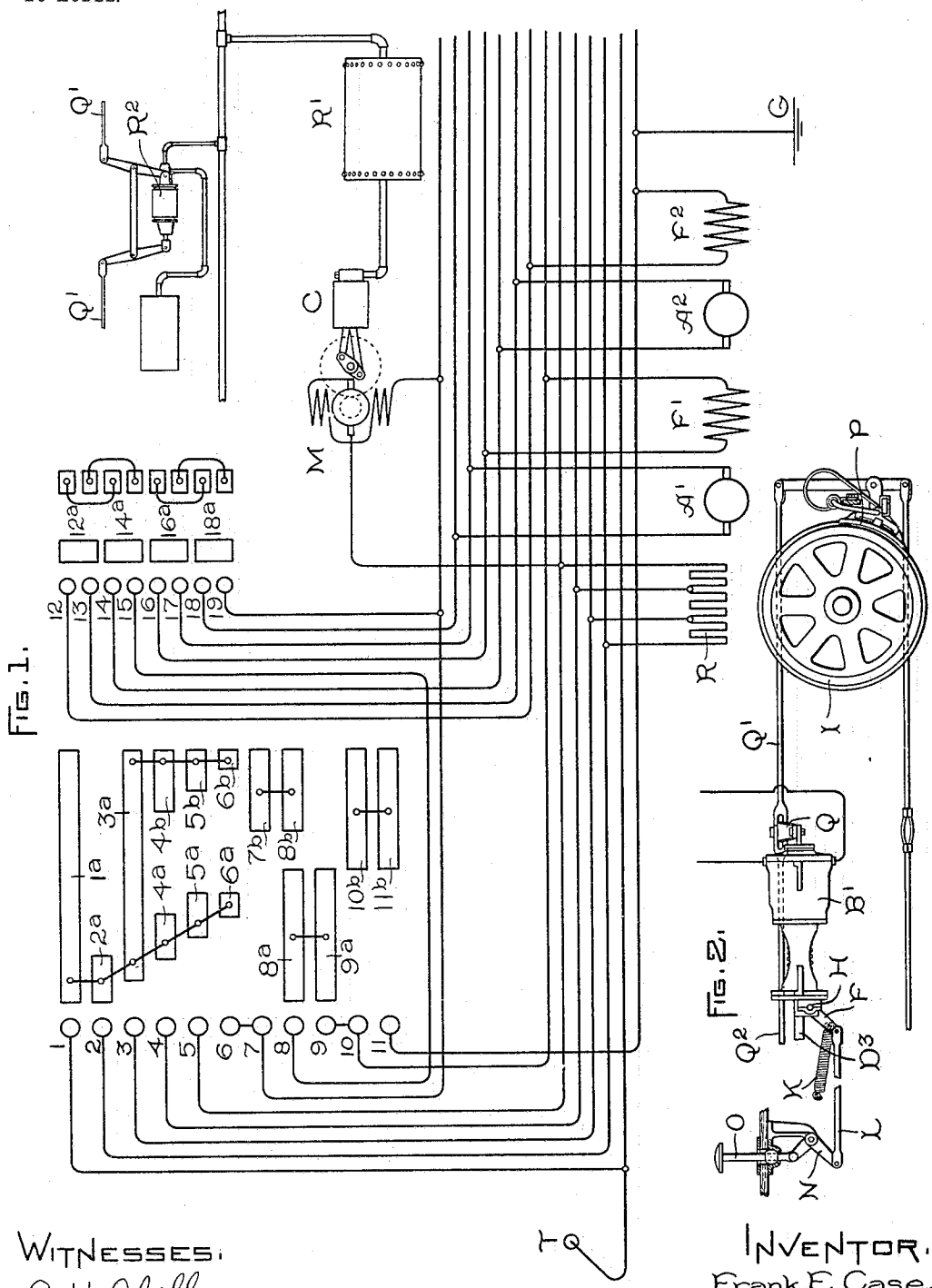
No. 766,325. PATENTED AUG. 2, 1904.

F. E. CASE.

REGULATING ELECTRIC MOTORS.

APPLICATION FILED APR. 15, 1898.

NO MODEL. 2 SHEETS—SHEET 1.



WITNESSES:

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INVENTOR.

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by Albert G. Davis

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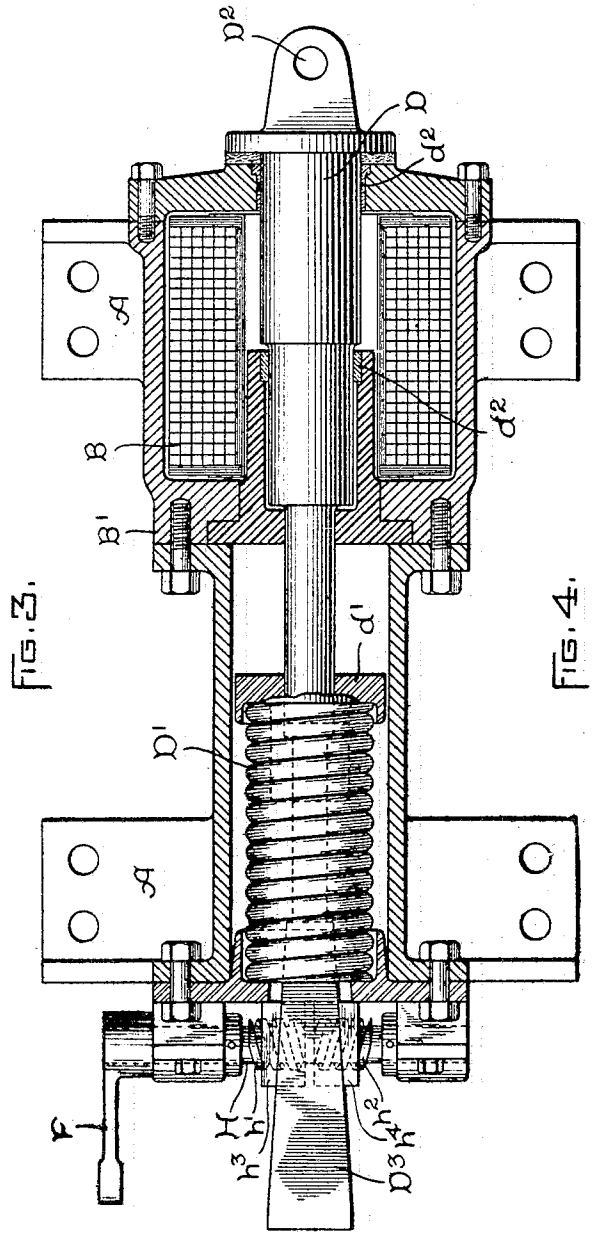

FIG. 3.

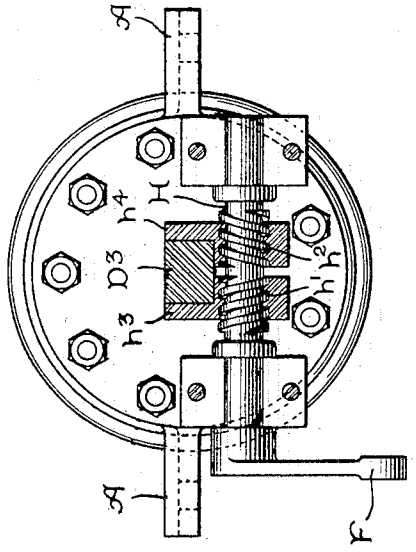

FIG. 4.

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No. 766,325. Patented August 2, 1904.

UNITED STATES PATENT OFFICE.

FRANK E. CASE, OF SCHENECTADY, NEW YORK, ASSIGNOR TO THE GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

REGULATING ELECTRIC MOTORS.

SPECIFICATION forming part of Letters Patent No. 766,325, dated August 2, 1904.

Application filed April 15, 1898. Serial No. 677,645. (No model.)

To all whom it may concern:

Be it known that I, FRANK E. CASE, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Regulating Electric Motors, of which the following is a specification.

My invention relates to the regulation of electric motors, particularly to those used on electric railways, and has for its object to provide means for increasing the efficiency of the system by utilizing, in part at least, the energy which ordinarily is wasted in the starting or running resistances. To attain this object, I substitute for a part of the regulating resistance a suitable motive device which by its resistance, self-induction, and counter electromotive force will reduce the current flowing to the main motors, but which instead of wasting energy may accomplish some useful auxiliary purpose, such as storing energy, as by running an air or similar fluid compressor, for instance, for operating the brakes. I am also able by my improvements to positively release the brakes at starting and to accomplish other useful results.

The invention is illustrated in the accompanying drawings.

Figure 1 is a diagram of circuits of a suitable controller. Fig. 2 is an illustration in diagram of the device used for releasing brakes. Figs. 3 and 4 are a horizontal section and an end elevation, partly in section, respectively, of the device shown in Fig. 2.

In Fig. 1 I have illustrated a well-known form of controller, known in the art as the "K" controller and described in one of its forms in the patent to W. B. Potter, No. 524,396. It is immaterial what form of controller is used; but this is one well adapted to the invention. The contacts are numbered 1 to 11, respectively, and the contact-plates are correspondingly designated from 1^a to 11^b. The reversing-switch is shown on the right, its contacts being numbered from 12 to 19 and the contact-plates correspondingly numbered, as above described. The various circuits will not be traced, as they will be apparent to those skilled in the art, and the particular combinations are not essential to the invention.

The general operation of the controller is to couple the motors in series with a resistance in its first position and to gradually cut the resistance out in subsequent positions until when the contacts 8 to 11 make contact, respectively, with the contact-plates 8^a to 11^b a shunt is thrown around the second motor with part of the resistance included in series. The shunt is broken as the contacts 8 9 pass off their contact-plates, and the motors are thrown in multiple with full resistance as contacts 7 8 touch the plates 7^b 8^b. Further rotation of the controller again cuts out resistance. The reversing-switch shown simply acts to reverse the connections between armatures and fields, and need not be more particularly described.

The circuit in the first controller position is as follows: from trolley T to contact 1, contact 2, through the resistance R to the motor M, (to be presently referred to,) through the reversing-switch to contact 18, through armature A′, through the reversing-switch to contact 16, through field F′ back to the controller-contact 9, contact 8, through the reversing-switch to contact 14, through armature A^2, through the reversing-switch to contact 12, and through field F^2 to ground at G. Thus it will be seen that the small motor M is included in series with the resistance R and, in effect, forms a step of the resistance. To operate to the best advantage, this motor should be one of comparatively high ohmic resistance, so that practically it will act as a dead resistance in the circuit and cut down the current even before it gets up its counter electromotive force. I have illustrated the motor M as geared to a compressor C and pumping air into a reservoir R′. It will be manifest thus that whatever energy is consumed by the motor will be, so far as the motor efficiency permits, stored in the tank R′ and not simply wasted in heat, as in the ordinary resistances. The compressed air may, particularly when the motor to be regulated is placed upon a railway car or train, be utilized for braking purposes. I have illustrated at R^2 the air-brake mechanism, which may be of any preferred type, acting upon the brake-rods Q′. It is further manifest that the principle just indicated might be carried out to a consider-

able extent by the duplication of motors of the class designated. This I have thought unnecessary to illustrate or describe because it would be readily understood by engineers.

In Figs. 2, 3, and 4 I show another device for accomplishing in another way the same useful results. In this figure I is the car-wheel, and P is the brake-shoe mounted thereon, controlled by the brake-rod Q'. This brake-rod is attached to an eye D^2, formed in the end of the core or shaft D. This connection is shown as made through a lever Q and a floating linkage, as usual, so that a movement of the core or shaft D to the right will apply the brakes at both ends of the car and a corresponding movement to the left will release them. The details of this linkage, which is similar to that shown in Fig. 1, are well known in the art and need not be illustrated. The spring D' is so placed on the shaft as to tend always to set the brakes powerfully on the wheels by moving the core D to the right in Fig. 3.

Mounted upon the same base A with the inclosing shell is a metal piece B', preferably of soft iron, inclosing a solenoid B, which when energized tends to draw the core to the left. It thus appears that when current flows through the solenoid-coil the brakes are released, while at other times the spring tends to cause them to engage the wheels. A stop d' and bushing d^2 are provided, as shown.

Fastened to one end of the core or shaft D, or integral therewith, is a wedge D^3, which slides between two stops h^3 h^4. These stops are pierced with an opening in which screw-threads are cut and are mounted on the shaft H, provided with reversely-cut threads h' h^2. This construction is well shown in Fig. 4. The arm F, mounted on the shaft H, is connected to a spring K, which tends always to rotate it in a right-handed direction, and is further connected, through the link L and bell-crank lever M, to a stud O, preferably placed upon the front platform of the car.

The electrical connections need not be shown in detail, since the coil B simply takes the place of the motor M in Fig. 1 or is in some other way interposed in place of a resistance-stop; but this coil should preferably be so placed that it is energized the moment the controller is thrown to such a position as to start the car in either direction.

Assume now that the parts are in the position shown in Fig. 3. The car is assumed to be running and current is flowing through the solenoid B. If now the motors be speeded up by cutting out all the resistance, it is evident that the solenoid will be deënergized. This would tend to set the brakes; but this action is prevented by the wedge D^3 and the stops h^3 h^4, which bear upon it, since it is obvious that in order to set the brakes it is necessary that the stops h^3 h^4 be separated, which would involve a partial rotation of the arm F against the spring K. The parts will therefore remain in the position shown utterly irrespective of any change which may take place in the motor connections.

When it is desired to stop the car, the motorman simply presses the stud O, which, acting through the bell-crank lever N and the link L, causes a partial left-handed rotation of the arm F. This rotates the shaft H and allows the stops h^3 h^4 to separate. The spring D' is then able to apply the brakes. It will be seen that it is possible in this way to apply the brakes suddenly to their full extent or it is possible to release the spring D' only by a certain small amount, as preferred.

The brakes once set will remain in position as long as desired; but the moment that the controller is moved to start the car the solenoid B is immediately energized and attracts its armature D in such a way as to produce a positive disengagement or release of the brakes. At the same time energy is restored by the compression of the spring D' sufficient to operate the brakes when it again becomes necessary. This device provides, therefore, means for positively disengaging the brake-shoes at the time of starting the car dependent upon and actuated by the current in the motor-circuit, such means acting also in the arrangement illustrated as a part of the necessary controlling resistance and being ordinarily cut out after it has performed its office. By the positive disengagement or release of the brake-shoes I mean a power-actuated release positively overcoming frictional or other accidental obstacles. With it I combine auxiliary means for retaining the brake-shoes in their retracted position, and this is by preference under the control of the motorman, and also an automatic device for applying the brakes under control of, but not dependent upon, hand-power. It will be apparent that as the wedge D^3 is maintained by the spring D' in contact with the nuts h^3 h^4, operated by the worms h' h^2, the spring D' is so far under the control of the detent for the brake-releasing mechanism that its force may be utilized to apply the brakes to any desired degree. As the stud O is pressed down, if it be pressed lightly, for instance, the spring will barely cause the engagement of the shoe with the wheel, so as to have but slight retarding effect, while if the stud be pushed down so that the worms are rotated sufficiently far the wedge D^3 will be released altogether and the spring will act to apply the brake-shoes with any desired force, according to its strength. One object of keeping the detent for the brake-shoes under direct control of the motorman is to prevent the automatic application of the brakes when the retracting device is cut out, which otherwise would occur. The objects of the invention, it is manifest, could be carried out by other mechanism or connections than those shown; but I aim to include all such variations in the

claims. Ordinarily the greatest utility of my invention will be found with electric motors, particularly those used on railways. Some of its features, it is manifest, are not thus limited, but may be applied wherever they are useful with any class of apparatus.

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

1. A circuit, a resistance therein, a dynamic energy-storing device included as part of the resistance, and a switch for cutting in or out at will the resistance-sections.

2. A circuit, a resistance therein, a dynamic energy-storing device included as part of the resistance, and a switch for cutting in or out at will the resistance-sections and said device.

3. A circuit including electric apparatus to be regulated, a resistance in the circuit, a dynamic energy-storing device included as part of the resistance, and a switch for cutting in or out the resistance-sections.

4. A resistance divided into sections, an electrically-actuated motive device included in the circuit as a resistance-section, electrical apparatus regulated by the resistance, and means for storing energy absorbed by the motive device.

5. The combination of a motor or motors driving a load, such as an electric car or train, a controlling device for the motors, a motive device included as part of the controlling resistance, and means for storing energy absorbed by the motive device.

6. The combination of a motor or motors driving a load, a resistance, a controlling device for the motor or motors, a brake for the load, and a motive device for positively releasing the brake at starting, included as a section of the regulating resistance, and operated by the controller.

7. The combination of a motor or motors driving a load, a controlling device for the motor or motors, brakes for the load, and means actuated by turning on the controller for the motor or motors, for positively disengaging the brakes, with a detent under the control of the motorman, for retaining the brakes out of engagement with the moving load.

8. The combination with a number of motors driving a load, such as a car or train, a controlling device for the motors, a brake, means actuated by the current, and controlled by the controller, for positively disengaging or releasing the brake, a detent for holding the brake out of engagement, and means for automatically applying the brakes, controlled by the detent and applied when the latter is released.

9. The combination of an electric motor driving a load, a controller for the motor, a brake, means operated in response to movement of the controller for positively releasing the brake, a detent holding the brake out of action after its release, and automatic means, controlled by the detent, for applying the brake with force.

10. The combination with an electric car of a motor and brake therefor, and a regulating means for the motor acting to store energy to operate the brake.

11. The combination with an electric car of a motor and brake therefor, a regulating-motor, driving a pump to store energy for the brakes, and means for coupling the regulating-motor armature in series with the main-motor armature.

12. The combination of an electric motor and a starting device therefor, consisting of a resistance, an energy-storing device in circuit with the resistance, and a switch for cutting in and out the resistance and the energy-storing device.

13. The combination of a motor driving a load, means for storing a part of the energy of the starting-current in the form of fluid-pressure when the motor starts and means for utilizing the energy thus stored.

14. The combination of a motor, a load for said motor, and means for storing a part of the energy of the starting-current in the form of fluid-pressure when the motor is started.

15. The combination in an electric-railway system, of a railway-motor, a counter-electromotive-force device in series with said motor and an air-compressor driven by mechanical energy derived from said device, and air-brakes operated by pressure due to said air-compressor.

16. The combination of a plurality of sources of counter electromotive force in series, means for storing mechanical energy derived from one of said sources, and means for utilizing said energy independently of any operation of said sources.

17. The combination of a plurality of sources of counter electromotive force in series with each other, means for storing mechanical energy derived from one of said sources and means for utilizing at will, the energy thus stored.

18. The combination of a motor to be regulated, a resistance, a counter-electromotive-force device, a pressure-storing device driven thereby, and a switch for connecting the resistance, the counter-electromotive-force device and the motor in circuit and for dissimultaneously cutting the resistance and the counter-electromotive-force device out of circuit.

19. The combination of a motor to be regulated, a resistance, a counter-electromotive device, means for storing mechanical energy derived from said counter-electromotive-force device, and a switch for connecting the resistance, the counter-electromotive-force device and the motor in circuit and for dissimultaneously cutting the resistance and the counter-electromotive device out of circuit.

20. The combination of a motor to be regulated, a resistance, a counter-electromotive device, means for storing mechanical energy derived from said counter-electromotive-force device, and a switch for connecting the resistance, the counter-electromotive-force device and the motor in circuit and for cutting the resistance out of circuit step by step and dis- simultaneously cutting the counter-electromotive-force device out of circuit.

In witness whereof I have hereunto set my hand this 13th day of April, 1898.

FRANK E. CASE.

Witnesses:
B. B. HULL,
C. L. HAYNES.