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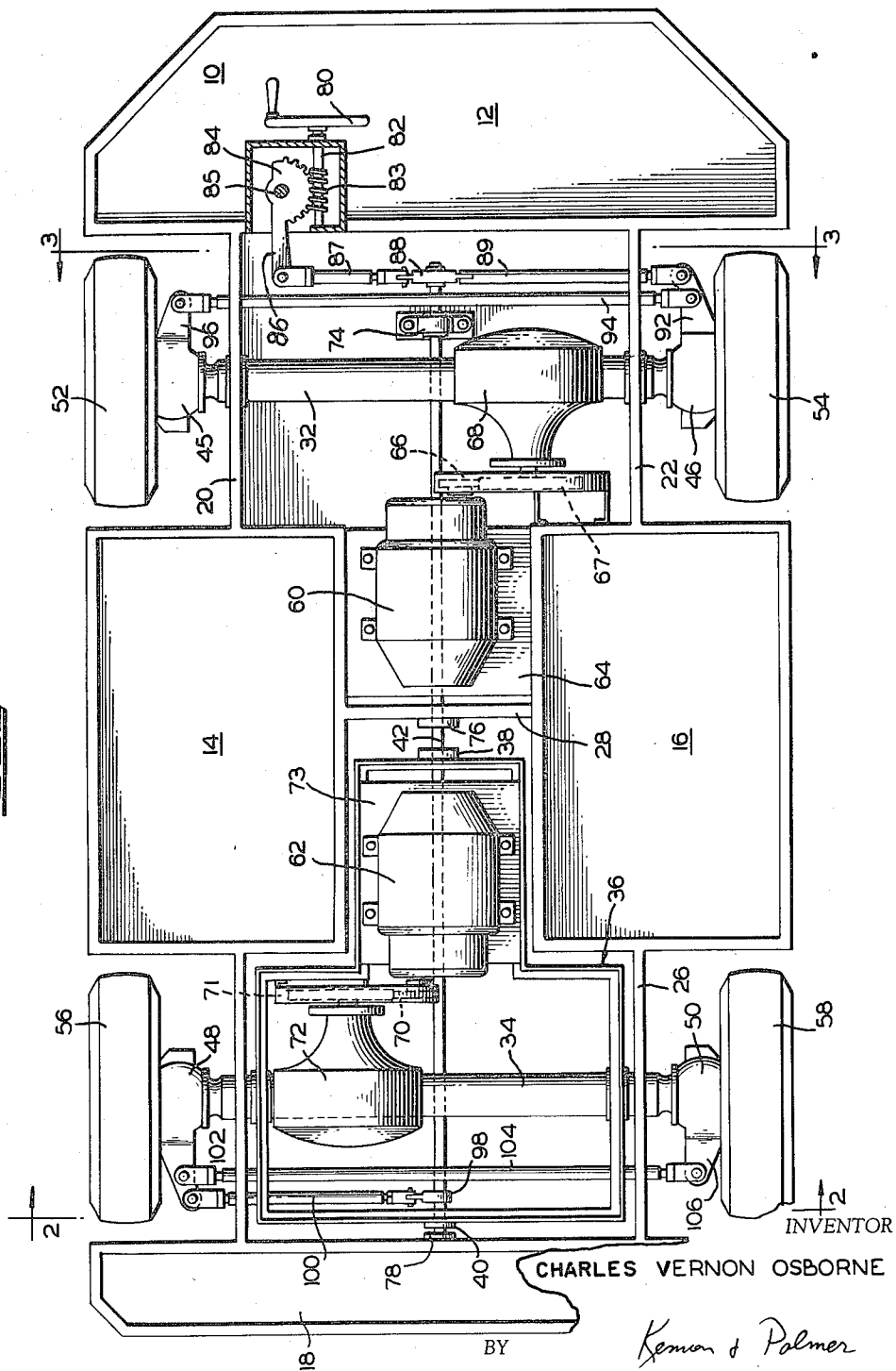
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FOUR WHEEL STEERING MECHANISM FOR A MINE CAR

Filed May 15, 1958

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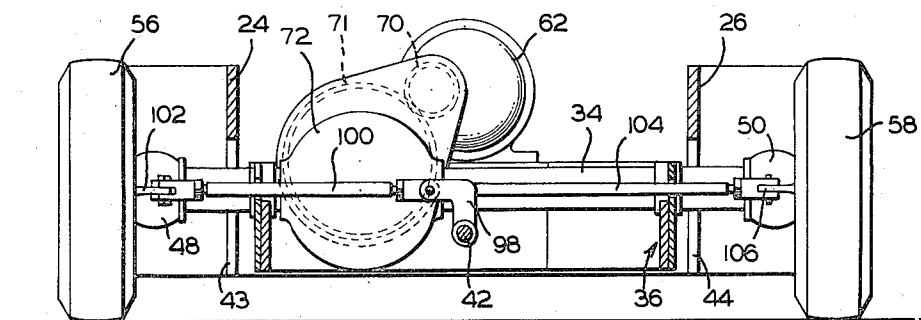
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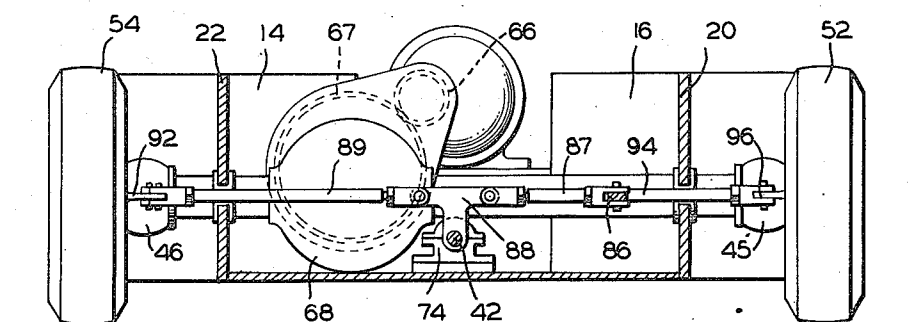
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Fig 2.



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FOUR WHEEL STEERING MECHANISM FOR A MINE CAR

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3 Claims. (Cl. 280—96)

This invention relates to motor vehicles, and more particularly, to electric motor cars of the type used in the mining industries.

In the mining industry, and especially in coal-mining, the practice has developed whereby trains of small rubber-tired mineral cars drawn by tractors or motor cars are used before removing coal from a location of diggings within a mine to a coal-mining tippie or the like outside of the mine. The tractor or motor car used in these operations must be sufficiently powerful to draw the loaded mineral cars and yet small and maneuverable in order to be operated within the small confines of a coal mine. For an example of cars of the general type to which the present invention is directed see U.S. Patent 2,812,191 of 1957 to Kersey et al.

Due to the adverse conditions under which a motor car of the type to which this invention relates must operate, such a motor car must have certain specific requirements. For example, in order that the motor car be able to gain access to all parts of a mine where mining operations are being carried out, the overall height of the car must be kept to a minimum. A desirable maximum height for such a car is in the range of 24 inches or less. On the other hand, it is highly important that there be sufficient ground clearance to enable such a car to operate effectively on the improvised and poorly surfaced road beds normally incurred in and about a coal mine. In addition, a most significant requirement for such a motor car is that it be highly maneuverable and be provided with steering means such that the sharp turns and narrow roadways, which are found within a coal mine, may be negotiated by the car while operating therein.

It has been the practice of the past to construct motor cars of this type having four driven wheels to develop the required traction and also having all four wheels steerable to achieve the maneuverability required. The advantage in providing steerage in all four of the driven wheels is that it, in effect, reduces the wheel base length of the motor car so far as steering is concerned. One disadvantage in prior constructions however, has been that the steering mechanism, particularly the linkage, is located below the main frame of the motor car and is exposed too close to the road bed of a mine in which the car is operated as well as outside grounds in the vicinity of the coal mining tippie. This close exposure to the road bed permits mine mire to cling onto the linkage and also decreases ground clearance which is vital to performance of the motor car. If the ground clearance is an insufficient amount, the roadbed must be maintained level and in an excellent condition to prevent the steering linkage to be destroyed during operations. These requirements place unnecessary operating costs on the mining operations. Further, the requirement of four wheel steering has, in the past, resulted in complex steering control systems which are necessarily space consuming and tend to increase the overall dimensions of the car. Thus, the desired smallness for efficient use has been sacrificed to incorporate this feature.

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An object of this invention is to produce an electrically driven motor car equipped with pneumatic tires and a four wheel drive which overcomes the difficulties pertaining to steering and wheeling performances heretofore encountered with coal mining vehicles of the type referred to.

Another object of this invention is to provide a motor car of the type referred to, having a steering mechanism adapted to be compactly incorporated into the car frame structure and additionally function as a working part of the frame.

A further object of this invention is to provide a motor car of the type referred to, having steering linkage for steering four driven wheels, which linkage is positioned entirely above the frame of the car but which does not in any way increase the height of the car.

Another object of this invention is the provision of a motor car of the type referred to, having one supporting axle pivotally connected to the car frame to effect a three point suspension, and a steering shaft so positioned on the frame to function as the axis of the pivotal connection.

These and other objects will be apparent from the following detailed description read in conjunction with the attached sheets of drawings in which:

Figure 1 is a plan view of an electric motor car incorporating the steering mechanism of this invention;

Figure 2 is a sectional elevation taken at lines 2—2 of Figure 1; and

Figure 3 is a sectional elevation taken at lines 3—3 of Figure 1.

In general, the objects of this invention are achieved by providing an electric motor car having four driven wheels rotatably mounted on pivoted stub shafts with a steering mechanism comprising a manually rotatable steering shaft lying on an axis running centrally and longitudinally of the car. The steering shaft is journaled in the frame of the car, and also in a sub-frame in a manner such that the sub-frame is carried pivotally with respect to the frame on the steering shaft. Crank arms at each end of the steering shaft are provided for translating rotational or oscillatory movement thereof into reciprocating motion in tie rods which in turn actuate or turn the wheels mounted on the stub shafts.

Referring now to the drawings, and more particularly to Figure 1 thereof, an electrically driven motor car is shown having a frame generally designated by the numeral 10. The frame is formed with an operator's platform 12 at the rear end thereof, a pair of centrally positioned platforms 14 and 16 for supporting electric power batteries as will be hereinafter more fully described, and a forwardly positioned buffer portion 18. The operator's platform 12 is connected to the central platforms 14 and 16 by sidebars or beams 20 and 22. In a similar manner, the central portions 14 and 16 are connected to the buffer portion 18 by sidebars 24 and 26. Also, the central portions 14 and 16 are connected to each other by a transversely extending beam member 28. A draft bracket, not shown, may be affixed at the rear edge of the operator's platform 12 for connecting the motor car to mineral cars to be drawn thereby. Similarly, a draft bracket, not shown, may be affixed at the leading edge of the front buffer portion 18.

The rearward portion of the frame 10 is supported on a transversely extending axle 32 to which sidebars 20 and 22 are affixed in any one of several fashions such as welding, bolting or the like. The forward portion of the frame is pivotally supported on a front axle 34. This pivotal support is effected by mounting the front axle 34 on a sub-frame generally designated by the numeral 36. The sub-frame 36 is T-shaped to compactly fit into the space defined by the central platforms 14 and 16 and the front buffer portion 18 as well as the beam members 24,

26, and 28 of the frame 10. Flange bearings 38 and 40 are provided at the ends of the sub-frame 36 for pivotally supporting the sub-frame on a steering shaft 42 which will be more fully described hereinafter. As shown in Figure 2, the sidebars 24 and 26 of the frame 10 are provided having cut out portions 43 and 44 to permit free oscillation of the front axle 34 and the subframe 36 about the pivotal axis formed by the steering shaft 42. Thus, by mounting the front axle 34 on the sub-frame 36 and the rear axle to the side-bars 20 and 22 of the frame 10, it becomes apparent that a three point suspension of the frame is effected, which suspension is highly desirable for operating the motor car over rough ground.

At the ends of each of the axles 32 and 34 are mounted stub shafts 45, 46, 48 and 50, which in turn rotatably receive pneumatic tire and wheel assemblies 52, 54, 56 and 58. Each of the stub shafts is pivotally connected to the ends of the front and rear axles in a manner well-known to those skilled in the art to permit angular movement of the wheels mounted thereon as required for steering.

Power required to drive the wheel assemblies of the motor car is developed by electric motors 60 and 62. The motor 60 is supported on a platform 64 which in turn is welded, bolted or riveted to the inside edges of the central platforms 14 and 16. As shown in Figure 3, the motor supporting the platform 64 is set down in the recess formed by the central platforms. This mounts the motor at as low a level as possible without interfering with the other operating components of the car and keeps the overall height of the car at a minimum. Power developed by the motor 60 is transmitted through gears 66 and 67 to a differential unit 68 mounted on the rear axle 32. The differential unit transmits driving power to the wheels 52 and 54 in a manner well-known in the art. The motor 62 is similarly arranged to drive the front wheels 56 and 58 through gears 70 and 71 and the differential unit 72 except that in this instance the motor 62 is mounted on a supporting platform 73 which in turn is supported by the subframe 36 and more specifically, that portion of the sub-frame which extends between the central platforms 14 and 16. As shown in Figure 2, the sub-frame is of such height that the platform 73 may be mounted on the upper edge thereof without materially increasing the overall height of the car. Electric power for driving the motors 60 and 62 is derived from storage batteries, not shown, which may be situated on the platforms 14 and 16. Also, other equipment such as cables, speed control boxes, brakes, lights and other necessities for operating the motor car are not shown in order to more clearly show the steering mechanism, linkage and drive wheel units as well as their relative locations, which features form the subject matter of the present invention.

Referring to the steering mechanism incorporated into the motor car of this invention, the steering shaft 42 is rotatably supported at one end by a pillow block bearing 74, at its mid point by flange bearing 76 mounted on the crossbeam 28 and at the opposite end by flange bearing 78 mounted on the front buffing portion 18 of the frame 10. The bearing 74 may be bolted to a floor plate which extends between the sidebars 20 and 22 or may be supported on a bracket member extending between the sidebars without departing from the scope of this invention.

It is to be noted that since the steering shaft 42 is supported by bearings 74, 76 and 78 in the manner described, it is free to rotate about its own axis to effect steering control. Moreover, because the sub-frame 36 is supported on the steering shaft through flange bearings 38 and 40, the sub-frame is permitted to pivot about the axis of the steering shaft independently of any steering shaft rotation as may be required for steering. This arrangement enables an extremely compact assembly which is highly desirable in mineral cars of the type here involved.

For imparting a rotary actuating movement to the steering shaft, a manually operated steering wheel 80 is provided, non-rotatably secured at one end of a shaft 82, mounting a worm 83, which engages a gear segment 84, adapted to be pivoted about a vertically disposed shaft 85. Extending from the gear segment 84, and formed integral therewith, is a lever arm 86 to which an actuating link 87 is pivotally connected. The opposite end of the actuating link 87 is pivotally connected to one arm of a T-shaped crank 88, the leg of which is secured to the rear end of the steering shaft 42. One end of a drag link 89 is pivotally connected to the other arm of the T-shaped crank 88, while the other end of the drag link is pivotally connected to a lever arm 92 formed integrally on the stub shaft 46. A tie rod 94 is pivotally connected at one end to the lever arm 92 and at the other end to a lever arm 96 on the stub shaft 45. An inverted L-shaped crank is non-rotatably connected at the forward end of the steering shaft 42 and a drag link 100 is provided for connecting the crank 98 to a lever arm 102 on the stub shaft 48. A tie rod 104 extends from the lever arm 102 to a lever arm 106 on the stub shaft 50 in a manner similar to tie rod 94 at the rear end of the car.

In operation, when the steering wheel 80 is rotated manually by the operator, the lever arm 86 is caused to oscillate about its supporting shaft 85 because of the engagement of the gear segment with the worm 83. This oscillatory motion imparts a reciprocating motion in the actuating link 87 and in the drag link to move the lever 92 and correspondingly the stub shaft 46 and wheel assembly 54 angularly with respect to the axle 32. The tie rod 94 interconnecting the lever arms 92 and 96 causes an equivalent angular movement to be imparted to the stub shaft 44 and the wheel assembly 52 carried thereby. The reciprocating movement thus imparted to the actuating link 87 simultaneously causes a rotary movement in the steering shaft 42 due to the connection of the actuating link with the T-shaped crank 88 and of the crank to the steering shaft. This rotary movement of the steering shaft causes oscillation of the inverted L-shaped crank 98 at the forward end thereof which in turn causes the drag link 100 to reciprocate, carrying with it the lever arm 102 on the stub shaft 48. Like the rear wheels, the front wheels 56 and 58 are caused to move simultaneously due to the interconnection of the tie rod 104 with the lever arms 102 and 106 on the stub shafts 48 and 50 respectively. It will be noted that because the tie rods are positioned on opposite sides of their respective axles, the rotation of the steering rod results in an addition of the angular movements of the front and rear wheel assemblies to lend increased steerability to the car for corresponding angular movements of the wheels of an arrangement wherein only the front wheels are steered.

Thus, it becomes apparent that by this invention there is provided a steering mechanism particularly adapted for use in an electric motor car of the type used in the coal mining industry. The positioning of the steering shaft centrally and longitudinally of the entire body enables it to function effectively to control four wheel steering without in any manner increasing the overall dimensions of the entire structure. Moreover, this particular positioning of the steering shaft permits it to serve the additional function of supporting the sub-frame for pivotal movement of the sub-frame with respect to the main frame. Still more significant is the fact that all of the elements of the steering mechanism are positioned about the lowermost extremities of the essential working components of the motor car and thus permitting a greater under clearance than that which exists in cars of this type heretofore manufactured, while at the same time not in any way increasing the overall height of the car.

Since many possible changes may be made in this invention, and since many changes may be made in the

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embodiments hereinbefore set forth without departing from the spirit of this invention, it is to be distinctly understood that the foregoing describes preferred embodiments and that the applicant claims the benefit of a full range of equivalents within the scope of the appended claims. 5 I claim:

1. The combination of a motor car and a four wheel steering mechanism, said motor car comprising a main frame having a pair of longitudinally displaced transverse members, a sub-frame between said members, a first pair 10 of wheel supporting pivotal stub-shafts carried by said main frame, and a second pair of wheel supporting pivotal stub-shafts carried by said sub-frame at points spaced from said first pair, said steering mechanism comprising a rotatable steering shaft extending centrally, longitudinally and within the vertical extent of said frames, said steering shaft being journaled in bearings on said transverse frame members and in bearings at both ends of said sub-frame, whereby said sub-frame is pivotally supported within said main frame on said steering shaft, 20 means for rotating said steering shaft and means for translating rotational movement of said steering shaft into pivotal movement of said stub-shafts, said last mentioned means being connected to said steering shaft at spaced points corresponding generally to the spacing of said first 25

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and second stub-shaft pairs and also lying within the vertical extent of said frames.

2. The combination recited in claim 1 in which said means for rotating said steering shaft comprises a rotary steering wheel, a worm gear operably connected to said steering wheel, a gear segment engaging said worm gear, a lever arm extending from said gear segment and linkage interconnecting said lever arm and said steering shaft.

3. The combination recited in claim 1 in which said means for translating rotational movement of said steering shaft to said stub-shafts comprises crank arms fixedly secured to said steering shaft, drag links interconnecting said crank arms to said stub-shafts and tie rods extending transversely of said frame and interconnecting the stub-shafts in each of said stub-shaft pairs. 15

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