

[54] **CONVERTIBLE RAIL-HIGHWAY VEHICLE**

[72] Inventors: **Herbert Gretzschel**, Lochham; **Walter Schneider**, Witzhelden; **Theodor Schmauder**, Schlossberg, all of Germany

[73] Assignee: **Martin Beifhack Maschinenfabrik und Hammerwerk G.m.b.H.**, Rosenheim, Germany

[22] Filed: **Dec. 12, 1969**

[21] Appl. No.: **884,622**

[52] U.S. Cl.105/215 C, 104/242, 104/245, 105/216, 105/217
 [51] Int. Cl.B61d 15/00, B61f 9/00, B62d 61/12
 [58] Field of Search.....105/215 C, 216; 104/242, 245

[56] **References Cited**

UNITED STATES PATENTS

2,986,102	5/1961	Cox.....	105/215 C
3,130,686	4/1964	Fiechter et al.....	105/215 C
3,228,350	1/1966	Cox.....	105/215 C
3,249,067	5/1966	Keller.....	105/215 C
3,344,747	10/1967	Keller.....	105/215 C
1,446,784	2/1923	Carter.....	105/215 C X

1,938,049	12/1933	Serrano.....	105/215 C
2,110,230	3/1938	Main.....	105/215 C
2,140,421	12/1938	Fageol.....	105/215 C
2,655,872	10/1953	Templeton.....	105/215 C
2,655,873	10/1953	McDonald.....	105/215 C
3,286,657	11/1966	Brown.....	105/215 C
3,311,067	3/1967	Gretzschel et al.....	105/216 X

Primary Examiner—Arthur L. La Point
Assistant Examiner—Howard Beltran
Attorney—Michael S. Striker

[57] **ABSTRACT**

A convertible rail-highway vehicle comprises two frames which are pivoted to the front and rear axles and carry sets of rail-engaging shoes or rollers. The frames are always concealed below the body of the vehicle and are pivotable between raised positions in which the shoes or rollers are out of the way and lowered positions in which the shoes or rollers engage the rails in immediate proximity of the respective wheels to hold the wheels against movement off the top surfaces of the rails. The frames can be locked in their lowered positions and the shoes or rollers are mounted thereon with some freedom of movement about vertical and/or horizontal axes.

27 Claims, 21 Drawing Figures

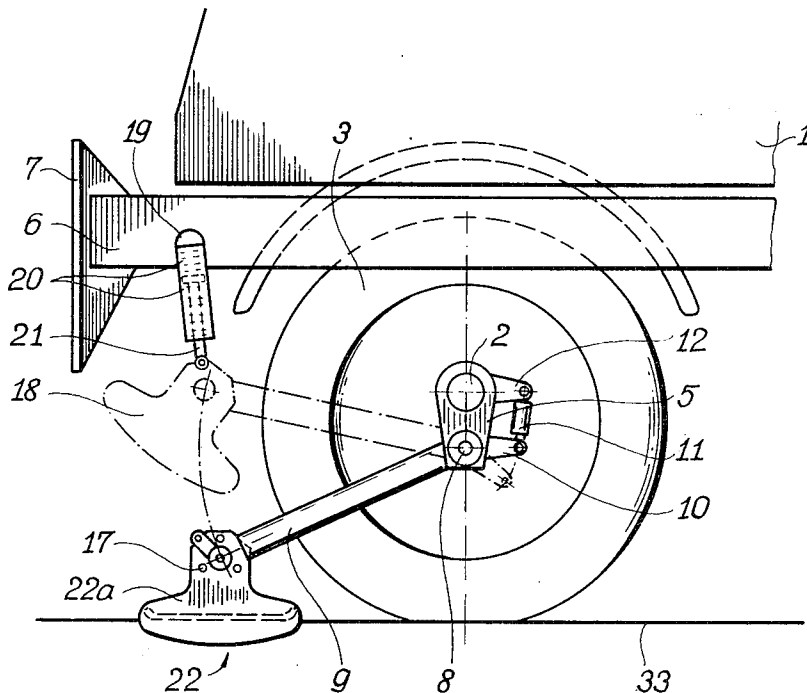


Fig. 1

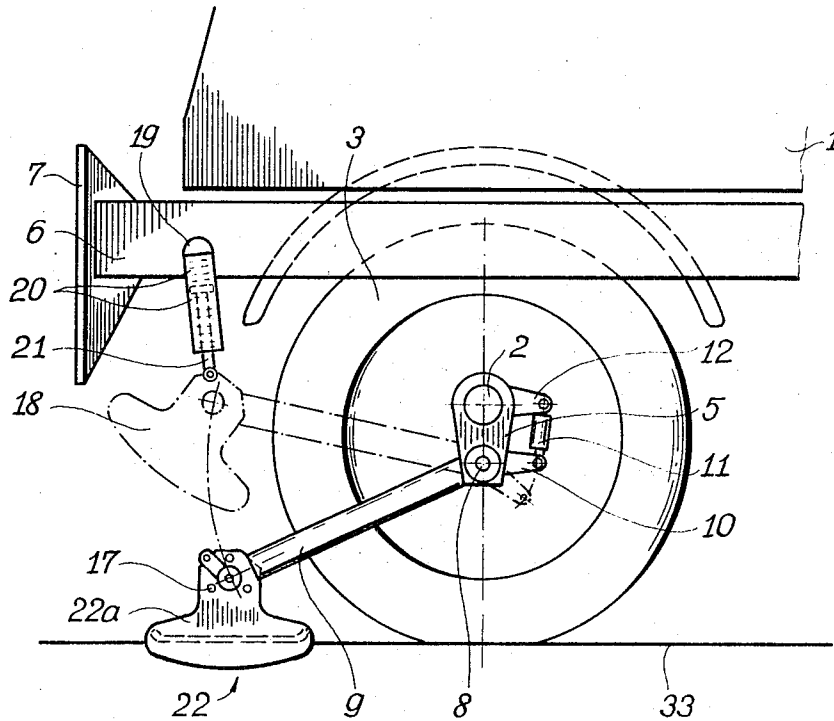
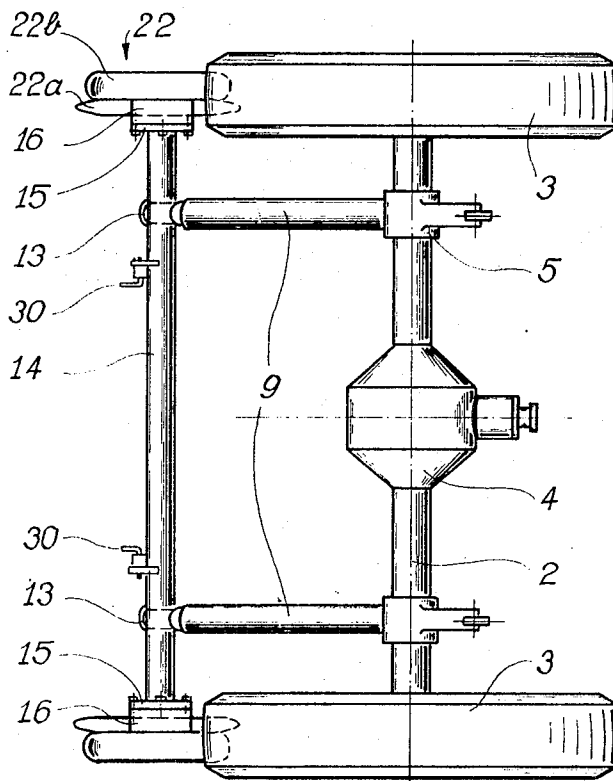


Fig. 2



INVENTORS
 HERBERT GRETZSCHEL
 WALTER SCHNEIDER
 THEODOR SCHMAUDER
 BY

Herbert Gretzschel
 Their ATTORNEYS

Fig. 3

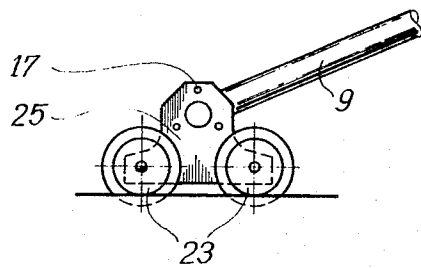


Fig. 5

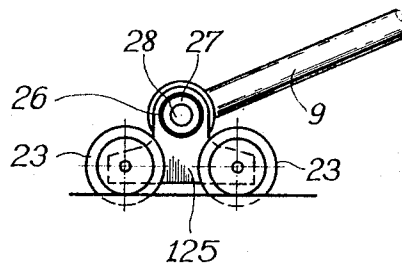


Fig. 4

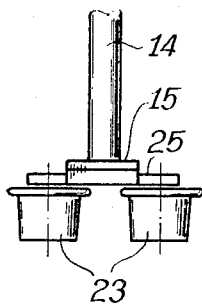


Fig. 6

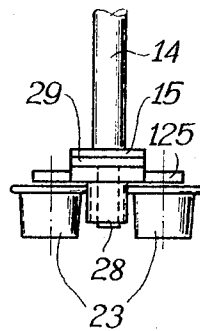
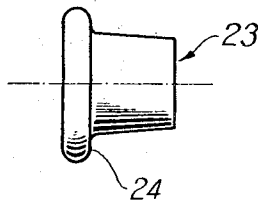


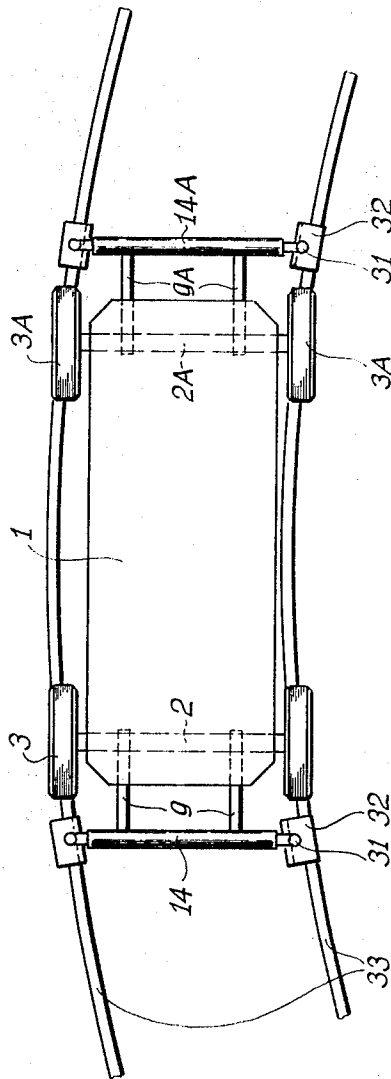
Fig. 7



INVENTORS:
HERBERT GRETZSCHEL
WALTER SCHNEIDER
THEODOR SCHMAUDER
BY

H. Schneider
their ATTORNEY

Fig. 8



INVENTORS,
HERBERT GRETZSCHEL,
WALTER SCHNEIDER,
THOEDOR SCHMAUDER

Fig. 9

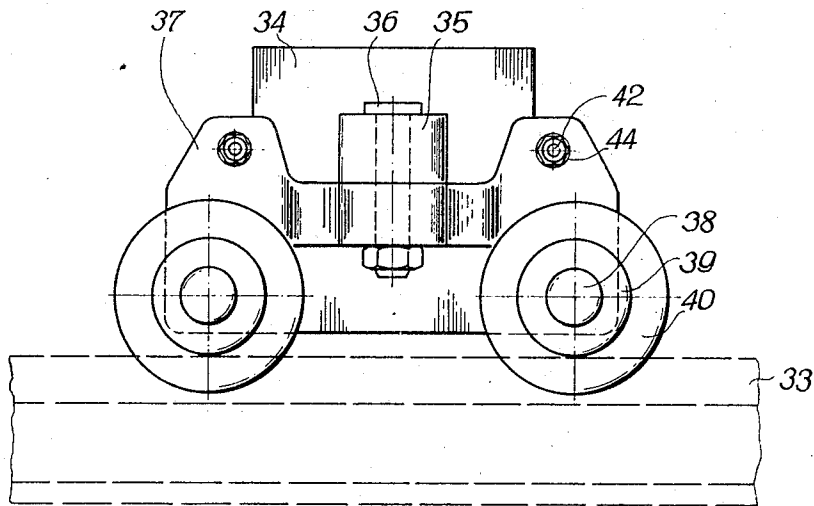
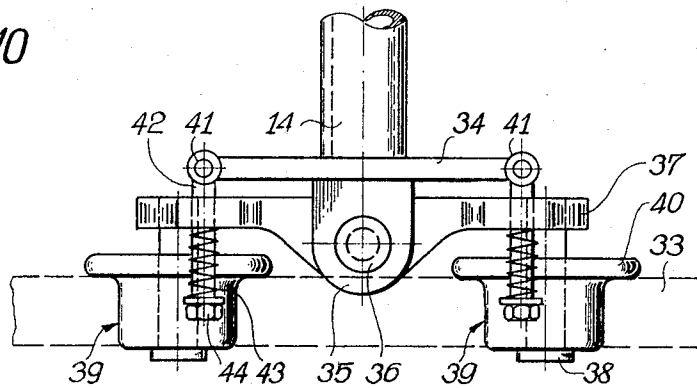


Fig. 10



INVENTORS:
HERBERT GRETZSCHEL
WALTER SCHNEIDER
THEODOR SCHMAUDER
BY

Walter L. He Co.
their ATTORNEY

Fig. 11

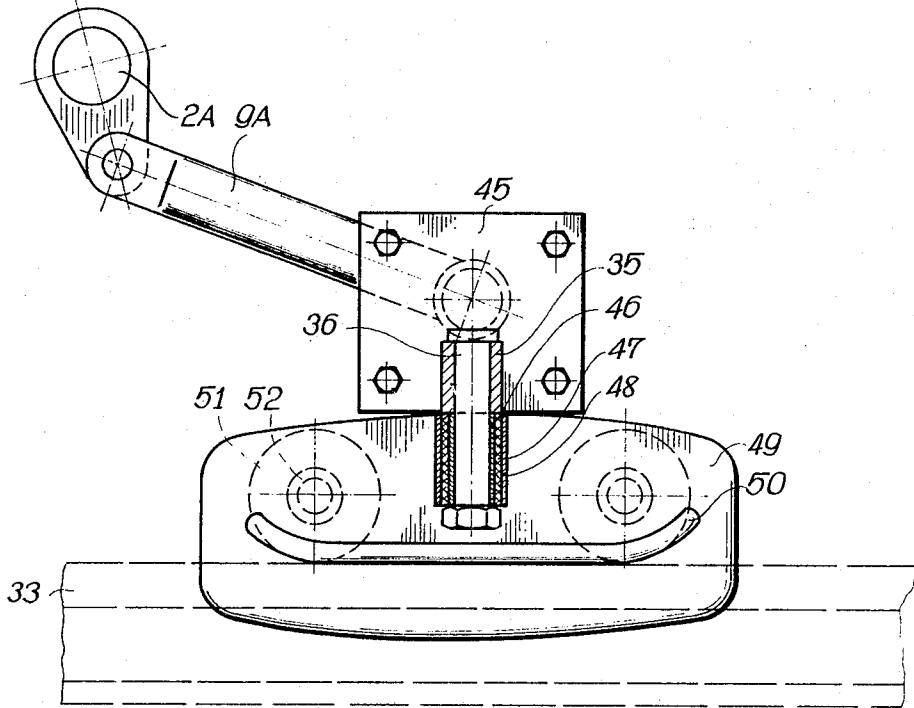
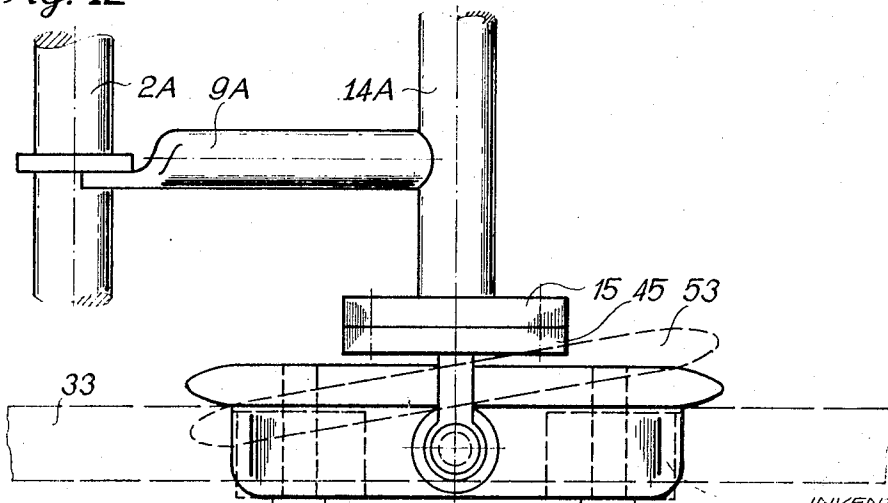


Fig. 12



INVENTORS

52 51 HERBERT GRETSCHHEL
WALTER SCHNEIDER
THEODOR SCHMAUDER

BY

Arthur H. Miller
their ATTORNEY

Fig. 13

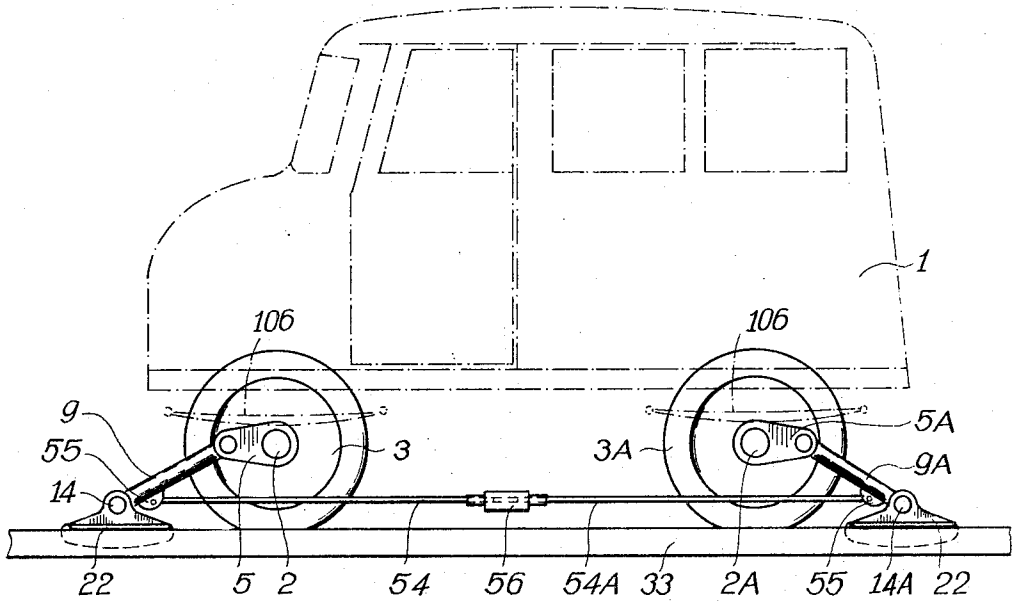
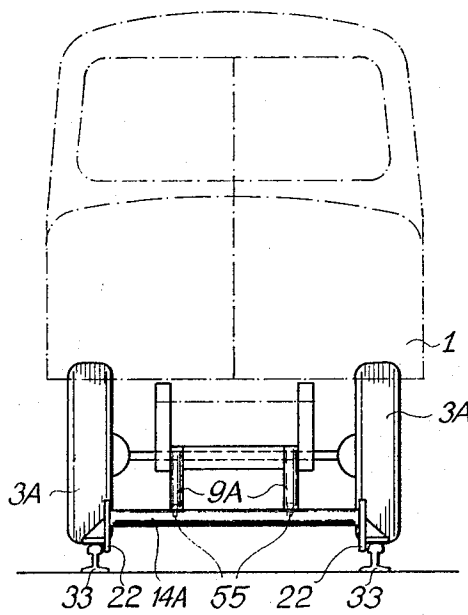


Fig. 14



INVENTORS:
HERBERT GRETSCHEL
WALTER SCHNEIDER
THEODOR SCHMAUDER
BY

Herbert Gretschel
their ATTORNEY

Fig. 15

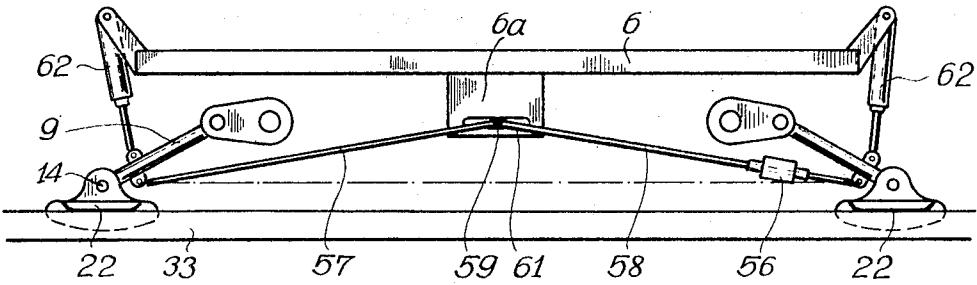


Fig. 16

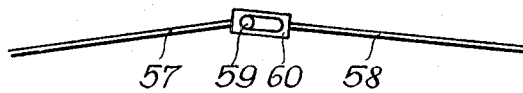


Fig. 17

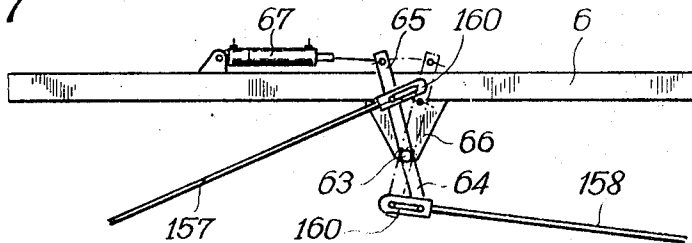
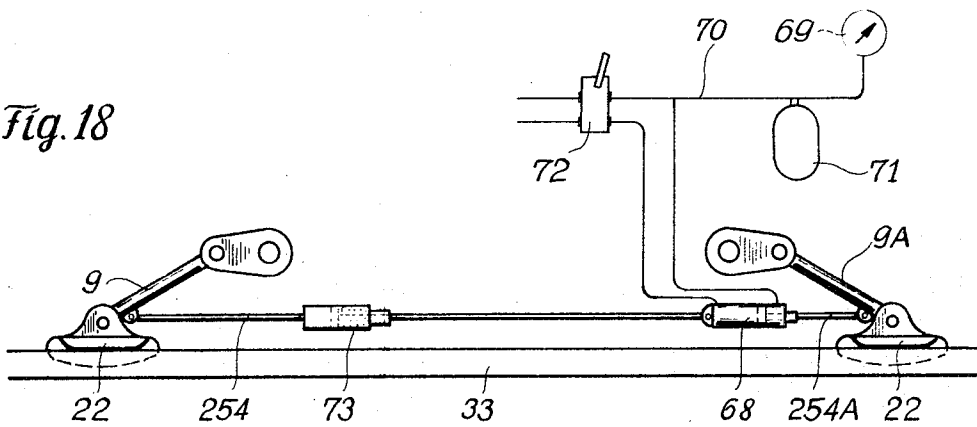


Fig. 18



INVENTORS:

HERBERT GRETZSCHEL
WALTER SCHNEIDER,
THEODOR SCHMAUDER

BY

Herbert H. G.
their ATTORNEY

Fig. 19

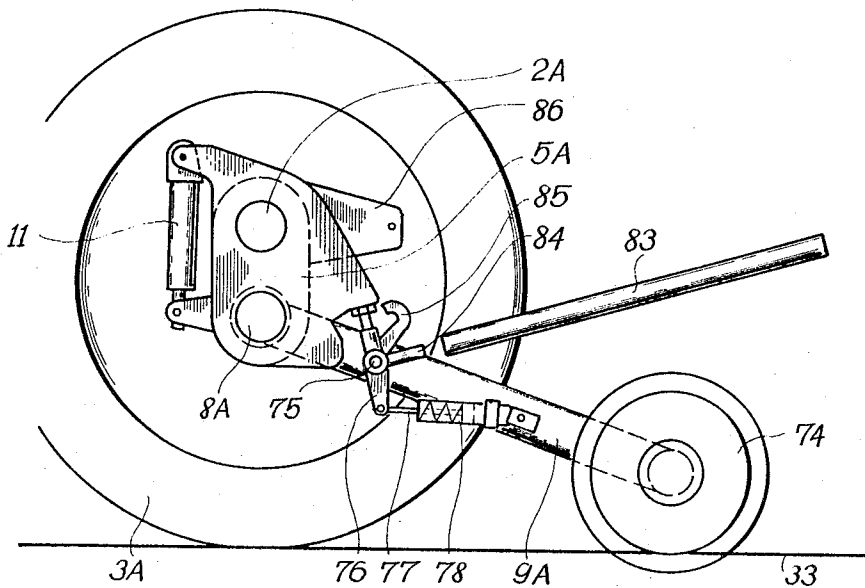
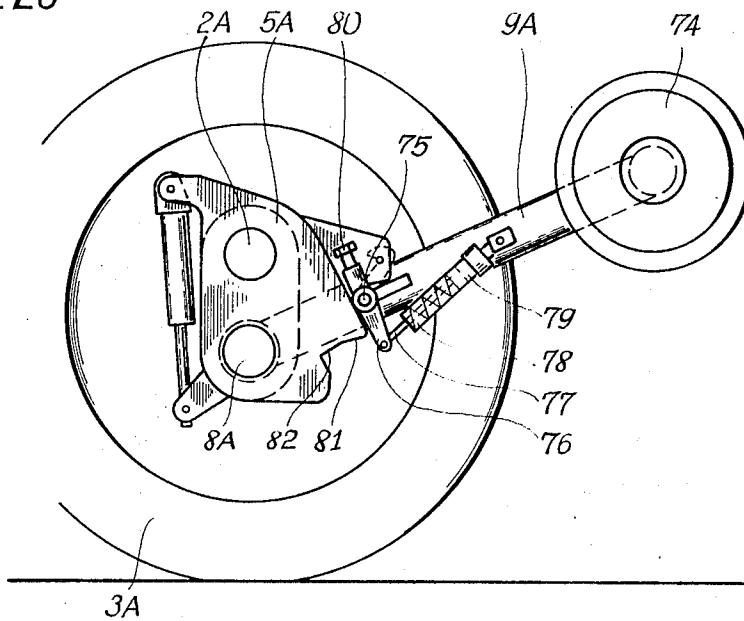


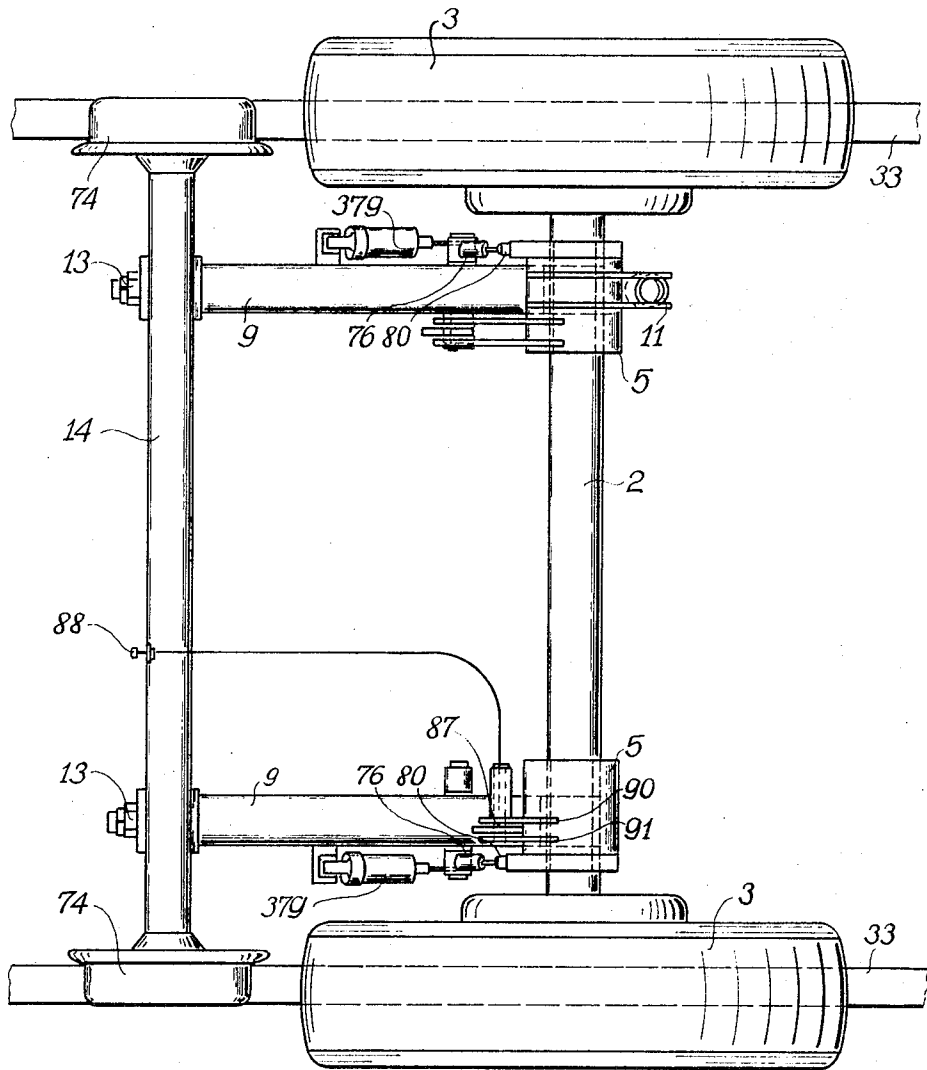
Fig. 20



INVENTORS:
HERBERT GRETZSCHEL
WALTER SCHNEIDER
THEODOR SCHMAUDER
BY

Herbert G. Gretzschel
their ATTORNEY

Fig. 21



INVENTORS:
HERBERT GRETZSCHEL
WALTER SCHNEIDER
THEODOR SCHMAUDER
BY

Lu. Sch. / H. G.
their ATTORNEYS

CONVERTIBLE RAIL-HIGHWAY VEHICLE

BACKGROUND OF THE INVENTION

The present invention relates to convertible vehicles for travel on railways or highways. More particularly, the invention relates to improvements in the construction, operation and mounting of devices which are used on such vehicles to confine the wheels to travel on rails.

The rail-engaging devices in vehicles of the character to which the present invention pertains comprise runners or wheels which are movable toward and out of engagement with the rails so as to prevent derailment when the vehicle is to travel on rails and to be out of the way when the vehicle travels on a road surface. As a rule, the rail-engaging devices of presently known convertible vehicles extend well beyond the body of the vehicle, i.e., forwardly of and behind the body. This is undesirable, impractical and actually forbidden by traffic laws of many countries. Therefore, whenever such a vehicle is to be used on roads, all of the rail-engaging devices must be dismantled and stored in the interior of the vehicle body. Alternatively, the vehicle must be equipped with bulky, expensive and complicated shock-preventing means which is applied over the rail-engaging devices during travel on roads. Therefore, the conversion of such vehicles for use on roads or on rails consumes considerable amounts of time. Furthermore, conventional rail-engaging devices are normally heavy and bulky so that they influence the distribution of weight in and hence the maneuverability of the vehicle, especially if the vehicle is intended to carry substantial quantities of auxiliary equipment. Such bulky devices cannot be readily mounted on vehicles whose center of gravity is close to the ground, i.e., which are designed to provide minimal clearance between the road surface and the underside of the body so that the mounting of bulky rail-engaging devices necessitates a special design and changes in the customary distribution of working machines or analogous auxiliary equipment. In many instances, a convertible vehicle includes a carriage which is installed below the body and supports auxiliary equipment; this carriage occupies substantial amounts of space between the road surface and the ground and thus contributes to difficulties in mounting of rail-engaging devices. In many convertible vehicles, the steering wheel is mounted well ahead of the front wheels to insure satisfactory maneuverability even if the front part of the body carries bulky and heavy auxiliary equipment.

SUMMARY OF THE INVENTION

An object of the invention is to provide a convertible vehicle for use on roads or rails with novel and improved rail-engaging devices which are simpler, lighter and less expensive than but at least as reliable as presently known devices.

Another object of the invention is to provide rail-engaging devices which need not be dismantled when the vehicle is used for travel on roads and which do not interfere with the use of the vehicle on bumpy roads or even on unpaved surfaces.

A further object of the invention is to provide a convertible vehicle with simple but reliable means which prevents uncontrolled movements of rail-engaging devices when the vehicle travels on rails to thus further reduce the likelihood of derailment.

An additional object of the invention is to provide a convertible vehicle wherein the rail-engaging devices can be manipulated by hand and/or by remote control, wherein those parts of such devices which undergo substantial wear are readily accessible for the purposes of inspection, repair and replacement, and whose application necessitates no substantial changes in the design of the vehicle.

Still another object of the invention is to provide rail-engaging devices which can be used in existing convertible vehicles as a substitute for presently known devices.

An ancillary object of the invention is to provide rail-engaging devices which can be installed in vehicles wherein the center of gravity is very close to the ground, which carry substantial quantities of auxiliary equipment, and wherein the steering wheel is located well ahead of the front wheels.

A concomitant object of the invention is to provide rail-engaging devices which can properly guide the road wheels during travel over joints between rails, at intersections of rails and/or in sharp curves.

The invention is embodied in a convertible vehicle for travel on roads and rails. The vehicle comprises a body provided with pairs of front and rear wheels arranged to travel on road surfaces or on the top surfaces of pairs of rails, and front and rear frames each movably mounted on and located within the confines of the body and each comprising a pair of rail-engaging devices (runners and/or one or more rollers) located below the body. The frames are movable between first positions in which the rail-engaging devices are remote from a road surface so that they cannot interfere with travel of the wheels on a road and second positions in which the rail-engaging devices engage the rails in close proximity of the respective wheels to hold the wheels against movement off the rails.

In accordance with a presently preferred embodiment of the invention, each frame comprises several arms which are pivoted to the respective wheel axle and a horizontal traverse which is coupled to the respective arms with some freedom of relative movement and supports the respective rail-engaging devices. The vehicle is preferably further provided with locking means for releasably retaining the frames in their first and/or second positions to insure that the frames cannot accidentally leave their first positions and/or that the rail-engaging devices cannot become disengaged from rails when the vehicle is to travel on a railroad track.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved convertible vehicle itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary side elevational view of the front part of a convertible vehicle which embodies one form of the invention and wherein the rail-engaging devices comprise shoes;

FIG. 2 is a plan view of the structure shown in FIG. 1, with the body of the vehicle omitted;

FIG. 3 is a side elevational view of a modified rail-engaging device which comprises a pair of rollers;

FIG. 4 is a plan view of the device shown in FIG. 3;

FIG. 5 is a side elevational view of a third rail-engaging device which also comprises a pair of rollers;

FIG. 6 is a plan view of the device shown in FIG. 5;

FIG. 7 is an enlarged plan view of a roller which can be used in the device of FIG. 3 or 5;

FIG. 8 is a schematic plan view of a further vehicle wherein the rail-engaging devices are pivotable about vertical axes with reference to their frames;

FIG. 9 is a side elevational view of a rail-engaging device which can be used as a substitute for the devices shown in FIG. 8;

FIG. 10 is a plan view of the device shown in FIG. 9;

FIG. 11 is a partly elevational and partly vertical sectional view of a further rail-engaging device which can be used in the vehicle of FIG. 8;

FIG. 12 is a plan view of the device shown in FIG. 11;

FIG. 13 is a schematic side elevational view of a vehicle which is provided with a locking means serving to prevent uncontrolled disengagement of rail-engaging devices from the rails;

FIG. 14 is a rear elevational view of the vehicle shown in FIG. 13;

FIG. 15 is a side elevational view of second locking means;

FIG. 16 illustrates a detail in the locking means of FIG. 15;

FIG. 17 is a fragmentary side elevational view of third locking means;

FIG. 18 is a side elevational view of fourth locking means;

FIG. 19 is a fragmentary side elevational view of a further vehicle and of fifth locking means for the rail-engaging devices;

FIG. 20 illustrates the structure of FIG. 19 but showing the rail-engaging device in raised position; and

FIG. 21 is a plan view of a portion of a vehicle which embodies locking means constituting modifications of the locking means shown in FIGS. 19 and 20.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1 and 2, there is shown a convertible vehicle which includes a body or chassis 1 carrying a front axle 2 for inflatable wheels 3. The differential is shown at 4. The front axle 2 is provided with a pair of brackets 5 which flank the differential 4 and can but need not be separable from the axle. A carriage 6 at the underside of the body 1 supports at its front end a mounting plate 7 which can carry one or more working machines or implements, not shown. The lower portions of the brackets 5 carry horizontal pivot pins 8 for forwardly extending arms 9. Each of these arms has a relatively short rearwardly projecting extension 10 which is articulately connected to the piston rod of a hydraulic or pneumatic actuating cylinder 11 pivotally mounted on an extension 12 of the respective bracket 5. When the piston rods of the cylinders 11 are caused to move downwardly, the arms 9 are raised to move from the solid-line to the phantom-line positions shown in FIG. 1.

The front end portions of the arms 9 carry or are integral with forwardly projecting coupling pins 13 which pass through a horizontal traverse 14. The coupling pins 13 have limited freedom of movement in the respective bores of the traverse 14. The outer end portions of the traverse 14 are provided or formed with flanges or holders 15 which are separably and interchangeably connected with flanges 16 by bolts 17 or other suitable fasteners. Each flange 16 forms part of a rail-engaging device here shown as a runner 22. The parts 9 and 14 together form a pivotable frame which is movable between the raised position 18 of FIG. 1 and the operative or lowered position which is shown in FIG. 1 by solid lines. It will be noted that, even when the frame assumes the raised position 18, it is completely concealed below the front portion of the carriage 6, i.e., it is located rearwardly of the mounting plate 7. When the wheels 3 travel or are intended to travel on a road surface for extended periods of time, the frame including the arms 9 and traverse 14 is preferably suspended on the body 1 and/or carriage 6 in the raised position 18. This can be achieved by resorting to suitable coupling or locking means, for example, one or more cylinders 19 shown in FIG. 1. The cylinder 9 of FIG. 1 is articulately connected to the carriage 6 and its piston rod 21 is articulately but separably connected with one of the runners 22. The piston in the cylinder 19 is flanked by two helical compression springs 20 which tend to maintain the piston in a median position. These springs enable the frame to move independently of the carriage 6 in response to shocks during travel on uneven terrain. The parts 19-21 constitute a simple shock absorber for the frame. When the piston rods 21 are detached from the respective runners 22, these runners can engage the respective rails 33 and insure that the wheels 3 run on the rails. If desired, the cylinders 19 can be separably coupled to the traverse 14; as shown in FIG. 2, the latter comprises two pins 30 which can be separably connected with the lower ends of the respective piston rods 21.

The runners 22 are of the simplest type which can be produced at a low cost and are of relatively lightweight construction. Each of these runners has a flange 22a which travels along the inner side of the respective rail 33 and a rail-engaging portion or shoe 22b which glides along the top surface of the corresponding rail.

If the convertible vehicle is to be used in areas where sparks eventually developing during travel of shoes 22b along the rails 33 could start a fire or cause an explosion (for example, in yards for storage of fuels or in mines), the runners 22 must be replaced by wheeled or rolling rail-engaging devices, for

example, those shown in FIGS. 3 to 6. Each of these rail-engaging devices comprises two small rollers which is normally desirable to reduce the overall dimensions of the device. Also, in certain countries the diameter of a single rail-engaging roller must exceed a certain value (for example, in Western Germany, the diameter of a single roller must exceed 400 millimeters if the vehicle is to travel at speeds up to 50 kilometers per hour).

The rollers 23 shown in FIGS. 3 and 4 are placed so close to each other that one thereof always engages a rail when the device travels over a frog at the point of intersection between two tracks. The diameters of the rollers 23 are preferably so small that the overall height of the device shown in FIG. 3 need not exceed the height of a runner 22. As shown in FIG. 7, each of the rollers 23 comprises a flange 24 which is located in a vertical plane and which is preferably without the customary inclined abutting edge. It was found that the design shown in FIG. 7 is more likely to prevent derailment of the vehicle. The rollers 23 are mounted on a bearing plate 25 which is affixed to the flanges 15 of the traverse 14 (see the bolts 17).

In the embodiment of FIGS. 5 and 6, the bearing plate 125 has a horizontal sleeve 26 which is mounted on a horizontal pivot pin 28 of the traverse 14 through the intermediary of a tubular cushioning element or jacket 27 of elastomeric material. The jacket 27 is affixed to a plate 29 which is secured to the corresponding flange 15. An advantage of such construction is that the plate 125 has limited freedom of universal movement with reference to the pivot pin 28. Similar results can be obtained by employing two cushioning springs which react against a portion of the traverse and bear against the plate 25 or 125 to normally hold it in a neutral position. Also, the jacket 27 can be omitted if the bolts 17 are surrounded by similar elastic cushioning means to provide a connection which permits some movements of the bearing plate with reference to the traverse.

Due to the fact that the bearing plate 125 has limited freedom of swiveling movement with reference to the traverse 14, the rail-engaging device of FIGS. 5 and 6 can readily move over the joints between rails even if the end of one rail is located at a level above or below the end of the other rail. In such instances, one of the rollers 23 travels on the higher rail and the other roller remains in engagement with the lower rail.

The rear portion of the vehicle which embodies the structure of FIGS. 1 and 2 is also provided with a frame carrying two runners 22 or two pairs of rolling rail-engaging devices.

It will be noted that the pivot pins 8 for the arms 9 are secured to the brackets 5 at a level below the axle 2. This allows for a reduction in the length of the arms 9. If the axle 2 is replaced by a so-called gantry-type axle, the pivots for the arms 9 are placed close to the shafts for the wheels 3. The just described mounting of arms 9 on the brackets 5 insures that the runners 22 or the devices of FIGS. 3-6 are movable along an arc whose center of curvature is located close to the common axis of the wheels 3. As a matter of fact, and as clearly shown in FIG. 1, the runners 22 are closer to the peripheries of the wheels 3 when the frame assumes the raised position 18. Such mounting renders it possible to conceal the frame below the carriage 6 in both positions of the frame as well as to insure that the vehicle can be used for travel on uneven terrain when the frame is held in raised position. Moreover, the frame does not interfere with the mounting of auxiliary equipment on the carriage 6 and/or with the use of such equipment.

Since the actuating cylinders 11 are mounted on the axle 2 and share all movements of the brackets 5, they can maintain the arms 9 in accurately determined positions irrespective of whether the runners 22 or rollers 23 engage the rails 33 or are held in the raised position. As a rule, the axle is mounted on springs (see the springs 106 in FIG. 13) so that, were the cylinders 11 mounted on the body 1 or on the carriage 6, they would not share all movements of the axle and would be free to move relative to the frame. This would prevent retention of the runners 22 or rollers 23 in accurately determined raised or lowered positions. Repeated movements between such cylin-

ders and the frames could lead to extensive vibrations and to eventual breakage of parts, especially at the points where the parts are pivotally or otherwise movably secured to the vehicle. Such vibrations are eliminated by mounting the cylinders 11 on the brackets 5 because their operation is not affected by eventual movements of the axle 2 with reference to the body 1.

The clearance between the pins 13 and the traverse 14 is desirable to insure that the runners 22 or rollers 23 remain in proper engagement with the rails 33 when one of the rails is located at a level above the other rail, for example, at crossings of rails. However, the frame should exhibit a certain rigidity to prevent uncontrolled lateral movements of the runners 22 or rollers 23.

The dimensions of the runners 22 or of the devices shown in FIGS. 3-6 should be selected in such a way that they do not occupy too much room below the carriage 6 but that they are capable of properly confining the wheels 3 to travel along the rails 33, not only when the wheels 3 travel along straight sections of rails but also during travel in a curve and/or at inter-sections of rails.

Due to the fact that the traverse 14 is provided with holders 15 which are readily separable from the rail-engaging devices, the operators of the vehicle can rapidly exchange one or more rail-engaging devices with other types of rail-engaging devices to insure that the vehicle is best suited for travel on rails under a given set of circumstances, e.g., in a mine, yard, magazine, etc. If necessary or desirable, at least one of the runners 22 shown in FIGS. 1 and 2 can be replaced with a device which includes rollers. It is clear that the holders 15 represent but one of several types of elements which can be provided on the traverse 14 to facilitate rapid attachment and separation of rail-engaging devices.

Referring to FIG. 8, there is shown a further convertible vehicle having a front axle 2, a rear axle 2A, a body 1, a front traverse 14, a rear traverse 14A, front arms 9, rear arms 9A, and front and rear wheels 3, 3A. The end portions of the traverses 14, 14A carry vertical pivot pins 31 for devices 32 which can engage the rails 33. The pins 31 allow for some pivotal movement of devices 32 when the vehicle travels along arcuate sections of the rails 33. However, such mounting of the devices 32 is also of advantage when the vehicle travels along straight sections of the rails 33. The devices 32 constitute simple runners similar to the runners 22 of FIGS. 1 and 2. These runners engage the rails 33 in immediate proximity of the respective wheels; this is particularly desirable in connection with the runners which are adjacent to the front wheels 3.

FIGS. 9 and 10 illustrate a rolling rail-engaging device which can replace the devices 32 of FIG. 8. This device comprises a platelike holder or flange 34 corresponding to one of the holders 15 shown in FIG. 1 or 2. The holder 34 is provided with an outwardly extending projection or eye 35 for a vertical pivot pin 36 corresponding to one of the pins 31 shown in FIG. 8. The pin 36 is coupled to a bearing plate 37 which carries two shafts 38 for rollers 39 having flanges 40. The end portions of the holder 34 are provided with eyelets 41 for threaded bolts 42 which are pivotable about substantially vertical axes and pass through openings in the bearing plate 37. The outer end portions of the bolts 42 carry nuts 44 which stress helical cushioning springs 43 bearing against the outer side of the bearing plate 37. In this way, the plate 37 can turn about the axis of the pivot pin 36 whereby it stresses the one or the other spring 43. Such turning of the plates 37 takes place when the vehicle embodying four rolling rail-engaging devices of the type shown in FIGS. 9 and 10 travels in a curve. The eyelets 41 serve as stops to limit the extent of pivotal movement of the bearing plate 37. The nuts 44 can be adjusted to stress the springs 43 in such a way that the bearing plate 37 is automatically held in an optimum neutral position when the rollers 39 are lifted above and away from the respective rail 33.

FIGS. 11 and 12 illustrate a rail-engaging runner which constitutes a modification of the runners 32 shown in FIG. 8. This

runner is mounted on the rear traverse 14A connected to the rear axle 2A by arms 9A. The traverse 14A is provided with a holder 15 which is bolted to a platelike holder 45 corresponding to the holder 34 of FIGS. 9-10. The eye 35 of the holder 45 accommodates a vertical pivot pin 36 which extends through an elastic cushioning jacket 47 (made of rubber or the like) surrounded by a sleeve 48 forming part of a flange 49 provided with a rail-engaging shoe 50. A muff 46 is interposed between the jacket 47 and the pivot pin 36.

In some instances, the shoe 50 can be replaced by flangeless rollers 51 (indicated by broken lines) which are rotatable on shafts 52 (indicated by broken lines) supported by the flange 49. Thus, the rollers 51 may have a common flange which insures that they cannot leave the respective rail 33. When the vehicle embodying rail-engaging devices of the type shown in FIGS. 11 and 12 travels in a sharp curve, each flange 49 assumes the position 53 shown in FIG. 12 by broken lines.

The rail-engaging devices of FIGS. 9-12 are particularly suited for use on vehicles which are intended for travel on rails including strongly curved sections. During travel in a sharp curve, the cushioning springs 43 or the cushioning jackets 47 yield and permit the rollers 39 or 51 or the shoes 50 to remain in an optimum engagement with the respective rails. Such rail-engaging devices can be used with equal advantage in vehicles which are intended for travel on rails which are in poor condition, for example, on temporarily laid rails wherein the ends of rails at the joints are improperly matched. The springs 43 or the jackets 47 then insure that each roller 39 or 51 remains in engagement with the rails or that the shoes 50 are in substantial surface to surface engagement with the respective rails.

The device shown in FIGS. 11 and 12 may be provided with means for adjusting the elasticity of the jacket 47.

A very important requirement for reliable and safe operation of the improved vehicle is that the wheels 3, 3A cannot leave the top surfaces of rails 33 when the vehicle is used for travel on rails. To this end, the pivot pins 31 and 36 shown in FIGS. 8 to 12 must be mounted in such a way that they cannot change their positions with reference to the wheels 3 and 3A. It is also important to mount the rail-engaging devices in such a way that, when the vehicle travels on rails, the shoes or the rollers of such devices are immediately or closely adjacent to the wheels 3, 3A. This contributes significantly to prevention of derailment. It should be borne in mind that convertible vehicles of the type to which the present invention pertains normally employ special (rather narrow) types of tires for the wheels 3, 3A and that the profiles of such tires must remain on the top surfaces of rails 33 regardless of whether the vehicles travel along straight or arcuate sections of rails. The heretofore described types of rail-engaging devices were found to be very reliable and capable of preventing derailment of the vehicle under all normal operating conditions.

FIGS. 13 to 20 illustrate various embodiments of a convertible vehicle which employs rail-engaging devices of the type shown in FIGS. 1 to 12 and is further provided with retaining or locking means for preventing movement of such devices upwardly and away from the rails when the frames are located in their lowered positions. Referring first to FIGS. 13 and 14, the vehicle comprises a body 1, front and rear wheels 3, 3A, front and rear axles 2, 2A, front and rear traverses 14, 14A, front and rear brackets 5, 5A, front and rear rail-engaging devices 22, front and rear arms 9, 9A, a carriage 6 below the body 1, springs 106, and a retaining or locking unit which includes rods 54, 54A respectively coupled to the front and rear frames, as at 55, and a turnbuckle 56 or an analogous tightening device which can reduce the combined length of the rods 54, 54A to thus insure that the runners 22 cannot be lifted above and away from the rails 33. FIG. 14 shows that the vehicle may be provided with two locking units each of which comprises two rods 54, 54A and a turnbuckle 56. The rods 54, 54A can be articulately connected to the arms 9, 9A, to the front and rear traverses 14, 14A or to the front and rear runners 22. The connections or couplings 55 between the rods 54, 54A and the front and rear frames are preferably of the quick-

release type so that the operators can rapidly convert the vehicle for travel on a road or for travel on rails 33. When the vehicle is used on rails, the turnbuckles 56 are preferably manipulated until the flanges of all four runners 22 rest on the respective rails 33 by gravity. The rods 54, 54A then insure that the runners 22 remain in such positions as long as the positions of the turnbuckles 56 remain unchanged. This practically excludes the possibility of derailment under normal operating conditions. The rods 54, 54A and the turnbuckles 56 are removed when the vehicle travels on a road.

Since the rods 54, 54A are subjected only to tensile stresses, they may be made of lightweight material and can be flexible or rigid. Simple cables or ropes can be used with equal advantage.

FIG. 15 illustrates a portion of a convertible vehicle provided with a locking or retaining unit which need not be detached when the vehicle travels on a road. This unit comprises two rods 57, 58 the former of which is provided with a follower 59 extending into an elongated slot 60 (see FIG. 16) formed in the front end of the rod 58. The turnbuckle 56 is installed between two sections of the rod 58. The carriage 6 of the vehicle has a plate 6a provided with a slot 61 which also receives a portion of the follower 59. The front and rear runners 22 can be raised and lowered by actuating cylinders 62 which are coupled to the carriage 6.

When the vehicle is to travel on rails 33, the cylinders 62 lower the frames including the arms 9 and traverses 14 so that the runners 22 rest on the respective rails 33. During such lowering of the frames, the follower 59 travels in the slot 60 of the rod 58. In the next step, the turnbuckle 56 is manipulated until the follower 59 enters the right-hand end of the slot 60; this locks the runners 22 in their operative positions.

The cylinders 62 can be mounted in the same way as described for the cylinders 11 of FIGS. 1 and 2.

FIG. 17 shows a retaining or locking unit which includes two rods 157, 158 each of which is provided with an elongated slot 160. The carriage 6 supports a bracket 66 for a lever having arms 64, 65 provided with follower pins respectively extending into the slots 160 of the rods 158, 157. When the runners (not shown) are lowered into engagement with the respective rails, the lever is pivoted on a pin 63 of the bracket 66 by a hydraulic or pneumatic cylinder 67 until the pins of the arms 65, 64 respectively enter the front end of the slot 160 in the rod 157 and the rear end of the slot in the rod 158. The runners are then held against movement away from the rails. The cylinder 67 is preferably operated by remote control.

The cylinder 67 can be omitted and the lever including the arms 64, 65 is then pivoted by hand. Such locking unit can be provided with a detent or blocking means which releasably holds the lever in operative position. An advantage of the locking unit shown in FIG. 17 is that it need not employ a turnbuckle, i.e., that the runners can be moved to and locked in operative positions with little loss in time. If the cylinder 67 is omitted, the lever including the arms 64, 65 can be mounted in such a way that it tends to assume the solid-line position by gravity. Thus, it is not even necessary to provide any detent means to hold the lever in operative position.

Alternatively, the lever including the arms 64, 65 can be mounted in such a way that it can hold the rods 157, 158 in two operative positions in one of which the corresponding rail-engaging devices extend to a first level and in the other of which such devices extend to a second level. This might be desirable when the wheels of the vehicle must travel only on the top surfaces of the rails or on the top surfaces of the rails while remaining in contact with the ground. In the second instance, the rail-engaging devices must be locked at a lesser distance from the body of the vehicle.

The retaining or locking unit of FIG. 18 includes the rods 254, 254A which are coupled to each other by a double-acting cylinder 68. The hydraulic circuit of the cylinder 68 includes a pressure gauge 69 which indicates the force with which the runners 22 bear against the respective rails 33. This circuit further includes an accumulator 71 which prevents excessive

fluctuations in fluid pressure. The accumulator 71 may be of the customary piston type and is installed in a pressure line 70 connected to a control valve 72. It is presently preferred to employ an accumulator which is effective only when the runners 22 engage the rails 33. For example, such accumulators may have a piston which engages a stop in operative positions of the runners 22 and then permits hydraulic fluid to oppose upward movement of the runners. When the resistance of the fluid to upward movement of the runners is terminated, the accumulator relieves the fluid pressure. The control valve 72 is used to permit refilling of the circuit with a suitable hydraulic fluid; this valve is preferably installed close to or is operable by the person occupying the driver's seat in the body of the vehicle. When the vehicle is to be used on rails, the control valve 72 is opened to admit into the circuit a pressurized fluid until the gauge 69 indicates that the fluid pressure has risen to a desired value. Such pressure is preferably selected in such a way that the runners 22 are biased against the rails to thus further reduce the likelihood of derailment. Simple experimentation will suffice to determine an optimum fluid pressure.

FIG. 18 shows a shock absorber or compensator 73 which is installed in and permits changes in the effective length of the rod 254. The shock absorber 73 includes a spring which tends to reduce the effective length of the rod 254 but can yield to compensate for eventual unevennesses in top surfaces of the rails 33 and to compensate for lifting of wheels during travel at rail crossings. When the wheels move upwardly, the shock absorber 73 cooperates with the accumulator 71 to maintain the runners 22 in requisite engagement with the rails 33. If necessary, the driver can increase or reduce the fluid pressure in the hydraulic circuit by way of the valve 72.

FIGS. 19 and 20 illustrate a modified retaining or locking unit which is shown as being mounted at the rear end of the vehicle. At least one similar unit is provided for the front frame, not shown. This unit comprises a retaining lever 76 which is mounted on a horizontal pivot pin 75 of one of the rear arms 9A. The upper arm of the retaining lever 76 carries an adjustable portion here shown as a screw 80 which can engage one of two shoulders 81, 82 provided on the bracket 5A. Thus, that part of the bracket 5A which is provided with the shoulders 80, 81 constitutes a complementary second retaining member which cooperates with the retaining lever 76 to hold the frame including the arms 9A and traverse 14A in the lower position. The shoulders 80, 81 are located at different levels above the ground. The lower arm of the lever 76 is coupled to a piston rod 77 whose piston is under the bias of a helical spring 78 installed in a hydraulic or pneumatic cylinder 79 coupled to the arm 9A. The free end of the arm 9A carries a rail-engaging roller 74. It is clear, however, that this roller can be replaced with a runner or with a device of the type shown, for example, in FIG. 3 or 5. The arm 9A is pivotable on the pivot member 8A by the actuating cylinder 11. The axle for the rear wheels 3A is shown at 2A.

The retaining lever 76 is further provided with a stud 84 and with a hook 85 which can engage a pin 86 on the bracket 5. An elongated handle 83 can be fitted onto the stud 84 to facilitate pivoting of the lever 76 in a direction to disengage the hook 85 from the pin 86 or to disengage the screw 80 from the shoulder 81 or 82. The shoulder 81 or 82 is engaged by the screw 80 when the roller 74 engages the rail 33.

When the vehicle is to be used on rails, the handle 83 is coupled to the stud 84 and is manipulated to disengage the hook 85 from the pin 86. This can be facilitated by admitting some fluid into the actuating cylinder 11 so that the latter pivots the arm 9A in a counterclockwise direction slightly beyond the raised position shown in FIG. 20. The cylinder 11 is then caused to pivot the arm 9A in a clockwise direction until the roller 74 engages the rail 33. The spring 78 automatically causes the screw 80 to engage one of the shoulders 81, 82 when the roller 74 reaches the lowered position of FIG. 19. By turning the screw 80, the operator can properly select the bias with which the roller 74 is urged against the rail 33. Such bias can be changed by moving the head of the screw 80 from en-

gagement with the shoulder 81 into engagement with the shoulder 82 or vice versa. To return the roller 74 to the raised position of FIG. 20, the operator again attaches the handle 83 to the stud 84 and disengages the screw 80 from the shoulder 81 or 82. The cylinder 11 is thereupon caused to pivot the arm 9A in a counterclockwise direction whereby the hook 85 automatically engages the pin 86 to hold the arm 9A in the raised position.

The two shoulders 81, 82 are desirable for reasons which were explained in connection with FIG. 17, i.e., when the wheels 3A must engage only the top surfaces of the rails 33 or the top surfaces and the adjoining ground.

FIG. 21 illustrates two retaining or locking units each of which constitutes a modification of the locking unit shown in FIGS. 19 and 20. Each of these units comprises a fluid-operated cylinder actuating 379 for the respective retaining lever 76. The hook 85 of FIGS. 19 and 20 is omitted; instead, at least one of the brackets 5 and the corresponding arm 9 are respectively provided with plates 90, 91 having openings which register in raised positions of the arms 9. A locking bolt 87 is then introduced into the registering openings to hold the arms 9 in raised positions. The locking bolt 87 can be moved by remote control, for example, by a Bowden wire 88 attached to the front traverse 14.

In order to raise the rollers 74, the operator first admits fluid into the actuating cylinders 379 so as to disengage the heads of screws 80 from the shoulders of the brackets 5. In the next step, fluid is admitted into the actuating cylinder 11 which moves the traverse 14 away from the rails 33 so that the rollers 74 assume positions corresponding to those shown for the roller 74 of FIG. 20.

It is clear that the retaining levers 76 can be disengaged from the brackets by means other than the handle 83 or actuating cylinders 379, for example, by Bowden wires or the like. Moreover, since the weight of each frame is rather small, such frames can be lifted by hand so that the actuating cylinders 11, too, can be dispensed with. Derailment is prevented in response to placing of screws 80 into engagement with the shoulders 81 or 82 of the respective brackets 5 or 5A.

It is further clear that the retaining levers 76 can be replaced by other types of retaining members which hold the rail-engaging devices in operative positions. For example, the arms 9 or 9A can be provided with pawls which ride over the teeth of ratchet wheels during lowering of the rail-engaging devices and automatically prevent upward movement of such devices unless the operator causes them to become disengaged from the respective ratchet wheels. The teeth of the ratchet wheels are then designed in such a way that they permit limited movements of the rail-engaging devices toward or away from the adjoining rails. The locking units which are shown in FIGS. 13 to 21 are merely illustrative but not exhaustive of various means which can be used to further reduce the likelihood of derailment.

The circuit of the actuating cylinders 11, 379 is preferably designed in such a way that the cylinder 11 is actuated automatically upon completion of actuation of the cylinders 379, i.e., that these cylinders are operated in a predetermined sequence.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art, and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended

1. In a convertible vehicle for travel on railways and highways, a combination comprising a body provided with front and rear axles each having pairs of front and rear wheels arranged to travel on pairs of rails or way surfaces; front and rear frames each movably mounted on said body and each

comprising a pair of rail-engaging devices located below said body, each of said frames being movable between a first position in which said devices are remote from a way surface and a second position in which said devices engage the rails in close proximity of the respective wheels to hold the wheels against movement off the rails, said frames each comprising a pair of transversely spaced arms pivoted to a respective one of said axles, and a transversely extending member secured to said arms and supporting the respective rail-engaging devices; and means for selectively retaining said arms in said first and said second positions and when said arms are in said second position, maintaining each rail-engaging device of a respective pair of at least one of said frames in engagement with an associated rail independently of the respective other rail-engaging device of the pair.

2. A combination as defined in claim 1, further comprising actuating means for moving said frames with reference to the respective axles.

3. A combination as defined in claim 1, further comprising pivot means securing said arms to the respective axles, each of said pivot means being located at a level below the respective axle.

4. A combination as defined in claim 1, further comprising coupling means connecting said arms to the respective transversely extending member with limited freedom of movement.

5. A combination as defined in claim 1, wherein each of said transversely extending member comprises a pair of holders and further comprising fastener means separably securing each of said rail-engaging devices to one of said holders.

6. A combination as defined in claim 1, wherein each of said devices comprises a pair of closely adjacent rail-engaging rollers.

7. A combination as defined in claim 1, wherein each of said frames comprises connecting means securing said devices to the respective transversely extending member with freedom of swiveling movement about axes which are substantially parallel to said transversely extending member.

8. A combination as defined in claim 7, further comprising stop means for limiting the extent of said swiveling movement.

9. A combination as defined in claim 7, wherein each of said connecting means includes at least one elastic cushioning element.

10. A combination as defined in claim 1, wherein each of said devices comprises at least one roller having a flange located in a vertical plane and a rail-engaging portion adjacent to said flange.

11. A combination as defined in claim 1, further comprising connecting means securing said devices to said frames for movement about axes which are at least substantially vertical in the second positions of said frames.

12. A combination as defined in claim 11, wherein said connecting means comprise elastic cushioning elements.

13. A combination as defined in claim 11, further comprising stop means for limiting the extent of said movement.

14. A combination as defined in claim 1, wherein said means comprises at least one unit for connecting said frames to each other against movement from said second to said first positions thereof.

15. A combination as defined in claim 14, wherein said unit includes a system of rods.

16. A combination as defined in claim 15, wherein said unit further comprises changing means for shifting the effective length of said system of rods.

17. A combination as defined in claim 16, further comprising control means for said changing means, said control means being within reach of the person occupying the driver's seat.

18. A combination as defined in claim 16, wherein the changing means for shifting the effective length of said system of rods comprises fluid-operated cylinder means.

19. A combination as defined in claim 18, wherein said unit further comprises accumulator means for pressurized fluid.

20. A combination as defined in claim 1, wherein said means comprises a first retaining member movably mounted

11

12

on said one frame and separably engaging a complementary second retaining member on said body in the second position of said one frame.

21. A combination as defined in claim 20, wherein said first retaining member is a lever and further comprising means for biasing said lever into engagement with said second retaining member.

22. A combination as defined in claim 20, wherein at least one of said retaining members includes a portion which engages the other retaining member in the second position of said one frame and is adjustable with reference to said one frame.

23. A combination as defined in claim 20, wherein said second retaining member includes a plurality of portions located at different levels above the ground and wherein said first retaining member is movable into engagement with one of said portions at a time to thereby maintain the respective rail-

engaging devices at a desired level in the second position of said one frame.

24. A combination as defined in claim 20, further comprising means for moving one of said retaining members with reference to the other retaining member by remote control.

25. A combination as defined in claim 20, further comprising first actuating means for moving said one frame between first and second positions, second actuating means for moving one of said retaining members with reference to the other retaining member, and means for operating said actuating means in a predetermined sequence.

26. A combination as defined in claim 1, further comprising coupling means for separably securing said frames on said body in the first positions of said frames.

27. A combination as defined in claim 26, wherein said coupling means includes at least one pin-and-hook coupling.

* * * * *

20

25

30

35

40

45

50

55

60

65

70

75