W. C. MAYO.

CONTROLLING SYSTEM FOR MOTOR TRACTION CARS.

APPLICATION FILED NOV. 3, 1908.

1,022,324.

Patented Apr. 2, 1912.

3 SHEETS—SHEET 1.

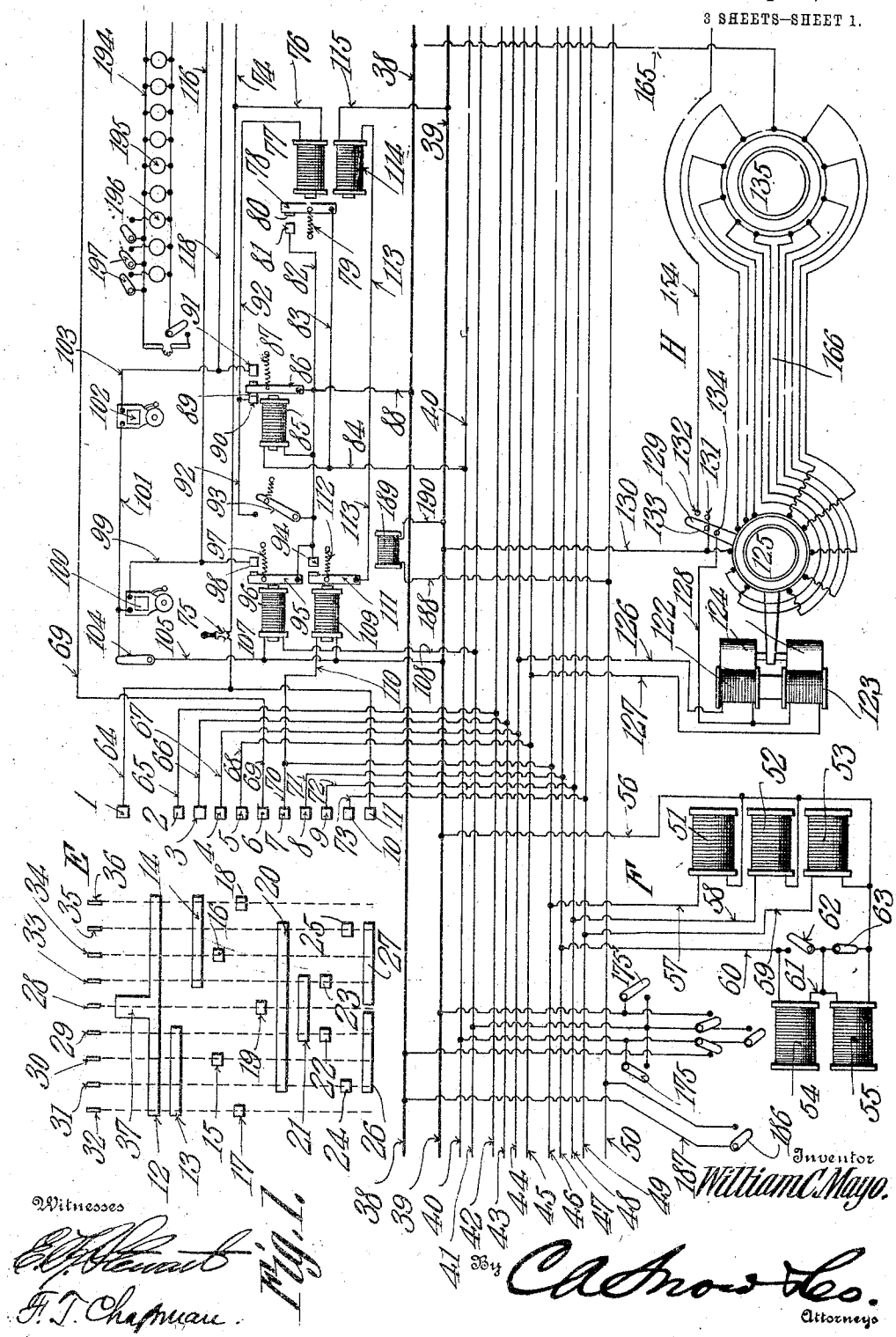

Fig. 1.

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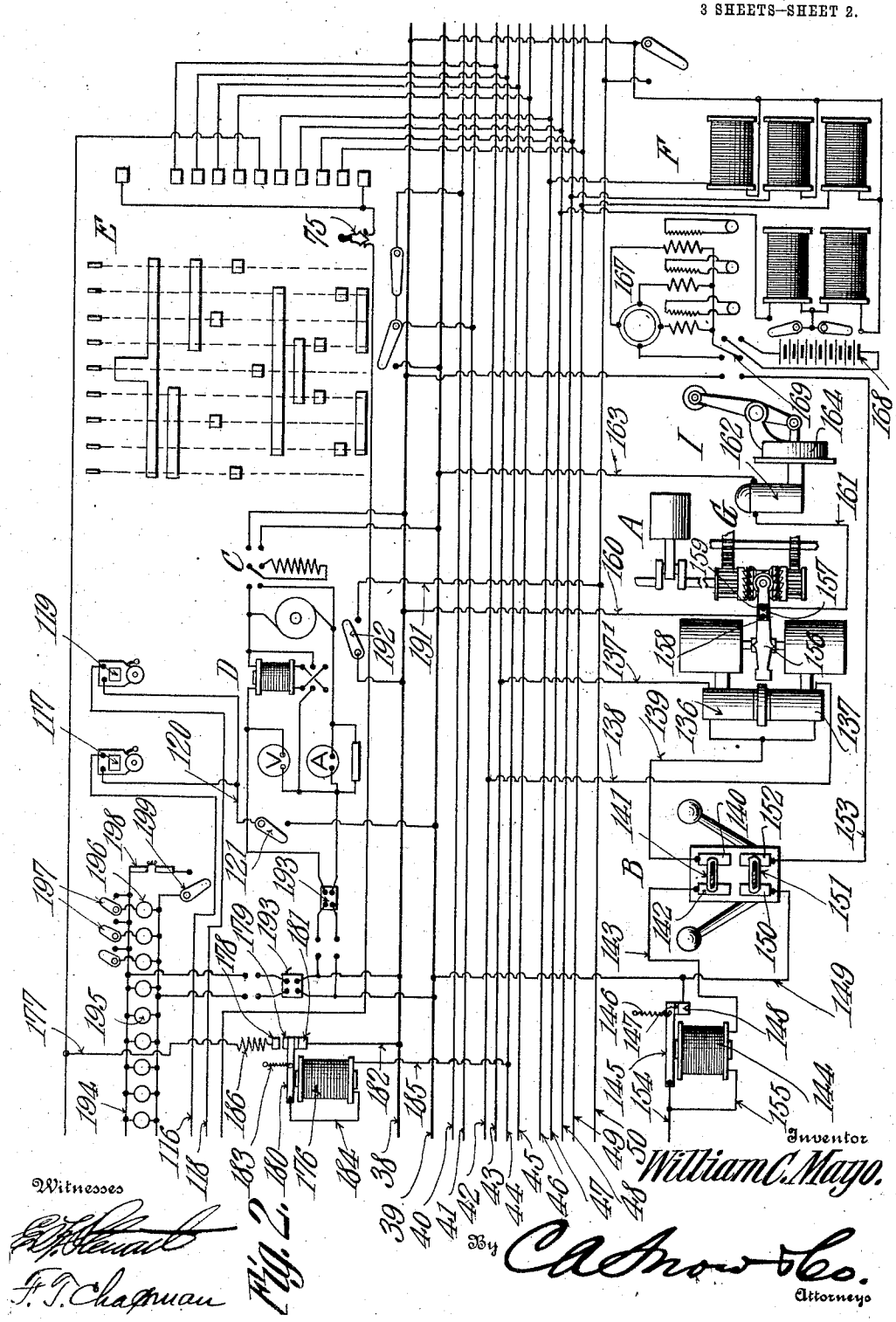

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Fig. 2.

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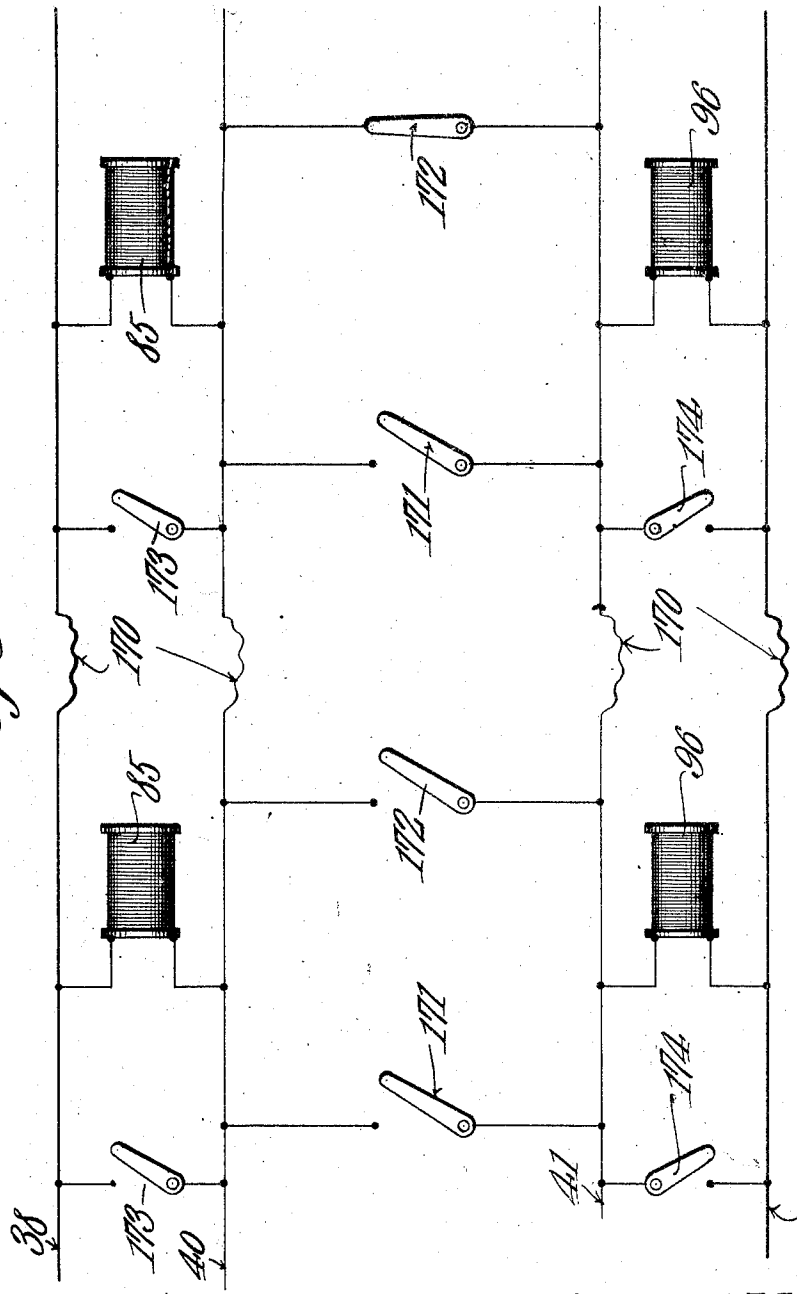
3 SHEETS—SHEET 3.

Fig. 3.



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UNITED STATES PATENT OFFICE.

WILLIAM C. MAYO, OF EL PASO, TEXAS, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, OF ONE-THIRD TO GEORGE E. BRIGGS, OF BARSTOW, TEXAS, AND ONE-THIRD TO JOHN HOULEHAN, OF EL PASO, TEXAS.

CONTROLLING SYSTEM FOR MOTOR-TRACTION CARS.

1,022,324. Specification of Letters Patent. Patented Apr. 2, 1912.

Original application filed February 24, 1908, Serial No. 417,431. Divided and this application filed November 3, 1908. Serial No. 460,828.

To all whom it may concern:

Be it known that I, WILLIAM C. MAYO, a citizen of the United States, residing at El Paso, in the county of El Paso and State of Texas, have invented a new and useful Controlling System for Motor-Traction Cars, of which the following is a specification.

This invention has reference to improvements in controlling systems for motor traction cars and its object is to provide a complete system of control which is in a great measure automatic and outside the volition of the motorman.

In the system to which this invention relates each power car, even when a number of such cars are coupled together to form a train, is provided with a prime mover. For reasons which need not be entered into here, such prime mover is preferably a multi-cylinder explosive engine and since the system contemplates the use of cars for city, suburban, and interstate traffic, such prime movers are of heavy construction and are designed to propel the car at high speed, say 80 or 90, or more miles per hour.

In the practical embodiment of the invention the engine may be provided with as many as or more than twelve power cylinders. Such engine is maintained in constant operation and is coupled to an electric generator through a suitable regulating device which maintains the voltage substantially constant. The regulator in itself forms the subject matter of Letters Patent No. 896,738, granted August 25, 1908, on an application filed by myself and John Houlehan, under the title of regulators for dynamo electric machines, and therefore it need not be particularly described herein.

The generator employed is preferably a direct current dynamo, and is utilized to supply current for all the purposes needed, as will hereinafter appear, and for this reason it must be maintained in constant operation, and, of course, the engine driving it is likewise maintained in constant operation.

To properly regulate the engine under the great variations of load incident to the operation of a car, there is provided an engine governor capable of taking care of these great variations in load without material variations in the speed of the engine. For economical reasons the governor is so designed as to regulate the speed by cutting in and out the individual engine cylinders or groups of engine cylinders in accordance with variations in load, without governing the charge of the individual cylinders, and the governor likewise controls certain other mechanisms which will be referred to later on. The structure of the governor however, forms no part of the present invention and constitutes the subject matter of Letters Patent No. 920,074, granted April 27, 1909, on an application filed by myself and John Houlehan under the title of governor for explosive engines.

In order that the car may be started and stopped and also regulated at different speed, there is provided a speed changing gear, the special construction of which is not a part of the present invention, but forms the subject matter of Letters Patent No. 901,980, granted October 27, 1908, on an application filed by myself and John Houlehan under the title of speed changing gear.

Connected with the speed changing gear is a positive clutch capable of connecting the gear up to the axles of the car in either the forward or the reverse direction, and another clutch is provided, constructed to act both as a friction clutch and as a positive clutch under circumstances which will be referred to hereinafter, though the structure of each of these clutches forms in itself no part of the present invention. Furthermore, the cars are each provided with electrically controlled air brake systems receiving current, when necessary, from the generator before referred to. Such an electrically operated air brake system does not in itself form a part of the present invention, but constitutes the subject matter of Letters Patent No. 897,218, granted August 25, 1908 on an application filed by me under the title of electrically operated air brake system, and will be referred to only to the extent necessary for the understanding of the present invention.

Included in the general control system of the cars are various signals, lights, and other devices which will be described in their proper place.

It is a feature of the present invention that all the several mechanisms necessary for the proper running of the car are, to a large extent, automatic in their operations, except that they may be controlled by a motorman or engineman from one point of control in a certain prescribed way, and no other, the purpose being to constrain the motorman to follow the proper procedure under the penalty of having the car or train slow down, or even come to a full stop, when such is neither intended nor desirable.

The present invention includes a controller by means of which the motorman may control the running of the car provided a prescribed course of movement of the controller be strictly followed. By suitably operating the controller the car may be started and brought up to any desired speed within the limits of the power, and maintained at such speed if so desired, and the speed if less than the maximum, may be raised or lowered at the will of the motorman, and any of the speeds may be maintained indefinitely. Furthermore, the car may be run in a reverse direction with the same facility of control by the proper manipulation of the same controller handle used to run it in the forward direction. Again, the car may be stopped by cutting off the power by moving the controller handle to a certain prescribed position, and then by further moving the handle in the same progressive direction the brakes may be applied in the same manner, generally considered, as the ordinary air brakes of steam roads are manipulated.

The controller structure itself forms no part of the present invention, but is fully shown and described in Letters Patent No. 902,985, granted November 3, 1908, on an application filed by me, of which application the present application is a division.

The present invention includes a signal system whereby communication may be had between the driver or motorman, and the conductor by a predetermined code of signals, and this signal system is further provided with means whereby the conductor or other properly authorized person may bring the train to a standstill irrespective of the motorman. These circuits are so arranged that should the conductor desire to stop the train independent of the motorman, as might be the case should an accident occur of which the motorman is not aware, or should the train break in two, then the emergency brakes will be applied by the conductor or will automatically be applied in the case of a break in the continuity of the train, while suitable audible signals will be employed for apprising the motorman of the condition of affairs. In case the train breaks in two provision is made for apprising the motorman of the fact by a signal different from that of the regular intelligence signal, and the emergency signal when the conductor purposely applies the emergency brakes. Provision is also made whereby the cutting in of the emergency brakes, whether under the volition of the conductor or through the accidental breaking in two of the train will at the same time throw out the power so that the mechanism of the car or train is not subjected to undue strain. The various operations, together with the advantages resulting from the signal circuit, will be fully set forth hereinafter.

The invention will be best understood from a consideration of the following detail description taken in connection with the accompanying drawings forming a part of this specification, in which drawings,

Figures 1 and 2 taken together illustrate, diagrammatically the electrical connections of a single car, showing generally the system of control and also the signal and lighting circuits. Fig. 3 is a diagram of a portion of the signal circuit extending through a train.

Referring to the drawings, Figs. 1 and 2 may be taken together as showing the system of control of a single power car. In the present system each car is a unit, and each car is capable of being coupled up to another car of like nature so that two or more power cars may be united to form a train. If trailers be used, power both mechanical and electrical will be furnished by the power cars, but it will be understood that each trailer may be provided with suitable brakes to be controlled by an electric system of control such as set forth in my aforesaid Letters Patent, No. 897,218.

Each power car is provided with a prime mover A, only diagrammatically indicated in Fig. 2, but which is to be understood as a prime mover of ample power for the purposes of the invention. Because it is desirable that each car should be a complete unit in itself, and also because of the advantages of such an engine, the system contemplates, but of course is not confined to, the use of an explosive engine of the multi-cylinder type. Because of the track conditions to be met in actual practice, and the high speed it is designed to use especially in long distance traffic, the engine employed may have as many as twelve cylinders or even more if found desirable. The cylinders may be controlled singly or in pairs or otherwise as found most desirable and for this purpose there is provided a governor B which however is only indicated diagrammatically in the drawings, but which is fully shown and described in the aforesaid Letters Patent No. 920,074.

While not strictly material to the present invention it may be stated that it is desir-

able that the governor should be inactive to a minimum number of engine cylinders but should be active to the remainder of the engine cylinders by and in accordance with variations in load put upon the car. It is designed that the prime mover should be continuously operating so long as the car is in service, and for this the governor is made inactive to a minimum number of engine cylinders.

The purpose of providing continuous power upon the car whether the latter be running or not is to insure the generation of electric current for various operations. Each car is provided with a suitable electric generator in the form of a dynamo C preferably of the direct current type, and in order that the voltage of the dynamo may be substantially constant, there is provided a suitable regulator D such as set forth in the aforesaid Letters Patent, No. 896,738. The dynamo and regulator are only diagrammatically represented in Fig. 2.

Each power car is provided at each end with a suitable controller E, the detail construction of which is shown and described in my aforesaid Letters Patent, No. 902,985 of which this application is a division. The circuit connections of the controller will be more particularly set forth hereinafter. Each power car is also provided with a suitable air brake system which however is only shown in this application in so far as the electrical connections are concerned, and these include electromagnetic means indicated at F for the control of the air brake valves, and are to be taken as indicative of the structure set forth in the aforesaid Letters Patent, No. 897,218. For reasons which need not be particularly entered into here, it is preferred that each car be provided with two air brake systems since the cars, having long bodies, are mounted upon distinct trucks at each end, and each truck is provided with its individual air brake system, individually controlled by the electrically operated controlling means. Each car is also provided with a speed changing and reversing gear G, which however is only indicated in Fig. 2 without any attempt to show its actual structure, the said speed changing gear being fully shown and described in the aforesaid Letters Patent, No. 901,980. The speed changing gear is electrically operated, and the electrical connections are schematically shown at H.

At a suitable point between the power unit and the car wheels there is provided a combined friction and positive clutch, the electrical portions of which are indicated diagrammatically at I, and the details of this clutch are fully shown and described, in the aforesaid Letters Patent No. 901,980, for speed changing gear.

In each controller E there is a series of contact terminals numbered in the drawings 1 to 11 both inclusive, this number being subject to change if under some circumstances it be found advisable to add to or subtract from the parts to be controlled. The movable parts of the controller, that is the movable contacts of the controller, are shown in the drawings as displayed and are numbered from 12 to 27 respectively, and since it is preferable though not imperative that the parts 12 to 27 be movable while the terminals 1 to 11 be stationary, the said parts 1 to 11 may be termed brushes or terminals and the parts 12 to 27 may be termed contact segments or contactors in order to facilitate the description.

In practice the several contactors or segments 12 to 27 are mounted upon a shaft within a suitable casing and this shaft is designed to have a rotative movement through an arc of about 180° more or less, and furthermore, the several segments are assumed to be in electrical connection with the said shaft in such manner that the several segments are in electrical connection one with the other. By suitable mechanisms such as described in the aforesaid Letters Patent No. 902,985, of which this is a division, or by any other suitable mechanism, the controller may be moved to any one of a number of positions, and these positions are indicated in the drawings of this application by the solid and dotted lines designated by the numerals 28 to 36 both inclusive.

The brushes 1 to 11 both inclusive, are each of sufficient size to carry the required current safely, but none of them is wide enough to bridge the distance between two steps of the controller. The segment 12 of the controller is of sufficient length to remain in contact with a circuit terminal, say the brush 1, throughout the entire range of movement of the controller about the axis of its shaft, and at a central point the segment 12 has an extension 37 of such length that the said segment may, when the controller is in the central position, have a vertical movement without disconnecting it from the brush 1, although the same vertical movement would disconnect the segment or contactor 12 from the said brush 1 when the controller handle is in any other than the central position. The purpose of this will appear hereinafter. The segment 13 is of such length as to make contact with the brush 2 when the controller is in the positions 29, 30, 31 and 32, and the segment 14 which is on the opposite side of the median line from that occupied by the segment 13 will make contact with the brush 3 when the controller is in the positions 33, 34, 35 and 36. The segment 15 is of such size as to contact with the brush 4 only when the controller is in the position 30, and the segment

16 is of such size as to make contact with the brush 4 only when the controller is in the position 34. The segments 17 and 18 will make contact with the brush 5 only when the controller is in the positions 32 and 36 respectively, and the segment 19 will make contact with the brush 6 only when the controller is in the position 28 which is the median position. The segment 20 is of such length as to make contact with the brush 7 when the controller is in the positions 28, 29, 30, 31, 33, 34 and 35. The segment 21 will make contact with the brush 8 when the controller is in the positions 28, 29 and 33. The segments 22 and 23 will make contact with the brush 9 only when the controller is in the positions 29 and 33 respectively, and the segments 24 and 25 will likewise make contact with the brush 10 only when the controller is in the positions 31 and 35 respectively, and finally the segments 26 and 27 are of such length with relation to the brush 11 that the segment 26 will make contact with the said brush in the controller positions 29, 30 and 31 only, and the segment 27 will make contact with the said brush 11 only when the controller is in the positions 33, 34 and 35.

Running through the length of the car are two main line conductors 38 and 39 receiving current from the dynamo C, and also running through the length of the car are other conductors 40 and 41 constituting signal conductors. There are also two other conductors 42 and 43 for the reversing clutch and two conductors 44 and 45 for the speed changing gear. There are also four conductors 46, 47, 48 and 49 which constitute the brake controlling conductors and finally there is another conductor 50 for the whistle, it being understood that it is desirable to provide each car with a whistle which may be blown by air taken from the air brake system, or by the exhaust of the engine the said whistle being used for warning or signal purposes in the same manner that a steam whistle is used upon a steam locomotive. In practice all these several conductors extend through the length of the car and are collected in a bundle or cable and may be thoroughly insulated and protected. Alto ther they occupy but little room. At each end the cable of conductors is provided with suitable coupling means of the usual kind, which however are not shown in the drawings, so that the main or supply conductors and the other conductors which may be termed the train conductors may be made continuous throughout the length of the train.

While the car is assumed to be provided with air brakes, the present invention has to do only with the electrical side of the triple valve, and this only is shown in the drawings. In this triple valve there is a controlling solenoid 51 for the emergency application of the brakes, another solenoid 52 for the slow release, another solenoid 53 for service application, another solenoid 54 for the ordinary release of the brakes, and still another solenoid 55 for the release of the brakes under the action of straight air, since the triple valve is adapted for either automatic or straight air or the systems in common use. One side of each solenoid is connected by a branch conductor 56 through the dynamo main 39. The other side of the emergency solenoid 51 is connected by a conductor 57 to the train conductor 46, the solenoid 52 is connected to the conductor 48 by a conductor 58, and the service solenoid 53 is connected to the conductor 49 by a branch conductor 59. The ordinary release solenoid 54 is connected to the conductor 47 by a branch conductor 60, and this solenoid 54 is connected in series with the solenoids 55 at corresponding ends by a conductor 61. By means of shunt switches 62 and 63 and appropriate conductors, the solenoid 54 may either be connected up between the conductor 47 and the conductor 39 or the solenoid 55 may be so connected up with the solenoid 54 cut out of the circuit by the shunt switch.

Referring again to the controller terminals it will be observed that the terminal 1 and the terminal 11 are connected together by a conductor 64. The terminal 2 is connected by a conductor 65 to the conductor 42 leading to one of the reversing clutches, the terminal 3 is connected by a conductor 66 to the conductor 43 leading to the other reversing clutch conductor, the terminal 4 is connected by a conductor 67 to one of the speed changing gear conductors which in this instance is the conductor 44, while the next terminal 5 is connected by a conductor 68 to the other speed changing gear conductor 45. The terminal 6 is connected by a conductor 69 to the corresponding terminal 6 of the other controller at the other end of the car. The terminal 7 is connected by a conductor 70 to the conductor 46 constituting one of the train brake conductors, the terminal 8 is connected by a conductor 71 to the brake conductor 47, the terminal 9 is connected by a conductor 72 to the brake conductor 48 and the terminal 10 is connected by a conductor 73 to the brake conductor 49. The conductors 64 connect the end terminals 1 and 11 together, and both controllers are connected together by a conductor 74 extending between the two controllers. The continuity of the conductor 74 is broken at any appropriate point and the terminals at this break are normally closed by a suitable bridging plug 75. As will appear from a consideration of the aforesaid Letters Patent No. 902,985, of which the present application is a division, it will be seen that the plug 75 is contained

within the controller structure at each end of the car, so that under proper conditions the circuit may be there broken by the removal of the plug, which will result in putting the whole system out of commission, as for instance, when the car is not used. It may be stated that in practice this plug is under the control of a lock and is accessible only to authorized persons. Branched off from the conductor 74 is another conductor 76 leading to one side of the magnet or solenoid 77 controlling an armature 78 in opposition to a spring 79, and this armature 78 is provided with a contact 80 in the path of which is another contact 81, constituting the terminal of a conductor 82. The armature 78 is connected by a branch conductor 83 to another branch conductor 84 which in turn is connected to one of the signal train conductors 40. The conductor 84 is connected at its other end to a magnet or solenoid 85, the other terminal of which magnet is connected to the conductor 82. The magnet 85 controls an armature 86 in opposition to a spring 87, and this armature 86 is connected by a conductor 88 to the dynamo main 38. The free end of the armature 86 carries a contact 89 in the path of which are oppositely disposed contacts 90 and 91. The contact 90 is connected to a conductor 92 leading from the magnet 77, and ultimately connected to the conductor 82 through a switch 93. The conductor 82 leads to a terminal 94 and also to an armature 95 controlled by a magnet 96 in opposition to a spring 97, and, in the path of the armature 95 is a contact 98 at one end of a conductor 99 leading to one side of an electric bell 100, the other side of which is connected to a conductor 101, one end of which latter is, in turn, connected to one side of an electric bell 102, and the other side of this bell is connected by a conductor 103 to the contact 91 before mentioned.

The conductor 101 is connected to a switch 104 which, in turn, is connected by a conductor 105 to the dynamo main 39, and branched off from this conductor 105 is another conductor 107 leading to one side of the magnet 96, the other side of which is connected by a conductor 108 to the signal wire or conductor 41. Also connected to the conductor 105 is a magnet 109, the other side of which latter is coupled to the conductor 70 by a conductor 110. Under the influence of the magnet 109 is an armature 111, controlled in opposition to the magnet, by a spring 112, by which the armature is drawn into contact with the terminal 94 when the magnet is deënergized. The armature 111 is connected by a conductor 113 to another magnet 114 which, in turn, is coupled by a conductor 115 to the dynamo main 39. Branched off from the conductor 99 is another conductor 116 leading to one side of a bell 117 at the end of the car remote from the bell 100, and branched off from the conductor 103 is another conductor 118 leading to one side of a bell 119 adjacent to the bell 117. The other sides of the two bells 117 and 119 are connected in multiple to a conductor 120 leading to the dynamo main 39 through a switch 121.

In the aforesaid Letters Patent No. 901,980, for speed changing gear, there is set forth a structure whereby the speed of translation between the prime mover and the car wheels will automatically increase or decrease as long as certain circuits are maintained, and which cease to either increase or decrease under certain other conditions. In this speed changing gear, there are two solenoids 122 and 123 controlling an air-impelled mechanism 124 arranged to put a rotary switch 125 into and out of action, and to cause it to move in either direction. The solenoid 122 is connected by a conductor 126 with the conductor 44 and the solenoid 123 is connected by a conductor 127 with the conductor 45. The other sides of each solenoid 122 and 123 are connected together and by a conductor 128 to an arm 129 carried by the switch 125, but normally not moving therewith. Current is supplied to the switch 125 through a conductor 130 coming from the dynamo main 39 and this conductor 130 is branched to a contact 131 adjacent to which is another contact 132. There is also in the branch leading to the contact 131 another contact 133 adjacent to a contact 134 to which the conductor 128 leads, and these two contacts 133 and 134 are normally bridged by the arm 129. As has been explained in the aforesaid Letters Patent No. 901,980, this arm 129 is movable for a very limited distance at the end of the travel of the switch arm in either direction to break the circuit between the contacts 133 and 134, and thus deënergize the solenoids 122 and 123 automatically. The switch 125 is coupled up to the speed changing gear which is only conventionally shown at 135, so that as the switch is moved around over its several contacts, the transmission of speed from the prime mover to the car axles is progressively increased or decreased, as the case may be, and this increase or decrease is progressive and automatic at all times.

In connection with the speed changing gear there is the reversing clutch mechanism G conventionally shown in Fig. 2. This clutch is also shown in detail and fully described in the aforesaid Letters Patent No. 901,980. It is only necessary to state herein that this clutch is designed to couple up the speed gear to the car axles to cause them to turn in either direction. This clutch is controlled by two solenoids 136 and 137, the solenoid 136 being connected to the conductor 43 by a conductor 137', and the

solenoid 137 being connected to the conductor 42 by a conductor 138, the other sides of the solenoids 136 and 137 being connected in common to a conductor 139 leading to a terminal 140 under the control of the governor B for the prime mover, which governor is, as before stated, shown in detail and fully described in the aforesaid Letters Patent No. 920,074. Since this governor forms no part of the present invention in so far as its detail construction is concerned, it is only conventionally shown in the drawings, and its operation will be referred to only in so far as may be necessary. The governor controls a bridging conductor 141 in operative relation to the terminal 140, and another terminal 142, which latter is connected by a conductor 143 to one side of a magnet or solenoid 144. This magnet 144 has an armature 145 provided with a spring 146 acting against the pull of the magnet, and the armature also carries a contact 147 in the path of which is another contact 148 connected by a conductor 149 to the dynamo lead or main 39. The conductor 149 is also connected to a terminal 150 under the control of a bridging conductor 151 carried by the governor, and coupling this terminal 150 normally to another terminal 152 coupled to a conductor 153. The purpose of this last conductor 153 will appear later.

The armature 145 is connected by a conductor 154 to the terminal 132 before referred to, and the other side of the magnet 144 from that connected to the conductor 143 is connected by a branch conductor 155 to the conductor 154. An operating arm 156 of the speed changing and reversing gear G carries a bridging conductor 157 arranged to close the circuit between two circuit terminals 158 and 159, the terminal 158 being connected by a conductor 160 to the dynamo main 38, and the terminal 159 being connected by a conductor 161 to a solenoid 162 which, in turn, is connected by a conductor 163 to the dynamo main 39. The solenoid 162 controls the clutch uncoupling mechanism 164 also fully shown and described in the aforesaid Letters Patent No. 901,980. It may be here stated with relation to the structure illustrated at I, that the clutch controlled thereby is interposed between the prime mover and the speed changing gear, and is of a type operating frictionally up to a certain predetermined speed, and then coupling the parts positively, all as fully shown and described in the said Letters Patent No. 901,980.

In considering the operation of the system as thus far described, it is to be understood that the construction of the controller, as set forth in the aforesaid Letters Patent No. 902,985, is such that the group of controller switch or contact segments 13 to 19 both inclusive, is movable by the controller handle only when the latter is pressed by a downward force exerted by the hand of the motorman, the said handle being constructed to have a limited vertical movement, and being capable of rotation about a vertical axis at either extreme of its limited vertical movement.

The controller segments 20 to 27 both inclusive, are movable under the action of the controller handle when the latter is at the upper extreme of its vertical movement. Furthermore it is to be understood that the vertical movement of the controller handle is only possible when all the controller segments are in the central or median position, and either group of segments can only be operated by the controller handle when the latter is in one extreme or the other of its vertical movement. The segment 12 is rotatable with the controller handle at either extreme of its vertical movement.

Now let it be assumed that the engine and dynamo are running but that the car is standing still, and let it further be assumed that the plug or plugs 75 are in position to complete the circuit through the conductor 74. Furthermore it will be assumed that the controllers are in the central position, and the motorman has not yet grasped the controller handle. With the controller lever or handle in the central position, there is established a circuit between the dynamo main 39 and the dynamo main 38 by way of the conductor 56, emergency solenoid 51 and conductor 57, release solenoid 54, and conductor 60, to the respective train conductors 46 and 47 and by the conductors 70 and 71 to the controller contact or switch segments 20 and 21, thence through the controller drums, which latter are not shown in the drawings but are assumed to be present, to the segment 12 and by way of this segment to the conductor 64, thence through the conductors 74 and 76, magnet 77, conductor 92, armature 86, to the other dynamo main 38, the magnet 85, which constitutes the emergency signal relay magnet, being normally charged. With the parts in the position described, the engine and dynamo are running and the brakes are in full release position, but the car is standing still or its axles are uncoupled from the driving power. Let it be assumed that the motorman desires to apply power to drive the car in the forward direction. To do this he grasps the controller handle and presses down upon the same so as to couple the upper group of segments 13 to 19 to the controller handle. Under these conditions if the controller handle or lever be moved laterally then the several contact segments at this time connected thereto will participate in the movement. The downward movement of the controller lever or handle has caused the elevation of the contact segment 12 until it is coincident

with the controller terminal 1, and since the length of the contact segment 12 is sufficient, it remains in contact with the terminal 1 throughout the entire sweep of the controller handle in either direction from the median line.

The motorman moves the controller handle in a direction to bring the contact segment 13 into engagement with the terminal 2, it being understood that the terminals are in the median line 28. The movement of the controller lever has been sufficient to advance the contactors or segments one step so that the relative position of the upper series of segments and of the fixed brushes or terminals of the controller is as though the fixed brushes had been moved to the position of the line 29. A circuit is then completed through the conductor 65 to the train conductor 42 thence to the solenoid 137 of the clutch mechanism G, and by the conductor 139 to the governor B, bridging conductor 141 and conductor 143, to the solenoid 144, thence by way of conductor 155 to the conductor 154 and to the contact 132. This last named contact and the contact 131 are under the conditions assumed now bridged by the arm 129, so that the circuit is completed through the conductor 130 back to the dynamo main 39. The solenoid or magnet 144 is thus energized and the armature 145 is drawn toward it so that another circuit through the contacts 147, 148 and the conductor 149 is completed to the dynamo main 39, and the solenoid or magnet 144 is thus maintained energized after the circuit between the contacts 131 and 132 is broken. The solenoid 123 moves the clutch into a position to couple up the speed changing gear for forward movement of the car. But the speed changing gear is not yet in mesh. This mechanism which is fully set forth in the aforesaid Letters Patent No. 901,980, is so arranged that the speed may be progressively raised or lowered by throwing into mesh different sets of gear teeth with pinions coupled to the clutch. Now the motorman moves the controller handle or lever until the fixed brushes of the controller and the movable segments then actuated by the controller handle have the relative position of the line 32. There is then established a circuit by way of the contact segment 17, to the terminal 5 and conductor 68, then to the conductor 45, and by way of conductor 127 to the solenoid 123, thence by conductor 128 to the arm 129, and by way of the contact 131 with which this arm is at this instant connected, to the conductor 130 to the dynamo main 39.

The solenoid 123 couples up the switch 125 of the speed changing gear to a moving part actuated by the engine in such manner that this switch is caused to make progressive contact with the series of conductors leading to the speed changing gear 135 so as to progressively protrude and retract series of gear teeth at suitable time intervals to cause the speed of the car to be increased progressively so long as the electrical contacts just described are maintained except that as soon as the switch 125 begins its movement the arm 129 has a slight movement sufficient to disconnect it from the contacts 131 and 132, and complete the circuit to the other contacts 133 and 134. The circuit through the electrical side of the speed changing gear mechanism indicated at 135 is from one dynamo main 38 through a conductor 165 to the speed changing gear 135, thence by one after the other of the conductors 166 connecting the switch and speed changing gear electro-mechanical parts, and back to the dynamo main 39 through the conductor 130. So long as the controller lever is in position where the connections correspond to the line 32, then the speed constantly picks up until ultimately the maximum speed may be reached, which in practice may be 80 or 90 miles per hour, or a higher speed as may be desired. When this speed is reached there is provision for the breaking of the circuit between the contacts 133 and 134 so that the solenoid 123 will be deenergized and further progressive movement of the switch is stopped automatically. This is all set forth in the aforesaid Letters Patent No. 901,980.

Suppose that the motorman desires to run his car at a speed below the maximum, then when the desired intermediate speed is attained he moves the controller lever or handle to a position where the controller terminals and the segments agree to the line 31, thus breaking the circuit through the solenoid 123 and stopping the movement of the switch 125 so that the speed changing gear remains in the position then attained, and the car will run indefinitely at that speed, or at a speed commensurate with the power supplied at that position of the speed changing gear.

Let it be assumed now that after having caused the car to run at some desired speed, the motorman desires to lower the speed, then he moves the controller lever or handle where the contact terminals and segments will agree to the line 30 thus bringing the contact segment 15 into engagement with the terminal 4 and the conductor 67, which is connected to the train conductor 44, and this in turn is connected by the conductor 126 to the solenoid 122 and the circuit is completed to the conductor 128, contacts 133 and 134, and conductor 130 back to the dynamo main 39, as before. Now the switch 125 is coupled up in the reverse direction and the speed changing gear is progressively actuated to lower the speed until a desired lower speed is attained, when by moving the controller

arm or lever back into the position where the segments and terminals agree with the line 31, this lower speed may be maintained.

Suppose now that the motorman wishes to stop the car, as for instance on the approach to a regular stop or station, then he moves the controller where the segments and terminals agree to the line 30, and beyond that position to the median position 28 which will disconnect the clutch and leaving the train moving under its own momentum. After having brought the controller to the median position, the car may be slowed up and stopped by first relieving the controller handle of the pressure of the hand of the motorman, so that the lever or handle moves to its upper limit of vertical travel, thus coupling the lower set of contacts to said lever, all as set forth in the aforesaid Letters Patent No. 902,985. The controller is now in position for applying the brakes, for the purpose assuming that the application of brakes is to be an ordinary service application, then the controller lever is moved in a direction so that the relative position of the controller terminals and segments is that of the line 35. Under these conditions, the emergency solenoid 51 is still energized through the segment 20, and conductor 70, and the service solenoid 53 is energized through the segment 25 and conductor 73 to the train conductor 49, to which this solenoid is connected, the return being through the common return conductor 56. The controller lever is held in this position for a sufficient length of time to produce the service reduction of pressure desired, whether the same be light or heavy, and when this is accomplished then the controller lever is moved so as to bring the terminals and contact segments into the relative position indicated by the line 34, which is the position of lap. When it is desired to again release the brakes the controller lever is brought back to the central position, or if it be desired to slowly release the brakes, then the controller is brought to the position where the contact terminals and segments will correspond to the line 33, thus bringing the contact segment 23 into connection with the conductor 72 which in turn is connected to the train conductor 48 and the latter is connected to the solenoid 52 by means of which the slow release of the brakes is effected, as fully set forth in the aforesaid Patent No. 897,218.

It is to be observed that the movement of the controller lever from the position of full speed to the brake position is in one progressive direction so that the motorman has not to change the direction of movement if he desires to slow down and stop. Also it will be observed that the various positions already described are duplicated so that for running in a reverse direction the motorman has but to proceed with the controller in the manner already described, but in a direction opposite to that assumed. When this is done the clutch solenoid 136 is energized instead of the solenoid 137, but the several other operations are the same as before. The solenoid 136 is energized through the segment 14 and its connections.

When the motorman desires to make an emergency application of the brakes he may slow down as before and by moving the controller to position 36, the emergency solenoid is cut out of the circuit and the brakes are applied in the manner fully set forth in the aforesaid Letters Patent No. 897,218, since in the triple forming in part the subject matter of the said Letters Patent the emergency application of the brakes is due to the de-energization of the emergency solenoid. If it be further presumed that the car is running and that for any reason the motorman should release the pressure on the controller lever, whether from illness or death or fright, or negligence, then the segment 12 will be lowered out of contact with the terminal 1 connected to the conductor 64 and the circuits through the car controlling mechanisms are then all broken so that the prime mover is disconnected from the car axles and the emergency solenoid is de-energized. There is at once an emergency application of the brakes and the car is automatically brought to a standstill in the least possible space of time. This emergency application of the brakes, is in the complete system of which this present application for patent forms a part, supplemented by an automatically operating track brake tending to materially shorten the time necessary for the stopping of the car when the brakes are applied under emergency conditions. When the controller handle is released from the central position, then the circuit is maintained through the projection 37 of the segment 12, since the automatic application of the brakes due to the disability or neglect of the motorman is effective only when the car is running.

Should the motorman become careless or attempt to jockey with his controller then provision is made whereby the circuit is automatically broken by the governor mechanism, as fully set forth in Letters Patent No. 920,074 before referred to, the construction being such that a motorman must bring the speed gear to the lowest point before he can again couple up the car to the prime mover, and this is also true in the case of the emergency application of the brakes while the car is coupled up for running. Should an emergency condition arise when the car is going at either full speed or some less speed, but still coupled up to the prime mover, then the motorman has but to release

the controller handle and the full emergency application will be brought about automatically so that whether the motorman sticks to his post or whether he becomes panic-stricken and jumps, the emergency application of the brakes will be made in either instance.

It is to be noted that the air brake mechanism is provided for each end of the car. This avoids the use of train pipes, except where used in connection with the usual brake systems, and is supplemented by the use of air brake cylinders on each track, thus avoiding the use of brake rigging.

The controller mechanism is of course duplicated at each end of the car. By carrying the train conductors through all the cars of the train and having these cars provided with the several mechanisms described, a single controller on the head car may be made to control all the cars simultaneously.

The invention contemplates the use of a prime mover upon each power car with a current generator on each car and a speed controlling mechanism as well as a brake mechanism, so that each car is a unit in itself but may have its electrical connections coupled up to the controller of the head car so that all these several mechanisms work in unison under the control of one motorman.

Each dynamo on each car is provided with a suitable regulator and is driven by a suitable prime mover as described; it is not deemed necessary however, to describe the generator circuits in detail since they are fully described in Letters Patent No. 896,738 for the Regulator, but it may be stated that these circuits are so arranged that the dynamos of the several cars may be connected up for action in unison and the current will be maintained at a substantially constant voltage by the regulators.

As set forth in Letters Patent No. 920,074, the governor is arranged to cut out the sparking circuit of a certain number of engine cylinders when the speed for any reason exceeds a certain predetermined limit. These sparking circuits are indicated generally at 167 while a battery 168 may be used for the purpose of initially starting the engine through a suitable switch 169 so that after the engine has been started, the battery may be switched out and the dynamo circuit switched in to maintain the engine in operation and to save the battery.

Before proceeding with the description of the signal and lighting circuits it will be observed that the contact segments 26 and 27 serve to maintain the controller circuit through the conductor 64 on the brake side of the controller as soon as the extension 37 of the segment 12 has been moved out of contact with the corresponding terminal 1 so that the main circuit is not broken in the brake position except in the emergency position. When the brake side of the controller is in the central position then these contact segments 26 or 27 no longer make contact with the particular brush 11 in their path so that the circuit through the conductor 64 may be broken at the contact segment 12 when the latter is in the car controlled position should the pressure of the motorman's hand upon the controller handle be released. All this has been set forth in detail in Letters Patent No. 902,985.

In Fig. 3, is shown a diagram of the signal circuits, and this figure may be taken in connection with Figs. 1 and 2. There is shown the two dynamo leads 38 and 39 and two signal conductors 40 and 41. There is also shown emergency signal relays 85 and the regular signal relays 96. In the diagram Fig. 3 two cars so equipped are shown and line wire couplings 170 are conventionally indicated as being located between the cars. It will be understood that any number of cars may be used. Each car is provided with an end switch 171 at one end and another end switch 172 at the other end to couple the corresponding ends of the signal wires 40 and 41. The end switch 172 in the rear end of the last car is always closed in the regular running of the train. Under these conditions the emergency signal relay 85 is coupled on one side to the dynamo lead 38 and on the other side to the signal wire 40 while the regular signal relay is coupled on one side to the dynamo lead 39 and on the other side to the signal wire 41 with the circuit between the signal wires closed by the end switch 172. The several relays are, therefore, in multiple series with each wound to the same ohmic resistance, which should be high to render the line resistance of the train wires 40 and 41 negligible, then for any given voltage the current used in each relay, and hence the magnetic values, are the same and are almost exactly one-half of what they would be were the relays connected in multiple to a line of similar voltage. Of course the emergency relays are in multiple circuit between the dynamo lead 38 and the signal wire 40 and the regular relays are in multiple circuit between the other dynamo lead 39 and the signal wire 41, and these two combinations are placed in series by the end switch 172 on the last car. It is of course evident that the end switch of any car may be closed for the same purpose, but in a train the end switch of the last car and only that switch must be closed so that should a train break in two then the circuits through all the relays will be open. Each car is also provided with two shunt signal switches 173

and 174. These shunt switches are secured to two suitable cords running through the train and in order to avoid confusion these cords may be differently colored or otherwise characterized so that by pulling one cord the shunt switch for the emergency signal relay may be operated by the conductor, or by pulling the other cord the shunt switch for the regular relay may be pulled by the conductor. To further differentiate these cords they may be located on opposite sides of the car.

Suppose now that the conductor desires to signal the motorman, he pulls the cord which closes the regular shunt switch 174 and whether this switch be on the first car or the last car or any intermediate car, the signal wire 41 will be short circuited, thus shunting every signal relay 96 of the train so that its spring 97 will pull back the armature 95, (see Fig. 1), thus establishing a local circuit through the bell 100, which may be of a distinctive type non-obtrusive to the passengers, but which will be readily apparent to the motorman. These severel signal bells or gongs are located at each end of each car and of course the one in the front end of the front car will be plainly audible to the motorman. When the gongs cease because the conductor has released the cord, then the motorman may, if he wishes to also signal the conductor, close a small switch, say the switch 175′, (see Fig. 1), within easy reach close to the controller so that he is not compelled to reach for the cord which might be difficult since the motorman must not let go the controller handle under penalty of stopping the train under emergency conditions. The conductor and motorman are thus in constant signaling relation no matter what part of the train the conductor may be in. Of course when signaling the emergency relays are then bridged directly across the dynamo mains and receive twice the current, but this only causes them to pull harder on their armatures and the electrical conditions are not otherwise changed. Should the conductor desire to instantly stop the train independent of the motorman, as for instance when a car has run off the track, and is dragging on the ties or some defect in the cars has developed which makes it necessary that the train be stopped in the shortest possible time, or should the motorman for some reason disregard the signals given by the conductor, then the conductor may pull the other rope to operate any one of the switches 173 and so suunt the emergency relays. This would shunt every emergency relay on the train, and thus since the common return of the controller is maintained closed by these relays, then such common return would be opened, more particularly in the car where the controller is in operation, that is, the front car. This will break the power circuit to all the electrically controlled mechanisms including the emergency solenoids of the triples, and the prime mover would be uncoupled from the car axles and the brakes would be applied under emergency conditions, and the train be brought to a standstill. At the same time the solenoid 77 will be cut out of circuit and its armature 78 will be retracted by the spring 79 until the contacts 80 and 81 are brought together, (see Fig. 1), thus establishing a shunt around the emergency relay solenoid. Even after the conductor releases the rope controlling the switches 173 the spring 79 of the series solenoid 77 maintains the shunt circuit closed. In this circuit is located the switch 93, (see Fig. 1). Under these conditions the motorman will place his controller in the brake position of lap, and then close the switch 93, this switch being normally held open by a stiff spring. The common return to the controller is thus temporarily closed through the series solenoid 77 which is then again energized to retract its armature, thus taking the shunt off the emergency relays on the signal circuit provided the conductor has already released the cord. The emergency relays then being energized by the removal of the shunt, the controller circuits will be again closed by the emergency relay, and the motorman can then release the switch 93 to the action of its spring. The controller being on lap the brakes will still hold while the motorman signals the conductor for instructions. The motorman could of course have placed his controller on release, but since it must be presumed that the conductor would only stop the train for imperative reasons, possibly not known to the motorman, he would naturally place the controller on lap until the reasons for the sudden emergency application was communicated to him. Meanwhile the emergency bell 102 rings because of the closure of the circuit between the armature 86 and the contact 91, and this bell is distinctly different from the regular signal bell. For this reason he knows that it is the conductor who is stopping the train. The motorman then first laps his controller, as explained, and closes the switch 93, and if the bell ceases then he knows that he has the current. Then he shunts the regular signal circuit with his shunt switch and gives the requisite number of signals agreed upon. Now, the conductor steps across the car and pulls the other rope, the regular signal rope being placed on the other side of the car to prevent the accidental pulling of one rope for the other as might be the case were they both located on one side of the car, and he answers the motorman's signal.

Suppose now that the train should break

in two. In this case, since the end switch on the last car was the only switch closed, the circuits to both relays are broken and both bells ring at once, thus indicating positively to the motorman that the train is broken in two and the conductor also is aware of the same condition. And, since each car of the train receives the current from the controller on the head car, then all cars to the rear of the break loose the control current and their power is shut off and the brakes are applied.

Should such a contingency as a train breaking in two occur on a train such as a steam driven train, then the brakes are applied while the full driving force of the engine is still active, and while an engine man will at once cut off steam still this cannot always be done quickly enough and disastrous results follow, and even under a most favorable condition the parts are put under enormous strains. In the system of the present invention a break in the train results in the application of the brakes with the simultaneous automatic cutting off of the power from the car axles because of the action of the governor structure shown in Letters Patent No. 920,074, which unclutches the driving gear from the axles as soon as the load becomes abnormally great, and this is done automatically. Also since the breaking in two of the trains will open the signal circuits because of the end switch being on the last car, it follows that the deënergizing of the emergency solenoid 85 will act to unclutch the prime mover by opening the controller circuit and hence power is shut off and the brakes are applied without strain. Should, however, some other end switch, say one on a forward car, be inadvertently closed, then the governor structure of Letters Patent No. 920,074 will act as has been explained. It, therefore appears that the action of the governor structure and the signal circuits are at all times protective. This is usually true of both, but should the wrong end switch be inadvertently closed then the main and sole reliance is on the governor structure. Furthermore, the danger of the broken portion of the train still continuing after the front part of the train is stopped, as for instance, when the break occurs on a hill and the rear end of the train is insufficiently braked, is entirely avoided with the system of this application since the matorman may place his controller on full release and then close the end switch 171 at his end of the train, thus restoring the series connections which were broken when the train broken in two because of the closed end switch being on the last car of the train. He may then close the switch 93 until the emergency solenoid 85 and series solenoid 77 have become energized, which is indicated by both bells ceasing to ring. The brakes have then come to release and he may keep ahead of the broken rear end of the train should there be danger of a rear end collision. With the ordinary air system this procedure is impossible since the air will escape from the broken hose at the rear of the train and the brakes cannot be released. Moreover, the conductor on the rear end of the train, or a trainman, has only to go to the head controller on the broken portion of the train with his controller key to unlock the controller, as explained in Letters Patent No. 902,985, the keys being in the possession of the members of the train crew, under appropriately rigid rules, and then by unlocking the controller may insert the circuit-closing plug 75 and place the controlled on lap and then close the corresponding switch 93 until the bells cease ringing. The adjacent end switch of course need not be closed since the end switch of this part of the train is already closed. Then on releasing the switch 93, the trainman, like the motorman at the head of the train, has the rear end of the train under perfect control. He may then release the brakes at discretion. Under these conditions the two train sections may be safely brought together and coupled up and proceed on their way.

It has already been stated that whenever the motorman for any reason releases the controller lever while the train is in running condition it causes the uncoupling of the power from the axles and the application of the emergency brakes. This is because the conductor 64 has its circuit broken by the dropping of the contact 12 out of connection with the terminal 1. This causes the deënergization of the series solenoid 77 and the cutting out of the emergency signal relays 85 with the consequent sounding of their gongs throughout the train. Assume now that the brakeman, or brakemen are not authorized to stop the train by pulling the cord controlling the emergency signal relays, except in instances of extreme danger, then the conductor may presume that the train is without engine control and acts accordingly. When the regular signal sounds, then the conductor knows that the motorman wishes to communicate with him and when the emergency bell sounds, then the train is without intelligent control from some reason or other, or possibly some other trainman is making an emergency stop under conditions of extreme danger. When both bells ring it indicates that the train is broken in two.

It is to be observed that the various solenoids and magnets, and whenever magnets are indicated they may be replaced by solenoids, are coupled up in multiple-circuit with the exception of the series controller solenoid 77. For reasons which need not

be entered into here it is preferred to employ a constant potential dynamo of the direct current type for the energization of the various electro-mechanical structures included in the system. For this reason the solenoids or magnets are coupled up in multiple-circuit and series arrangements are avoided wherever possible. However, the series magnet or solenoid 77 must be so constructed as to operate as needed under extreme variations in current. The current value in this solenoid will depend on the position of the controller since there are different solenoids included in the circuit at different positions. Each one of these variations is multiplied by each additional car and if in each car there are five variations due to the five controller positions, then on twenty cars there will be one hundred variations and on a hundred cars five hundred variations. Since with one car the signal wires and solenoids are unnecessary, though they should be present with a view to using the car in a train, therefore, the minimum number of cars to be considered may be taken as two and the maximum may be any number within reason. The area of wire of the solenoid must therefore be such as to safely carry the maximum current without undue resistance or heating. Since the magnetism is nearly proportional to the ampere turns and also with shallow windings the length of the turns may be made nearly equal, then it may be assumed that with such windings the magnetism is directly proportional to the ampere turns and the magnetic pull being given the ampere turns may be readily calculated, while the given ampere turns divided by the maximum controller current necessary for the two cars will give the actual turns of winding. The resistance of the winding may be calculated, and this added to the train line resistance, both of which may be made negligible for two cars, will give the external resistance in circuit with the operating solenoids of the train and in order that undue magnetic variations may not occur in the train line solenoids from current variations due to the external resistance on cars being added to form a long train, the resistance of the solenoids should be relatively high. On determining the ratio betwen the resistance of the series solenoid and the resistance of the external line and assuming a given voltage, say twenty-five volts, the magnetic pull for the solenoid can be re-calculated. When the values for the train solenoids and the series solenoid have been finally determined comparisons can then be made and changes be effected until the proper values for the respective devices have been determined. Under these conditions even when the series solenoid is energized by the weakest current, still it is able to perform the functions desired, and since it is calculated to work magnetically at or near the saturation point, increased ampere turns due to increased current will have practically no effect since the slightly greater magnetism, if kept within bounds and the armature is prevented from contact with solenoid core to avoid sticking, will be ineffective. To avoid any detrimental effects from the heavy winding and small amount of iron present in the magnetic circuit, tending to produce residual magnetism, then a reversing switch may be added which may be thrown at intervals to cure such tendency.

Since direct current is used in this system the area of the winding of the solenoid 77 will be sufficient to carry the maximum current without considerable voltage drop, and considering the relatively high resistance of the train solenoids, it will be seen that the latter are not disturbed to an appreciable extent by current variations in the series solenoid, as might be the case with alternating current due to the counter electro motive force generated in such windings when alternating current is used, and while these current changes may cause considerable current difference in the winding of the series solenoid 77 they will produce much less effect magnetically because of the small magnetic core. The solenoids are all small since little air is needed for the opening and closing of the various air valves of the air brake system, and consequently the energy passing through the controller will never be large, although considering the low potential, say twenty-five volts, the current may be fairly large. Should, under some conditions, it be found that such a low voltage necessitates too heavy a controller construction and involves too much copper, then a higher pressure may be used, but low pressures have the advantage of promoting durability and reliability of translating devices in service because there is less danger of short circuits or wire troubles, and the insulation problems are simple, windings are cheap, and so on. For higher pressures the current-carrying parts will be smaller and hence cause less tendency of heating at switches and other contacts. Of course each individual case will present its own problems and usually the voltage required will in most cases not fall below twenty-five nor rise above fifty volts.

The circuit-breaking relay 144 used with the engine governor has only certain solenoids local to each car to deal with and hence the current in it does not perceptibly vary, and though it is a series solenoid it presents no particular difficulty and need not be further considered. This is also true of the circuit-breaking relay 176 shown in Fig. 2 in connection with the speed-changing gear controlling segment 19. The two

terminals 6 in the path of the two segments 19 of the two controllers of the car are connected together by the conductor 69 as already explained. Tapped off from this conductor is a jumper conductor 177 leading to a contact 178 in the path of a contact 179 carried by the armature 180 of the relay magnet or solenoid 176. In the path of the contact 179 is another contact 181 connected by a conductor 182 to the dynamo lead 38. The armature 180 is under the control of a spring 183 in opposition to the pull of the magnet, and this armature is connected by a conductor 184 to one side of the coil of the magnet or solenoid 176, the other side of which is connected by a conductor 185 to the train wire 44, which in turn is connected to the solenoid 122 of the speed-changing gear switch 125. The spring 183 tends to maintain the armature 180 with the contact 179 against the contact 178. This connects the segments 19 of both controllers to the speed-down side of the switch 125 of the speed-changing gear. As has been already stated, should the motorman shut off power while at high speed, the rotary switch 125 will remain in the high speed position and after a quick stop it is not desirable to place the rotary switch on the slow speed by means of the controller, this controller position being used merely to reduce speed under normal conditions. Now, should the motorman start the car with the speed-changing gear set for high speed, the corresponding load will cause the governor to cut the engine out. When the motorman places the controller on the central or cut-off position, the current passes through the relay 176 and this connects the low speed side of the rotary switch 125 to the same side of the circuit that the contact 15 or 16 would connect it. Under these conditions the magnet or solenoid 176 remains in series with the rotary switch-controlling solenoid 122 and ultimately the rotary switch is moved to the lowest speed, after which the arm 129 automatically opens this circuit, all as set forth in detail in the aforesaid Patent No. 901,980. The rotary switch 125 is so arranged that when the clutch circuit is closed the speed-changing gear is still on the first or lowest speed position with the low speed circuit open and the car may run on such speed indefinitely. If the motorman places his controller in position to cause the switch 125 to move toward the speed-raising position, then just previous to its going to the second speed the rotary switch will close the lowering speed circuit. The solenoid or magnet 176 may not receive enough current to operate all of the lowering speed solenoids on a long train. This is of no consequence since just previous to the breaking of the circuit between the terminals 178 and 179 the circuit is completed from the dynamo lead 38 through the terminal 181. To prevent short circuiting on account of the low resistance of solenoid 176 a resistance unit 186 is included in the conductor 177.

No matter at what speed the car or train may be traveling the controller, if placed at off position, will through the solenoid 176 cause the rotary switch 125 to be rotated in a direction to bring it to the lowest speed position, which position is suitable for the starting of the car, and the limited movement of the arm 129 then momentarily breaks the circuit, thus deënergizing the solenoid 176, this break occurring only when the low speed position has been reached.

It is to be especially noted that the closing of the contact terminals 179 and 181 is effected just previous to the opening of the contact between the terminals 178 and 179, so that the continuity of the circuit is preserved, since otherwise the spring 183 would produce a vibrating of the armature 180 and thus prevent the proper operation of the solenoid 176. When the branch 182 has been included in the circuit, then sufficient current will flow for energizing the solenoid 122. To prevent undue heating, resistance, etc., the winding of the solenoid 176 must be such as to carry the maximum current for the number of solenoids 122 which will be included in the circuit when the maximum number of cars are included in the train. What has been stated with respect to the winding of solenoid 77 will apply to the winding of the solenoid 176.

In practice, the solenoid 176 with the attendant parts, may be used in the ballistic form, which may be attained by a small glycerin dash-pot or any other suitable damping device. Since such devices are commercially available it is not deemed necessary to illustrate them. The disadvantages of a series solenoid as hereinbefore outlined will hardly apply as strongly to the solenoid 176 since the work demanded of it is normal and lasts but for an instant. When the controller actuates the solenoid 176 the current passing through it into the solenoid 122 under each car will in most cases be too small to actuate the several solenoids 122, but as before stated, when the branch 182 is included, then the current is sufficient.

Since the contact segment 20 is in circuit with the conductor 70 except in the emergency position of the brakes, then the solenoid or magnet 109, which is in circuit with this conductor is constantly energized. When, however, the controller is put in the emergency position this magnet 109 is deenergized and another circuit is established through the magnet or solenoid 114 which, through a suitable mechanism not shown, is made to operate suitable sand valves so

that sand could be deposited upon the track when the emergency brakes are applied. Of course these sand valve magnets 114 may be operated directly by the controller, but with long trains this would mean an unnecessarily heavy controller segment and a useless consumption of current. With one or two car trains some of the relays need not be used at all but are advisable in long trains and are to be used upon any car which is intended to be used in long trains. Of course for city street cars relays and many other parts of the equipment designed more particularly for long trains for suburban or interstate traffic can be dispensed with but when the cars are used for freight or passenger traffic in regular trains the relays and other parts are needed.

In the case of trailers when used, and there is no hose connection between the cars, then such trailers are provided with air-pump and brake equipments and such other parts as may be necessary, but in the case of trailers the engine and dynamo are omitted. The air pump in such case if present on the trailer is operated from the car axles through suitable machinery or otherwise.

Located within easy reach of the motorman is a switch 186 connected on one side by a conductor 187 to the dynamo lead 38, and on the other side to the train conductor 50 which in turn is connected by another conductor 188 to a solenoid 189 constructed to operate an air whistle or a whistle receiving the exhaust impulses of the engine. This solenoid 189 is connected by a conductor 190 to the other dynamo main 39. The switches 186 with their connections are located at each end of the car, while the conductor 50 may be connected at an intermediate point by another conductor 191 to the dynamo main 38 through a suitable switch 192, and this switch 192, is located within easy reach of the conductor or train man other than the motorman. Should the motorman desire to warn persons of the approach of the train by means of the whistle he has but to close the switch 186. Should the train break in two then the signals may be exchanged between the motorman on the front of the train and the train men on the broken away portions of the train at the rear by means of whistle signals.

The dynamo circuits are provided with suitable fuse blocks 193, and such switches as may be necessary, and leads to lamp circuits 194 in which may be included a suitable number of incandescent lamps 195 for the lighting of the car, and when needed may be carried to a trailer unsupplied with a source of current. The lamp circuits include pilot lamps 196 under the control of switches 197 and if needed an arc lamp 198 of a train head light under the control of a switch 199. These pilot lights and are lights are duplicated on the two ends of each car.

What is claimed is:—

1. In a system of electric car control, electric means for operating a triple valve to the positions of service, lap, release, and emergency, and a controller provided with contact segments for effecting the operations of release, lap, and service by the electric means and for maintaining the emergency electric controlling means active except in the position for the emergency application of the brakes.

2. In a system of electric car control, electric means for operating a triple valve to the position of full release, slow release, lap, service and emergency, and a controller provided with circuit-controlling means for causing the several operations.

3. In a system of electric control for cars, electric means for controlling a triple valve and including a normally closed circuit for preventing the emergency application of the brakes and permitting such application when the normally closed circuit is ruptured.

4. In a system of electric control for cars, electrically controlled means for maintaining the prime mover of the car in connection with the car axles, and active on closed circuit, and other electrically controlled means for operating the brakes and holding the emergency side of the brake operating means inoperative on closed circuit, the means for maintaining the connection between the prime mover and the car axles and the emergency side of the brake operating means causing the release of the car axles from the prime mover and the application of the brakes on the breaking of the circuit.

5. In a system of electric control for cars, electrically-controlled means for maintaining the prime mover of the car in connection with the car axles and active on closed circuit, other electrically-controlled means for operating the brakes and holding the emergency side of the brake-operating means inoperative on closed circuit, and a controller having means for maintaining such closed circuits during the normal running of the car and causing the break of said circuits under abnormal conditions.

6. In a system of electric control for cars, normally closed circuits for maintaining the emergency side of the brake mechanism out of action, said closed circuits extending throughout the car or train of cars, and means other than the controller of the car or train for breaking said circuits to cause the emergency application of the brakes.

7. In a system of electric control for cars, normally closed electric circuits for maintaining the emergency side of the brake mechanism out of action, electro-magnetic circuit closers included in said closed circuit, and electro-magnetic controlling means

for the application of sand to the car tracks rendered active on the breaking of the circuit holding the emergency brake mechanism inactive.

8. In a system of electric car control, electro magnetically operating means for the various mechanisms, a coupling means between the driving power and the car axles, a speed changing means also between the driving power and the car axles, and brake controlling means, all being controlled by said electro magnetically operated means, the said coupling means and speed changing means being active on closed circuit and the emergency side of the brake operating mechanism being inactive on closed circuit.

9. In a system of electric car control, electrically operated coupling means between the power side of the car and the car axles, electric brake operating mechanism including emergency brake applying means, and means for automatically causing the uncoupling of the power from the axles on the active operation of the emergency side of the brake mechanism.

10. In a system of electric car control, a normally open electric circuit controlling the application of sand to the rails, a normally closed electric circuit holding the first named circuit open, and a brake controlling circuit rupturing the second circuit on the emergency application of brakes.

In testimony that I claim the foregoing as my own, I have hereto affixed my signature in the presence of two witnesses.

WILLIAM C. MAYO.

Witnesses:
H. C. BARSTOW,
K. P. INGERSON.