

Nov. 16, 1937.

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2,098,949

TRAIN

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4 Sheets-Sheet 1

Fig. 1.

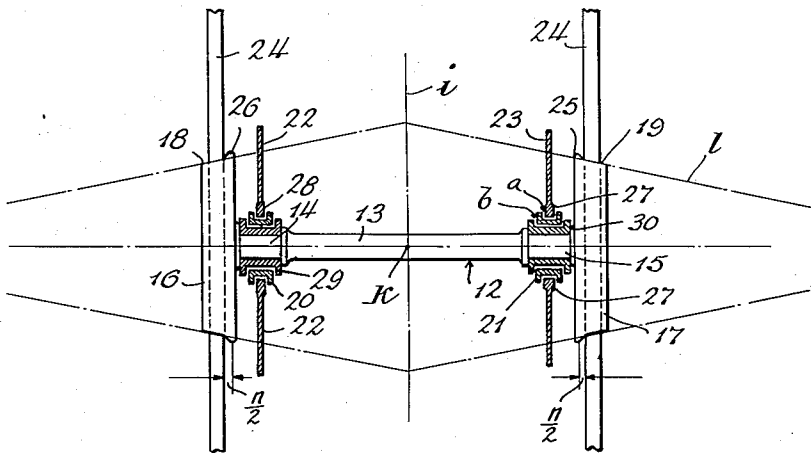


Fig. 2.

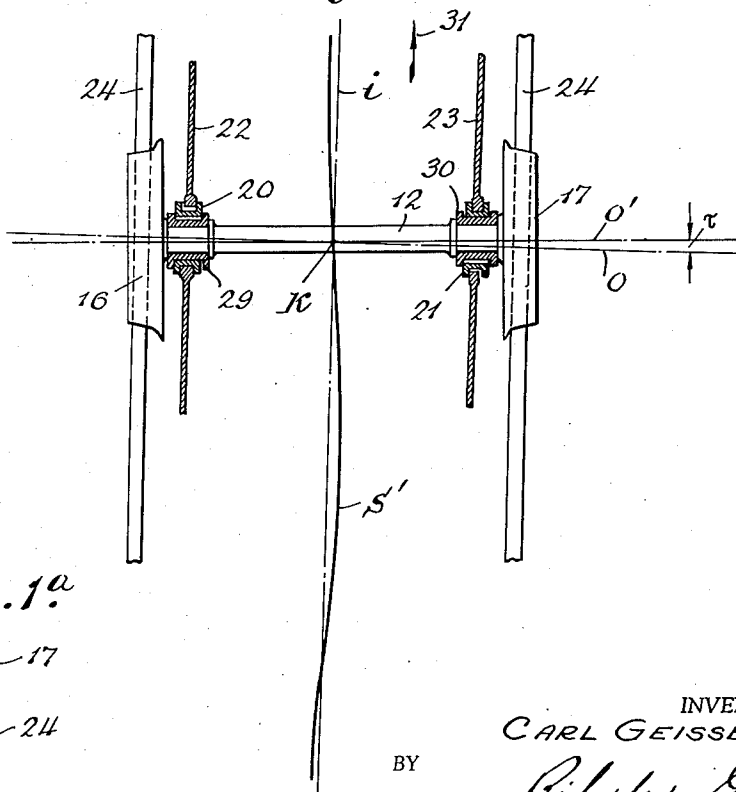
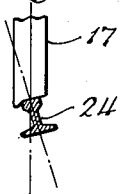


Fig. 1^a



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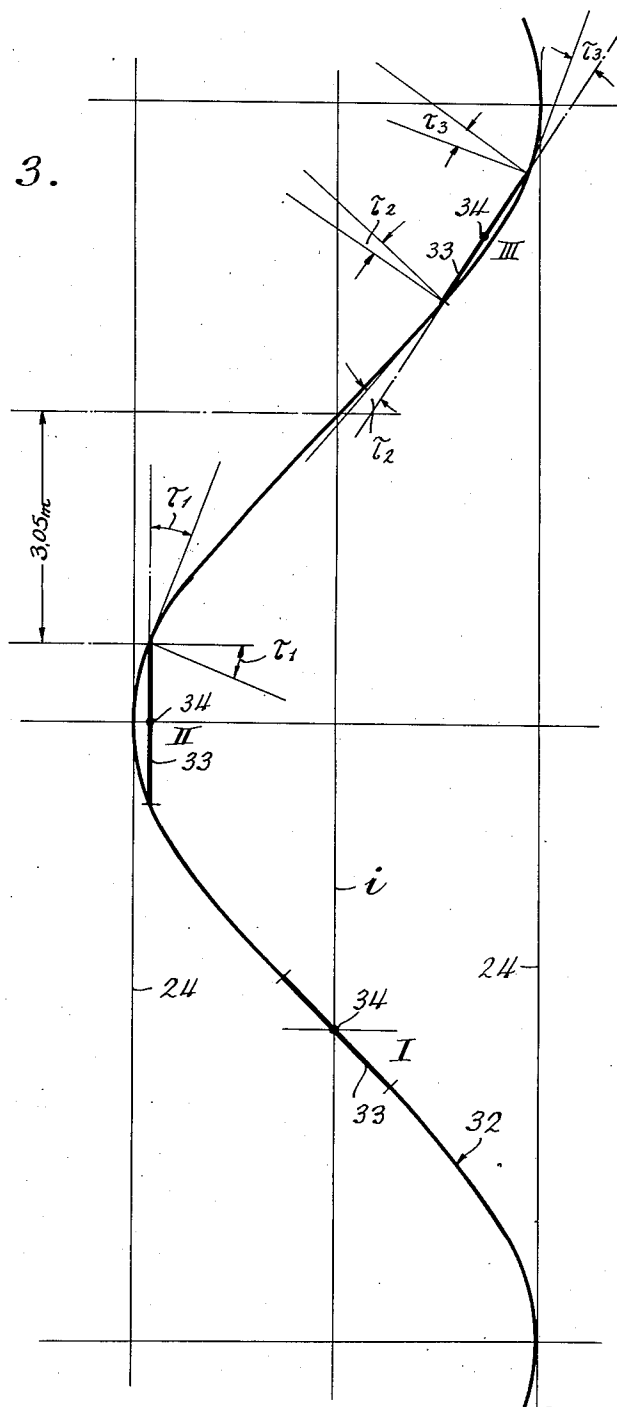
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Fig. 3.



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Fig. 4.

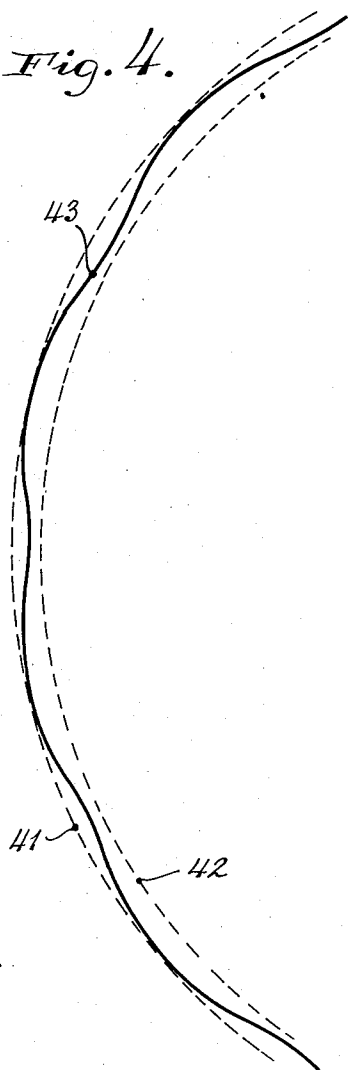


Fig. 5.

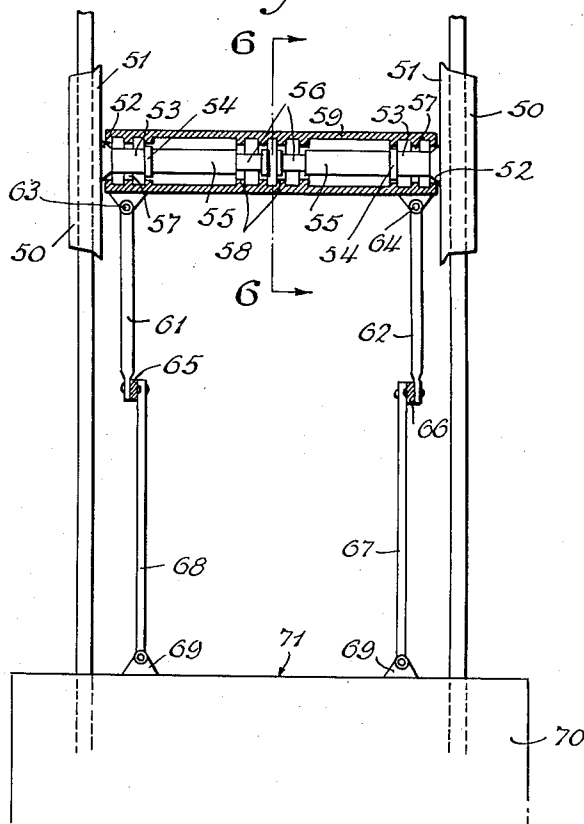
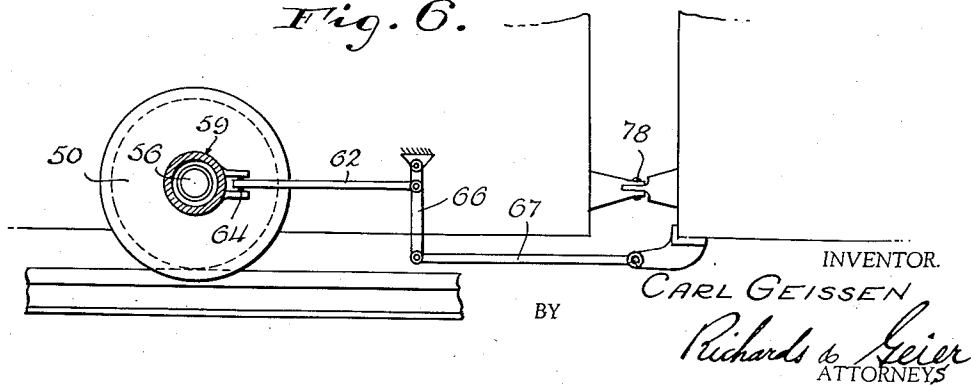


Fig. 6.



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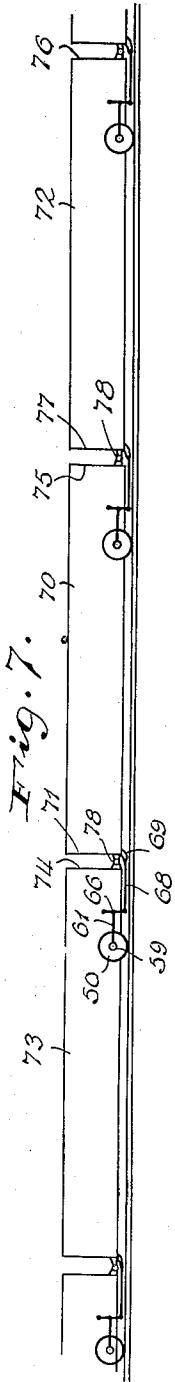
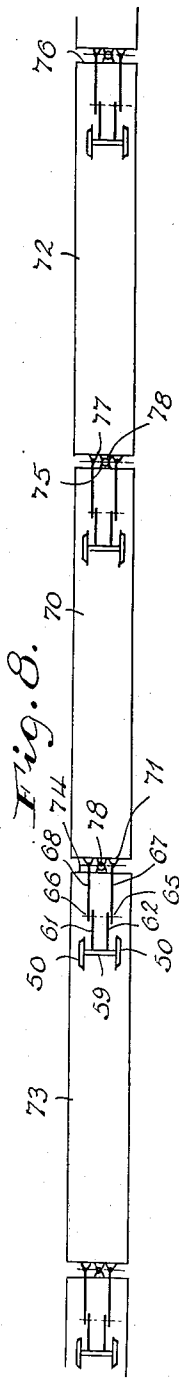
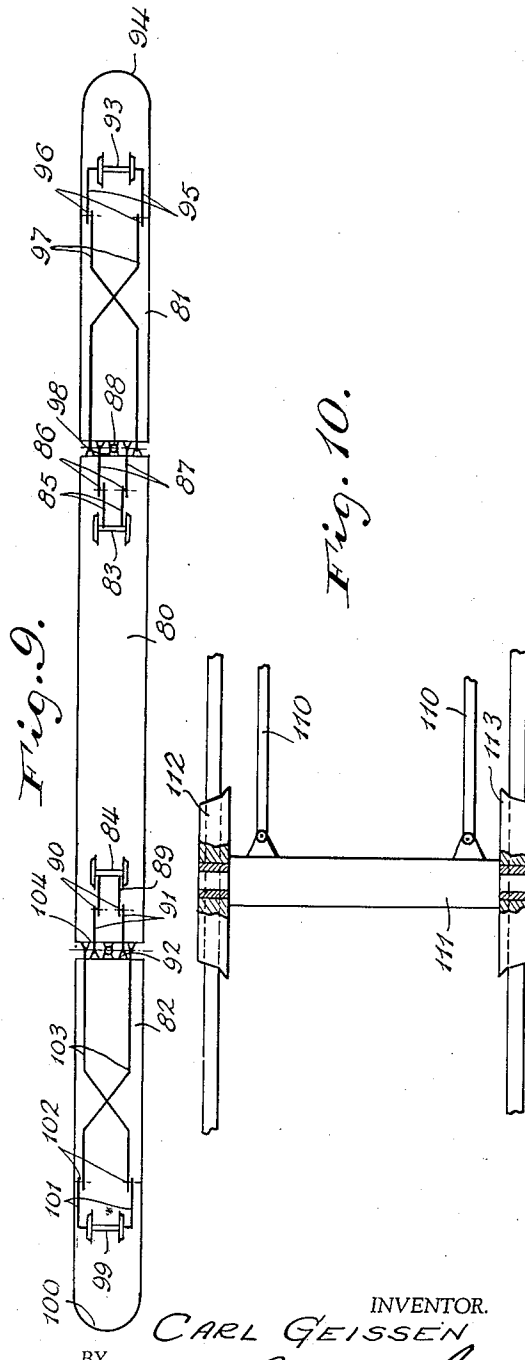


Fig. 10.

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In Germany January 8, 1936

4 Claims. (Cl. 105—168)

This invention relates to train cars and refers more particularly to an express train composed of a plurality of light cars, each of which is provided with a single axle carrying one pair of wheels,—and one car provided with two or more axles.

The invention will appear more clearly from the following detailed description when taken in connection with the accompanying drawings, in which:

Figures 1, 1a, 2, 3, and 4 are diagrams used for the purpose of explaining the occurrence of vibrations in prior art constructions,—Figure 1 being a diagrammatic horizontal section through a car axle, Figure 1a showing a wheel upon a rail, Figure 2 being similar to Figure 1 and illustrating the shifting of the car axle due to vibrations, Figure 3 illustrating the path of movement of an axle and Figure 4 illustrating the sine-like movements of a car passing along a curve.

Figure 5 shows in horizontal section a car axle constructed in accordance with the principles of the present invention.

Figure 6 is a section along the line 6—6 of Figure 5.

Figure 7 shows a part of a train in side elevation.

Figure 8 is a bottom view of the train shown in Figure 7.

Figure 9 is a bottom view of a train of a somewhat different form; and

Figure 10 shows a car axle of a somewhat different type.

Figures 1 and 2 show a wheel axle 12 of the standard type, comprising a middle portion 13 and two end portions 14 and 15 connected with the wheels 16 and 17, and enclosed by bearing sleeves 29 and 30, respectively. The wheels 16 and 17 have conical surfaces 18 and 19, respectively, the angle of which is indicated by the broken lines 1 in Figure 1.

The end portions 14 and 15 which are enclosed by sleeves 29 and 30 are carried by bearings 20 and 21 which are supported by the guides 27 and 28 of the inner frame members 22 and 23. A play a is provided between the guide members 27 and 28 and the bearings 20 and 21; a play b is provided between the bearings 20 and 21 and the axle end portions 14 and 15. The standard distance be-

tween the frame members 22 and 23 for European railroads is 1150 millimeters.

The wheels 16 and 17 run upon a track or rails 24 of the standard type. The flange 25 of the wheel 17 is situated at a distance

$$\frac{n}{2}$$

from the adjacent edge of a rail 24. Since the flange 25 of the wheel 16 is situated at the same distance from the edge of its rail, the total wheel flange play is equal to n .

The geometrical center of gravity of the wheel axle 12 lies in the intersection of the longitudinal axis of the axle 12 and the longitudinal axis i of the track 24 and is designated by the letter k in Figures 1 and 2. If the car is to run smoothly, without being vibrated by transverse dynamic forces, the path of the geometrical center of gravity k must coincide with the central track line i ; however, it is impossible to attain such movement except for a few brief occasional moments.

Due to the provision of the wheel flange play n and the conical shape of the running surfaces 18 and 19, the center of gravity k will move along a sine-like curve s' (Figure 2) while the axle 12 is running along the track 24 in the direction of the arrow 31.

In the course of this sine-like movement of the center of gravity k the longitudinal axis of the axle 13 will oscillate between a central position o (Figure 2) and one of the end positions o' , the oscillation angle being designated by the letter τ in Figure 2. Such oscillations may have a serious detrimental effect upon the structure of the car frame or the bogie-frame. However, the primary effect of these oscillations is an increase in friction, since no play b between the sleeves 29 and 30 and the bearings 20 and 21 can be maintained in the course of such oscillations; this is equally true as far as the play a between the bearings 20 and 21 and the frame guide members 27 and 28 is concerned. Figure 2 shows the axle 12 in a deviated position caused by the movements of the point k , with the resulting decrease of the plays a and b . As already mentioned, the sine-like movements of the point k cause an oscillation of the wheel axle thereby increasing the frictional forces to a considerable extent.

Any further unevenness or deviation from the

correct geometrical form of the rails will create another sine-like movement of the point k which will be added to the described original sine-like movement with the result that the path of the point k will be actually along an irregular curve. This curve of actual movement of the point k consists at each point of the sums of sine-like movements existing at that moment; however, the curve of actual movement will retain its general character of the sine-like curve. The amplitude and the wave length of this curve will change continuously and it may happen that the amplitude will become greater than the wheel flange play.

Figure 3 illustrates a theoretical curve 32 of the sine-like movements of a wheel axle, said curve being drawn on an incorrect and highly exaggerated scale, particularly as far as the amplitude is concerned, to show more clearly the principles involved.

In Figure 3 the lines 33 represent three positions I, II and III of the longitudinal axis of a bogie-frame and the points 34 represent the corresponding three positions of the central pivot of a bogie-frame. In the position I the longitudinal track axis i passes through the pivot 34; in this position the total play $a+b$ exists between the axle and the supporting frame, as shown in Figure 1, and the angle τ between the ideal longitudinal axis o of the axle 13 and the actual axis o' (Figure 2) is equal to zero.

In the position II the longitudinal axis 34 is at the top of the sine curve 32. The distance between the point 34 and the curve 32 is a maximum at that point, and so is the angle τ_1 representing the angle of inclination between the ideal position of the longitudinal axis of the axle 13 and the actual position of this axis.

In the position III adjacent another top of the curve 32 there are two different angles of inclination τ_2 and τ_3 for the two axes of a bogie-frame, the angle τ_3 which is nearer the top of the curve 32 being greater than the angle τ_2 .

Consequently, a wheel axle 12 will need more play $a+b$ to enable it to vibrate freely, when it is in the position II than when it is in the position III, the prerequisite smallest amount of the play which would permit complete vibrations, increasing as the axle is moved from the position I to the position II.

As a general rule, however, sine-like oscillations continue while the car is moving along a curve, particularly if the curve is a comparatively flat one. Figure 4 illustrates diagrammatically a curved track having rails 41 and 42, the curve of the sine-like oscillations of the car being designated by the numeral 43. This curve indicates that as a rule, the outer top portions of the curve touch the edge of the outer rail 41 while the inner top portions of the curve 43 extend only slightly beyond the central longitudinal axis of the track 41, 42 and usually do not reach as far as the inner rail 42. The inner top portions of the curve 43 are quite flat and the curve is somewhat similar to a polygon with rounded corners. The passengers in the car also receive the impression of a polygon-like movement.

One of the objects of the present invention is to eliminate the sine-like movements of cars.

Another object is to increase the durability of trains, car wheels, tracks and the permanent way by eliminating car vibrations.

The present invention is based upon the discovery that the sine-like movements cannot be

eliminated by mere improvements of existing constructions and that radically new forms of cars must be devised in order to eliminate vibrations.

The above and other objects of the present invention may be realized through the provision of an express train composed of a plurality of light cars each of which is provided with one axle, said train including a combination of two features, namely, the provision of supporting couplings which are situated between adjacent cars, the distance of the pivotal point of each coupling from the adjacent cars being a permanent one, and the feature that the wheels of an axle rotate independently one from the other, or that the axle of each car is a divided one, the steering of each axle depending upon the angle between the car carrying that axle and that car which is situated nearest to said axle.

A divided and guided axle constructed in accordance with the principles of the present invention is shown in Figures 5 and 6 of the drawings. There are two wheels 50 having wheel flanges 51, each of the wheels being firmly connected with a half-axle comprising a connecting portion 52, a bearing portion 53, a ring portion 54, a middle portion 55 and an end portion 56. Two bearings 57 support the portions 53 of the two half-axes. The end portions 56 of the half-axes are supported by the guide bearings 58. The bearings 57 and 58 are carried by a hollow casing or sleeve 59 which encloses the two half-axes.

Divided axles of this type have no movement of their own and, consequently, they cannot be subjected to sine-like oscillations. When they run freely, they may assume any inclined position, in contrast to the usual axles, and roll off the rails. Even when small deviations from the ideal position of the longitudinal axis take place, the wheel flanges continue to roll along the rail edges without attempting to move away from them.

In view of these peculiar characteristics of the half-axes it is necessary to steer them simultaneously in such manner that they extend exactly at right angles to the longitudinal track axis when the track is a straight one, and that they coincide exactly with the direction of the track radius when the track extends along a curve. It is not sufficient, for example, to keep the half axes straight while the track is a straight one. The precision with which the half axes are steered must remain within the permissible angular deviations of the inaccuracies in the rails, in order that the wheel flange may touch the rail edge only at the top portions of those inaccurate portions of the rails which have the form of projections extending toward the middle of the track. It is not difficult from a mechanical point of view, to achieve such precision in steering, due to the comparatively small angular deviations of the inaccuracies in the rails.

In accordance with the present invention, the half axes are steered with great precision also when the car is running along a curve. This steering is carried out by means of steering rods which will be described in greater detail hereinafter, and which constitute a parallelogram the movements of which depend upon the existence of an angle between two adjacent cars, the steering angles of the half-axes being functions of the car angles.

In order to be able to use the angular inclination of two adjacent cars for the purpose of steer-

ing the wheel half-axes, it is necessary to find a pivotal point between the two car frames or car bodies which will always remain a component part of both these cars.

However, a car having two or more axles, or a bogie frame having two pivots assume their own independent positions; every point of the front surface of the car is always moving in space relatively to a point upon the opposite surface of an adjacent car. Therefore, for the purposes of the present invention it is necessary to use cars having one pair of wheels each, the single divided axle of the car being situated near one of the ends thereof.

15 The steering device for the divided axle is illustrated in Figures 5 to 8. The device comprises two steering rods 61 and 62 connected to the axle casing 59 by means of pivots 63 and 64. The opposite ends of the steering rods 61 and 62 are connected to the reducing leverage systems 65 and 66. Two rods 67 and 68 connect the leverage systems 65 and 66, with a support 69 which is integral with the car 70 and is situated near the end 71 thereof.

25 Each of the cars 70, 72 and 73 is provided with a single divided axle situated adjacent the ends 74, 75 and 76 of these cars. The opposite ends 77 and 71 of the cars 72 and 70 are connected with the ends 75 and 74 of the cars 70 and 73, respectively, by means of the link couplings 78.

30 As shown in Figures 7 and 8, the single divided axle of a car is situated adjacent one of the ends thereof. That end of a car, which is furthest from its axle, is carried by means of a supporting link coupling 78 by the adjacent end of another car, the last-mentioned end being one near which the axle of that car is situated.

35 Each coupling 78 constitutes the apex of the angle formed between two adjacent cars while they are upon a curve, and used for the purpose of steering the wheels of the cars. This angle determines the position of a divided axle by means of the rods 61, 62, 67 and 68 and the reducing leverage systems 65 and 66.

45 Each of the cars of a train is provided with the same steering device, so that for the purposes of theoretical calculation the train may be assumed to be infinitely long; if the train has X cars, it will also have X axles.

50 For practical purposes, it is advisable to provide one car having two divided axles. An arrangement of this type which is shown in Figure 9 of the drawings, may comprise three cars 80, 81 and 82. The car 80 has two axles 83 and 84. The axle 83 is steered by means of the steering rods 85, the reducing leverage systems 86 and the rods 87 which are attached to the end 88 of the car 81. The axle 84 is steered by means of the steering rods 89, the reducing leverage systems 90 and the rods 91 which are attached to the end 92 of the car 82. These steering means are similar to those shown in Figures 5 to 8.

55 The single axle 93 of the car 81 is situated adjacent the end 94 of this car and is steered by means of the steering rods 95, the reducing leverage systems 96 and long rods 97 attached to the end 98 of the car 80. The axle 99 of the car 82 is situated adjacent the end 100 of this car and is steered by means of the steering rods 101, the reducing leverage systems 102 and long rods 103 attached to the end 104 of the car 80.

60 Due to this arrangement the car 80 provided with two axles 83 and 84 supports the ends 88 and 92 of the two cars 81 and 82 which are provided with one axle each, the ends 88 and 92

being furthest removed from the axles 93 and 99. The connecting means or couplings of the last cars 81 and 82 of the train steer not only the adjacent axles 83 and 84, but the end axles 93 and 99 of the train as well.

65 While the train shown in Figure 9 has three cars, the number of such cars may be varied at will. When the train has y cars, the number of its axles will be $y+1$.

70 A car constructed in accordance with the principles of the present invention includes, therefore, two features, namely, the provision of a divided axle and means for steering said axle in accordance with the angle between this car and an adjacent one. By combining these two features 15 it is possible to eliminate the sine-like movements entirely, thereby sparing and preserving the cars, the track and the road-bed, as well as the wheels of the cars.

20 It should be noted, however, that the same advantageous results may be achieved by combining the described steering means 110 shown in Figure 10, with an undivided axle 111, the wheels 112 and 113 of which rotate independently one from the other. Many other changes also may 25 be made in the described constructions within the scope of the appended claims.

30 It will be understood that the supporting connections between the car bodies and the axles may be of any suitable conventional type and as it does not form part of the instant invention it is not believed necessary to described the same in detail.

35 The advantages of the described constructions, namely, the elimination of sine-like movements, increase with an increase in the speed of the trains. The greater the speed the more remarkable are the quietness and security in the movement of the trains and the greater is the saving in the costs of maintenance and replacement. Trains constructed in accordance with the principles of the present invention may run much faster than 200 kilometers per hour without being subjected to any excessive forces or vibrations.

45 What is claimed is:

1. In an express train, comprising a plurality of single-axled cars and a multi-axled car; a supporting joint coupling interconnecting two adjacent cars and having a common pivot point 50 the distance of which from said two adjacent cars remains constant; each of said single-axled cars having one divided axle, and means connected with said divided axle and an adjacent car to steer said divided axle depending upon the angle of intersection between the car carrying the divided axle and said adjacent car.

2. In an express train, comprising a plurality of single-axled cars and a multi-axled car; a supporting joint coupling interconnecting two adjacent cars and having a common pivot point the distance of which from said two adjacent cars remains constant; each of said single-axled cars having an axle and wheels which are rotated independently of each other and which are carried by said axle; and means connected with said axle and an adjacent car to steer said axle depending upon the angle of intersection between the car carrying the axle and said adjacent car.

3. In an express train comprising at least two 70 singled axled cars and an intermediate multi-axled car; a supporting joint coupling interconnecting each of said single axled cars with said intermediate multi-axled car, and having a pivot point the distance of which from said single 75

axled car remains constant; each of said single axled cars having one divided axle; and means connected with said divided axle and said intermediate multi-axled car to steer said divided axle depending upon the angle of intersection between the car carrying the divided axle and said intermediate car.

4. In an express train comprising at least two single axled cars and an intermediate multi-axled car; a supporting joint coupling interconnecting each of said single axled cars and said

intermediate car and having a pivot point the distance of which from said single axled car remains constant; each of said single axled cars having an axle and wheels which are rotated independently from each other and which are carried by said axle; means connected with said axle and said intermediate car to steer said axle depending upon the angle of intersection between said single axled car and said intermediate car.

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