PATENT SPECIFICATION

415,808

Application Date: March 6, 1933. No. 6768/33.

„ „ March 20, 1933. No. 8422/33.

„ „ April 6, 1933. No. 10,370/33.

One Complete Left: Dec. 7, 1933.

Complete Accepted: Sept. 6, 1934.

PROVISIONAL SPECIFICATION.

No. 6768, A.D. 1933.

Improvements in Railway Motor Wagons.

I, GEORGE CONSTANTINESCO, of Oxen House, Torver, Coniston, Lancashire, British subject, do hereby declare the nature of this invention to be as follows:—

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way that only a small portion of the weight of the wagon acts upon it through the interposition of properly adjusted springs or suitable balancing levers.

The invention further consists in fitting

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SPECIFICATION No. 415,808

Page 6, line 30, *for* "view" *read* "views"

Page 9, line 1, *for* "thereon" *read* "thereof"

Page 12, line 55, *after* "any" *insert* "of"

THE PATENT OFFICE,

24th April, 1935.

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cost and at the same time eliminate the risk of damaging the machinery by involuntary overloading at starting.

The invention consists in suspending from the frame of the wagon an ordinary type of automobile driving axle which is preferably provided with differential gear. This axle, hereinafter referred to as the auxiliary axle, is suspended in such a

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dition to the suspension afforded by the springs or balancing levers previously referred to.

The pressure on the rubber tyres in contact with the rail can be very moderate because the coefficient of friction between the rubber and the rails, whether they be dry or wet, is considerable. On account of such low loading on the

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Application Date: March 6, 1933. No. 6768/33.

„ „ March 20, 1933. No. 8422/33.

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PROVISIONAL SPECIFICATION.

No. 6768, A.D. 1933.

Improvements in Railway Motor Wagons.

I, GEORGE CONSTANTINESCO, of Oxen House, Torver, Coniston, Lancashire, British subject, do hereby declare the nature of this invention to be as follows:—

The present invention relates to a new method and means for propelling railway motor wagons, small locomotives and like vehicles, driven by internal combustion engines, steam or electric motors.

It is customary to propel rail vehicles by driving one of the axles of the vehicle through a suitable transmission either by chain gearing or cardan shafts and bevel gearing. When the available motive power is small, considerable difficulty is experienced in designing the transmission for existing axles of a railway vehicle on account of the necessarily heavy sections of such axles which have to support heavy loads and resist shocks and torsion. Also on account of the heavy nature of standard railway wagons, when attempting to use small engines it is difficult to design the transmission strong enough to withstand the heavy stresses which occur at starting, especially when using ordinary change gear mechanisms and clutches, for the reason that the stresses depend on the skill of the driver in changing gear and manipulating the clutch. Consequently, heavy and expensive gearing is necessary.

The present invention renders it possible to employ ordinary automobile engines and transmissions which are relatively of light construction, and adapting standard motor car components to propel relatively heavy railway stock and thus obtain very considerable reduction of cost and at the same time eliminate the risk of damaging the machinery by involuntary overloading at starting.

The invention consists in suspending from the frame of the wagon an ordinary type of automobile driving axle which is preferably provided with differential gear. This axle, hereinafter referred to as the auxiliary axle, is suspended in such a way that only a small portion of the weight of the wagon acts upon it through the interposition of properly adjusted springs or suitable balancing levers.

The invention further consists in fitting to this auxiliary axle light driving wheels provided with rubber tyres which are preferably flat, the wheels not having retaining flanges, the width of the tyre being sufficient to ensure contact with the rail all the time even when passing round curves.

The invention further consists in providing means for shifting the auxiliary axle transversely to the rails to enable different tracks of the rubber tyres to be moved into contact with the rails so that when one track is worn out a fresh one can be brought into use.

The invention further consists in providing means to adjust the load on the auxiliary axle so that the load thereon will never exceed a predetermined amount which is substantially independent of the load on the wagon.

The invention further consists in driving the auxiliary axle by an engine and transmission mounted on the wagon and connected to the auxiliary axle either through a cardan shaft and differential gear or through a differential gear mounted on the wagon and connected by two chains to the wheels on the auxiliary axle.

According to a further feature of the invention the auxiliary axle differential gear, transmission and engine form a single unit which is pivotally suspended from the frame adjacent the engine in addition to the suspension afforded by the springs or balancing levers previously referred to.

The pressure on the rubber tyres in contact with the rail can be very moderate because the coefficient of friction between the rubber and the rails, whether they be dry or wet, is considerable. On account of such low loading on the

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auxiliary axle, if by any chance the transmission is overloaded, the only result will be that the wheels will slip.

The pressure of the tyres should therefore be adjusted so that slip occurs at a predetermined maximum torque which the transmission can convey with safety.

The invention further consists in providing a wagon with a plurality of auxiliary axles and engines so as to obtain higher tractive effort.

The invention renders it possible to adapt to any standard railway wagon any standard automobile driving axle, thereby combining the advantages of the light construction of ordinary automobile construction, while still employing a railway wagon of standard robust construction of axles and steel tyres. The adaptation is simple and inexpensive. In case of damage to the rubber tyres through wear or accident, no harm occurs to the wagon as the ordinary axles which support the wagon are not affected in any way.

It may be pointed out that since the main axles which support the wagon are steel tyred and flanged, while the wheels of the auxiliary axles are light and rubber-tyred but not flanged, the wear of these rubber tyres is very considerably less than if they were themselves flanged. The auxiliary axle and wheels can float a certain amount transversely to the rail and thus, instead of continually bearing on the same tread, the whole of the floating surface of the rubber tyre will be utilised.

The rubber tyre is cylindrical and is preferably of the solid type, but pneumatic tyres may also be employed.

The load on the auxiliary driving axle can be reduced up to about one tenth of the weight of the wagon. Thus, a ten ton wagon can be propelled through an auxiliary axle loaded to only one ton. This very low loading will secure to the rubber tyres a long life and the auxiliary axle can be of light construction. For climbing heavy gradients, the load may be adjusted, say, to two tons, which even in this case represents only one fifth of the weight of the wagon.

Dated this 6th day of March, 1933.

CARPMAELS & RANSFORD,
Agents for Applicant,
24, Southampton Buildings, London,
W.C. 2.

PROVISIONAL SPECIFICATION.

No. 8422, A.D. 1933.

Improvements in Railway Motor Vehicles.

I, GEORGE CONSTANTINESCO, of Oxen House, Torver, Coniston, Lancashire, British subject, do hereby declare the nature of this invention to be as follows:—

This invention relates to improvements in railway motor coaches and wagons, and particularly to the invention described in the specification of my application No. 6768, dated the 6th March, 1933, in which a railway wagon is propelled through wheels having "flat" tyres (usually of rubber) mounted on one or more auxiliary axles which are of relatively light construction and are suspended from the wagon independently of the main axles of the vehicle in such manner that only a small portion of the weight of the wagon acts upon the axle in use.

The present invention consists in providing a method and means to obtain reverse motion of the wagon without the use of special reversing gears.

The invention further consists in suspending the auxiliary axle in such a manner that when it is desired to run forward, the wheels on the said axle are pressed into contact with the rails as described in the aforesaid specification, and when it is desired to run the wagon in the reverse direction, the axle is raised from its normal position so that the tyres of the wheels on the said axle are raised out of contact with the rails and are pressed against the steel tyres of one of the ordinary axles of the wagon.

For this purpose the auxiliary axle is located near to one of the ordinary axles of the wagon so that when the wagon is running forward, the steel tyres on the ordinary wheels and the tyres of the wheels on the auxiliary axle are close to one another but out of contact.

The invention further consists in providing a system of linkage between the bearings of the ordinary axle and those of the auxiliary axle such that when one point of articulation of this linkage is lifted up, the auxiliary axle with its wheels is lifted up from the rail and is pressed towards the ordinary axle so that the steel tyres and the tyres of the auxiliary axle are moved into contact with the desired pressure. When such articulation is moved downwards, the reverse action occurs.

Mechanical, pneumatic, hydraulic or electrical means may be employed to actuate such system of linkage.

The invention further consists in employing a plurality of auxiliary axles, each arranged as described above, but so that when the wagon is running forward one or more are driving forward through contact with the rails; the other or others are driving forward also but through contact with the steel wheels. In this way, irrespective of the direction in which the wagon is running, the load due to the weight of the intermediary axles is borne partially by the rails and partially by the wagon.

The invention further consists in introducing in the linkage system suitable springs in order that the pressure of the tyres of the wheels of the auxiliary axle (or axles) on the rails or on the wagon wheels may be kept fairly constant and/or so that it may be adjusted at will by the driver.

Although in many cases I prefer to use rubber for the tyres of the wheels of the auxiliary axle (or axles), I may employ leather, wood, copper, soft iron or special steels or alloys having a high coefficient of friction. Or I may employ fabrics containing bonded asbestos, rubber and other substances like fibre and the like. The use of such fabrics and substances is possible in view of the relatively low pressure required on such auxiliary axles.

For heavy wagons in which a plurality of auxiliary axles is employed, a single engine may be used to drive them through cardan shafts, chains or gearing, or several synchronising motors may be employed to drive said axles independently.

When a plurality of auxiliary axles is employed, of which one or more drives by contact on the rails while one or more drives by contact with the wagon wheels, the rotation of such auxiliary axles will normally be in opposite directions so that the wagon shall proceed in a single direction.

Dated this 20th day of March, 1933.

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Agents for Applicant.
24, Southampton Buildings, London, W.C. 2.

PROVISIONAL SPECIFICATION.

No. 10,370, A.D. 1933.

Improvements in Railway Motor Vehicles.

I, GEORGE CONSTANTINESCO, of Oxen House, Torver, Coniston, Lancashire, British subject, do hereby declare the nature of this invention to be as follows:—

This invention relates to improvements in the invention described in my pending applications Nos. 6768/33 and 8422/33.

The necessary load on the auxiliary axle referred to in the aforesaid specifications need not be at any time greater than just sufficient to ensure the grip of the driving tyres on the rails. For example, the co-efficient of friction of the rubber tyres on the rails is high for dry rails and may be as great as 70 to 80% in favourable circumstances. In such circumstances therefore, a very moderate load on the tyres will ensure the necessary grip. On wet rails however, or when ice, sleet or snow covers the rails, the co-efficient diminishes considerably and greater loads are necessary; such greater loading may however, be necessary only for a very limited time during the service of the vehicle. For example supplementary loading may be necessary while the vehicle is travelling over a greasy patch of rails or during a sudden shower of rain or sleet, while during the remainder of the time and especially when coasting down hill a reduced load will be sufficient.

The present invention consists in providing a method of and/or means for automatically adjusting the load on the auxiliary driving axles.

The invention consists in regulating the load on the driving auxiliary axle through an adjustable loading and unloading device controlled or acted on by the relative slip between the wheels on the auxiliary axle and the ordinary wheels supporting the vehicle.

The auxiliary axle may be carried on a frame (hereinafter referred to as the auxiliary frame) through interposed springs, this auxiliary frame being in turn articulated at one end to the frame of the vehicle and at the other end supported from the frame of the vehicle through an adjustable screw, rack or like mechanical device which permits the lifting or lowering of the auxiliary frame relatively to the frame of the vehicle and thus enabling the loading of the auxiliary axle to be increased or decreased; the auxiliary frame is guided so as to prevent or limit movement thereof transversely to the rails.

The screw, rack or the like may be replaced by a pneumatic or hydraulic cylinder and piston or diaphragm to act between the auxiliary frame and the frame of the vehicle so that by varying the pressure of the air or other fluid in the cylinder, the load on the auxiliary axle can be varied accordingly.

Alternatively the auxiliary axle is connected through a suitable linkage to the vehicle frame, such linkage being actuated by one or more pistons and cylinders attached to the frame of the vehicle and to the linkage so that loading of the auxiliary axle can be varied by varying the fluid pressure.

In order to actuate the adjustable screws, racks, pistons, diaphragms or the like loading devices by motion or pressure derived from the relative slip between the wheels of the auxiliary axle and the vehicle supporting wheels, the auxiliary axle or wheels may be arranged to drive one member of a differential while the supporting axle or wheels of the vehicle are arranged to drive in a reverse direction, the other member of the differential; the arrangement is such that when no slip occurs the centre or driven member of the differential is stationary but when slip occurs the centre member rotates and this rotation is transmitted to actuate or control the adjustable loading devices. This may be accomplished either directly as by driving the screws, racks or the like or indirectly as by driving a compressor, pump or the like which will create the fluid pressure for operating the pneumatic or hydraulic devices referred to.

Alternatively a differential pump or compressor may be employed one member of the pump being driven by the auxiliary axle while the other member is driven by the axle of the vehicle in such way that when there is no slip between the driving axle and the rail, the differential pump produces no pressure while when slip occurs, pressure is created so long as the slip persists, the pressure created being conveyed through pipes to the adjustable loading devices. Instead of a differential pump, two pumps may be used, one driven by the auxiliary axle, the other by the vehicle axle, the delivery side of the first pump being connected to the suction side of the second, while a branch from this connection conveys fluid to the cylinders of the loading device.

When liquids are used the delivery side of the second pump is preferably connected to a compensating tank from which the first pump draws the liquid thus providing a closed circuit.

The invention further consists in providing a differential relay device one member of which is actuated by the auxiliary axle and the other by the vehicle axle in such a way that the middle or driven member which receives the differential motion remains stationary when no slip occurs. When, however, slip takes place, the middle member is actuated and the relay device thereby actuates a servo motor which may be mechanical, electrical or fluid operated, the servo motor actuating the adjustable loading device so as to increase the load when slip occurs.

The differential devices will be arranged so as automatically to unload the auxiliary axle when the slip has ceased and may also be arranged to effect this when the vehicle is over-running the driving axle.

The differential operating devices are preferably so arranged that when no slip occurs, there will be a slow unloading action which will automatically unload the auxiliary axle to a fixed but preferably adjustable predetermined minimum value. Means may also be provided for limiting the loading to a fixed but preferably adjustable predetermined maximum value.

It will be seen that with an arrangement according to this invention, on starting the vehicle or when the vehicle is on steep gradients under adverse conditions, as regards the coefficient of friction between the auxiliary driving wheels and rails, the wheels will first slip but this action will automatically cause an increase in the loading on such wheels until the slip will cease or will be reduced to very small proportions. As soon as slip has ceased the drive will become normal and the load will either be gradually diminished as for example on account of the fixed or adjustable leakages when fluids are used, or by the positive gradual unloading action which will occur when the differential control system is so arranged that when no slip occurs there shall actually be a slow unloading action either up to a minimum load determined beforehand or up to a load at which slip will occur again.

This control of loading is automatic so that the driver of the vehicle need pay no attention to what load is actually on the auxiliary axle nor need he take into account the load on the vehicle which load will of course vary with the number of passengers or goods carried.

The invention therefore ensures the minimum loading necessary for providing the grip to ensure propulsion of the vehicle, thus during the greater part of the driving time the load on the auxiliary axle will be considerably reduced as compared with an arrangement in which fixed loading is provided; this will result in low tyre wear and higher overall efficiency, as if a fixed loading is provided, this must of necessity correspond to the maximum loading necessary to secure grip under the most adverse conditions, as for the condition when the friction between rail and rubber tyre drops temporarily to a very low value. The invention enables the use of sand for assisting wheel grip to be dispensed with except in very exceptional cases such as starting on ice or grease covered rails.

If the vehicle is arranged to run in both directions, means can be provided to cause operation of the loading devices no matter in which direction the wheels rotate; in the case when fluid pressure is relied upon to vary the loading, means could be provided to reverse the fluid connections; when relays are employed this can be effected very simply, the relays actuating the loading devices in the same direction no matter in which direction the driving wheels are rotating; for an entirely mechanical action, through differential control gear and mechanical loading gear, this could be effected either by suitable reversing clutches or by a linkage of the toggle type which will act in the same direction irrespective of the direction of actuation of the differential control gear.

Dated this 6th day of April, 1933.
CARPMAELS & RANSFORD,
Agents for Applicant.
24, Southampton Buildings, London, W.C. 2.

COMPLETE SPECIFICATION.

Improvements in Railway Motor Vehicles.

I, GEORGE CONSTANTINESCO, of Oxen House, Torver, Coniston, Lancashire, British subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to a new method and means for propelling railway motor wagons, small locomotives, and like vehicles of the kind in which in addition to the ordinary flanged metal wheels there are provided wheels driven by an engine or motor, which wheels constitute the driving wheels of the vehicle.

In vehicles of this kind it has been proposed to raise the driving wheels out of contact with the rails, either to facilitate the starting of the electric motor by which the vehicle is driven, or to avoid the necessity of stopping the motor when the vehicle is at rest.

It is customary to propel rail vehicles by driving one of the axles of the vehicle through a suitable transmission either by chain gearing or cardan shafts and bevel gearing. When the available motive power is small considerable difficulty is experienced in designing the transmission for existing axles of a railway vehicle on account of the necessarily heavy sections of such axles which have to support heavy loads and resist shocks and torsion. Also on account of the heavy nature of standard railway wagons, when attempting to use small engines, it is difficult to design the transmission strong enough to withstand the heavy stresses which occur at starting, especially when using ordinary change gear mechanisms and clutches, for the reason that the stresses depend on the skill of the driver in changing gear and manipulating the clutch. Consequently heavy and expensive gearing is necessary.

The present invention renders it possible to employ ordinary automobile engines and transmissions which are relatively of light construction, and adapting standard motor car components to propel relatively heavy railway stock and thus obtain very considerable reduction of cost and at the same time eliminate the risk of damaging the machinery by involuntary overloading at starting.

According to one feature of the present invention, in addition to the usual flanged metal wheels there is provided an auxiliary axle suspended from the railway vehicle and having wheels which constitute at all times the driving means and fluid actuated means for adjusting the loading on said auxiliary axle whereby the wheels on said auxiliary axle are normally pressed into contact with the rails to such a degree as will enable them to drive the vehicle to suit varying conditions (e.g. gradients or rails which may have become slippery owing to rain, sleet or snow) the flanged metal wheels retaining their guiding and supporting function.

According to another feature of the invention, in addition to the usual flanged metal wheels there are provided in combination an underframe articulated to the vehicle, an auxiliary axle supported by said underframe, wheels on said auxiliary axle which wheels at all times constitute the driving means and means for adjusting the loading on said auxiliary axle whereby the wheels on said auxiliary axle can be pressed into contact with the rails to such a degree as will enable them to drive the vehicle to suit varying conditions the flanged metal wheels retaining their guiding and supporting function.

Preferably the auxiliary axle is formed of a rear axle of the automobile type suspended by an underframe articulated at the vehicle, whilst transmission of the automobile type is also preferably employed, but any other form of transmission may be employed.

Various forms of the invention are illustrated diagrammatically by way of example in the accompanying drawings in which Figures 1, 2 and 3 show one form. Figure 1 being a transverse section, Figure 2 a longitudinal section and Figure 3 a plan. Figure 3A shows an arrangement similar to that shown in Figures 1—3 but in which the auxiliary axle is floating. Figures 4 and 5 are view similar to Figure 2 of modifications; Figure 6 is a longitudinal section of the arrangement shown in Figure 2 and showing the driving unit and Figures 7 and 8 show means for adjusting the loading on the auxiliary axle, Figure 8 showing a vehicle with a pair of auxiliary axles. Figures 9, 10, 11 and 12 show the method by which the wheels of the auxiliary axle can be brought into engagement with the flanged metal wheels.

Figures 13, 14 and 15 show modified forms of the arrangement shown in figures 7 and 8. Figures 16, 17, 18 show respectively in longitudinal section, transverse section and plan, another method of adjusting the loading on the auxiliary axle. Figures 19, 19A. 19B and 20 show another method of adjusting the loading on the auxiliary axle. Figures 21, 22 and 23 show further modifications of the arrangement shown in figures 7 and 8. Figures 24 and 25 show two forms of tyres employed on the wheels carried by the auxiliary axle whilst figure 26 shows in side elevation a complete vehicle according to the invention.

Referring now to the arrangement shown in figures 1, 2 and 3, which arrangement is adapted to a railway wagon or vehicle, 1 is the usual vehicle frame supported by flanged metal wheels 2 on an axle 2^1 and springs 3. Suspended from the frame 1 is a frame 4 of the automobile type which frame 4 is in turn supported by wheels 5 carried on an auxiliary axle 6, the usual springs 7 being interposed between the axle 6 and frame 4. The wheels 5 constitute the driving wheels of the vehicle and are provided with rubber tyres (such as are shown in figures 24 and 25) the width of the tyre being sufficient to ensure contact with the rail 8 all the time even when the vehicle passes round curves. The frame 4 is pivoted at 9 to the frame 1. which frame 1 is provided with depending arms 10 having holes 11 which can be brought into register with corresponding holes in the frame 4 so that, by means of a bar 12, the pressure on the auxiliary axle can be varied. Furthermore the depending arms 10 are provided with holes 13 whereby the auxiliary axle 6 can be shifted transversely to the rails 8 to enable different portions of the tread of the tyres to be moved into contact with the rails so that when one portion of the tread is worn out, a fresh one can be brought into use. 14 represents a universal joint, such as is generally employed in the transmission 15 of the automobile type.

Figure 3a, shows an arrangement in which the frame 4 carrying the auxiliary axle is allowed to float between the depending arms 10 on the frame 1. In this arrangement, a double acting piston 84, fast on a rod 85 slidably mounted between the arms 10 for adjustment purposes according to varying loads, is located within a closed cylinder 86 to which the frame 4 is secured, the cylinder 86 being slidably mounted on the rod 85. 87 are springs which tend to keep the cylinder and frame centrally positioned between the arms 10. The piston 84 and cylinder 86 act as a dashpot and are so arranged as to damp the lateral oscillations of the frame, so that the system during the motion of the vehicle can oscillate from one side to the other a limited amount which can be controlled by the construction of the damping cylinder. In one way of effecting this more clearance is allowed between the piston and cylinder in its mean position thereby allowing free oscillations to take place whilst the vehicle runs in a straight line; little clearance however is allowed towards the ends of the cylinder thereby damping out any oscillations when the vehicle is running in a curve.

In figure 4 the spring 3 is connected in the usual manner at one end through a link 16 to the frame 1 and at the other end is connected to a link 17 centrally suspended from the frame 1 and adjustably connected by means of holes 18 to a link 19 which is connected to the auxiliary frame 4. In this arrangement the link 17 is secured to the link 19 at one particular hole 18 according to the load on the vehicle. The frame 4 is prevented from lateral movement by means of guides 1^1.

In order that the load on the auxiliary axle 6 will never exceed a predetermined amount which is substantially independent of the load on the vehicle, the arrangement shown in figure 5 may be employed.

In this figure the auxiliary frame 4, is, as before, pivotally connected at 9 to the vehicle frame 1 whilst the other end of the frame 4 is connected to a piston 20 working in a cylinder 21 to which fluid under pressure from any convenient source is supplied through a pipe 22. In the arrangement shown in figure 6, 23 represents an internal combustion engine which may be supported on the vehicle frame 1 in any convenient manner. The drive from the engine 23 is taken via a universal joint 14, and the transmission 15 to the auxiliary axle 6, either through a cardan shaft and differential gear or from a differential gear mounted on the vehicle and connected by two chains to the wheels 5 in the ordinary manner, as employed on road vehicles.

In the arrangement shown in figure 7 the auxiliary axle 6, differential gear, transmission and engine 23 form a single unit which is pivotally suspended at 24 from the frame 1 adjacent the engine. The rear end of the single unit is connected to a piston 20 in the same manner as is described in figure 5 with reference to the auxiliary frame 4.

The pressure on the rubber tyres in contact with the rail can be very moderate as long as the rails are dry because the coefficient of friction between the rubber and the dry rails, is considerable. On account of such low loading on the auxiliary axle, if by any chance the transmission is overloaded, the only result will be that the wheels will slip. However when the rails are wet, the pressure can be automatically increased to the necessary degree.

The pressure on the tyres should, therefore, be adjusted so that slip occurs at a predetermined maximum torque which the transmission can convey with safety according to the state of the rails.

In the arrangement shown in figure 8 the vehicle is provided with a plurality of auxiliary axles 6, 6^1 so as to obtain higher tractive effort. As shown the drive from the engine 23 is transmitted in the usual manner to a differential gearing 25 to drive the first set of auxiliary wheels on the auxiliary axle 6 the drive being transmitted to a second differential 26 through universal joints 27 to drive a second set of auxiliary wheels. The auxiliary frame 4 is connected to a piston 20 as described in figures 5 and 7 so that the load on the auxiliary axles 6, 6^1 can be adjusted. If desired more than one engine such as 23 may be employed.

The invention renders it possible to adapt to any standard railway wagon any standard automobile driving axle, thereby combining the advantages of the light construction of ordinary automobile construction, while still employing a railway wagon of standard robust construction of axles and steel tyres. The adaptation is simple and inexpensive. In case of damage to the rubber tyres through wear or accident, no harm occurs to the wagon as the ordinary axles which support the wagon are not affected in any way.

It may be pointed out that since the main axles which support the wagon are steel tyred and flanged, while the wheels of the auxiliary axles are light and rubber-tyred but not flanged, the wear of these rubber tyres is very considerably less than if they were themselves flanged. The auxiliary axle and wheels can float a certain amount transversely to the rail and thus, instead of continually bearing on the same tread, the whole of the floating surface of the rubber tyre will be utilised, such a floating arrangement being shown in figure 3A.

The load on the auxiliary driving axle can be reduced up to about one tenth of the weight of the wagon. Thus, a ten ton wagon can be propelled through an auxiliary axle loaded to only one ton. This very low loading will secure to the rubber tyres a long life and the auxiliary axle can be of light construction. For climbing heavy gradients, the load may be adjusted, say, to two tons, which even in this case represents only one fifth of the weight of the wagon.

In order that the vehicle may be driven in the reverse direction without the use of special reversing gears the auxiliary frame 4 is suspended in such a manner that when it is desired to run forward the wheels on the auxiliary axle 6 are pressed into contact with the rails 8, as has been described with reference to figures 1—8, inclusive, and when it is desired to run the vehicle in the reverse direction the axle is raised from its normal position so that the tyres of the wheels on the said axle 6 are raised out of contact with the rails and are pressed against the flanged metal wheels 2. As shown in figures 9 and 10 the auxiliary axle 6 is located near to one of the ordinary axles 2^1 so that when the vehicle is running forward, as indicated by the arrow A in figure 9, the steel tyres on the ordinary wheels and the rubber tyres of the wheels on the auxiliary axle

6 are close to one another but out of contact. In order to run the vehicle in the reverse direction, as shown by the arrow B in figure 10, the auxiliary wheel 5 is raised out of contact with the rail 8 and into contact with the flanged metal wheel 2. In order to effect this motion one end of the auxiliary frame 4 is connected to a piston 28 working in a cylinder 29 which is pivoted at 30 to a bracket 31 on the vehicle frame 1. The auxiliary frame 4 is also pivotally connected to the axle box 32 carrying the axle 2^1 by means of a link 33 and to the frame 1 by a link 33^1. The cylinder 29 is adapted to receive fluid under pressure from any convenient source through a port 34 so that pressure on the auxiliary axle 6 may be increased, as shown in figure 9. The cylinder is also provided with a second port 35 whereby pressure can be supplied to the underside of the piston 28 instead of being supplied through the port 34. If pressure be supplied through the port 35 the piston 28 is raised, thereby lifting the auxiliary wheel 5 into contact with the flanged metal wheel 2, thereby driving the vehicle in the reverse direction.

The actuation of the link 33 to raise the auxiliary axle 6 may be effected as has been shown in figures 9 and 10 or by mechanical or electrical means.

Figure 11 shows a modified form of the arrangement shown in figures 9 and 10. The auxiliary frame 4 is connected to a bell crank lever 36, one arm of which is connected to the axle box 32, the other arm being connected to a double acting piston 28.

As shown in figure 12 a plurality of auxiliary axles 6 may be provided each arranged as described with reference to figures 9 and 10 or figure 11 and as shown in this figure. Two pairs of auxiliary wheels 37 remain in contact with the rails 8 whilst the vehicle is proceeding in the direction of the arrow C whilst two other pairs 38 are in contact with the flanged wheels 2, all the auxiliary or non-flanged wheels being driven according to any of the methods previously described. To reverse the direction of motion of the vehicle the wheels 38 are lowered into contact with the rails 8 and the wheels 37 are raised into contact with the wheels 2, as has been described heretofore. In this way, irrespective of the direction in which the vehicle is running, the load due to the weight of the auxiliary axles is borne partially by the rails and partially by the vehicle. It will be noticed that the rotation of the auxiliary axles 38 and 37 are in opposite directions so that the vehicle will proceed in either direction.

In order that the pressure of the tyres of the wheels 5 on the rails, or of the wheels 2, may be kept fairly constant and/or so that it may be adjusted at will by the driver the arrangement shown in figure 13 may be employed. As shown in this figure there is interposed between the piston 28 and the link 39, which is pivoted to the auxiliary frame 4 and the axle box 32, a spring 40.

The necessary load on the auxiliary axle referred to above need not at any time be greater than just sufficient to ensure the grip of the driving tyres on the rails. For example, the coefficient of friction of the rubber tyres on the rails is high for dry rails and may be as great as 70 to 80% in favourable circumstances. In such circumstances therefore, a very moderate load on the tyres will ensure the necessary grip. On wet rails however, or when ice, sleet or snow covers the rails, the coefficient diminishes considerably and greater loads are necessary; such greater loading may however, be necessary only for a very limited time during the service of the vehicle. For example, supplementary loading may be necessary while the vehicle is travelling over a greasy patch of rails or during a sudden shower of rain or sleet, while during the remainder of the time and especially when coasting down hill a reduced load will be sufficient. As an illustration with a railway vehicle weighing 10 tons, and in which the auxiliary axle is provided with two rubber tyres normal driving can be effected if the auxiliary axle has a load of ½ ton per wheel, i.e. 10% of total load on driving axle. However when climbing a gradient of say 1 in 40 in rainy weather it is necessary to increase the load on the rubber tyres to as much as 2 to 2½ tons on each wheel namely 4—5 tons on the driving axle i.e. 40—50% of total load.

One method of carrying this out is shown in figure 14 in which the auxiliary axle 6 is carried on the auxiliary frame 4 through interposed springs 7 the auxiliary frame 4 being in turn articulated at one end to the frame 1 and at the other end supported from the frame 1 through an adjustable screw rack or like mechanical device (not shown) which acts upon one end of a bell crank lever 41, the other end of which is connected to a second bell crank lever 42 pivoted to the frame 4 and to a link 43 suspended from the frame 1. On actuation of the adjustable screw rack or like mechanical device the auxiliary frame 4 is lifted or lowered relatively to the frame 1 thereby enabling the loading of the auxiliary axle to be increased or decreased. The auxiliary frame 4 may be guided as shown in any of the preceding figures so as to prevent or limit movement thereon transversely to the rails. The screw rack or the like may be replaced by a pneumatic or hydraulic cylinder and piston or diaphragm as shown, for example, in figure 5, to act between the auxiliary frame 4 and the frame 1 so that by varying the pressure of the air or other fluid in the cylinder the load on the auxiliary axle 6 can be varied accordingly. To vary the pressure on the auxiliary axle, an arrangement as shown in figure 15 may be employed. The auxiliary axle 6 is connected through a suitable linkage such as a toggle 44 to the vehicle frame 1, the toggle being connected at its centre point to a piston 20 working in a cylinder 21 attached to the frame 1. By this means the relatively small increase in pressure of the fluid will give a relatively large increase of pressure on the auxiliary axle.

If the load on the auxiliary axle is not adjustable within the limit of 1—5 tons it will be necessary to run all the time with the maximum of 5 tons on the driving axle. This will result in destruction of the rubber tyres in very short time. Means are therefore provided for automatically adjusting the load on the auxiliary driving axles 6. The load on the driving axles 6 may be regulated through an adjustable loading and unloading device controlled or acted upon by the relative slip between the wheels 5 on the auxiliary axle 6 and the flanged metal wheels 2 supporting the vehicle.

Referring now to figures 16—18 inclusive, in order to actuate the adjustable screws, racks, pistons, diaphragms or the like loading devices by motion or pressure derived from the relative slip between the wheels 5 of the auxiliary axle and the vehicle supporting wheels 2, the auxiliary frame 4 carries a differential 45 one member of which is driven by the auxiliary wheels 5 the other member being driven by the flanged wheels 2 both through chain mechanism 46. The third member of the differential carries a screw 47 working in a nut 48 carried by a member 49 pivoted to the frame 1 and connected by a link 50 to the frame 4. The arrangement is such that when no slip occurs the centre or driven member of the differential carrying the screw 47 remains stationary but when slip occurs this member rotates, causing the nut 48 to move vertically downwards, which movement causes the adjustable loading member 49 to actuate so as to increase pressure on the auxiliary axle 6 through the link 50. In order that the built-up pressure may slowly be released, when slip has ceased, the diameter of the chain wheel mechanism on the auxiliary axle 6 is made slightly larger, so that the nut 48 tends slowly to unwind.

Another method of automatically increasing the load on the driving wheels 5 when slip occurs is shown in figures 19 and 20. This arrangement consists in replacing the screw and nut mechanism and link mechanism 49 and 50 by a compressor pump or the like which will create the fluid pressure for operating the pneumatic or hydraulic devices referred to previously. In figure 19, the auxiliary wheels 5 drive, for example through a chain mechanism 46, although any other means of drive may be employed, the first element of the differential 45, whilst the third element of the differential is driven in the same direction as the first element through any suitable gearing, as shown chain drive 46, by the flanged metal wheels 2, the third element however being driven at half the speed of the first element. The second element of the differential is connected through suitable mechanism to a compressor 51 which, on slip occurring, is driven by the second element of the differential to build up pressure which may be transmitted by any of the previously described methods to increase load on the axle 6. The driving wheels 5 are mounted on the auxiliary axle 6 which carries a crown wheel 6^1 in mesh with a bevel 15^1 mounted on the transmission shaft 15. When slip has ceased by pressure being built up, the pressure can conveniently be released, e.g. by a suitable leak or by a natural leak past the piston.

In the arrangement shown in figure 19A the differential device 45, and pump 51 are adapted to be operated should slip occur between either of the wheels 5 on the auxiliary axle 6 and the metal wheels 2 mounted on the axle 2^1. In order that this may be effected the first element of the differential 45 is driven by the transmission shaft 15 through reduction gearing 150, the driving wheels 5 being mounted on an auxiliary axle 6 of the automobile type so that if either of the wheels 5 slip, the transmission shaft speeds up to operate through the differential device the pump 51 whereby the loading on the auxiliary axle is adjusted to the desired amount. It is obvious that the first element of the differential may be actuated from the gear box instead of from the transmission shaft and that the third element of the differential may be driven by an additional axle having flanged wheels. The arrangement shown in figure 19B is such that the pump 51 is actuated through the differential 45 should slip occur between either of the wheels 5 and the rails. In this arrangement the first member of the differential is driven by one of the wheels 5 whilst the second member is driven by the other wheel 5 through a crossed belt or chain, the pump 51 being driven by the third member.

Alternatively to the arrangement shown in figures 19 and 20, that shown in figure 21 may be employed in which the auxiliary wheels 5 actuate a pump 52 whilst the flanged wheels 2 drive a second pump 53. The exhaust from the pump 52 is connected to the inlet of the pump 53, the exhaust of which is connected to the inlet of the pump 52. Between the exhaust of the pump 52 and the inlet of the pump 53 is arranged a chamber 54 in which is provided a diaphragm 55 carrying a valve 56 adapted to open or close the supply of fluid under pressure from any convenient source to a cylinder 57 fast with the auxiliary frame 4, in which cylinder is arranged a piston 58 fast with the frame 1. 54^1 is a gauge showing the pressure acting upon the diaphragm 55, and 54^{11} is a second gauge, located between the chamber 54 and the cylinder 57. 59 is a compensating tank from which, when liquids are used, the pump 52 can draw liquid. When there is no slip between the auxiliary axle 6 and the rail 8 the pumps 52, 53 provide a closed circuit for the liquid no pressure being produced, whilst when slip occurs the pump 52 accelerates, thereby drawing liquid from the compensating tank 59 and building up pressure in the chamber 54 whereupon the diaphragm 55 opens the valve 56 so that pressure is supplied to the cylinder 57 thereby increasing the load on the auxiliary axle 6. This building up of pressure continues so long as the slip persists, the pressure being released when slip has ceased through a convenient leak 60. If desired a differential pump or compressor may be employed in place of the two pumps 52, 53, one member of the pump being driven by the auxiliary axle 6 and the other by the flanged wheel 2. In order that the vehicle may be driven in reverse the compensating tank 59 is connected both to inlet and exhaust of the pump 52, suitable non-returns 59^1 being provided.

A further modification is illustrated in figures 22 and 23 for automatically increasing the load on the wheels 5 when slip occurs. In these figures there is provided a differential relay device one member 61 of which is actuated by the auxiliary axle 6 and the other 62 by the vehicle axle 2^1 in such a way that the middle or driving member 63 of the differential relay device, which receives the differential motion remains stationary when no slip occurs. The members 61 and 62 of the differential relay device drive drums 64, 65 respectively, which drums rotate within a third drum 66 carrying the third member 63 of the relay the drums 64, 65, 66 being contained within a casing 67 containing oil.

The third member 63 of the relay is adapted to make contact with one or other of two contacts 68 of an electric circuit which includes a solenoid 69, battery 70 and armature 71. The solenoid 69 is contained within a casing 72 through which fluid pressure from any convenient source may be supplied via a pipe 73 to a cylinder 74 in which is adapted to reciprocate a piston 75. The armature 71 is so shaped that on actuation of the solenoid it can open or close the entrance to the pipe 73. When no slip occurs, fluid pressure is supplied to the cylinder 74 through a pipe 76 communicating with a chamber 77 closed by a diaphragm 78 carrying a valve 79. The chamber 77 is also provided with a pipe 80 which communicates with the pipe 73 the valve 81 being positioned at the point of juncture of the pipes 80 and 73. It will be noticed that pressure can be supplied to the cylinder 74 through the pipe 76, chamber 77 and pipe 80 but if this pressure exceeds that required the diaphragm 78 is operated to move the valve 79 on to its seat, thereby cutting off further supply of pressure. When slip occurs the drum 66 is caused to oscillate owing to the friction of the oil and closes the electric circuit, by making contact between the member 63 and either of the contacts 68. The solenoid 69 is thereby energised and the armature 71 pulled back against the action of a spring 82 thereby opening the entrance to the pipe 73 so that pressure on the piston 75 is increased through the pipe 73 at the same time closing the valve 81 at the point of juncture of the pipes 73 and 80. 83 represents a leak for relieving the pressure when slip has ceased to occur, whilst the increased pressure may automatically unload when the vehicle is overrunning the driving axle.

The differential operating devices are preferably so arranged that when no slip occurs, there will be a slow unloading action which will automatically unload the auxiliary axle to a fixed but preferably adjustable predetermined minimum value. Means may also be provided for limiting the loading to a fixed but preferably adjustable predetermined maximum value.

It will be seen that with any such arrangements, on starting the vehicle or when the vehicle is on steep gradients under adverse conditions, as regards the coefficient of friction between the auxiliary driving wheels and rails, the wheels will first slip but this action will automatically cause an increase in the loading on such wheels until the slip will cease or will be reduced to very small proportions. As soon as slip has ceased the drive will become normal and the load will either be gradually diminished as for example on account of the fixed or adjustable leakages when fluids are used, or by the positive gradual unloading action which will occur when the differential control system is so arranged that when no slip occurs there shall actually be a slow unloading action either up to a minimum load determined beforehand or up to a load at which slip will occur again.

This control of loading is automatic so that the driver of the vehicle need pay no attention to what load is actually on the auxiliary axle nor need he take into account the load on the vehicle which load will of course vary with the number of passengers or goods carried.

The invention therefore ensures the minimum loading necessary for providing the grip to ensure propulsion of the vehicle, thus during the greater part of the driving time the load on the auxiliary axle will be considerably reduced as compared with an arrangement in which fixed loading is provided; this will result in low tyre wear and higher overall efficiency, as if a fixed loading is provided, this must of necessity correspond to the maximum loading necessary to secure grip under the most adverse conditions, as for the condition when the friction between rail and rubber tyre drops temporarily to a very low value. The invention enables the use of sand for assisting wheel grip to be dispensed with except in very exceptional cases such as starting on ice or grease covered rails.

If the vehicle is arranged to run in both directions, means can be provided to cause operation of the loading devices no matter in which direction the wheels rotate; in the case when fluid pressure is relied upon to vary the loading, means could be provided to reverse the fluid connections; when relays are employed this can be effected very simply, the relays actuating the loading devices in the same direction no matter in which direction the driving wheels are rotating; for an entirely mechanical action, through differential control gear and mechanical loading gear, this could be effected either by suitable reversing clutches or by a linkage of the toggle type which will act in the same direction irrespective of the direction of actuation of the differential control gear.

Referring to figure 24, the tyre shown herein is of the well known pneumatic type whilst that shown in figure 25 is of the solid rubber type.

The recesses in the tyre shown in Figure 25 may, if desired, be arranged diagonally say at an angle between 30° and 45° across the tread surface. Such recesses are necessary when ordinary rubber is used to allow water trapped between the tyre and the rail to be expelled. In place of employing rubber as the tread surfaces of the tyres carried by the auxiliary axle, any surface having a high coefficient of friction may be employed such for example as bonded fibrous fabrics, such as cotton asbestos, with or without rubber reinforcement, or alternatively, tyres of metal of a high coefficient of friction elastically supported e.g. on rubber or spring cushions, in which case the metal tyre could be flanged.

Figure 27 represents diagrammatically a complete railway vehicle constructed in accordance with this invention.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A railway vehicle of the kind referred to in which in addition to the usual flanged metal wheels there is provided an auxiliary axle suspended from the vehicle and having wheels which at all times constitute the driving means, and fluid actuated means for adjusting the loading on said auxiliary axle whereby the wheels on said auxiliary axle can be pressed into contact with the rails to such a degree as will enable them to drive the vehicle to suit varying conditions the flanged metal wheels retaining their guiding and supporting function.

2. A railway vehicle of the kind referred to in which in addition to the usual flanged metal wheels there are provided in combination an underframe articulated to the vehicle, an auxiliary axle supported by said underframe, wheels on said auxiliary axle which wheels at all times constitute the driving means and means for adjusting the loading on said auxiliary axle whereby the wheels on said auxiliary axle can be pressed into contact with the rails to such a degree as will enable them to drive the vehicle to suit varying conditions the flanged metal wheels retaining their guiding and supporting function.

3. An arrangement as claimed in claim 1 or 2 in which the loading on the auxiliary axle is automatically effected.

4. An arrangement as claimed in claim 3 in which variation of the loading is

automatically effected when slip occurs between any wheel on the auxiliary axle and a rail.

5. An arrangement as claimed in claim 1, 3 or 4 in which the auxiliary axle is suspended by an underframe articulated to the vehicle.

6. The combination with an arrangement as claimed in any of the preceding claims of means whereby the wheels on the auxiliary axle can be raised out of engagement with the rails and pressed into contact with the flanged wheels in order to drive the vehicle in reverse direction.

7. The combination with the arrangement claimed in claim 1 of means for regulating the fluid pressure.

8. An arrangement as claimed in any of the preceding claims in which the auxiliary axle and an axle of the vehicle are connected by a differential device in such manner that when slip occurs between the wheels on the auxiliary axle and the rails, the pressure on the auxiliary axle is automatically increased so long as slip occurs.

9. An arrangement as claimed in claim 8 in which one member of the differential device is driven by the transmission shaft or gear box which drives the auxiliary axle.

10. An arrangement as claimed in any of claims 1 to 8 in which the wheels on the auxiliary axle and means for varying the pressure on the auxiliary axle are connected by a differential device in such manner that when slip occurs between the wheels on the auxiliary axle and the rails, the pressure on the auxiliary axle is automatically increased so long as slip occurs.

11. An arrangement as claimed in claim 8, 9 or 10 in which when slip has ceased means are provided for allowing the increased pressure on the auxiliary axle to decrease to normal pressure.

12. An arrangement as claimed in any of claims 7 to 11 in which when the pressure on the auxiliary axle has been increased by means of a fluid, a small leak is provided in the differential device for allowing the increased pressure slowly to lessen when slip ceases.

13. An arrangement as claimed in any claims 7 to 11 in which when the pressure on the auxiliary axle has been increased by mechanical means, means are provided for slowly releasing said increased pressure when slip ceases.

14. An arrangement as claimed in any of claims 7 to 11 in which the differential device comprises an electrical relay device.

15. An arrangement as claimed in any of the preceding claims in which the wheels on the auxiliary axle are provided with tyres which are of resilient material and have a substantially flat tread such as are used on heavy road vehicles.

16. The combination with the arrangement claimed in claim 15 of means whereby the auxiliary axle can be moved in a direction transverse to the axis of the vehicle to enable different parts of the tread of the tyres of the wheels on said auxiliary axle to engage the rails.

17. An arrangement as claimed in claim 1, 2, 3 or 4 in which the means by which the axle, carrying the flanged wheels of the vehicle is supported, and the means by which the auxiliary axle is supported are connected by links or the like whereby the load on the auxiliary axle varies as the load on the axle carrying the flanged wheels varies.

18. An arrangement as claimed in claim 1, 2, 3 or 4 in which the auxiliary axle can move a limited distance transversely to the vehicle.

19. A railway vehicle constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 1st day of December, 1933.
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Agents for Applicant.
24, Southampton Buildings, London, W.C. 2.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1934.

Fig. 1.

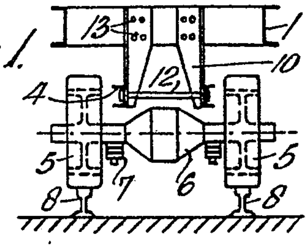

Fig. 3A

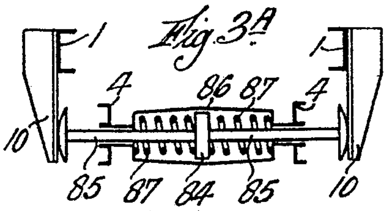

Fig. 2.

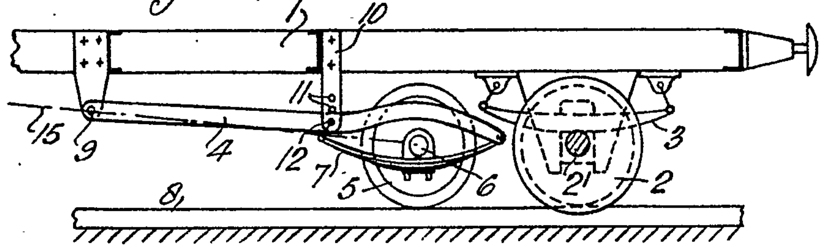

Fig. 3.

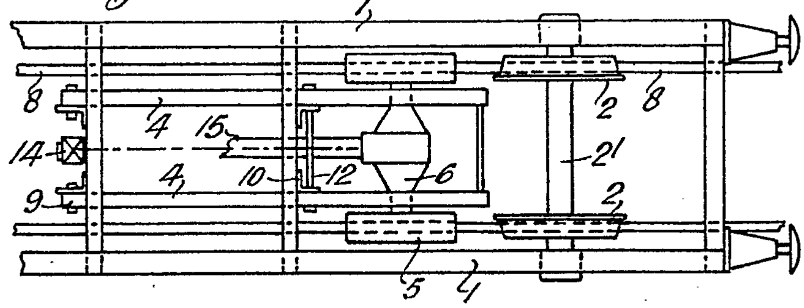

Fig. 4.

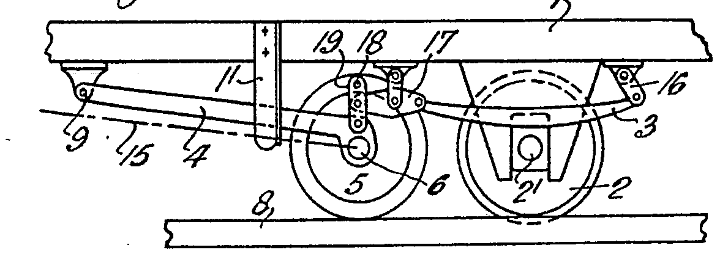

Fig. 5.

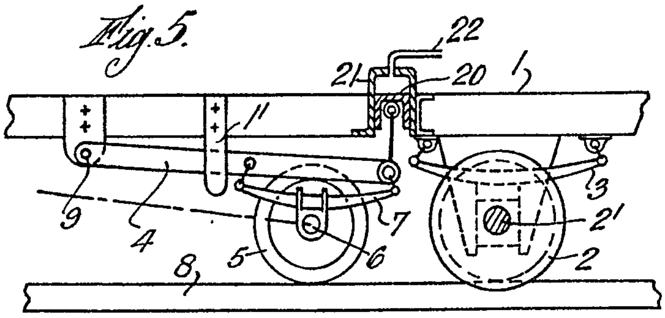

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Fig. 6.

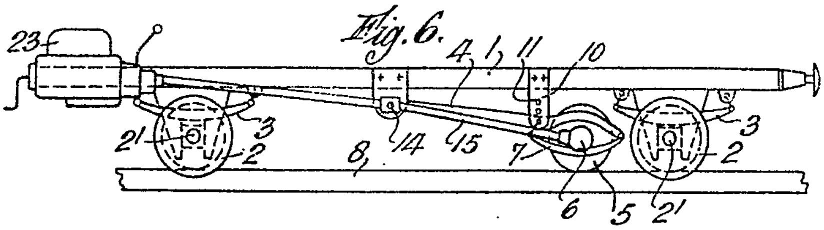


Fig. 7.

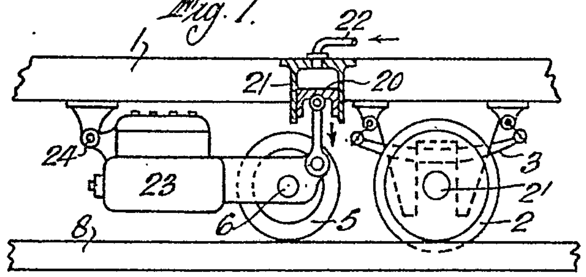


Fig. 8.

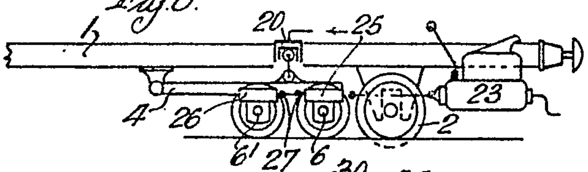


Fig. 9.

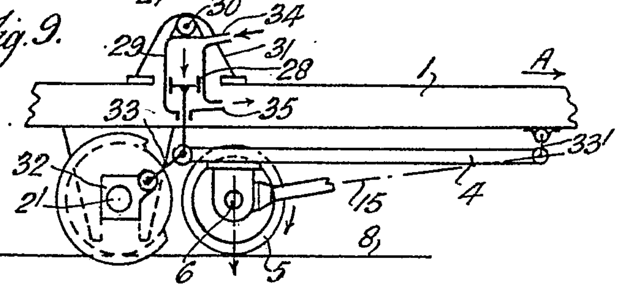


Fig. 10.

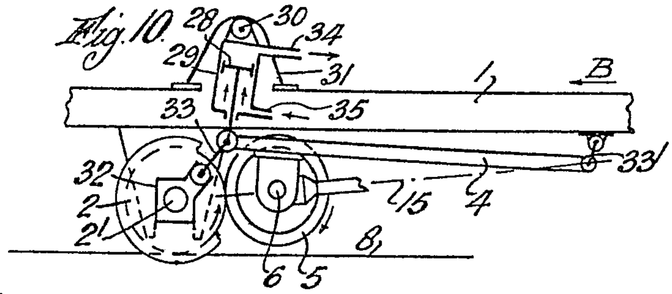
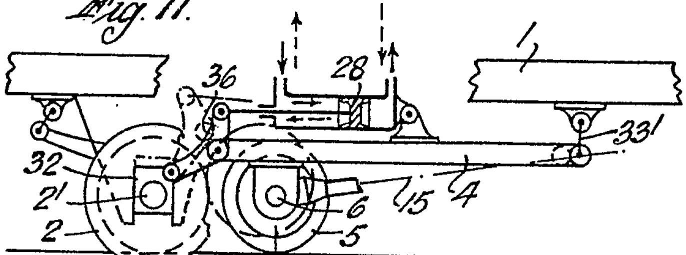


Fig. 11.



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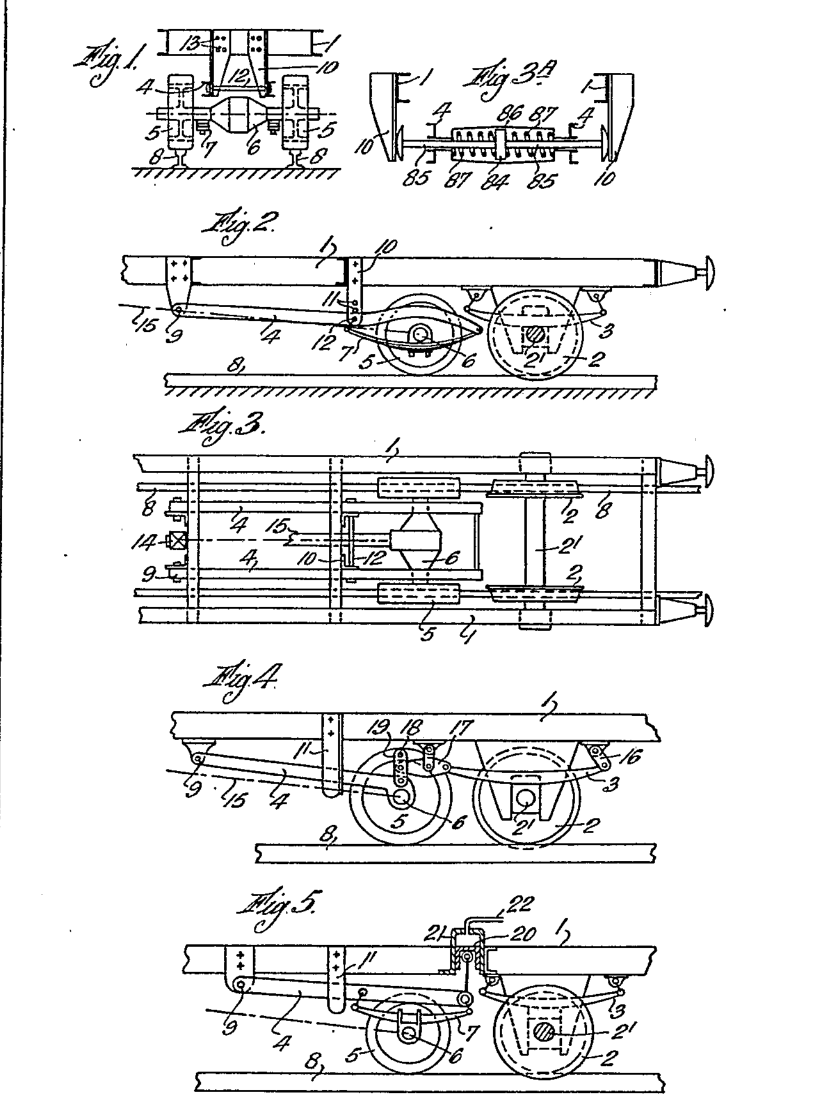

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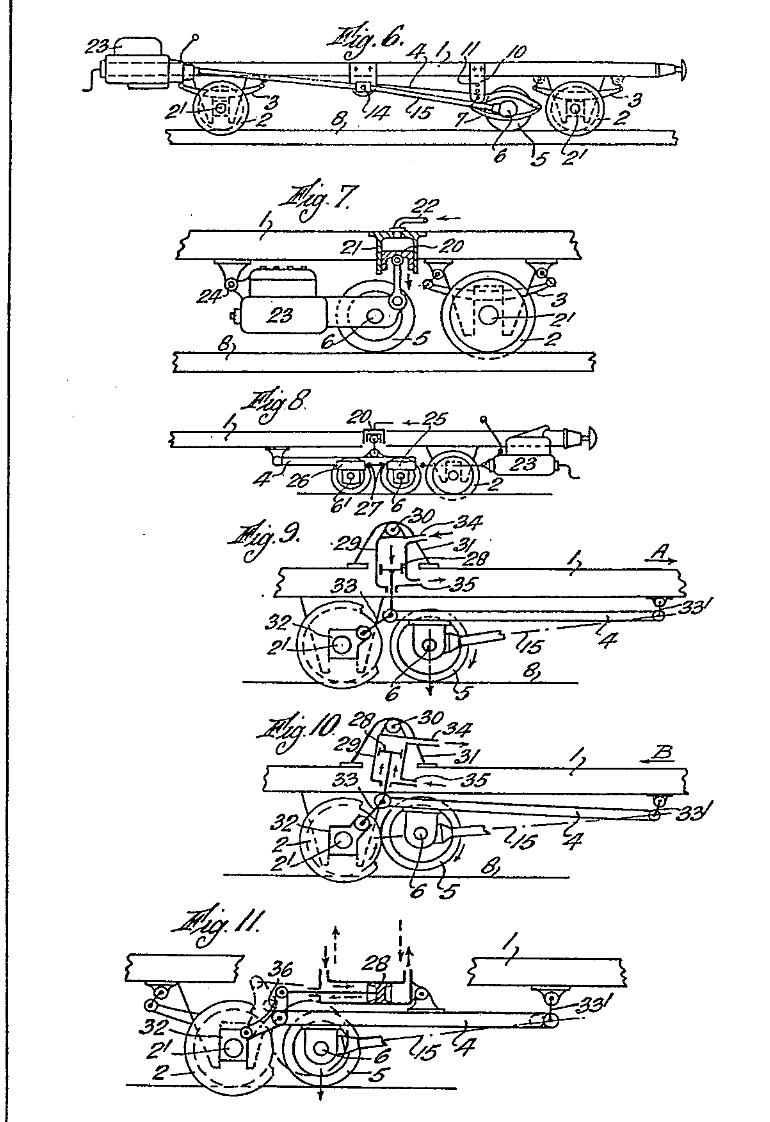

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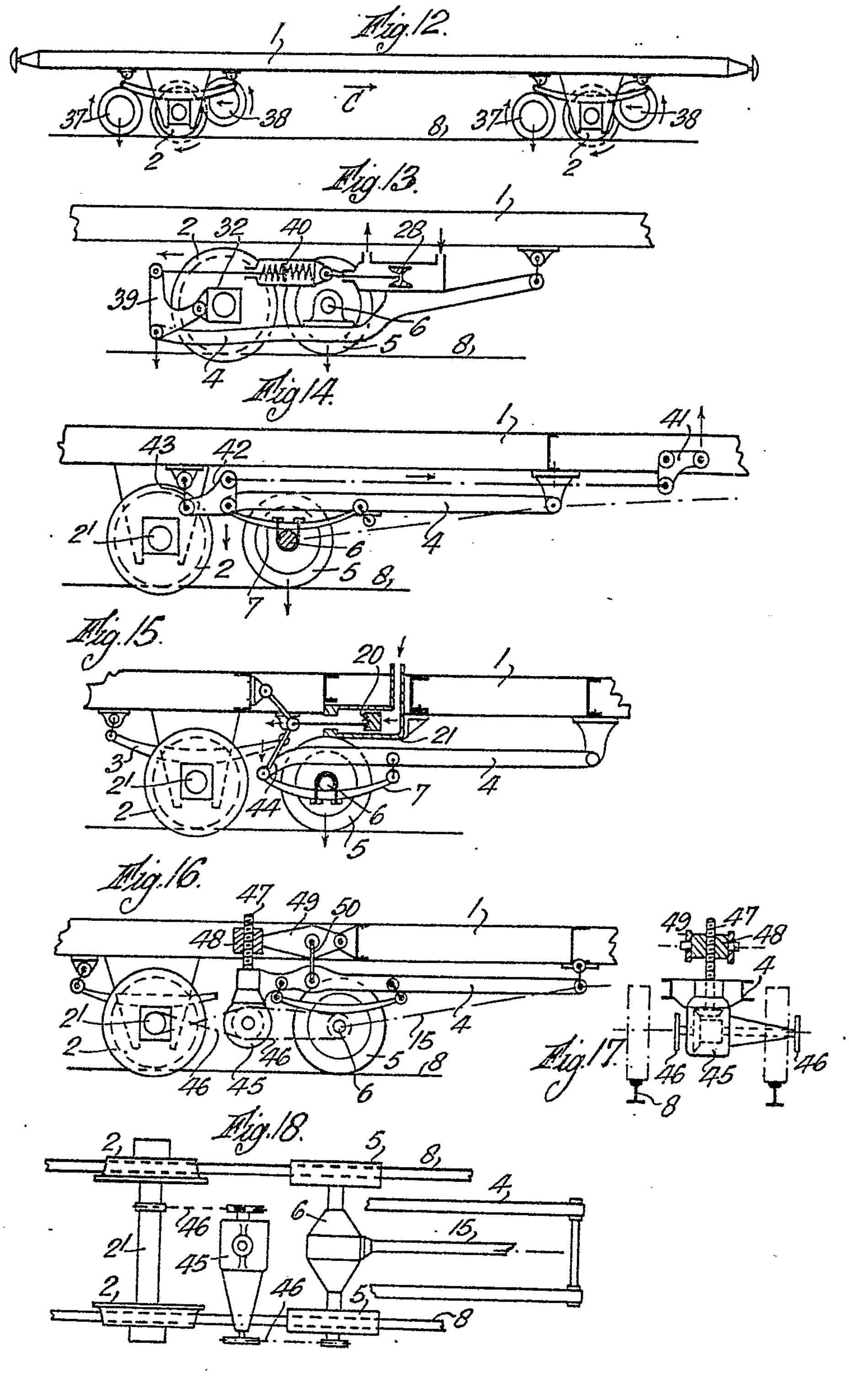
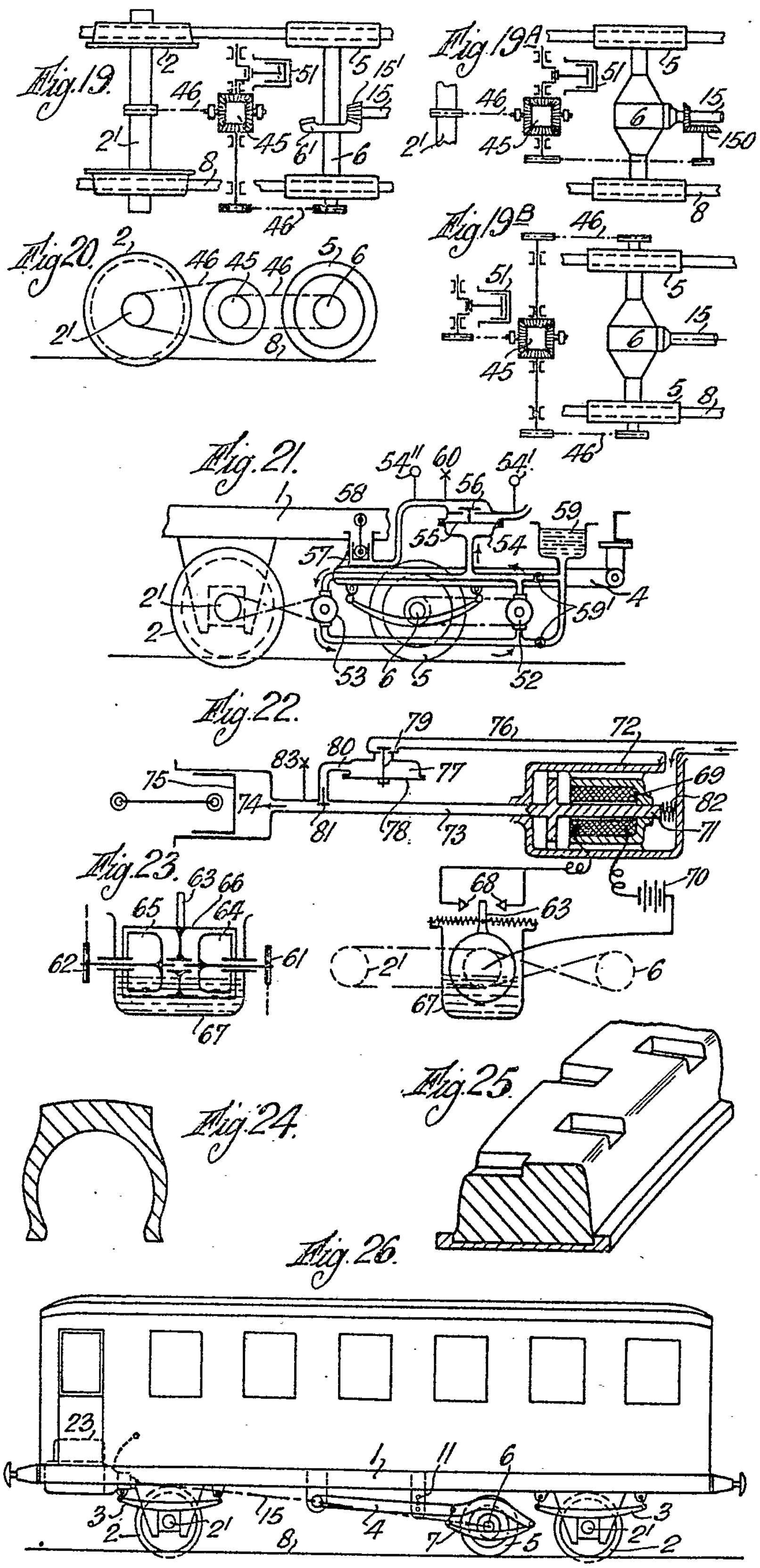


Fig. 12.
Fig. 13.
Fig. 14.
Fig. 15.
Fig. 16.
Fig. 17.
Fig. 18.



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4 SHEETS

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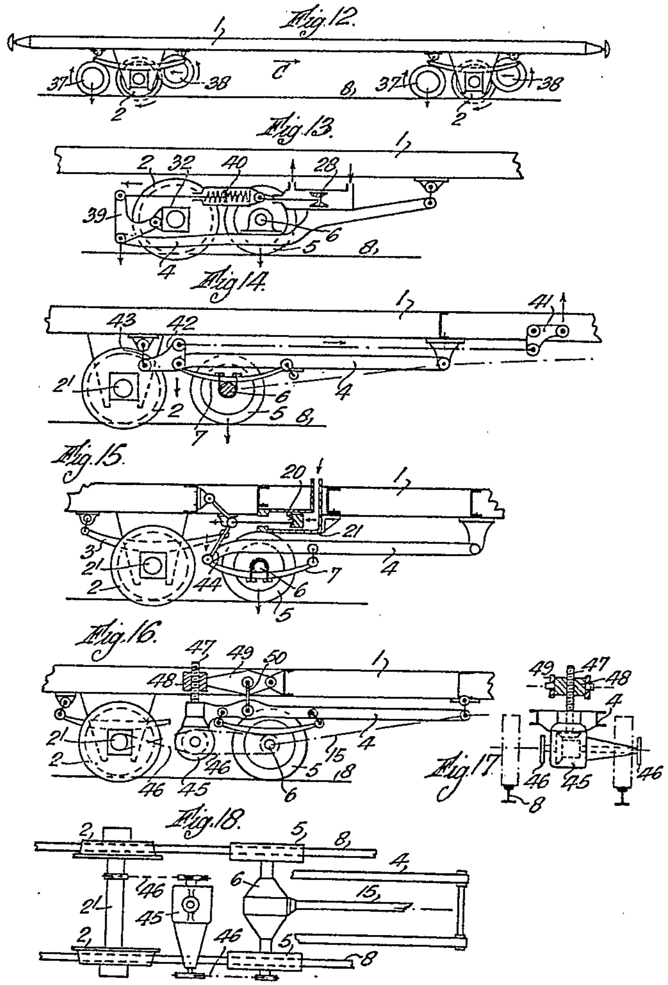

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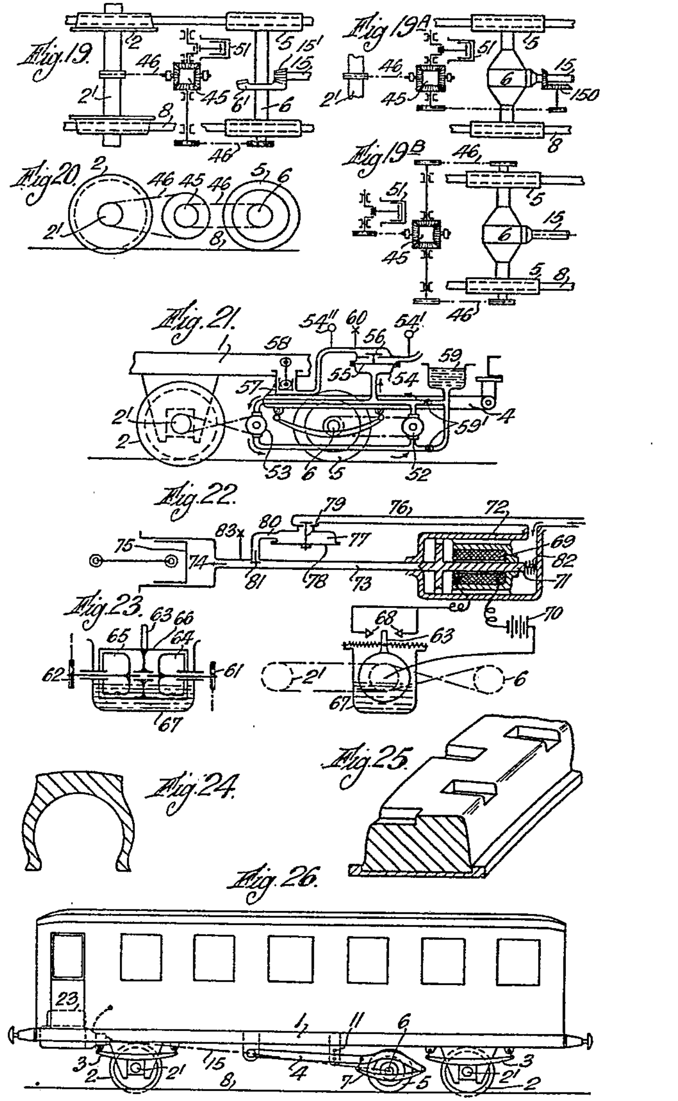

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