge of the opening 21 and the central portion 15a.

[0061] The elastic means 16, on the other hand, are preferably lodged in the space comprised between two lateral shoulders 17 facing each other, i.e., within the articulated frame 2. In particular, the elastic means are preferably arranged adjacent to a corresponding lateral wall 17.

[0062] In greater detail, the elastic means 16 are preferably lodged in the space comprised between a lateral portion 15b of the support member 15 and a corresponding upper wall 20 of the articulated frame 2.

[0063] The operation of the railway bogie 1 will now be described, assuming that it starts from a rectilinear motion operating condition, as shown in Figure 2.

[0064] In this operating condition, the articulated frame 2 is in an aligned operating configuration, i.e., the front sub-frame 5, the central sub-frame 4 and the rear sub-frame 6 are aligned along the longitudinal axis A, and the rotation axes R_1, R_2 and R_3 of the wheels 3 are parallel to each other.

[0065] On the other hand, when travelling around a curve, the front sub-frame 5 and the rear sub-frame 6 rotate relative to the central sub-frame 4 about respective rotation axes S_1 and S_2 in opposite directions, following the profile of the rails. In other words, the articulated frame 2 arranges itself in a rotated operating configuration.

[0066] In this operating configuration, the rotation axes R_1, R_2 and R_3 of the independent wheels 3 are incident to each other and converge towards the instantaneous centre of curvature (not shown) of the curve travelled by the bogie 1.

[0067] In greater detail, when travelling around a curve, the pin 9 translates along the oblong slot 12 in the transverse direction d_1, and the front 5 and rear 6 sub-frames translate parallel to the longitudinal axis A approaching the central sub-frame 4, guided by the movement of the pins 7 and 8 along the corresponding slots 10.

[0068] Considerable and clear advantages are associated with the particular structure of the railway bogie 1.

[0069] Firstly, the railway bogie 1 is able to keep all the wheels 3 perfectly parallel and aligned with the rails when travelling around a curve, drastically reducing the noise produced by the railway vehicle and the wear of the rails and wheels.

[0070] In particular, when travelling around a curve, all the pairs of wheels 3 of the railway bogie 1 arrange themselves with their rotation axis orthogonal to the curve described by the rails, and travel along a circular trajectory with the same bending radius as the rails.

[0071] In addition, the absence of bulky axles rigidly connecting the wheels 3 to each other in pairs frees up the space between the wheels 3 and allows the position of the wagon to be lowered in relation to the bogie 3. Accordingly, the centre of gravity of the railway vehicle 1 can be lowered, with all the benefits that this entails.

[0072] The wheels 3 and the suspension assemblies 14 can also be applied to railway bogies with different rail gauges (track widths) without requiring structural changes to the railway bogie 1.

[0073] In addition, the structure of the railway bogie 1

makes it much easier and cheaper to maintain the railway vehicle 1, because it allows the wheels 3 to be replaced/removed individually and independently of each other.

[0074] In particular, each individual wheel 3 can be removed from the bogie 1 by simply removing the elastic means 16 and lifting the wheel 3 and the support member 15 attached thereto until the support member 15 is disengaged from the articulated frame 2.

[0075] Moreover, the reduced wear of the wheels 3 and the possibility of replacing each wheel 3 easily and independently of the others bring about additional benefits.

[0076] These benefits include the possibility of fitting rims made of high friction materials (e.g., elastomeric, polymer and/or similar materials) on the wheels 3, particularly on the drive wheels, and/or of replacing the wheels 3 or the rims fitted thereto according to the season in which the railway vehicle is used.

[0077] This significantly increases the grip of the wheels 3 on the rails and therefore the performance of the railway vehicle on winding routes, on steep slopes and/or in adverse weather conditions, without compromising the service life of the wheels 3 or affecting operating/maintenance costs.

[0078] Moreover, since the independent wheels 3 are not rigidly constrained to each other by axles, they can rotate at different angular speeds. This greatly reduces the well-known snaking phenomenon, and avoids the use of expensive anti-snaking systems.

[0079] Lastly, it is clear that modifications and variations may be made to the above-described railway bogie 1 without however departing from the scope of the present invention.

[0080] For example, in an alternative, more sophisticated embodiment, not shown, the railway bogie 1 may be equipped with drive units carried by the wheels 3 and configured to provide them with drive torque for moving the railway vehicle on the rails. In particular, these drive units may comprise electric motors operatively coupled to the wheels 3.

[0081] In addition, the railway bogie 1 may also comprise braking units carried by the wheels 3 and configured to brake the railway vehicle. In particular, these braking units may comprise disc brakes operatively coupled to the wheels 3.

[0082] According to one embodiment of the railway bogie 1, the pair of central wheels 3a may carry said drive units, whereas the pairs of front 3b and rear 3c wheels may carry said braking units.

[0083] The positioning of the drive units on the wheels 3 of the railway bogie 1 allows the drive torque to be distributed along the railway vehicle, greatly increasing the traction of the railway vehicle on the rails during acceleration.

[0084] Such use of the drive units significantly increases the performance of the railway vehicle during acceleration and/or on steep slopes, and may avoid the use of traditional sandboxes to increase the grip between the wheels and the rails.

[0085] In addition, according to one embodiment, not shown, the elastic means 16 may be leaf springs operatively interposed between the articulated frame 2 and the support member 15.

[0086] Finally, it is clear that the cross-section of the articulated frame 2 may also be different, such as, for example, a closed cross-section of rectangular and/or similar shape.

[0087] In particular, the articulated frame 2 could comprise a single upper wall 20 extending like a bridge between two lateral walls 19 facing each other on opposite sides in relation to the longitudinal axis A.

Claims

1. A railway bogie (1) comprising an articulated frame (2) which extends along a longitudinal axis (A) and a plurality of wheels (3), which are carried in a rotatable manner by said articulated frame (2) independently of each other to allow the movement of said railway bogie (1) on a rolling plane (P),
said articulated frame (2) comprising:

   - a central sub-frame (4), which carries a first pair (3a) of said wheels (3),
   - a front sub-frame (5), which carries a second pair (3b) of said wheels (3) and is carried in a movable manner by said central sub-frame (4) so as to rotate/oscillate about a first rotation axis (S_1) orthogonal to said rolling plane (P),
   - a rear sub-frame (6), which carries a third pair (3c) of said wheels (3) and is carried in a movable manner by said central sub-frame (4) so as to rotate/oscillate about a second rotation axis (S_2) orthogonal to said rolling plane (P).

2. The railway bogie according to claim 1, wherein said front sub-frame (5) and/or said rear sub-frame (6) are mechanically connected to said central sub-frame (4) by means of a two-degrees of freedom joint.

3. The railway bogie according to claim 1 or 2, wherein said front sub-frame (5) and said rear sub-frame (6) are mechanically connected to each other in a rotatable manner, such that they can rotate relative to each other about a third rotation axis (S_3) orthogonal to said rolling plane (P) .

4. The railway bogie according to claim 1, 2 or 3, comprising an angular backlash limiting device (11), which is configured for limiting the maximum articulation angle of said articulated frame (2).

5. The railway bogie according to any one of the pre-

ceding claims, wherein at least one of said wheels (3) is mechanically coupled to said articulated frame (2) by means of a suspension assembly (14) comprising:

- a support member (15), which is configured to support said wheel (3) in a freely rotatable manner, and is carried by said articulated frame (2) in a slidable manner, so as to slide with respect to said articulated frame (2) along a direction (d_2) orthogonal to said rolling plane (P),
- elastic means (16) which are mechanically interposed between said articulated frame (2) and said support member (15) and are adapted to exert forces between said articulated frame (2) and said support member (15).

6. The railway bogie according to claim 5, wherein said articulated frame (2) comprises two lateral shoulders (17) carried by said articulated frame (2) on opposite sides with respect to said longitudinal axis (A), and the support member (15) of each suspension assembly (14) cooperates in a slidable manner with one of said lateral shoulders (17).

7. The railway bogie according to claim 6, wherein said elastic means (16) are lodged in the space comprised between said lateral shoulders (19).

8. The railway bogie according to claim 6 or claim 7, wherein said support member (15) comprises a central portion (15a) that is configured to carry said wheel (3) in a freely rotatable manner and to cooperate in a slidable manner with said lateral shoulder (17), and two lateral portions (15b) which extend cantilevered from said central portion (15a) and are configured to cooperate with said elastic means (16).

9. The railway bogie according to claim 6, 7 or 8, wherein said lateral shoulders (17) are provided with an opening (21) which extends along said direction (d_2) and is configured to lodge in a slidable manner said support member (15) .

10. The railway bogie according to claim 9, wherein said support member (15) is configured to cooperate in a slidable manner with said opening (21) by means of a form-fit coupling.

11. The railway bogie according to claim 10, wherein one of the axial edges of said opening (21) along said longitudinal axis (A) and said central portion (15a) comprises at least one rib (22), which cooperates in a slidable manner with a complementarily shaped groove (23) realized on the other of the axial edges of said opening (21) and said central portion (15a).

12. The railway bogie according to any one of the claims 6 to 11, wherein said articulated frame (2) comprises a horizontal base wall (18); said lateral shoulders (19) being integral with said base wall (18) and extending vertically cantilevered therefrom.

13. The railway bogie according to claim 12, wherein each lateral shoulder (17) comprises a lateral wall (19), which extends in a vertical direction from said base wall (18), and an upper wall (20), which extends in a horizontal direction from said lateral wall (19), spaced above said base wall (18).

14. The railway bogie according to claim 13, wherein said support members (15) are free to move along said direction (d_2) in the space comprised between said base wall (18) and said upper wall (20);
said elastic means (16) being lodged in the space comprised between said lateral portions (15b) and said upper wall (20).

15. A railway vehicle comprising at least one body carried by at least one railway bogie (1) realized according to any one of the preceding claims.

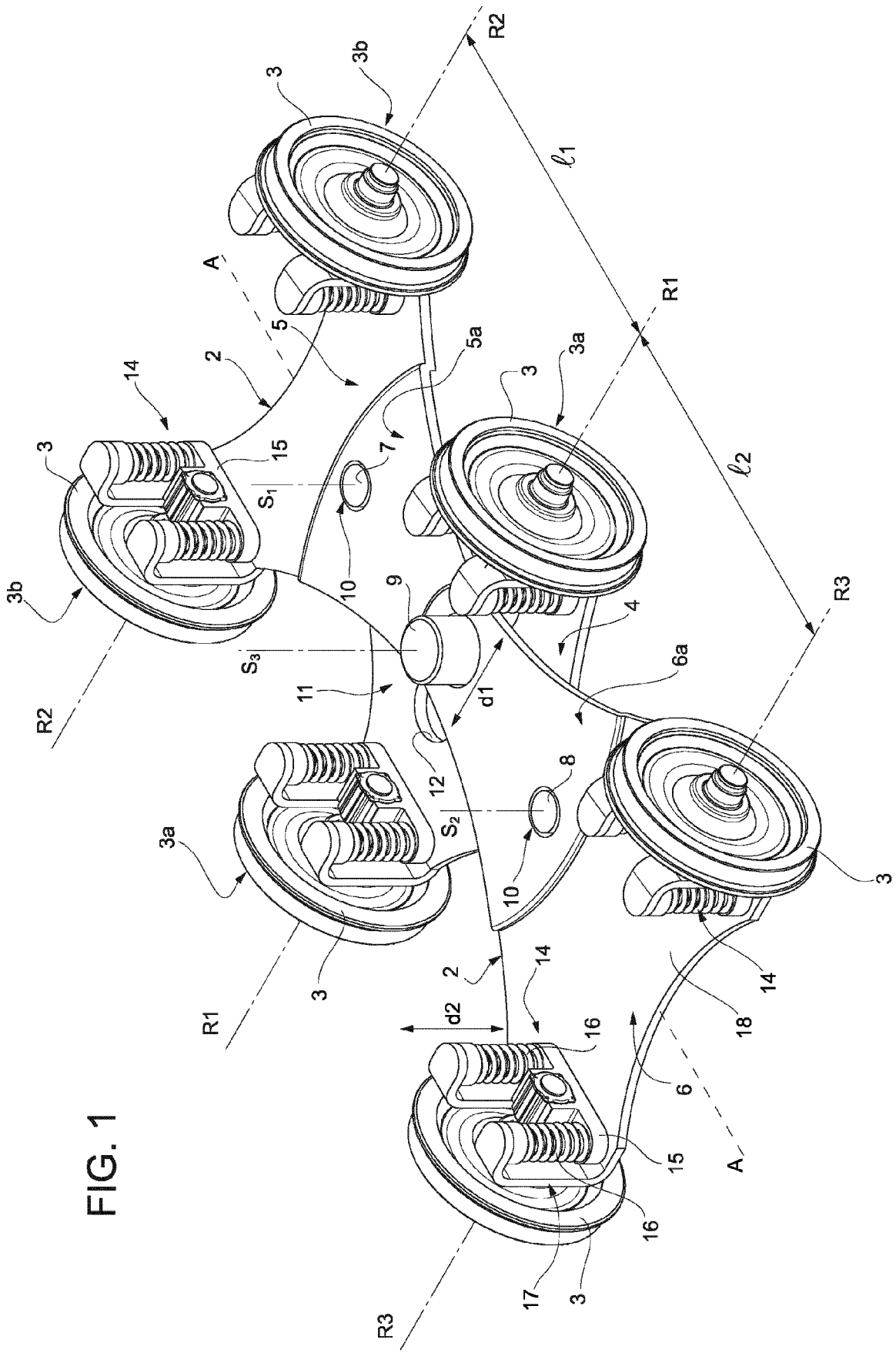

R2
3b
3
ℓ_1
A
R1
5
5a
2
14
3a
3
15
7
S_1
ℓ_2
3
3b
10
9
4
R3
S_3
6a
R2
11
d1
12
8
S_2
3a
10
3
2
14
R1
3
d2
16
18
6
15
A
16
17
3
R3

FIG. 1

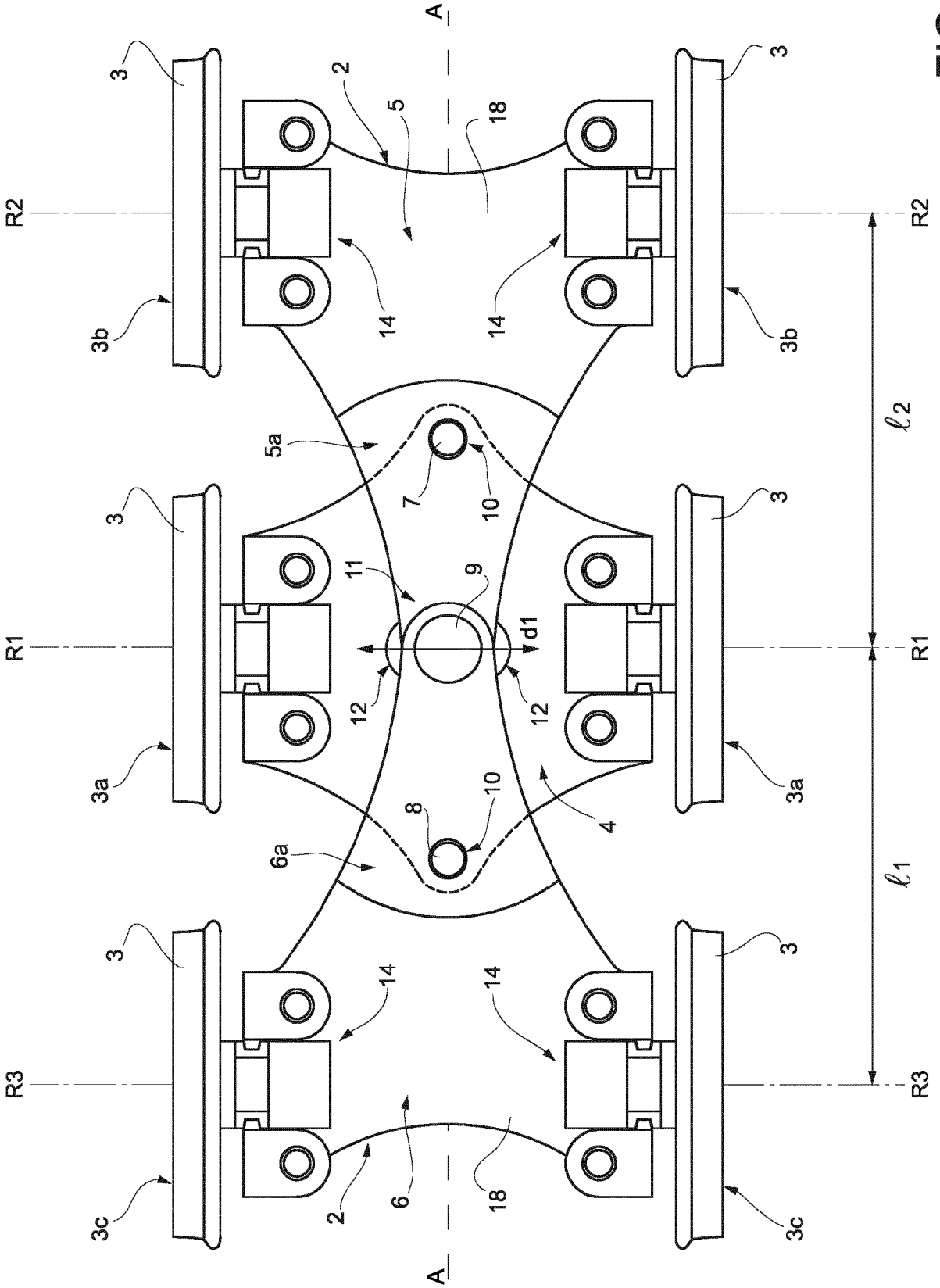


FIG. 2

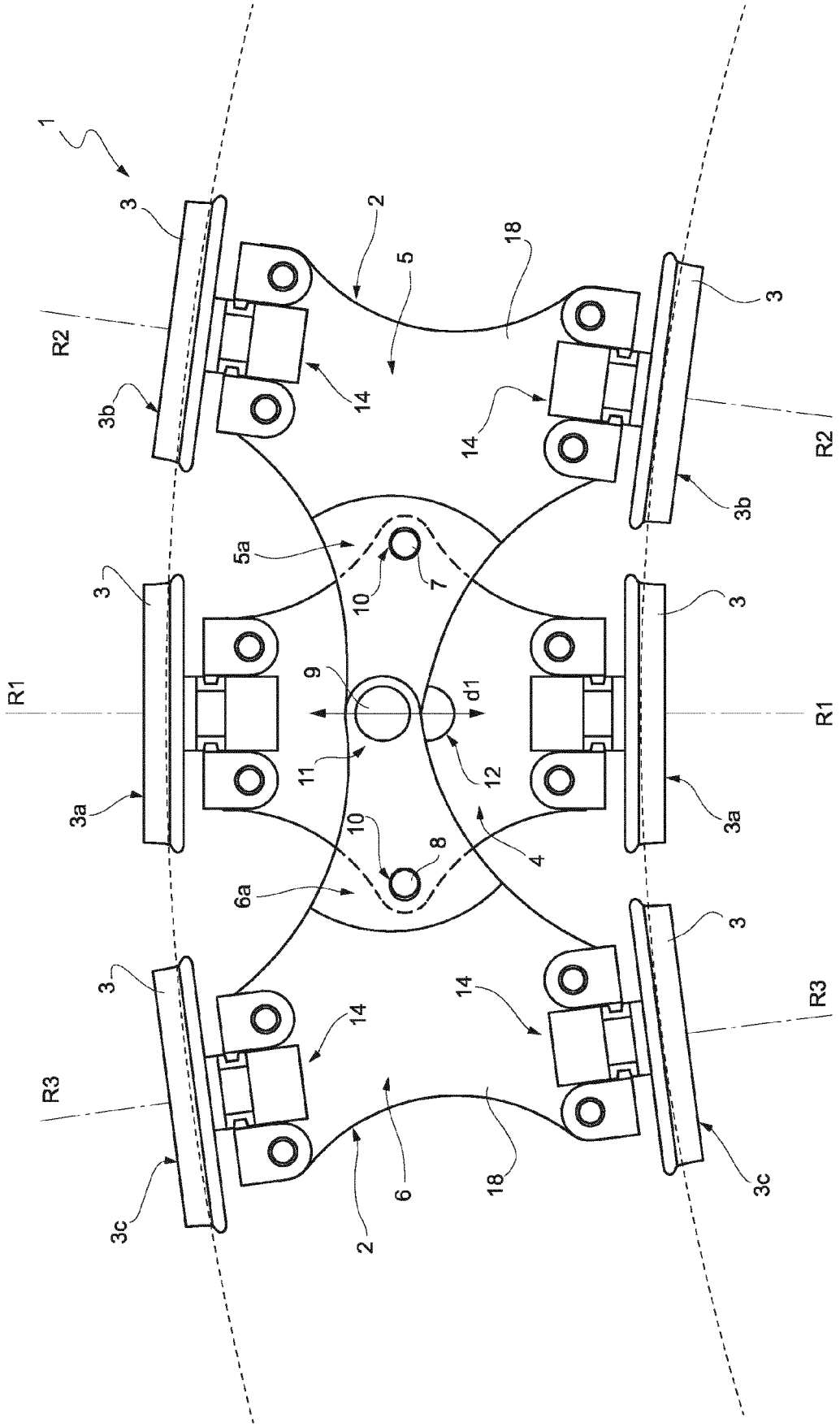


FIG. 3

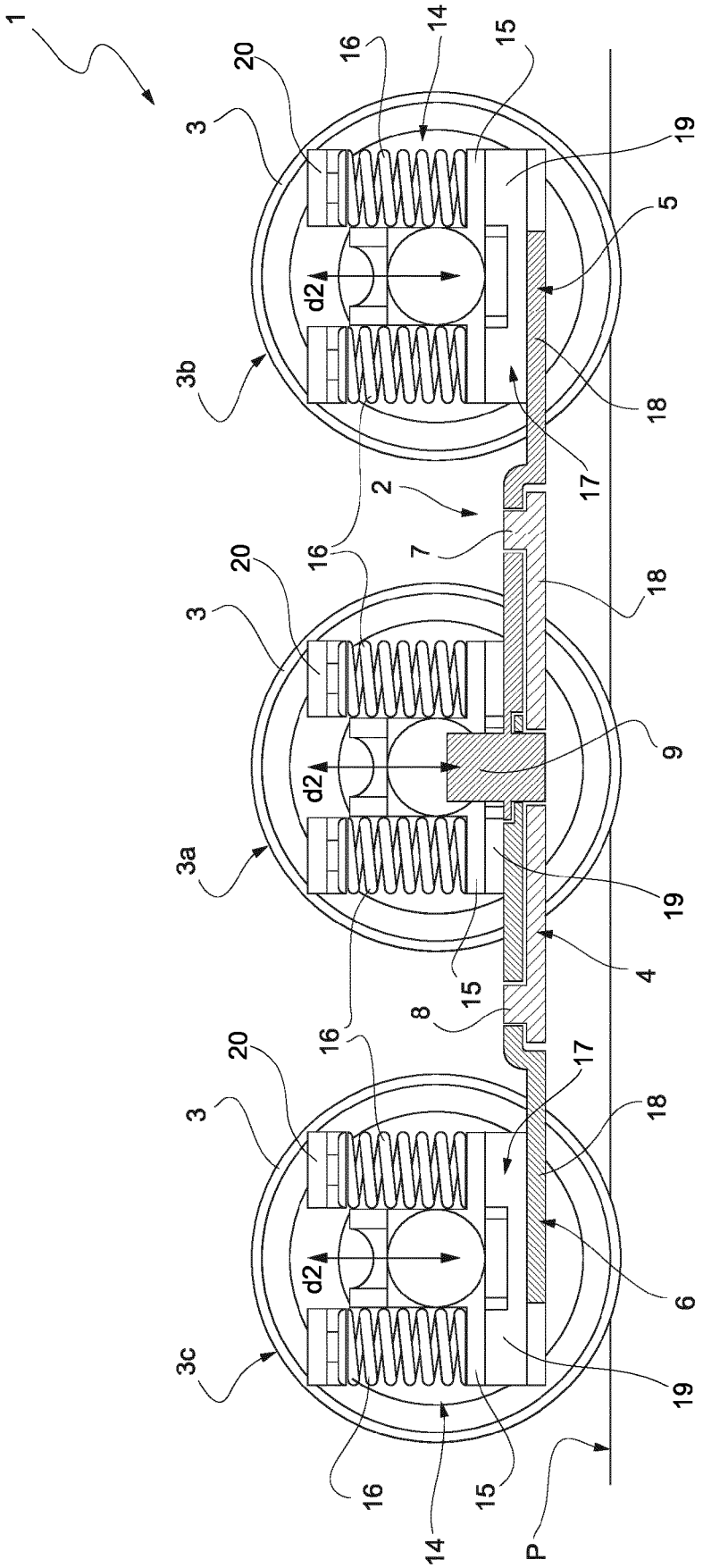

1
20
16
14
15
3
19
5
d2
3b
18
17
2
7
16
20
18
3
9
d2
3a
19
4
15
8
16
20
17
3
18
d2
6
3c
19
16
15
14
P

FIG. 4

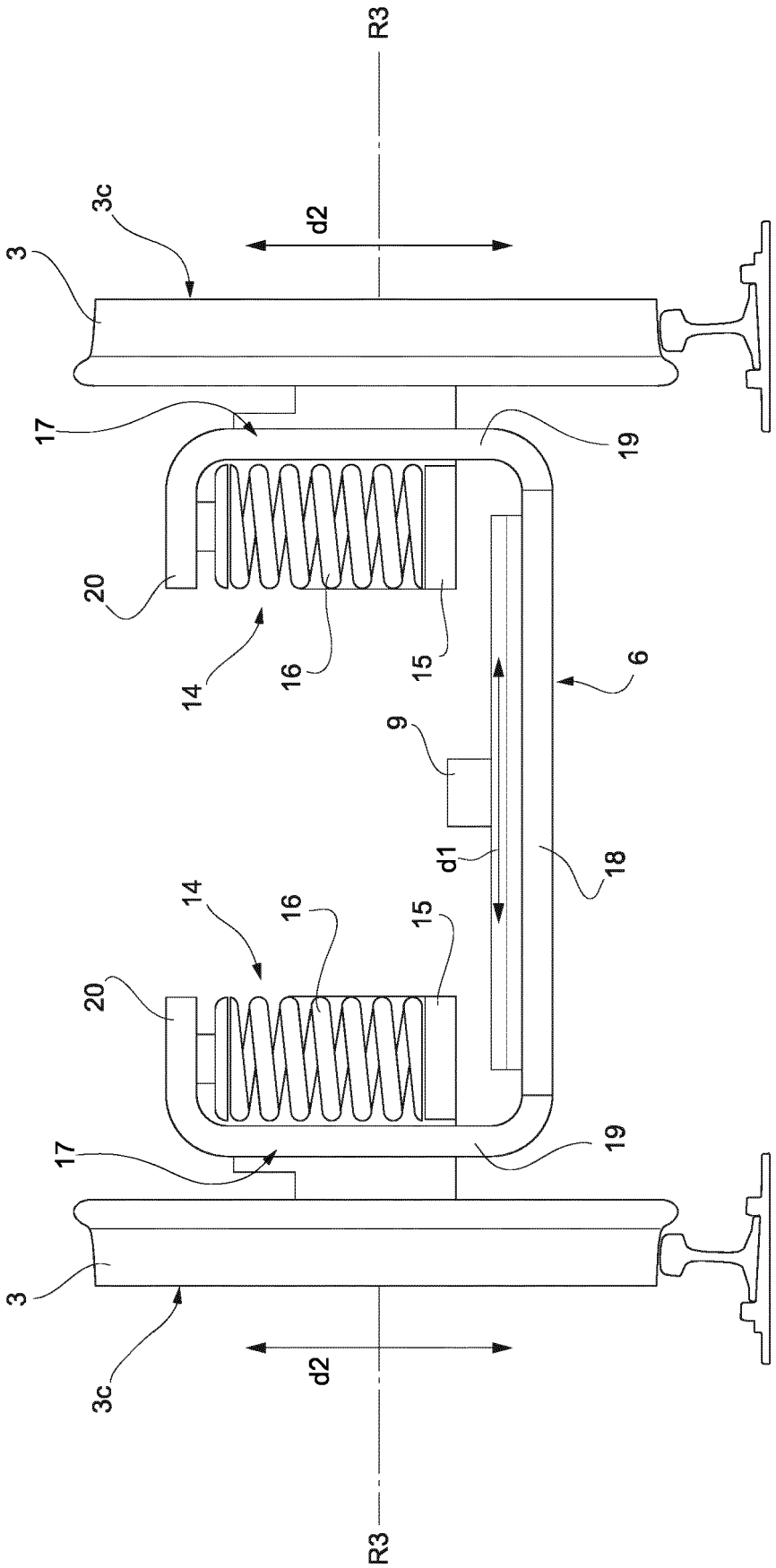


FIG. 5

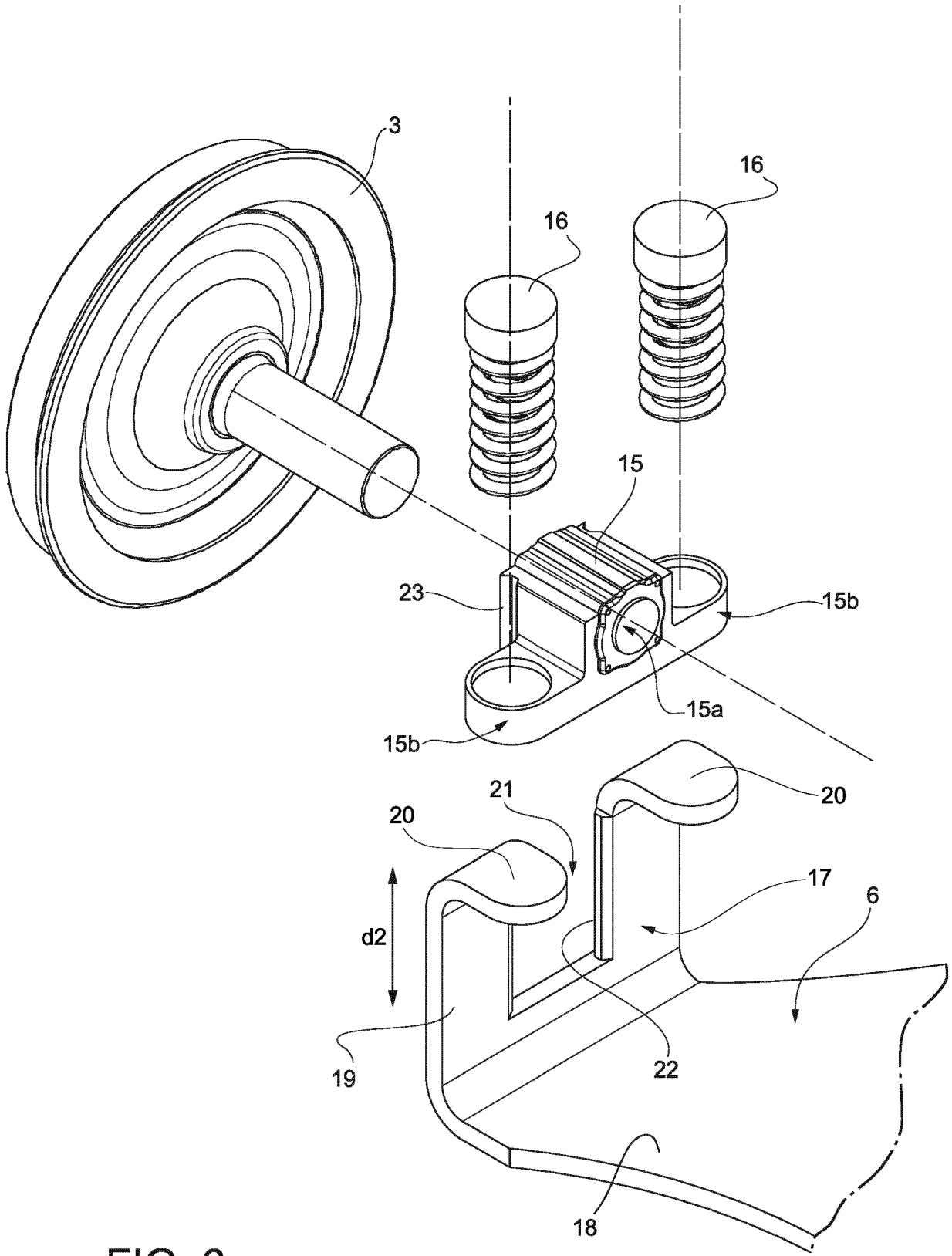


FIG. 6

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 16 0975

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y A	US 422 079 A (EDWARD HUBER) 25 February 1890 (1890-02-25) * column 1, line 26 - line 27; claim 1; figures 1-4 *	1,2, 5-11,15 3,4 12-14	INV. B61F3/10
A	US 4 164 188 A (HALLAM KEITH J [US] ET AL) 14 August 1979 (1979-08-14) * figure 2 *	1,15	
A	EP 2 184 214 A1 (UNIV TOKYO [JP]) 12 May 2010 (2010-05-12) * figures 1,2 *	1,15	
Y A	US 1 728 096 A (PAUL ALGRAIN) 10 September 1929 (1929-09-10) * figures 1,2 *	3,4 1,15	
A	EP 0 727 339 A2 (STORK RMO BV [NL]) 21 August 1996 (1996-08-21) * figure 3 *	1,15	
			TECHNICAL FIELDS SEARCHED (IPC)
			B61F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 June 2023	Lorandi, Lorenzo

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 16 0975

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

12-06-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 422079 A	25-02-1890	NONE	
US 4164188 A	14-08-1979	CA 1070567 A	29-01-1980
		US 4164188 A	14-08-1979
EP 2184214 A1	12-05-2010	EP 2184214 A1	12-05-2010
		JP 5311414 B2	09-10-2013
		JP WO2009017114 A1	21-10-2010
		WO 2009017114 A1	05-02-2009
US 1728096 A	10-09-1929	BE 335989 A	30-09-1926
		BE 336547 A	12-06-2023
		BE 349130 A	31-03-1928
		FR 637188 A	24-04-1928
		GB 278337 A	22-03-1928
		GB 287541 A	05-07-1928
		GB 306549 A	13-03-1930
		NL 20073 C	12-06-2023
		US 1728096 A	10-09-1929
		US 1770827 A	15-07-1930
EP 0727339 A2	21-08-1996	EP 0727339 A2	21-08-1996
		NL 9500315 A	01-10-1996

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- IT 102022000004646 **[0001]**