No. 750,434. PATENTED JAN. 26, 1904.

P. P. CRAFTS.

ELECTRIC BRAKE.

APPLICATION FILED NOV. 29, 1899.

NO MODEL. 4 SHEETS—SHEET 1.

FIG. 1.

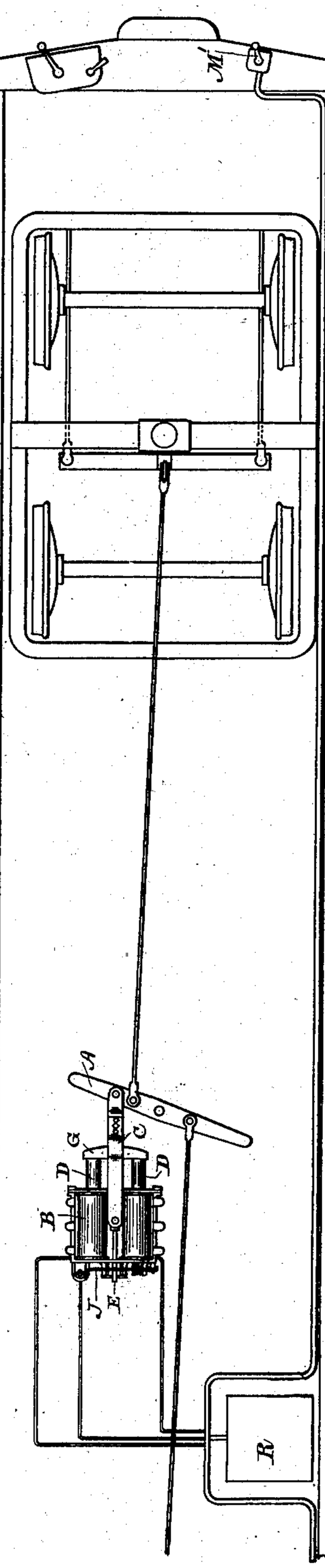


FIG. 4.

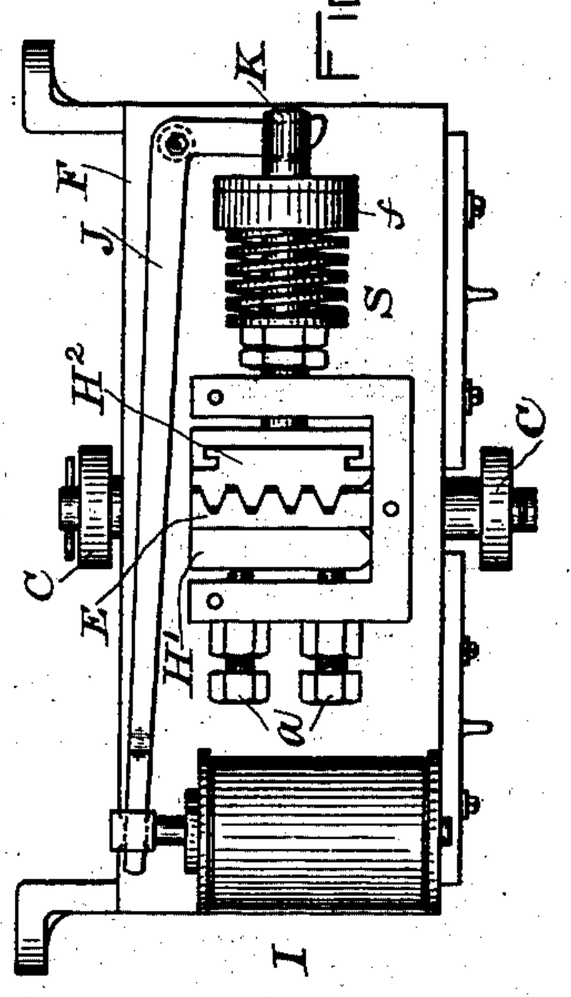


FIG. 5.

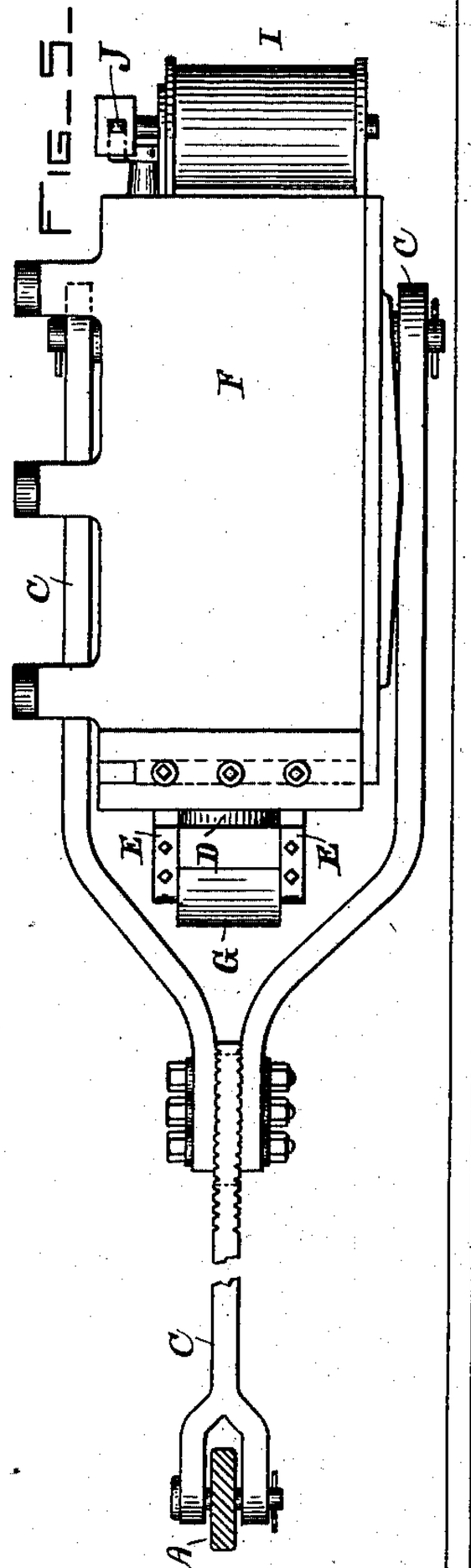
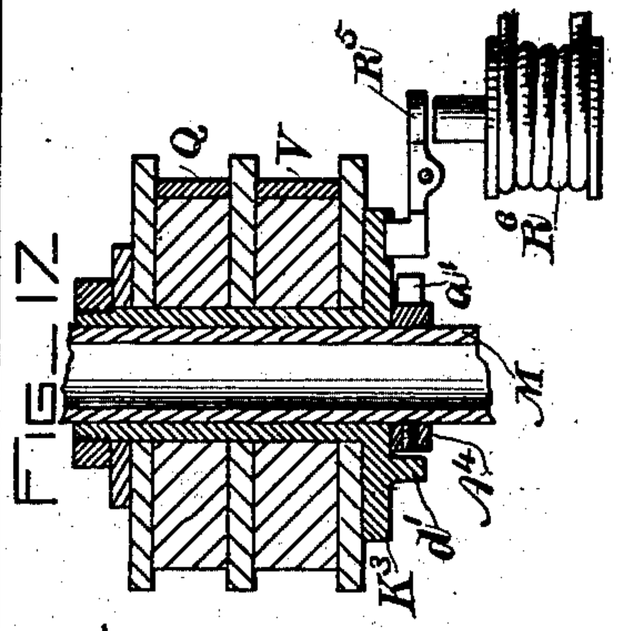


FIG. 2.

FIG. 17.



WITNESSES

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by E. M. Bentley

Atty

No. 750,434. PATENTED JAN. 26, 1904.

P. P. CRAFTS.

ELECTRIC BRAKE.

APPLICATION FILED NOV. 29, 1899.

NO MODEL. 4 SHEETS—SHEET 2.

FIG_2_

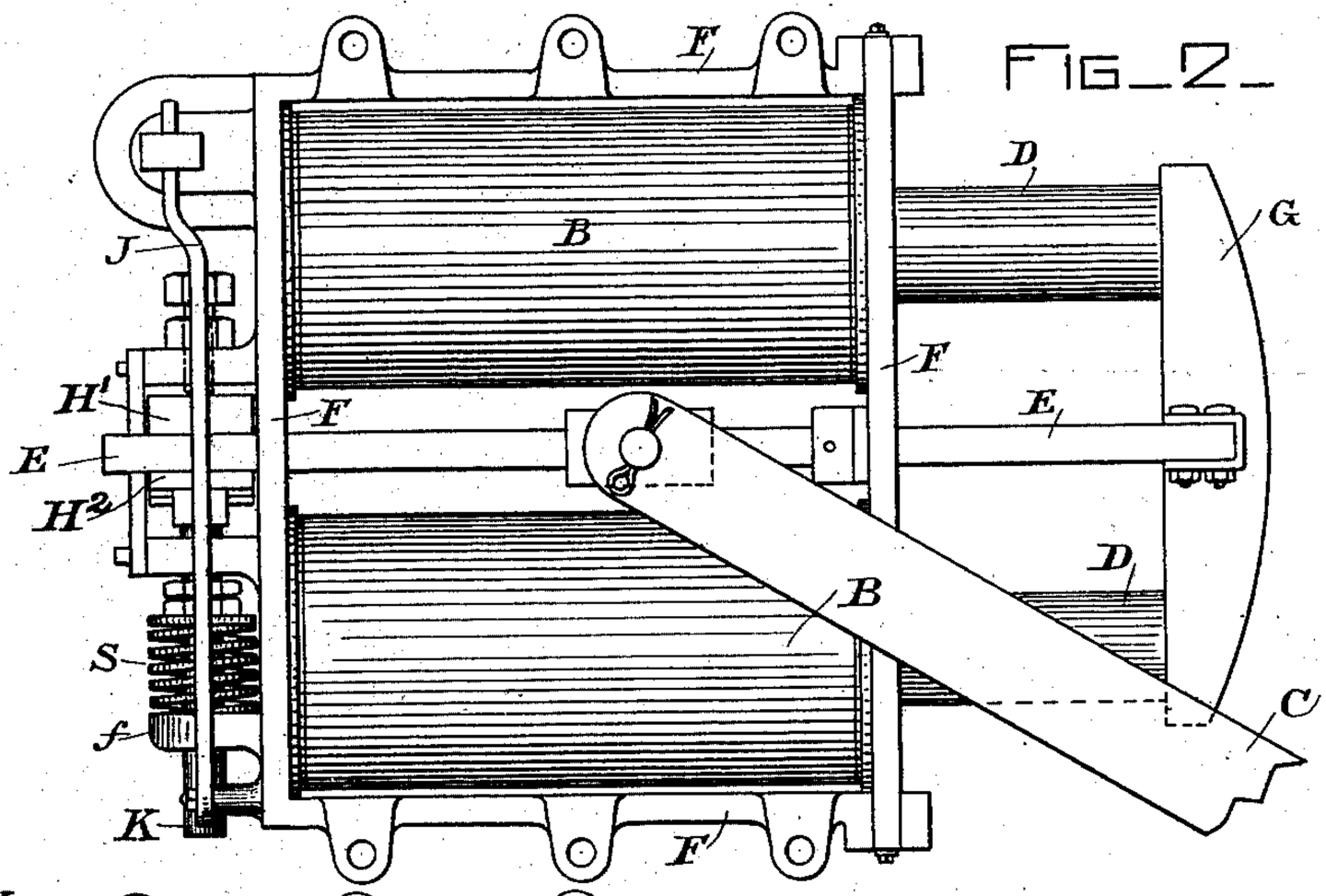


FIG_3_

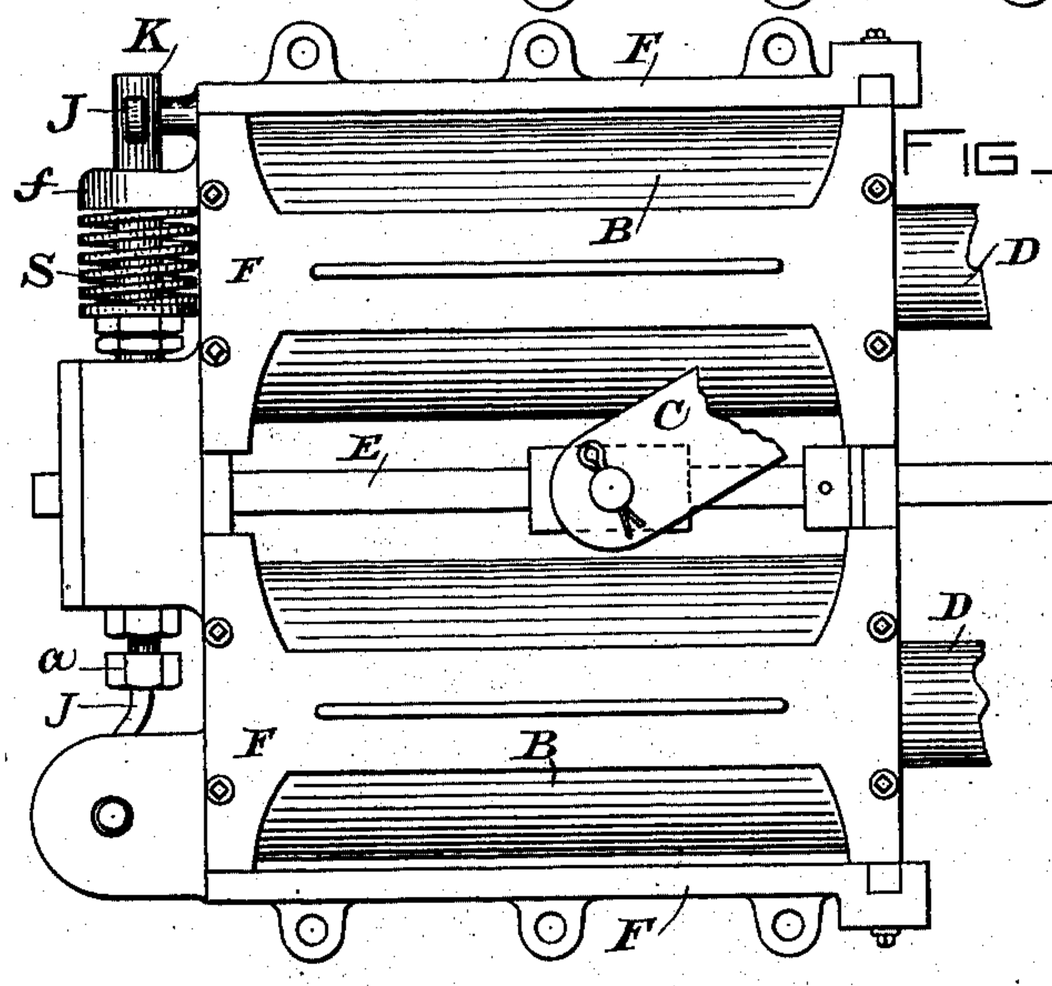


FIG_8_

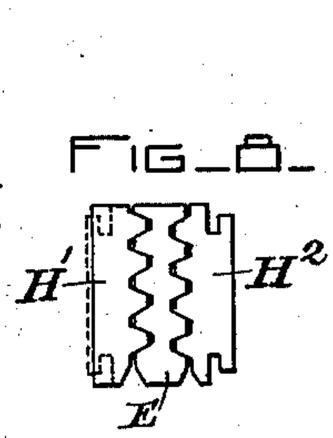


FIG_7_

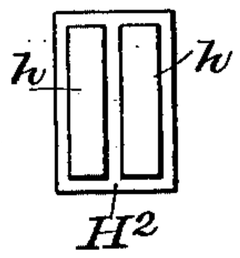
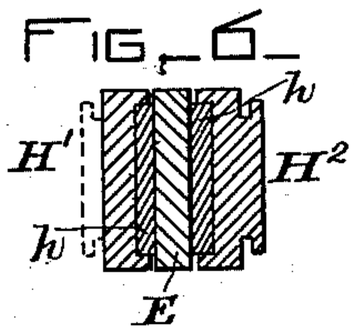


FIG_6_



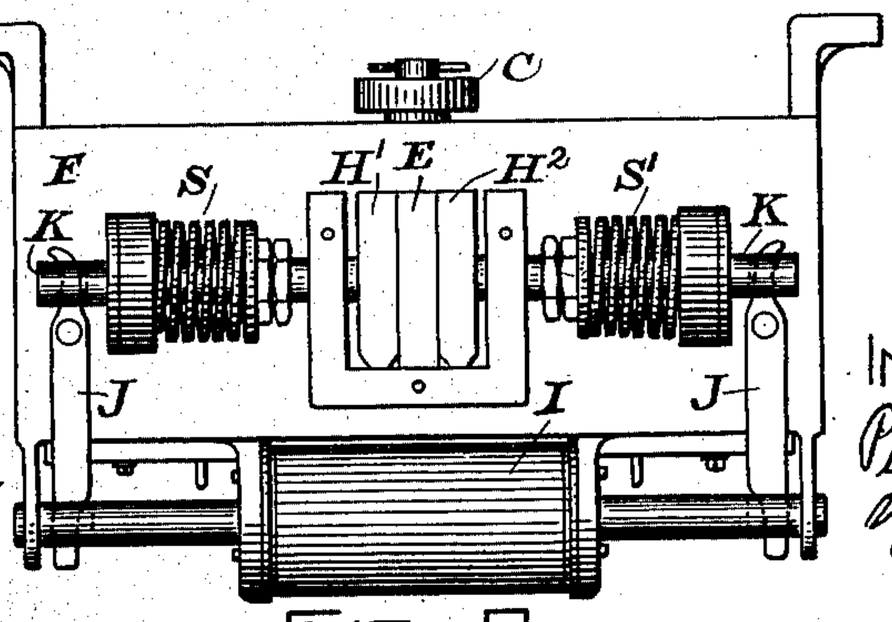


FIG_9_

WITNESSES

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No. 750,434. PATENTED JAN. 26, 1904.

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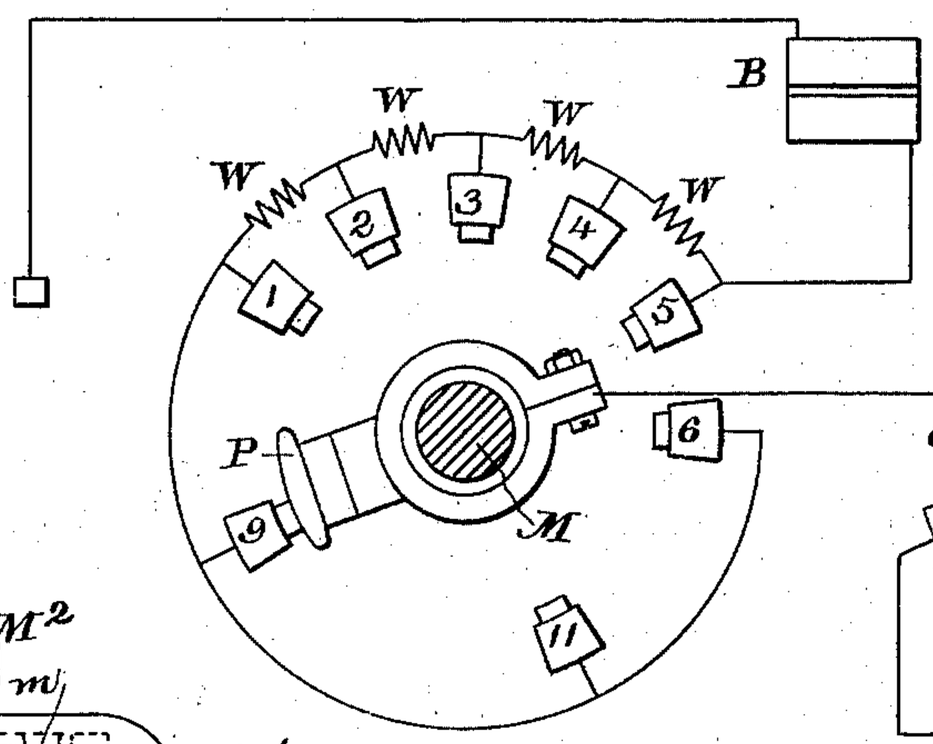
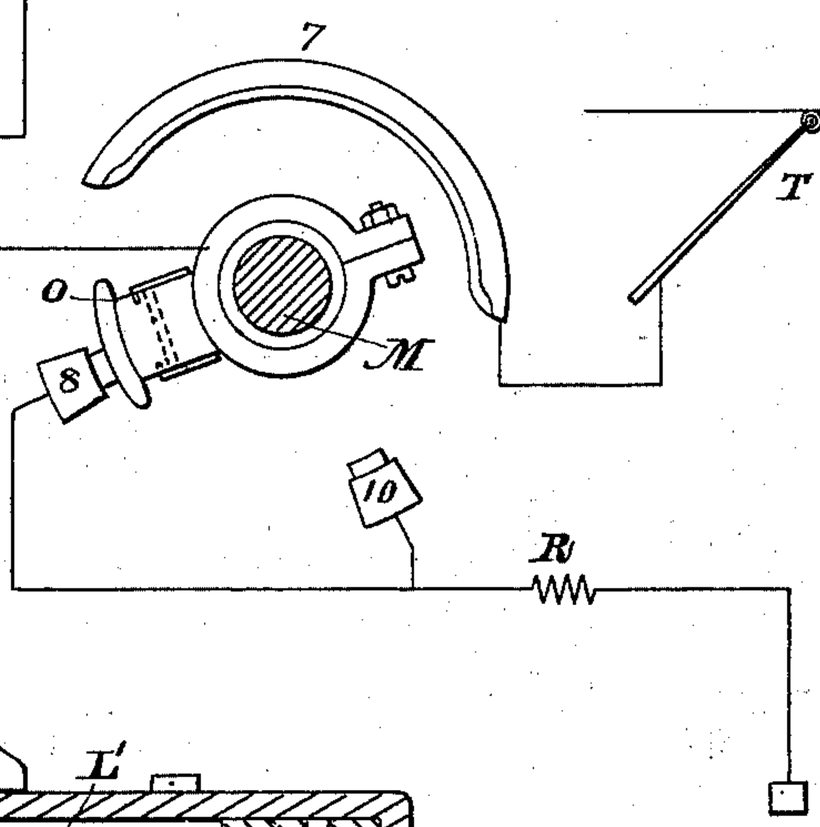
ELECTRIC BRAKE.

APPLICATION FILED NOV. 29, 1899.

NO MODEL. 4 SHEETS—SHEET 3.

FIG. 10.





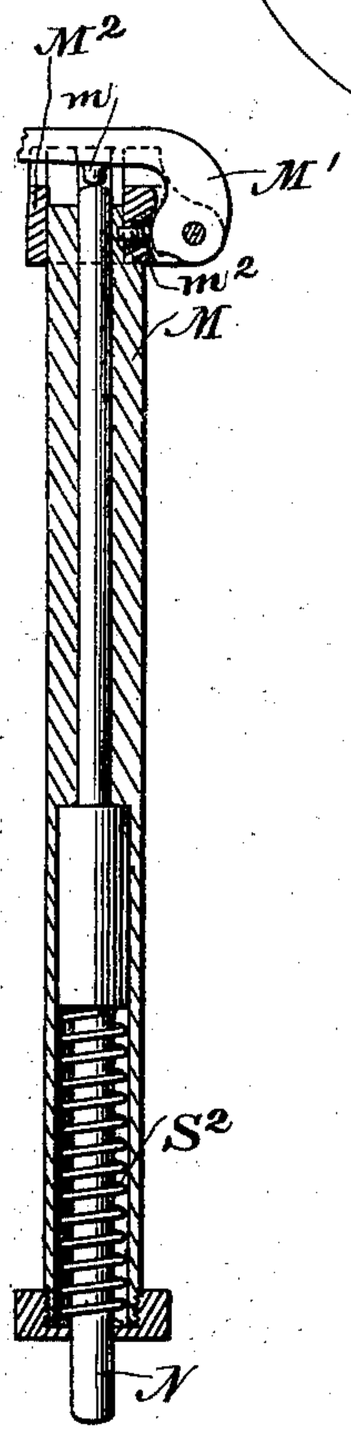


FIG. 12.

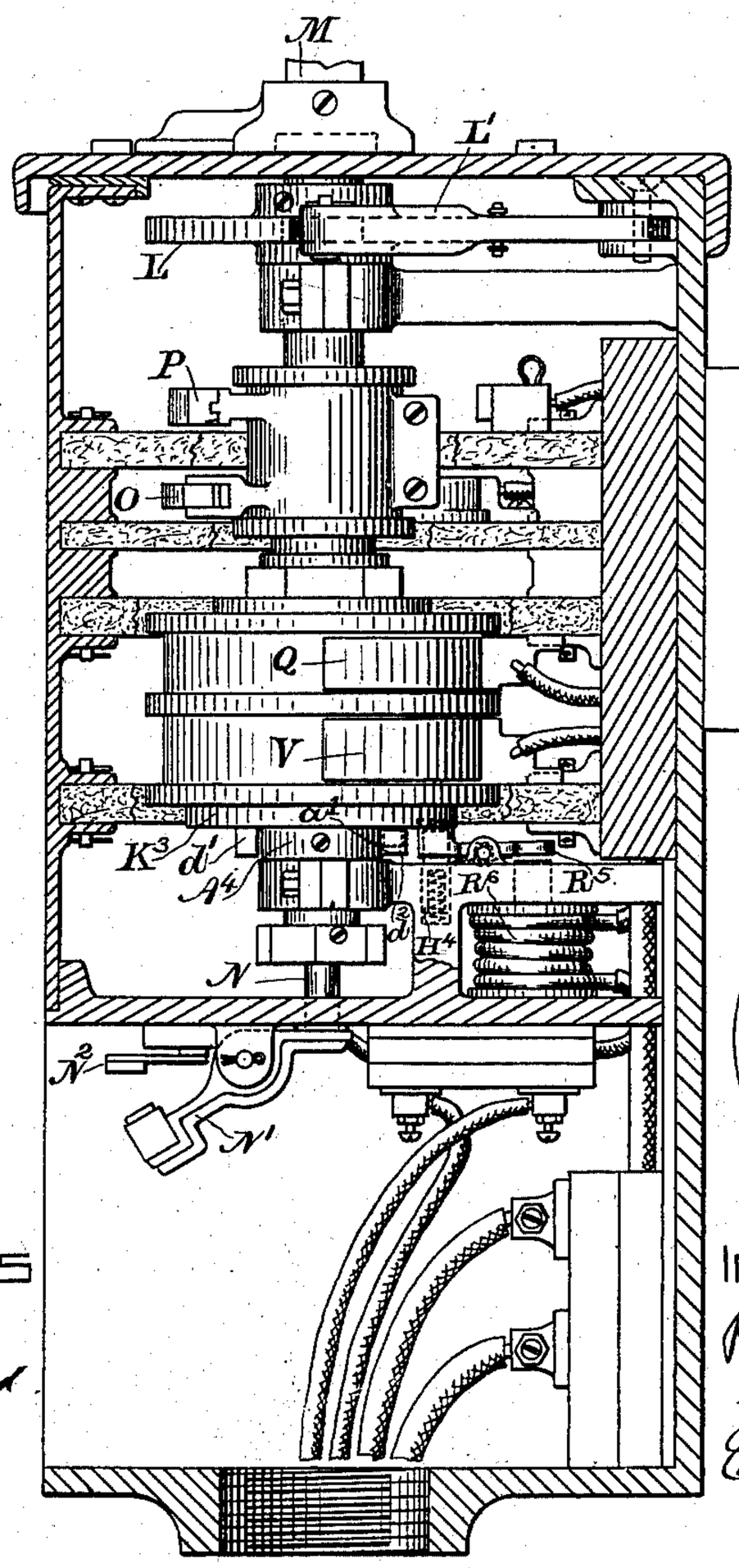
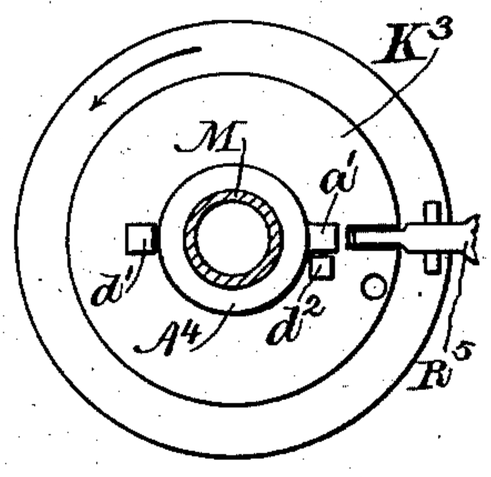


FIG. 11.

FIG. 13.



WITNESSES

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No. 750,434. PATENTED JAN. 26, 1904.

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ELECTRIC BRAKE.

APPLICATION FILED NOV. 29, 1899.

NO MODEL. 4 SHEETS—SHEET 4.

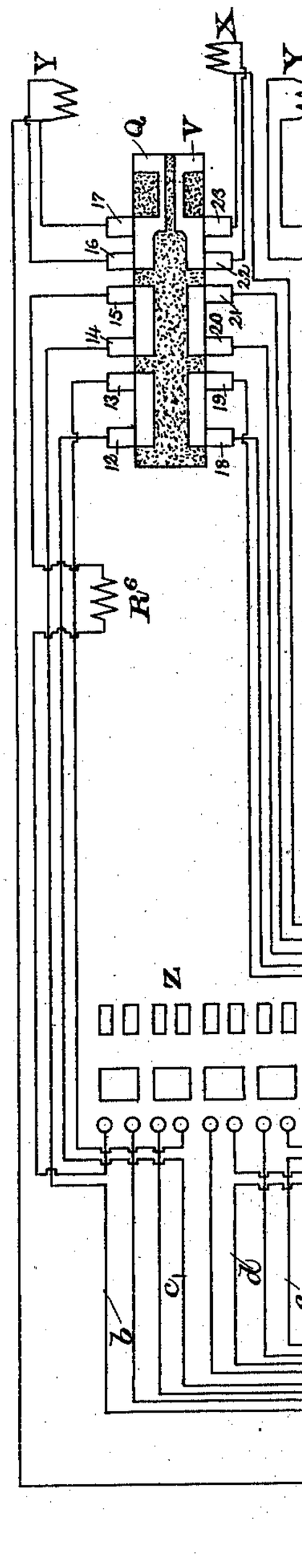

FIG. 14.

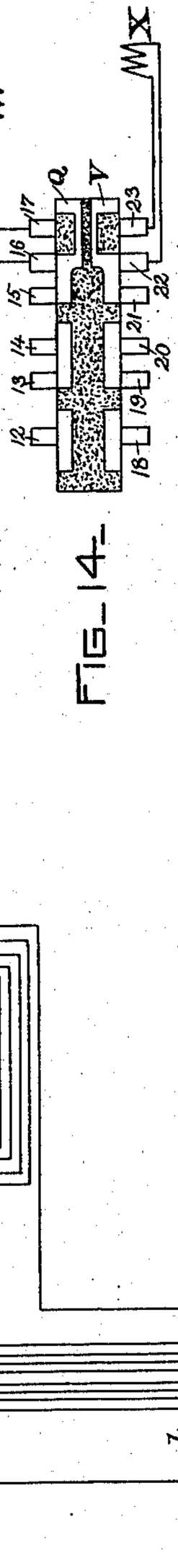

FIG. 15.

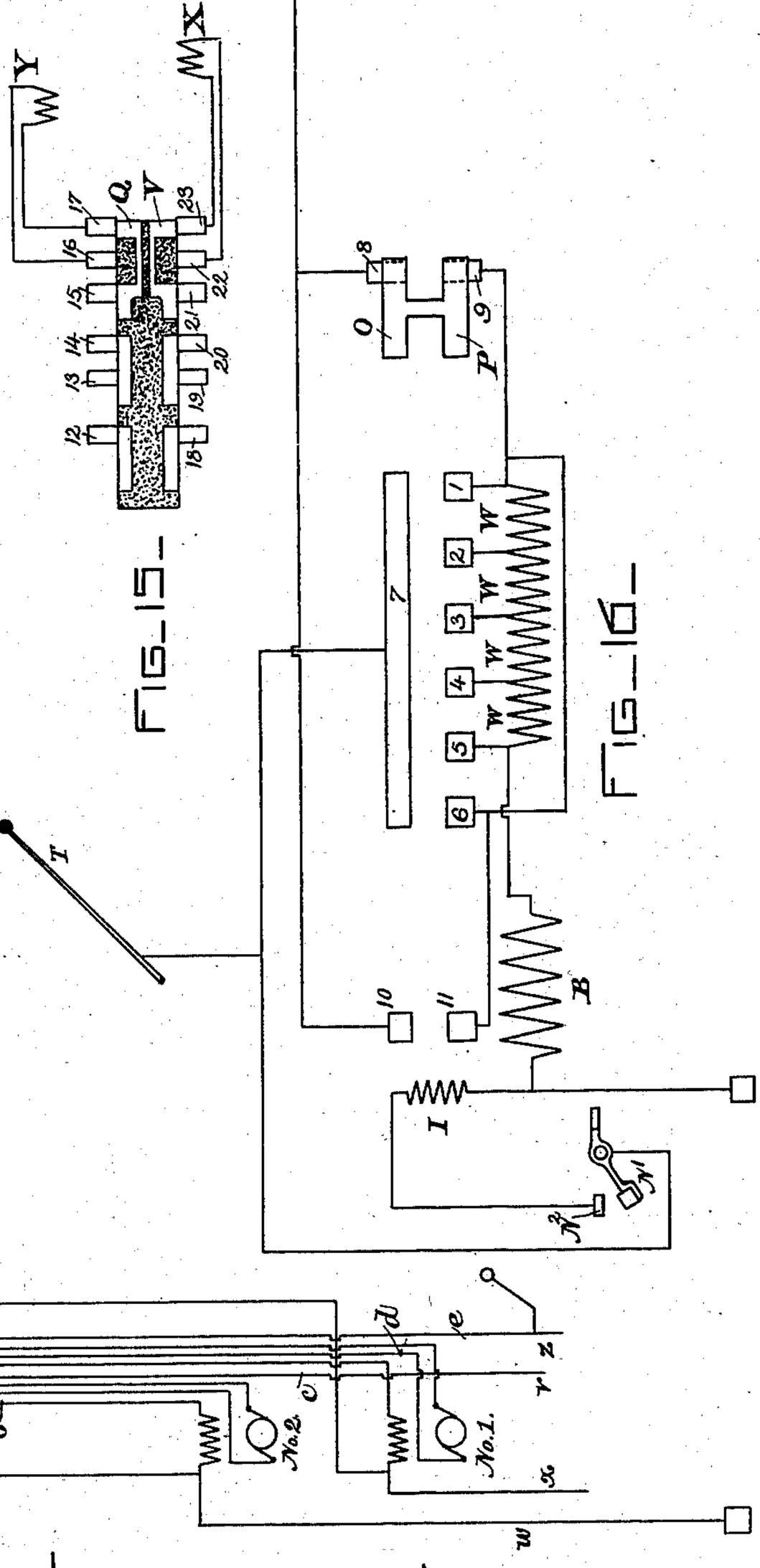

FIG. 16.

FIG. 17.

WITNESSES

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No. 750,434. Patented January 26, 1904.

UNITED STATES PATENT OFFICE.

PERLEY P. CRAFTS, OF BOSTON, MASSACHUSETTS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO ALGONQUIN ELECTRIC BRAKE CORPORATION, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MAINE.

ELECTRIC BRAKE.

SPECIFICATION forming part of Letters Patent No. 750,434, dated January 26, 1904.

Application filed November 29, 1899. Serial No. 738,622. (No model.)

To all whom it may concern:

Be it known that I, PERLEY P. CRAFTS, a citizen of the United States, residing at Boston, county of Suffolk, State of Massachusetts, have invented certain new and useful Improvements in Electric Brakes, of which the following is a specification, reference being made to the accompanying drawings, wherein—

Figure 1 shows in general the method of applying my brake to a car. Fig. 2 is a plan of the brake-magnet and appurtenances. Fig. 3 is a view of the same from the under side. Fig. 4 is an end elevation, and Fig. 5 a side elevation, thereof. Figs. 6, 7, and 8 are details of the clutching devices. Fig. 9 shows a modified arrangement of clutching magnets and springs. Figs. 10, 11, and 12 illustrate the controller. Figs. 13, 14, 15, and 16 are diagrams of the circuit connections. Fig. 17 shows a detail of the stops for the emergency-cylinder. Fig. 18 is a plan of the same from the under side.

My invention relates to that type of electric brake wherein the brake-levers are directly operated by a magnet energized by the line-current and wherein also, for the purpose of economizing current and relieving the magnets from heating by constant use, the brake when once set by the action of the magnet is held in place or locked mechanically by a spring-actuated clutch, which in turn is controlled by a second magnet that serves when energized to release it.

In this particular type of brake I have provided a clutch-spring acting directly on the clutch and a clutch-magnet acting indirectly on the spring through a lever and have devised other improvements in the structural details of the apparatus. I have also devised a controller by means of which various degrees of brake-pressure may be applied by the continued movement of the brake-handle, while during the entire range of play of the handle or at any point in such range the clutch may be controlled through the clutch-magnet, whose circuit is opened or closed at will by a different movement of the handle, such as an upward or downward movement, if the normal brake-controlling movement is horizontal. I have also provided an emergency device to be used in the event of the line-current through the brake-magnet being interrupted, by which device the motors are separately short-circuited on themselves through a resistance which is subsequently cut out after it has served its purpose of mitigating the shock of the instantaneous short-circuiting of the running-motors. I have also devised certain details of construction, which will be hereinafter described and claimed.

Referring to the drawings, Fig. 1, A represents an ordinary brake-lever attached to the usual brake-rods, by which when turned it draws the brake-shoes against the wheels. This lever A may be operated by hand through the usual brake-chains; but in addition I connect it to the armature of a strong magnet B of the solenoid type, which when energized draws thereon in the same manner as the chains would do when worked by hand. The coils of this magnet are contained in an iron box or framework F, (see Figs. 2, 5, and 3,) adapted to be bolted to the under side of the car-body, and are provided with cores D D, connected across at their outer ends by a bar G, from the center of which a bar E passes along between the two magnet-coils parallel with the cores and sliding in guideways formed in the opposite walls of the frame F. To this bar E about midway of its length is pivoted the forked link or stirrup C, whose outer end is pivoted to brake-lever A. By this connecting arrangement the magnet-cores are enabled to draw on the lever, the link C serving to accommodate the rectilinear movement of the cores to the circular movement of the lever, while the pull or tension exerted by the magnet will be dependent on the amount of the energizing-current flowing in the magnet-coils. The said link and also the clutch mechanism to be described are thus applied centrally with the two parallel cores and coils of the magnet, and a direct well-balanced action on the brake-lever is insured.

The bar E at its rear end passes between two clamping-jaws H′ and H², Figs. 4 and 9, which

are normally pressed against it by one or more springs S and the springs retracted by one or more magnets I, this portion of the apparatus forming the clutch for holding the brake mechanically without current in any of the magnets. The bar E at the point between jaws H′ and H² may be grooved longitudinally, as shown in Fig. 8, with corresponding projections on the faces of the jaws, or both jaws and bar may be smooth, as shown in Fig. 9. Moreover, the jaws may be provided with removable wearing-shoes *h*, as appears in cross-section in Fig. 6 and in elevation in Fig. 7, or the jaws H′ H² may be themselves removable, being held in place by dovetails on their rear side, as shown in Figs. 4, 6, and 8. Again, one jaw may be smooth and the other grooved, as in Fig. 4, wherein also one jaw is fixed and the other movable, the former being made adjustable for taking up wear by means of screws *a a*. A single clutch-spring S is used in the form of Figs. 2, 3, and 4, or two springs S and S′ may be used, as shown in Fig. 9. Likewise a single clutch-magnet I may be employed, as appears in Fig. 4, wherein the core of the magnet terminates in a loop that engages the longer arm of angle-lever J, pivoted to the framework and having its shorter arm engaging in a slot in the rear end of bolt K, which carries the movable jaw H². The spring S surrounds bolt K, being seated at its inner end against a flange *f*, projecting from the framework and through which the bolt passes, while its outer end presses against a nut on the bolt, tending to press the bolt and jaw against the bar E. The downward movement of the core or clutch-magnet I when energized draws down on lever J, thus retracting the spring and releasing the clutch. In place of a single magnet I a double magnet may be used, as in Fig. 9, with two cores acting, respectively, against the two springs S and S′ through levers J and J′. By means of the leverage thus introduced between magnet and spring a smaller magnet with a longer throw may be used than would be possible if the action of the magnet were direct. The magnet B and clutch mechanism being all on the common framework F may be made up and applied as a unitary structure to the car.

Turning next to the controller, Figs. 10 to 12, it is of the same general type as the ordinary motor-controller, being provided with a vertical shaft M, operating a cylindrical switch when turned by a crank-handle M′, Fig. 12. It is likewise provided with a notched disk L, having a spring-stop L′ engaging its periphery in the usual manner to indicate the successive points of brake regulation and also the emergency-points.

The shaft M is hollow (see Fig. 12) and contains a rod N, free to slide longitudinally therein, but upheld by a spiral spring S². The handle M′ is pivoted in a detachable sleeve M², which may be slipped over the end of shaft M and which also carries a spring-pin *m*², normally retracted, but forced into a notch in shaft M by a cam-surface on handle M′ when the latter is turned down to its horizontal working position. This serves to lock the handle when in use on the controller-spindle; but by lifting it up it may be readily removed, together with sleeve M², and carried to the opposite end of the car. The crank-handle M′ being thus hinged to the shaft M lies across the upper end of the shaft with a lug *m* on its under side resting against the upper end of rod N. Therefore as the handle and shaft are turned the operator may at any point in its circular movement press downward on his handle and force the rod N down against the force of spring S². As is shown in Fig. 11, the lower end of N engages a switch-lever N′ in the circuit of clutch-magnet I, which makes contact with terminal N², so as to close that circuit, or by letting up on the handle open it again. This novel arrangement puts the clutch under control during the whole range of play of the brake-magnet regulator. This permits the pull or tension of the brake-magnet to be maintained by the current in the brake-magnet while the clutch is being released preparatory to an increase or decrease in the tension by a change in the current, and when the new current adjustment is reached by turning the handle to vary the resistance in the brake-magnet circuit the clutch may be again set by allowing the handle to rise and open the circuit of the clutch-magnet. Thus the brake may be set and then locked mechanically by the clutch and the current be shut off from both magnets, while any change of tension adjustment is accomplished by the introduction of current prior to unlocking, so that the brakes do not fall back, but remain in their applied position when the unlocking occurs.

The normal braking operation, so far as the controller is concerned, involves besides the switch N only the two mechanically and electrically connected contact-plates O and P on the switch-cylinder, (see Figs. 10 and 11,) which coöperate with certain stationary circuit-terminals. (Shown in Figs. 10 and 16.) The plate O engages three terminals—viz., 7, (connected to trolley,) 8 and 10, (connected to ground,)—and the plate P engages the terminals 1, 2, 3, 4, and 5 (connected to resistances W W, &c., leading to ground through brake-magnet B) and 6, 9, and 11, (connected to the same circuit, but on the opposite side of the resistances.) Referring to Fig. 16, it appears that in the "off" position, which is the one shown in the figure, O and P join 8 and 9, closing a ground-circuit disconnected from the trolley, but including between the two ground-terminals resistances W and discharge-resistance R in series with magnet B. This affords a path for the self-induced current from mag-

net B when the circuit is opened and prevents injury to the magnet. As the controller is turned the plates O and P next close the circuit from trolley-terminal 7 to terminal 1 and thence through resistances W to brake-magnet B and ground, while a further movement over plates 2, 3, and 4 to plate 5 gradually cuts the resistances W out. This constitutes the ordinary range of movement of the controller, the switch N′, controlling the clutch-lever I, being operated at any point of this range in the manner described. In the event of the line-current being interrupted, however, something further is required to stop the car. For this emergency the controller-handle is thrown still farther, (against the resistance of a particularly steep notch in the stop disk.) That part of the switch-cylinder which carries the plates Q and V is not, however, rigidly attached to spindle M. It is loose thereon, but normally disabled by being held fast against any movement by a magnet, which is energized so long as any current is flowing and released by the magnet whenever the line-current is interrupted and it becomes desirable or possible to employ the emergency control. Referring to Figs. 11, 17, and 18, there is attached to the under side of the cylinder a plate K^3, and a projection on armature R^5 of magnet R^6 engages a notch in this plate when the magnet is energized, and so locks the cylinder. The cylinder is also held to a degree by a mechanical spring-stop H^4, which, however, will yield when the operator turns the handle, but will hold the cylinder against accidental jarring out of its normal place when the controller is not in use and the current is absent in the locking-magnet R^6. There are also two pins d' d^2 on the under side of plate K^3, while fast on the spindle M is a collar A^4 with a lug a', that engages one or the other of the two pins d' d^2. Thus if the spindle is turned in the direction of the arrow, Fig. 18, it will not carry with it the emergency-cylinder, but will operate the brakes in the manner described until lug a' strikes pin d' at the end of its normal play. Thus an extra movement of the spindle will force lug a' against pin d' and so operate the emergency-switch, provided it is unlocked by a failure of current in magnet R^6. After the emergency-cylinder has been worked the reverse movement of the handle brings lug a' against pin d^2 and brings the cylinder back to its normal position. (Shown in Fig. 18.) The operation of the emergency-cylinder will cause plates O and P to connect 7 and 6 and the whole resistance W to be instantly thrown into the circuit and the circuit then broken by a further movement, which causes O and P to leave 6 and 7 and pass to 10 and 11, thereby closing the grounded discharge-circuit above mentioned. Simultaneously with this extra throw of contact-plates O and P the two sets of emergency contact-plates Q and V (see Fig. 11, also Figs. 13, 14, 15) are moved out of their normal connections for the purpose of short-circuiting the motors. These plates are of the form shown in Figs. 13, 14, and 15, the set Q coöperating with stationary terminals 12 17 and the set V with the terminals 18 23, their normal condition being that giving the connections indicated in Fig. 13. Now in order that the short-circuiting of the motors may not interfere with or be interfered with by the reversal of the motors I have arranged to lead the connections from the motor to the ordinary reversing-switches used with the motor-controller through the emergency controller-terminals and contact-plates, and to that end I take out loops to the emergency-terminals from certain of the wires leading into the reversing-switches from the motor and motor-controller. Thus wire *b*, leading from one field-magnet terminal of motor No. 2, has taken from it before it reaches reversing-switch Z a loop, including the terminals 14 and 15 of the emergency-switch and their connecting contact-plate. In this loop is also included the locking-magnet R^6, which is there placed so as to have but a low difference of potential between its coils and the ground at all times. In like manner wire *c*, leading from terminal *v* of the controller, passes to reversing-switch Z, but before doing so has taken from it a loop, including terminals 12 and 13 of the emergency-switch. So wire *d* has a loop to terminals 20 and 21 and wire *e* a loop to terminals 18 and 19 of the emergency-switch. Of the remaining emergency-terminals 16 is connected to one end of resistance Y and 17 to the other end and also to controller-terminal *w*. In like manner 22 is connected to one end and 23 to the other end of resistance X, the latter being also connected to motor-terminal *x*. With the connections as shown in Fig. 13 the motors are in their usual running condition, being quite unaffected by the connections running through the emergency-switch. With the operation of that switch, however, the plates Q and V are first thrown into the position shown in Fig. 14, when each motor is put into a local short-circuit containing a resistance X or Y, and by a further movement the resistances are cut out, as appears in Fig. 15, having the motors each short-circuited, when they will come very quickly to a stop, or nearly so, the brake-magnet being, as already described, disconnected entirely from the line-circuit.

The circuit in Fig. 13 may be traced from the trolley-terminal *z* of the motor by wire *e* to contacts 18 and 19 of the emergency-switch, thence to the reversing-switch, where, assuming that the reversing-switch contacts rest upon the left-hand row of contact-plates, to the armature of motor No. 1, thence by the wire *d* to the reversing-switch; but before entering the reversing-switch it passes through the loop taken out to the emergency-switch and

containing the contact-plates 20 and 21, which, as shown in Fig. 13, are connected together in the same manner as the plates 18 and 19. From the reversing-switch the current then passes to the field-magnet of motor No. 1 and thence to the terminal *x*, leading into the ordinary motor-controller. In this manner the two terminals of motor No. 1 are placed under the control of the ordinary controller or regulator of the vehicle and are unaffected by the presence of the emergency-switch. The latter simply maintains closed the above-described loops taken from the motor-circuit before they enter the reversing-switch *z*. In like manner the terminal *b* of motor No. 2 starting from the controller passes by the wire *c* and proceeds to reversing-switch Z, but before reaching the reversing-switch passes through the closed loop containing the contacts 12 and 13 of the emergency-switch. The circuit then passes from the reversing-switch Z to the armature of motor No. 2 and back to the reversing-switch. Thence it passes by the wire *b*, which in like manner contains a closed loop, passing through contact 14 and 15 of the emergency-switch to the field-magnet of motor No. 2 and thence to the terminal *w* of the ordinary controller. Thus motor No. 2 is in like manner placed under the control of the ordinary car-controller and remains unaffected by the loops taken out to the emergency-switch from the leads extending from motor No. 2 to the reversing-switch Z.

In the condition shown in Fig. 14 the wire *e*, leading from the controller-trolley terminal is left out of circuit, being open-ended at the contact 18 of the emergency-switch. The right-hand armature-terminal of motor No. 1 is connected first to the lower plate of the reversing-switch and the connection is thence to contact 19 of the emergency-switch, to contact 20 of the same switch, thence to the second plate of the reversing-switch, to the field-magnet of motor No. 1, to the resistance X, to contact 22 of the emergency-switch, thence to contact 21 of the same switch, to the opposite armature-terminal of motor No. 1. This motor is thus placed on short-circuit through the resistance X, and the corresponding circuit for motor No. 2 can be traced in the same manner, showing that this motor is also short-circuited through the resistance Y.

In the condition of Fig. 15 the circuits remain the same as they are in Fig. 14, except that the resistances X and Y are left out of the circuit, being open-ended at the contacts 22 and 16, respectively, of the emergency-switch.

In operation but a single brake-handle is required, and in whatever position the handle may be a simple additional movement of the hand without changing the brake regulation will deënergize the clutch-magnet and lock the brake.

The working of this brake approximates somewhat to that of the ordinary hand-brake, it being only necessary to move the handle to any desired degree and then unlock the brake by depressing the handle, and after it has responded to the current thus introduced into the brake-magnet lock it by letting up on the handle, or the handle may be depressed and the brake unlocked at the same time that it is being moved to admit the required current to the brake-magnet and lifted after the brake has responded to the current, as it will instantly do.

It is to be understood that I do not limit myself to the precise details shown herein for illustration, but that they may be varied in many ways without departing from the spirit of my invention, it being particularly feasible to provide other equivalent arrangements for permitting the operator with one and the same hand to regulate the brake-magnet and lock and unlock the brake at any point in such regulating range.

Among the advantages of my invention it may be noted that I practically make no extra demand on the capacity of the motors, such as is occasioned by those forms of electric brake which rely on the generative action of the motors for the ordinary braking effect. That effect I secure by a draft on the supply-current, not by a draft on the motors acting as generators, while it is only in the rare event of a cessation of line-current that the motors are called upon to furnish the braking energy. This event is so unusual that the motors do not have to be of any extra capacity to meet it; but the motors now employed for the mere propulsion of the car may be safely continued in use with my brake. It is also impossible for the operator to use the emergency-brake for ordinary stops without shutting off the current at the controller, as he might do if he could. By my invention the emergency device is disabled so long as the normal conditions prevail, and it is only when the emergency conditions—namely, the cessation of line-current—occur that the emergency-brake is available.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination with a spindle of an electric-brake controller, of a removable collar thereon, a handle pivoted to the said collar, a locking device between the collar and the spindle controlled by the said handle, a mechanical lock for the brake, a magnet controlling the said lock, and a switch in the circuit of said magnet operated by the movement of the said handle on its pivot.

2. The combination with a brake-magnet of the solenoid type, having two parallel coils and cores, of a link leading to the brake-lever applied centrally between the two coils and cores and a clutch for the cores applied in a line with the pivotal point of the link.

3. The combination with a brake-magnet of the solenoid type having two parallel coils and

cores of a forked link or stirrup embracing the said magnet and intervening between the said cores and the brake-rod.

4. The combination with a vehicle, a friction-brake therefor, a controlling-switch for the brake-magnet admitting line-current thereto, and an emergency braking device, consisting of a switch connecting the motor-terminals to short-circuit the motor exclusive of the said magnet in the event of a cessation of the line-current supplied to the vehicle.

5. A braking device for an electric-railway vehicle, consisting of a friction-brake, a magnet for operating the same, a controlling-switch admitting line-current to the magnet, and an emergency-switch for opening the circuit between the trolley or supply-terminal and the motor and short-circuiting the motor upon itself exclusive of the said magnet in the event of a cessation of the line-current supplied to the vehicle.

6. A braking device for an electric vehicle comprising in combination a friction-brake, an operating-magnet for the brake, a controlling-switch admitting line-current to the magnet, an emergency braking device, consisting of a switch connecting the motor-terminals to short-circuit the motor exclusive of the said magnet in the event of a cessation of the line-current supplied to the vehicle, and a common operating device for the said switches operating the former by its normal movement and the latter by an abnormal movement.

7. The combination with a vehicle, a friction-brake therefor, an operating-magnet for the brake contained in a circuit parallel to the circuit of the propelling-motor, a controlling-switch admitting line-current to the magnet, an emergency braking device, consisting of a switch connecting the motor-terminals to short-circuit the motor exclusive of the said magnet in the event of a cessation of the line-current supplied to the vehicle and a common operating device for the said switches operating the former by its normal movement and the latter by an abnormal movement.

8. The combination with a brake-operating magnet, of a controlling-switch admitting line-current thereto, electrical emergency braking devices and an emergency-switch for said devices normally held stationary, but operated by the controlling-switch at a predetermined point in the movement of the latter.

9. The combination of a friction-brake, an operating-magnet therefor, a controlling-switch admitting line-current to the magnet, electrical emergency braking devices and an emergency-switch therefor normally held stationary but having a projection in the path of movement of the controlling-switch so as to be operated by an abnormal movement thereof.

10. The combination with a vehicle, of a friction-brake therefor, an operating-magnet for the brake, a controlling-switch admitting line-current to said magnet, an emergency-switch for short-circuiting the propelling-motor of the vehicle, normally held stationary, and an operating connection between the emergency-switch and controlling-switch adapted to come into action at a predetermined point in the range of movement of the latter, whereby the emergency-switch is operated by an abnormal movement of the controlling-switch.

11. The combination of a vehicle, a friction-brake therefor, an operating-magnet for the brake, a controlling-switch admitting line-current to said magnet, an emergency braking-switch having a loose connection with the controlling-switch so as to be operated therewith by an abnormal movement thereof and provided with a stop for holding it when free of the controlling-switch.

12. The combination with a braking device operated by the line-current, of an emergency-switch, a stop therefor and a magnet operated by the line-current for holding said stop in position to prevent the operation of the emergency-brake, except when the line-current is interrupted.

13. The combination with a vehicle, a normal brake therefor, a magnet operating said brake, a controlling-switch admitting line-current to said magnet, an emergency braking device, consisting of a switch controlling the motor-circuits and a disabling device for the latter switch controlled by the line-current.

14. The combination with a brake for an electric vehicle, of an operating-magnet therefor, a switch for admitting line-current to the said magnet, a motor-controller for the propelling-motors of the vehicle, a reversing-switch for said motor, and an emergency-switch having its contacts included in loop-circuits between the controller and reversing-switch and adapted to disconnect the motor from the supply and short-circuit it directly upon itself.

In testimony whereof I have affixed my signature in presence of two witnesses.

PERLEY P. CRAFTS.

Witnesses:
A. O. ORNE,
F. C. MILDRAW.