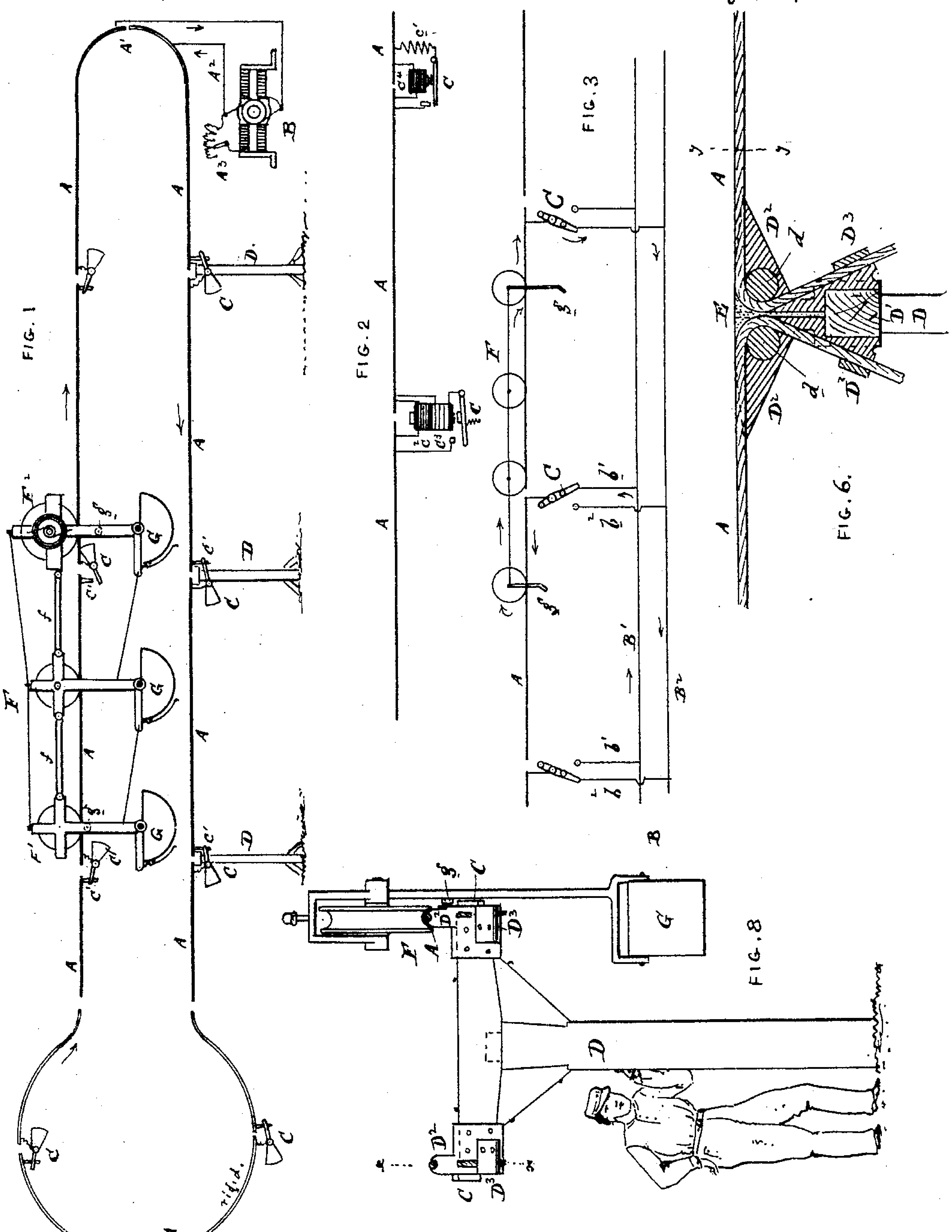
(No Model.) 2 Sheets—Sheet 1.

R. M. HUNTER.

ELECTRIC RAILWAY.

No. 455,796. Patented July 14, 1891.



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Inventor
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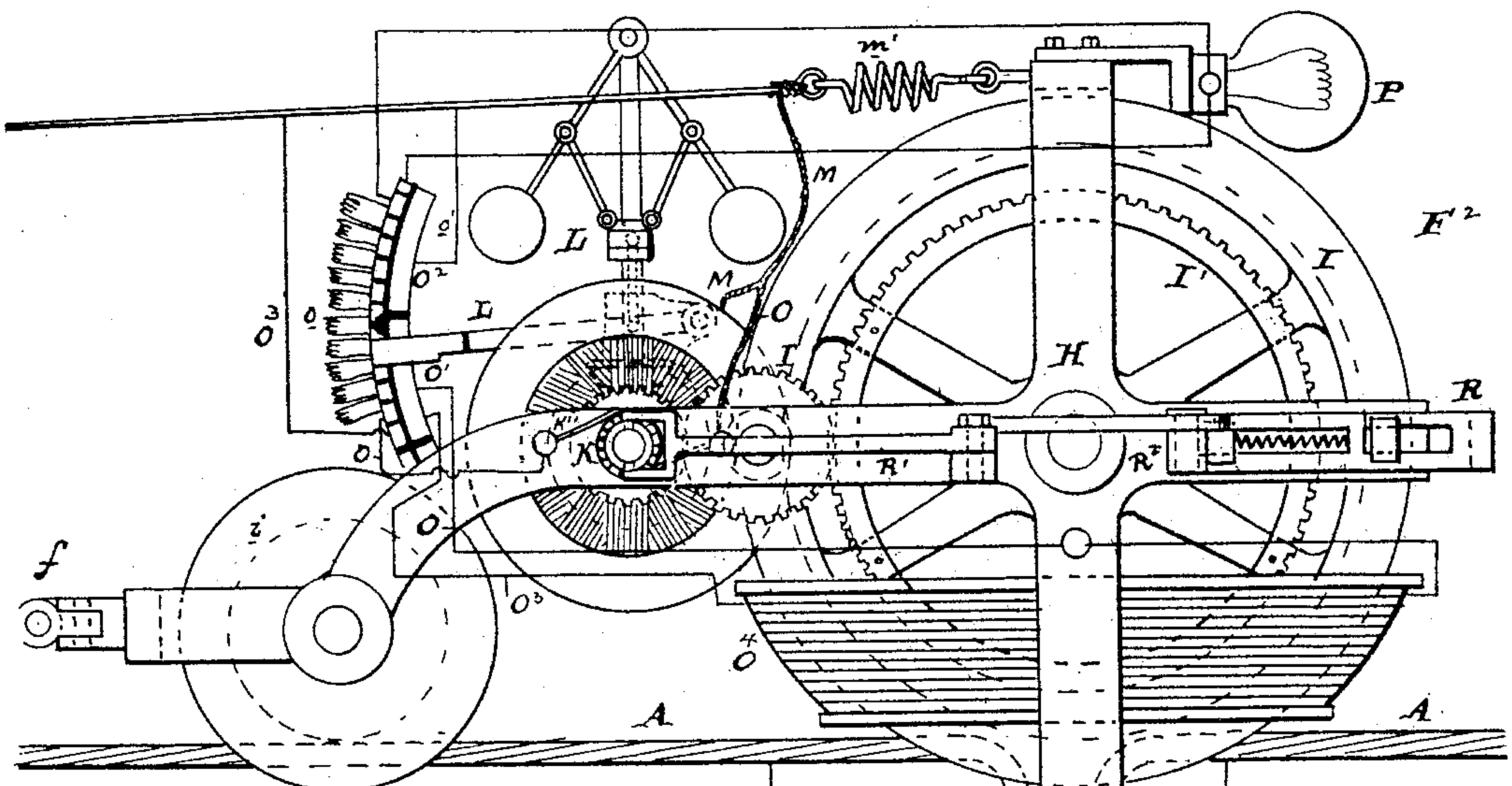

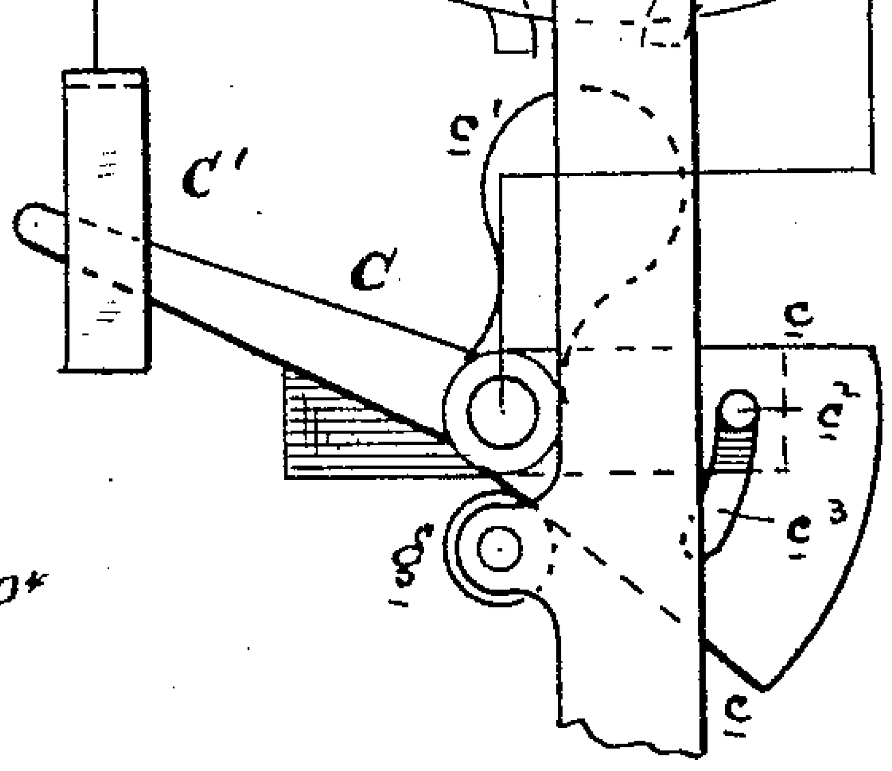

FIG. 4

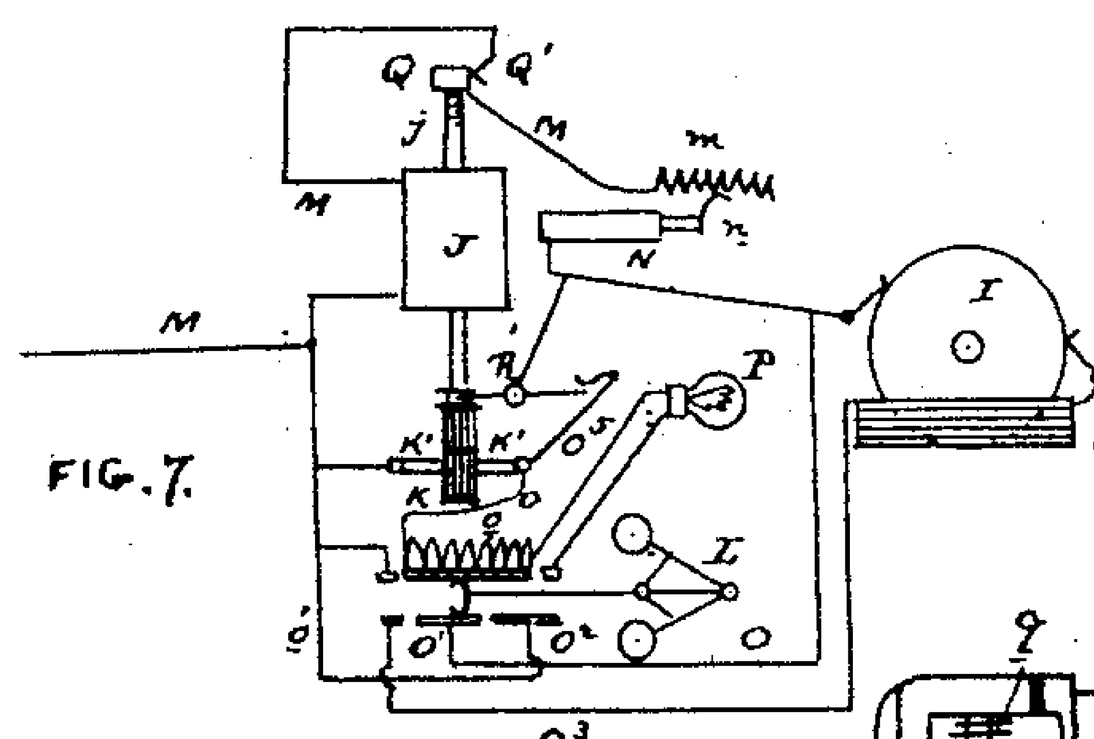

FIG. 7.

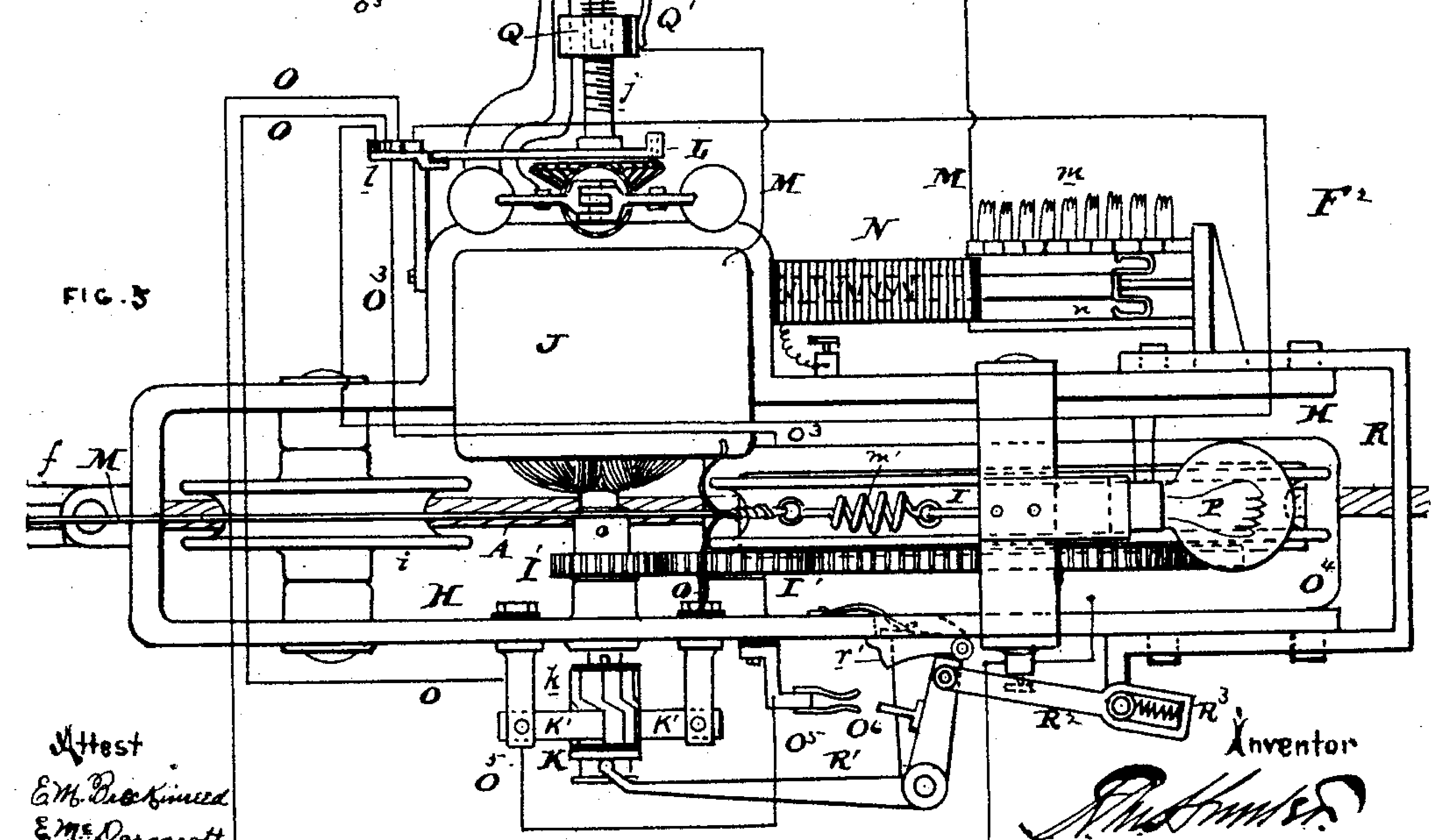

FIG. 5

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UNITED STATES PATENT OFFICE.

RUDOLPH M. HUNTER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE THOMSON-HOUSTON ELECTRIC COMPANY, OF BOSTON, MASSACHUSETTS.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 455,796, dated July 14, 1891.

Original application filed May 22, 1886, Serial No. 202,950. Divided and this application filed October 6, 1886. Serial No. 215,458. (No model.)

To all whom it may concern:

Be it known that I, RUDOLPH M. HUNTER, of the city and county of Philadelphia, and State of Pennsylvania, have invented an Improvement in Electric Railways, of which the following is a specification.

My invention has reference to electric railways; and it consists in certain improvements, all of which are fully set forth in the following specification and shown in the accompanying drawings, which form part thereof.

There are two generic systems of electric railways—one in which the car or motor is controlled by an operator and is adapted for passenger transportation, and the other of which is for merchandise transportation and is self-regulating. This latter system when cables or elevated rails are used is technically called "telpherage," and it is to such system that my invention has more particular reference.

The essential feature of this system is that the motors or trains are made to travel over or parallel to a conductor which is automatically broken at successive points within range of the length of the train, so that the current is brought up from the line through the motor and led back again to the line, whereby all the motors or trains are working in series with each other and receiving their electro-energy from a common source.

While I show and describe the railway as formed of taut wires, cables, or rails in an elevated position upon posts, it is to be understood that the same system is applicable to surface roads and with operators to control the trains or cars.

In carrying out my invention I stretch cables between posts or supports, say, one hundred feet apart, and these sections are electrically coupled by suitable switch devices, either mechanical or electrical, and adapted to be automatically actuated by the passing train or motors. A current of electricity is made to flow over said stretched line by a dynamo connected with the home end. The trains may be made up of several cars propelled by a single motor, or each car may have a motor, and said trains or motors should be of a length equal to the distance between two switches. The forward end of the train automatically opens one switch, while the rear end of the train closes the next switch in the rear. By this means there will only be one switch open at one time, and this switch will make a break in the line. The current is led up from the rear end of the train through the electric motor to the forward end and again to line beyond the break. If the distance between the switches is small, then a single car may be made to operate the switches. This, however, would be more suitable in surface roads, and the particular means for accomplishing that result will form subject-matter of another application.

The train in a telpherage system is without any one to control it. Hence it must be made self-regulating. I therefore provide the motor of said train with the following devices:

This application is a division of that filed May 22, 1886, Serial No. 202,950, and is designed to cover the specific constructions of railway as embodied in the claims appended, the original application being more particularly for the means of regulating or controlling the travel of the motor, and for the broadest construction of the series principle of electric railways.

In the drawings, Figure 1 is a general view illustrating the main features of my system. Fig. 2 are diagrams illustrating methods of operating the switches electrically, but yet controlled by the passage of the train. Fig. 3 is a similar view showing the same general system, but in which the line-wires are separate from the working-conductor and connected to it at intervals and in which the working-conductor is in section. Fig. 4 is a side elevation of a train-motor embodying my invention. Fig. 5 is a plan view of same. Fig. 6 is a sectional elevation on line x x, showing method of uniting the ends of the line conductors. Fig. 7 is a diagram illustrating the principles involved in the construction of the motor, and Fig. 8 is a cross-section of the railway on line y y.

A are sections of the working-conductor, which is shown as composed of stretched cables supported at their ends upon posts D D′, but insulated from each other. (Best shown in Fig. 6.) They may be bent over guide-pulleys *d*, held in frames D^2, which are bolted to the cross-bar D′ of the support, and the ends of the cables after the cables are stretched are clamped at D^3, the pulleys *d* allowing the cable to be drawn up taut without excessive friction. The space E between the two frames D^2 of adjacent cables is filled with asphaltum, concrete, cement, or other hard and insulating material. One of the ends of these sections A is connected to the switches C, (see Fig. 1,) which when closed completes the line-circuit from one section to the next, the contact being made by springs C′. These switches C have the cams *c c*, (see Fig. 4,) whereby they are adapted to be shifted by the passing train. The roller or pin *g* on the forward motor or car opens the switch as the train runs upon each new section, and the roller or pin *g* on the last car or motor (see Fig. 1) closes the switch as it leaves the section. The switch-lever C is combined with a weight *c′*, which is shifted to one or the other side of the fulcrum of the switch to hold it open or closed after being shifted by the passing train or motor. This acts as a lock whereby friction is not relied upon to hold the switch in its extreme positions. In addition to this function the weight assists in shifting the switch-lever, so as to make it operate quickly to open or close. The movements of the switch are limited by a pin c^2 on the supporting-frame, working in a slot c^3 on the switch. Referring to Fig. 1, it will be seen that by this means there is always a break in the line-circuit between the front car or motor F^2 and rear car F′ of the train F.

G are buckets or cars for carrying earth, ores, coal, or other merchandise. They may, if desired, be passenger-cars. The section A forms a continuous track, the juncture of the terminals A′, however, not being connected by a switch, but connected with the respective poles of the generator.

A^3 is a resistance-changer for short-circuiting a portion of the current from the generator and may be used to regulate the line-current, and also to reduce the current in the line for the instant the train is passing over the break A′ to prevent injury to its motor.

In place of making the switches C to be moved by contact with the train, they may be made automatic by the electric current flowing through the line. Two ways of accomplishing this are shown in Fig. 2.

C^2 is a high-resistance helix and connects the adjacent ends of two sections A of the cable.

C^3 is a low-resistance coil and has one terminal connected with one section A and the other terminal to the armature or switch C, which is attracted by the core of these helices. When the armature or switch is attracted, it connects with the other section A, and thus a closed circuit is made through the low-resistance coil. When a train spans or bridges one of these electrical switches, so much of the current is shunted that the armature falls, opening the low-resistance circuit, making a practical break in the line. After the train has passed the total line-current is flowing through the high-resistance helix, which instantly draws up the armature C, bringing the low-resistance helix into circuit, and thereby protecting the fine wire of the high-resistance helix or shunt from destruction. In place of two helices a single helix C may be used; but in this case a resistance *c′* must be put in the switch-circuit; otherwise magnet C^4, which is in a shunt-circuit between the sections A and the switch-armature, would act as a vibrator. In these cases it has been proposed to use the sections A as the line or supply circuit as well as the working-circuit. There is considerable objection to this, as the bare cables are exposed, and as the current is constantly passing over them there must of necessity be leakage and abnormal resistances, due to imperfect contacts, which when duplicated are greatly magnified.

In the system shown in Fig. 3 the current is fed to line-wires B′ B^2, which are continuous and which may be embedded or properly supported and insulated above ground. From these wires the current is fed by branches *b′* b^2 to the working-sections A, the switches C controlling the connection of the section A with the conductors B′ or B^2. The working of this system is evident upon examining Fig. 3. It will be noticed that only two sections A are coupled up in series while the train is in contact with them and all others are out of circuit and no current is passing over them.

F^2 is the motor-car. H is its frame, in which the main traction-wheel I and the trail or guide-wheel *i* are mounted.

J is the electric motor and is carried by said frame H and is geared at I′ with the main wheel I.

K is the commutator and has an auxiliary part *k*, in which the sections are advanced sufficiently for reversing the motor. This commutator is movable longitudinally upon the armature-shaft, so that the part *k* may be moved into working position with the brushes K′, if desired. The various cars are connected by couplings *f*, which may have universal joints, as shown in Figs. 4 and 5, to admit of the long train turning corners and following quick changes in altitude. The current is brought from the rear car by wire M to the motor. Here it divides, part of the current going through the field-magnet circuit M, to frame H, and wheel I to line, and part to the armature-circuit frame H and wheel I to line. Of course it is evident that the armature might be coupled up in series with the field-magnets in place of multiple-arc connection.

N is a helix in the circuit M and operates an armature *n*, which sweeps the resistances

m, also in the circuit M, whereby the resistance in the field-magnet circuit may be automatically varied, for the purpose hereinafter specified.

L is an ordinary centrifugal or speed governor and is connected either directly or indirectly with the armature-shaft of the motor. Hence its speed is dependent upon the speed of the armature, and consequently the motor as an entirety. This governor moves a contact-brush l, which sweeps the resistance o in the armature-circuit O, and also the contacts O' O^2, the former of which is in the armature-circuit and connects to line, and the latter of which is in a closed armature-circuit. When the speed is normal, the current passes from M through the armature, through circuit O, resistances o, contact O', and circuit O to line. Any slight variations in speed are governed by the governor increasing or decreasing the resistance o in the armature-circuit. If now the speed should continue to increase, due, say, to steep incline and heavy load, the governor will continue to move the contact-brush l, and it will leave contact O' and pass on to contact O^2, which is in circuit with the other end of the armature-circuit by wire o'. The armature is now cut out of the line-circuit and coupled up in a local circuit with the resistances o, which increase with the speed. The motor has now become a generator or dynamo-electric machine, and the resistance to the rotation of the armature is utilized as a brake. The motor has practically disappeared and the breaking-dynamo substituted in its stead. The current generated in the armature is expended in overcoming the resistances o, which are increased or decreased according as the speed of the train increases or decreases. The dynamo into which the motor has been converted through the inductive action of the armature augments the line-current, and this increase is further made apparent in that as the current in the line or field circuit M increases, the helix N draws in its armature and reduces the resistances m. This reduction in the resistance increases the power of the field of force and acts more powerfully upon the armature, tending to bring it to rest much sooner. If the speed still increases, (which can only occur in exceptional cases or where there is derangement of some of the working parts of the motor,) the governor will close the armature-circuit through the danger-signal lamp P, which, while it acts as an additional resistance, is a signal at night to indicate the enormous speed at which the train is traveling, and when its movement could not be perceived. This display of a danger-signal when the train is a long distance off will give ample time to operate a switch or turn-out or provide suitable means to arrest its movement and prevent excessive damage. This signal-light will naturally be a red light, but may be of any color desired, and is preferably of the large incandescent type. There may be any number of these lights desired, and one or more white lights may be used as head-lights, as set forth in my application filed April 28, 1886, and serially numbered 200,400.

One other office of the governor is to close a branch circuit O^3, including the helix O^4, surrounding the lower part of the traction or drive wheel I, to magnetize and cause it to attract the cable A and form a greater traction effect. This will come into play only at starting or when the train is running slowly, as in mounting heavy grades.

R is a buffer carried by the frame H and is supported at the rear by springs r. If the car runs into anything, the first concussion is received by the buffer. The backward movement of the buffer is utilized to shift the commutator to bring the part k under the brushes K' to reverse the motor, and also to couple up the armature into a motor-circuit again. This result is accomplished by a lever R', which connects with the commutator, and a slotted link R^2, which connects the lever R' with the buffer R. As the buffer is forced back the lever R' is oscillated, shifting the commutator and closing the armature-circuit to line by wire O^5 and circuit-closer O^6. (See Fig. 5.) The instant the lever R' is shifted it is locked by spring-lock r', and the buffer may remain locked against return or it may be allowed to return, compressing the small spring R^3 in the link R^2. The motor is now reversed and the train travels backward away from the danger; but the instant the armature is reversed the screw j thereon screws into the nut Q, pressed against it by light spring q, and causes said nut to travel and break the contact Q', which ruptures the line-circuit M through the field-magnets and stops the motor and train.

The motor proper may be of the series, shunt, or compound-shunt type or any other form.

The switches C may be made to work upon a horizontal or vertical axis, as desired, or may be made like any of the well-known sliding switches. In the form shown (see Fig. 5) it would be advisable to use a locking weight c', which acts to retain the switch in either of its extreme positions until positively acted upon by the rollers or switch-cams g. In place of cables A the rails may be made of bars, rods, or beams, elevated or upon the surface, or any or all of these may be combined to suit requirements in particular cases. The line M, connecting the front and rear cars of a train, may be connected at one or both ends by springs m', which allow for rocking or fore-and-aft swinging of the cars or motors or for changes due to the train traveling over unequal elevations. At curves the cables A would be changed to rigid curved sections.

It is very evident that the details of construction may be changed and modified in various ways without departing from the invention. Therefore I do not in any wise limit myself to the particular construction shown.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In the herein-described system of telpherage, the combination of a conductor divided into sections, switches which normally bridge from one section to the other, traveling trains or vehicles, one or more electric motors on the trains or vehicles by which they are driven, and devices operated by the trains or vehicles to move said switches successively and divert the current through the motors on said trains or vehicles, so that the motors are connected in series through the divided conductor.

2. The combination, substantially as set forth, of a conductor divided into sections, switches which normally bridge from one section to the other, trains or vehicles which run upon said divided conductor as a support or roadway, one or more electric motors on the trains or vehicles, and means for actuating said switches to move them successively and divert the current from the divided conductor through the motors on the trains or vehicles, whereby such motors are connected in series through the divided conductor.

3. In a system of telpherage, the combination of an insulated suspended conductor, a source of electric energy connected therewith, a traversing train or vehicle sustained thereby and traveling thereon, and an electric motor upon said vehicle supplied with electricity from said sustaining-conductor.

4. In a system of telpherage, the combination of a suspended wire, cable, or support, a vehicle traveling thereon and hanging below or in part below said wire, cable, or support, an electric motor on the vehicle, and an electric circuit connected with a source of electric energy from which said motor is supplied with electricity.

5. The combination of a traveling vehicle, an electric motor thereon for actuating it, an electric supply-circuit, a governor carried by the vehicle, which governor automatically cuts out the electric motor when a given speed is reached, and a brake which is applied by short-circuiting the motor when a higher speed has been reached.

6. The combination of a traveling vehicle, an electric motor thereon for actuating it, an electric-supply circuit, a branch or shunt circuit around the motor, a governor carried by the vehicle, and mechanism whereby the governor automatically shunts the current from the electric motor when a given speed is reached.

7. The combination of a support or roadway, electrically-actuated trains or vehicles traveling along said support or roadway, an electric circuit, a source of electric energy, and one or more motors on the trains or vehicles for driving them, connected in series in said circuit.

8. The combination, substantially as set forth, of a divided insulated conductor, traveling trains or vehicles, one or more electric motors carried by said vehicles for driving them, connected in series with the sections of said conductor, and mechanism by which said motors are connected in series with the sections of the divided conductor.

9. The organization of apparatus for propelling trains or vehicles in series by electricity, consisting in the combination of apparatus at a station for maintaining a uniform electric current, a conducting system by which said current passes to and through the trains or vehicles upon the line in series, and a speed-governing apparatus on each train or vehicle, which regulates the reception of current from the conductor.

In testimony of which invention I hereunto set my hand.

RUDOLPH M. HUNTER.

Witnesses:

E. M. BRECKINREED,
RICHD. S. CHILD, Jr.