

TITLE OF THE INVENTION

Gear-type flexible joint

BACKGROUND OF THE INVENTION**1. FIELD OF THE INVENTION**

The present invention relates to a gear-type flexible joint for flexibly coupling a motor shaft and a pinion shaft of a gear unit and especially relates to the gear-type flexible joint used in a Cardan drive device for a railway electric motor car wherein the motor is fixed on a bogie frame and the gear unit is suspended on an axle which is relatively movable to the motor shaft.

2. DESCRIPTION OF THE PRIOR ART

A conventional bogie for railway electric motor car which is generally known in the art is described referring to FIG.3, which is a plan view showing the constitution of the conventional bogie... In FIG.3, axles 2 are elastically borne on a bogie frame 1 and the axles 2 are movable in the axial direction thereof. Wheels 3 are press-fit to the axles 2. Gear units 4 are suspended on the axles 2 and the bogie frame 1. Traction motors 5 are fixed on the bogie frame 1 in a manner that motor shafts 5a are to be parallel to the center axes of the axles 2. Pinion shafts 4a of the gear units 4 and the motor shafts 5a of the motors 5 are respectively coupled flexibly by gear-type flexible joints 6. A body of the railway electric motor car (not shown in the figure) is mounted on

center plate 7 of the bogie frame 1.

Details of the conventional gear-type flexible joint 6 is described referring to FIGs. 4(A), 4(B) and 4(C). FIG.4(A) is a front view of the conventional gear-type flexible joint. FIG.4(B) is an enlarged sectional front view showing an engagement of an internal gear and an external gear of the conventional gear-type flexible joint shown in FIG.4(A). FIG.4(C) is a sectional side view of the conventional gear-type flexible joint shown in FIG.4(A).

In FIGs.4(A) and 4(C), the conventional gear-type flexible joint 6 comprises a tube shaped coupling sleeve 10, a pair of internal gears 11 and 11' and a pair of external gears 12 and 12'. The internal gears 11,11' are provided on inner peripheries of both ends of the coupling sleeve 10. For example, one of the external gears 12 is fixed on the motor shaft 5a of the motor 5 and the other 12' is fixed on the pinion shaft 4a of the gear unit 4. In FIGs. 4(A), 4(B) and 4(C), numeral 11a designates teeth of the internal gears 11,11' and numeral 12a designates teeth of the external gears 12,12'.

The gear-type flexible joint 6 transmits a torque of the motor 5 to the gear unit 4. Furthermore, the gear unit 4 transmits the torque of the motor 5 to the axle 2. Thereby, the wheels 3 which are fixed on the axle 2 are rotated. Friction force generated between the

wheels 3 and rails (not shown in the figure) acts on the bogie as an attractive force, and thereby, the railway electric motor car moves. Each of the axles 2 is elastically borne on the bogie frame 1 by axle boxes and axle springs (not shown in the figure) for reducing the vibration of the body and improving the comfortableness thereof. When the railway electric motor car starts to move, the wheels 3 and the axle 2 are moved up and down relative to the bogie frame 1 owing to the unevenness of the rail surfaces and/or the gaps at the joint parts of the rails, and so on. Thereby, the axle springs (not shown in the figure), which support the axle 2 via the axle boxes (not shown in the figure), are deflected. Furthermore, the axle 2 is displaced in the axial direction thereof relative to the bogie frame 1 owing to the movement of the axial boxes. As a result, large discordance is produced between each of the center of the motor shaft 5a of the motor 5 and the center of the pinion shaft 4a of the gear unit 4, since the motor 5 is fixed on the bogie frame 1 and the gear unit 4 is suspended on the axle 2. Such discordance between the motor shaft 5a and the pinion shaft 4a is always varied. Therefore, each of the gear-type flexible joints 6 must be flexibly coupled with the motor shaft 5a and the pinion shaft 4a for relatively smoothly transmitting the torque of the motor 5 to the gear unit 4.

In the gear-type flexible joint 6, all the teeth 12a of the external gears 12,12' are engaged with the teeth 11a of the internal gears 11,11'. The gear-type flexible joint 6, however, must have a given discordance between the motor shaft 5a and the pinion shaft 4a where the external gears 12,12' are fixed. Therefore, a specific crowning is provided on each addendum 12f of the tooth 12a of the external gears 12,12' for forming a curved convex face 12b. Furthermore, a given backlash 12c (or a gap between the tooth flanks 12d and 11b which are facing to each other) is provided between each tooth 12a of the external gears 12,12' and the tooth 11a of the internal gears 11,11' which are to be engaged with each other. And also, a given clearance 12e is provided between the addendum 12f of the external gears 12,12' and the dedendum 11c of the internal gears 11,11'. Thereby, the torque of the motor 5 is smoothly transmitted to the gear unit 4.

In the conventional gear-type flexible joint 6 configured above, when the gear-type flexible joint 6 is rotated without transmitting the torque of the motor 5 to the gear unit 4, for example, under the coasting of the railway electric motor car, the teeth 12a of the external gear 12 and the teeth 11a of the internal gear 11 repeatedly collide with each other, because the internal gear 11 and the external gear 12 are freely rotated in the

backlash between the teeth 11a of the internal gears 11, 11' and the teeth 12a of the external gears 12, 12'. As a result, there are problems to be solved that the coupling sleeve 10 having the internal gears 11 occasionally is irregularly vibrated and that the vibration produce the acoustic noises.

An object of the present invention is to solve the above-mentioned problems and to provide an improved gear-type flexible joint which does not generate acoustic noise due to irregular vibration of the coupling sleeve when the gear-type flexible joint rotates without load for transmitting the torque of the motor to the pinion shaft of the gear unit.

A gear-type flexible joint in accordance with the present invention comprises: a tube-shaped coupling sleeve having a respective internal gear formed on the inner periphery of each end thereof; a pair of external gears respectively engaging with the internal gears of the tube-shaped coupling sleeve with a given backlash provided between teeth of the internal gear and the external gear and with a given clearance provided between addendum circle of the external gear and addendum circle of the internal gear, one of the external gears being fixed on a shaft of a motor and the other being fixed on a pinion shaft of a gear unit, and the center of the pinion shaft being misaligned relative to the center of the motor shaft; and provided between the internal gears and the external gears, respectively, for making the teeth of the internal gears contact the teeth of the external gears when the gear-type flexible joint is rotated without transmitting torque of the motor to the gear unit.

The restraint means are, for example, one or more permanent magnets provided on a tooth or teeth of the internal gears, or springs provided between the internal gears and the external gears, respectively. The restraint means makes the teeth of the external gears contact the teeth of the internal gears.

While the novel features of the invention are set forth particularly in the appended claims, the invention, both as to organization and content, will be better understood and appreciated, along with other objects and features thereof, from the following detailed description taken in conjunction with the drawings, in which:

FIG.1(A) is a front view showing a first preferred embodiment of a gear-type flexible joint in accordance with the present invention.

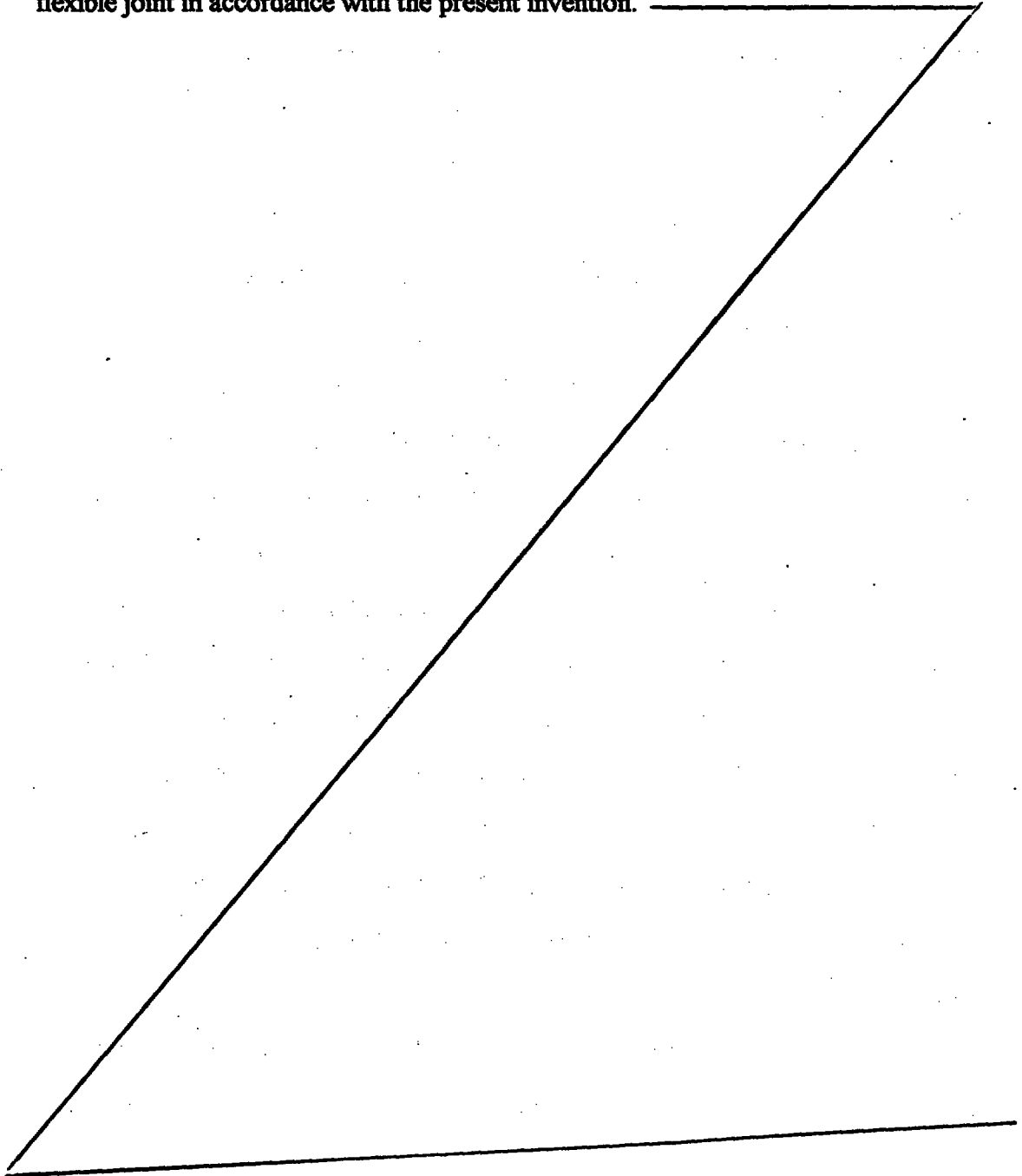


FIG.1(B) is an enlarged sectional front view of an engagement of an internal gear and an external gear of the gear-type flexible joint shown in FIG.1(A).

FIG.1(C) is a sectional side view of the gear-type flexible joint shown in FIG.1(A).

FIG.2 is a sectional front view showing a second preferred embodiment of a gear-type flexible joint in accordance with the present invention.

FIG.3 is the plan view showing a constitution of the conventional bogie.

FIG.4(A) is the front view showing the conventional gear-type flexible joint.

FIG.4(B) is the enlarged sectional front view of the engagement of the internal gear and the external gear of the conventional gear-type flexible joint shown in FIG.4(A).

FIG.4(C) is the sectional side view of the conventional gear-type flexible joint shown in FIG.4(A).

It will be recognized that some or all of the Figures are schematic representations for purposes of illustration and do not necessarily depict the actual relative sizes or locations of the elements shown.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[First embodiment]

A first preferred embodiment of a gear-type flexible joint in accordance with the present invention is

described referring to FIGs. 1(A), 1(B) and 1(C) and FIG.3. FIG.1(A) is a front view showing the first embodiment of the gear-type flexible joint. FIG.1(B) is an enlarged sectional front view of an engagement of an internal gear 11 or 11' and an external gear 12 or 12' of the gear-type flexible joint shown in FIG.1(A). FIG.1(C) is a sectional side view of the gear-type flexible joint shown in FIG.1(A). The plan view of the bogie wherein the flexible joint of the embodiment is illustrated is the same as that of the conventionally known bogie elucidated with reference to FIG.3, and thereby the repetition of the explanation of the same is omitted.

In the gear-type flexible joint 60, all the teeth 12a of the external gears 12,12' are engaged with the teeth 11a of the internal gears 11,11'. The gear-type flexible joint 60 permits a given discordance between the motor shaft 5a and the pinion shaft 4a whereto the external gears 12,12' are fixed. Namely, a crowning is provided on each addendum 12f of the tooth 12a of the external gears 12,12' for forming a curved convex face 12b. Furthermore, a given backlash 12c (or a gap between the tooth flanks 12d and 11b which are facing to each other) is provided between each tooth 12a of the external gears 12,12' and the tooth 11a of the internal gears 11,11' which are to be engaged with each other. And also, a given clearance 12e is provided between the addendum 12f

of the external gears 12,12' and the dedendum 11c of the internal gears 11,11'. Thereby, the torque of the motor 5 is smoothly transmitted to the gear unit 4.

In FIGs. 1(A) and 1(C), the first preferred embodiment of the gear-type flexible joint in accordance with the present invention 60 comprises a tube shaped coupling sleeve 10, a pair of internal gears 11 and 11' and a pair of external gears 12 and 12'. Internal gears 11,11' are provided on inner peripheries of both ends 10a and 10b of the coupling sleeve 10. For example, one of the external gear 12 is fixed on the motor shaft 5a of the motor 5 and the other 12' is fixed on the pinion shaft 4a of the gear unit 4. In FIGs. 1(A), 1(B) and 1(C), numeral 11a designates teeth of the internal gears 11,11' and numeral 12a designates teeth of the external gears 12,12'. A permanent magnet 13 which serves as restraint means is embedded in each tooth 11a of the internal gears 11,11', for making the teeth 11a of the internal gears 11,11' contact to the teeth 12a of the external gears when the gear-type flexible joint is rotated without transmitting the torque of the motor 5 to the gear unit 4.

In the first embodiment of the gear-type flexible joint 60 configured above, magnetic forces produced by the permanent magnets 13 act on the teeth 12a of the external gears 12,12' to be attracted to the permanent magnets 13. When the gear-type flexible joint

60 in accordance with the present invention is rotated without transmitting the torque of the motor 5 to the gear unit 6 (coasting rotation), as shown in FIG.1(B), each tooth flank 12g of the external gears 12,12' are attracted and contacted on the surface 13a of the permanent magnet 13 by magnetic attraction of the permanent magnet 13. Therefore, the internal gear 11,11' and the external gears 12,12' are maintained in a contact state, and thereby, the inner sleeve 10 does not irregularly vibrate owing to the collisions of the teeth 11a of the internal gears 11,11' and the teeth 12a of the external gears 12,12' due to the backlashes between them. Furthermore, when the gear-type flexible joint 60 rotates with transmitting to the torque of the motor 5 to the gear unit 4 and the rotation force of the motor 5 acts in the same direction as that of the magnetic attraction of the permanent magnets 13, each tooth flank 12g of the external gears 12,12' contacts the same surface 13a of the permanent magnet 13 as the case of the above-mentioned coasting. And when the rotation force of the motor 5 acts in the opposite direction to that of the magnetic attraction of the permanent magnets 13, the rotation force of the motor 5 overcomes the magnetic attraction of the permanent magnets 13 since the torque of the motor 5 is much larger than the magnetic attraction of the permanent magnets 13. Thereby, the other (opposite side) tooth flank 12d of the external gears 12 contacts

the tooth flank 11b of the internal gears 11,11' which are opposite to the permanent magnets 13.

[Second embodiment]

A second preferred embodiment of the gear-type flexible joint is described referring to FIG.2, which is a front view showing the second embodiment of the gear-type flexible joint in accordance with the present invention.

In FIG.2, for example, tension springs 14 which serve as the restraint means are provided for making the teeth 11a of the internal gear 11,11' contact to the teeth 12a of the external gear 12,12' when the gear-type flexible joint 60 is rotated without transmitting the torque of the motor 5 to the gear unit 4. When the gear-type flexible joint 60 of the second embodiment is rotated without transmitting the torque of the motor 5 to the gear unit 4 (coasting rotation), each tooth flank 12g of the external gears 12,12' are attracted and contacted on a tooth flank 11d of the internal gears 11,11' by the elastic force of the tension springs 14. And thereby, the inner sleeve 10 does not irregularly vibrate owing to the collisions of the teeth 11a of the internal gears 11,11' and the teeth 12a of the external gears 12,12' due to the backlashes between them. Furthermore, when the gear-type flexible joint 60 rotates for transmitting to the torque of the motor 5 to the gear unit 4 and the rotation force of the motor 5 acts in the same direction as that of the

elastic force of the tension springs 14, the teeth 11a of the internal gears 11,11' and teeth 12a of the external gears 12,12' are made to contact with the same tooth flanks 12g and 11d as the case of the above-mentioned coasting. And when the rotation force of the motor 5 acts in the opposite direction to that of the elastic force of the tension springs 14, the rotation force of the motor 5 overcomes the elastic force of the tension springs 14 since the torque of the motor 5 is much larger than the elastic force of the tension springs 14. Thereby, the teeth 11a of the internal gears 11 and the teeth 12a of the external gears 12 are contacted on the tooth flanks 11b and 12d.

Although the present invention has been described in terms of the presently preferred embodiments, it is to be understood that such disclosure is not to be interpreted as limiting. Various alterations and modifications will no doubt become apparent to those skilled in the art after having read the above disclosure. Accordingly, it is intended that the appended claims be interpreted as covering all alterations and modifications as fall within the scope of the invention.

CLAIMS:

1. A gear-type flexible joint comprising:

a tube-shaped coupling sleeve having a respective internal gear formed on the inner periphery of each end thereof;

a pair of external gears respectively engaging with the internal gears of the tube-shaped coupling sleeve with a given backlash provided between teeth of the internal gear and the external gear and with a given clearance provided between addendum circle of the external gear and addendum circle of the internal gear, one of the external gears being fixed on a shaft of a motor and the other being fixed on a pinion shaft of a gear unit, and the center of the pinion shaft being misaligned relative to the center of the motor shaft; and provided between the internal gears and the external gears, respectively, for making the teeth of the internal gears contact the teeth of the external gears when the gear-type flexible joint is rotated without transmitting torque of the motor to the gear unit.
2. A gear-type flexible joint in accordance with claim 1, wherein

said restraint means is at least one permanent magnet embedded in a tooth of the internal gears.
3. A gear-type flexible joint in accordance with claim 1, wherein

said restraint means is at least one spring provided between each of said internal gear and said external gear.
4. A gear-type flexible joint substantially as herein described with reference to Figures 1A to 1C, or Figure 2 of the accompanying drawings.

