No. 756,000. PATENTED MAR. 29, 1904.

W. H. COOLEY.

BRAKE FOR VEHICLES.

APPLICATION FILED DEC. 9, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

Figure 1.

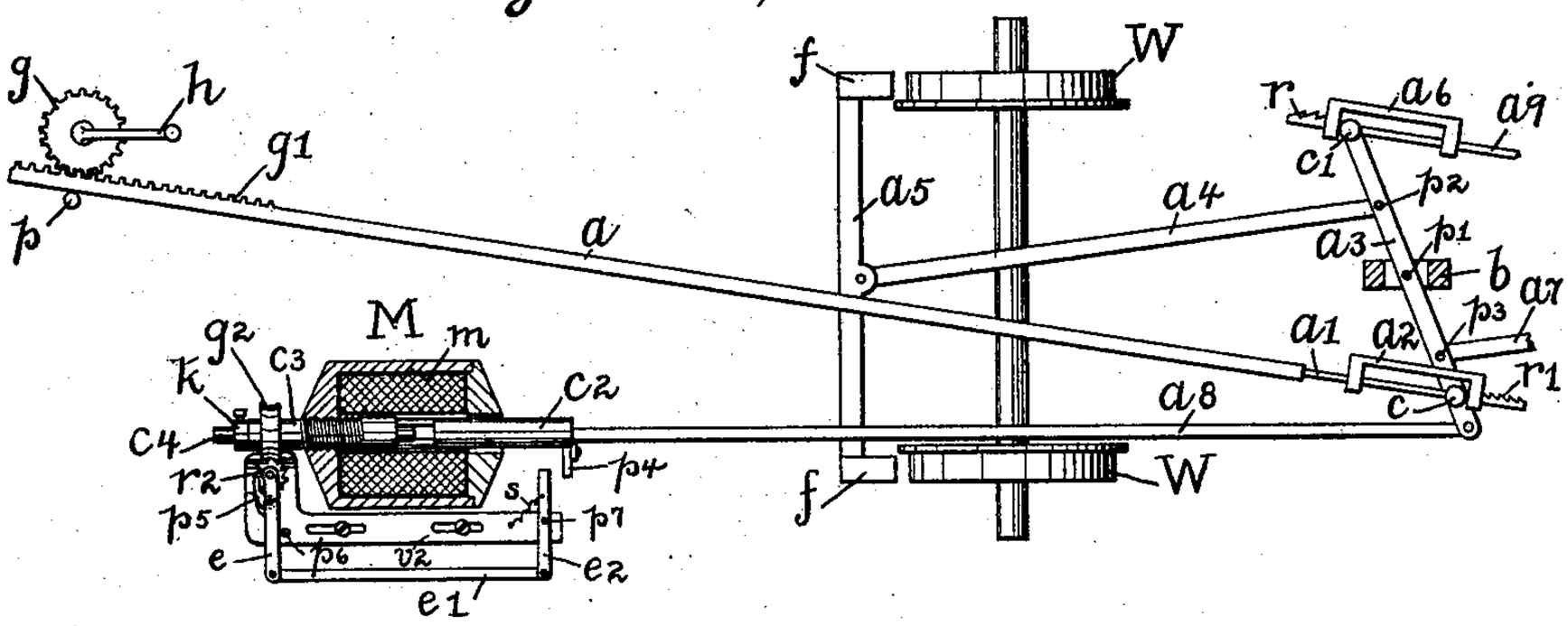


Fig. 2.

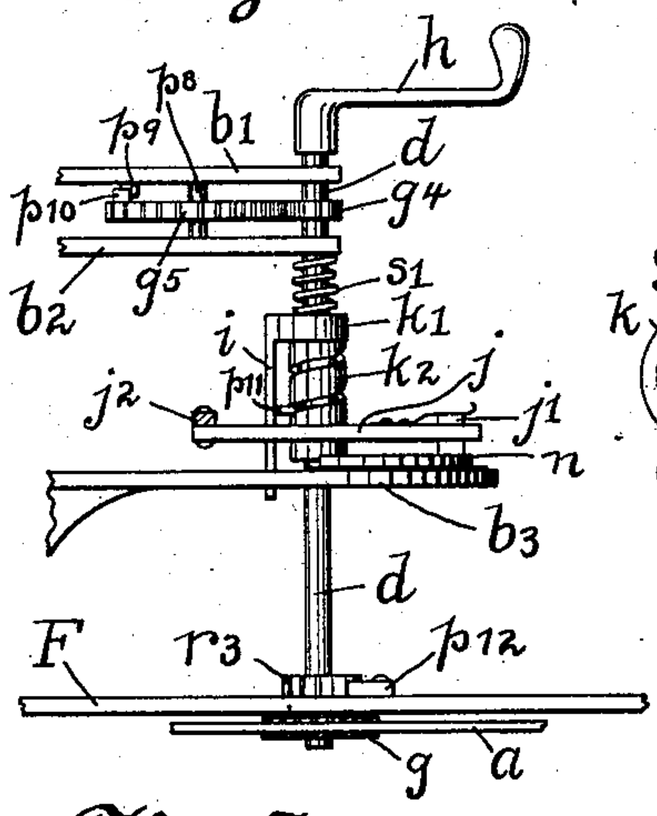


Fig. 3.

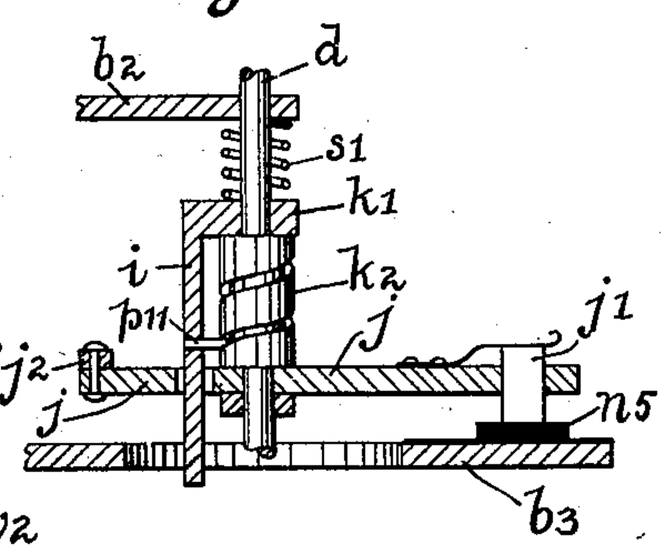


Fig. 6.

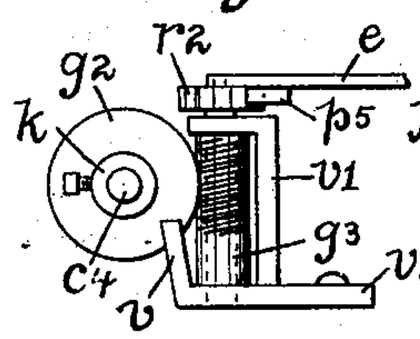


Fig. 4.

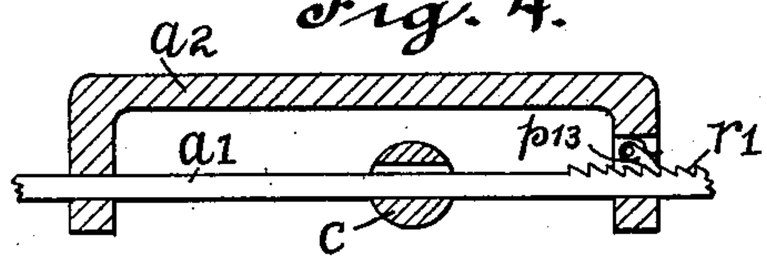


Fig. 7.

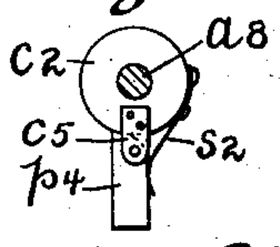


Fig. 8.

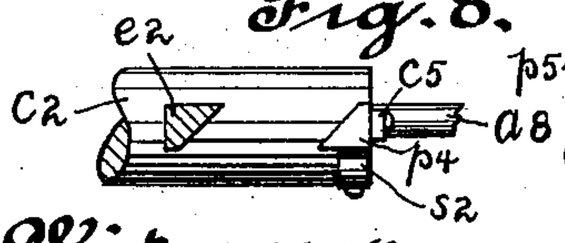
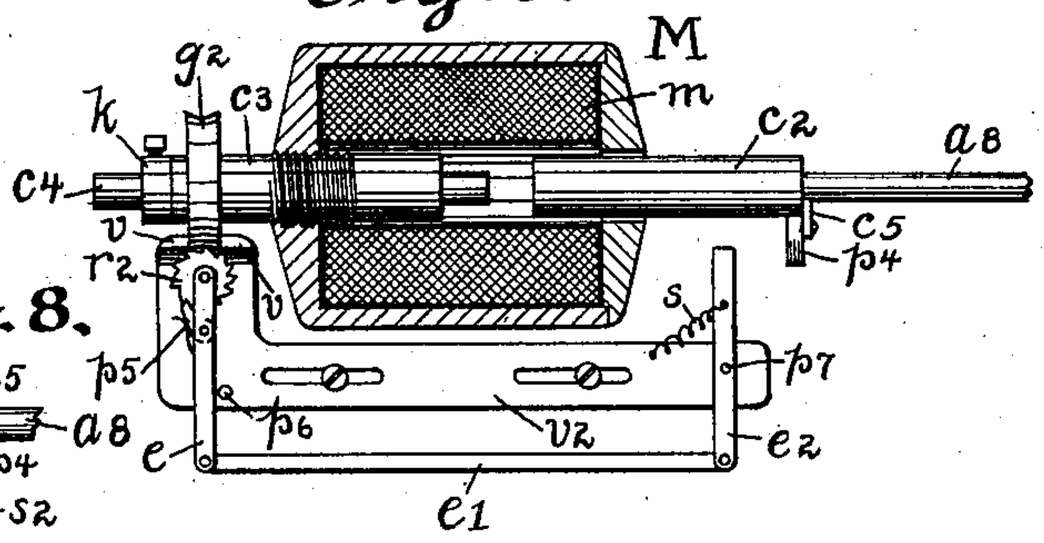


Fig. 5.



Witnesses:

Albert C. Bell.

Etha M. Smith

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No. 756,000. PATENTED MAR. 29, 1904.

W. H. COOLEY.

BRAKE FOR VEHICLES.

APPLICATION FILED DEC. 9, 1902.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 9.

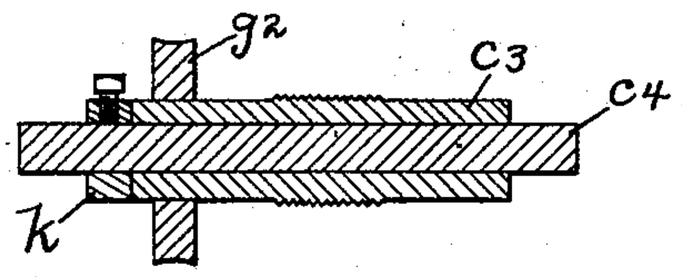


Fig. 10.

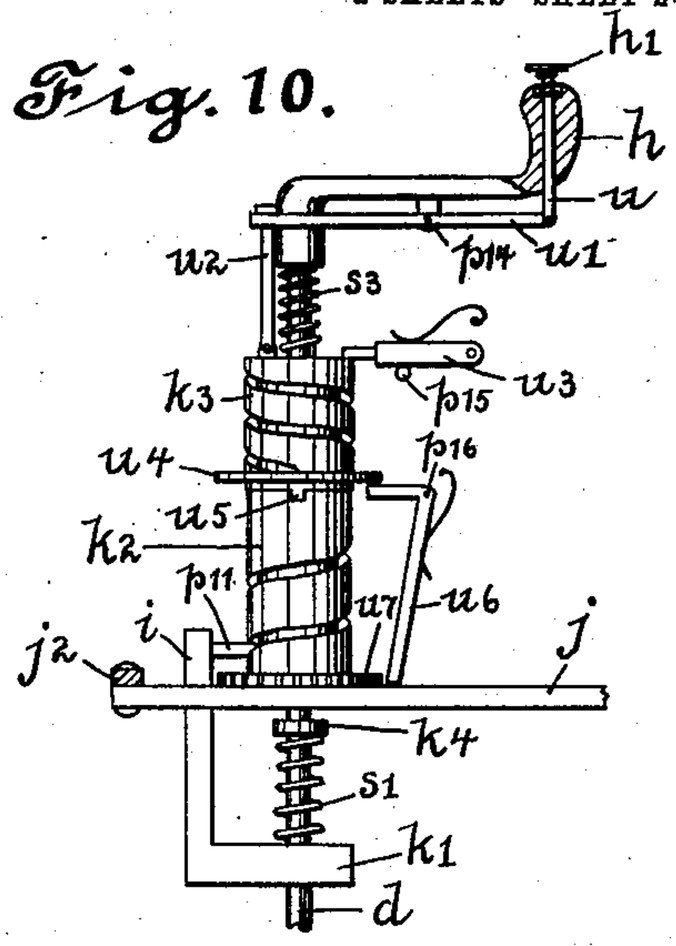
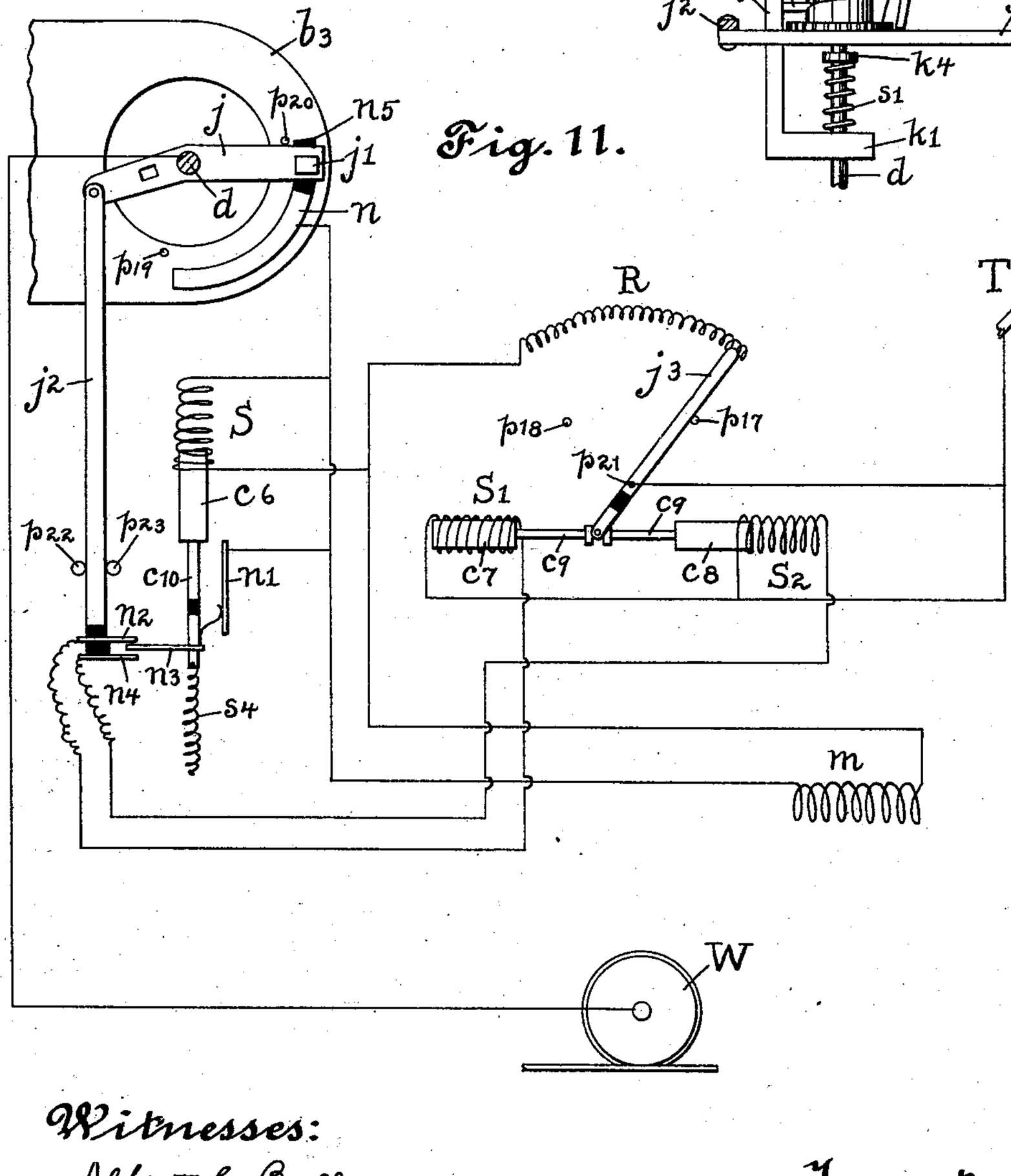


Fig. 11.



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No. 756,000. Patented March 29, 1904.

UNITED STATES PATENT OFFICE.

WILLIAM H. COOLEY, OF BROCKPORT, NEW YORK.

BRAKE FOR VEHICLES.

SPECIFICATION forming part of Letters Patent No. 756,000, dated March 29, 1904.

Application filed December 9, 1902. Serial No. 134,585. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM H. COOLEY, a citizen of the United States, residing at Brockport, in the county of Monroe and State of New York, have invented an Improvement in Brakes for Vehicles, of which the following is a specification.

The object of my invention is to provide for the application of the brakes both electrically and by means of hand-operated mechanism by the movement of a single operating-handle in such a way that the handle shall at all times have a practically constant starting position, the amount of motion of the handle from which shall determine the amount of braking effort applied through the electrically-operated mechanism regardless of wear or variations in the potential of the source of supply for the electric energy which is applied to the brakes.

In carrying out my invention I provide a hand-operated braking mechanism of substantially the usual construction and arrangement, and combined therewith I also make use of electrically-applied braking mechanism under the control of the usual brake-staff handle and means for taking up the additional slack, as it occurs from time to time from wear of the parts, by the movement of an element upon which there is practically no mechanical tension during the time that it is moved to meet the required adjustment for the new conditions resulting from a predetermined amount of wear upon the parts or after the accumulation of a predetermined amount of additional slack to the apparatus. I further provide means whereby the different potentials impressed upon the energizing-coil of the electrically-applied brake shall be determined by the several positions of the operating-handle regardless of the fluctuations in the line potential.

The accompanying drawings illustrating my invention are as follows:

Figure 1 is a diagrammatic top view of the mechanical connections between the brake-handle h and the brake-shoes $f\,f$ of one pair of wheels W W of a car and also between the operating-magnet M and such brake-shoes. Fig. 2 shows in side view the brake-rod d and parts carried thereby, as well as the parts directly engaged thereby. Fig. 3 is a partial sectional view through the center of rod d to show more clearly the construction of some of the parts seen in Fig. 2. Fig. 4 is a partial sectional view showing the mechanism used to automatically adjust the mechanical connection between the brake-shoes $f\,f$ and the handle h, so that as such shoes $f\,f$ wear there will be practically a uniform clearance between the wheels W W and the shoes $f\,f$ when the brakes are released. Fig. 5 is an enlarged partial sectional view through the axis of the operating-magnet M, showing also the mechanism operated by such magnet to maintain a practically constant maximum air-gap in such magnet independent of the wear of the shoes $f\,f$. Figs. 6, 7, and 8 are detail views of part of the mechanism shown in Fig. 5. Fig. 9 is a central longitudinal section of cores c^3 and c^4 of magnet M. Fig. 10 is a side view of a modification of my invention, by means of which the electrical braking may be carried to any desired point and the braking continued from that point wholly by hand. Fig. 11 is a diagrammatic view of the means used to automatically effect a certain fixed braking of the car, corresponding to a particular fixed position of the handle h, independently of the potential difference between the trolley and the rail.

Similar letters refer to similar parts throughout the several views.

Refer to Figs. 1, 2, 3, 4, and 11. The brake-handle h is rigidly secured to a brake-rod d, supported in bearings b' b^2 and the floor F of the car. Rigidly secured to this brake-rod d are seen the gears g and g^4 and the ratchet-wheel r^3, engaging, respectively, rack g', gear g^5, and pawl p^{12}. Gear g engages a rack g', formed on the left-hand end of rod a. The reduced right-hand end a' of rod a works longitudinally in a yoke a^2 and through a hole therefor in the post c, secured to the lever a^3 near its lower end. A spring-pawl p^{13}, carried by yoke a^2, (see Fig. 4,) engages a ratchet r' on the rod a'. A suitable guide p is provided to insure that the gear g and rack g' shall always be in proper mesh. The lever a^3 is pivoted at p' to a suitable support b, car-

ried on the under side of the car-floor, and also articulates at p^2 with the right-hand end of a link a^4, the other end of which articulates with the middle point of the brake-beam a^5, carrying brake-shoes $f\,f$, arranged to bear on the wheels W W of the car. Only one pair of wheels and shoes is shown. Connection to the other brake-shoes is indicated by link a^7, articulating with lever a^3 at point p^3. The right-hand end of connecting-rod a^8 articulates with the lower end of lever a^3, while its left-hand end is secured to the moving core c^2 of electromagnet M. The magnet M is so proportioned that the distance between the stationary core c^3 thereof and the movable core c^2 is only a little more than that necessary to be traversed by the core c^2, operating through the mechanism just described as connected therewith to set the brakes for maximum braking, starting with the shoes $f\,f$ at the proper clearance distance from the wheels W W.

The distance between the ends of the yoke a^2 is such that when the brakes are set by means of magnet M the post c, arranged to slide freely on the rod a', will just clear such yoke a^2 at each end thereof. When the shoes $f\,f$ and other parts have so worn as to permit the post c to move farther to the left in order to effect the same degree of braking, it engages the left-hand end of yoke a^2 and slides it upon rod a'. Spring-pawl p^{13} and ratchet r' on rod a' (see Fig. 4) operate to hold these parts in each successive adjustment.

When it is desired to brake by hand, the handle h is rotated to the right, moving rod a to the left. Yoke a^2 is carried to the left by rod a', and yoke a^2 in turn carries post c and the lower end of lever a^3 to the left, thus applying the brakes. Thus yoke a^2 and pawl p^{13}, carried thereby, together with ratchet r', constitute a means by which, as the brakes are operated by magnet M, a constant amount of slack is maintained between the handle h and the shoes $f\,f$, so that starting always from the same initial point a practically uniform amount of motion of handle h is required to set the brakes independent of the wear of the parts. A similar mechanism consisting of rod a^9, yoke a^6, and ratchet r, coöperating with the post c', carried by the upper end of lever a^3, perform a similar function for the handle situated at the other end of the car.

Ratchet-wheel r^3 and pawl p^{12} constitute the ordinary ratchet-wheel and pawl as found on hand-brakes. Gear g^5 has suitable bearings in supports b' and b^2 and carries a stop p^{10}, arranged to strike against a similar stop p^9, secured to support b'. These stops p^9 and p^{10} and gears g^4 and g^5 coöperate to permit the necessary amount of right-handed motion of the handle h for applying the brake by hand and also provide a fixed stop, so that the handle h may always be brought back against the same fixed stop through the same amount of motion as imparted in braking.

The fixed core c^3 of magnet M is threaded into such magnet M, as indicated in Figs. 1 and 5, and carries near its left-hand end a worm-gear g^2, arranged to mesh with a worm g^3, as seen in Fig. 6. This worm g^3 is revolubly supported in a bearing in a base v^2 and a bearing v' carried thereby. Such base v^2 is supported so as to move longitudinally, as indicated, by slots and screws therethrough. This base v^2 carries upwardly-extending projections $v\,v$, arranged to engage either side of gear g^2 to cause the base v^2 and parts carried thereby to move with such gear longitudinally when the core c^3 is being adjusted in magnet M.

The worm g^3 has pivoted to its upper end one end of a lever e, carrying also the spring-pawl p^5, arranged to engage the ratchet-wheel r^2, rigidly secured to the worm g^3.

The moving core c^2 of magnet M has secured to its right-hand end a support c^5 for a pawl p^4, as seen in Figs. 1, 5, 7, and 8, such pawl being normally held in position by spring s^2, as seen in Fig. 7. This pawl p^4 is arranged to engage a lever e^2, pivoted to base v^2 at p^7. The lower end of this lever e^2 is connected to the lower end of lever e by means of link e'. A spring s is provided to keep the levers e and e^2 and link e' normally in the position shown in Fig. 5 and is prevented from moving them too far by stop p^6, carried by the base v^2. The upper end of lever e^2 and the lower end of pawl p^4, as seen in Fig. 5, are so conformed, as seen in Fig. 8, that if the core c^2 move so far to the left as to cause pawl p^4 to pass to the left of the upper end of lever e^2 pawl p^4 is depressed, so as to pass under the lever e^2, and when core c^2 moves to the right pawl p^4 engages lever e^2, moving such lever e^2 over to the right against the action of spring s, thereby moving link e' and the lower end of lever e to the left. This motion by means of ratchet-wheel r^2 and pawl p^5 rotates the worm g^3 over to the right, and thus rotates gear g^2 over away from the observer, as seen in Fig. 5, or to the left, as seen in Fig. 6. This results in core c^3 being withdrawn or screwed out of magnet M somewhat, which is the action desired to maintain a practically uniform distance between cores c^3 and c^2.

As seen in Figs. 1, 5, and 9, core c^3 carries inside of it a sliding core c^4, adjustable longitudinally by means of collar k. The effect of this sliding core c^4 is to reduce the initial air-gap between cores c^3 and c^2, and thus to reduce the amount of electric energy which it is necessary to use to exert the desired pull on core c^2. When the core c^2 contacts with the core c^4, the core c^2 is moved the remaining distance by the magnetic action between cores c^3 and c^2, core c^4 sliding in core c^3 at this time.

Refer to Figs. 2, 3, and 11. The brake-rod

d carries besides the parts already described a sleeve k^2, rigidly secured thereto and threaded on its outside surface, so as to engage a pin p^{11}, carried by an arm i, rigidly secured to and projecting downward from a collar k', supported on brake-rod d, so as to rotate and slide upon such rod d as may be required. The arm i passes downward through a suitable opening in contact-arm j, also rotatably supported upon rod d. This contact-arm j carries at its right-hand end a brush j'' and has articulating with its left-hand end a link j^2, used to operate mechanism to be described. Brush-arm j is held up against sleeve k^2 by a suitable collar, as indicated. Brush j'' is arranged to engage contact n when brush-arm j is rotated to the right, such contact n being insulated from and carried by a suitable support b^3. Stops p^{20} and p^{19} limit the motion of brush-arm j in either direction, as seen in Fig. 11. When the handle h is moved to the right, brush j'' is moved upon contact n from insulating-section n^5 and closes the energizing-circuit of magnet M, and thus sets the brakes of the car in the manner to be described.

Brush-arm j is operated from brake-rod d in the following manner: A spring s' is used to keep the collar k' down against sleeve k^2, and thus to keep the pin p^{11} in the bottom end of the thread in sleeve k^2. As sleeve k^2 is rotated to the right positively, there is a tendency for pin p^{11} to rise in the thread in sleeve k^2; but spring s' is made of such a strength that the pin p^{11} is held down firmly in the thread in sleeve k^2, and therefore as the rod d is rotated to the right the brush-arm j is rotated also to the right until it strikes the stop p^{19}. If then the handle h is moved farther around to the right, the brush-arm j, pin p^{11}, and arm i and collar k' cannot rotate farther to the right, and the pin p^{11} is moved upward in the thread in sleeve k^2, carrying with it collar k' against the action of the spring s'. This construction permits the handle h to make as many revolutions as desired after the brush-arm j strikes the stop p^{19} and requires that as many be made in the reverse direction before the rod d can again operate the brush-arm j.

Refer to Fig. 11. Connected in parallel with the energizing-coil m of magnet M is seen the solenoid S, such solenoid S and magnet-coil m being connected in circuit with the resistance R between the trolley T and car-wheel W. The link j^2 passes between suitable guides p^{22} and p^{23} near its lower end, and at its lower end it carries the contacts n^2 and n^4, insulated from each other and from link j^2, and so arranged that contact n^3, carried by and insulated from rod c^{10}, may engage either contact n^2 or contact n^4, according as such contact n^3 is moved up or down. Rod c^{10} is rigidly secured to core c^6 of solenoid S. A spring s^4 is provided to return core c^6 to its normal position after having been operated upon by solenoid S and also to secure a proper opposition to the operation of such solenoid S as will be described. Contact n^3 is connected by means of a spring, as indicated, with a fixed contact n'. Contacts n^2 and n^4 are connected, respectively, to one terminal of the solenoids S′ and S², the other terminals of which are connected together and to the trolley T. These solenoids S′ and S² have cores c^7 and c^8, respectively, such cores rigidly connected together by rod c^9, which by means of suitable collars, as seen, engages the lower end of the rheostat-arm j^3, pivoted at p^{21}. Stops p^{17} and p^{18} are provided to limit the motion of this arm j^3 in either direction. When the brush-arm j has been moved around to the right until brush j'' is brought upon contact n, a circuit is closed, as follows: trolley T, pivot 21, rheostat-arm j^3, resistance R, thence in parallel through solenoid S and magnet-coil m, contact n, arm j to wheel W. If contact n^2 engages contact n^3, a second circuit is closed, as follows: trolley T, solenoid S′, contact n^2, contact n^3, contact n', contact n, arm j to wheel W. If contact n^3 engages contact n^4, this last circuit is as follows: trolley T, solenoid S², contact n^4, contact n^3, contact n', contact n, arm j to wheel W. When solenoid S′ is energized, cores c^7 and c^8 are moved to the left and rheostat-arm j^3 is rotated over to the right and more of the resistance R is cut into circuit with the magnet-coil m and solenoid S. When solenoid S² is energized, cores c^7 and c^8 are moved to the right and rheostat-arm j^3 is moved over to the left and part of resistance R is cut out of circuit with magnet-coil m and solenoid S. Only one of the solenoids S′ or S² can operate at a time.

As a result of the mechanism and circuits just described it is evident that for any position of the link j^2 after a balance between the pull of the solenoid S and the spring s^4 has been effected by the adjustment of the resistance R if the potential on the line increases the current in the solenoid S increases and contacts n^2 and n^3 are brought together, solenoid S′ is energized, and the amount of resistance R in circuit is increased until the current in solenoid S is decreased to its original value, at which time connection between contacts n^2 and n^3 is broken and solenoid S′ ceases to operate. Similarly, if the potential on the line decreases spring s^4 pulls core c^6 out of solenoid S and brings contacts n^3 and n^4 together and energizes solenoid S², which decreases the amount of resistance R in circuit until the current in solenoid S is increased to its original value, at which time the increased pull of the solenoid breaks the connection between the contacts n^3 and n^4 and solenoid S² ceases to operate. Thus the mechanism operates to maintain a constant current in the solenoid S, and therefore in the magnet-coil m, and hence to maintain a constant braking effort for any fixed position of the contacts n^2 and n^4, and hence of the brake-staff handle h.

The current in the solenoid S is of course much less than the current in the magnet-coil m; but the ratio between the two is constant.

As the contacts n^2 and n^4 are moved up, as seen in Fig. 11, it is evident that it will take a larger current in solenoid S to balance the increased pull of spring s^4 and break the connection between contacts n^4 and n^3, and hence the current in magnet-coil m and the braking effect are correspondingly increased.

In order to carry the electric braking as far as desired and from that point to continue the braking wholly by hand, use is made of the modified mechanism shown in Fig. 10. The handle h is rigidly secured to the brake-rod d, and feathered upon this rod d is a threaded sleeve k^3, which carries a circular flange u^4 and also a tooth u^5, arranged to engage a corresponding notch in the upper end of the threaded sleeve k^2. This threaded sleeve k^2 is not secured to the rod d in this modification, but is free to rotate thereon except as engaged by the tooth u^5 and carries at its lower end a notched disk u^7.

The threaded sleeve k^2, pin 11, arm i, collar k', and spring s' work in the manner already described to operate arm j and link j^2. In this modification, however, the collar k' and spring s' are arranged below the sleeve k^2 instead of above and the arm i projects upward instead of downward. A collar k^4, rigidly secured to rod d, is provided to take the upward thrust of spring s'.

A push-bar u, having secured to its upper end a disk h', is located in the handle h and articulates at its lower end with the right-hand end of lever u', pivoted at p^{14} to handle h. A link u^2, having an enlarged upper end, passes through the left-hand end of this lever u' in such a way that such link u^2 may pass up through the lever u' without moving it; but the lever u' cannot be moved up at its left-hand end without lifting the link u^2 with it. This link u^2 articulates at its lower end with an ear formed on the upper end of sleeve k^3. A small spring is provided under disk h' to keep it normally in its upper position, while a spring s^3 is provided to keep the sleeve k^3 down normally. A bell-crank lever u^6, pivoted at p^{16}, is arranged, as indicated, to be thrown into engagement with the notched disk u^7 by a suitable spring when sleeve k^3 is raised, and thus serves to lock the sleeve k^2 in any position to which it may be carried by the handle before sleeve k^2 is released from k^3. A pawl or latch u^3, normally held down by a spring, as indicated, against a stop p^{15}, is raised when sleeve k^3 is raised, and as the handle h continues to rotate to the right the left-hand end of this latch u^3 enters the thread upon sleeve k^3, drops upon stop p^{15}, and then lifts sleeve k^3 against the action of spring s^3.

By means of the mechanism just described if the handle h be rotated to the right the electric braking is effected, as already described, as long as desired. The disk h' may be at any time depressed. This lifts link u^2 and sleeve k^3, thereby releasing sleeve k^2 from rod d and locks sleeve k^2 by means of bell-crank lever u^6, so that it cannot move, and as the handle h is then rotated to the right the sleeve k^3 is lifted by the action of its thread and the latch u^3 and the braking is continued from that point by hand. The threaded sleeve k^3 and parts coöperating therewith operate to maintain a fixed relation between the handle and the sleeve k^2, so that after sleeve k^2 has been released when the handle h is rotated to the left it must make just as many revolutions in this direction as it had previously made to the right after releasing sleeve k^2 before it can reëngage such sleeve k^2.

The operation of my mechanism is as follows: When it is desired to apply the brakes of the car, handle h is rotated to the right slowly until the desired degree of braking is effected. This action first moves the shoes $f\,f$ a little toward the wheels W W by hand by means of gear g, rack g', rod a, and the parts connected therewith, and at the same time closes the circuit through magnet-coil m and solenoid S, which immediately gives the degree of braking corresponding to the position to which handle h may have been moved, as the solenoid S will adjust the resistance R by means of solenoids S′ and S² until the currents in coil m and solenoid S correspond to such braking effort and handle position and will maintain such braking effect for any variations that may occur in the line-potential. As the magnet M operates to apply the brakes it slides the posts c and c' on rods a' and a^9, respectively, between the ends of the yokes a^2 and a^6. After there has been some wear of the parts these posts c and c' move the yokes a^2 and a^6 along on rods a' and a^9, and thus automatically adjust the connection between the handle h and the brake-shoes so as to give the proper amount of slack at all times.

If for any reason the electric brake should fail, the handle h is rotated farther to the right, thus setting the brakes by means of gear g, rack g', rod a, and their connections already described to the shoes $f\,f$.

In order to adjust the magnet for the wear that occurs, so as to maintain a practically constant air-gap, the pawl p^4 and lever e^2 coöperate, as already described, to operate, through the mechanism connected therewith, the worm g^3 and worm-gear g^2, so as to screw out the core c^3 from time to time, as is necessary to effect such adjustment.

The sliding core c^4 when used may be so adjusted as to contact with the core c^2 at the time when all the slack has been taken up and the forcible application of the brakes begins, or it may be so adjusted and proportioned that the core c^2 will contact therewith at any desired point in the application of the brakes. It operates not only to reduce or cut down the

final effort of the magnet M, but it also operates to increase the initial effort by increasing the density between the core c^4 and the core c^2 at the initial air-gap.

What I claim is—

1. In an electric braking system, in combination with the magnet for applying the brakes, means whereby the increased slack resulting from wear of the parts is taken up, as it occurs from time to time, by the adjustment of a member not subjected to any mechanical strain by the braking apparatus during the process of such adjustment.

2. In an electric braking system, in combination with the magnet for applying the brakes, means whereby the increased slack resulting from wear of the parts is taken up, as it occurs from time to time, by the adjustment of a member constituting a part of the magnetic path of such magnet, such member inoperative in the magnetic path of such magnet during the time of such readjustment or movement thereof.

3. In an electric braking system, in combination with the magnet for applying the brakes, means whereby the increased slack resulting from wear of the parts is taken up, as it occurs from time to time, by the adjustment of a member not subjected to any mechanical strain by the braking apparatus during the process of such readjustment, and means whereby a corresponding readjustment is effected between the handle for applying the brakes by hand and the mechanism between such handle and the brakes proper.

4. In an electric braking system, in combination with the magnet for applying the brakes, means whereby the increased slack resulting from wear of the parts is taken up, as it occurs from time to time, by the adjustment of a member constituting a part of the magnetic path of such magnet, such member inoperative in the magnetic path of such magnet during the time of such readjustment or movement thereof, and means whereby a corresponding readjustment is effected between the handle for applying the brakes by hand and the mechanism between such handle and the brakes proper.

5. In an electric brake and located in the path of the magnet for applying the brakes, a movable or sliding member arranged to cut down the air-gap at the initial point of movement of the armature and until the armature contacts therewith and arranged also to yield at the advance of the armature in closing another branch of the same magnetic path.

6. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle and means for securing, independently of wear of the parts, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

7. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle and means for securing, independently of fluctuations in the voltage of the supply-circuit, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

8. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle and means for securing, independently of wear of the parts and of fluctuations in the voltage of the supply-circuit, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

9. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle and means under the control of such handle for securing, independently of wear of the parts, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

10. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle and means under the control of such handle for securing, independently of fluctuations in the voltage of the supply-circuit, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

11. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle and means under the control of such handle for securing, independently of wear of the parts and of fluctuations in the voltage of the supply-circuit, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

12. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means for securing a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

13. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means for securing, independently of wear of the parts, a braking effort predetermined and different for each differently-operative posi-

tion of such handle but always practically uniform for each one of such positions.

14. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings, and means for securing, independently of fluctuations in the voltage of the supply-circuit, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

15. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means for securing, independently of wear of the parts and of fluctuations in the voltage of the supply-circuit, a braking effort predetermined and different for each differently-operative postion of such handle but always practically uniform for each one of such positions.

16. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means under the control of such handle, for securing a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

17. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means under the control of such handle for securing, independently of wear of the parts, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

18. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means under the control of such handle for securing, independently of fluctuations in the voltage of the supply-circuit, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

19. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means under the control of such handle for securing, independently of wear of the parts and of fluctuations in the voltage of the supply-circuit, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

20. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle arranged to apply a braking effort by hand-operated mechanism and means for securing, independently of wear of the parts, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

21. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle arranged to apply a braking effort by hand-operated mechanism and means for securing, independently of fluctuations in the voltage of the supply-circuit, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

22. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle arranged to apply a braking effort by hand-operated mechanism and means for securing, independently of wear of the parts and of fluctuations in the voltage of the supply-circuit, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

23. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle arranged to apply a braking effort by hand-operated mechanism and means under the control of such handle for securing, independently of wear of the parts, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

24. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle arranged to apply a braking effort by hand-operated mechanism and means under the control of such handle for securing, independently of fluctuations in the voltage of the supply-circuit, a braking effort predetermined and different for each differently-operative position of such handle but always practically uniform for each one of such positions.

25. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle arranged to apply a braking effort by hand-operated mechanism and means under the control of such handle for securing, independently of wear of the parts and of fluctuations in the voltage of the supply-circuit, a braking effort predetermined and different for

each differently-operative position of such handle but always practically uniform for each one of such positions.

26. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle and means for securing, independently of fluctuations in the voltage of the supply-circuit, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

27. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle and means for securing, independently of wear of the parts and of fluctuations in the voltage of the supply-circuit, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

28. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle and means under the control of such handle for securing, independently of fluctuations in the voltage of the supply-circuit, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

29. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle and means under the control of such handle for securing, independently of wear of the parts and of fluctuations in the voltage of the supply-circuit, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

30. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means for securing a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

31. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means for securing, independently of wear of the parts, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

32. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means for securing, independently of fluctuations in the voltage of the supply-circuit, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

33. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means for securing, independently of wear of the parts and of fluctuations in the voltage of the supply-circuit, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

34. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means under the control of such handle for securing a supply of electric energy to such windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

35. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means under the control of such handle for securing, independently of wear of the parts, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

36. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means under the control of such handle for securing, independently of fluctuations in the voltage of the supply-circuit, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

37. In combination with the exciting-windings of a magnetic braking system and an elec-

tric supply-circuit therefor, an operating-handle for controlling the potential of the current delivered to such exciting-windings and means under the control of such handle for securing, independently of wear of the parts and of fluctuations in the voltage of the supply-circuit, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

38. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle arranged to apply a braking effort by hand-operated mechanism and means for securing, independently of fluctuations in the voltage of the supply-circuit, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

39. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle arranged to apply a braking effort by hand-operated mechanism and means for securing, independently of wear of the parts and of fluctuations in the voltage of the supply-circuit, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

40. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle arranged to apply a braking effort by hand-operated mechanism and means under the control of such handle for securing, independently of fluctuations in the voltage of the supply-circuit, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

41. In combination with the exciting-windings of a magnetic braking system and an electric supply-circuit therefor, an operating-handle arranged to apply a braking effort by hand-operated mechanism and means under the control of such handle for securing, independently of wear of the parts and of fluctuations in the voltage of the supply-circuit, a supply of electric energy to such exciting-windings predetermined and different in amount for each differently-operative position of such handle but always practically uniform for each one of such positions.

42. In combination with the magnet of an electric braking system and an electric supply-circuit therefor, means for securing each one of a series of different braking efforts at a correspondingly different, but for the same braking effort always practically the same, air-gap in the magnetic path of such magnet.

43. In combination with the magnet of an electric braking system and an electric supply-circuit therefor, means for securing, independently of wear of the parts, each one of a series of different braking efforts at a correspondingly different, but for the same braking effort always practically the same, air-gap in the magnetic path of such magnet.

44. In combination with the magnet of an electric braking system and an electric supply-circuit therefor, means for securing, independently of fluctuations in the voltage of such supply-circuit, each one of a series of different braking efforts at a correspondingly different, but for the same braking effort always practically the same, air-gap in the magnetic path of such magnet.

45. In combination with the magnet of an electric braking system and an electric supply-circuit therefor, means for securing, independently of wear of the parts and of fluctuations in the voltage of such supply-circuit, each one of a series of different braking efforts at a correspondingly different, but for the same braking effort always practically the same, air-gap in the magnetic path of such magnet.

46. In combination with the magnet of an electric braking system and an electric supply-circuit therefor, means operable on a constant voltage of such supply-circuit to secure each one of a series of different braking efforts at a correspondingly different, but for the same braking effort always practically the same, air-gap in the magnetic path of such magnet.

47. In combination with the magnet of an electric braking system and an electric supply-circuit therefor, means operable on a constant voltage of such supply-circuit to secure, independently of wear of the parts, each one of a series of different braking efforts at a correspondingly different, but for the same braking effort always practically the same, air-gap in the magnetic path of such magnet.

48. In combination with the magnet of an electric braking system, an operating-handle therefor, and means for securing for each differently-operative position of such handle a correspondingly different, but for the same position of such handle always practically the same, air-gap in the magnetic path of such magnet.

49. In combination with the magnet of an electric braking system, an operating-handle therefor, and means for securing, independently of wear of the parts, for each differently-operative position of such handle a correspondingly different, but for the same position of such handle always practically the same, air-gap in the magnetic path of such magnet.

50. In an electric braking system and in combination with an electric supply-circuit therefor, magnetic elements therein arranged to move relatively toward each other in apply-

ing the brakes, and means for securing each one of a series of different braking efforts at correspondingly different, but for the same braking effort always practically the same, relative positions of such magnetic elements.

51. In an electric braking system and in combination with an electric supply-circuit therefor, magnetic elements therein arranged to move relatively toward each other in applying the brakes, and means for securing, independently of wear of the parts, each one of a series of different braking efforts at correspondingly different, but for the same braking effort always practically the same, relative positions of such magnetic elements.

52. In an electric braking system and in combination with an electric supply-circuit therefor, magnetic elements therein arranged to move relatively toward each other in applying the brakes, and means for securing, independently of fluctuations in the voltage of such supply-circuit, each one of a series of different braking efforts at correspondingly different, but for the same braking effort always practically the same, relative positions of such magnetic elements.

53. In an electric braking system and in combination with an electric supply-circuit therefor, magnetic elements therein arranged to move relatively toward each other in applying the brakes, and means for securing, independently of wear of the parts and of fluctuations in the voltage of such supply-circuit, each one of a series of different braking efforts at correspondingly different, but for the same braking effort always practically the same, relative positions of such magnetic elements.

54. In an electric braking system and in combination with an electric supply-circuit therefor, magnetic elements therein arranged to move relatively toward each other in applying the brakes, and means operable on a constant voltage of such supply-circuit, to secure each one of a series of different braking efforts at correspondingly different, but for the same braking effort always practically the same, relative positions of such magnetic elements.

55. In an electric braking system and in combination with an electric supply-circuit therefor, magnetic elements therein arranged to move relatively toward each other in applying the brakes, and means operable on a constant voltage of such supply-circuit, to secure, independently of wear of the parts, each one of a series of different braking efforts at correspondingly different, but for the same braking effort always practically the same, relative positions of such magnetic elements.

56. In an electric braking system in combination with an operating-handle therefor, magnetic elements therein arranged to move relatively toward each other in applying the brakes, and means for securing for each differently-operative position of such operating-handle correspondingly different, but for the same position of such handle always practically the same, relative positions of such magnetic elements.

57. In an electric braking system in combination with an operating-handle therefor, magnetic elements therein arranged to move relatively toward each other in applying the brakes, and means for securing, independently of wear of the parts, for each differently-operative position of such operating-handle correspondingly different, but for the same position of such handle always practically the same, relative positions of such magnetic elements.

58. In combination with the magnet of an electric braking system, an operating-handle therefor arranged also to apply a braking effort through hand-operated mechanism, and means for securing for each differently-operative position of such handle a correspondingly different, but for the same position of such handle always practically the same, air-gap in the magnetic path of such magnet.

59. In combination with the magnet of an electric braking system, an operating-handle therefor arranged also to apply a braking effort through hand-operated mechanism, and means for securing, independently of wear of the parts, for each differently-operative position of such handle a correspondingly different, but for the same position of such handle always practically the same, air-gap in the magnetic path of such magnet.

60. In an electric braking system in combination with an operating-handle therefor arranged also to apply a braking effort through hand-operated mechanism, magnetic elements therein, arranged to move relatively toward each other in applying the brakes, and means for securing for each differently-operative position of such operating-handle correspondingly different, but for the same position of such handle always practically the same, relative positions of such magnetic elements.

61. In an electric braking system in combination with an operating-handle therefor arranged also to apply a braking effort through hand-operated mechanism, magnetic elements therein, arranged to move relatively toward each other in applying the brakes, and means for securing, independently of wear of the parts, for each differently-operative position of such operating-handle correspondingly different, but for the same position of such handle always practically the same, relative positions of such magnetic elements.

62. In an electric braking system, means for taking up the slack, as it occurs from time to time from the wear of the parts, comprising an adjustable and normally stationary magnetic member toward which a coöperating magnetic member is arranged to move in applying the brakes and means for moving such adjustable and normally stationary member from time to time to compensate for such slack.

63. In combination with the two coöperating elements of a magnet arranged to move relatively toward each other in shortening the magnetic circuit of such magnet, a slidable extension for a first one of such elements arranged to shorten the magnetic path between such elements when in their initial positions farthest apart and arranged to slide, relatively to such first element, under pressure exerted thereon by such second element as such elements approach each other in closing still further the magnetic circuit between them.

64. In combination with the two coöperating elements of a magnet arranged to move relatively toward each other in shortening the magnetic circuit of such magnet, a slidable extension for a first one of such elements arranged to shorten the magnetic path between such elements when in their initial positions farthest apart and arranged to slide, relatively to such first element, under pressure exerted thereon by such second element as such elements approach each other in closing still further the magnetic circuit between them and adjustable means far varying as desired, the maximum distance which such extension may project beyond such first element toward such second element and thereby also inversely the distance between such extension and such second element.

WM. H. COOLEY.

Witnesses:
HERBERT LEARY,
ALBERT C. BELL.