(No Model.) 2 Sheets—Sheet 1.

C. J. VAN DEPOELE.

ELECTRO DYNAMIC MOTOR.

No. 404,324. Patented May 28, 1889.

Fig. 1.

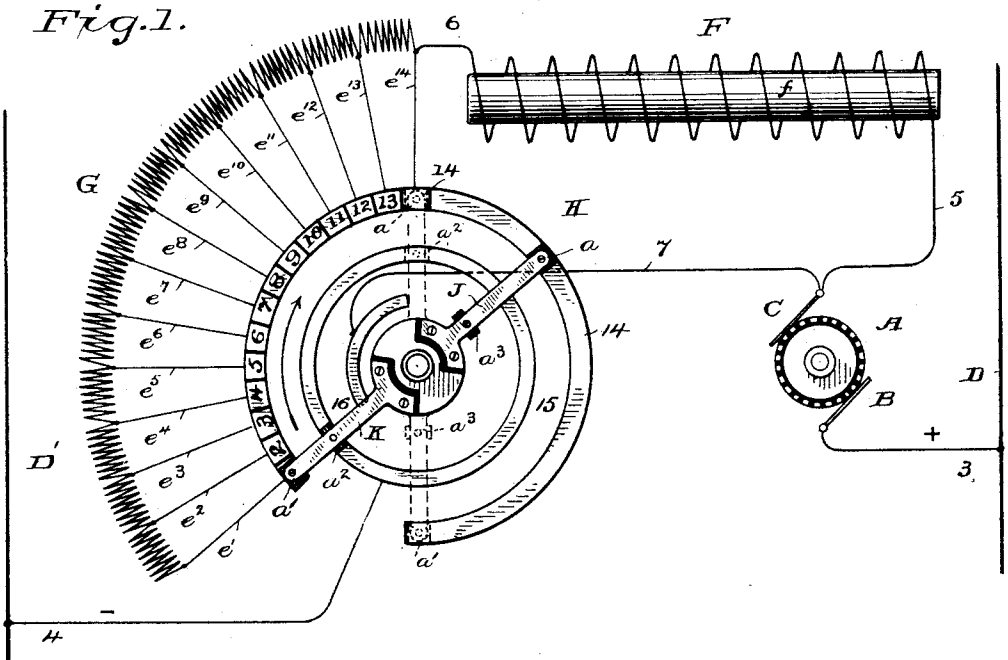
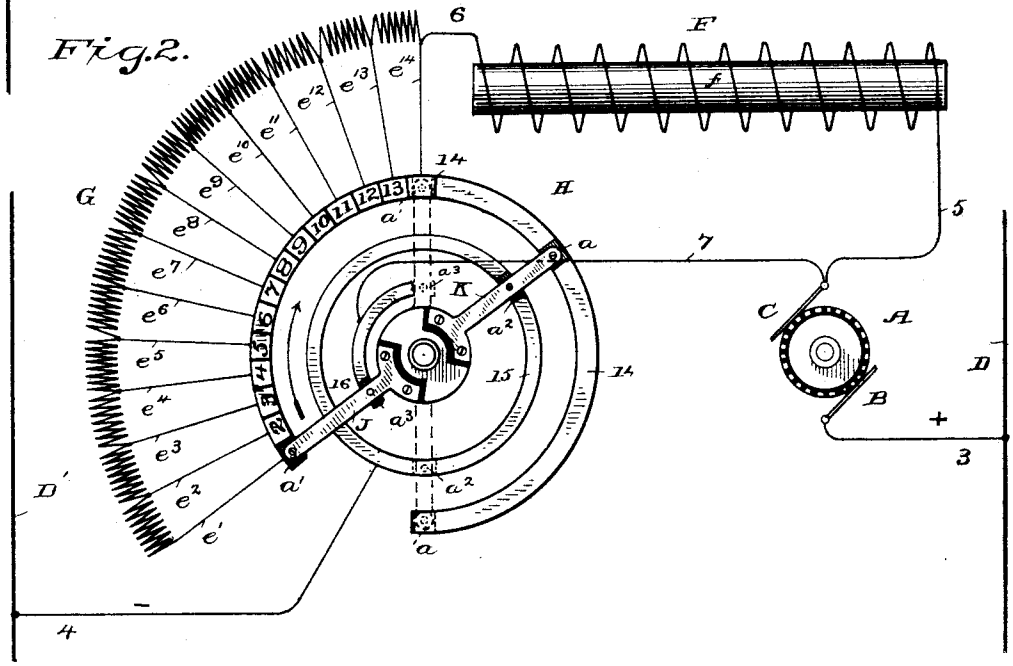


Fig. 2.



Witnesses.

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 3.

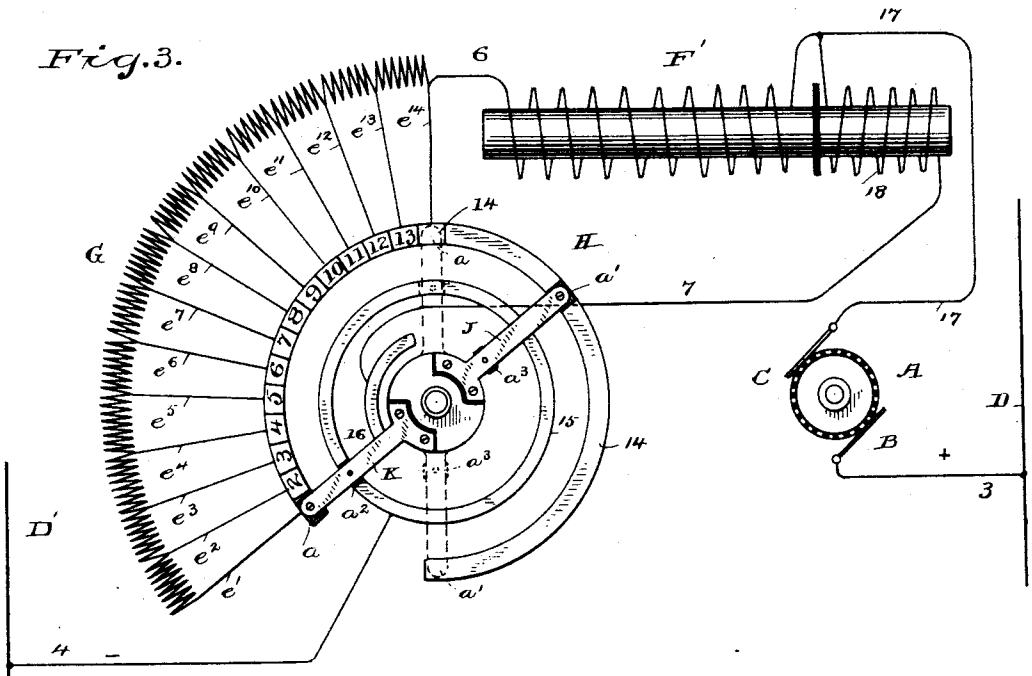
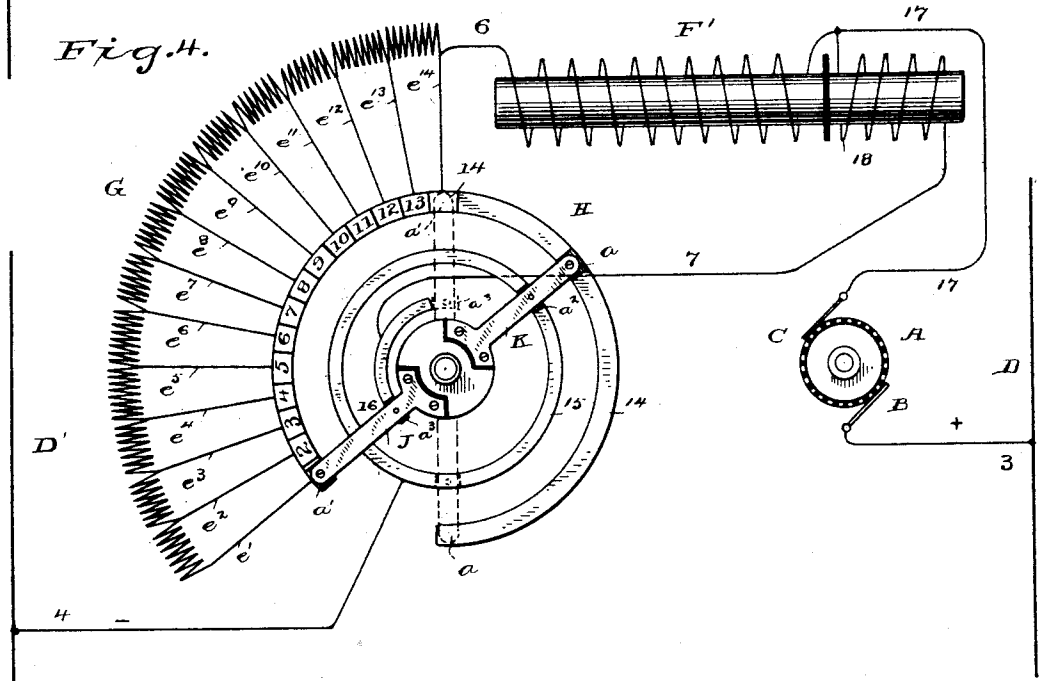


Fig. 4.



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CHARLES J. VAN DEPOELE, OF LYNN, MASSACHUSETTS.

ELECTRO-DYNAMIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 404,324, dated May 28, 1889.

Application filed February 28, 1889. Serial No. 301,492. (No model.)

To all whom it may concern:

Be it known that I, CHARLES J. VAN DEPOELE, a citizen of the United States, residing at Lynn, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Electro-Dynamic Motors, of which the following is a description, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon.

My invention relates to electric motors; and its object is to provide means for regulating the speed and power of the motor and at the same time to so control the flow of current therethrough that it will be commensurate with the results accomplished—that is, with the torque exerted by the field-magnets upon the armature—and, further, that the magnetizing effect of the field-magnet will be such that I can produce in the armature, even at low speed, such a counter electro-motive force as will operate to prevent too great a flow of current therethrough. I am thus enabled to cut out of circuit the artificial resistance frequently used and permit the entire current to flow through the coils of the field-magnet, thereby securing the maximum torque even at continued low speed, thus preventing an abnormal rush of current through the motor when pulling a heavy load.

In a prior patent, No. 347,902, August 24, 1886, I have shown and claimed a long series field-magnet in series with the armature, a number of the coils being so arranged that they could be cut out to reduce the resistance of the motor-circuit and also weaken the field-magnet when it was desired to increase the speed of the motor. In the present instance an artificial resistance is employed which is connected in series with a field-magnet not provided with sections to be cut out, the resistance and field-magnet being relatively so arranged that by means of suitable switching devices I can cut out resistance and throw the entire current through the coils of the field-magnet or place the resistance in a derivation from the field-magnet, or place all or part of said resistance in series with the field-magnet, or place said resistance in derivation from the field-magnet, and by cutting out part of said resistance cause it to divert a corresponding portion of the current from the field-magnet. Another form comprises the same elements as the foregoing, except that an additional demagnetizing-coil is wound upon the field-magnet and so connected that it can be coupled with the resistance spanning the field-coils acting to weaken the field-magnet.

An electric motor employing a short field-magnet must use in connection therewith a large artificial resistance; otherwise at the moment of starting an abnormal rush of current will take place through the motor and give a sudden jerk to the armature and gearing and the mechanical connections, besides taking too much current from the generator. Therefore with such a motor, in ordinary railway work, where the load has to be frequently stopped and started, a very large artificial resistance must be used in connection with the motor, consuming a large proportion of the total current energy supplied by the generator. Furthermore, in ascending steep grades the motor must either run at comparatively high speed or be, by the introduction of resistance, deprived of a large proportion of its possible power. The impracticability of developing the highest power of the motor at low speed without danger of overheating is therefore the difficulty which it is the principal object of the present invention to overcome.

The field-magnet of my improved motor is wound with coils sufficient to magnetize the pole-pieces to a high degree, the effect of which upon the armature, even at low speed, will be to produce a considerable counter electro-motive force. My improved method of utilizing an artificial resistance enables me to adjust the relative resistance of the field-magnet circuit and the remainder of the motor-circuit so perfectly in accord with the duty to be performed that the motor may exert its maximum power continuously at low speed for any desired length of time without overheating or consuming a wasteful proportion of the supply-current.

Several arrangements for carrying my invention into effect are shown in the accompanying drawings, and will be referred to in the appended description and claims.

In the drawings, Figure 1 is a diagrammatic view of the motor-circuit and resistance-

switch. Fig. 2 is a similar view, the switching device being shown in other positions. Fig. 3 is a diagrammatic view of the motor-circuit, including the additional demagnetizing-coil on the field-magnet. Fig. 4 is a view of the devices illustrated in Fig. 3, the switching apparatus being shown in other positions.

In the drawings, A indicates the commutator of the armature; B C, the commutator-brushes; D D′, the main conductors; 3, branch leading from the positive main conductor to the positive commutator-brush, and 4 branch conductor extending from the switch to the negative-line conductor.

F are the coils of the field-magnet, of which *f* is the core.

G is an adjustable resistance or rheostat formed in one connected series, but divided into fourteen sections by terminals e' to e^{14}, with insulated contact-blocks 1 to 14, arranged for convenience so as to form a segment of a circle. The outer extremity of the field-magnet coils F are connected by conductor 5 with the negative commutator-brush C, and the inner terminal of the said coils is connected by conductor 6 with one end of the resistance-coil G.

H indicates a switch, which may be circular, as shown. The outer diameter of the switch is partly composed of the resistance-terminals 1 to 13, and from the terminals 13 extends a continuous segmental contact, 14, to which the extremity of the resistance-coil G and also the inner terminal of the field-magnet coil F are connected by the conductor e^{14}. The outer diameter of the switch is not, however, a complete circle, a space being left between the extremity of the segmental contact 14 and the first one of the switch-terminals. Within the outer circle of the switch composed of the resistance-terminals and the contact 14 is placed an annular metallic contact, 15, which is connected with the return-conductor 4, and constitutes the common return for the switch.

A short segmental contact, 16, is located within the return-contact 15, and connected by the conductor 7 with the negative commutator-brush C. A switch-lever composed of metallic arms J K, connected to a central insulating-block, is pivoted to the axis of the switch. The arm J is provided with a contact brush or block, *a*, adapted to bear upon the outer circle of the switch, and the arm K is provided with a similar block, a', so that the extremities of the switch-lever J K will be at all times in contact with some portion of the outer circle, except when one or other of the said extremities occupies the space between the end of the contact 14 and the resistance-terminal 1. The arm J is also provided with a contact brush or block, a^3, arranged in such position that when the arm is properly moved it will engage the short segmental contact 16. The contact a^3 is in electrical connection with the brush *a* through the arm J. The arm K carries, in addition to the contact a', a contact, a^2, which is at all times in contact with the return-conductor through the circle 15, upon which it moves.

At starting, the arms J K, hereinafter referred to as the "switch-lever," are placed in position indicated in full lines in Fig. 1, with the terminal a' upon the resistance-block 1. In this position the field-magnet coils and the whole of the rheostat are connected in series, the current flowing from the negative commutator-brush through the coils of the field-magnet, thence by conductor 6 through the coils of the resistance G, then out by conductor e', terminal 1, contact a' upon the arm K of the switch-lever, thence through the arm K to contact a^2, thence to return-conductor through the circle 15. The contact *a* upon the arm J rests, meanwhile, upon the segment 14; but as said arm J has no connection with the return 15 the current cannot escape that way, and is compelled to traverse the entire series of coils, as stated.

To increase the current flowing through the field-magnet, the switch-lever is turned in the direction indicated by the arrow, thereby gradually reducing the amount of resistance in series with the field-magnet and permitting a greater flow of current therethrough, subject, of course, to the counteracting effect of the counter electro-motive force in the armature. With the switch-lever in the position shown in dotted lines in Fig. 1, the entire resistance is cut out, and the motor will act as a simple series machine. The action of the contact devices upon the arm J at the other end of the switch-lever is, for convenience, depicted in Fig. 2. As there seen in full lines, the position of the switch-lever is reversed, the contact a' resting upon the switch-terminal 1 and the contact *a* upon segment 14. In this position the contact a^3 engages the segment 16 and the contact a^2 the circle 15. The entire rheostat is now connected in derivation from the field-magnet coils, the circuits being as follows: from commutator-brush C by conductor 5 through the field-magnet coils and by conductors 6 and e^{14} to segment 14, thence through contact *a*, arm K, to contact a^2 and the return-conductor 15. The other path for the current starts also from brush C, passing through conductor 7, segment 16, contact a^3, arm J, and through contact a' and terminal 1 to the resistance G. The resistance being now in derivation from the field-magnet coils, the current will divide itself between said field-coils and the resistance-coils, according to their respective resistances or conductivities. When the switch-lever is moved in the direction of the arrow, thereby carrying the contact a' toward switch-terminal 14, the resistance G is gradually diminished, and, being still in derivation from the field-magnet, will, as the contact a' approaches the terminal 14, divert more and more current from the field-magnet coils by affording a by-path for its passage, thus affording means for weakening

the field-magnet to any desired degree, and thus regulating the speed of the motor by modifying the counter electro-motive force, as is well understood in the art.

With the switch-lever in the position shown in dotted lines in Fig. 2 the resistance is entirely cut out and the main current entirely shunted around the field-magnet coils. Thus it will be noted that the action of the switch-lever in the positions indicated in Fig. 1 connects any desired portion of the resistance in series with the field-magnet coils, while with the positions indicated in Fig. 2 the same lever reversed is used to place the resistance in derivation from the field-coils, thereby shunting any desired portion of the main current.

In Figs. 3 and 4 the same form and lettering are adhered to for convenience; but, in addition to the circuits and connections previously described, a differential winding is placed upon the field-magnet and arranged to be connected in series with the rheostat G when the latter is manipulated by the switch-lever, as described with reference to Fig. 2—that is, when the resistance is operated in shunt relation to the said field-magnet. As indicated in said Fig. 3, the circuit from the commutator-brush C is by conductor 17, through demagnetizing-coil 18, and thence by conductor 7 to the segment 16. The working-coils F′ of the field-magnets are connected to the conductor 17, the current flowing therethrough and out by conductor 6 and e^{14}, as previously described.

With the switch-lever in the position shown in full lines the segment 16, through which the rheostat is placed in shunt relation, is not in circuit, and consequently the demagnetizing-coils 18 receive no portion of the current, the said current flowing through the field-magnet coils and resistance, all in series, passing out through terminal 1, contact a, arm K, contact a^2 thereon, and the return-conductor 15. By moving the switch-lever in the direction indicated by the arrow the resistance may be gradually cut out until on reaching the position indicated in dotted lines the resistance will be all out and the field-magnet coils only in series with the armature.

In Fig. 4 the position of the switch-lever is reversed, the contact a' resting upon the terminal 1, the contact a^3 upon the terminal 16. The current passing from brush C through conductor 17 will divide, one part passing through the magnet-coils, passing therethrough and out by conductors 6, e^{14}, and segment 14, contact a, arm K, contact a^2, and the conductor 15, the remainder of the current passing through the demagnetizing-coil 18, conductor 7, segment 16, contact a^3, arm J, contact a', terminal 1, the resistance G, out by e^{14}, segment 14, and return-connections. With the position shown in full lines in Fig. 4 very little, if any, current will be shunted from the field-magnet coils through the demagnetizing-coils and the resistance; but as the switch-lever is moved in the direction of the arrow the resistance of the shunt-circuit will decrease and more and more current flow therethrough and be diverted from the field-magnet coils until, with the arm in the position seen in dotted lines, the resistance will be almost entirely cut out and most of the current be shunted from the field-magnet coils through the demagnetizing-coils, thereby still further weakening the field-magnet.

It will be apparent that with the combination described almost any degree of magnetic relationship can be established between the field-magnet and armature of the motor, while at the same time the total resistance of the motor-circuit can be adjusted as required for any duty. The highest practical magnetization can be instantly secured and as readily reduced, placing the motor under the most complete control and enabling it to perform any service of which it is capable without developing the dangerous conditions by which electric motors are so often damaged or destroyed, and also without the waste of energy resulting from admitting the current to the motor-circuit through a large artificial resistance, whereby, as in previous practice, the maximum amount of current has been consumed when the motor was doing the least work.

It will be understood that the field-magnet coils in series with the armature can be used independent of the adjustable resistance, and that the differential coils and the resistance could be utilized to effect all the desired regulation by first placing all resistance in series with the armature and field-coils and after cutting the resistance out of circuit the circuit to be placed upon the demagnetizing or differential coils.

It will also be understood from consideration of my prior patent above referred to that all the coils—both the resistance-coils and demagnetizing-coils—may be wound upon the cores of the field-magnets of the motor, thereby producing an added effect, and at the same time constituting a very compact and efficient arrangement.

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

1. In an electric motor, the combination, with the armature thereof, of a long field-magnet coil in series therewith, an adjustable resistance, and means for placing any desired portion of the resistance either in series or in shunt relation to the coils of the field-magnet, substantially as described.

2 In an electric motor, the combination, with the armature thereof, of a long series field-magnet coil, an adjustable resistance adapted to be connected in series therewith at starting, and means for placing said resistance or any desired portion thereof in derivation from the field-magnet coils, substantially as described.

3. In an electric motor, the combination,

with the armature thereof, of a long series field-magnet coil, an adjustable resistance adapted to be connected in series therewith at starting, means for placing said resistance or any desired portion thereof in derivation from the field-magnet coils, an opposing or differential coil or coils upon the field-magnet, and series connections between the differential coil or coils and the resistance when in shunt relation with the field-magnet, substantially as described.

4. In an electric motor, the combination, with the armature, of a long field-magnet coil in series therewith, an adjustable resistance, a switch, connections between the coils of the field-magnets and the resistance and the switch, and means for placing the resistance in series or in shunt relation to the field-magnet coils or cutting it out entirely to regulate the power and speed of the motor, substantially as described.

5. In an electric motor, the combination, with the armature, of a long series field-coil and an adjustable artificial resistance, a switch, and connections between the switch and the several portions of the resistance, said switch being so arranged that the resistance can be placed either in series or in derivation from the main field-magnet coils of the motor, substantially as described.

6. In an electric motor, the combination, with the armature, of field-magnet coils, an adjustable resistance, a switch, connections between the field-magnet coils and the coils of the resistance and the said switch, and a switch-lever adapted to be moved into successive engagement with the several parts of the switch, and to thereby connect the field-magnet coils and resistance in series, then gradually cut out the resistance, then connect the said resistance in derivations over the field-magnet circuit, and then gradually cut out the shunted resistance, or vice versa, substantially as described.

7. In an electric motor, the combination, with the armature, of a field-magnet coil in series therewith, an adjustable resistance, a switch, connections between the coils of the field-magnet and of the resistance and the switch, and a switch-lever adapted to be moved into engagement with the several parts of the switch and in one rotation to connect the resistance in series with the field-magnet coils, then to gradually cut it out, then to connect the entire resistance in derivation from the said field-magnet coils and cut it out altogether, substantially as described.

8. The combination, with a series field-magnet and a divided artificial resistance, of a switch having an extended terminal connected to one end of the field-magnet coil, a number of contact-points connected to terminals arranged along the resistance, an extended return-connection, a short segmental contact, a conductor extending from the beginning of the field-magnet to said contact, and a movable contact-arm provided with contacts adapted to engage the several parts of the switch and to connect the resistance in series or in derivation with the field-magnet coils, substantially as described.

In testimony whereof I hereto affix my signature in presence of two witnesses.

CHARLES J. VAN DEPOELE.

Witnesses:
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CHARLES L. OECHSNER.