No. 817,031. PATENTED APR. 3, 1906.

T. VON ZWEIGBERGK.

CONTROLLER.

APPLICATION FILED MAY 15, 1903.

2 SHEETS—SHEET 1.

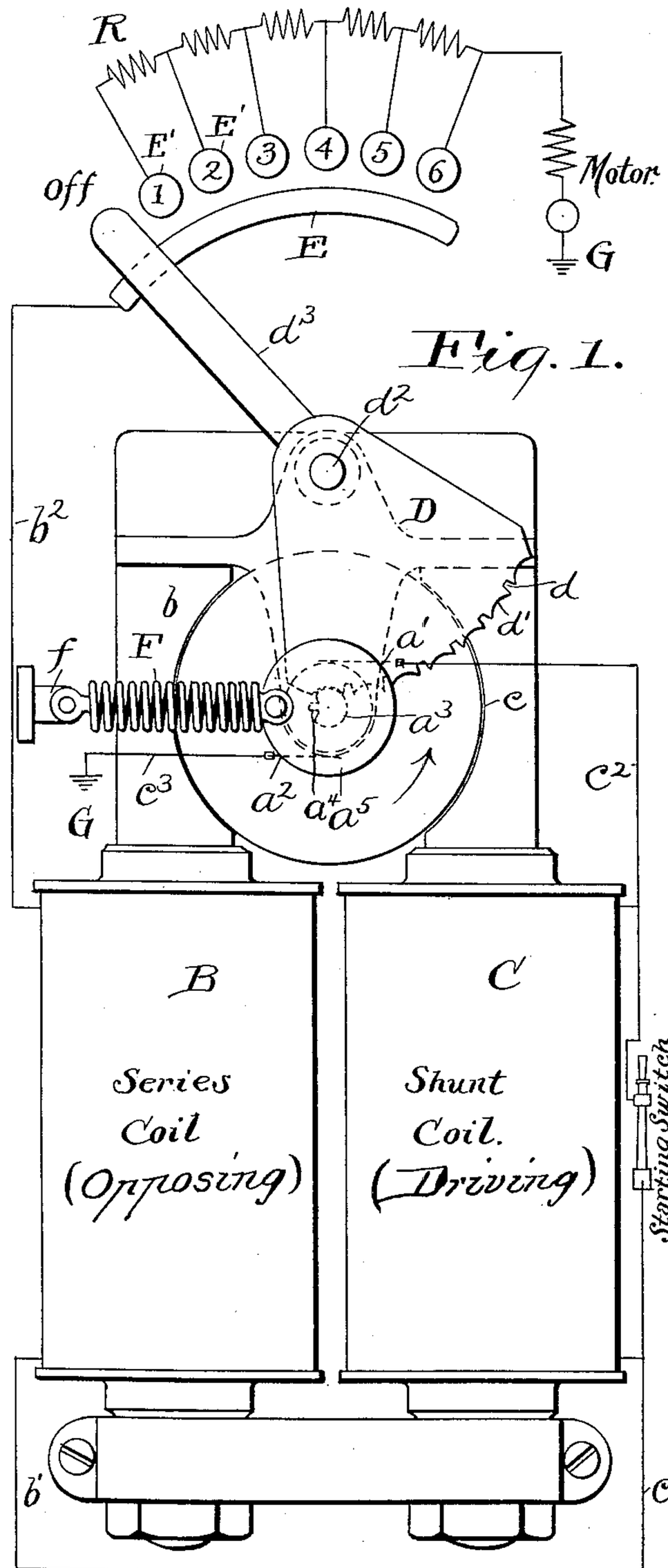

Fig. 1.

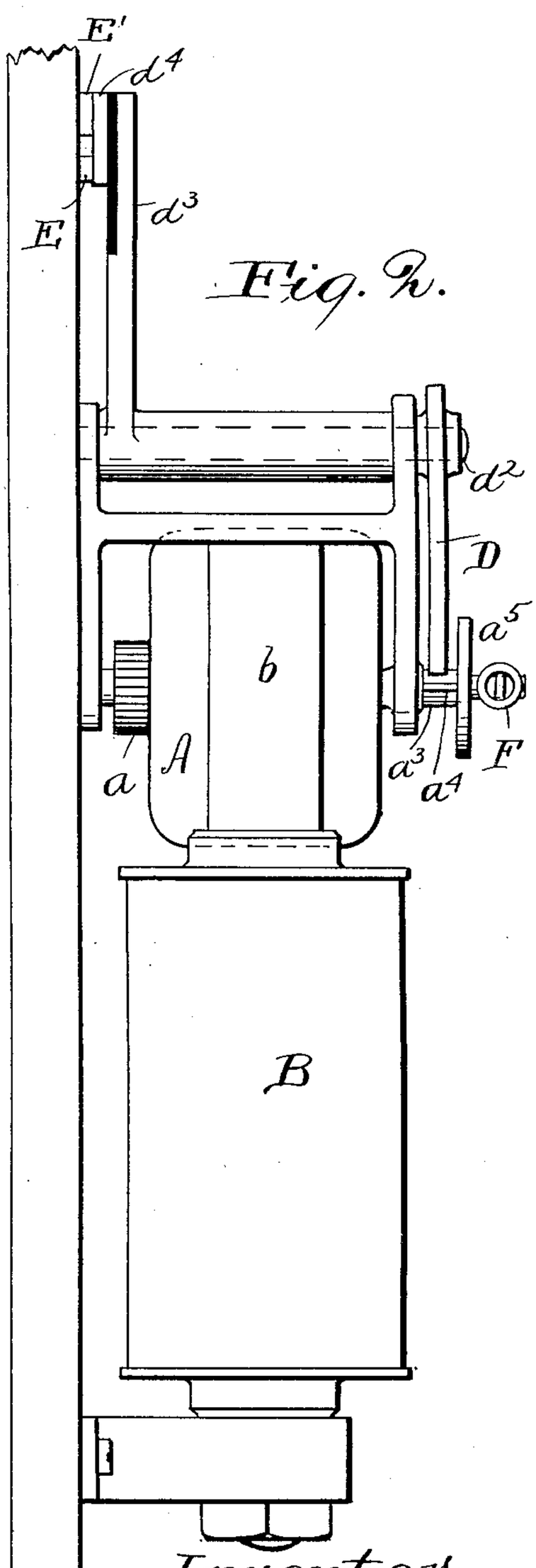

Fig. 2.

Witnesses.
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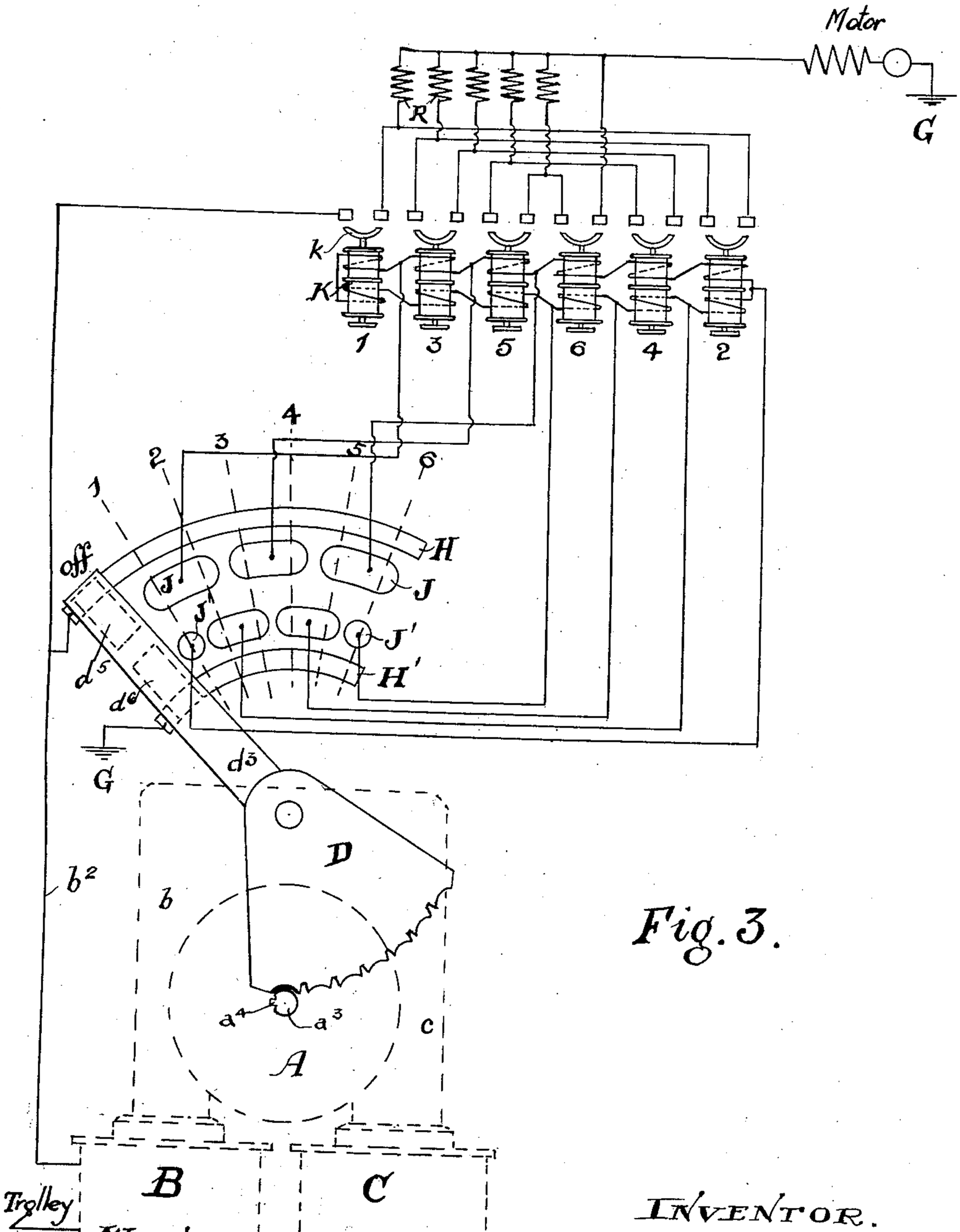

Fig. 3.

WITNESSES.

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UNITED STATES PATENT OFFICE.

THORSTEN VON ZWEIGBERGK, OF PRESTON, ENGLAND.

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No. 817,031. Specification of Letters Patent. Patented April 3, 1906.

Application filed May 15, 1903. Serial No. 157,286.

To all whom it may concern:

Be it known that I, THORSTEN VON ZWEIGBERGK, a citizen of the United States, residing at Preston, in the county of Lancaster, England, have invented a certain new and useful Improvement in Controllers, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings.

The object of this invention is to provide a controller adapted to be started by a simple starting-switch and thereafter operate automatically to successively cut out resistance in a line to a motor as the motor builds up, thus feeding a constant current through it. For this purpose I provide a controlling-switch and a relay-motor which is adapted to move one member of the switch, this relay-motor being so connected with the line and the power-motor that it moves the switch in a step-by-step movement to cut out resistance as the power-motor builds up. This is accomplished by providing the relay-motor with one coil which is adapted to be in series with the power-motor and another coil which is on a shunt of the power-line, the tendency of the shunt-coil being to operate the relay-armature to cut out the resistance and the tendency of the series coil to oppose that movement. Such a system is broadly comprehended within the present invention.

The present invention also includes the more particular embodiment of the above system and of the arrangement of the circuits from the controller to the motor, as hereinafter more fully described. The invention may be thus conveniently summarized as consisting of the combinations of essential elements herein illustrated, and enumerated in the claims.

In the drawings, Figure 1 is a front elevation of my automatic controller, the circuit to the motor being illustrated in its simplest form. Fig. 2 is a side elevation of the controller. Fig. 3 is a diagram illustrating a more elaborate but in some ways preferable system of circuits from the controller to the motor.

The relay-motor of the controller consists of an armature A and a pair of coils B and C, arranged to energize the pole-pieces *b* and *c* adjacent to the armature.

B is a series coil wound with comparatively coarse wire, and C a shunt-coil wound with finer wire and more ampere-turns. From the shunt-coil the conductor c^2 leads to one of the brushes a' of the commutator *a*. From the other brush a^2 a line c^3 leads to the ground.

On the front end of the armature is a pinion a^3, adapted to mesh with a gear-segment D. This pinion has but one tooth a^4, which takes into notches *d* in the segment. Between the notches the edge of the segment is concavely curved at d' to interlock with the smooth surface of the pinion. Thus for the most of the rotation of the pinion the gear-segment is held in place thereby, but for each complete rotation of the pinion the gear-segment is moved the distance of from one notch to the next.

The gear-segment D is rigid on a suitable rock-shaft d^2, which carries an arm d^3, adapted to govern the circuit to the motor. As illustrated in Figs. 1 and 2, this arm d^3 insulatingly carries a contact-piece d^4, adapted to bridge a contact E and any of a series of contacts E′. The contact-plate E is connected by the line b^2 with the series coil B. The lines from the contacts E′ pass through continuously-decreasing portions of the resistance R to the power-motor and thence to the ground.

Mounted on the front side of the pinion a^3 of the armature is a disk crank a^5, connected to the pin of which is a spring F, the other end of which is secured to a stationary support *f*.

The line from the trolley leads via the line b' to the series coil B and via the line c' to the shunt-coil C. A starting-switch is placed across this shunt-line c'. When the starting-switch is closed, the parts are in the position shown in Fig. 1, the series line being also open at the contacts E E′.

When the starting-switch is opened, the current from the trolley flows via the line c' through the shunt-coil C and through the brushes and commutator to the ground. This energizes the relay-motor to rotate the armature A in the direction of the arrow in Fig. 1. This rotation is opposed by the force of the spring F, which is being stretched thereby, but overcomes that force. As soon, however, as the armature has rotated more than halfway around the tension of the spring assists the rotation, and the remaining half of the rotation is completed very quickly. In this remaining half the tooth a^4 engages the first notch *d* in the segment D and rocks the shaft d^2 to swing the arm d^3 to bridge the contact E to the first contact E′. This closes the series

line to the motor, and the motor begins to rotate. The series coil B of the relay-motor is thus energized and tends to rotate the armature A in the opposite direction. This rotation, however, is counteracted by the balance of ampere-turns in favor of the shunt, together with the assistance of the spring F. As the motor builds up, however, its counter electromotive force holds back the current through the series coil and sends more lines through the shunt-coil, giving the armature another turn in the same direction, as before. This moves the arm d^3 to bridge over the second contact E′, cutting out a portion of the resistance. This movement allows more force to the series coil; but this, as before, is counterbalanced by the shunt and the spring. Then as the motor continues to build up, the increasing force in the shunt gives the armature another turn, and so on, until the arm d^3 has successively moved to the last position, cutting out all of the resistance R and connecting the series line directly with the motor. It will thus be seen that a simple opening of the starting-switch causes the controller to successively cut out resistance just as rapidly as the motor is ready for it, operating to feed a constant current through the motor. To stop the motor, the starting-switch is moved to close the shunt, and the current through the series coil rotates the motor in the reverse direction to successively cut in the resistance R and bring the arm d^3 back to the off position. The shunt-coil and armature are each of high resistance, so that the grounding of the line through them will be immaterial.

In the installation illustrated in Fig. 3 the controller-arm d^3 instead of directly controlling the main-line contacts controls the series of local magnets which govern such main-line contacts. These local magnets are designated K and consist each of a pair of coils having a sliding core which carries a bridge-piece k. The coils of all the magnets are connected in one permanent local series circuit. This local circuit is made by the controller to be a derived portion of a shunt-line from the trolley to the ground. The points at which this derived circuit begins and ends are varied by the controller to cause the current to flow in the direction desired through the various coils. The current flows through all the coils in every operative position; but in the first position all the coils except those of the magnet No. 1 are bucked against each other. In the second position all except the coils of magnets Nos. 1 and 2 are bucked, and so on. Each successive turning-on movement of the controller causes a change in direction of the current through one of the coils of the next bucked magnet, unbucking it and adding another to the series of bridged contacts k which are in engagement.

With the arm d^3 in the off position no current flows through the local magnets. In the first position the shunt-line from the trolley passes from the contact H by means of the plate d^5 on the arm d^3 to the first contact J, thence to the local circuit between the first and third magnets. The return-line to the first plate J′ passes from the line connecting two coils of magnet No. 2. The direction of the current in each magnet for this first position is indicated by the arrows in the diagram. It will be seen that every magnet has its coils bucked except No. 1, where the current is in the same direction. No. 1 is thus energized, and the first of the main-line contacts are bridged, and the current flows to the motor.

In position No. 2 the current flows, as before, to the line connecting magnets Nos. 1 and 3, but leaves on the line connecting Nos. 2 and 4. This leaves magnets Nos. 3, 5, 6, and 4 the same as they were before, but allows the current to flow through both coils of No. 2 in the same direction, energizing this magnet and bridging the second set of main-line contacts, cutting out some of the resistance.

In position No. 3 the return-line from the magnets is the same as before; but the line leading to them connects with the local circuit between magnets Nos. 3 and 5. This leaves magnets 4, 5, and 6 the same as before, but unbucks No. 3, and so on, for positions Nos. 4, 5, and 6, in the last position of the main line contacts being closed and the trolley-circuit leading directly to the motor. The advantage of this indirect connection from the controller to the main-line contacts is that the controller may be made much lighter than if its contacts had to carry the full motor-current. Placing the local magnets on a closed local circuit and operating them by successively unbucking them I am able to make this circuit of a constant resistance, and the individual magnets may be wound with heavier wire, thus minimizing the danger of a breakdown.

My automatic controller, with either the direct or indirect connection to the motor, is suitable for a variety of installations—as, for example, where there are a number of motors on different cars of a train all operated from one starting-switch at the head of the train. The cutting out of the resistance being automatic in a step-by-step movement, just as required, the controller is also particularly adapted for installation in various places where through ignorance or carelessness of the operator there is danger of the motor being injured by being started too quickly, or wherever it is desirable to do the manual work of turning on the motor without delay or precision. Moreover, my controller cuts out the resistance more accurately according to the motor requirements than even the most skilful operator can do by hand.

I claim—

1. The combination of a motor, a controlling-switch therefor, and electric means for actuating the controller step by step, said means being automatically governed by the counter electromotive force of the motor and including an armature whose cycle of movement corresponds to a step in the control.

2. The combination of a motor, a controlling-switch therefor, and electric means for actuating the controller step by step, said means being automatically governed by the counter electromotive force of the motor and including a rotatable armature whose cycle of movement corresponds to a step in the control, and shunt and series wound coils tending to rotate the armature in opposite directions.

3. A controller comprising a switch, an armature for moving the same step by step, a pair of coils tending to move the armature in opposite directions, a motor which said switch is adapted to govern, one of said coils being in series on the main line to the motor and the other being on a shunt of such line.

4. A controller comprising a switch, an armature for moving the same, a coil in series with the switch tending to operate the armature in one direction, a coil in a shunt around the switch but in series with the armature tending to operate the armature in the other direction.

5. A controller comprising a switch, an armature for moving the same step by step, a pair of coils tending to move the armature in opposite directions, a motor which said switch is adapted to govern, one of said coils being in series on the main line to the motor and the other being on a shunt of such line, said shunt-coil tending to operate the switch in the direction to cut out resistance in the main line, and said series coil tending to retard such movement.

6. In a controller, the combination of a switch, a motor, gearing between the armature of said motor and the switch to move the switch from one contact to the next for each rotation of the armature, and means tending to retard one portion of the rotation of the armature and accelerate another portion.

7. In a controller, the combination of a switch, a rotatable armature, gearing between said armature and the switch to move the switch from one contact to the next for each rotation of the armature, and means tending to retard one portion of the rotation of the armature and accelerate another portion, and a pair of coils operating one to rotate the armature in one direction and the other to counteract such rotation.

8. In a controller, the combination of a switch, a rotatable armature, a geared connection between the same and the switch, whereby a rotation of the armature corresponds to a step of the switch, means for rotating said armature, and a spring acting on the armature and tending to return it to a given position.

9. In a controller, the combination of a switch, a rotatable armature, an operative connection between the armature and the switch, means for rotating said armature, a crank-pin carried by the armature, and a spring connected with the crank-pin and thus tending to retard one portion of the rotation of the armature and accelerate another portion.

10. In a controller, the combination of a switch, a rotatable armature, a connection between the same and the switch, a pair of field-coils coöperating with the armature, one coil being series and the other on a shunt, and a spring tending to return the armature periodically to the same position for the successive steps of the switch.

11. In a controller, in combination, a rotatable armature, a switch, an operative connection between the armature and switch, a pair of field-coils tending to rotate said armature in opposite directions, one coil being on a shunt, a crank secured to the armature, and a spring secured to the crank and operating to retard half the rotation of the armature and assist the next half.

12. In a controller, the combination of a switch, a motor having a rotatable armature, and gearing connecting said armature and switch, said gearing including a mutilated pinion rotatable with the armature and a notched member connected with the switch, said notched member having between its notches surfaces adapted to bear on the pinion and lock the notched member without locking the pinion.

13. A controller comprising a switch, a motor having an armature and gearing connecting the switch with the armature, said gearing comprising a one-tooth pinion operated by the armature, and a segmental gear consisting of alternate notches and concave surfaces connected with the switch, the concave surfaces locking the segmental gear in place when the pinion-tooth is not in mesh with a notch.

14. In a controller, the combination of a switch, a rotatable armature, gearing between said armature and the switch to move the switch from one contact to the next for each rotation of the armature, and means tending to retard one portion of the rotation of the armature and accelerate another portion, a power-motor, resistances therefor adapted to be cut out by said switch, a pair of coils for rotating the armature of the controller, one coil being on a shunt and tending to rotate the armature of the controller in the direction to cut out resistance and the other coil being in series with said motor and tending to counteract the movement of the armature which the shunt gives.

15. A controller comprising a switch and a relay-motor for operating it step by step, said relay-motor having shunt and series magnets connected with the main line, combined with a power-motor, resistance, a series of local magnets for cutting such resistance in or out, and operative circuits from said switch to said local magnets.

16. The combination of a power-motor, resistance therefor, contacts for controlling such resistance, a series of local magnets for controlling said contacts, said magnets being arranged with coils adapted to buck each other, and a controller adapted to unbuck successive magnets by changing the direction of the current therethrough.

17. A series of magnets each consisting of a pair of coils, all the coils being on a permanently-closed circuit, combined with a controller, and conductors leading therefrom to different portions of said closed circuit whereby the controller may reverse some of the coils of the magnets, causing the magnets to be neutralized or energized, as desired.

18. A series of magnets each comprising a pair of coils, all the coils being on a permanently-closed circuit, combined with a controller, and conductors leading therefrom to different portions of said closed circuit, enabling the controller to successively direct current through the coils of each magnet in the same direction or in opposite direction to energize or neutralize it without disturbing the condition of the preceding magnet.

19. A power-motor, resistance, a series of local magnets for cutting such resistance in or out, said local magnets each consisting of a pair of coils, all the coils being on a closed local circuit, combined with a controller, and circuits leading therefrom to different portions of said local circuit, whereby the controller may cause various coils to buck each other.

20. The combination of a power-motor, resistance therefor, contacts for controlling such resistance, a series of local magnets for controlling said contacts, said magnets being arranged with coils adapted to buck each other, a controller, circuits therefrom to said magnets, said controller having a pair of coils for operating it, one coil being in series with the power-motor, and the other coil being on a shunt of the power-line and tending to operate the controller in a direction to unbuck successive magnets, said series coil tending to retard such movement.

21. A power-motor and a set of resistance, a series of local magnets for cutting such resistance in or out, said local magnets each consisting of a pair of coils, all of the coils being on a closed local circuit, combined with a controller having a switch, an armature connected therewith and a pair of coils for operating said armature, one coil being in series with the power-motor and the other on a shunt-coil tending to operate the armature in the direction to cause successive magnets to cut out resistance, and the series coil tending to retard such movement.

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

THORSTEN VON ZWEIGBERGK.

Witnesses:
W. J. SULIS,
WM. PIERCE.