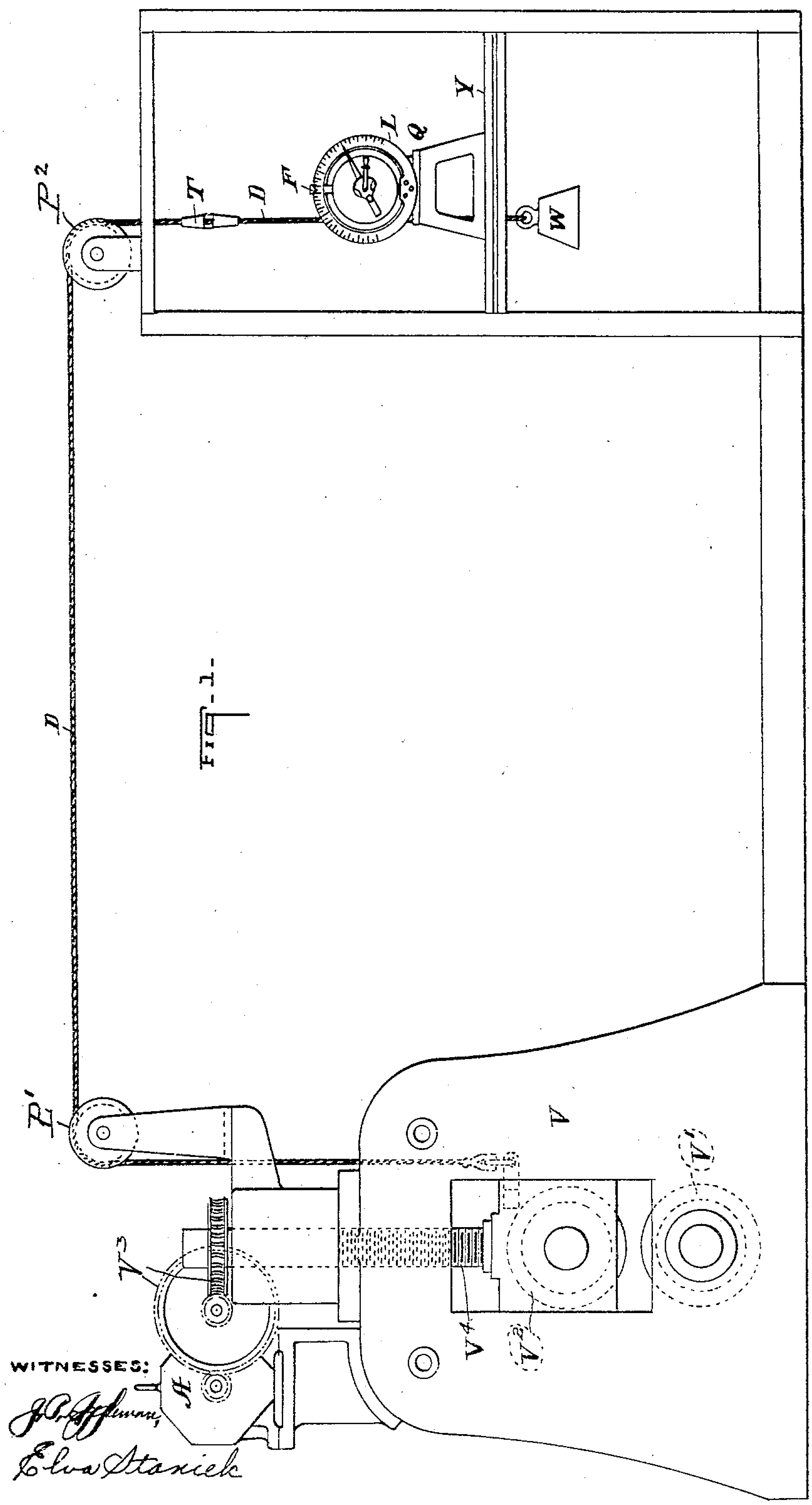
A. C. EASTWOOD & J. S. McKEE.

ELECTRIC CONTROLLER.

APPLICATION FILED MAR. 2, 1909.

947,059. Patented Jan. 18, 1910.

4 SHEETS—SHEET 1.



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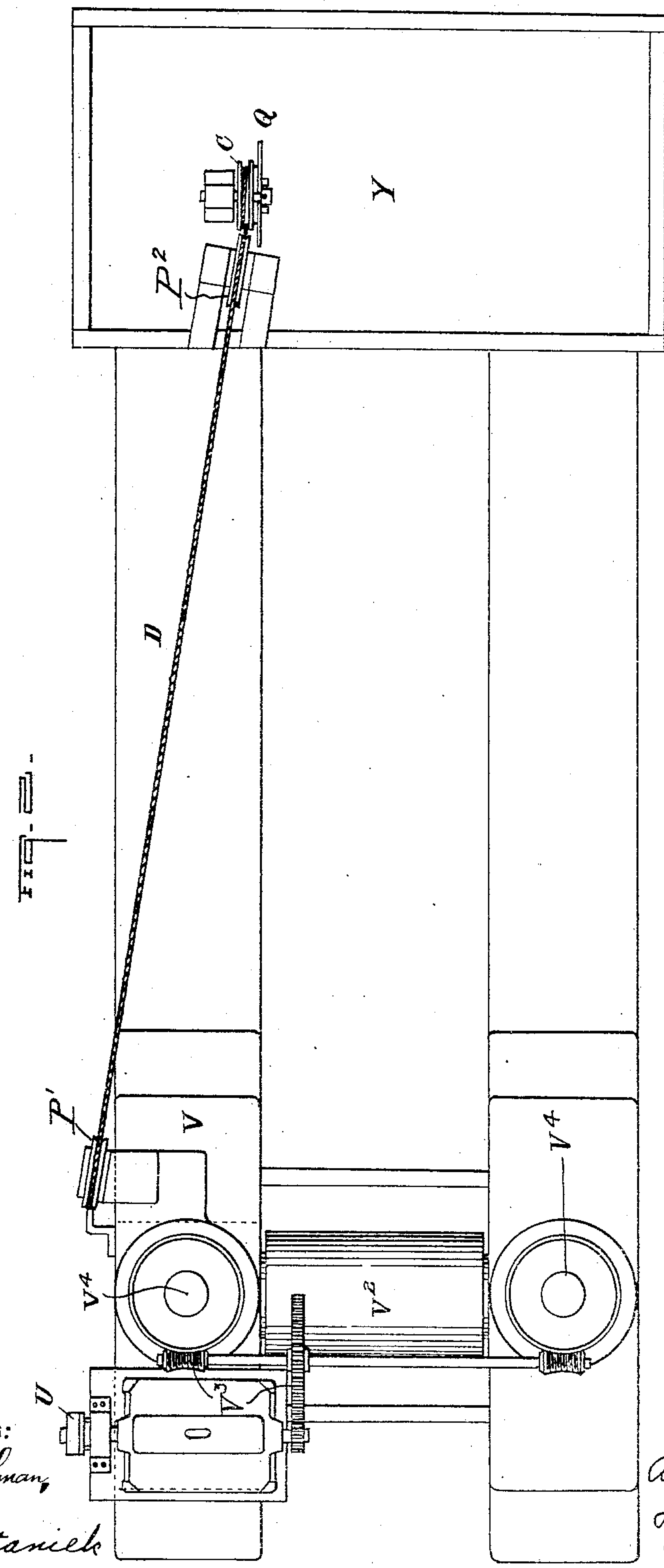

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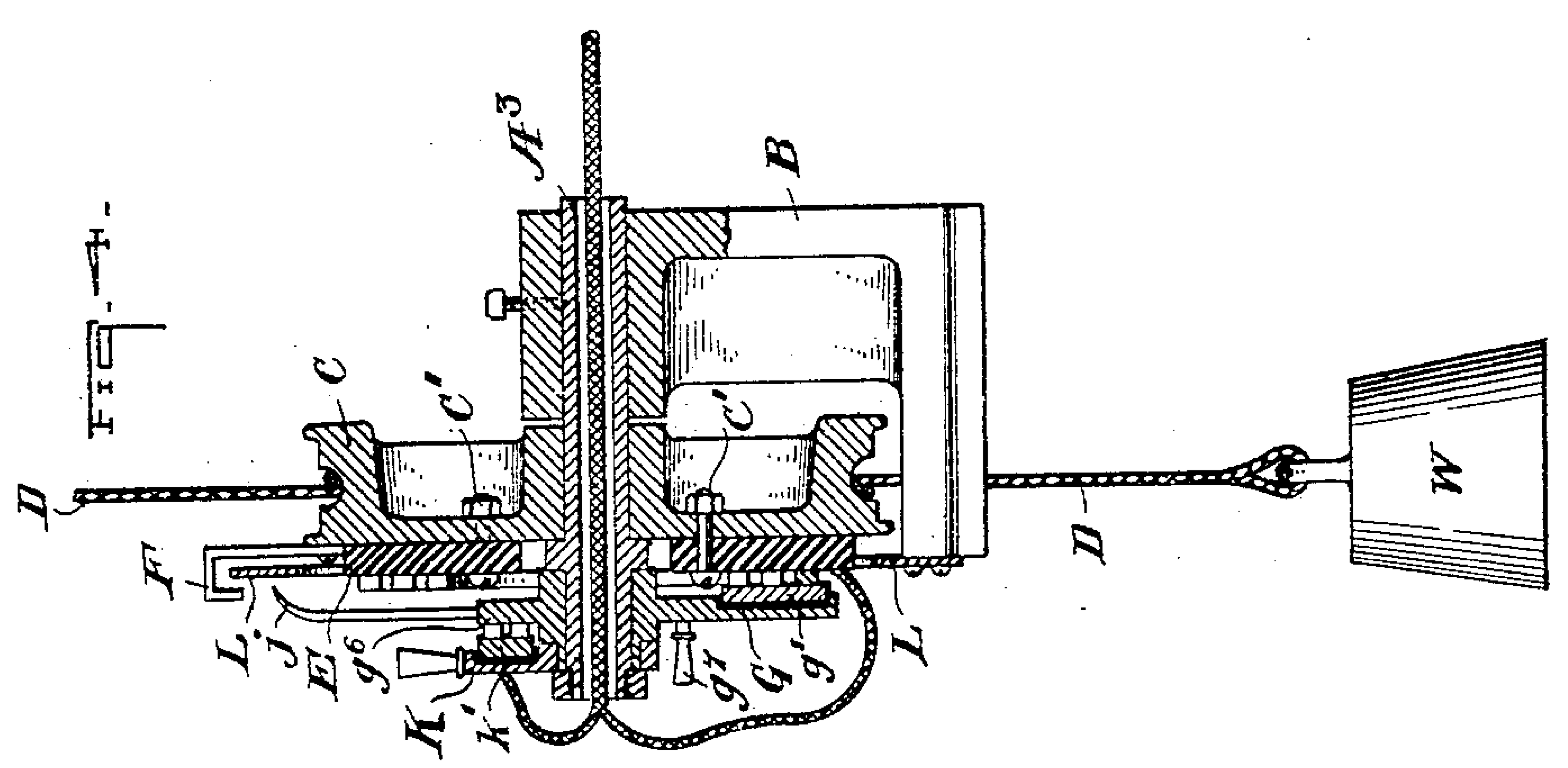

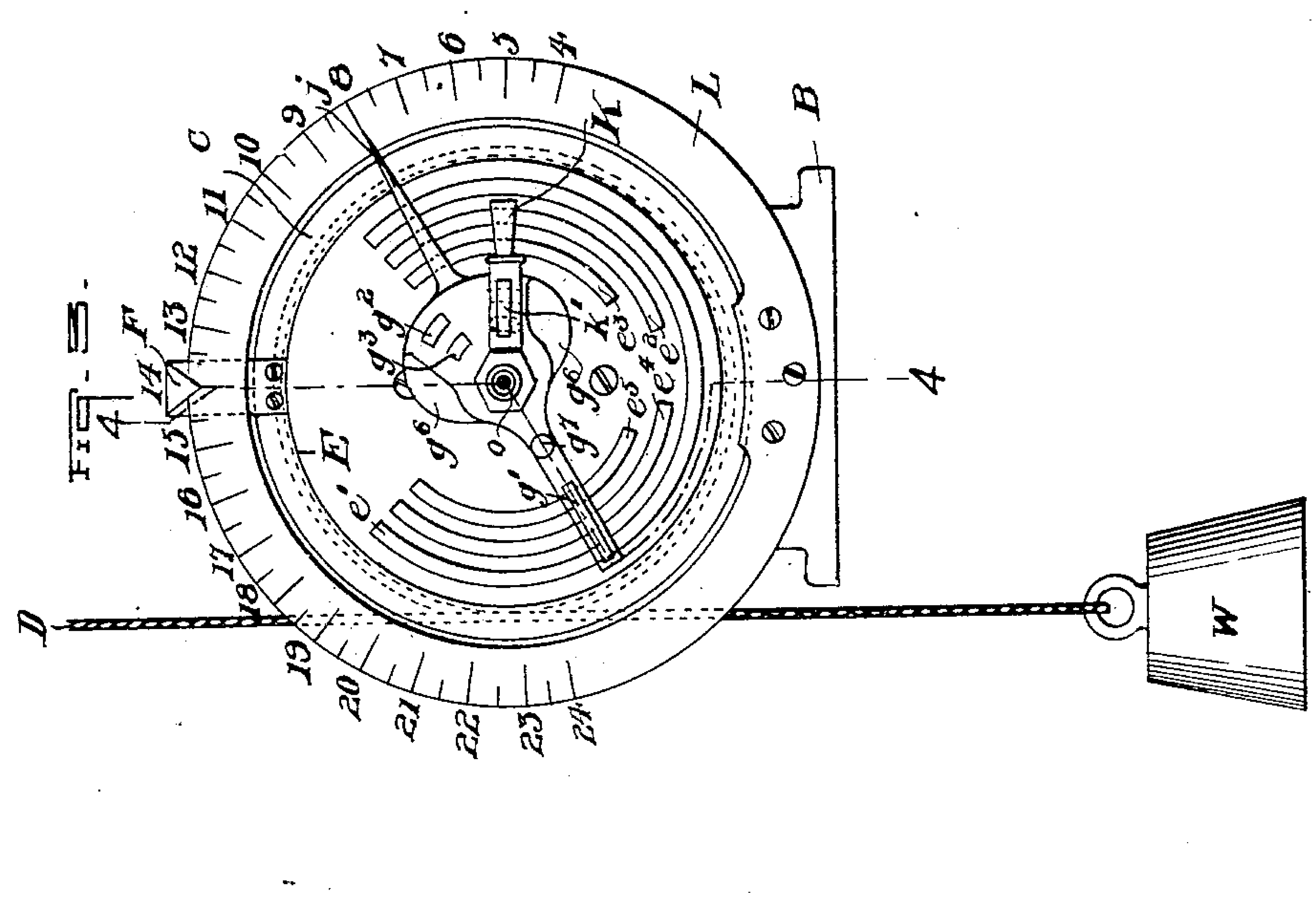

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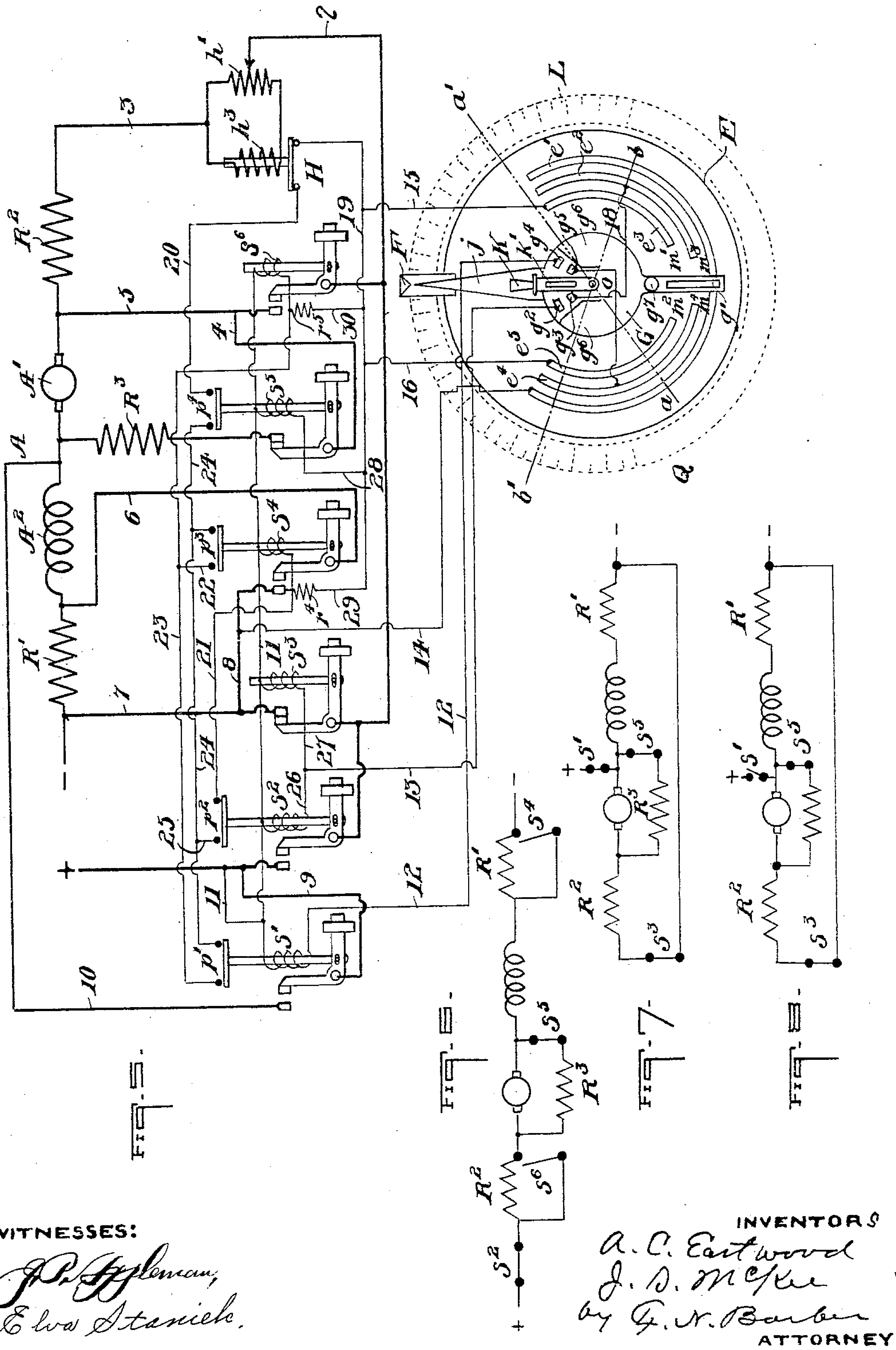

FIG. 5. FIG. 6. FIG. 7. FIG. 8.

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UNITED STATES PATENT OFFICE.

ARTHUR C. EASTWOOD, OF CLEVELAND, OHIO, AND JOHN S. McKEE, OF PITTSBURG, PENNSYLVANIA.

ELECTRIC CONTROLLER.

947,059. Specification of Letters Patent. **Patented Jan. 18, 1910.**

Application filed March 2, 1909. Serial No. 480,921.

To all whom it may concern:

Be it known that we, ARTHUR C. EASTWOOD, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, and JOHN S. McKEE, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented or discovered new and useful Improvements in Electric Controllers, of which the following is a specification.

Our invention relates particularly to new and useful means for controlling the action of electric motors used for driving "screw-downs;" that is, the mechanism in rolling mills which regulates the distance between the rolls of the mill, thus determining the size and shape of the material after passing between the rolls, but we do not limit our invention to the said use.

The objects of our invention are to provide a controller which automatically stops the motor at points previously determined by the setting of a gage by the operator; to provide a controller which eliminates false or unnecessary moves of the driving motor which are frequent when the motor is under the direct manual control of the operator; to provide a controller which automatically stops the motor at predetermined points, but which at the same time is within limits subject to the will of the operator so that the operation of the controller may be readily governed to meet unexpected conditions in service; to provide a controller which materially reduces the wear and tear on its own parts and the parts of the motor and the mechanism driven thereby; and to provide a controller which permits the separating of the rolls at maximum speed, but which so alters the circuit connections of the motor that a lower speed and accurate control are secured in adjusting the distance between the rolls for subsequent passes of metal between them.

Referring to the accompanying drawings, Figures 1 and 2 show respectively an elevation and plan of that portion of a rolling mill which has to do with our invention. Fig. 3 is a front elevation of the indicating master switch and cutout. Fig. 4 is a cross section on the lines 4—4, Fig. 3. Fig. 5 is a complete wiring diagram of the controller. Figs. 6, 7, and 8 are simplified diagrams showing the motor connections at various stages of operation as later described.

In Figs. 1 and 2, V are the housings; V′ is the non-adjustable roll; and V^2 is the movable roll which it is desired to operate by the motor A, the gears V^3 and the screws V^4. The operator who controls the movement of the roll V^2, through the screw-down motor A, stands on the raised platform Y. On the platform we mount the controller Q, in which we have incorporated three distinct and separate features: (1) a switch for starting the motor A; (2) a cutout for automatically stopping the motor A when the distance between the rolls V′ and V^2 has reached any predetermined amount; and (3) an indicator or gage which shows at all times the distance between the rolls V′ and V^2. The first two of these features we will describe hereinafter. The third feature we prefer to show as follows: A rope or cable D, one end of which is attached to the bearing of the roll V^2, passes over suitably placed sheaves P′ and P^2 and makes one or more turns around a rotatable drum C, forming a part of the controller Q. To the other end of this rope is attached a weight W. A pointer F attached to the drum C passes before a fixed dial L, on whose face are marked divisions so arranged that the pointer F will indicate the distance between the rolls V′ and V^2. Since the weight W keeps the rope D taut, any movement of the roll V^2 will cause the drum to rotate, thus moving the pointer F to the division corresponding to the distance between the rolls. At T we introduce a turnbuckle or other means of changing the length of the rope D so that the pointer F may be adjusted to indicate this distance accurately.

Referring to Figs. 3 and 4, A^3 is a fixed shaft held by the frame B, and made hollow to accommodate the control wires. Mounted concentrically with this shaft are three members C, G, and K, each of which is independently free to rotate through certain limits. The drum C is free to move about the shaft A^3 and has mounted upon it the plate E made preferably of insulating material and held by the bolts *c′*. Mounted on the plate E are the contact segments *e′*, e^2, e^3, e^4, and e^5. The pointer F is also attached to the drum C. The fixed dial L is attached to the frame B and has marked upon it divisions from 4 to 24 which represent in inches the full range of distances obtainable between the rolls V′ and V^2. The plate G is free to turn about the shaft A^3 and has mounted upon it the contacts g^2, g^3, g^4, and g^5 insulated therefrom. The brush g' is carried by the plate G and makes contact with the segments e' to e^5. The plate G has also mounted upon it the pointer J and is provided with the operating handle g^7. The operating arm K is mounted upon and free to turn about the hub of plate G and carries the brush k' which makes contact with the contacts g^2, g^3, g^4, and g^5. Lugs or stops are provided at g^6 which the arm K engages and by which the plate G may be revolved by further movement of the arm K after contact has been made by its brush k' with contacts g^2 and g^3 on the one side, or g^4 and g^5 on the other. It will be noticed that any movement of the arm K does not move the plate G until the arm K engages the stop g^6, but any movement of the plate G by the handle g^7 moves K with it at whatever position the arm K occupies in reference to the plate G at the beginning of the movement; that is, if the arm K is at a central position between the contacts g^2 and g^4, any movement of the plate G by the handle g^7 also moves the arm K so that it always remains at the above described central position. It therefore appears that, if the positions of the arm K, the plate G, and the pointer F are such that their center line is over the line passing through the division 14, the controller Q is at the off-position, as shown in the diagrammatic view on Fig. 5, and that the rolls V′ and V^2 are 14 inches apart. If now it is desired to lower the roll V^2 so that it will be 8 inches from the roll V′, the operator moves the arm K to the right, which we will assume is in the lowering direction, until it engages the stop g^6 and further moves the plate G until the pointer J points to division 8 (Fig. 3). The result desired is that the motor shall start in a direction to lower the roll V^2, accelerate automatically, slow down, and stop when the pointer F is exactly opposite the pointer J and the division 8. In like manner, any other desired distance between the rolls may be secured either greater or smaller by moving the plate G until the pointer J is opposite the proper division on the dial.

We show in Fig. 5 a complete wiring diagram of the controller, in which A is the screw-down motor, A′ and A^2 being respectively the armature and series field thereof. S′, S^2, S^4, and S^6 are magnetic switches or contactors which open by the action of gravity or a spring and close whenever their magnets are fully energized. S^3 and S^5 are similar contactors except that they close by the action of gravity or a spring and open whenever their magnets are energized. p', p^2, p^3, and p^4 are auxiliary contacts of the switches S′, S^2, S^4 and S^6 and each closes whenever its respective switch-magnets are energized.

H is a throttle by which automatic acceleration is secured. Its magnet winding h^3 is in shunt with more or less of the resistance h', the wire 2 being adjustably connected to this resistance so that a varying proportion of the motor current can be made to pass through magnet winding h^3 in order to adjust the acceleration of the motor.

R′, R^2, and R^3 are resistances in the motor circuit for controlling the motor speed. The resistances r^4 and r^5 are each so proportioned that when connected across the supply mains in series with its respective switch magnet, the current established is not strong enough to close the switch, but after it once closes, the magnetism is increased due to the diminished air gap in the magnetic circuit of the switch magnet, and holds the switch closed.

With the controller Q in the position shown, the distance between the rolls will be the distance as indicated by the pointer F on the dial L. If it is now desired to increase the distance between the rolls to any point such as is represented at b' on the dial L, the member G is moved by means of the arm K so that the pointer J is on the line O^{b}′, and the brush g', on the line O^b. The segments g^2 and g^3 are first engaged with the brush k', but no circuit is established thereby. As soon as the brush g' makes contact with the segment e^2, the following circuit is established: from the positive, through the wire 11, the winding of the switch S^2, the wires 26 and 13, the segment g^2, the brush k', the segment g^3, the wire 18, the segment e^2, the brush g', the segment e', and the wires 14, 8, and 7 to the negative. This closes the switch S^2. A circuit is also established from the positive through the wire 11, the winding of the switch S^3, the wires 27 and 13, and the remainder of the last circuit traced to the negative, which opens the switch S^3. A motor circuit is now established as follows: from the positive through the switch S^2, the wires 1 and 2, the throttle H in a divided path, part of the current passing through the resistance h', and the other part through part of the resistance h', and the winding of the magnet h^3, the wire 3, the resistance R^2, the armature A′, the field A^2, and the resistance R′ to the negative. This starts the motor with the starting resistances R′ and R^2 in series and a slow speed is maintained due to the shunted circuit around the armature A′, through the resistance R^3, the switch S^5, and the wires 4 and 5. These motor connections are as shown in the simplified diagram in Fig. 6. This slow speed is maintained until the brush g' makes contact with the segment e^3, at which time the magnet of switch S^5 is energized through the wires 11, 28, 19, and 15, the contact e^3, the brush g', and the negative contact e'. This opens the switch S^5, removing the shunt from the armature, allowing it to speed up. At the first rush of current through the motor, the magnet h^3 causes the throttle H to open its contacts. As the motor speed now increases, the current decreases to a point where the throttle H will close its contacts, and a circuit is established from the positive, through the wire 11, the winding of the switch S^4, the wire 21, the auxiliary contact p^2, the wires 25 and 24, the auxiliary contact p^4, the wire 20, the throttle H, the wire 15, the segment e^3, the brush g', and the segment e' to the negative. This closes the switch S^4, short-circuiting the starting resistance R'. The motor is accelerated thereby, causing the throttle H to open, but the switch S^4 remains closed by the circuit through the resistance r^4, the wires 19 and 15, the segment e^3, the brush g', and the negative segment e'. When the motor current next diminishes due to the rise in speed, the throttle H again closes and a circuit is established from the positive through the wire 11, the winding of the switch S^6, the wires 23 and 22, the auxiliary contact p^4, the wire 20, the throttle H, the wire 15, the segment e^3, the brush g', and the segment e' to the negative. This closes the switch S^6, short-circuiting the resistance R^2. This system of acceleration is shown in United States Patent, No. 867,810, granted October 8th, 1907, to Arthur C. Eastwood. The motor is now across the line and runs at its highest speed, causing the roll V^2 to rise. The rising of the roll V^2 causes the drum C (Fig. 4) and its pointer F to move toward the point b', and since the plate E is fastened to the drum C, it will rotate all its contacts toward the line bb'. As this rotation continues, the contact e^3 will pass from under the brush g' which lies along the line O^b. This causes the switches S^4 and S^6 to open and the switch S^5 to close, inserting the resistance R' and R^2 in series with the armature and shunting the resistance R^3 around the armature through the switch S^5. The motor slows down and proceeds at slow speed until the contact e^2 has moved from under the brush g', which causes the switch S^2 to open and allows the switch S^3 to close. The motor will now stop since it is cut off from the supply mains.

The gaps m' and m^3 may be so adjusted that the motor will stop with the pointer F exactly at the point b', and the distance between the rolls will be the desired amount. The motor stops with the pointers F and J in the line $O^{b'}$, the brush g' in the line O^b, and the middle point of the contact e' under the brush g'. If it is now desired to diminish the distance between the rolls to a point on the dial corresponding to the position a', the plate G with its pointer J and brush g' is moved by means of the arm K in a clockwise direction to the line $a\ a'$, when the brush makes contact with the segments e^4, and a circuit is established as follows: from the positive, through the wire 11, the winding of the switch S', the wire 12, the segment g^4, the brush k', the segment g^5, the wire 17, the segment e^4, the brush g', the segment e', and the wires 14, 8, and 7 to the negative. The switch S' is thereby closed and the following circuit is established: from the positive through the wire 9, the switch S', the wire 10, to a point between the armature A' and the field A^2, one portion of the circuit continuing through the field A^2, in the same direction as before, and the resistance R' to the negative, and the other portion continuing through the armature A' in the direction opposite to the former direction, the resistance R^2, the wire 3, the throttle H, the wire 2, the switch S^3, and the wire 7 to the negative. The armature is shunted as before with the resistance R^3 through the switch S^5. The motor starts in the lowering direction its connections being shown in the simplified diagram Fig. 7. The motor is by this connection converted into practically a shunt-wound motor since the field is separately excited and a slow speed may be obtained if it is desired in lowering the roll. When the brush g' makes contact with the segment e^5, the magnet of the switch S^5 is energized from the positive, through the wires 11, 28, and 16, the segment e^5, the brush g', and the segment e' to the negative. The switch S^5 opens, removing the shunt from the armature. As the motor current diminishes, due to its increased speed, the throttle H closes, and the switch S^6 is closed by a circuit through its magnet, from the positive, the wire 11, the wire 23, the auxiliary contact p', the wire 24, the auxiliary contact p^4, the wire 20, the throttle H, the wires 19 and 16, the segment e^5, the brush g', and the segment e' to the negative. The switch S^4 cannot close when the motor is running in this direction, and the resistance R' therefore is not short-circuited. The resistance R' is maintained in series with the field A^2 to secure the proper energization of the field during the period of lowering. Since the lowering of the roll is accomplished by many short moves, the speed may be regulated by the energization of the field A^2, and full speed is obtained in lowering which is slower than the full speed in hoisting, which is one of the objects of our invention. As the roll lowers, the drum C and the pointers F move from the line $b\ b'$ in a clock-wise direction to the line $a\ a'$, the segments e' to e^5 moving with the plate E at the same time. As the pointer F approaches the point a', the segment e^5 passes from under the brush g', which allows the switch S^5 to close and causes the switch S^6 to open. The motor slows down and when the segment e^4 passes from under the brush g', the switch S′ opens, leaving the motor connected in a dynamic braking circuit as follows: from one terminal of the armature A′ through the series field A^2, the resistance R′, the wire 7, the switch S^3, the wire 2, the throttle H, the wire 3, and the resistance R^2 to the other terminal of the armature. The armature is also shunted by the resistance R^3 through the switch S^5. These circuit connections are shown simplified in Fig. 8. These connections cause the motor to stop with the pointer F at the point a' and the rolls to be adjusted to the desired amount. In a similar manner as before, the gaps m^2 and m^4 may be so proportioned that the motor will stop at the exact position which will bring the pointer F at the desired point a'.

It will be noticed that when the plate G is moved to any point by means of the arm K that the motor begins to operate as soon as the brush g' makes contact with either segment e^2 or e^4 as the case may be. If, however, it is desired to move this plate G to any point without starting the motor, this can be accomplished by leaving the arm in a central position between the segments g^2 and g^4 and moving the plate G by means of the handle g^7. In this way the pointer J can be carefully set at any point on the dial at which it is desired that the motor shall next stop, and when the operator is ready to start the motor, he can move the arm K to make contact with the segment g^2 or g^4, depending upon which direction he wishes to operate the motor. At any time during the operation of the motor the operator can start or stop his motor at will if the occasion so demands by moving the arm K only. It is thus seen that we have provided a controller which is simple in operation and which will automatically stop the motor at any point previously determined by the setting of a gage or indicator, that all false movements are eliminated since the motor stops exactly at the predetermined point; that the operator can start or stop his motor during the operation between the limits set by his gage to meet any unexpected conditions in service. We have provided a controller which will reduce the wear and tear of the motor and controller parts and the parts of the mechanism driven thereby, and we have provided an arrangement by which the motor will operate at its maximum speed on long periods of travel and at any slow speed on short periods of travel.

Our invention is not confined to the control of screw down motors but may be applied to a motor driving any mechanism having similar characteristics. We have shown our invention as using a series wound motor but a compound motor can be used equally well.

We claim—

1. An automatic operating device for motor driven screw-downs, combining a gage for indicating the separation of the rolls, a setting device for determining the position at which the motor is to be automatically stopped in moving the movable roll, means for automatically stopping said motor, and an operating switch by means of which the motor may be started in either direction, and may be stopped independently of the automatic stopping means.

2. In a control system for series wound motors, means for operating the armature and field windings of the motor in branch circuits for one direction of rotation, and means for automatically stopping said motor, embracing means for first throwing a shunt around the armature of said motor to slow down its motion, and means for subsequently disconnecting the windings of said motor from the source of power, and connecting said windings in a dynamic braking circuit.

3. The combination of an electric motor, resistance for regulating the speed thereof, automatic switches for the said resistance, a mechanism actuated by the motor, a switch settable at various positions corresponding to predetermined positions of said mechanisms and having contacts arranged and constructed to actuate said automatic switches, connections between the motor and the settable switch constructed to move the latter so as to cause said switches to regulate the resistance first to slow down the motor, and, when said mechanism reaches the predetermined position indicated by the said gage, to include the motor in a dynamic braking circuit.

4. The combination of an electric motor, a mechanism actuated by the same, a gage settable at various positions corresponding to predetermined positions of said mechanism, resistance for controlling the speed of the motor, means for automatically regulating the resistance so as to slow down the motor when the said mechanism approaches the predetermined position indicated by the gage, and subsequently to include the motor in a dynamic braking circuit.

5. The combination of an electric motor, a mechanism actuated thereby, a gage settable at various positions corresponding to predetermined positions of the said mechanism, means for automatically stopping the motor when the said mechanism reaches the predetermined position indicated by the said gage, and a master switch movable as a whole with the said stopping means and having contacts controlled independently thereof.

6. The combination of an electric motor, a mechanism actuated thereby, and a switch having one element also actuated by the motor, the other element of said switch being settable at various positions corresponding to predetermined positions of the said mechanism, contacts carried by said elements for varying the speed of the motor as the said mechanism moves, and for including the motor in a dynamic braking circuit when the said mechanism reaches the predetermined position indicated by the first switch element.

7. The combination of an electric motor, a mechanism actuated thereby, a switch having one element also actuated by the motor, the other element of said switch being settable at various positions corresponding to predetermined positions of the said mechanism, contacts carried by said elements for varying the speed of the motor as the said mechanism moves, and for including the motor in a dynamic braking circuit when the said mechanism reaches the predetermined position indicated by the first switch element, and a master switch having contacts arranged to control the stopping and starting of the motor and the direction of rotation thereof.

8. The combination of a motor, a mechanism actuated thereby, a rotary drum actuated by the motor and having thereon contacts, means connected to said contacts for varying the speed of the motor, a manually actuated setting-switch coöperating with the said contacts, and means for including the motor in a dynamic braking circuit when the drum is rotated to a position corresponding to the position at which the said manually actuated switch has been set.

9. The combination of a motor, a rotary contact carrier operated by the motor, a second rotary contact carrier coöperative with the first named carrier and operated independently of the same, a master switch having one element rotary with one of said carriers and the other element controlled by the operator, and means for stopping the motor when the two said contact carriers reach a predetermined relative position.

10. The combination of a motor, a rotary contact carrier operated by the motor, a second rotary contact carrier coöperative with the first named carrier and operated independently of the same, a master switch having one element rotary with one of said carriers and the other element controlled by the operator, and means for slowing down the motor as the said contact carriers approach a predetermined relative position and for stopping the motor when the said carriers reach said predetermined position.

11. In a motor control system, automatic acceleration switches, a throttle constructed and arranged to control the operation of the said switches, a resistance in a loop with the winding of said throttle, one of the conductors for the said throttle being adjustably connected to the said resistance.

12. In a motor control system, automatic acceleration switches, a throttle constructed and arranged to control the operation of the said switches, a resistance in a loop with the winding of said throttle, one of the conductors for said throttle being connected to a point between the resistance and the winding of the throttle, and the other conductor being adjustably connected to the resistance.

13. In a motor control system, resistances, means for automatically removing the said resistances from the motor circuit to increase the speed of the motor in one direction and for preventing the removal of some of the said resistances when the motor is running in the opposite direction, whereby a slower motor speed is necessarily obtained in one direction than in the other direction.

Signed by the said Arthur C. Eastwood, at Cleveland, Ohio, this 22nd day of February, 1909, and by the said John S. McKee, at Pittsburg, Pa., this 25'' day of February, 1909.

ARTHUR C. EASTWOOD.
JOHN S. McKEE.

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