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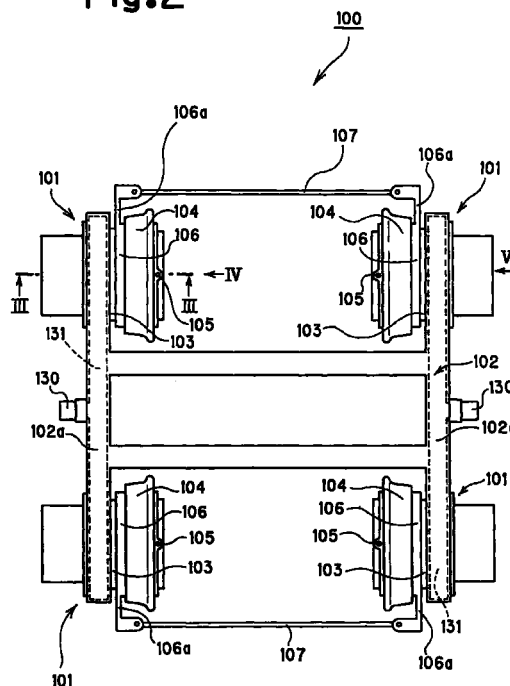
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(54) **Independent wheel driving component, independent wheel steering bogie and cooling structure**

(57) An independent wheel driving component (101) comprising a motor (103) fixed to a bogie frame (102), a reduction gear, a wheel (104) attached to an outer peripheral surface of a steering plate (106) by a rolling bearing, and a power transmission member is disclosed. The rotating force of the motor (103) is transmitted to the wheel (104) via the reduction gear, a flexible plate, a drive shaft, and a flexible plate to rotate the wheel (104). The steering plate (106) can turn about a turning pin (105). An elastic member is press-fitted and interposed between the steering plate (106) and a motor frame. When the wheel (104), rolling bearing, and steering plate (106) make a steering turn, the elastic member elastically deforms to permit the steering turn of the wheel (104), etc. The elastic member also damps vibrations of the wheel (104). Thus, the motor (103), etc. do not make a steering turn, but only the wheel (104) can make a steering turn.

Fig.2



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an independent wheel driving component, an independent wheel steering bogie, and a cooling structure for a railway vehicle. This invention is designed to perform a satisfactory steering action by enabling wheels alone to make a steering turn (the motion of inclining in a horizontal plane to steer a vehicle) without causing a motor, etc. to make a steering turn. The invention is also designed to improve the response of a motor to rotation control by reducing the moment of inertia of a rotating portion of an independent wheel driving component, to make wheels alone capable of making a steering turn, and to transmit a driving force while absorbing displacement of the wheel without a heavy burden. The invention is further adapted to effectively cool a motor incorporated into an independent wheel driving component.

2. Description of the Related Art

[0002] Driving bogies for many railway vehicles in current use employ integral type wheels composed of a right wheel and a left wheel coupled together via an axle. A driving force from a motor installed on the bogie is reduced by a reduction gear, and transmitted to the integral type wheels to make a run. When a run is to be taken on a curved track, a self-steering effect utilizing a slope of a wheel tread of the wheel makes a curved run possible.

[0003] Recently, an independent wheel bogie has been developed to adopt a structure, such as a low floor structure in which the floor surface of a railway vehicle is low. With this independent wheel bogie, an axle is omitted to allow a right wheel and a left wheel to rotate individually and independently, and each wheel is driven by a separate motor. Since this independent wheel bogie has no axle, the floor surface of the railway vehicle, if made low, does not interfere with an axle, so that a low floor can be realized. A low floor type railway vehicle enables a passenger to get on and get off from a track surface in a stepless manner, thus increasing convenience.

[0004] Such an independent wheel bogie may adopt an independent wheel driving component of a hub motor type. In this independent wheel driving component, wheels are located beside the outer periphery of a motor, and the rotation of the motor is transmitted to the wheels via a reduction gear. The motor, the wheels, and the reduction gear are integrally built in to make up a component structure.

[0005] With an independent wheel bogie of a type having four wheels, four independent wheel driving

components are mounted. That is, two independent wheel driving components are attached to a right frame of a bogie frame, and two independent wheel driving components are attached to a left frame of the bogie frame. Compared with a one-axis type independent wheel bogie, this four-wheel type independent wheel bogie is unlikely to derail even if the wheel slips, and also is highly stable during a high speed run.

[0006] A first example of a conventional hub motor type independent wheel driving component will now be described. With a conventional independent wheel driving component 010, as shown in FIG. 8, the rotating force of a motor 011 is transmitted to a reduction gear 012 via a motor shaft 011a, and is decreased thereby. The decreased rotating force is transmitted to a wheel housing 013. The wheel housing 013 is rotatably disposed beside the outer periphery of a motor frame 011b. To an outer peripheral surface of the wheel housing 013, a wheel 015 is attached via an elastic member 014. The elastic member 014 is disposed in an annular form along a circumferential direction, and damps wheel vibrations while rotating together with the wheel 015.

[0007] Hub support arms 016, 016 and bearings 017, 017 are constituted as pairs at upper and lower positions. Upper and lower pins (not shown) fixed to a vehicle body 020 are adapted to penetrate into the site of the hub support arms 016, 016 and bearings 017, 017 from above and below. Thus, the whole of the independent wheel driving component 010 can make a steering turn about the site of the hub support arms 016, 016 and bearings 017, 017 as a turning center. The reference numeral 018 denotes a brake.

[0008] Next, a second example of a conventional hub motor type independent wheel driving component will be described. With a conventional independent wheel driving component 10, as shown in FIG. 9, a motor shaft 11a of a motor 11 is a hollow pipe shaft. Inside the motor shaft 11a, a drive shaft 12 is rotatably inserted. A reduction gear 13 installed on a right end face of the motor 11 reduces rotations of the motor 11, and transmits the reduced rotations to the drive shaft 12. The rotating force of the drive shaft 12 is transmitted to a wheel housing 17. The wheel housing 17 disposed beside a left end face of the motor 11 is a thick-walled member, and has nearly the same radius as that of the motor 11. To an outer peripheral surface of the wheel housing 17, a wheel 15 is attached via an elastic member 14. The elastic member 14 is disposed in an annular form along a circumferential direction, and damps wheel vibrations while rotating together with the wheel 015. The reference numeral 16 denotes a brake.

[0009] According to the earlier technology shown in FIG. 8, the whole of the independent wheel driving component 010 makes a steering turn for a steering action, thus upsizing a steering mechanism. Since this mechanism is large in size, the space of a vehicle compartment is small. Moreover, it is impossible to impose a restoring force on, or impart a damping action to, the

wheel 015 that steers. Thus, stability during a high speed run is poor. Furthermore, the elastic member 014 rotates along with the wheel 015, so that the elastic member 014 may undergo fatigue fracture under repeated stress due to rotations. If the elastic member 014 breaks, a great vibration will act on the wheel 015. This vibration may cause the wheel 015 to bounce, inducing a serious derailment accident.

[0010] With the earlier technology shown in FIG. 8, moreover, the outer peripheral surface of the motor frame 011b of the motor 011 is surrounded by the rotating wheel housing 013, the reduction gear 012 is disposed beside the left end face of the motor 011, and the hub support arms 016, etc. are disposed beside the right end face of the motor 011. Hence, it was impossible to supply cooling air from outside into the motor 011, so that the motor 011 could not be air cooled forcedly. In addition, since the circumferential surface of the motor 011 is surrounded by the wheel housing 013, running air does not touch the motor frame 011b, so that heat dissipation is poor. Thus, the cooling of the motor 011 could not be performed effectively.

[0011] With the earlier technology shown in FIG. 9, the wheel housing 13 with a large wall thickness and a large radius also rotates. Thus, the entire rotating portion (motor rotor, motor shaft 11a, drive shaft 12, wheel housing 13, and wheel 15) had a great moment of inertia. Hence, the response of the motor 11 to rotation control was poor, arousing a delay in speed control. Besides, the wheel 15 cannot make a steering turn, and thus was unable to run smoothly on a curved track. Furthermore, the elastic member 14 rotates along with the wheel 15. Therefore, the elastic member 14 may undergo fatigue fracture under repeated stress due to rotations. If the elastic member 14 breaks, a great vibration will act on the wheel 15. This vibration may cause the wheel 15 to bounce, inducing a serious derailment accident.

SUMMARY OF THE INVENTION

[0012] The present invention has been accomplished in light of the above-described problems with the earlier technologies. It is an object of this invention to provide an independent wheel steering bogie with excellent high speed stability which can make a smooth turning run by allowing wheels alone to make a steering turn without causing an entire independent wheel driving component to make a steering turn; and to provide an independent wheel driving component conveying these advantages.

[0013] It is another object of the invention to provide an independent wheel driving component which can decrease the moment of inertia of a rotating portion to improve the response of a motor to rotation control, which allows wheels alone to make a steering turn, and which can transmit a driving force while absorbing displacement of wheels reasonably.

[0014] It is still another object of the invention to provide a cooling structure for an independent wheel driving component which can effectively cool a motor incorporated in the independent wheel driving component.

[0015] An aspect of the present invention, as a means of attaining the above objects, is an independent wheel driving component having, integrally assembled therein, a motor, a reduction gear for reducing rotations of the motor, a wheel, and a power transmission member for transmitting an output of the reduction gear to the wheel, wherein

a cylindrical steering plate is disposed beside an outer periphery of a motor frame of the motor in such a manner as to be capable of making a steering turn in a horizontal plane, the wheel is rotatably supported on an outer peripheral surface of the steering plate via a rolling bearing, and an elastic member is press-fitted and interposed between an inner peripheral surface of the steering plate and an outer peripheral surface of the motor frame.

[0016] In the above independent wheel driving component, the elastic member may be disposed in an upper circumferential space portion and a lower circumferential space portion of a space between the inner peripheral surface of the steering plate and the outer peripheral surface of the motor frame.

[0017] Because of the foregoing constitution, only the wheel can be caused to make a steering turn without turning the entire independent wheel driving component, and a satisfactory, stable turning run can be achieved even on a small curved track. Since there is no need to turn the entire independent wheel driving component, moreover, the constituent members for a turning action can be decreased in number. This contributes overall to downsizing, ensuring a wide space for the vehicle compartment. Furthermore, the elastic member performs a damping action and imparts a restoring force in response to the steering action of the wheel. Thus, a stable run at a high speed can be realized. Besides, the elastic member does not rotate, and so does not undergo repeated stress due to rotations, so that the durability of the elastic member increases. Even if the elastic member breaks, oscillations due to breakage of the elastic member do not occur in the wheel, because the elastic member does not rotate. Thus, there is no possibility for derailment, and high reliability is ensured.

[0018] In the independent wheel driving component, moreover, a motor shaft may be a hollow pipe shaft, the wheel may be rotatably disposed around an outer periphery of the motor, and the reduction gear fixedly disposed on an end face of the motor may reduce rotations transmitted from the motor shaft, and

the power transmission member may comprise a

drive shaft disposed in an inserted state within the motor shaft, a first flexible coupling for coupling one end of the drive shaft to a reduction output portion of the reduction gear, and a second flexible coupling for coupling the other end of the drive shaft to the wheel.

[0019] Because of this constitution, the invention can decrease the moment of inertia of the rotating portion to improve the response of the motor to rotation control.

[0020] The first and second flexible couplings may be each formed of a flexible plate. The reduction gear may be a planetary type epicycle reduction gear.

[0021] Since the flexible couplings are formed of flexible plates, the independent wheel driving component can be lightweight and compact. Moreover, since the reduction gear is a planetary type epicycle reduction gear, the moment of inertia of the independent wheel driving component can be decreased.

[0022] Another aspect of the invention is an independent wheel steering bogie, in which the steering plate of the right-hand independent wheel driving component, and the steering plate of the left-hand independent wheel driving component are coupled together by a link mechanism so that steering turn angles of the steering plates will be the same.

[0023] Still another aspect of the invention is an independent wheel steering bogie, in which the steering plate makes a steering turn about a position inward of the wheel relative to an axial direction of the wheel as a turning center.

[0024] Thus, the steering angles of the right and left wheels of the independent wheel steering bogie are the same, so that a stable turning run can be achieved. Furthermore, the wheel that has made a steering turn can be returned toward a track center, thus resulting in improved stability.

[0025] A further aspect of the invention is a cooling structure for the independent wheel driving component in a bogie for a railway vehicle, the bogie having the independent wheel driving component disposed on each of the right and left of a bogie frame, wherein

a frame of the bogie frame is made hollow, an air duct is formed inside the frame, a fan for feeding air into the air duct is installed on the frame, an inlet port for taking air, which has passed through the air duct, into the motor is formed in the motor frame, and an outlet port is formed in an end face of the motor.

[0026] Because of the above constitution, the invention can flow air forcedly in the motor to air cool the motor, thereby enhancing a motor cooling effect, and eventually, downsizing the motor and the independent wheel driving component.

[0027] In the cooling structure for the independent

wheel driving component, a plurality of the inlet ports may be formed along a circumferential direction of the motor frame.

[0028] Because of the above constitution, the invention can blow air uniformly into the motor to raise a cooling efficiency.

[0029] In the cooling structure for the independent wheel driving component, the reduction gear may be disposed outside a vehicle body, and the outlet port may be disposed inside the vehicle body.

[0030] Thus, the constituent parts can be arranged without waste, the reduction gear can be cooled with outside air, and the entry of rain drops, etc. into the motor through the outlet port can be prevented.

[0031] A still further aspect of the invention is an independent wheel steering bogie having two independent wheel driving components attached in a tandem arrangement to a right frame of a bogie frame, and having two independent wheel driving components attached in a tandem arrangement to a left frame of the bogie frame, wherein

each of the independent wheel driving components is constituted such that

the independent wheel driving component has, integrally assembled therein, a motor fixed to the bogie frame, a reduction gear for reducing rotations of the motor, a wheel, and a power transmission member for transmitting an output of the reduction gear to the wheel, and

a cylindrical steering plate is disposed beside an outer periphery of a motor frame of the motor in such a manner as to be capable of making a steering turn in a horizontal plane, the wheel is rotatably supported on an outer peripheral surface of the steering plate via a rolling bearing, and an elastic member is press-fitted and interposed between an inner peripheral surface of the steering plate and an outer peripheral surface of the motor frame.

[0032] The above constitution can realize a two-axis independent wheel steering bogie in which only the wheel can make a steering turn to steer the bogie.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] The above and other objects, features and advantages of the present invention will become more apparent from the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a constitution drawing showing an example of a railway vehicle to which the present invention has been applied;

FIG. 2 is a constitution drawing, as a plan view, showing an independent wheel steering bogie to which the invention has been applied;

FIG. 3 is a sectional view showing an independent

wheel driving component according to the invention;

FIG. 4 is an end view showing the independent wheel driving component of the invention;

FIG. 5 is a constitution drawing showing an end portion of a bogie frame;

FIG. 6 is a constitution drawing showing the independent wheel driving component and a cooling structure;

FIG. 7 is a constitution drawing, as a plan view, showing another example of an independent wheel steering bogie to which the invention has been applied;

FIG. 8 is a constitution drawing showing a conventional independent wheel driving component; and

FIG. 9 is a constitution drawing showing another conventional independent wheel driving component.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0034] Embodiments of the present invention will now be described in detail with reference to the accompanying drawings, which in no way limit the invention.

Explanation for the entire structure of vehicle)

[0035] First, an example of a railway vehicle using an independent wheel driving component of the invention will be described with reference to FIG. 1. As shown in FIG. 1, one independent wheel steering bogie 100 is attached to one vehicle body 1 in a railway vehicle according to this example. A front vehicle body 1 and a rear vehicle body 1 are connected together by a spherical bearing type connector 2. The independent wheel steering bogie 100 is a bogie provided with four independent wheel driving components 101.

[0036] When the vehicle runs on a curved track, the front vehicle body 1 and the rear vehicle body 1 take a bent shape bending at the site of the connector 2. Thus, the independent wheel steering bogie 100 makes little turn (yawing rotation) relative to the vehicle body 1. That is, the independent wheel steering bogie 100 constitutes a moving center plate mechanism with a bogie rotational displacement angle reduced nearly to zero. When the vehicle runs on an ordinary circular track, the vehicle bends at the site of the connector 2, so that the vehicle can make a curved run at zero bogie rotational displacement angle. When the vehicle runs on an S-shaped curved track, a slight bogie rotational displacement angle occurs to permit a curved run.

[0037] To improve turning performance for perfect steering on a curved track, each wheel of the independent wheel driving components 101 provided on the independent wheel steering bogie 100 can make a steering turn at an angle of only 1 to 2 degrees, although a detailed structure for this function will be described later

on. Furthermore, the structure is designed to enable only the wheel to make a steering turn, with a motor or reduction gear of the independent wheel driving component 101 making no steering turn. Also, the vehicle is designed such that the moment of inertia of the rotating portion is decreased to improve the follow-up properties of rotation and enhance response to rotation speed control.

Explanation for the independent wheel steering bogie)

[0038] Next, the independent wheel steering bogie 100 is described. As shown in FIG. 2, four independent wheel driving components 101 are attached to a bogie frame 102 of the independent wheel steering bogie 100. That is, two of the independent wheel driving components 101 are mounted on a right frame 102a of the bogie frame 102 in a tandem arrangement, and two of the independent wheel driving components 101 are mounted on a left frame 102a of the bogie frame 102 in a tandem arrangement. In each of the independent wheel driving components 101, a wheel 104 is rotatably disposed beside an outer periphery of a motor 103, and a rotating force of the motor 103 is transmitted to the wheel 104 via a reduction gear (not shown in FIG. 2). Thus, the motor 103, the wheel 104, and the reduction gear are integrally assembled to form a component structure. The wheel 104 can make a steering turn at an angle of only 1 to 2 degrees about a turning center pin 105 as a wheel yawing rotation center (a steering turn center). Details of this motion will be described again in the column "Explanation for the independent wheel driving component" (to be offered later on). In accordance with the steering turn of the wheel 104, a cylindrical steering plate 106 also makes a steering turn. The right and left steering plates 106 are connected together by steering arms 106a and a steering link 107. As a result, the steering turn angles of the right and left wheels 104 become the same. The motor 103 and the reduction gear are fixed to the bogie frame 102, and do not make a steering turn. With the independent wheel steering bogie 100, the wheel 104 makes a steering turn. Thus, even during a run on a sharp small curved track with a small turning radius, perfect steering takes place to ensure a stable turning run.

Explanation for the independent wheel driving component)

[0039] Next, the independent wheel driving component 101 is described. Its overall structure is outlined such that the independent wheel driving component 101, as shown in FIG. 3 (a sectional view taken on line III-III in FIG. 2), is composed mainly of a motor 103, a reduction gear 108, a disc brake 109, power transmission members, such as a drive shaft 111 and flexible plates 112, 113, a wheel 104, and steering permitting members, such as an elastic member 116 and a cylin-

drical steering plate 106. These members are assembled integrally to form a component structure. The independent wheel driving component 101 is attached to the bogie frame 102.

[0040] Rotations of the motor 103 are reduced by the reduction gear 108, and transmitted to the wheel 104 via the flexible plate 112, drive shaft 111, and flexible plate 113 to rotate the wheel 104. During a curved run, the elastic member 116 elastically deforms to allow a steering turn of the wheel 104 about a turning center pin 105 as a turning center (details will be offered later on). The motor 103 and the reduction gear 108 are adapted not to make a steering turn.

[0041] The detailed structure, effects and actions of the various parts of the independent wheel driving component 101 will be described.

[0042] As shown in FIG. 3, a stator core 103b is disposed on an inner peripheral surface of a motor frame 103a of the motor 103, while a rotor core 103c is provided on a motor shaft 103d. The motor shaft 103d is a hollow pipe shaft, and its opposite ends are rotatably supported by bearings 103e.

[0043] The reduction gear 108 is fixedly disposed beside one end face (left end face in FIG. 3) of the motor 103 to reduce rotations received from the motor shaft 103d and produce a decreased output. This reduction gear 108 is composed of a built-in planetary type epicycle reduction mechanism inside a reduction gear case 108a. That is, a carrier 108b as a reduction gear output portion is rotatably supported by a bearing 108c, and a planet gear 108d is attached to the carrier 108b via a bearing 108e. The planet gear 108d meshes with a sun gear 108f secured to the motor shaft 103d, and also meshes with an internal gear 108g secured to the inner peripheral surface of the reduction gear case 108a.

[0044] The planetary type epicycle reduction gear 108 has a larger reduction ratio than does a star type epicycle reduction gear. Thus, a high speed motor can be used as the motor 103. Since a high speed motor is small in size, it can contribute to the downsizing of the independent wheel driving component 101. Since the motor 103 of a small size can be adopted, moreover, the moment of inertia of the rotating portion can be decreased, and response to rotation control can be increased.

[0045] Epicycle reduction gears are classified into the following types:

- (1) Planetary type (internal gear is fixed for rotation of the reduction gear)
- (2) Solar type (sun gear is fixed for rotation of the reduction gear)
- (3) Star type (planet gear is fixed for rotation of the reduction gear, but can revolve on its own axis)

Of these reduction gears, the planetary type epicycle reduction gear in which the internal gear having a great moment of inertia is fixed is the lowest in inertia.

[0046] The disc brake 109 is disposed beside one end face (left end face in FIG. 3) of the motor 103. The disc brake 109 is disposed at a position outward of the motor 103. A brake disc 109b of the disc brake 109 is connected to the carrier 108b of the reduction gear 108. The motor 103, the reduction gear 108, and the disc brake 109 are fastened to the bogie frame 102 by bolts 110.

[0047] The drive shaft 111 is disposed in an inserted state inside the motor shaft 103d. To one end (left end in FIG. 3) of the drive shaft 111, a flange 111a is fixed. The flange 111a is connected to the brake disc 109b via the flexible plate 112, a displacement absorbing member. On the other end (right end in FIG. 3) of the drive shaft 111, a drive shaft arm 111b is formed, as shown in FIG. 4 (a view taken along an arrow IV in FIG. 2). The drive shaft arm 111b is connected to the wheel 104 via the flexible plate 113, a displacement absorbing member.

[0048] A flexible coupling is a tool for damping vibrations or absorbing deviations in axis by use of the elasticity of a material. The couplings are classified, by the type of an elastic material, as follows:

- (1) Rubber coupling
- (2) Resin coupling
- (3) Metal spring coupling

Of these couplings, the most lightweight, compact (low in moment of inertia) coupling is a metal spring coupling, and an important part of this coupling is a flexible plate.

[0049] Because of the above constitution, the rotating force of the motor 103 is transmitted to the wheel 104 by the following route: motor shaft 103d → reduction gear 108 → brake disc 109b → flexible plate 112 → drive shaft 111 → flexible plate 113. Thus, the wheel 104 is rotated. A braking force generated by the disc brake 109 is transmitted to the wheel 104 by the following route: brake disc 109b → flexible plate 112 → drive shaft 111 → flexible plate 113. Thus, the wheel 104 is braked.

[0050] As stated earlier, the motor shaft 103d is a hollow pipe shaft, in which the drive shaft 111 is disposed. Thus, the radius of the rotating portion is small as a whole, so that the moment of inertia of the rotating portion can be decreased. Thus, response to rotation speed control can be improved.

[0051] Furthermore, the two flexible plates 112, 113 are used. Thus, the driving force can be transmitted, with vertical displacements, transverse displacements, and steering angle displacements of the wheel 104 being absorbed reasonably. That is, displacements are dissipated and absorbed by the two flexible plates 112, 113. Hence, absorption of displacements can be performed reasonably, and the wheel 104 can be made to do a smooth steering turn. Besides, the flexible plates 112, 113 are thin plate materials, and so their moment

of inertia is so small as to be capable of making the moment of inertia of the rotating portion small. Instead of the flexible plates 112, 113, other type of flexible coupling, which can absorb displacements while transmitting a rotating force, can be employed.

[0052] Beside the outer periphery of the motor frame 103a, the cylindrical steering plate 106 is disposed. The steering plate 106 is connected to the turning center pin 105 via a rubber bush 114, and can make a steering turn in a horizontal plane about the turning center pin 105 as a turning center. In this embodiment, the turning center pin 105 is fixed to the motor frame 103a in such a manner as to be disposed inwardly of the wheel 104 in the axial direction of the wheel 104.

[0053] Between the outer peripheral surface of the steering plate and the inner peripheral surface of the wheel 104, rolling bearings 115 are interposed. That is, the wheel 104 is rotatably supported on the outer peripheral surface of the steering plate 106 via the rolling bearings 115. Thus, the wheel 104 can be rotated, and also the wheel 104, the rolling bearings 115 and the steering plate 106 can make an integral steering turn about the turning center pin 105 as a turning center. To the steering plate 106, the steering arm 106a is attached integrally.

[0054] Between the inner peripheral surface of the steering plate 106 and the outer peripheral surface of the motor frame 103a, the elastic member 116 is press-fitted and interposed. The elastic member 116, as shown in FIG. 4, is disposed in an upper circumferential space portion and a lower circumferential space portion of a space between the inner peripheral surface of the steering plate 106 and the outer peripheral surface of the motor frame 103a, but is not disposed in a front space portion or a rear space portion of the space. The elastic member 116 undergoes a compressive load ascribed to vertical vibrations transmitted from the wheel 104 to the motor 103, and is thereby compressed and shrunk or expanded to damp vibrations. Since the elastic member 116 does not rotate, repeated load due to rotations does not act on the elastic member 116, so that the durability of the elastic member 116 is improved. Even if the elastic member 116 breaks, oscillations due to breakage of the elastic member 116 do not occur in the wheel 104, because the elastic member 116 does not rotate. Thus, there is no possibility for derailment.

[0055] Sideways vibrations occurring in the wheel 104 are transmitted to the rubber bush 114 via the rolling bearings 115 and steering plate 106, and are damped by the rubber bush 114.

[0056] During a run on a curved track, an external force is imposed from the track side onto the wheel 104 to give a steering turn to the wheel 104. At this time, the rolling bearings 115 and the steering plate 106 also make a steering turn along with the wheel 104. The elastic member 116 is interposed between the steering plate 106 that makes a steering turn, and the motor

frame 103a that does not make a steering turn. Thus, when the wheel 104 makes a steering turn, the elastic member 116 undergoes elastic deformation (torsional displacement). Because of the elastic deformation of the elastic member 116, the wheel 104 can make a steering turn at an angle of only 1 to 2 degrees.

[0057] In the space between the inner peripheral surface of the steering plate 106 and the outer peripheral surface of the motor frame 103a, no elastic member is disposed in the front space portion or the rear space portion. Thus, during a steering turn of the wheel 104, the elastic member 116 can elastically deform. If the elastic member were press-fitted and provided in the entire space between the inner peripheral surface of the steering plate 106 and the outer peripheral surface of the motor frame 103a, torsional deformation would become almost impossible, and the wheel 104 would be unable to make a steering turn.

[0058] Since the elastic member 116 elastically deforms in the above manner, a steering turn of the wheel 104 is permitted. When the wheel 104 is to make a steering turn, the elastic member 116 produces a damping action for suppressing the steering turn. To the wheel 104 that has made a steering turn at an angle of only 1 to 2 degrees, the elastic member 116 imparts a restoring force for restoring the wheel 104 to the original position (the position where the steering angle is zero). As noted from this, the elastic member 116 gives a damping action and a restoring action in response to the steering turn of the wheel 104. Thus, the steering motion is stabilized and a stable run at a high speed can be realized.

[0059] As shown in FIG. 2, moreover, the steering arm 106a integrally attached to the right steering plate 106, and the steering arm 106a integrally attached to the left steering plate 106 are connected together by the steering link 107 to bring the steering turn angles of the right and left steering plates 106, accordingly the steering angles of the right and left wheels 104, into agreement. Thus, high speed stability performance is further improved.

[0060] Also, the steering turn of the wheel 104 can be realized by the elastic deformation of the elastic member 116. Thus, the motor 103 and the reduction gear 108 can be fixedly installed on the bogie frame 102, the constituent members that make a steering turn can be decreased in number, and the members of the component can be cut down on. Consequently, the steering inertia is decreased, and a satisfactory steering run can be made. Since the number of the constituent members is decreased, moreover, the parts that protrude toward the vehicle compartment are eliminated, so that the passage width of the vehicle compartment can be enlarged.

[0061] To sum up, the elastic member 116 has all of the following functions:

- (1) Damping vertical vibrations transmitted from the

wheel 104 to the motor 103 to protect the motor 103;

(2) Elastically deforming to permit a steering turn of the wheel 104;

(3) Imparting a damping action when the wheel 104 is making a steering turn; and

(4) Imparting a restoring force for returning the wheel 104, which has made a steering turn, to the original position.

[0062] The independent wheel driving component 101 of the above-described constitution has the following advantages:

(1) Disposes the drive shaft 111 inside the motor shaft 103d, a hollow pipe shaft, to decrease the radius of the rotating portion as a whole;

(2) Employs a planetary type reduction gear with a high reduction ratio, to enable the use of a high speed type motor as the motor 103, thereby making the radius of the motor small; and

(3) Uses the thin flexible plates 112, 113.

These advantages lead to a small moment of inertia of the entire rotating portion of the independent wheel driving component 101. In other words, a thick-walled, large-diameter rotating member, such as the wheel housing 13 (see FIG. 9) in the earlier technology, is not used, and instead, the rotating member used is small in diameter, and thin-walled as a whole. Thus, the moment of inertia of the entire rotating portion can be made small. Consequently, the response of the motor to rotation control can be improved.

(Explanation for parking brake)

[0063] Next, a parking brake 120 provided in the independent wheel driving component 101 is described. A lining disc 120a of the parking brake 120 is joined to an outer peripheral surface of the carrier 108b by a spline or the like. The lining disc 120a rotates in synchronism with the carrier 108a, and is slidable in the axial direction. One end face (left end face) of the lining disc 120a contacts an inner wall of the reduction gear case 108a, and a disc plate 120b is fixed to the other end face (right end face) of the lining disc 120a. A backing plate 120c is fixedly installed on an inner periphery surface of the reduction gear case 108a. A piston 120d is disposed axially slidably, and is urged toward the lining disc 120a by a brake spring 120e provided in the internal gear 108g.

[0064] An electromagnetic valve 120g is fitted on an air supply pipe 120f. The electromagnetic valve 120g is demagnetized during parking to fall into a closed state, and is excited, when the vehicle is not parked, to become open. When the electromagnetic valve 120g is open, compressed air is fed between the piston 120d and the backing plate 120c via the air supply pipe 120f.

When in an unparked state, the electromagnetic valve 120g is open, and compressed air is fed between the piston 120d and the backing plate 120c. Thus, the piston 120d is pushed toward the internal gear 108g by air pressure, and brought into contact with the internal gear 108g against the spring force of the brake spring 120e. Thus, the piston 120d separates from the disc plate 120b, whereupon a parking brake is released.

[0065] When in a parked state, the electromagnetic valve 120g is closed, and compressed air is removed from between the piston 120d and the backing plate 120c. Thus, the piston 120d is pushed toward the disc plate 120b by the spring force of the brake spring 120e, and brought into contact with the disc plate 120b. Thus, the piston 120d presses the lining disc 120a via the disc plate 120b to generate a braking force because of its frictional resistance, whereupon a parking brake becomes effective. The parking brake 120 does not perform a braking action while the vehicle is running, and performs a braking action when the vehicle is parked. In case of an emergency requiring an emergency brake, the braking action of the parking brake 120 may be added to an ordinary brake (disc brake 109, etc.).

[0066] As described above, the parking brake 120 is disposed within the reduction gear 108, so that a special installation space for the parking brake 120 is not needed, meaning a space saving. Also, the parking brake 120 is disposed in lubricating oil of the reduction gear 108. Thus, its motion (sliding motion) is smooth, no rust forms, and its reliability is high.

(Explanation for cooling structure)

[0067] Next, a cooling structure is described. As shown in FIG. 2, fans 130 are installed on the center of the right and left frames 102a of the bogie frame 102. The right and left frames 102a are hollow, and each have an air duct 131 formed inside. As shown in FIG. 5 (a view taken along an arrow V in FIG. 2), front and rear end portions of the frame 102a are curved in a state covering the upper circumferential surface of the motor frame 103a of the motor 103. That is, the air duct 131 is disposed in such a manner as to cover the upper circumferential surface of the motor frame 103a.

[0068] In the upper circumferential surface of the motor frame 103a, as shown in FIGS. 3 and 6, a plurality of inlet ports 132 are formed along the circumferential direction of the motor frame 103a. As shown in FIG. 3, an outlet port 133 is formed in the end face (bracket) of the motor 103, the end face on the side opposite to the end face where the reduction gear 108 is disposed. Since this outlet port 133 is directed toward the vehicle compartment (disposed inside the vehicle body), there is no possibility for the entry of rain drops, etc. through this outlet port 133. Since the reduction gear 108 and the disc brake 109 are positioned outside the vehicle body (on the side opposite to the vehicle compartment), moreover, the reduction gear 108 and the disc brake

109 are easily exposed to air during a run (outside air), so that natural cooling of the reduction gear 108 and the disc brake 109 takes place satisfactorily.

[0069] Air delivered from the fan 130 passes through the air duct 131, and is blown from the inlet port 132 into the motor 103. Air taken in through the inlet port 132 flows in the motor 103, and is discharged to the outside through the outlet port 133. Because of this forced flow of air in the motor 103, the motor 103 can be air cooled effectively and forcedly. Furthermore, the inlet ports 132 are formed in plural numbers in the circumferential direction of the motor frame 103a. Thus, air can be fed into respective portions of the motor 103 effectively and uniformly to raise the cooling efficiency.

[0070] In addition, air during travel directly touches the outer peripheral surface of the motor frame 103a. Thus, heat dissipation of the motor 103 is satisfactory, and natural heat dissipation and natural cooling of the motor can be performed effectively. In detail, the outer peripheral surface of the motor frame 103a, that excluding the portion on which the elastic member 116 is disposed, is exposed to the outside air. Thus, air during travel touches the motor frame 103a to perform natural cooling of the motor 103 satisfactorily.

[0071] As shown in FIG. 2, the independent wheel steering bogie 100 is provided with the four independent wheel driving components 101, while the number of the fans 130 installed may be two. This simplifies the structure. That is, the right and left frames 102a are used as the air ducts 131. Thus, air fed by one fan 130 can be divided into two by the air duct 131, and can be supplied to the two motors 103.

[0072] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Claims

1. An independent wheel driving component (101) having, integrally assembled therein, a motor (103), a reduction gear (108) for reducing rotations of the motor, a wheel (104), and a power transmission member for transmitting an output of the reduction gear to the wheel, wherein

a cylindrical steering plate (106) is disposed beside an outer periphery of a motor frame of the motor in such a manner as to be capable of making a steering turn in a horizontal plane, the wheel is rotatably supported on an outer peripheral surface of the steering plate via a rolling bearing, and an elastic member (116) is press-fitted and interposed between an inner peripheral surface of the steering plate and an

outer peripheral surface of the motor frame.

2. The independent wheel driving component of claim 1, wherein the elastic member (116) is disposed in an upper circumferential space portion and a lower circumferential space portion of a space between the inner peripheral surface of the steering plate and the outer peripheral surface of the motor frame.

3. The independent wheel driving component (101) of claim 1, wherein

a motor shaft (103d) is a hollow pipe shaft, the wheel is rotatably disposed around an outer periphery of the motor, and the reduction gear fixedly disposed on an end face of the motor reduces rotations transmitted from the motor shaft, and

the power transmission member comprises a drive shaft (111) disposed in an inserted state within the motor shaft, a first flexible coupling (112) for coupling one end of the drive shaft to a reduction output portion of the reduction gear, and a second flexible coupling (113) for coupling the other end of the drive shaft to the wheel.

4. The independent wheel driving component (101) of claim 3, wherein the first and second flexible couplings are each formed of a flexible plate.
5. The independent wheel driving component (101) of claim 3, wherein the reduction gear (108) is a planetary type epicycle reduction gear.
6. An independent wheel steering bogie (100) comprising:

the independent wheel driving component of claim 1, 2 or 3 disposed on a right-hand part of the independent wheel steering bogie; and the independent wheel driving component of claim 1, 2 or 3 disposed on a left-hand part of the independent wheel steering bogie; the steering plate of the right-hand independent wheel driving component, and the steering plate of the left-hand independent wheel driving component being coupled together by a link mechanism (107) so that steering turn angles of the steering plates will be the same.

7. An independent wheel steering bogie (100) comprising a plurality of the independent wheel driving components of claim 1, 2 or 3, wherein the steering plate of each of the independent wheel driving components makes a steering turn about a position inward of the wheel relative to an axial direction of the wheel as a turning center.

8. A cooling structure for the independent wheel driving component of claim 1 in a bogie for a railway vehicle, said bogie having the independent wheel driving component disposed on each of the right and left of a bogie frame, wherein 5
- a frame of the bogie frame is made hollow, an air duct is formed inside the frame, a fan (130) for feeding air into the air duct is installed on the frame, an inlet port (132) for taking air, which 10 has passed through the air duct, into the motor is formed in the motor frame, and an outlet port (133) is formed in an end face of the motor.
9. The cooling structure for the independent wheel driving component of claim 8, wherein a plurality of the inlet ports (132) are formed along a circumferential direction of the motor frame. 15
10. The cooling structure for the independent wheel driving component of claim 8 or 9, wherein the reduction gear (108) is disposed outside a vehicle body, and the outlet port (133) is disposed inside the vehicle body. 20
11. An independent wheel steering bogie having two independent wheel driving components attached in a tandem arrangement to a right frame of a bogie frame, and having two independent wheel driving components attached in a tandem arrangement to 25 a left frame of the bogie frame, wherein
- each of the independent wheel driving components (101) is constituted such that 30 the independent wheel driving component has, integrally assembled therein, a motor fixed to the bogie frame, a reduction gear for reducing rotations of the motor, a wheel, and a power transmission member for transmitting an output of the reduction gear to the wheel, and 35 a cylindrical steering plate is disposed beside an outer periphery of a motor frame of the motor in such a manner as to be capable of making a steering turn in a horizontal plane, the wheel is rotatably supported on an outer peripheral surface of the steering plate via a rolling bearing, and an elastic member is press-fitted and interposed between an inner peripheral surface of the steering plate and an outer peripheral surface of the motor frame. 40 45 50

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Fig.1

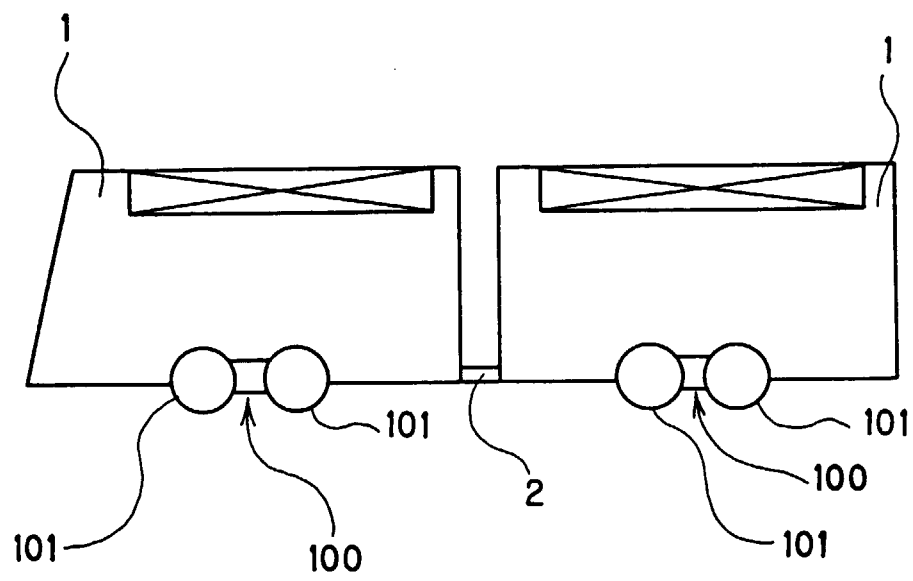


Fig.2

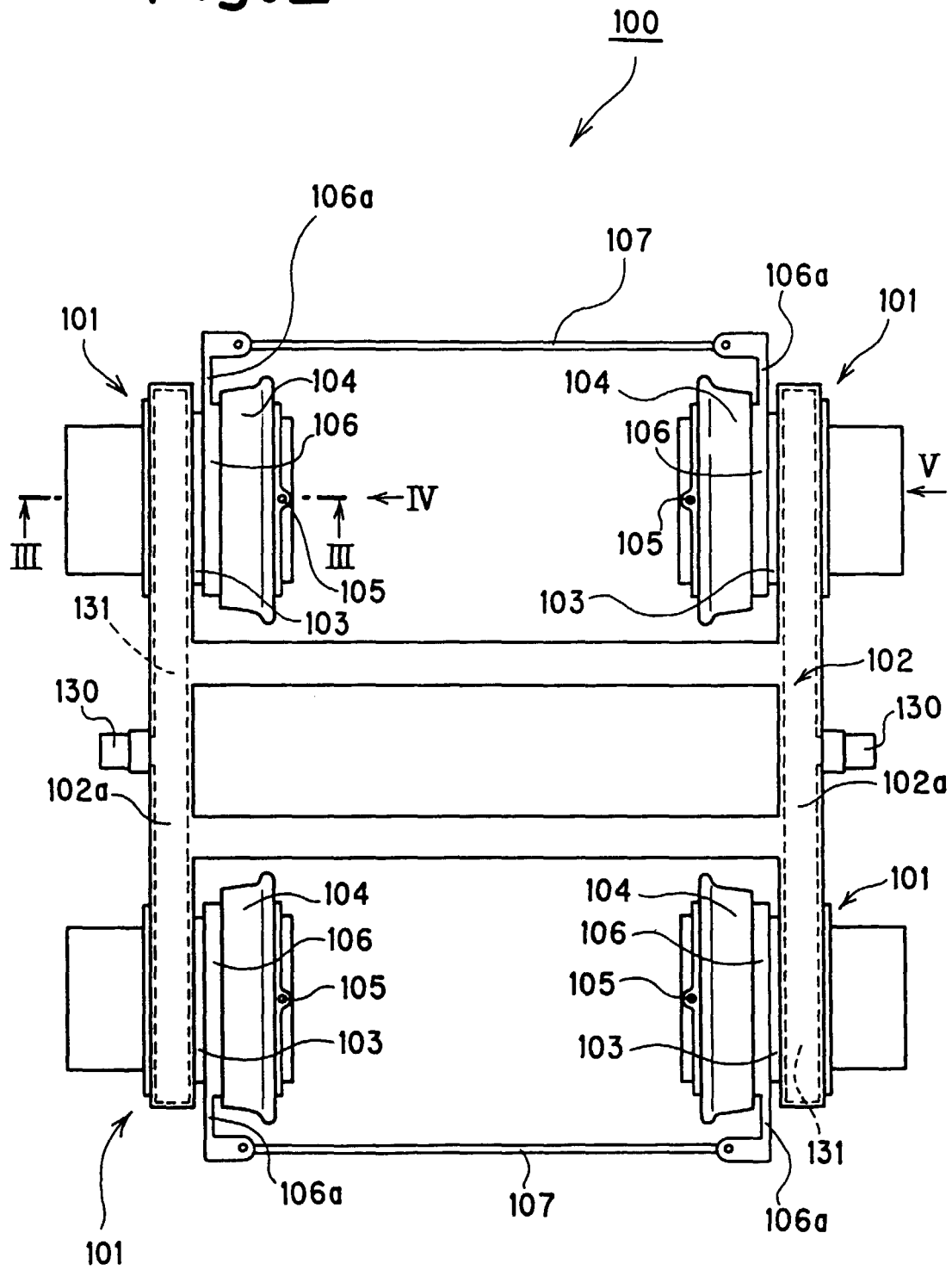


Fig. 3

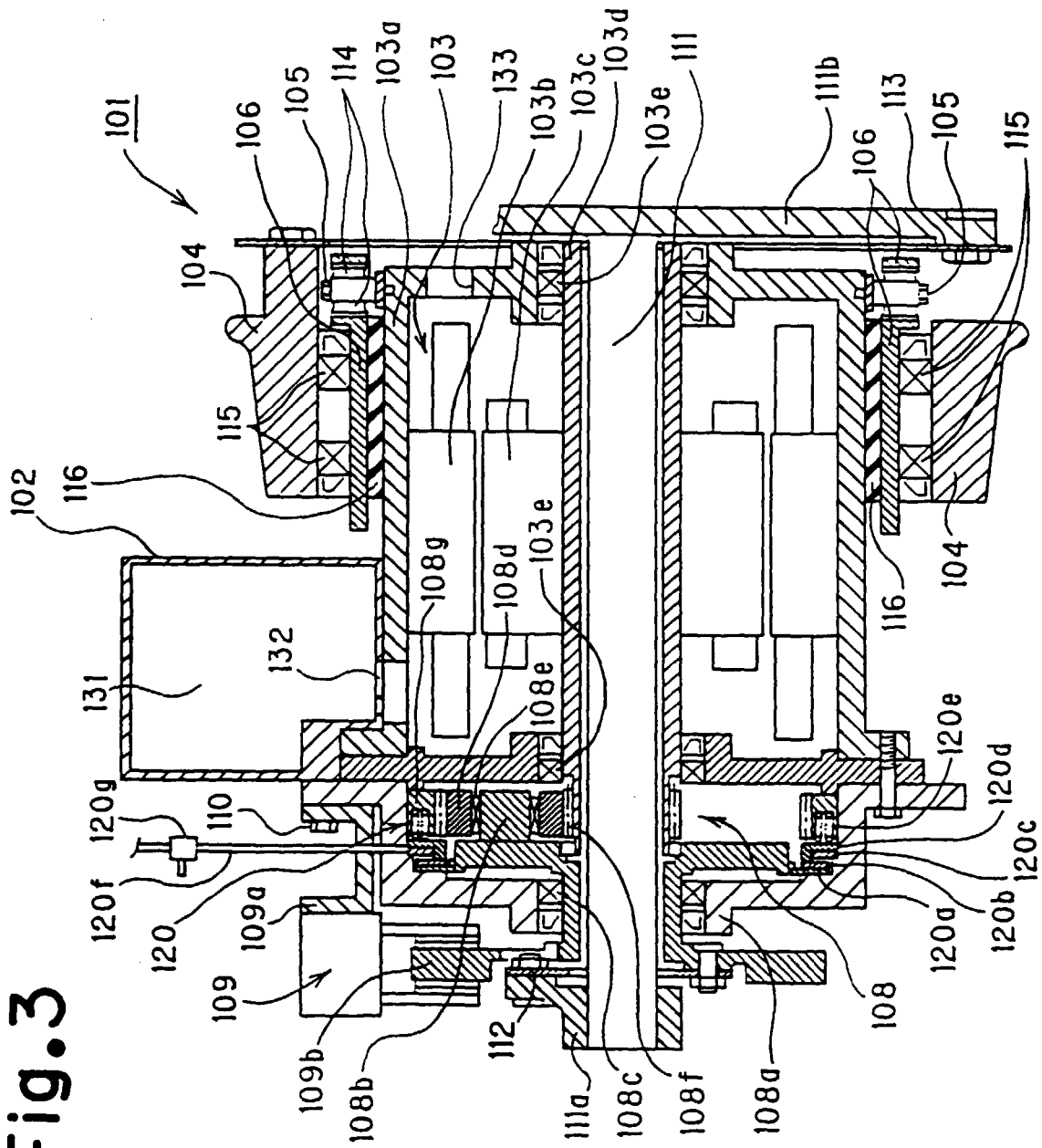


Fig.4

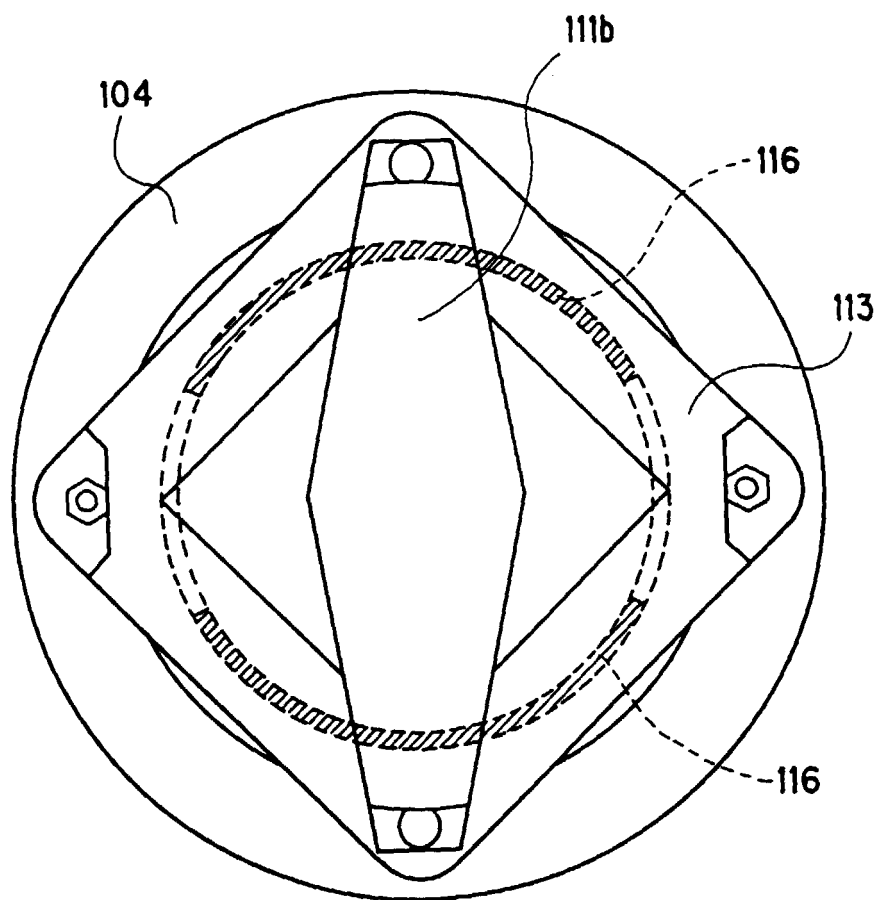


Fig.5

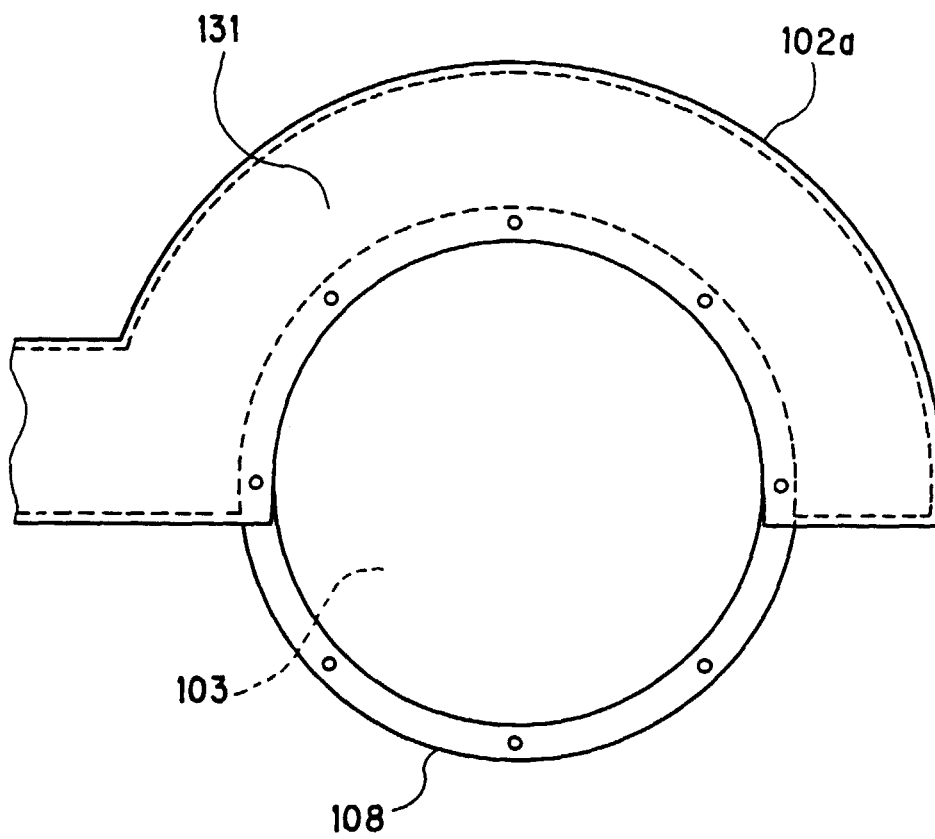


Fig.6

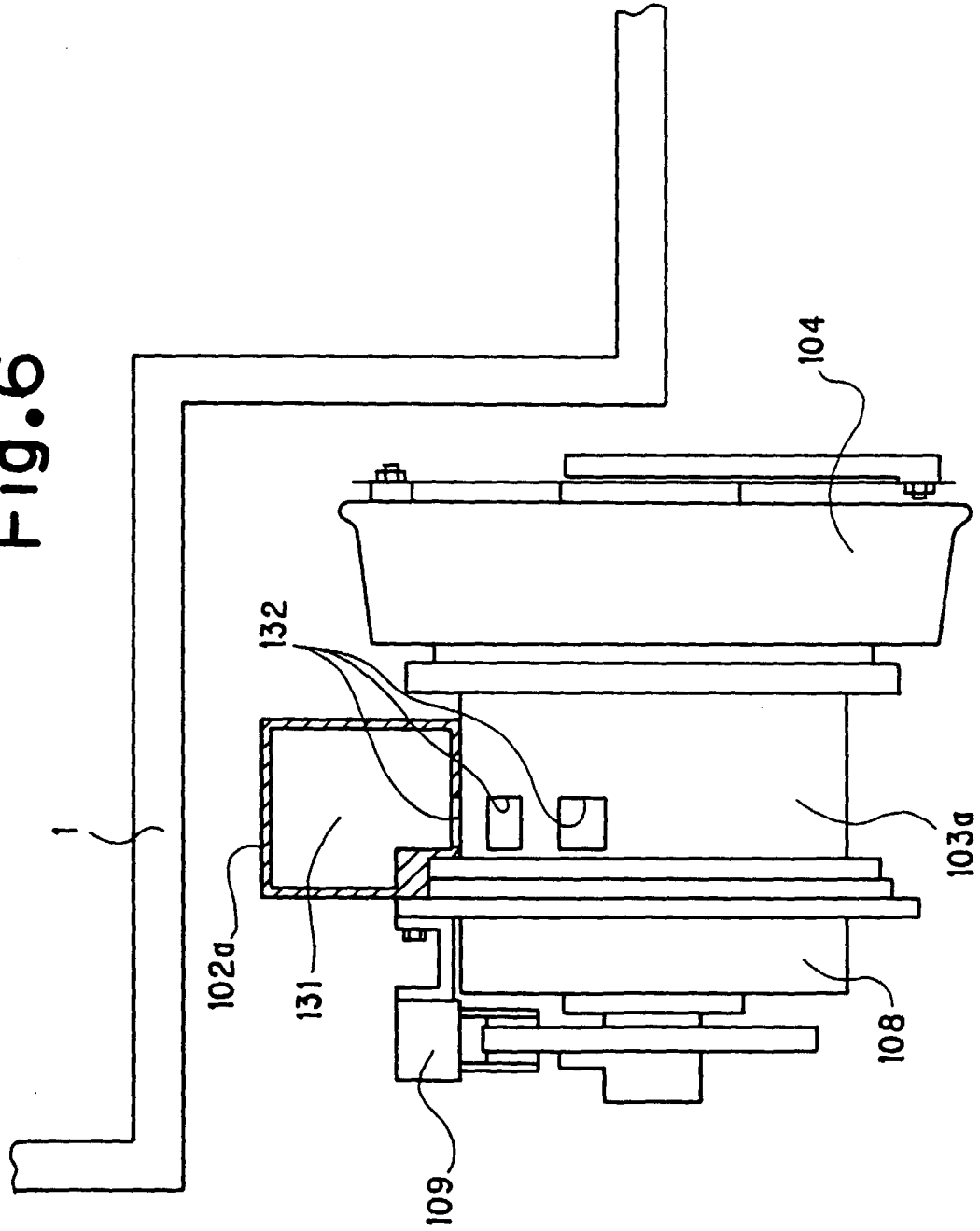


Fig.7

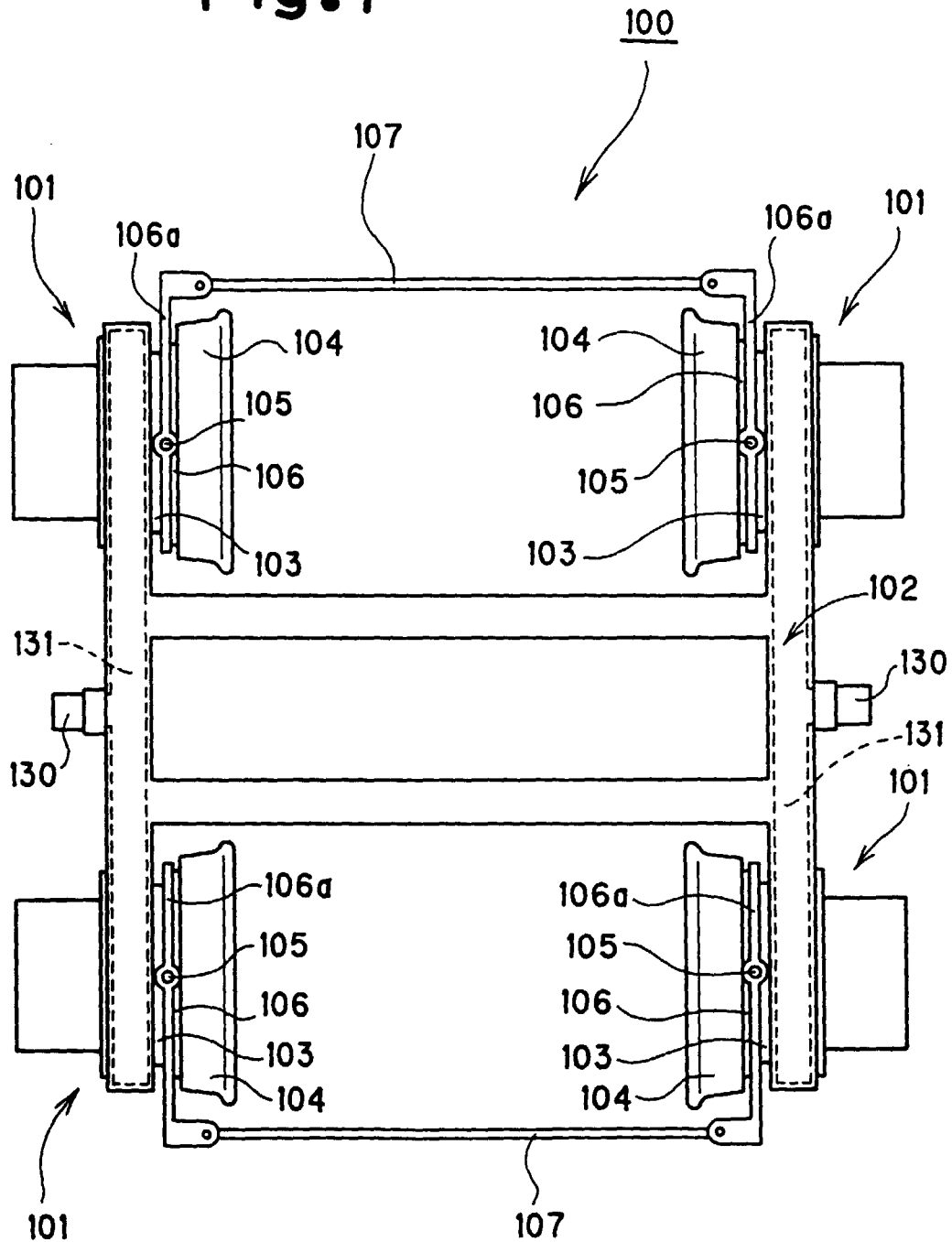


Fig.8

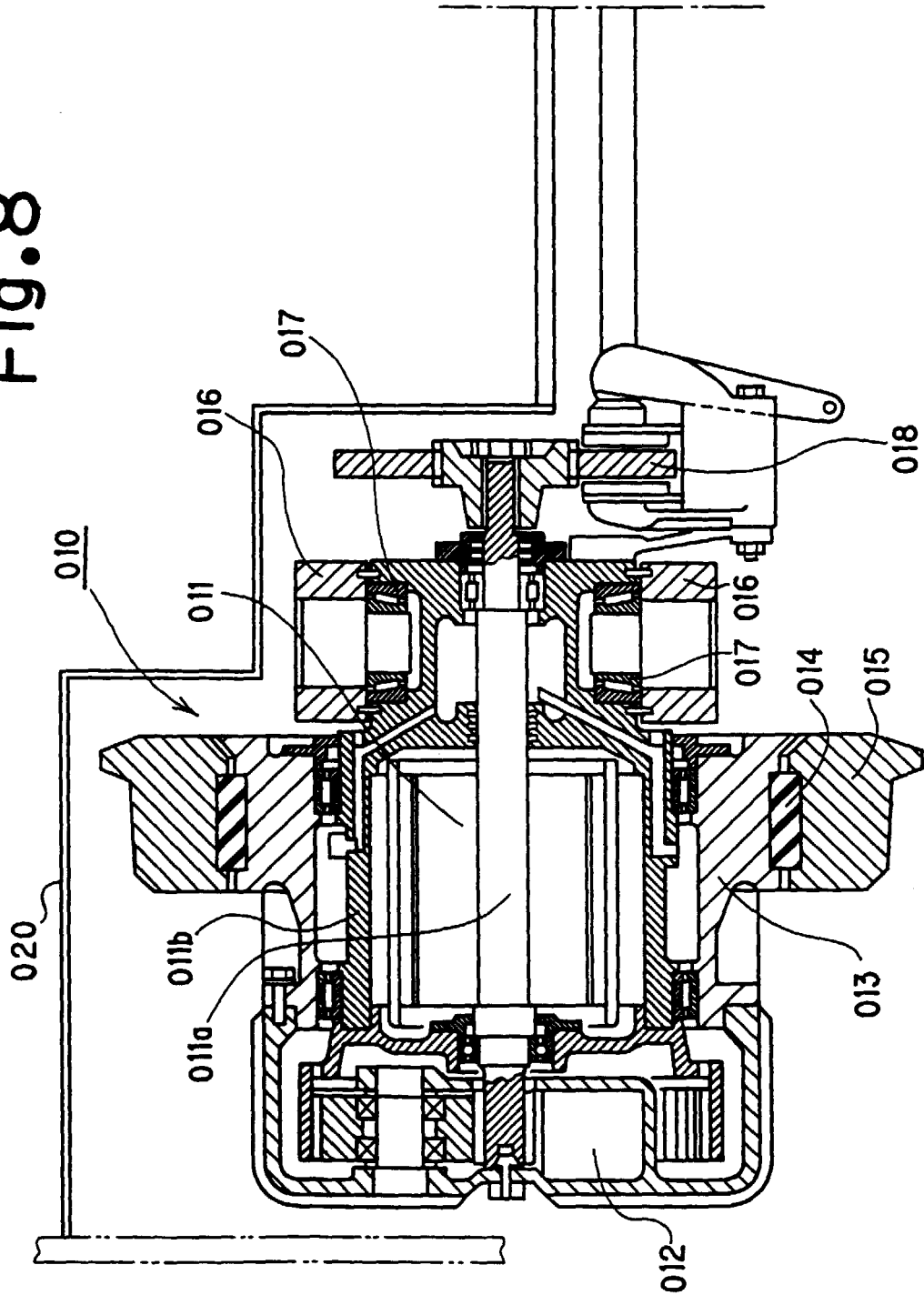


Fig.9

