(No Model.)

D. HIGHAM.

REGULATION OF ELECTRIC MOTORS.

No. 407,293. Patented July 16, 1889.

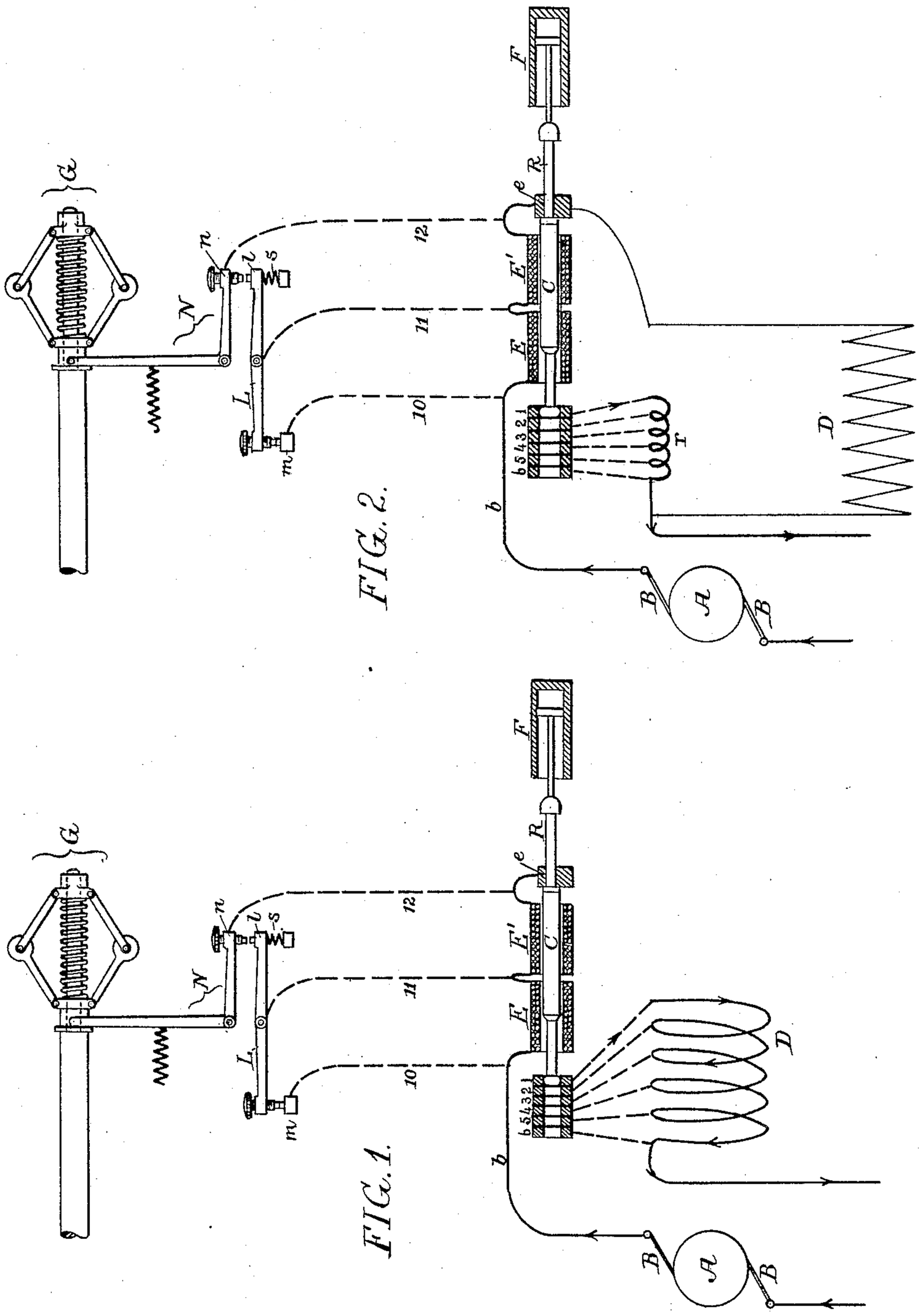

FIG. 2.

FIG. 1.

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UNITED STATES PATENT OFFICE.

DANIEL HIGHAM, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE HIGHAM ELECTRIC MOTOR COMPANY, OF SAME PLACE.

REGULATION OF ELECTRIC MOTORS.

SPECIFICATION forming part of Letters Patent No. 407,293, dated July 16, 1889.

Application filed October 3, 1887. Renewed December 22, 1888. Serial No. 294,445. (No model.)

To all whom it may concern:

Be it known that I, DANIEL HIGHAM, a citizen of the United States, and a resident of Philadelphia, Pennsylvania, have invented certain Improvements in the Regulation of Electric Motors, of which the following is a specification.

The object of my invention is to provide electric motors, more especially constant-current motors, with means whereby they may be automatically maintained at a constant speed irrespective of the load, and this object I attain by providing a centrifugal governor driven by the armature-shaft, in combination with electro-magnetic devices controlled by this governor, to automatically increase the field magnetism when the load is increased, and vice versa.

In the accompanying drawings, Figure 1 is a diagram illustrating my invention, and Fig. 2 is a diagram of a modification.

In the diagram Fig. 1, A is the armature of the motor, with commutator-brushes B B, while D represents the field-magnet coils in series with the armature-coils.

G is the centrifugal governor driven by the shaft of the armature, and for this purpose it may be mounted on the shaft or driven therefrom by indirect means. In connection with this centrifugal governor are the electro-magnetic devices controlling the field magnetism. In the circuit between the field-magnet coils and armature-coils I insert two solenoid-coils E and E′ in connection with devices for short-circuiting one or other of these solenoid-coils. One terminal of the coil E is connected through the conductor *b* to the commutator-brushes B, while the other terminal of the coil is connected to the terminal of the adjoining solenoid-coil E′. The opposite terminal of the solenoid E′ is connected to the bracket *e*, in which is guided one end of the rod R, carrying the solenoid-core C. The opposite end of the rod R is guided in a series of adjacent rings 1 2 3 4 5 6, insulated from each other, and this end of the rod is in electrical contact with one or other of the rings, while the opposite end of the rod is in electrical contact with the bracket *e*. Each of the rings 1 2 3, &c., is connected to a section of the field-magnet coils in such a way that when the rod R is in contact with, say, ring 3 the sections of the field-magnet coils which are connected to the rings 1 2 will be cut out of circuit, as will be readily understood.

The terminal of the solenoid-coil E, which is connected to the commutator-brush B, is electrically connected to a contact-stop *m* through the medium of the conductor 10. Against this stop normally bears one end of a pivoted lever L under the action of a suitable spring *s* or other means. Adjacent to the opposite end *l* of the lever L is the contact end *n* of a bell-crank lever N, which is acted on by the centrifugal governor G. The lever L is in electrical connection through the conductor 11 with the connected terminals of the solenoid-coils, while the contact-point *n* of the lever N is in electrical communication through the conductor 12 with the terminal of the coil E′, which is connected to the bracket *e*.

Under normal conditions the lever L is in electrical contact with the stop *m*, while the point *n* is out of contact with the opposite end of the lever. The circuit then, as indicated by the arrows, from the brush B is through the conductor 10, contact-stop *m*, lever L, conductor 11, solenoid-coil E′, bracket *e*, rod R, ring 1, and through the field-magnet coils, which are all in circuit. Under these conditions the solenoid-coil E is short-circuited, while the solenoid-coil E′ tends to draw the core C to its center and maintain the rod R in contact with the first ring 1 to keep all the field-magnet coils in circuit. When, however, there is any tendency on the part of the motor to increase its speed by a decrease of the load, the centrifugal governor G, acting on the lever N, will bring the contact *n* up against the end *l* of the lever L and break the contact at *m*. By this means the solenoid-coil E will be thrown into circuit, while the solenoid-coil E′ is short-circuited out. Immediately the coil E tends to draw the core C toward its center and move the end of the rod R into electrical connection with the rings 2 3 4, &c., to cut out more or less of the field-magnet coils of the motor, and so decrease the field magnetism of the latter and restore the normal conditions. By this means of controlling the field magnetism

the motors will be automatically maintained at a constant speed irrespective of the load by increasing the field magnetism when the load is increased and decreasing the field magnetism when the load is decreased.

It will be understood that instead of cutting out more or fewer of the coils of the field-magnet directly the devices above described may be used in connection with resistances in a shunt-circuit around the coils to automatically increase or decrease the field magnetism with an increase or decrease of load. In Fig. 2, for instance, I have illustrated resistances *r* connected to the rings 1 2 3 4, &c., and arranged in a shunt around the field-coils, so that under normal conditions all the resistances *r* are in the shunt-circuit and but little current passes through the shunt; but when there is a tendency on the part of the motor to unduly increase its speed by a decrease of load the solenoid-coil E′ is cut out of circuit through the devices above described and the coil E thrown into circuit, so that the rod R is brought into contact with the succeeding rings 2 3 4, &c., and more or less of the resistance in the shunt is cut out, so that more current will pass through the shunt and less through the field-magnet coils, as will be readily understood.

I claim as my invention—

1. The combination of the armature of an electric motor and a field-magnet having all its coils in series with the armature-coils with a centrifugal governor driven by the armature-shaft and electro-magnetic devices controlled by the governor to increase the field magnetism when the load is increased, and vice versa, substantially as described.

2. The combination of the armature and field-magnet of an electric motor with solenoid-coils, a core therefor and contacts controlled thereby, and centrifugal devices driven by the armature to automatically cut out one or the other of the solenoid-coils to vary the field magnetism, substantially as described.

3. The combination of the armature and field-magnet coils of an electric motor, and contact-rings connected to sections of the field-magnet coils, with a pair of solenoid-coils, and a common core controlling the contact for the said rings, and devices for automatically throwing one or other of the solenoid-coils out of action under the control of the armature-shaft, all substantially as set forth.

4. The combination of the armature and field-magnet coils of an electric motor, a pair of solenoid-coils, and a common core therefor with contact-rings, and a contact-rod controlled by said core, a centrifugal governor driven by the armature of the motor, and contacts acted on by the said governor to cut out one or other of the solenoid-coils, all substantially as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

DANIEL HIGHAM.

Witnesses:

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