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Rack railway vehicle with improved trucks.

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Rack railway vehicle with single-axle trucks, which single axle is integral with two idling wheels borne by it and running on the tracks, and is integral with at least one gear wheel inmeshing with a rack rail, which railway vehicle comprises two equal trucks installed opposite to each other under the flatbed, or load-bearing chassis of the vehicle; wherein each one of said trucks comprises a bridge-shaped structure (2) connected with the flatbed of the vehicle by means of a ball joint (3) and a pair of generally vertical springs (5), positioned at the three vertices of a triangle, with said bridge-shaped structure two electrical motors (9) being connected, which

are suitable for transmitting the motion, by means of couplings (10) incorporating a disk brake and two separate speed reduction gears (12), to a gear wheel (17) integral with the wheel axle and inmeshing with said rack rail (18), with said bridge-shaped structure also comprising an emergency brake (24) of the passive-action type with a hydraulic cylinder, equipped with shoes with end pads (25) suitable for self-blocking onto the head of the rail in case of absence of pressure inside said hydraulic cylinder, with said emergency brake being furthermore equipped with derailment-preventing teeth.

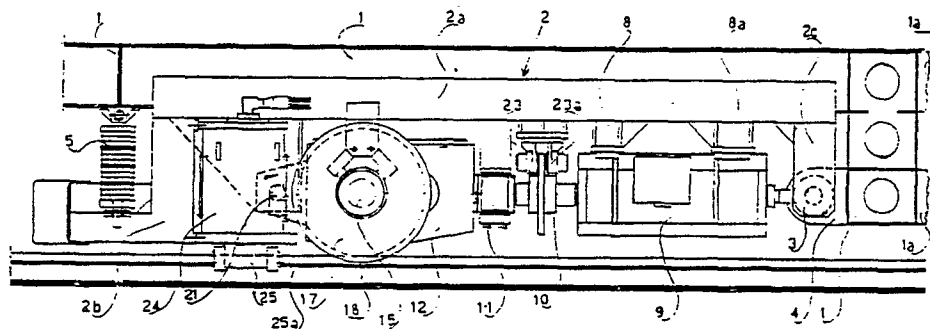


FIG. 1

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RACK RAILWAY VEHICLE WITH IMPROVED TRUCKS

The present invention relates to a railway vehicle of the type driven by means of a rack rail, which railway vehicle is equipped with single-axle trucks having such a structure as to make it possible high traction powers to be accomplished, and traveling safety and stability to be secured.

As known, the rack railway vehicles which use, for transporting the true car, two single-axle trucks, i.e., two axles, each of which is integral with two mutually opposite wheels running on the tracks, are provided with one gear wheel keyed onto each one of their axles, and inmeshing with a rack rail installed at rail level.

Usually, each truck is composed by one electrical, direct-current motor, anchored under the flat-bead, or the load-bearing chassis of the vehicle, which constitutes the bottom of the same railway car, which electrical motor transmits the motion, through a shaft and the relevant Cardan joints and elastic joints, to a speed reduction gear, positioned astride of the wheel axle; this latter transmits then the motion to the wheel gear which, by being inmeshed with the rack rail, causes the vehicle, supported by the vehicle wheels, idling on the same axle, to move. In order to enable the car and the truck to mutually shift and oscillate during traveling, the shaft of transmission of the movement from the motor to the speed reduction gear normally is given a telescopically extensible structure.

The elastic suspension of the car relatively to the trucks is normally constituted by reversed-"V"-shaped spring systems, or similar systems, which springs are positioned astride of the wheel axles on both truck sides and are anchored, at one of their ends, to the bottom of the car, and at their other end, inside housings integral with the wheel axle.

The braking system consists of a disk brake installed on the coupling which connects the driving shaft with the speed reduction gear; this brake is the normal service brake. Furthermore, an emergency brake, or parking brake, is provided, which is constituted by a metal band acting on a drum keyed on the axle bearing the two vehicle wheels and the driving gear wheel. As a further braking system also the electrical motor is used which, when its running speed adjustment is varied, with said running speed, i.e., its revolutions per minute, being adjusted at decreasing values, opposes a resistance to the revolution, generating a braking force which is proportional to the intensity of said variation. In this case, it is the same motor which is dragged to rotate by the torque applied by the transmission organs, with said electrical motor consequently turning from operating in propulsor mode into operating in electrical-brake mode, starting act-

ing as a dynamo which generates electrical power, which is then dissipated as heat by means of suitable resistors, or which can also be fed back to the power supply line.

Under normal operating conditions, the braking is normally carried out by means of the electrical motor, through the electrical system. The service disk brake, usually performing a modulated action, automatically undertakes its braking action in case the electrical braking results to be insufficient, and the band-drum brake is the emergency brake.

In practice, the railway vehicles having the above structure show some drawbacks, in particular in case of narrow-gauge railways.

In fact, the structure of the trucks provides for room for only one electrical motor per each axle, so that only a reduced power can be fed and, as a consequence, the traveling speed of the vehicle is rather low; the various braking systems, either directly or indirectly acting on the wheel axles, do not secure that the vehicle will be stopped in the not seldom case of damages to the teeth of the driving gear wheel inmeshing with the rack rail, with the consequent possibility of derailments.

Furthermore, in case of sudden strong brakings, the vehicle can tend to pitch and to overturn in the longitudinal direction, i.e., in the traveling direction, discharging the uphill wheels and sometimes causing said uphill wheels to disengage from the tracks.

Finally, not always is the spring-based suspension system capable of controlling the side shifts of the car relatively to the trucks; in practice, not always does it secure the desired comfort for the vehicle's users. Moreover, the coupling between the motor and the speed reduction gear, installed on different components of the vehicle, relatively to each other, causes, owing to the oscillations of said different vehicle components relatively to each other, uncontrolled changes in mutual revolutionary motion, with vibrations and resonance phenomena being consequently generated.

A purpose of the instant invention is of providing a rack railway vehicle provided with single-axle trucks having such a structure, as to obviate the drawbacks which affect the railway vehicles known from the prior art, and, above all, which is capable of enabling the vehicle to operate at higher traveling speeds, and of securing the greatest safety in case of sudden brakings also on high line slopes.

Another purpose of the instant invention is of providing a railway vehicle equipped with highly reliable emergency brakes, capable of stopping the vehicle also in case troubles occur, which affect the toothing of the gear wheel inmeshing with the rack

rail.

A further purpose of the present invention is of securing the traveling of the vehicle, even if at a reduced speed, also in case one, or two, of the electrical driving motors, or their electrical systems, undergo a fault.

A not least purpose is of providing a railway vehicle which is particularly, but not exclusively, suitable for use on narrow-gauge rack railways, and is capable of securing comfortable traveling conditions also on tracks positioned on irregular-surface lands.

These and still further purposes, which will be clearer from the following disclosure, are achieved by a rack railway car or vehicle with two single-axle trucks, which single axle is integral with two idling wheels running on the tracks, and is integral with at least one gear wheel inmeshing with said rack rail and driven by electrical motors, which railway vehicle is constituted according to the present invention by a load-bearing chassis for supporting the car, or by a self-supporting bodywork structure, and by two trucks equal to each other, symmetrically installed opposite to each other under said chassis or said self-supporting bodywork of the vehicle, with each one of said trucks comprising a substantially bridge-shaped structure connected with said chassis or self-supporting bodywork, at one of its ends, by means of a ball joint and, at the other one of its ends, by means of a suspension based on a pair of cup springs or the like, positioned at the vertices of the base of an isosceles triangle, the third vertex of which is constituted by said ball joint, with two electrical motors being then connected with said bridge-shaped structure, which electrical motors are suitable for transmitting the motion, by means of two coaxial couplings incorporating a disk brake and two separate speed reduction gears integral with said bridge-shaped structure, to at least one gear wheel integral with the wheel axle and inmeshing with a rack rail, with an emergency brake being furthermore associated with said bridge-shaped structure, which emergency brake is of the type with a hydraulic cylinder and of passive type, equipped with shoes with end pads suitable for getting clamped, i.e., blocked, onto the head of the rail in case of absence of pressure inside said hydraulic cylinder, and furthermore equipped with derailment-preventing teeth.

More in particular, between said bridge-shaped structure and said load-bearing chassis a vertical-axis pivot or stud, or guide system, or the like, is installed, which is peripherally coated with a vibration-damping material, suitable for preventing the bridge-shaped structure from laterally shifting relatively to the load-bearing chassis of the railway vehicle.

Furthermore, with each one of said suspension

springs, a telescopic shock absorber, or the like, is provided.

Further features and advantages of the vehicle according to the instant finding will appear more clearly from the following disclosure in greater detail of a preferred, non-exclusive, form of practical embodiment of said finding, made by referring to the hereto attached drawing tables, supplied for merely indicative purposes, in which drawing tables:

Figure 1 shows a longitudinal sectional view of one of the two trucks, equal to each other, for a railway car, accomplished according to the present invention;

Figure 2 shows a top view of the truck of Figure 1; and

Figure 3 schematically shows, in top view, the layout of the two single-axle trucks under the flatbed chassis of a railway vehicle.

With particular reference to the above specified figures, the railway vehicle according to the present invention is constituted by a main chassis, or load-bearing chassis 1, on which a usual railway car, not depicted in the drawing, is installed. The chassis 1 shown in Figures 1 and 2 corresponds to a half of the complete chassis of the railway vehicle; the other half of said chassis is equal to the depicted half, and is indicated by the reference numeral 1a.

Under each chassis 1 a single-axle truck according to the present invention is arranged and in the complete vehicle the two trucks, equal to each other, are symmetrically positioned opposite to each other, as shown in Figure 3 for indicative purposes.

Each single-axle truck is constituted, according to the instant invention, by a bridge-shaped structure 2 consisting of a flat, horizontal, framework 2a and by two mutually opposite pairs of uprights 2b and 2c, with said bridge-shaped structure being connected, at one of its ends, with the chassis 1 by means of a ball joint 3 interposed between the upright 2c and a bracket 4 protruding from the chassis 1, and, at its opposite end, by means of two large vertical springs 5 and 5a interposed between the chassis 1 and two horizontal appendices 2d-2e respectively fixedly mounted onto the uprights 2b of the bridge-shaped structure 2.

The suspension of the chassis is hence provided on three points 3-5a-5 arranged at the vertices of an isosceles triangle (Figure 2). With the large vertical springs 5-5a, two telescopic shock absorbers 6-6a are installed, which are positioned inclined relatively to the axis of said springs 5-5a, so as to converge towards the longitudinal middle axis of the bridge-shaped structure.

The ball joint 3 is preferably coated with a vibration-damping material, and is capable of enabling the bridge-shaped structure 2 (and therefore

the whole truck, as it is better seen in the following) to partially rotate relatively to the load-bearing chassis 1 according to two mutually perpendicular axes passing through the centre of the ball joint; such partial rotations enable the truck to follow the layout of the tracks and of the rack rail independently from the trim of the vehicle.

A stud 7 is then provided, and is visible in Figure 2, also provided with a vibration-damping coating, which stud 7 is interposed, in a vertical position, between said large springs 5-5a and performs the function of preventing the load-bearing chassis from shifting in a transversal horizontal direction relatively to the truck.

With the bridge-shaped structure 2, thus hanging from the load-carrying chassis 1, two electrical, direct-current motors 9-9a are rigidly connected by means of two pairs of brackets 8-8a, with the axes of said electrical motors being parallel to each other. The shafts of both of said motors transmit the motion, through two couplings 10-10a, to two speed reduction gears 12-12a (clearly shown in schematic view in Figure 3), which speed reduction gears, through a pair of bevel gears 13 and speed reduction gears 14-14a, transmit, in their turn, the motion to the axle 15 of the wheels 16-16a of the truck and of the gear wheel 17 inmeshing with the rack rail 18. The axle 15 is revolutionarily supported by means of revolving bearings installed in the cases of the speed reduction units 12-12a.

The speed reduction units 12-12a are connected with the bridge-shaped structure 2 by means of the vibration-damping supports 11-11a and of the horizontal-pivot vibration-damping supports 21-21a (Figure 2).

Furthermore, said couplings 10-10a are each provided with a brake disk 22-22a and with relevant shoe brakes with pads 25-23a (Figure 1), of a type known from the prior art; said disk brakes constitute the normal-operations braking system.

Finally, with each twin-electrical-motors truck, a safety -- i.e., an emergency -- brake generally indicated by the reference numeral 24, is associated, of the type with hydraulic cylinder with return springs in case, owing to unexpected causes, the fluid pressure is absent in the cylinder, and which is equipped with shoes bearing pads 25 at their bottom end, which pads 25 are suitable for being brought into clamping against the opposite walls of the rail head, with the vehicle being hence automatically stopped.

Furthermore, said emergency brake is provided, under said clamping pads, with teeth facing the web of the rail 25a, which teeth are capable of preventing the wheels of the truck from accidentally moving upwards in case the rack undergoes a failure, or in case solid, foreign bodies are interposed between the wheels and the rails, therefore

preventing said vehicle from derailing.

In practice, the hydraulic brake which is the subject-matter of the Italian patent application No.19181 A/89 filed on January 25, 1989 in the same Applicant's name, demonstrated to be particularly efficacious.

As shown in Figure 3, the railway vehicle according to the present finding is provided with two bridge-shaped trucks, equal to each other, as such trucks are disclosed hereinabove by referring to Figures 1 and 2, which trucks are arranged aligned to each other and mutually opposite under the load-bearing chassis 1 of the vehicle. Therefore, in practice, the second truck, generally indicated by the reference numeral 26 in Figure 3, has its own ball joint connected with a relevant bracket protruding from the chassis 1a, in a position opposite to, and aligned with, the bracket 4 of the bridge-shaped structure of Figure 1. Therefore, the vehicle can oscillate around six points constituted by the two ball joints in central position, and the two pairs of large springs installed at the opposite ends of both trucks.

In practice, the instant Applicant was able to observe that the use of two electrical motors on each truck, and consequently of four motors on each railway vehicle, makes it possible very high traction powers to be obtained with small overall dimensions so that, also in case of narrow-gauge railways, it results it possible high speeds to be obtained, always under conditions of maximum safety; furthermore, the particular, hereinabove disclosed, emergency brake, acting on the tracks, makes it possible the vehicle to be stopped under any emergency cases, with no risk of vehicle derailment.

The feed of power to the four motors is accomplished in such a way that the electrical current is subdivided among all of said motors, in order to prevent some of the transmission organs from being overloaded and overstressed relatively to the remainder transmission organs. Furthermore, the power of each individual motor is selected in such a way as to enable the vehicle to travel, even if at a reduced speed, or, in case two motors undergo a failure, at half speed, independently from how said faulty motors are distributed between the trucks.

In case only two motors are used, these latter shall be so dimensioned, as to allow a full-loaded car to travel at half speed along the highest slope.

However, the electrical equipment is so studied, as to automatically allow the traveling speed to be increased when the required torque decreases, when the slope and/or the transported load are smaller than the maximum slope/transported load.

Obviously, structurally and technically equivalent modifications and variants can be supplied to the finding as hereinabove disclosed without de-

parting from the scope of protection of the same finding.

Claims

1. Rack railway vehicle with single-axle trucks, which single axle is integral with two idling wheels running on the tracks, and is integral with at least one gear wheel inmeshing with said rack and driven by electrical motors, which railway vehicle is characterized in that it is constituted by a load-bearing chassis for supporting the car, or by a self-supporting bodywork structure, and by two trucks equal to each other symmetrically installed opposite to each other under said chassis or said self-supporting bodywork of the vehicle, with each one of said trucks comprising a substantially bridge-shaped structure connected with said chassis or self-supporting bodywork, at one of its ends, by means of a ball joint and, at the other one of its ends, by means of a pair of cup springs or the like, positioned at the vertices of the base of an isosceles triangle, the third vertex of which is constituted by said ball joint, with two electrical motors being then connected with said bridge structure, which electrical motors are suitable for transmitting the motion, by means of two coaxial couplings incorporating a disk brake and two separate speed reducing gears integral with said bridge-shaped structure, to at least one gear wheel integral with said wheel axle and inmeshing with a rack rail, with an emergency brake being furthermore associated with said bridge-shaped structure, which emergency brake is of the type with a hydraulic cylinder and with passive-type action, is equipped with shoes with end pads suitable for getting clamped onto the head of the rail in case of absence of pressure inside said hydraulic cylinder, and is furthermore equipped with derailment-preventing teeth.

2. Vehicle according to claim 1, characterized in that between said bridge-shaped structure and said load-bearing chassis a vertical-axis pivot or stud, or guide system is installed, which is peripherally coated with a vibration-damping material, suitable for preventing the bridge-shaped structure from laterally shifting relatively to said load-bearing chassis of the railway vehicle.

3. Vehicle according to claim 1, characterized in that with each one of said suspension springs, a telescopic shock absorber is associated in order to dampen the oscillations of the vehicle relatively to the trucks.

4. Vehicle according to the preceding claims, characterized in that said motors are fed with electrical current equally subdivided between said motors, in order not to overcharge any transmission

organs relatively to the remainder transmission organs.

5. Vehicle according to one or more of the preceding claims, characterized in that said speed reduction gears support said bridge-shaped structure with the interposition of vibration-damping supports.

6. Vehicle according to the preceding claims, characterized in that said electrical motors are so dimensioned as to feed a high enough power for a reduced-speed traveling in case one or two of the above said motors undergo a fault.

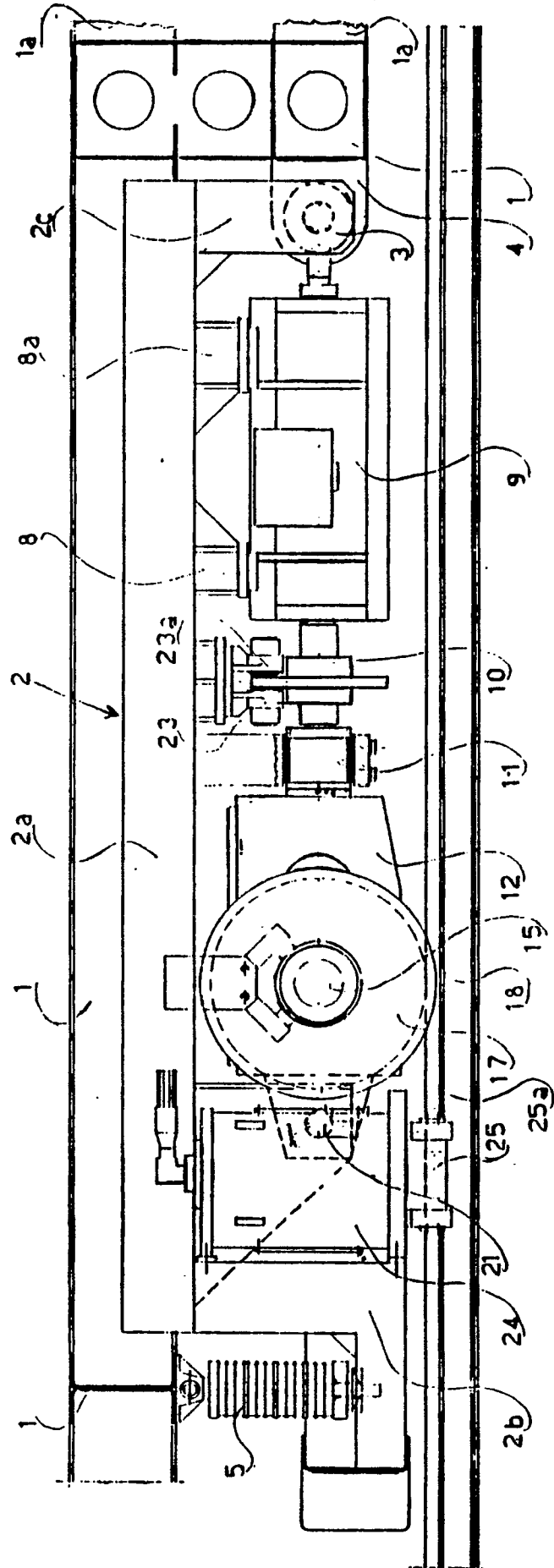


FIG. 1

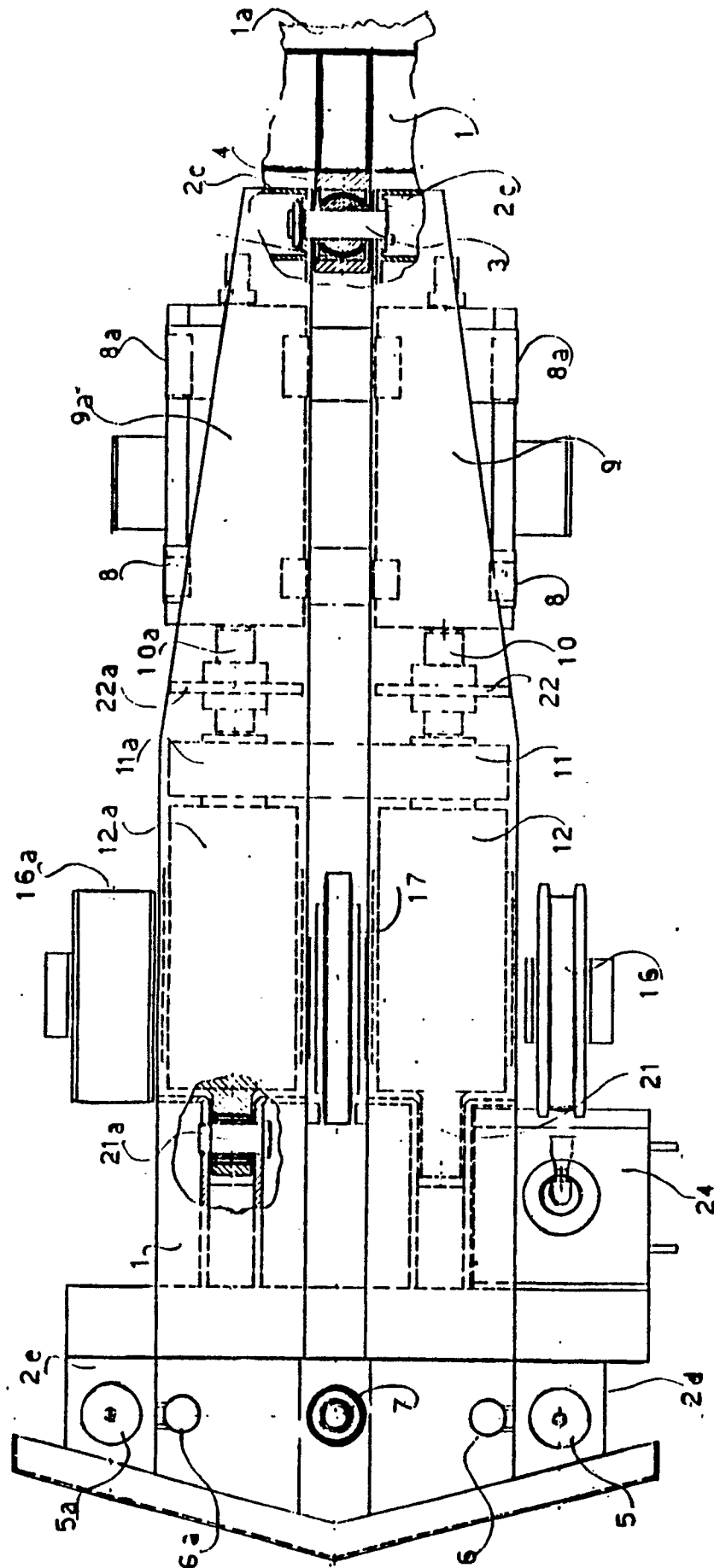


FIG. 2

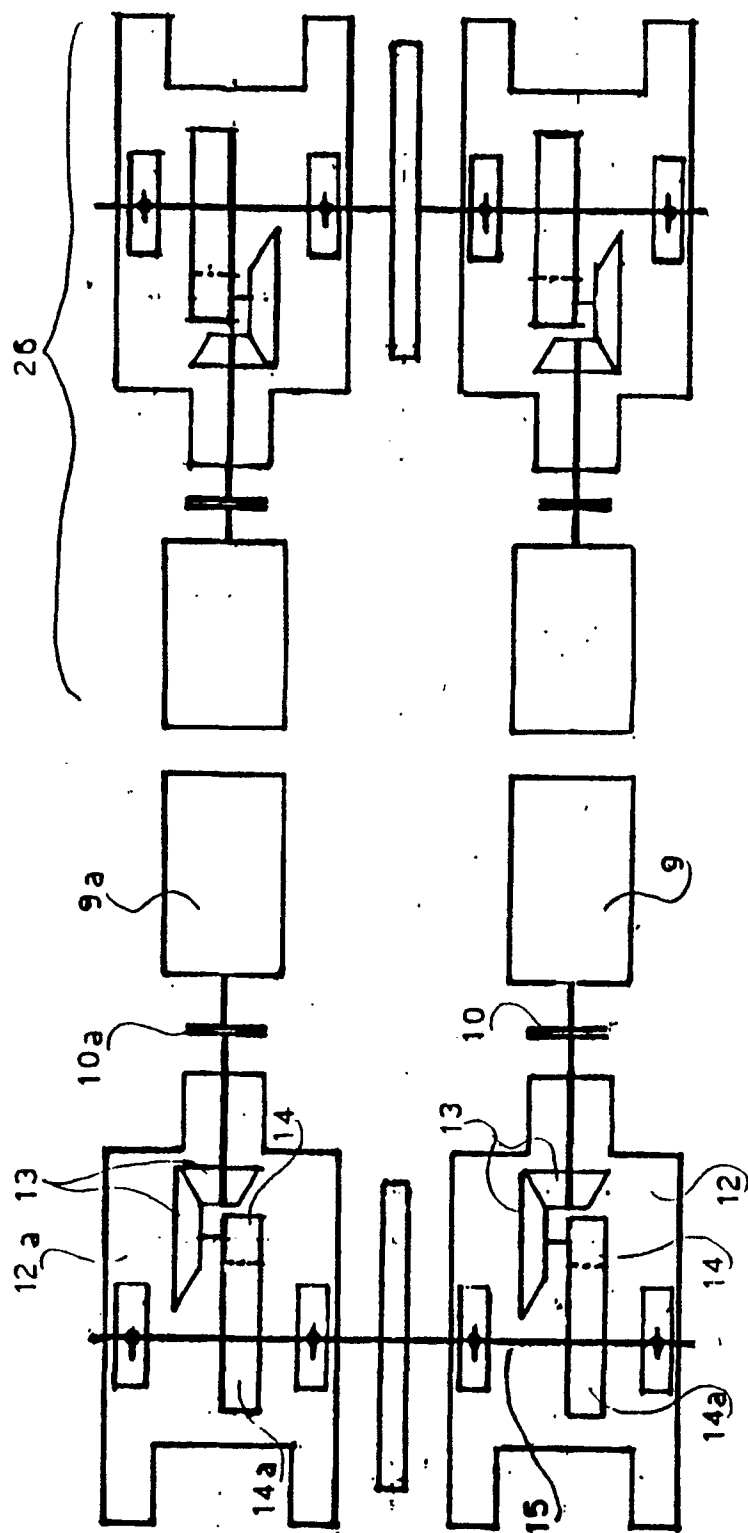


FIG. 3