(No Model.) 2 Sheets—Sheet 1.

E. H. JOHNSON.

ELECTRICAL PROPULSION OF VEHICLES.

No. 450,742. Patented Apr. 21, 1891.

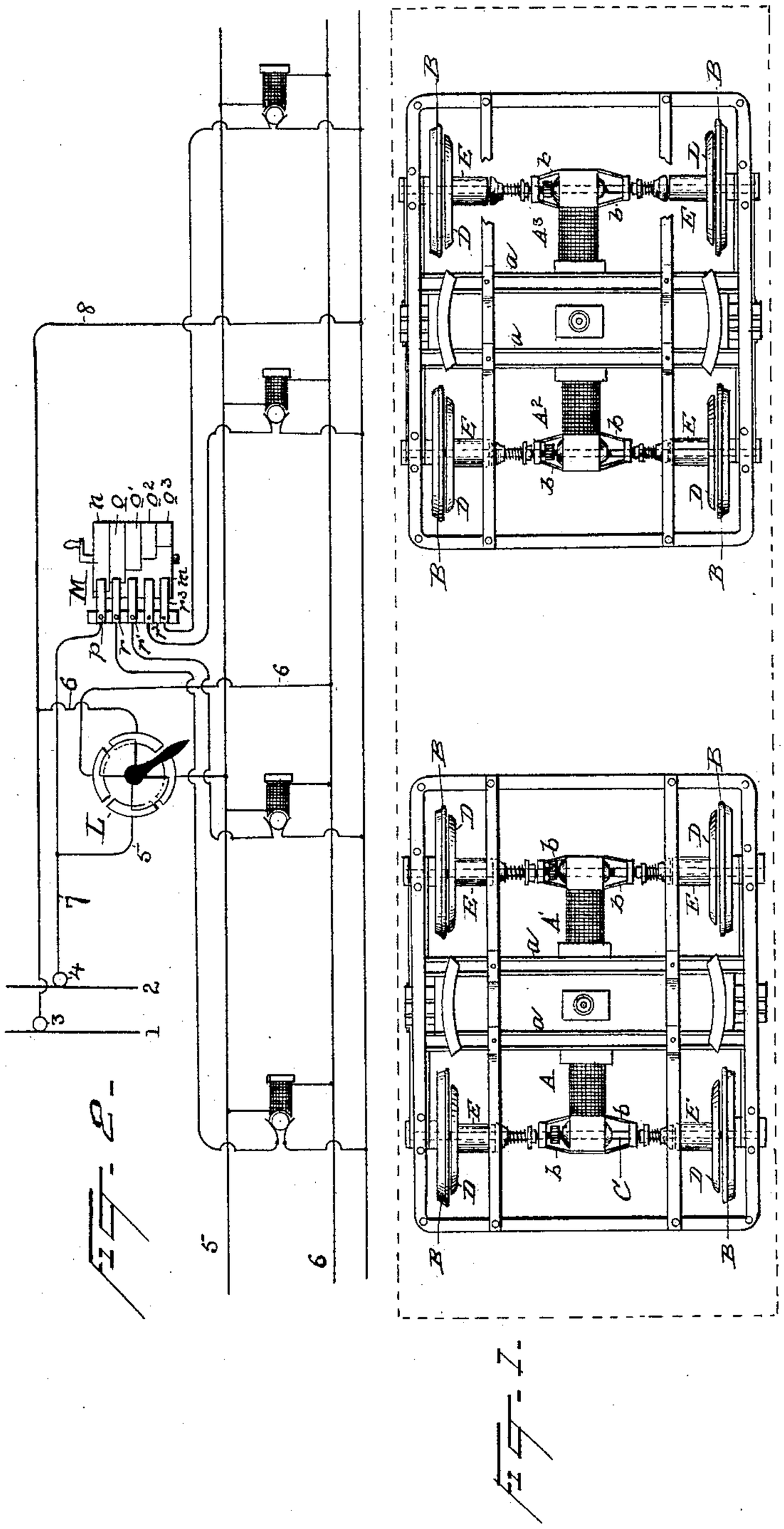

FIG. 2.

FIG. 1.

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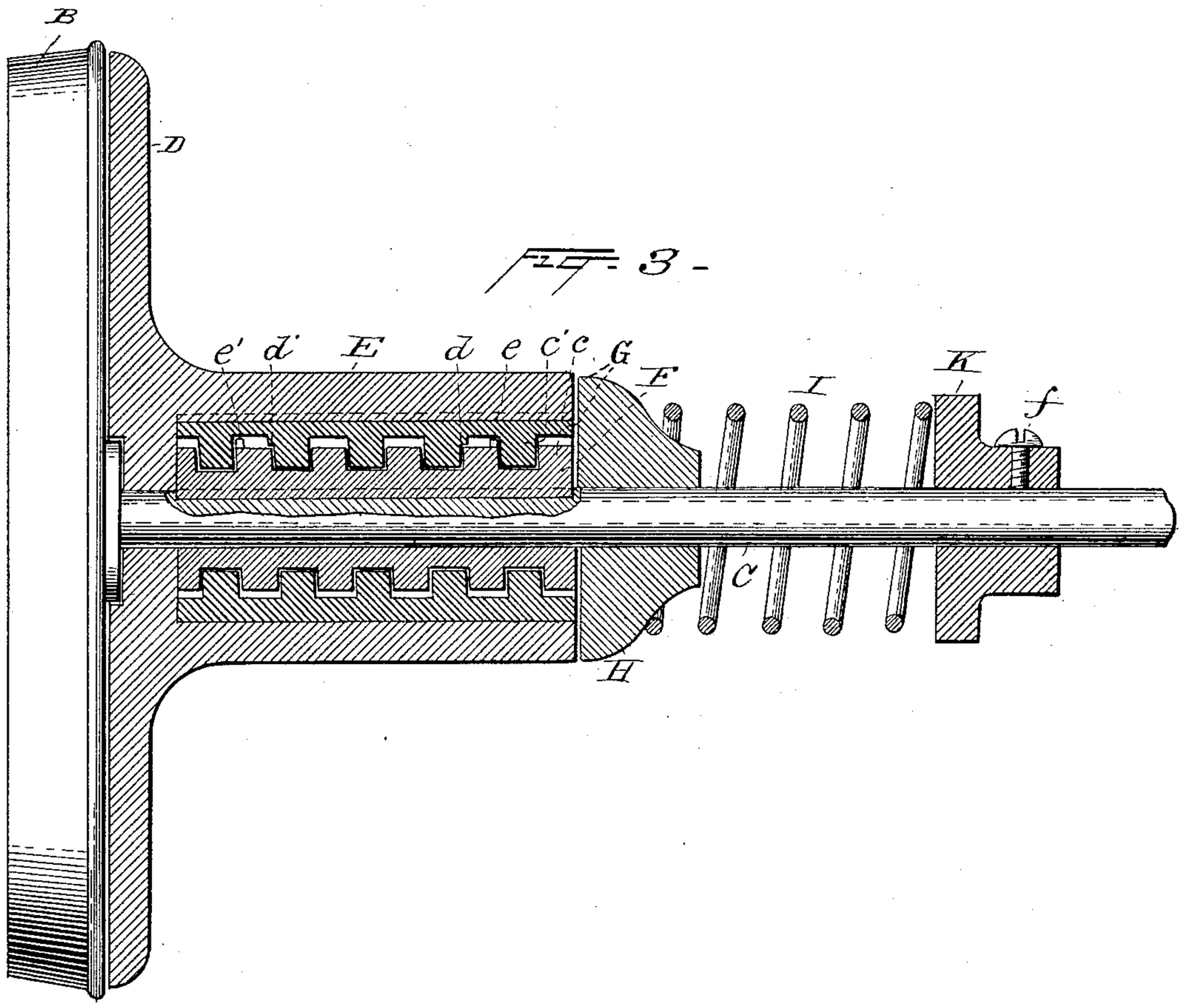

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UNITED STATES PATENT OFFICE.

EDWARD H. JOHNSON, OF NEW YORK, N. Y.

ELECTRICAL PROPULSION OF VEHICLES.

SPECIFICATION forming part of Letters Patent No. 450,742, dated April 21, 1891.

Application filed August 8, 1890. Serial No. 361,423. (No model.)

To all whom it may concern:

Be it known that I, EDWARD H. JOHNSON, a citizen of the United States, residing at New York city, in the county and State of New York, have invented a certain new and useful Improvement in the Electrical Propulsion of Vehicles, of which the following is a specification.

My invention relates to the propulsion of vehicles by electricity; and my object is to provide such electrical and mechanical arrangements of the motors and the power-transmitting devices as shall enable the power developed to be at all times proportional to that required, so that the vehicle may be started gradually and with the smallest possible expenditure of power; so that the circuit shall not be suddenly called upon for the total current required to start the vehicle; so that a propelling electric motor shall in starting receive its load gradually, the application of the power being retarded and the inertia of the load gradually overcome; so that the motor is permitted to develop its counter electro-motive force before it is called upon to do its work, and so that such motor can never be called upon to exceed its normal effective capacity and so be exposed to the danger of being burned out and destroyed, or where storage-batteries are used these also cannot be called upon for more than their normal current and so be exposed to rapid deterioration.

In carrying my invention into effect I employ upon the vehicle to be propelled a plurality of motors, usually a motor for each axle of the vehicle. Heretofore when a plurality of motors have been so used the circuiting arrangements have been such as to put both or all the motors into circuit or remove them all from circuit simultaneously. The total power in such case being much greater than that required to propel the car on a level and under normal conditions, the effect of throwing on all the motors each at its full capacity in starting is, especially with a heavy car, to start the car suddenly and violently, and also to suddenly take an excessive amount of current from the line or from the generator.

One feature of my invention consists in successively applying the motors whereby the power necessary to start the car is applied gradually and the car starts slowly and without any jerk, and the power applied is only that required at the time, since the number of motors introduced is only that necessary to start the car.

While the expedient just described is sufficient to accomplish to a certain extent the objects of my invention, I still further increase its effectiveness by so arranging the individual motors that each of them applies its power gradually and proportionately to what is required of it, and is permitted to develop its counter electro-motive force before the load is placed upon it. I do this primarily by the use of devices of the general character set forth in my patent, No. 431,811, dated July 8, 1890—that is to say, I employ between the armature-shaft of each motor and the shaft propelled by it a frictional mechanical connecting device and an elastic determining device for determining the frictional engagement. The frictional connecting device is applied by means of a screw turned by the driving-shaft, and the elastic determining device is preferably a spring coiled on such shaft in such position as to oppose the screw movement. When current is applied to the motor, the motion of the armature-shaft is not immediately communicated to the driven axle, but it compresses the spring or other elastic medium until sufficient movement has been had to bring the frictionally-engaging surfaces into the required degree of contact to cause the rotation of the driven part. By this means the individual motor is itself allowed to start gradually and to gradually communicate its motion to the driven part, and is allowed to develop counter electro-motive force before its load is placed upon it.

Generally speaking, the devices just described form by themselves no part of my present invention, they being broadly covered by my patent above referred to. My present invention, however, includes certain special devices and combinations of devices constituting improvements on the form of apparatus set forth in said patent and designed to more effectively carry out the ob-

jects above named, and others which arise in the particular situations herein referred to.

My invention includes a provision for the contingency that when the frictional connecting devices are in effective engagement and the motor has reached its full safe capacity or such power as it is desired that such motor shall develop the load is too great to be started by the motor. In this case the motor, being required to exceed its capacity, will be in danger of being destroyed, or there may be danger of injury to the mechanical portions of the apparatus, since with the apparatus as so far described the frictional devices have a constant tendency to increase their frictional engagement so long as the driving-shaft continues to revolve and the driven shaft does not start; and, further, in cars propelled by storage-batteries the batteries will be called upon for current in excess of their effective capacity, which results in the buckling of the plates, this difficulty being one of the most serious in the way of the introduction of storage-batteries for propulsion, and, indeed, the danger exists with other generators than storage-batteries, that by reason of an excessive demand for power the capacity of the generator may be exceeded. To avoid these dangers and difficulties I provide a limiting stop or device, so situated that at a predetermined point it stops the movement of the friction-surfaces toward each other and permits the same to yield or slip relatively to each other, whereby the motor or generator, or both, are prevented from exceeding their safe capacity, although the motor continues to develop and exert the same power as before, such power being employed to move the friction-surfaces past each other until the load is relieved in some way, or by the successive application of other motors, as hereinbefore described, sufficient power is obtained to start the car.

In stopping the car, the current being shut off from the propelling motor or motors, the frictional connecting device releases itself from engagement and the parts return to their original position, and to facilitate this operation the motor may be reversed for a moment, so that there is a positive force acting on such parts to cause their return.

My invention is illustrated in the annexed drawings.

Figure 1 is a top plan view of the trucks of a railway-car embodying my invention; Fig. 2, a diagram of the electrical connections of the motors, and Fig. 3 a longitudinal section of one of the power-transmitting devices used in connection with each motor.

I have shown my invention in connection with a railway-car having two four-wheeled trucks.

A, A′, A², and A³ are electric motors, one for each pair of wheels B B of the car. I prefer to make the wheels B B loose on the axles C and to place the armature of each motor directly upon the middle portion of an axle, the shaft C being connected through the devices to be presently described with the wheels B, in order to turn said wheels. I preferably employ slow-speed motors, and support the same in any suitable way. As shown, the field-magnets are hung in a suitable manner at their yokes from the cross-bars *a a* of the truck-frames. Brackets *b b* extending from the pole-pieces support bearing-sleeves for the armature-shafts C. The wheel B has an inner friction-surface adapted to engage frictionally a friction-disk D, which has a hub E extending out over the axle.

Keyed to the shaft C, inside the hub E, is a sleeve F, having an external screw-thread at *c*. Engaging with this is a sleeve G, internally screw-threaded at *c′* and keyed to the hub E. Upon the shaft at the end of the hub is a sliding disk H, behind which is a spring I, coiled on the shaft between the disk H and collar K, whose position on the shaft is adjustable by loosening the set-screw *f*, whereby the tension of the spring may be altered and adjusted. The screw-thread *c′* is deeper than the screw-thread *c*, and near each end of the former is formed or placed in the thread a projection or pin *d* or *d′*. At corresponding, but opposite, portions of the screw-thread *c* are like projections *e* and *e′*. These are the limiting-stops, to avoid the exertion of the motor above the desired capacity.

Referring now to Fig. 2, the motors shown are shunt-wound motors. 1 and 2 represent the two sides of the supplying-line of conductors, which may be of any usual or suitable character, and with which connection is made from the car by suitable traveling contact devices 3 and 4. The field-magnets of the motors are all in separate parallel branch circuits from the circuit 5 6, and all the armatures likewise are in parallel branch circuits from the circuit 7 8, which is in parallel with 5 6. L is a simple circuit-reverser in circuit 5 6, whereby all the motors may be reversed simultaneously by the reversal of the current in their field-magnet circuits. M is the armature-circuit switch designed to bring the motors successively into circuit. It consists of a cylinder or body *m* of insulating material, on which is a long contact block or ring *n* and shorter contact blocks or rings *o o′ o² o³*, one for each motor. The main armature circuit terminal 7 is connected with spring *p*, which bears on ring *n*. Springs *r*, *r′*, *r²*, and *r³* are terminals for the individual parallel armature-circuits. The plates or rings on the turning cylinder are all electrically connected together. It will be seen that when the switch is turned and ring *o* reaches spring *r* motor A will be placed in circuit. On a further movement ring *o′* reaches spring *r′* and motor A′ is in circuit, and so on; and on the reverse movement of the switch the motors are progressively removed from circuit in the reverse order.

The operation of the devices described is as follows: When it is desired to start the car, the switch is turned, as described, the field-

magnets being constantly in circuit in the arrangement illustrated, and the motor A is started. The friction-surfaces being always in contact, the effect of the rotation of shaft C is to screw either the sleeve F or the sleeve G out along the shaft against the disk H. If the shaft turns in one direction, sleeve F will be moved longitudinally, if in the other direction sleeve G, and in each case the other sleeve will have a tendency to move toward the wheel. In either case the effect is to compress the spring and to increase the pressure of disk D on the wheel until such a degree of friction is produced at the two ends of shaft C as will enable the wheels to be turned, the arrival at this point being determined by the spring I, so that the strain is placed gradually upon the armature and the same is allowed to first develop its speed. It is not, however, intended that the single motor so far referred to shall itself suffice to start the car, and in order that the motor shall not exceed its capacity the limiting-stops are provided in the screw-threads. If, for instance, the sleeve G moves away from the sleeve F at the beginning of the movement, the projections *c d* and *c' d'* move past each other, they being on opposite sides of the channel of screw-thread *c'*, but near the end of the movement *d'* will engage with *e* and the travel of the sleeve will be stopped. The stops are preferably so arranged that this point will be reached somewhat before the motor reaches its full capacity, and at this time, there being no further increase in frictional contact between B and D, these surfaces will slip on each other and the motor will thereupon continue to run, maintaining the same amount of power, but without any increase in the load upon it, and will wait, so to speak, for the other motors to come to its assistance. While this operation has been going on, the switch will have been turned so as to bring the motors successively into circuit, and the same operation is performed at each motor, each gradually developing its power and maintaining such power and then waiting, prepared to act at once, for the moment when the final motor is placed in circuit and has compressed its springs and brought its frictional surfaces into contact sufficiently to give the necessary slight increase of power to start the car, whose inertia has already been almost overcome by the preceding motors. The number of motors required to start the car will of course depend on the load which it carries and the other conditions at the particular time. After the car is running the switch may be turned back and one or more motors removed from circuit. When the circuit of a motor is broken, the pressure of springs I moves the sleeves back along their screw-threads and removes the frictional pressure from the wheels B. In stopping the car the switch is turned backward and such motors as are in circuit are thus successively removed therefrom; or in order to more quickly produce this effect the motors may be reversed for a moment, so that the reverse movement of the shaft immediately screws the parts in the reverse direction from before and brings them back to their normal position, after which the current may be shut off. The continuance of the reversed current of course will cause the application of the friction in an opposite direction from before, causing first a braking action and ultimately a backward movement of the car.

The number of motors in circuit is varied from time to time while the car is in operation as the load varies or as the conditions of grade, &c., change, and in each case the total load will be distributed equally among such motors as may be in circuit. When it is desired to run in an opposite direction, the reversing-switch in the field-magnet circuit is shifted, whereby the direction of rotation of all the motors is changed, the operation of the power-transmitting devices being the same in either direction, as already explained.

I do not claim herein the power-transmitting devices or any feature thereof by themselves, but only in connection with the successively introduced motors, these mechanical features being claimed in my application filed August 16, 1890, Serial No. 362,296.

What I claim is—

1. The method herein described of operating an electrically-propelled vehicle, which consists in successively closing circuit to two or more electric motors mechanically connected with the wheels of the vehicle in starting the same.

2. The combination of a wheeled vehicle, two or more electric motors mounted thereon and mechanically connected with the wheels of the vehicle for propelling the same, and electrical connections such that said motors may be successively introduced into circuit, substantially as set forth.

3. The combination of a wheeled vehicle, two or more electric motors mounted thereon and mechanically connected with the wheels of the vehicle for propelling the same, and a switch for throwing such motors successively into circuit, substantially as set forth.

4. The combination of a wheeled vehicle, two or more electric motors mounted thereon and mechanically connected with the wheels of the vehicle for propelling the same, means for reversing the direction of rotation of said motors, and a switch for throwing such motors successively into circuit, substantially as set forth.

5. The combination of a wheeled vehicle, two or more electric motors mounted thereon, each of such motors being connected with the wheels of said vehicle through a frictional connecting device, and electrical connections such that said motors may be successively introduced into circuit, substantially as set forth.

6. The combination of a wheeled vehicle, two or more electric motors mounted thereon,

each of such motors being connected with the wheels of said vehicle by means of a frictional connecting device and an elastic determining device determining the frictional engagement, and electrical connections such that said motors may be successively introduced into circuit, substantially as set forth.

7. The combination of a wheeled vehicle, two or more electric motors mounted thereon, each of such motors being connected with the wheels of said vehicle by means of a frictional connecting device and an elastic determining device determining the frictional engagement, a stop positively limiting the frictional engagement of each motor, and electrical connections such that said motors may be successively introduced into circuit, substantially as set forth.

8. The combination of a wheeled vehicle, two or more electric motors mounted thereon, each of said motors being provided with means for gradually applying its power to the vehicle, and electrical connections such that the motors may be successively introduced into circuit, substantially as set forth.

9. The combination of a wheeled vehicle, two or more electric motors mounted thereon, each motor being connected with the running-gear of the vehicle by a frictional connecting device operated by the movement of the motor, and electrical connections such that said motors may be successively introduced into circuit, substantially as set forth.

10. The combination of a wheeled vehicle, two or more electric motors mounted thereon, each motor being connected with the running-gear of the vehicle by a frictional connecting device operated by the movement of the motor and provided with a spring opposing its operation, and electrictrical connections such that said motors may be successively introduced into circuit, substantially as set forth.

11. The combination of a wheeled vehicle, two or more electric motors mounted thereon, each motor being connected with the running-gear of the vehicle by a frictional connecting device operated by the movement of the motor and provided with a spring opposing its operation and a stop positively limiting the frictional engagement, and electrical connections such that said motors may be successively introduced into circuit, substantially as set forth.

12. The combination of a wheeled vehicle, two or more electric motors mounted thereon, each motor being connected with the running-gear of the vehicle by a frictional connecting device provided with a stop limiting the frictional engagement to a predetermined extent, and electrical connections such that said motors may be successively introduced into circuit, substantially as set forth.

13. The combination of a wheeled vehicle, two or more electric motors mounted thereon, a frictional connecting device for each motor for transmitting its power to the vehicle, said device being operated in each case by a screw moved by the motor and provided with a spring opposing the screw-movement, and a stop positively limiting such movement, and electrical connections such that said motors may be successively introduced into circuit, substantially as set forth.

This specification signed and witnessed this 7th day of August, 1890.

EDWARD H. JOHNSON.

Witnesses:

D. H. DRISCOLL,

W. PELZER.