

No. 799,780.

PATENTED SEPT. 19, 1905.

J. LE C. DAVIS.
SELF PROPELLED VEHICLE.
APPLICATION FILED APR. 9, 1904.

3 SHEETS—SHEET 1.

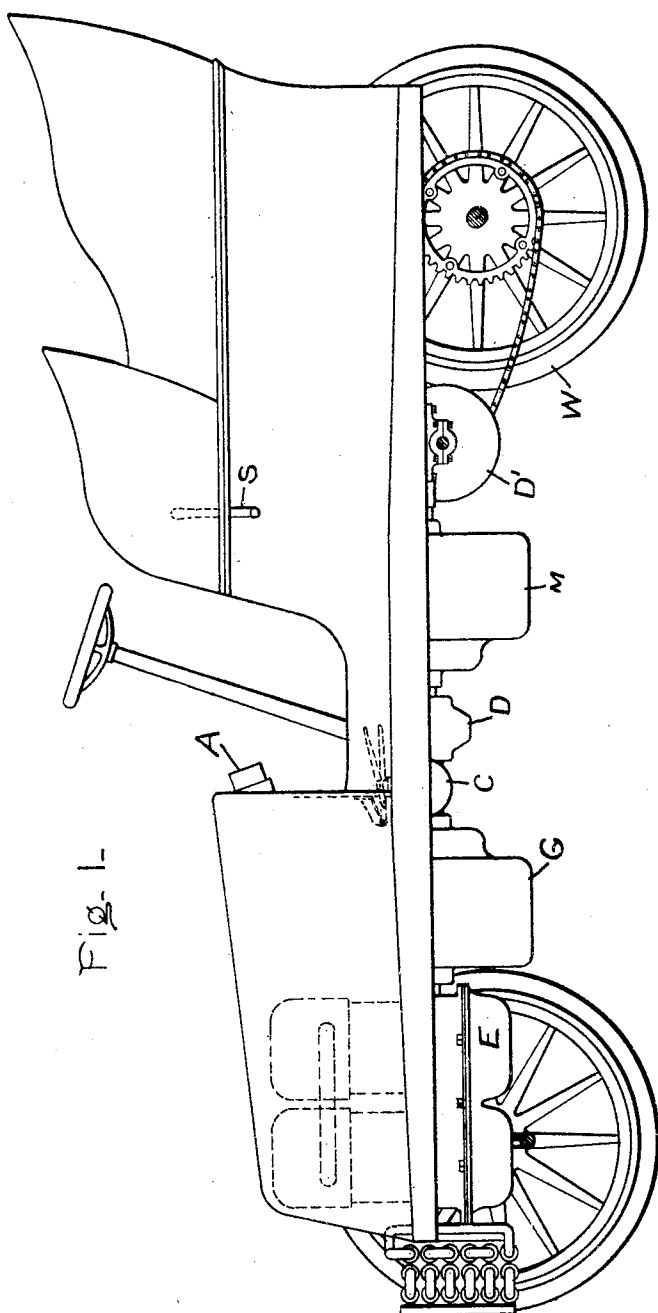


Fig. 1-

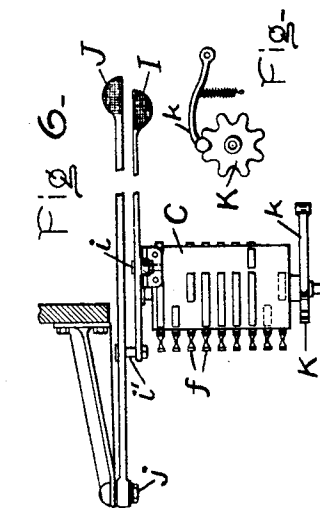


Fig. 6-

Fig. 7-

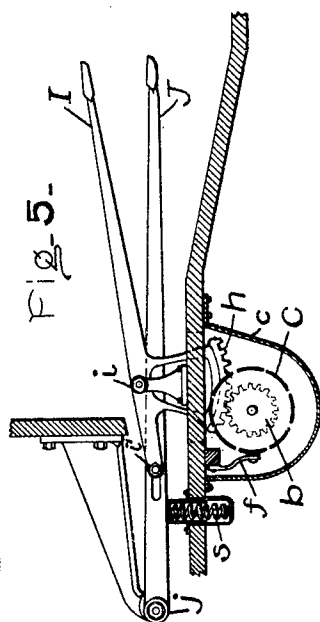


Fig. 5-

Witnesses.

Jonathan C. Briggs.
Helen Arford

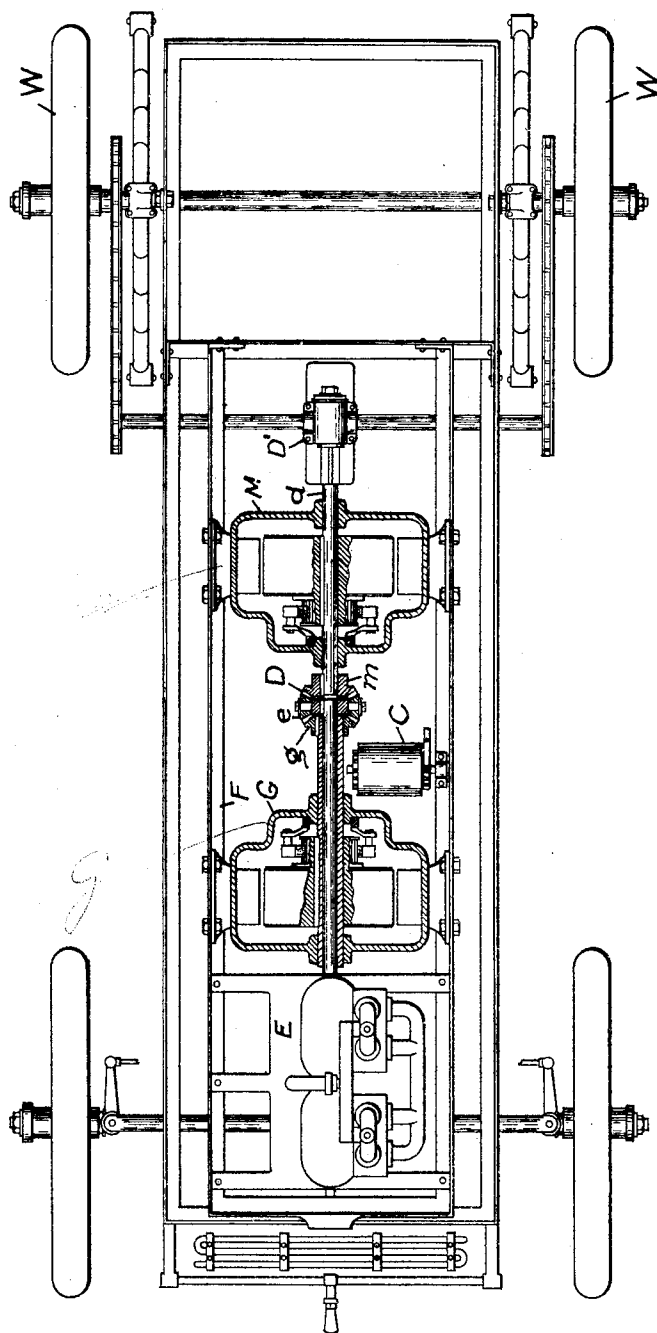
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3 SHEETS-SHEET 2.

Fig. 2-



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3 SHEETS—SHEET 3.

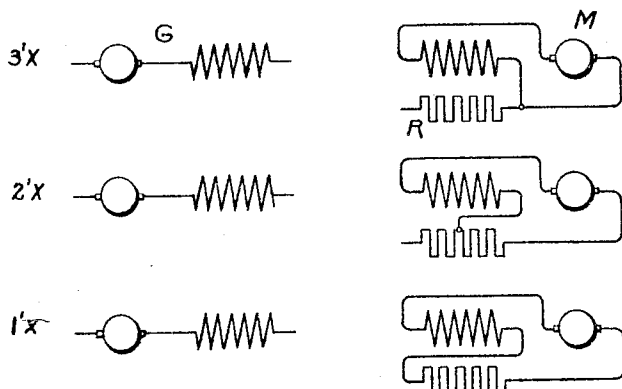
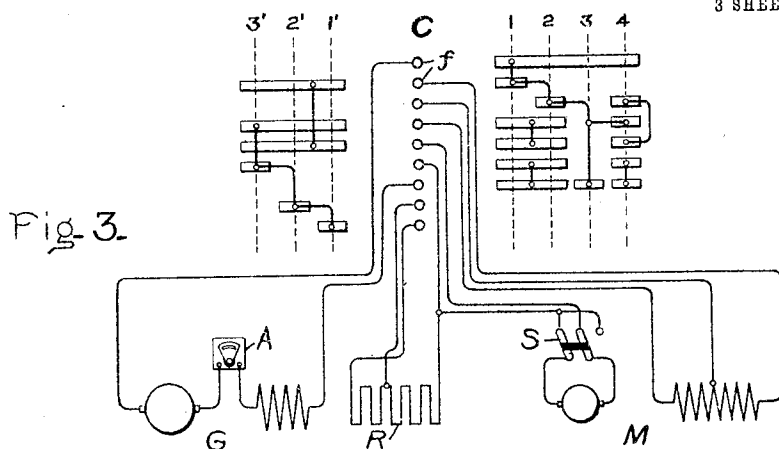
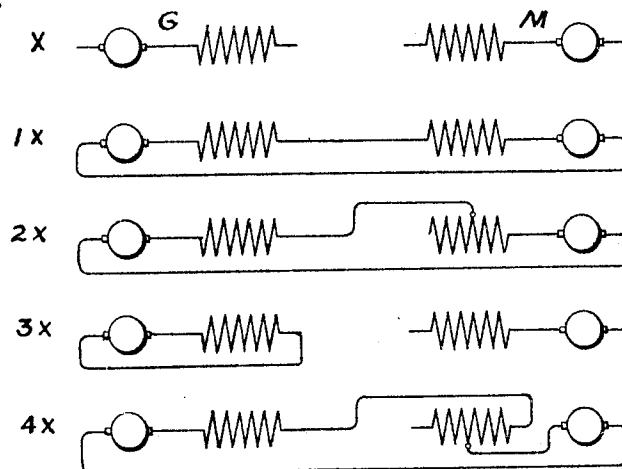


Fig. 4.



Witnesses.

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UNITED STATES PATENT OFFICE.

JOSEPH LE CONTE DAVIS, OF SCHENECTADY, NEW YORK, ASSIGNOR TO
GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

SELF-PROPELLED VEHICLE.

No. 799,780.

Specification of Letters Patent.

Patented Sept. 19, 1905.

Application filed April 9, 1904. Serial No. 202,413.

To all whom it may concern:

Be it known that I, JOSEPH LE CONTE DAVIS, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Self-Propelled Vehicles, of which the following is a specification.

My invention relates to self-propelled vehicles, and particularly to vehicles deriving their motive power from a prime mover—such, for instance, as a gas-engine.

In United States Patent No. 723,168, issued to Hermann Lemp March 17, 1903, an arrangement is shown in which by means of a transmission mechanism comprising an electric generator and motor it is possible to deliver the output of the prime mover, which may run at a constant speed to the driving-wheels of the vehicle with variable relations of speed and torque factors.

By my invention I so rearrange the elements of the transmission mechanism described in the above patent that I am enabled to use a generator and motor of only one-half the size required for the arrangement therein disclosed and in addition may be enabled to obtain efficient electric braking with simple controlling means.

A further object of my invention is to provide a novel and simple operating means for the controlling-switch which shall require the minimum of attention on the part of the operator.

Further objects of my invention will appear from the following specification and drawings, in which—

Figure 1 shows a side view of an automobile arranged in accordance with my invention. Fig. 2 shows a plan view of the same, the car-body being removed to show the transmission mechanism. Fig. 3 is a diagrammatic representation of a controlling-switch and arrangement of circuits adapted to my invention. Fig. 4 shows a set of diagrams illustrating the circuit connections corresponding to the several positions of the controlling-switch. Figs. 5 and 6 show, respectively, a side elevation and a plan view of the controller, illustrating the operating mechanism therefor; and Fig. 7 is a detail of the star-wheel and pawl used on the controller.

In the drawings, E represents a prime mover, such as a gas-engine, supported from the frame F. The engine-shaft is connected to the cen-

tral member *e* of the differential gear D. G is a generator the field of which is supported from frame F and the armature of which is sleeved on the engine-shaft. The sleeve on which the armature is mounted carries one of the outside members *g* of the differential gear D. The other outside member *m* of the differential gear is mounted on the driven shaft *d*, which is connected in the usual manner to the driving-wheels W through the differential gear D'. Keyed to the driven shaft *d* is the armature of the electric motor M, the field of which is supported from frame F.

If generator G is open-circuited, so that its armature may revolve freely, and if the central member *e* of differential gear D is driven by engine E, the external member *m*, which is connected to the load, will remain stationary and the external member *g* will be driven at twice the engine speed. Now if the circuit of generator G is closed a torque will exist between its field and armature which will cause member *g* to resist rotation and will produce a certain torque upon member *m* and driven shaft *d*. By varying the field strength of generator G this torque may be varied and the speed of the automobile consequently varied. Moreover, instead of allowing the energy generated in the armature of generator G by its rotation relative to the field to be wasted in resistances this energy may be applied to the motor M, so as to assist in driving the shaft *d*. Thus the engine output is delivered to the driving-wheels with variable relations to speed and torque factors.

It will be seen from the above description that the operation of my transmission mechanism is similar to that described in the above-mentioned patent to Lemp. There is this difference between the two mechanisms, however: In the arrangement of Lemp the engine is connected to one of the external members of the differential gear, as are also the motor and generator, while the load is driven from the central member. In my transmission mechanism the engine is connected to the central member of the differential gear, while the two electric machines and the load are connected to the external members. By this alternation the speeds of the motor and generator are doubled relative to the engine speed and the necessary torque of these machines consequently cut in two. As a result I am enabled to use machines of only one-

half the weight required for the transmission mechanism described in the Lemp patent. That this is the case will be evident from the following considerations: Assume the load to be connected to the central member of the differential gear, as in the Lemp mechanism. Let the engine drive one outside member, and let the electric generator connected to the other outside member be free to revolve. The load will remain stationary and the electric generator will be driven at the same speed as the engine and in the opposite direction. Consequently whatever output must be exerted by the generator in order to start the vehicle must be delivered at the engine speed. On the other hand, with the transmission mechanism arranged in accordance with my invention if the armature of generator G is free to revolve and the engine is driving the central member *e* of the differential gear the armature of generator G will be driven at a speed equal to twice the engine speed, and consequently whatever may be the necessary output in order to start the vehicle this output is delivered at twice the engine speed, and consequently with a torque only one-half as great as in the former case. The same is true throughout the entire operation of the transmission mechanism, so that by my invention the size of generator and motor may be reduced one-half.

A further advantage attained by my invention consists in the possibility of electric braking. Since the motor M is rigidly connected to the driven shaft *d*, it may be used for braking purposes by connecting it in short circuit with the relative field and armature connections reversed. This electric braking, which is not possible in the arrangement of the Lemp patent above mentioned, in which neither electric machine is rigidly connected to the load, makes a transmission mechanism arranged in accordance with my invention particularly advantageous.

Referring now to Figs. 3 and 4, I will explain the method of control. In Fig. 3 C represents a controlling-switch, which is shown in outline in Figs. 1 and 2. The controlling-switch comprises nine stationary fingers *f* and movable contacts arranged for seven positions of the controller, as indicated by dotted lines 1 to 4 and 1' to 3', the movable contacts being shown in Fig. 3 developed on a plane surface. G represents the generator, and M the motor of the preceding figures. R is a resistance adapted for connection to the motor M for braking purposes. S is a reversing-switch for varying the relative connections of the field and armature of the motor M. If controlling-switch C is in its off position, the circuits of generator and motor are open, as shown in diagram X of Fig. 4. With this condition of the circuits if the engine is running the generator G rotates freely at twice the engine speed, while

the motor M is stationary. Now if controlling-switch C is moved to position 1, a circuit is closed from the armature of generator G through the field and armature of motor M back to the field of generator G. Generator G will consequently force a current through motor M. This current in generator G opposes the rotation of the member *g* of the differential gear of Fig. 1, thereby exerting a torque upon the driven shaft *d*, and at the same time this current in motor M exerts an additional torque upon the shaft *d*. The vehicle consequently starts from rest. The circuit connections are shown in diagram 1^x of Fig. 4. Both generator and motor are shown as having full fields. In practice if the generator picks up too suddenly with full field, so as to start the vehicle too abruptly, a part of the field of generator G may be cut out at the start. Now as the vehicle speeds up controlling-switch C is moved to position 2. It will be seen by tracing out the circuit connections that a portion of the field of motor M is cut out. This is shown in diagram 2^x. This relative weakening of the motor-field produces a decreased torque per ampere and counter electromotive force relative to generator G. The speed of motor M consequently increases and the speed of generator G decreases. In other words, the speed of member *g* of differential gear D slows down, while the speed of member *m* and of the vehicle increases. When controlling-switch C is moved to its third position, motor M is open-circuited and generator G is short-circuited on itself. With this connection generator G acts practically as a magnetic clutch, holding its armature nearly stationary. Its armature and member *g* rotate at a speed just sufficient to produce the current to give the necessary torque. The driven shaft *d* is now rotating at a speed nearly twice that of the engine E and with one-half the engine torque. Now if the relative connections of armature and field of motor M are reversed the motor will act as a generator, and if connected to generator G will force a current through generator G, thereby driving the armature of generator G in the opposite direction of that of the engine-shaft—that is, members *e* and *g* of the differential gear D are rotating in opposite directions, which produces an increased speed of member *m*. In other words, part of the torque delivered to member *m* is transformed into electric energy by motor M and is supplied through generator G to increase the speed of the driven shaft *d*. This arrangement is shown in diagram 4^x, motor M being connected with a weak field to generator G and the relative connections of field and armature of motor M reversed. With these variations in circuit connections it is evident that a wide variation in speed may be obtained. A greater number of steps may be obtained by further

subdivision of the field of motor M or by subdividing the field of generator G, or both. For the sake of simplicity, however, only four running positions have been shown. Now if it is desired to brake the vehicle the controlling-switch C is moved to the first position 1'. Generator G is then open-circuited, and motor M is short-circuited through the resistances R. This is shown in diagram 1^x, the relative connections of field and armature of motor M being reversed, as shown in the diagram. With this connection a powerful braking action may be obtained. To increase the braking effect, the controlling-switch may be moved to positions 2' and 3', respectively, thereby gradually cutting out resistance R from the circuit of motor M, as shown in diagram 2^x and 3^x.

In an automobile it is extremely advantageous that the control should be as simple as possible, since such vehicles are frequently operated by persons with little experience. I accordingly provide a novel operating means for the controlling-switch C, which enables the operator to obtain both the variation of speed and braking by the manipulation of two foot-pedals, thus enabling him to keep both hands at all times on the steering-wheel and to devote his entire attention thereto during the operation of the vehicle.

Referring to Fig. 5, C represents the controller, which is preferably mounted below the floor of the carriage and contained in a dust-proof casing *c*. Controller C carries at one end a gear *b*, which is engaged by a segmental gear *h*, carried by the pedal I, which is pivoted at *i*. Pedal I has an extension carrying a bolt or roller *j'*, which engages a slot in the pedal J, pivoted at *j*. With this construction it will be seen that when pedal I is depressed the controller C will be rotated in one direction and pedal J will be raised. If pedal J is depressed, the controller will be rotated in the opposite direction and pedal I raised. Controller C is preferably provided with the star-wheel K and spring-pressed pawl *h*, as shown in Figs. 6 and 7, the notches in the star-wheel corresponding to the several positions of the controller. When pedals I and J are in the position shown in Fig. 5, it will be seen that pedal J rests against the top of a spring *s*, and any downward movement of pedal J would result in a compression of the spring. This position of the pedal corresponds to the off position of the controller. Thus if the vehicle is running at any speed and it is desired merely to throw off the power pedal J is depressed until it comes in engagement with the spring. The resistance offered by the spring to the further movement of the pedal tells the operator that the controller is in the off position without requiring him to look at the position of the pedals. If it is desired to apply the brakes, the operator puts a greater pressure on pedal

J, compressing spring *s* and rotating controller C to the braking positions. Thus the controller may be moved by a single pedal from any running position to the off position or to a braking position, according to the will of the operator, without requiring him to move his hands from the steering-wheel or his eyes from the road.

Reversal of the direction of movement is the only operation not performed by the controller and its two pedals. Since reversal of direction is necessary only when the vehicle is at rest and no attention is required by the steering-wheel, I prefer to employ a reversing-switch separate from and independent of the main controlling-switch. Such a switch is indicated at S in Fig. 1, and its connections are shown at S in Fig. 3. An ordinary double-throw switch is employed for this purpose, and when it is thrown in either position according to the direction of rotation desired all the speeds and all the braking positions of the controller may be utilized.

In Fig. 3 I have shown an ammeter A connected in series with the generator, and in Fig. 1 I have shown this ammeter A placed in a position convenient for reading by the operator. Since the engine torque is always proportional to the generator torque and since the generator torque is proportional to a function of the current-flow through it, the ammeter always gives a proper indication of the work that the engine is doing and enables the operator to tell at a glance whether the engine is working satisfactorily. The ammeter may be calibrated in amperes or in foot-pounds, or both, as desired.

In the drawings and the foregoing description I have shown and described one complete embodiment of my invention; but it will be understood that the construction and arrangement of parts, as well as the arrangement of the control-circuits, may be greatly varied, as desired. Furthermore, I have shown a number of features which, while I prefer to use them together, may with advantage be used independently and which I desire to claim whether used together or not. Accordingly I do not desire to limit myself to the particular construction and arrangement of parts here shown, since changes which do not depart from the spirit of my invention and which are within the scope of the appended claims will be evident to those skilled in the art.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a power-transmission mechanism, a driving member, a differential gear having its central member connected thereto, a driven member connected to one outer member of said gear, a dynamo-electric machine connected to and adapted to assist in driving the driven member, and a second dynamo-electric machine connected to the other member of said gear.

2. In an automobile, a prime mover, a dif-

ferential gear having its central member connected to the prime mover and one outside member connected to the driving-wheels of the automobile, a dynamo-electric machine
5 connected to and adapted to assist in driving said outer member, and a second dynamo-electric machine connected to the other outer member of said gear.

3. In an automobile, a prime mover, a differential gear having its central member connected thereto, a driven member connected to one outer member of said gear, means for converting the power delivered to the other outer member into electric energy, and means for
15 utilizing said energy to assist in driving said driven member.

4. In an automobile, a prime mover, a differential gear having its central member connected thereto, a driven member connected to one outer member of said gear, means for converting the power delivered to the other outer member into electric energy, and means for utilizing said energy with variable-speed and torque factors to assist in driving said driven
25 member.

5. In an automobile, a prime mover, a differential gear having its central member connected thereto, a driven member connected to one outer member of said gear, a dynamo-electric machine connected to the other outer member, a second dynamo-electric machine connected to and adapted to assist in driving said driven member, and means for connecting said machines in series and varying their
35 relative field strengths.

6. In an automobile, a prime mover, a differential gear having its central member connected thereto, a driven member connected to one outer member of said gear, a dynamo-electric machine connected to the other outer member, a second dynamo-electric machine connected to and adapted to assist in driving said driven member, means for connecting said machines in series and varying their relative field
45 strengths, and means for reversing the relative connections of field and armature of the second machine.

7. In an automobile, a prime mover, a differential gear having one member connected thereto, a driven member connected to another member of said gear, a dynamo-electric machine connected to the third member, a second dynamo-electric machine connected to and adapted to assist in driving said driven member, and means for short-circuiting said second machine to brake said driven member.
55

8. In an automobile, a prime mover, a differential gear having its central member connected thereto, a driven member connected to one outer member of said gear, a dynamo-electric machine connected to the other outer member, a second dynamo-electric machine connected to and adapted to assist in driving said driven member, means for connecting said machines in series and varying their relative field
65

strengths, and means for short-circuiting either machine.

9. In an automobile, a prime mover, a differential gear having its central member connected thereto, a driven member connected to one outer member of said gear, a dynamo-electric machine connected to the other outer member, a second dynamo-electric machine connected to and adapted to assist in driving said driven member, means for connecting said machines in series and varying their relative field strengths, means for varying the relative connections of the field and armature of said second machine, and means for short-circuiting either machine.
70 75 80

10. In an automobile, a prime mover, a differential gear having its central member connected thereto, a driven member connected to one outer member of said gear, a dynamo-electric machine connected to the other outer member, a second dynamo-electric machine connected to said driven member, and a controller having its contacts constructed and arranged to first connect said machines in circuit in such a manner that the dynamo-electric machine connected to the driven member will operate as a motor supplied with current from the other machine operating as a generator, then to weaken the field of the dynamo-electric machine connected to the driven member, and then to open the circuit of the dynamo-electric machine connected to the driven member and short-circuit the other dynamo-electric machine on itself.
85 90 95

11. In an automobile, a prime mover, a differential gear having its central member connected thereto, a driven member connected to one outer member of said gear, a dynamo-electric machine connected to the other outer member, a second dynamo-electric machine connected to said driven member, and a controller having its contacts constructed and arranged to first connect said machine in circuit in such a manner that the dynamo-electric machine connected to the driven member will operate as a motor supplied with current from the other machine operating as a generator, then to weaken the field of the dynamo-electric machine connected to the driven member, then to open the circuit of the dynamo-electric machine connected to the driven member and short-circuit the other dynamo-electric machine on itself, and finally to connect the two machines in circuit again with the relative connections of the field and armatures of the machine connected to the driven member reversed.
100 105 110 115 120

12. In an automobile, a prime mover, a differential gear having a central member connected thereto, a driven member connected to one outer member of said gear, a dynamo-electric machine connected to the other outer member, a second dynamo-electric machine connected to said driven member, and a controller having its contacts constructed and
125 130

arranged in certain positions to connect said machines in series with varying circuit connections and in another position or positions to short-circuit the dynamo-electric machine
5 connected to the driven member in such a manner that the said machine will operate as a braking-generator.

13. In an automobile, a prime mover, a differential gear having a central member connected thereto, a driven member connected to one outer member of said gear, a dynamo-electric machine connected to the other outer member, a second dynamo-electric machine connected to said driven member, a controller
10 having its contacts constructed and arranged in certain positions to connect the said dynamo-electric machines in series and vary the circuit connections in such a manner as to vary the speed of the driven member and in
15 another position or positions to short-circuit the dynamo-electric machine connected to the driven member in such a manner that it will operate as a braking-generator, and independent levers for moving the said controller into
20 its speed-controlling and braking positions.

14. In an automobile, an electrically-controlled speed-changing mechanism, a controlling-switch therefor, and two operating-levers for said controller adapted to move said controller in opposite directions.
25 30

15. In an automobile, an electrically-controlled speed-changing mechanism, a controlling-switch therefor, two operating-pedals, and connecting means whereby said switch is
35 moved in opposite directions when said pedals are alternately depressed.

16. In an automobile, an electrically-operated speed-changing mechanism, a rotatable controlling-switch therefor, a gear carried by
40 said switch, a second gear engaging said gear, and two pedals adapted when alternately depressed to rotate said second gear in opposite directions.

17. In an automobile, an electrically-controlled speed-changing mechanism, a controlling-switch therefor, two operating-pedals,
45

connecting means whereby said switch is moved in opposite directions when said pedals are alternately depressed, and a spring-pressed pawl adapted to retain said switch in its several
50 positions.

18. In an automobile, an electrically-controlled speed-changing mechanism, a controlling-switch therefor movable in either direction from its off position, and yielding means
55 opposing its movement in one direction from its off position.

19. In an automobile, an electrically-controlled speed-changing mechanism, a controlling-switch therefor movable in either direction from its off position, two operating-pedals adapted when alternately depressed to move
60 said switch in opposite directions, and a spring opposing the movement of said switch in one direction beyond its off position.
65

20. In an automobile, an electrically-controlled speed-changing mechanism, a controlling-switch therefor adapted when moved in one direction from its off position to connect
70 said mechanism for variable speeds and when moved in the other direction to connect said mechanism for braking, and a spring opposing the movement of said switch to braking position.

21. In an automobile, an electrically-controlled speed-changing mechanism, a controlling-switch therefor adapted when moved in one direction from its off position to connect
75 said mechanism for variable speeds and when moved in the other direction to connect said
80 mechanism for braking, two pedals adapted when alternately depressed to move said switch in opposite directions, and a spring opposing the movement of said switch to braking position.
85

In witness whereof I have hereunto set my hand this 8th day of April, 1904.

JOSEPH LE CONTE DAVIS.

Witnesses:

BENJAMIN B. HULL,
HELEN ORFORD.