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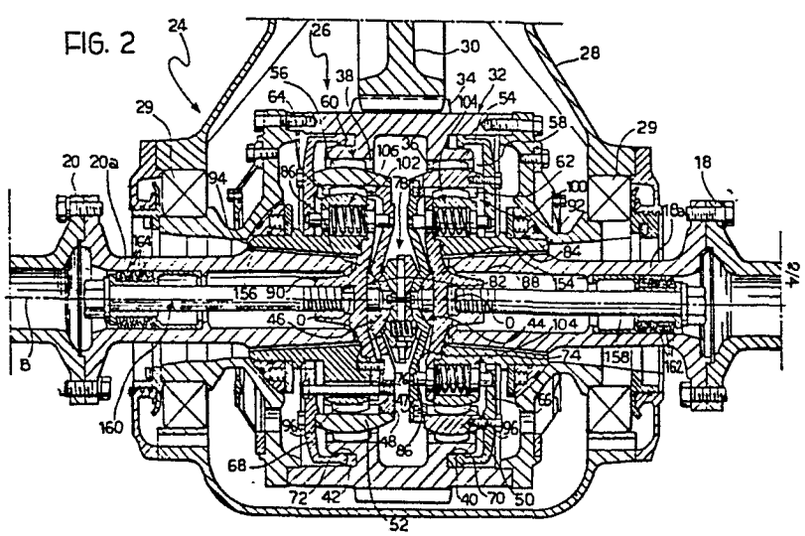
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(54) Transmission system for motor-bogies of railway vehicles, and railway vehicles using this transmission system.

(57) A transmission system for motor-bogies of railway vehicles, having a pair of spaced-apart driving axles (14, 16) driven by at least one drive motor (22, 23) supported by the body of the vehicle, and transmission means between the drive motor and each driving axle, including a coupling (26) with barrel-shaped teeth capable of allowing relative movement of each of the driving axles with respect to the drive motor.

FIG. 2



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Transmission system for motor-bogies of railway vehicles, and railway vehicles using this transmission system

The present invention relates generally to railway vehicles with motor-bogies with a pair of spaced-apart driving axles rotated by at least one drive motor through transmission means between the drive motor and each driving axle.

In particular, the invention concerns railway vehicles of the type defined above, in which the or each drive motor is supported by the body of the vehicle and is therefore independent of and not coupled to the respective bogie.

Similar vehicles, some of which are already in service, like the T.G.V. in France and the Pendolino in Italy, and some of which are still at the design stage, find application in high-speed railway transport systems. In fact, the removal of the weight of the drive motors from bogies, and thus the lightening effect thereof, allows particularly advantageous results to be achieved from the point of view of stability and safety in operation, as well as from that of low "rail aggressiveness".

It is clear that these solutions necessitate the use of transmission members between the drive motors and the driving axles, which should be capable of ensuring the necessary relative movements between these elements, without of course involving any weight increase such as to adversely affect the motion of the bogies.

Until now, the solutions proposed for these transmission members have shown themselves to be poorly functional

from this point of view, involving certain limitations as regards the degree of relative movement between the motors and axles, as well as problems of lubricating and difficulties in servicing the transmissions and the motors.

The object of the present invention is precisely that of avoiding these disadvantages, by providing a transmission system for railway vehicles of the type defined initially, which is capable of ensuring a noticeably greater degree of relative movement between the motors and axles compared to conventional transmission means, ensuring at the same time a drastic reduction in the weight which affects the motion of the bogies and a significant facilitation of the installation of the motors and the changing of the gear ratios.

According to the invention, this object is achieved by means of a transmission system for motor-bogies of railway vehicles, having a pair of spaced-apart driving axles, at least one drive motor supported in such a way that it is not coupled to the bogie, and transmission means between the drive motor and each driving axle, the main characteristic of which lies in the fact that the transmission means include a coupling with barrel-shaped teeth, which connects each driving axle to the drive motor and is capable of allowing relative movement of each of the driving axles with respect to the drive motor.

According to the invention, the coupling with barrel-shaped teeth includes, for each of the driving axles, first and second couplings with barrel-shaped

teeth arranged in series, of which the second is capable of allowing relative movements of the driving axles with respect to the drive motor of a degree greater than a threshold value corresponding to the maximum degree of movement allowed by the first coupling.

The transmission system according to the invention is capable of allowing angles and relative movements of a significant degree between the axles and motor, and permits the following important advantages to be achieved compared with conventional solutions:

- a drastic reduction in the weight which affects the motion of the bogie;
- an increase in the moment of inertia of the body of the vehicle and thus a reduction in the frequency of all motions thereof;
- ease of installation of motors with very varied characteristics (particularly fast and powerful motors);
- ease of lubrication;
- ease of changing of the gear ratio and therefore the type of service of the vehicle.

Moreover, the parasitic motions characteristic of bogies (second vertical frequency, pitching, and transverse and longitudinal rolling) involve noticeably reduced masses and therefore lose importance to the effects of all the trouble and stresses that they cause. These parasitic motions do not, on the other hand, have any effect on the transmission system.

In short, the transmission system according to the invention gives the bogie in which it is used considerable stability, above all laterally, at the

same time reducing the "rail aggressiveness" of the vehicle.

According to the invention, the coupling with barrel-shaped teeth includes for each of the driving axles:

- an annular rotary input member rotated by the drive motor about a fixed axis parallel to the longitudinal axis of the bogie and having internal teeth,
- a rotary output member for rotating the driving-axle, the output member being arranged concentrically with the input member and having external teeth,
- an intermediate annular rotaty member interposed concentrically between the input member and the output member and having external teeth which engage the internal teeth of the input member through a first coupling with barrel-shaped teeth, and internal teeth which engage the external teeth of the toothed output member through a second coupling with barrel-shaped teeth; the first coupling with barrel-shaped teeth allowing oscillations of the output member together with the intermediate member relative to the input member up to a pre-established maximum angular value, and the second coupling with barrel-shaped teeth allowing further oscillations of the output member relative to the input member of a degree greater than this pre-established maximum angular value.

The invention will now be described in detail with reference to the appended drawings, provided purely by way of a non-limiting example, in which:

Figure 1 is a schematic view of a motor-bogie of a railway vehicle, provided with a transmission system according to the invention,

Figure 2 is a vertical sectional view of the transmission system according to the invention,

Figure 3 shows a detail of Figure 2 in section and on an enlarged scale,

Figure 4, 5 and 6 are three diagrams which illustrate schematically a part of the transmission system in three different operating conditions,

Figure 7 illustrates a variant of Figure 1, and

Figure 8 is a plan view of Figure 7 from above.

Referring initially to Figure 1, by 10 is schematically indicated a motor-bogie of an electric locomotive, the body of which is partially indicated 12.

In known manner, the structure of the bogie 10 supports a pair of spaced-apart axles comprising respective driving axles 14, 16 driven by an electric drive motor 22 through two drive-shafts 18, 20. The motor 22 is supported by the body 12 and is therefore not coupled to the bogie 10, and drives the two drive-shafts 18, 20 by means of a transmission system, generally indicated 24 in Figure 1.

Referring now in greater detail to Figure 2, the transmission system 24 comprises a coupling 26 contained in a lubricating casing 28 out of which the two drive-shafts 18, 20 project through seals,

and driven in rotation by means of a gear wheel 30 forming part of a reduction gear incorporated in the casing 28 and driven by the shaft of the drive motor 22. The axis of rotation of the wheel 30 is parallel to the longitudinal axis L of the bogie 10.

The coupling 26 includes an annular input member 32 supported rotatably by the casing 28 about an axis B parallel to the axis of rotation A of the toothed wheel 30 by means of rolling bearings 29. The input member 32 has an external ring gear 34 meshing with the gear wheel 30, and a pair of axially spaced internal gears 36, 38. Between each of the sets of teeth 36, 38 and the external body of the input member 32, is defined a lateral annular stop surface 40, 42 the function of which will be explained below.

Two intermediate rotary members 44, 46, each comprise a disc-like part 47, 48 carrying an annular part 50, 52 concentric on 0,0' with a respective internal gear 36, 38 of the input member 32.

Each annular part 50, 62 has an external ring gear 54, 56 with barrel-shaped teeth which mesh with the internal gears 36, 38 of the input member 32 in such a way as to define a respective first coupling 58, 56 with barrel-shaped teeth.

Each annular element 50, 52 also has an internal gear 62, 64 and is provided, on its end opposite the respective disc 47, 48, with an annular member 66, 68 forming respective stops 70, 72 for cooperating with the stop surfaces 40 and 42 in the manner explained in what follows.

The disc parts 47 and 48 of the two rotary input members 44 and 46 have central coupling parts 74, 76 with spherical surfaces, which are articulated together by an articulated coupling of known type, for example an Oldham coupling 78, which will not be described in these details for the sake of brevity.

Two rotary output members 80, 82 are coupled for rotation with the two drive-shafts 18, 20 respectively.

Each output member 80, 82 comprises a disc-like part 84, 86 forming an internally threaded hub 88, 90 and an externally splined hub with a conical surface 92, 94 facing the respective drive-shaft 18, 20.

In addition, each rotary output member 80, 82 has an external ring gear 96, 98 with barrel-shaped teeth which meshes with the internal gear 62, 64 of the respective intermediate rotary member 44, 46 in such a way as to define a respective second coupling 100, 102 with barrel-shaped teeth.

It should be noted that the gears 36, 54, 62 and 96 on the one hand, and the gears 38, 56, 64 and 98 on the other hand, that is, the first and second couplings 58, 100 and 60, 102 with barrel-shaped teeth, are arranged concentrically on 0 and 0' repsectively.

While, as stated above, the rotary input member 32 and each intermediate rotary member 44, 46 are provided with respective lateral stop means 40, 70 and 42, 72, each rotary output member 80, 82 is coupled axially to the corresponding intermediate rotary member 44, 46 by means of a respective ring centred on 0, 0' and formed by a respective series of

angularly spaced-apart, elastically yielding restraining units 104, 106.

With reference to Figure 3, one of the units 104 will now be described in detail, it being borne in mind that the other units 104 and the units 106 are absolutely identical.

The unit 104 illustrated in Figure 3 comprises a tubular guide element 108 inserted slidably in an axial hole 110 formed in the output member 80 between the external hub part 92 and the ring gear 96. The hole 110 has an intermediate part of larger diameter 112 with which an external annular rebate 114 of the guide element 108 corresponds. A helical compression spring 116 which coaxially surrounds the guide element 114 is inserted in the part 112 and its ends bear against washers 118, 120 the radially internal portions of which bear against the guide element 114 and the radially external portions of which bear against the ends of the widened part 112 of the hole 110 on the output member 80. Clearly, the spring 116 biasses the tubular guide element 108 into a centered position relative to a diametral median plane of the hole 110.

Two axially opposing push rods, indicated 112 and 124, bear in an articulated manner internally against the guide element 108 and externally against the intermediate rotary member 44, in such a way as to permit relative sliding movements between the guide element 114 and the output member 80 against the action of the spring 116. In effect, each push rod 112, 124 is formed by telescopically-engaged external and internal parts, 126,130 and 128, 132 respectively,

having ends with spherical surfaces 134, 136 and 138, 140 arranged in sliding contact with corresponding bearing members with spherical surfaces 142, 144 and 146, 148 carried respectively by the intermediate rotary member 44 and the tubular guide element 108. In effect, the bearing elements 142 and 144 are carried respectively by the annular element 66 and by the disc-like part 47 of the intermediate rotary member 44, while the elements 146 and 148 are fitted in correspondence with the central part of the cavity in the guide element 108.

As is evident from Figure 3, the spherical bearing surfaces 134, 138 and 136, 140 of the push rods 122 and 124 are concave, while the complementary spherical bearing surfaces of the elements 142, 144 and 146, 148 are convex. The correct contact pressure between these surfaces is ensured by means of compression springs 150, 152 interposed axially between the parts 126, 128 and 130, 132 of the two push rods 122 and 124.

Returning now to Figure 2, each of the drive shafts 18, 20 has, at its end 18a, 20a within the casing 28, a splined end part with a conical surface 154, 156 engaged in the splined hub 92, 94 of the respective output member 80, 82. The ends 18a,20a are hollow and house respective axial screws 158 160 which are screwed into the internal hubs 88, 90 and urge the ends 18a, 20a towards the disc-like parts 84, 86 of the output members 80, 82 through resilient members 162, 164.

The opposite ends of the drive-shafts 18, 20 are connected to the driving axles 14, 16 through two conventional connections including toothed couplings,

not illustrated.

It will be evident from the foregoing that the couplings 58, 100 and 60, 102 with barrel-shaped teeth each constitute a double coupling with barrel-shaped teeth for the transmission of drive from the drive motor 22 to the respective driving axle 14, 16, thus allowing the necessary angular and axial movement between these axles and the motor supported by the body 12 of the vehicle.

The functioning of the transmission system 24 is illustrated in the diagrams of Figures 4 to 6, in which, for simplicity, only the double coupling with barrel-shaped teeth associated with drive-shaft 18 has been shown schematically. In effect, the functioning of the other coupling with barrel-shaped teeth associated with the drive-shaft 20 is exactly the same.

Figure 4 illustrates the system in static conditions, or in the configuration in which the axis H of the drive-shaft 18 or the output member 80 is aligned with the axis B of the input member 32. Under such conditions, the contact points P_1 between the gears 36 and 54 of the first connection 58 and P_2 between the gears 62 and 96 of the second connection 100 are arranged on a common plane passing through the centre 0 and perpendicular to the axis B. In this position, the respective lateral stop surfaces 40 and 70 of the input member 32 and the intermediate member 44 are spaced from each other.

Small relative dynamic movements between the drive-shaft 18 or the output member 80 and the input member 32 about the centre of rotation 0 are allowed

by the toothed coupling 58 between the respective gears 36 and 54 of the input member 32 and the intermediate member 44. In fact, during these small movements the output member 80 and the intermediate member 44 move together about the centre of rotation 0, since the springs 116 of the restraining members 104 stay in an undeformed condition. The plane passing through the contact points P_1 between the gears 36, 54 and P_2 between the gears 62, 96 of the connections 58 and 100 is inclined to the axis B at an angle equal to that of the inclination between the axis H and the aforesaid angle B. The maximum value of this angle, indicated X in Figure 5, is determined by the abutment between the respective surfaces 70 and 40 of the intermediate member 44 and the input member 32.

Further angular movements of the axis H relative to the axis B from this configuration are permitted by virtue of the relative movements between the output member 80 and the intermediate member 44 rendered possible by the restraining members 104. In fact, when the angle of the axis H relative to the axis B tends to exceed the value of the angle X, the intermediate member 44 is maintained in the stop position of abutment between the surface 70 and the surface 40, while the springs 116 of the restraining members 104 are compressed in the manner illustrated in Figure 6, and consequently the output member 80 slides relative to the guide elements 108. As a result of this, while the plane passing through the contact points P_1 between the gears 36 and 54 of the connection 58 is kept inclined to the axis B at the angle X, the plane passing through the contact points P_2 between the gears 62 and 96 of the

connection 100 can turn about the centre of rotation 0 until it is disposed at an angle with a value Y noticeably greater than X.

It is clear that the value of the angle Y corresponds to the maximum angle in operation between the mechanical members connected by the transmission system.

It should be noted that the invention could also be applied to the case of a twin-motor-bogie provided with an independent motor for each of the driving axles 14, 16.

This configuration is illustrated in Figures 7 and 8, in which the respective drive motors are indicated 22, 23 and drive the shaft 18 and the shaft 20 respectively through a single central unit 25. In this case,the unit 25 is substantially similar to the unit 24 described above, and differs therefrom only in that the input member 32 is divided and is thus constituted by two separate internal ring gears each actuated by a respective motor 22, 23.

CLAIMS

1. A transmission system for motor-bogies (10) of railway vehicles (12), having a pair of spaced-apart driving axles (14, 16) at least one drive motor (22) supported in such a way that it is not coupled to the bogie (10), and transmission means (24, 25) between the drive motor (22) and each driving axle (14, 16), characterised in that the transmission means include a coupling (26) with barrel-shaped teeth, which connects each driving axle (14, 16) to the drive motor (22) and is capable of allowing relative movement of each of the driving axles (14, 16) with respect to the drive motor (22).

2, A system according to Claim 1, characterised in that the coupling (26) with barrel-shaped teeth includes, for each of the driving axles (14, 16), first and second couplings (58, 100; 60, 102) with barrel-shaped teeth arranged in series, of which the second (100, 102) is capable of allowing relative movement of the driving axles (14, 16) relative to the drive motor (22) of a degree (Y) greater than a threshold value corresponding to the value (X) of maximum movement allowed by the first coupling (58, 60).

3. A system according to Claim 1, characterised in that the coupling (26) with barrel-shaped teeth includes, for each of the driving axles (14, 16):

- an annular rotary input member (32) rotated by the drive motor (22) about an axis (B) parallel to the longitudinal axis (L) of the bogie (10) and having internal teeth (36, 38);
- a rotary output member (80, 82) for rotating the driving axle(14, 16), the output member having

external teeth (96, 98) concentric with the teeth (36, 38) of the input member (32);

- an intermediate annular rotary member (44, 46) interposed between the input member (32) and the output member (80, 82) and having external teeth (54, 56) which engage the internal teeth (36,38) of the input member (32) through a first coupling (58, 60) with barrel-shaped teeth, and internal teeth (62, 64) which engage the external teeth (96, 98) of the output member (80, 82) through a second coupling (100, 102) with barrel-shaped teeth;

the first coupling (58, 60) with barrel-shaped teeth being capable of allowing oscillations of the output member (80, 82) together with the intermediate member (44, 46) relative to the input member (32) up to a pre-established maximum angular value (X), and the second coupling (100, 102) with barrel-shaped teeth being capable of permitting further oscillations of the output member (80, 82) relative to the input member (32) of a degree (Y) greater than the pre-established maximum angular value (X).

4. A system according to Claim 3, characterised in that a drive shaft (18, 20) is coupled to the output member (80, 82) for rotation, so as to rotate the respective driving axle (14, 16).

5. A system according to Claim 4, characterised in that the drive shaft (18, 20) is provided with means for the take-up of axial play, including a splined coupling with a conical surface (154, 92; 156, 94) between the shaft (18, 20) and the respective output member (80, 82).

6. A system according to Claim 3 or Claim 4, characterised in that the intermediate member (44,46)

and the input member (32) are provided with lateral stop means(40, 70; 42, 72) which cooperate at the pre-established maximum angular value (X), and in that the intermediate member (44, 46) and the output member (80, 82) are coupled together axially by means of a series of elastically-yielding restraining units (104, 106) so as to allow oscillations of the output member (80, 82) relative to the intermediate member (44, 46) following the intervention of the stop means (40, 70; 42, 72).

7. A system according to Claim 6, characterised in that the restraining units (104, 106) are arranged in a ring concentric with the output member (80, 82) and each includes a tubular guide element (108) inserted with a sliding coupling in an axial hole (110) in the output member (80, 82),resilient means (116) reacting between the output member (80, 82) and the guide element (108) and serving to maintain the guide element (108) in a centered position relative to the hole (110) in the output member (80, 82), and means (122, 124) for effecting an articulated axial connection between the guide element (108) and the intermediate member (44, 46) and capable of allowing relative sliding movement between the output member (80, 82) and the guide element (108) against the action of the resilient means (116).

8. A system according to Claim 7, characterised in that the articulated axial connecting means (122, 124) of each restraining unit (104) comprise a pair of opposing push rods with spherical end surfaces (134, 136, 138, 140) arranged in sliding contact with a pair of external bearings with

spherical surfaces (146, 148) carried by the guide element (108).

9. A system according to Claim 8, characterised in that the spherical end surfaces (134, 136, 138, 140) of the push rods (122, 124) are concave and the spherical surfaces of the external and internal bearings (142, 144, 146, 148) are convex.

10. A system according to Claim 3, characterised in that there is a single drive motor (22) which drives a single input member (32) with two axially spaced-apart sets of internal teeth (36, 38) meshing with the external teeth (54, 56) of intermediate members (44, 46) associated with the two driving axles (14, 16), the intermediate members (44, 46) being interconnected by an articulated coupling (78).

11. A system according to Claim 3, characterised in that there are two drive motors (22, 23) which drive respective separate input members each having a respective set of internal teeth (36, 38) which meshes with the external teeth (54, 56) of the intermediate member (44, 46) associated with a respective driving axle (14, 16).

12. A railway vehicle including a body (12), at least one motor-bogie (10) having a pair of spaced-apart driving axles (14, 16), at least one drive motor (22) supported by the body (12) in such way that it is not coupled to the bogie (10) and a transmission system according to any one of the preceding claims, which connects each driving axle (14, 16) with the or with the respective drive motor (22).

FIG. 1

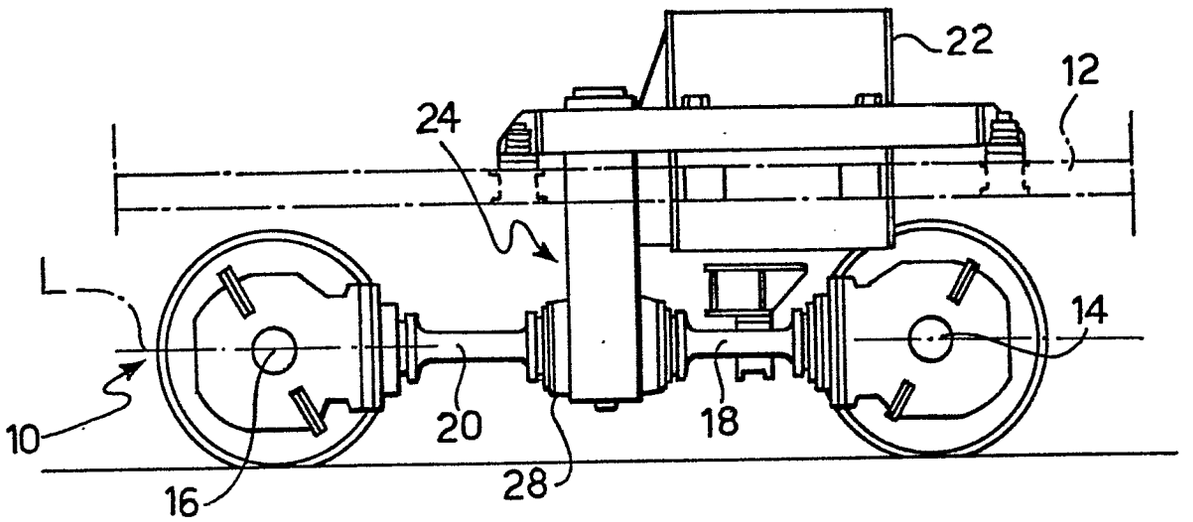
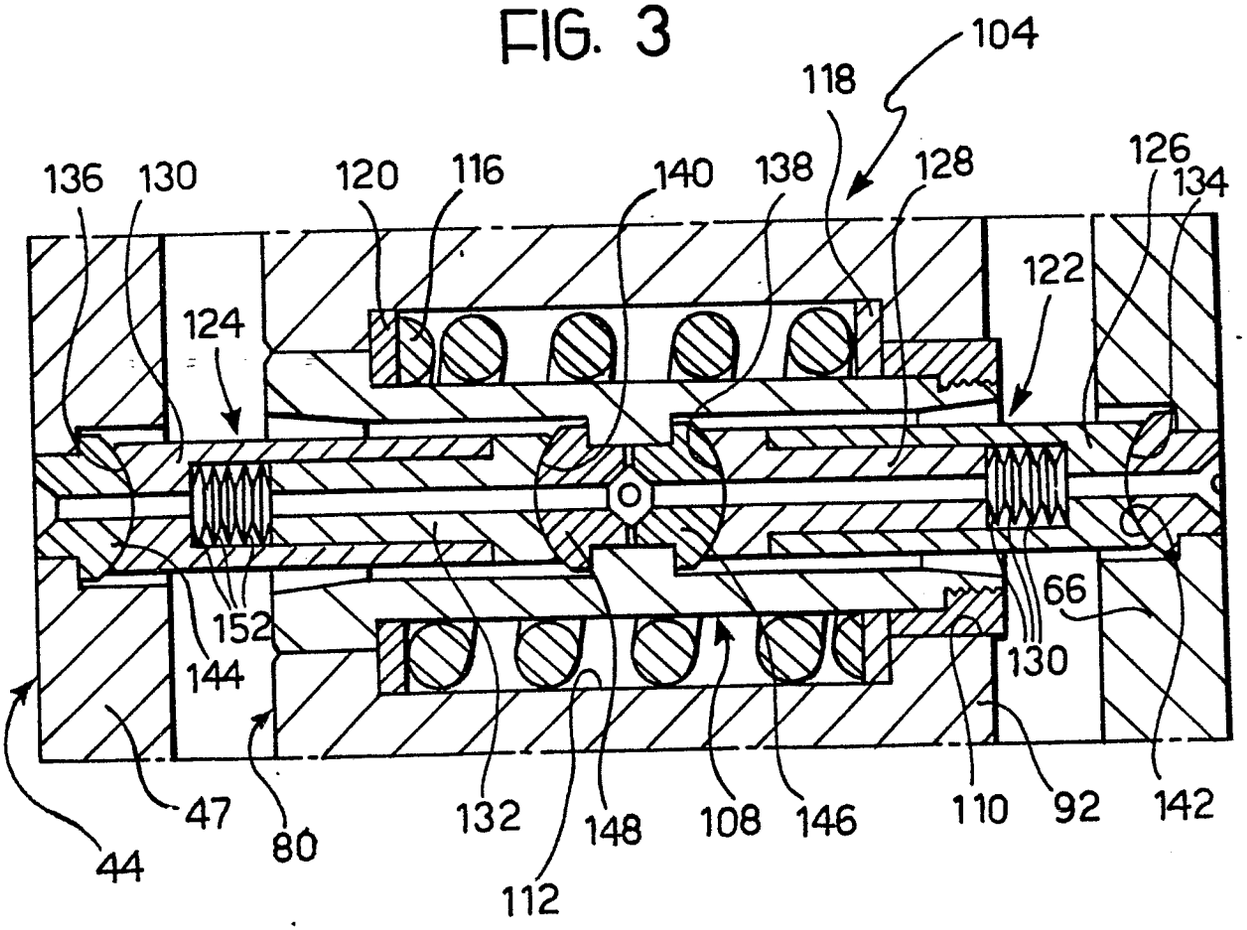

22
12
24
L
14
10
20
18
16
28

FIG. 3


104
118
136
130
120
116
140
138
128
126
134
122
124
66
152
144
130
47
80
132
148
108
146
110
92
142
44
112

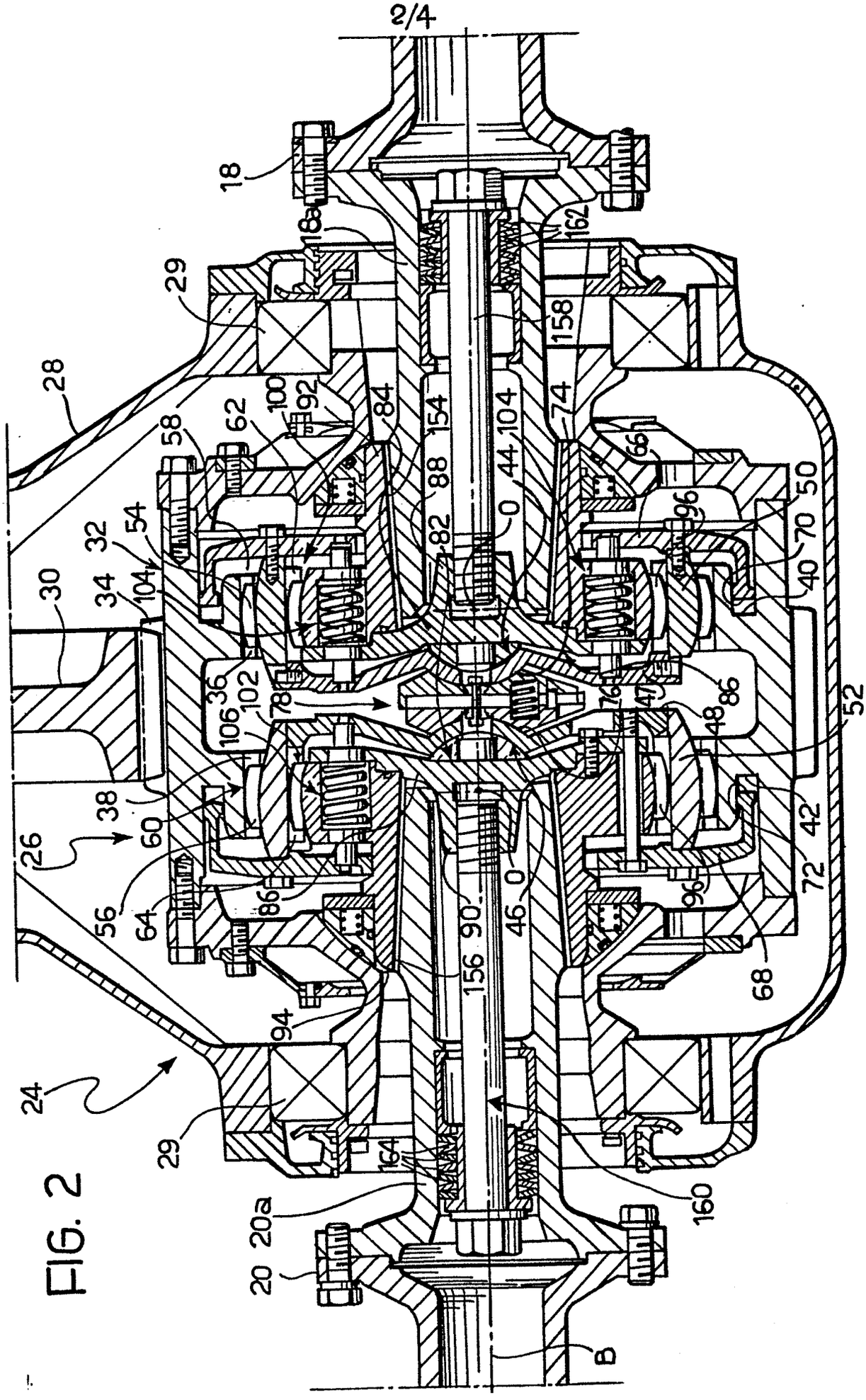

18
18a
162
29
158
28
100
92
84
154
104
74
62
58
88
44
0
82
96
70
50
32
54
34
104
30
40
36
102
106
78
76
47
86
48
52
38
60
26
56
64
86
46
0
96
72
42
90
156
68
94
24
29
164
160
20a
20
B

FIG. 2

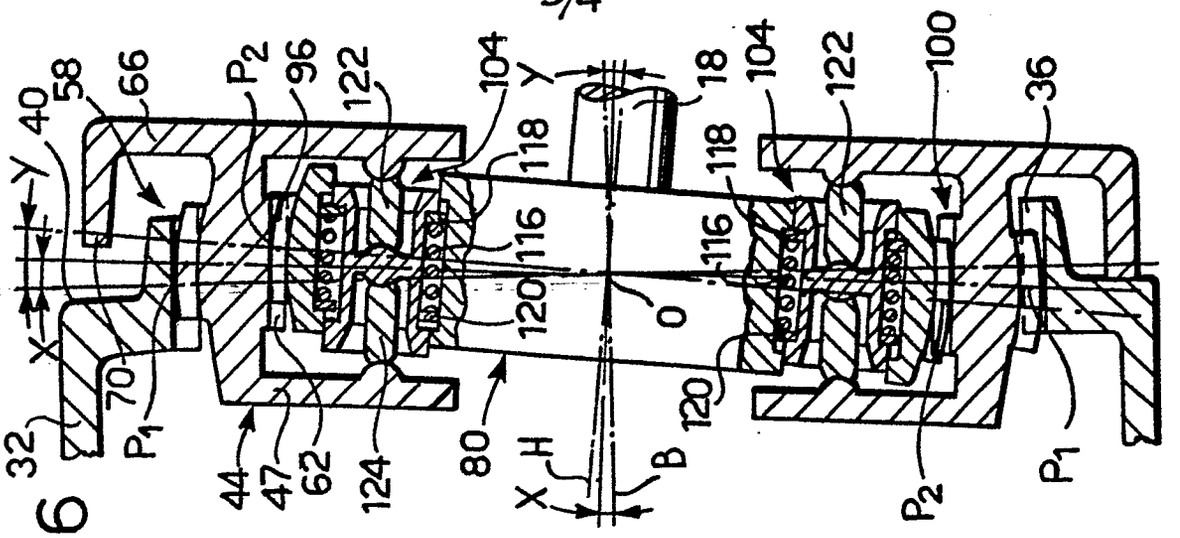


FIG. 6

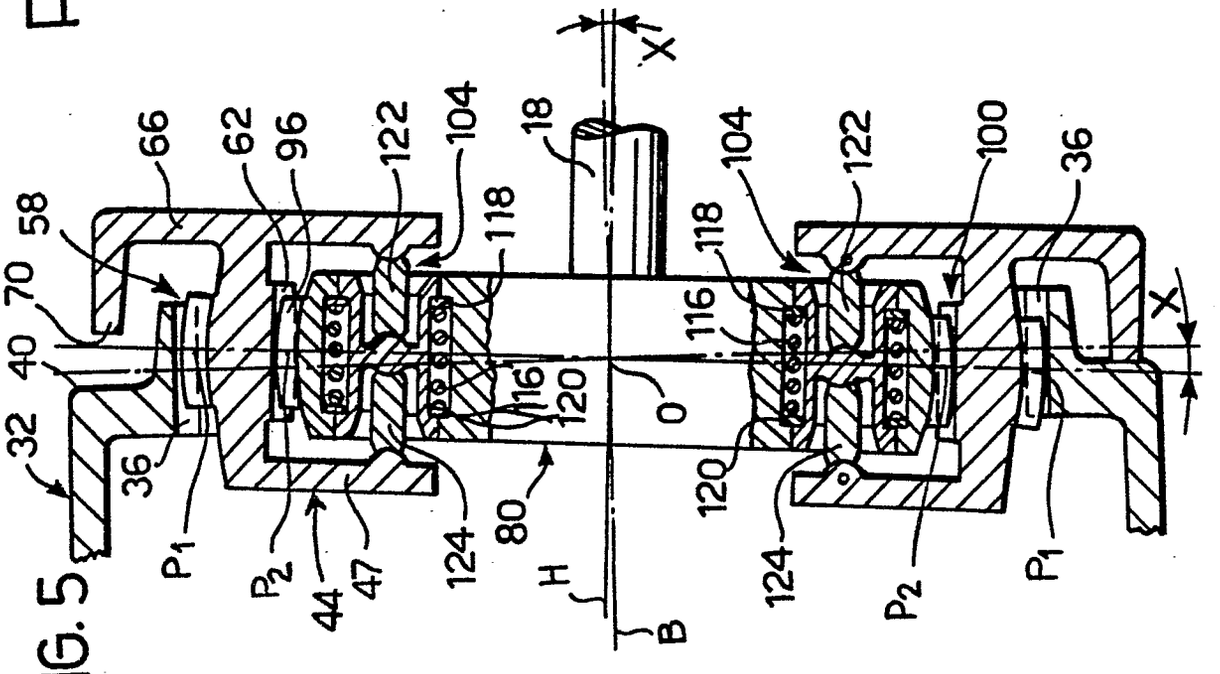


FIG. 5

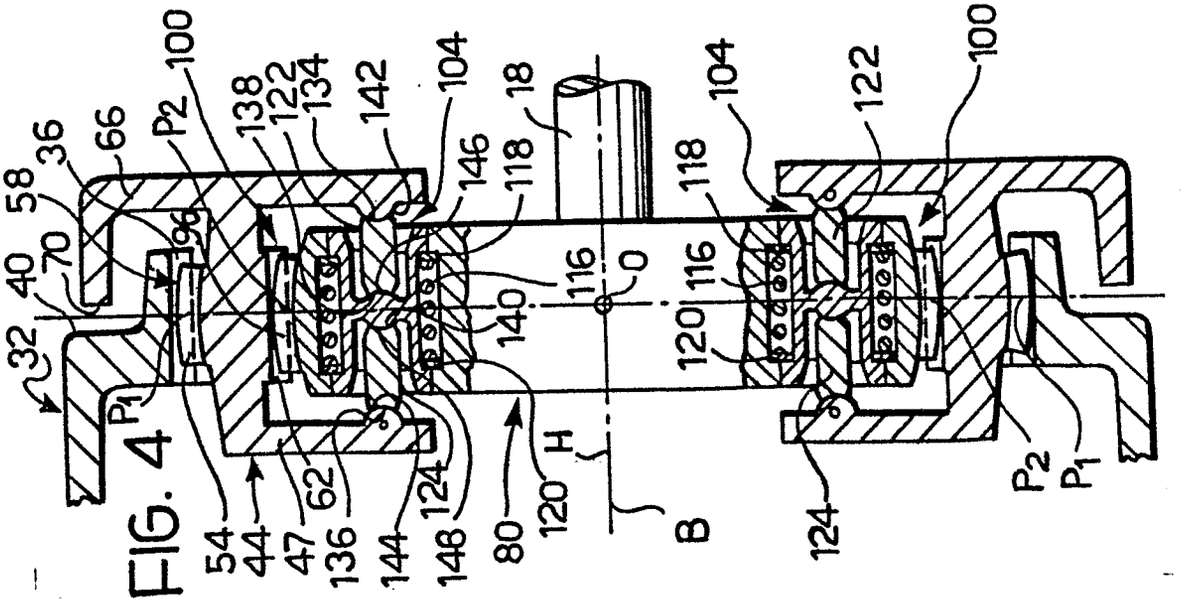


FIG. 4

FIG. 7

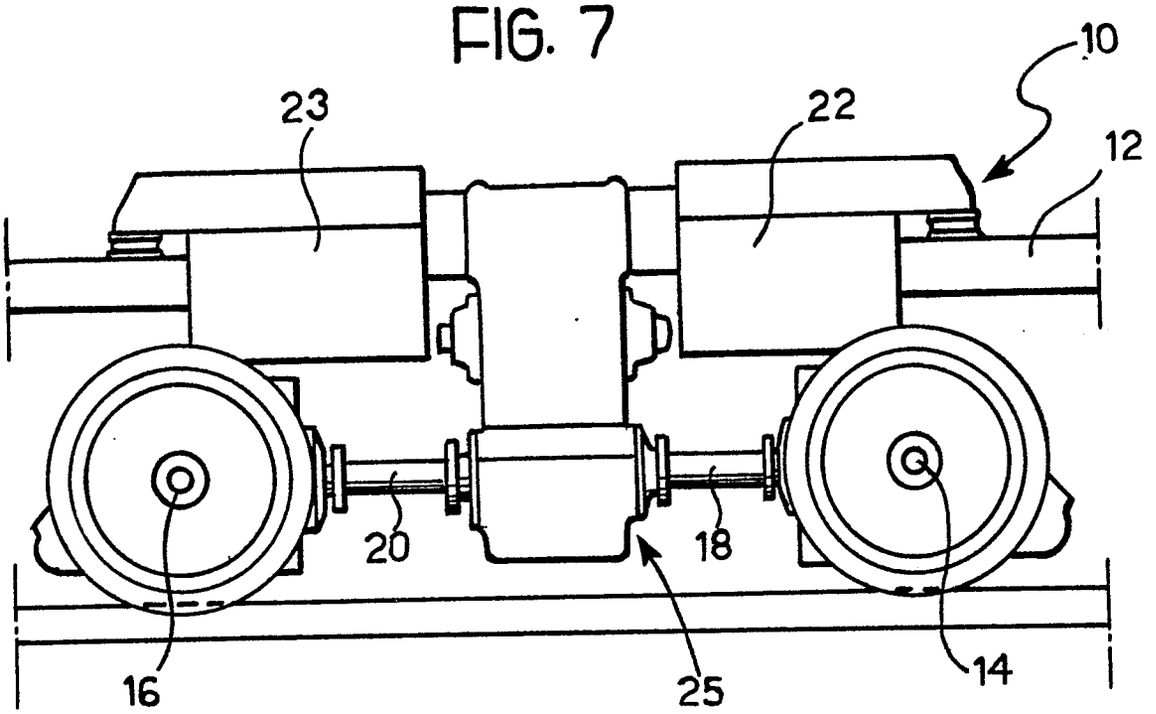


FIG. 8

