(No Model.) 11 Sheets—Sheet 1.

C. A. MAŸRHOFER.

ELECTRIC RAILWAY CONTROLLING SYSTEM.

No. 324,476. Patented Aug. 18, 1885.

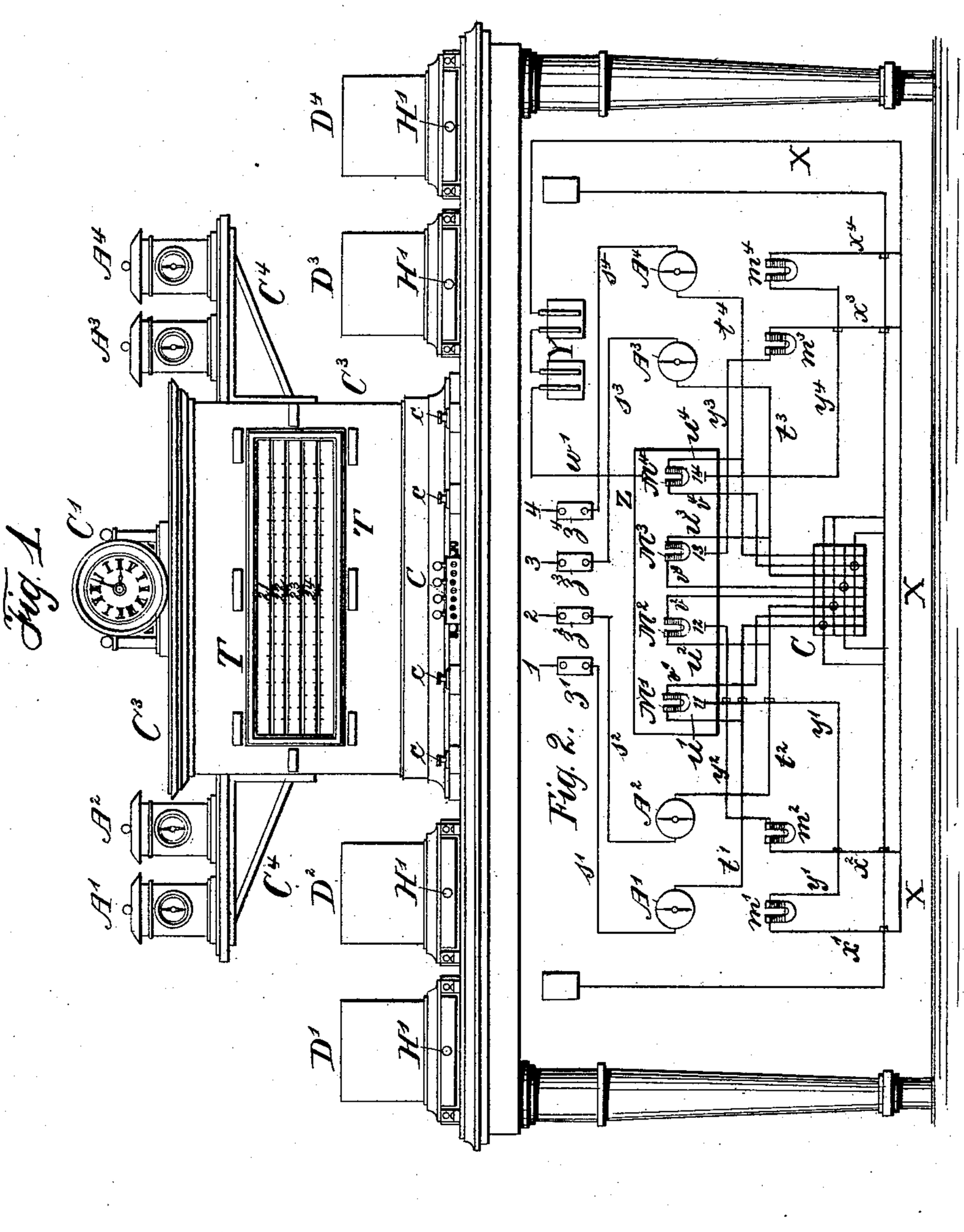

Fig. 1.

Fig. 2.

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by Henry Orth
his atty

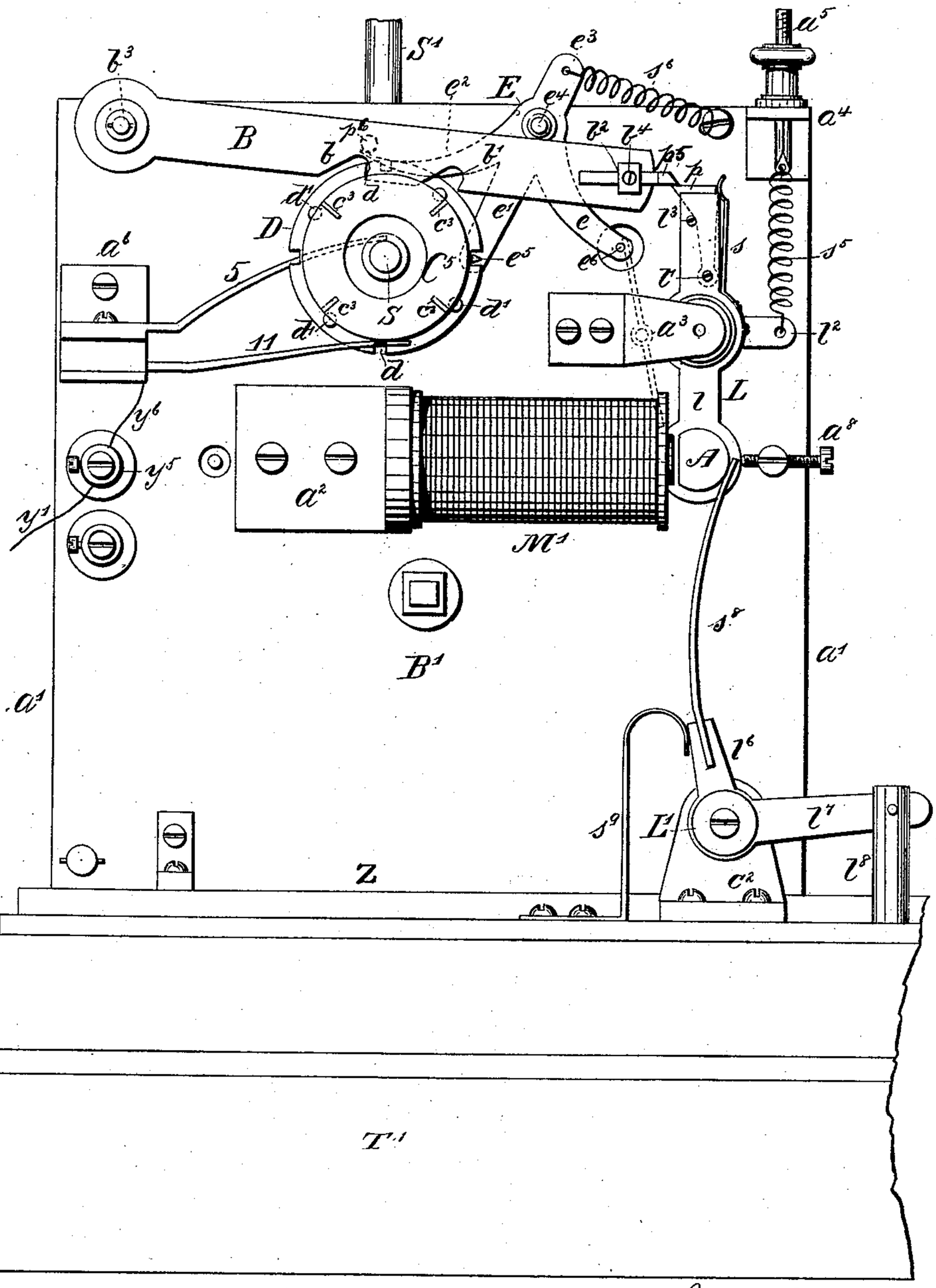
(No Model.) 11 Sheets—Sheet 2.

C. A. MAŸRHOFER.

ELECTRIC RAILWAY CONTROLLING SYSTEM.

No. 324,476. Patented Aug. 18, 1885.

Fig. 3.



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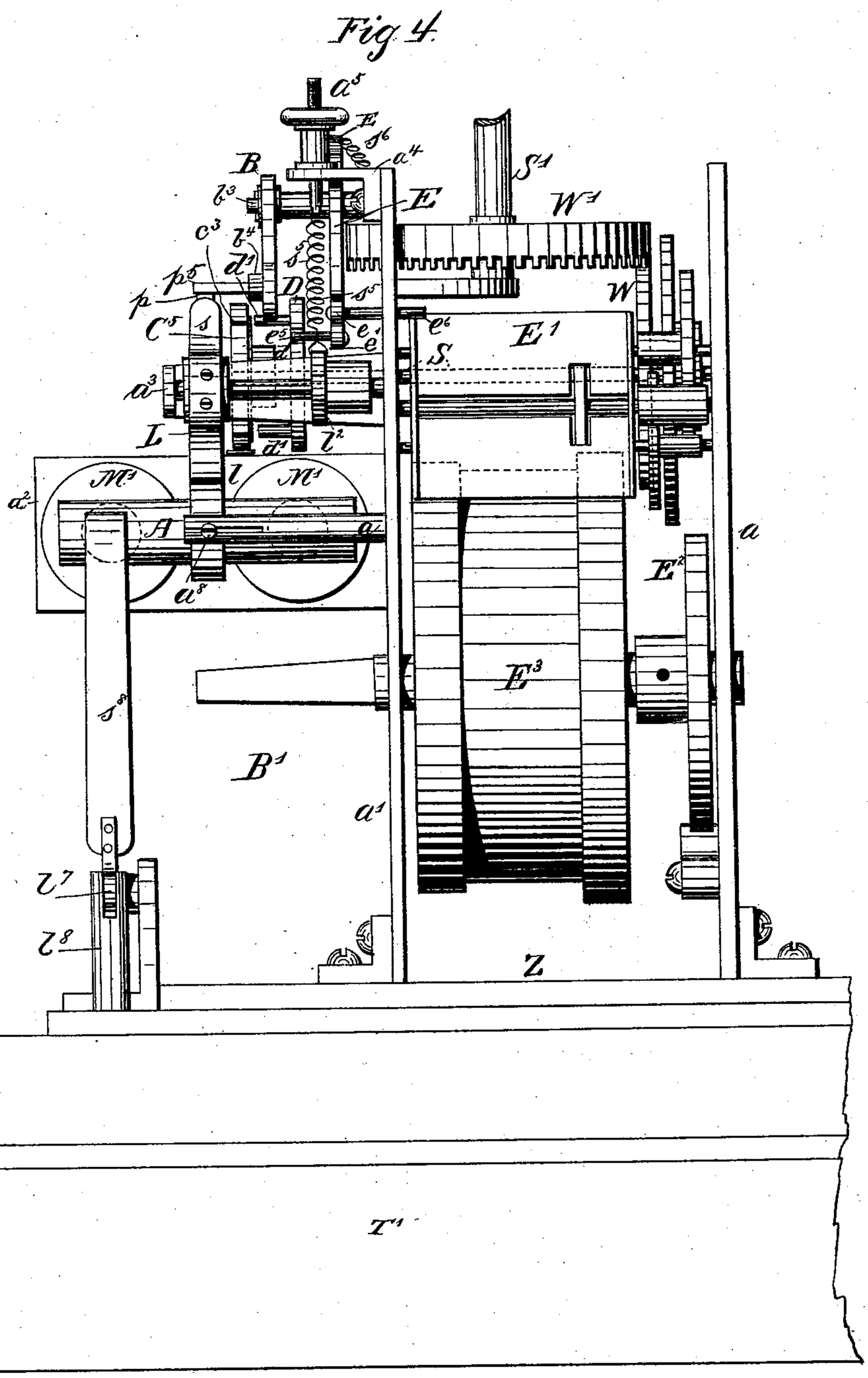
C. A. MAŸRHOFER.

ELECTRIC RAILWAY CONTROLLING SYSTEM.

No. 324,476. Patented Aug. 18, 1885.

Fig 4.



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(No Model.) 11 Sheets—Sheet 4.

C. A. MAŸRHOFER.

ELECTRIC RAILWAY CONTROLLING SYSTEM.

No. 324,476. Patented Aug. 18, 1885.

Fig. 6.

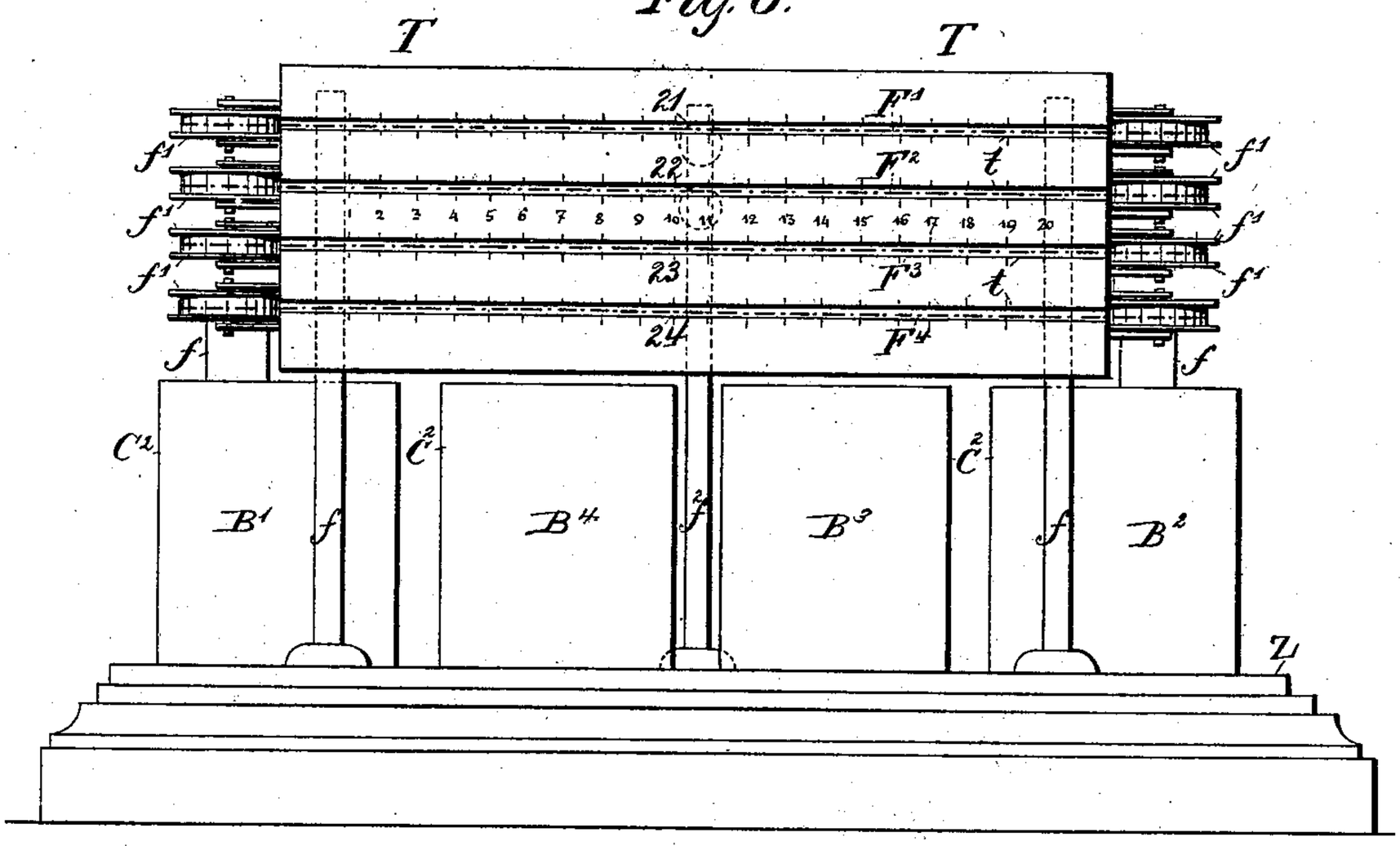
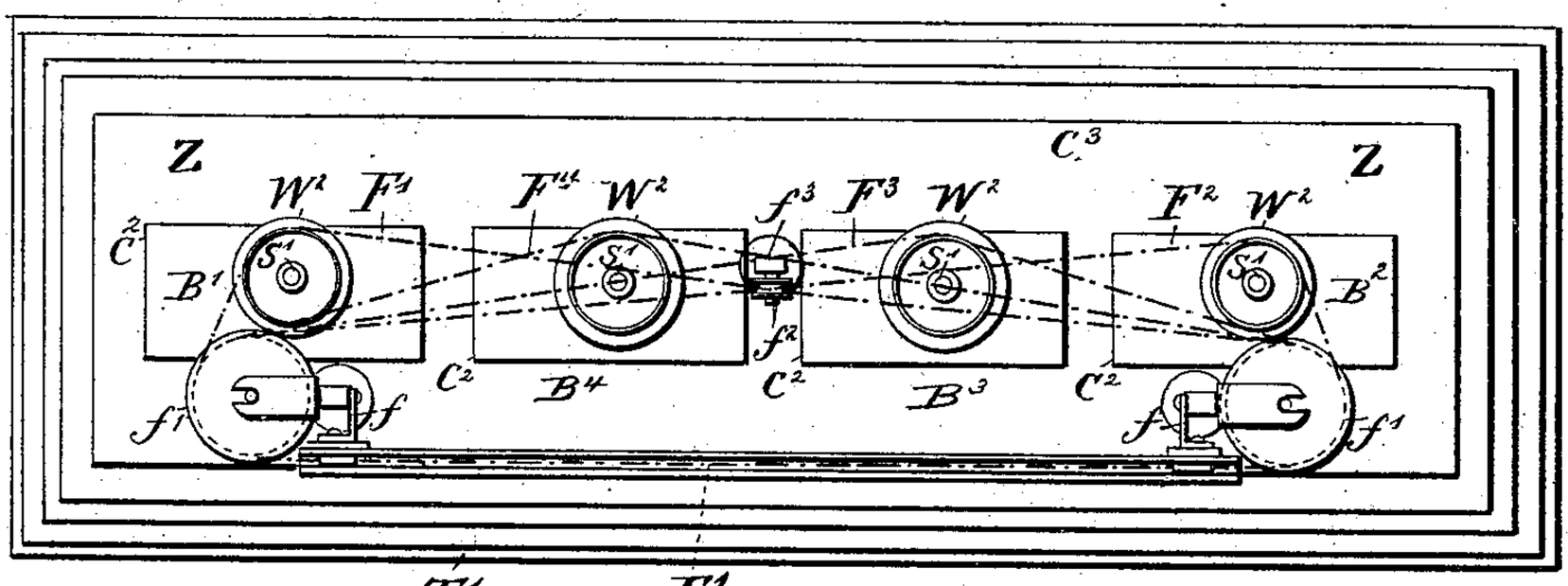


Fig. 5.



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(No Model.) 11 Sheets—Sheet 5.

C. A. MAŸRHOFER.

ELECTRIC RAILWAY CONTROLLING SYSTEM.

No. 324,476. Patented Aug. 18, 1885.

Fig. 8.

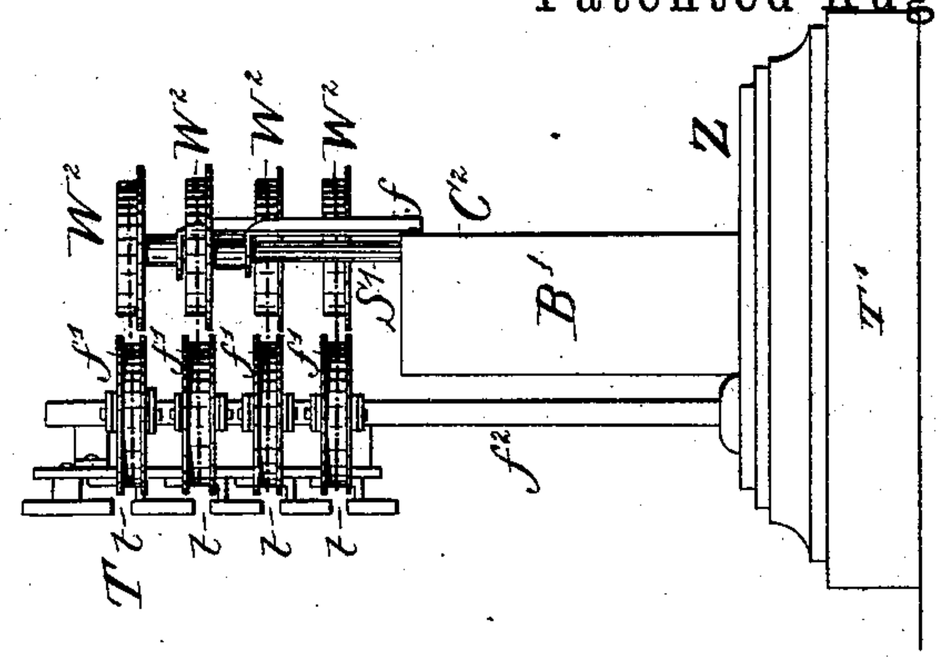
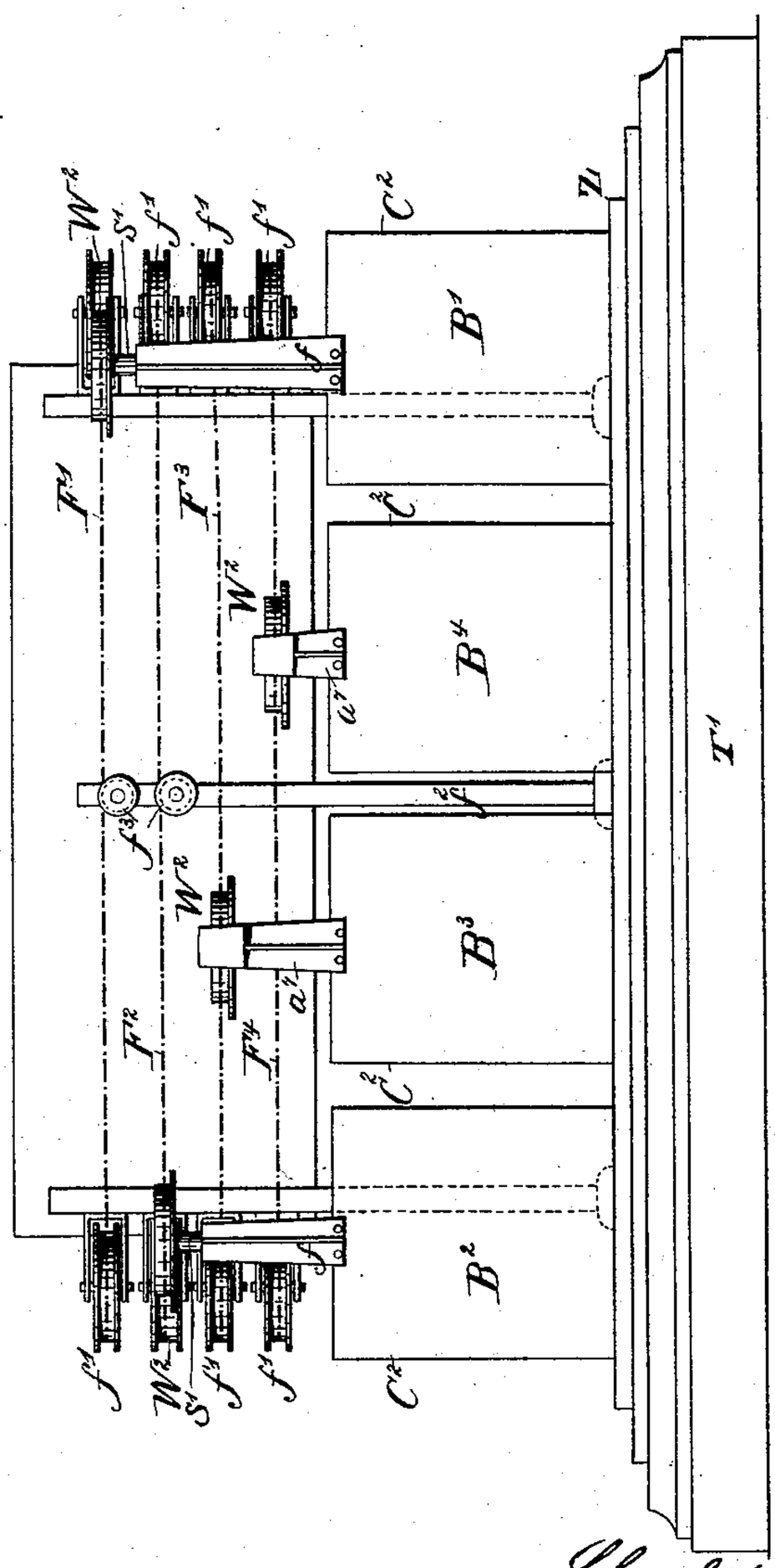


Fig. 7.



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(No Model.) 11 Sheets—Sheet 6.

C. A. MAŸRHOFER.

ELECTRIC RAILWAY CONTROLLING SYSTEM.

No. 324,476. Patented Aug. 18, 1885.

Fig. 9

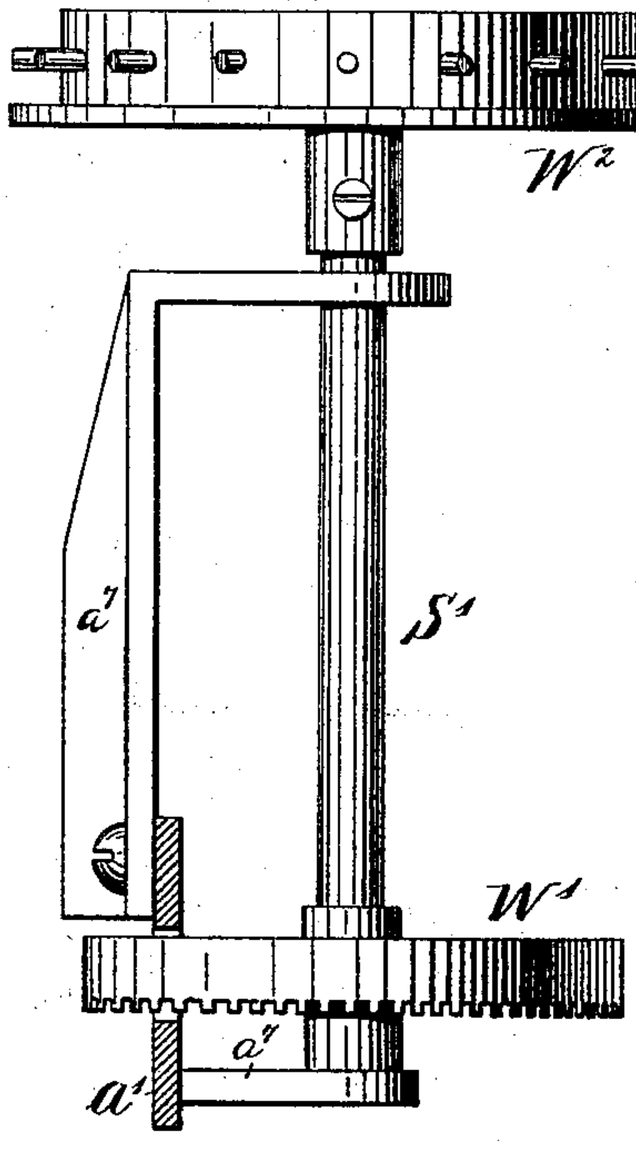


Fig. 10.

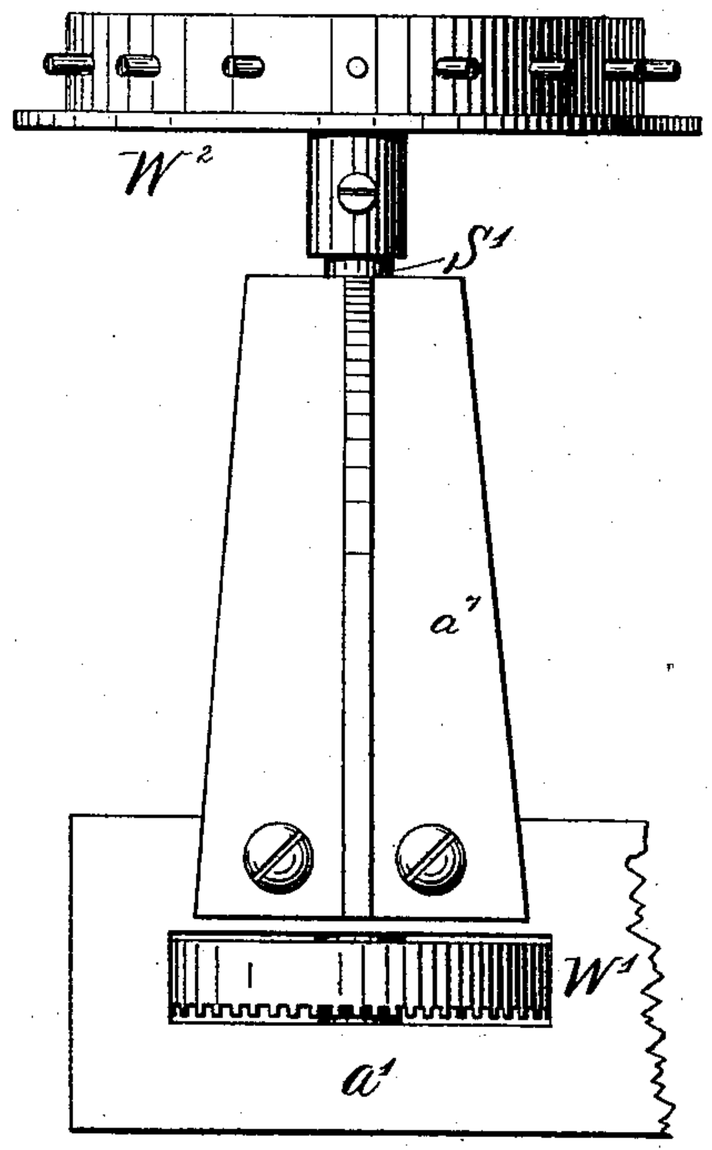


Fig. 11.

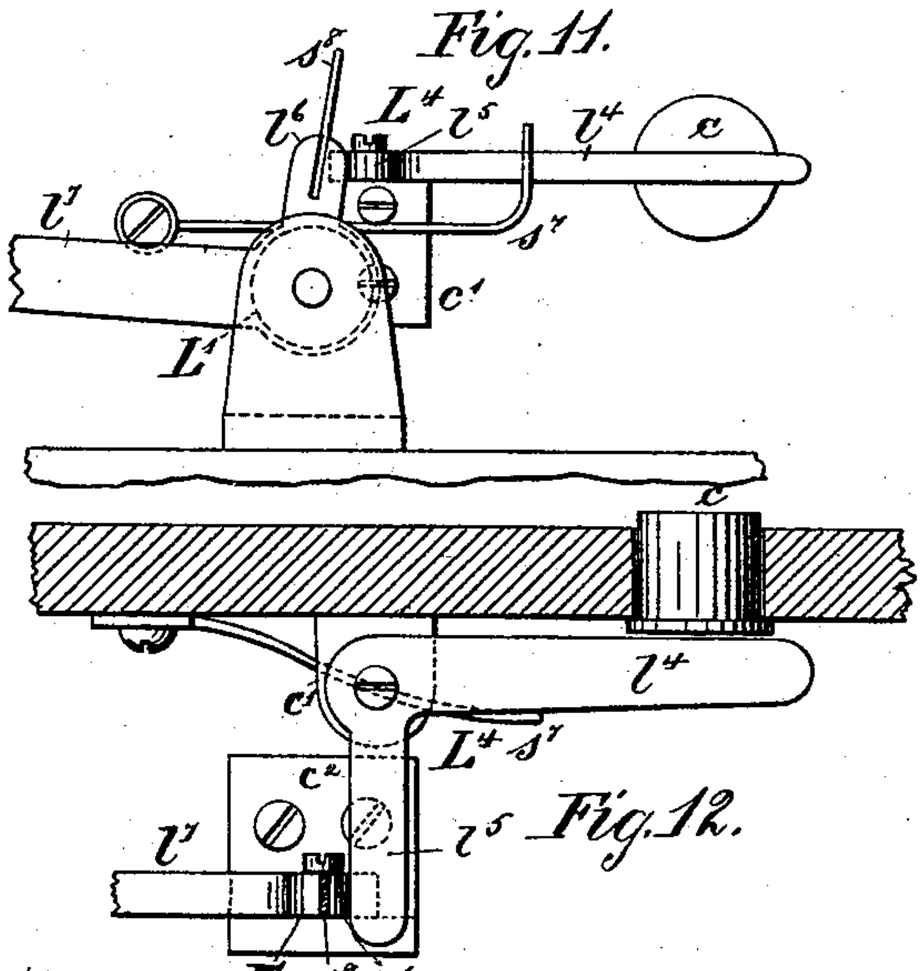
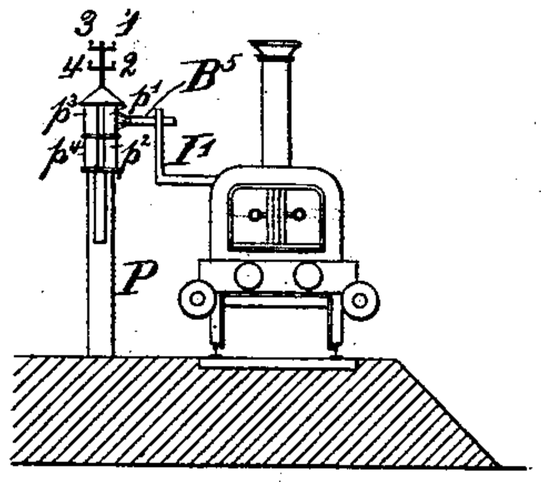


Fig. 12.

Fig. 21.



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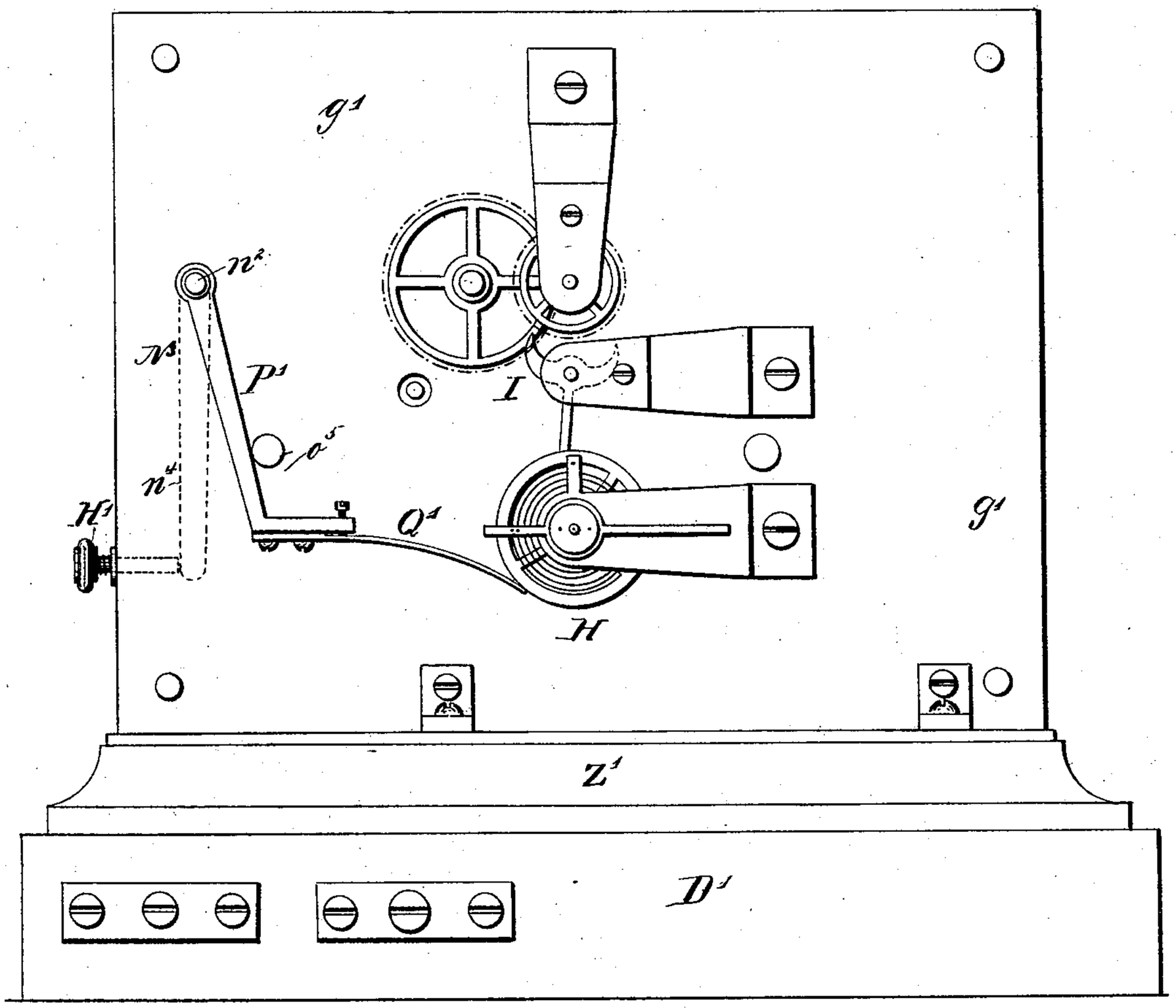
ELECTRIC RAILWAY CONTROLLING SYSTEM.

No. 324,476. Patented Aug. 18, 1885.

Fig 13.



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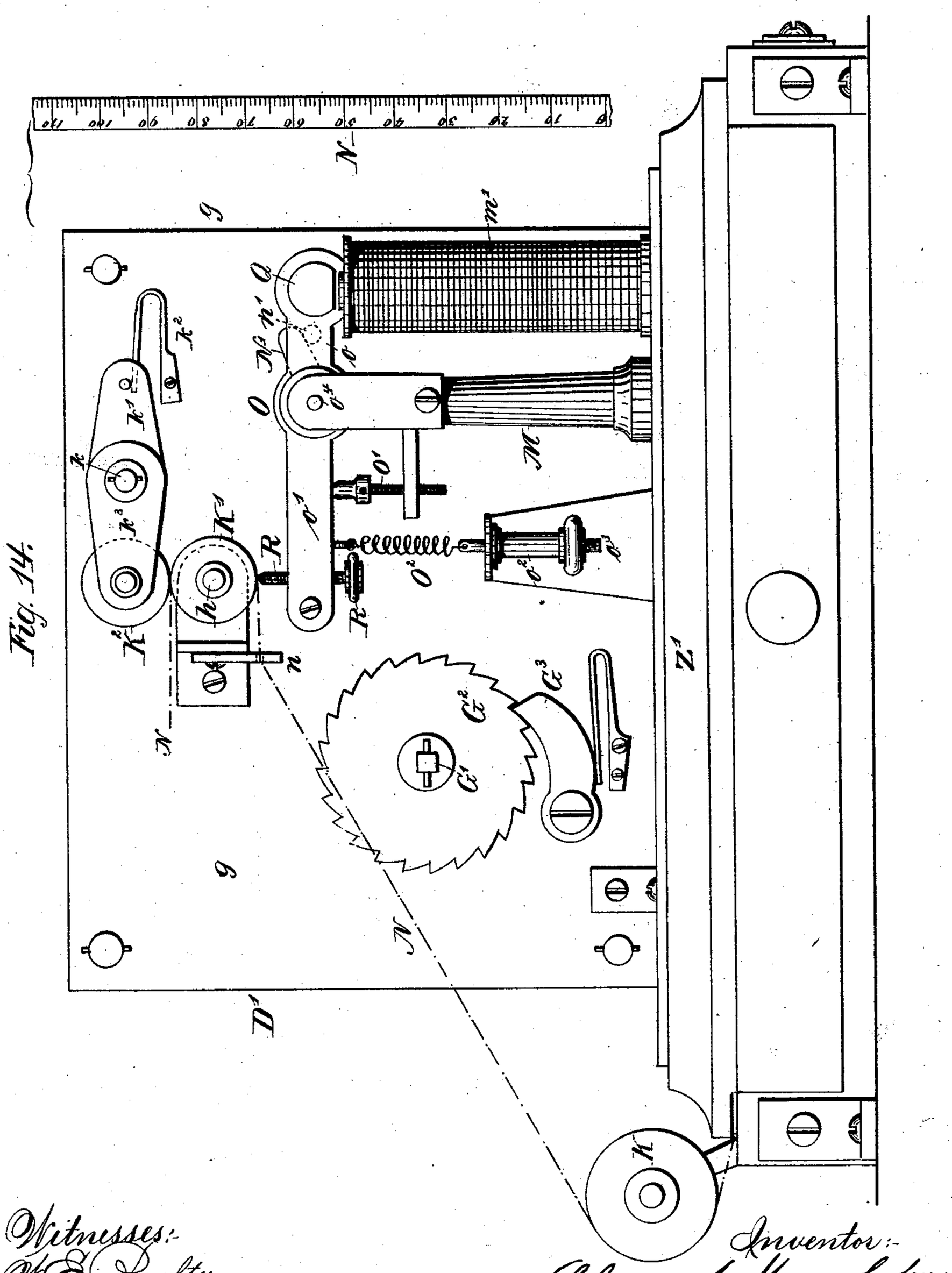
ELECTRIC RAILWAY CONTROLLING SYSTEM.

No. 324,476. Patented Aug. 18, 1885.



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ELECTRIC RAILWAY CONTROLLING SYSTEM.

No. 324,476. Patented Aug. 18, 1885.

Fig. 16.

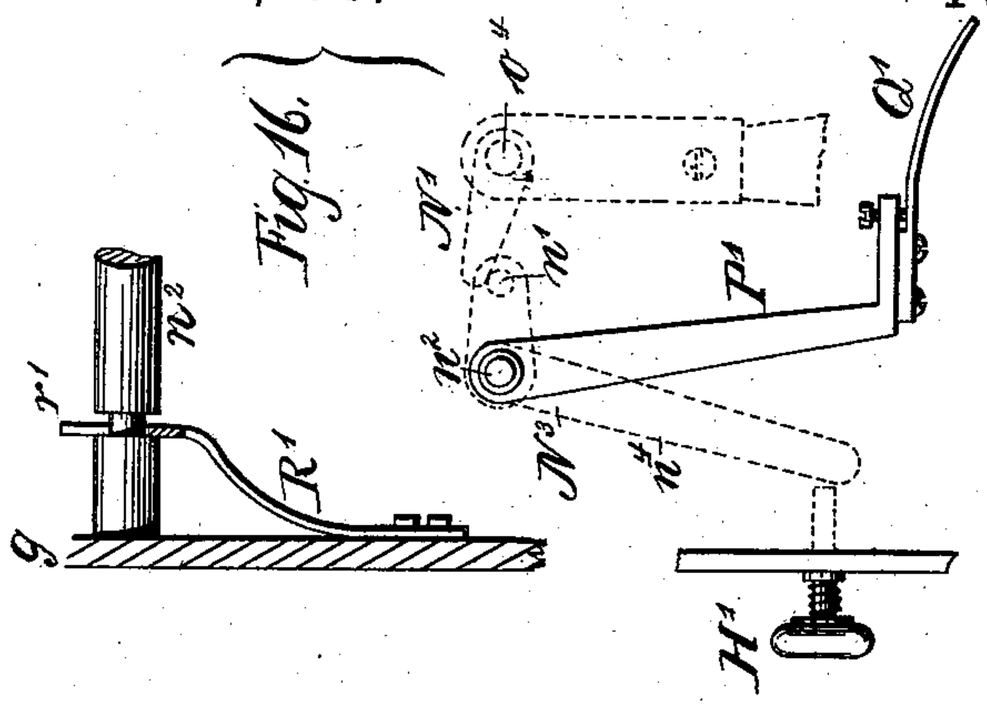
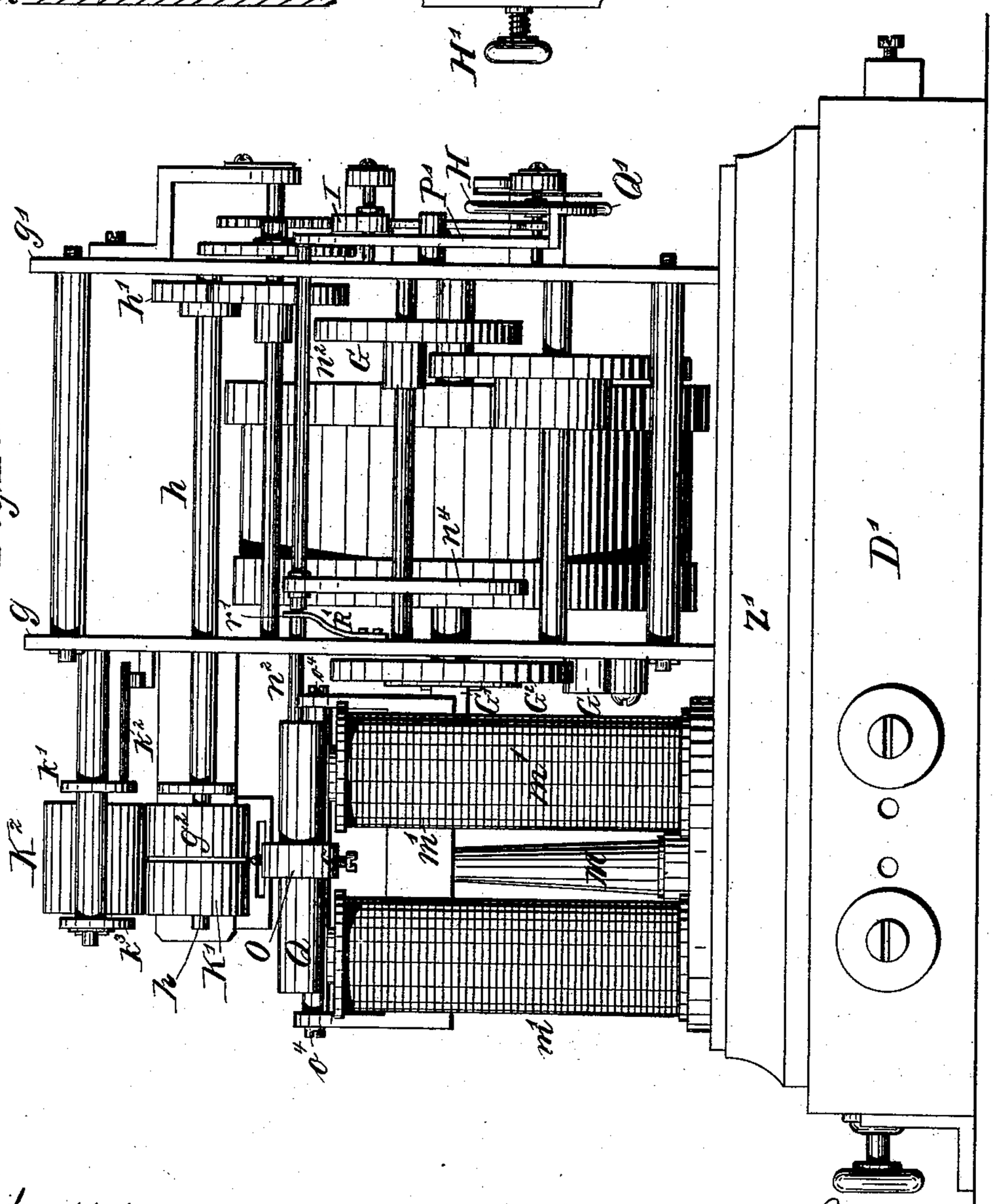


Fig. 15.



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ELECTRIC RAILWAY CONTROLLING SYSTEM.

No. 324,476. Patented Aug. 18, 1885.

Fig. 17.

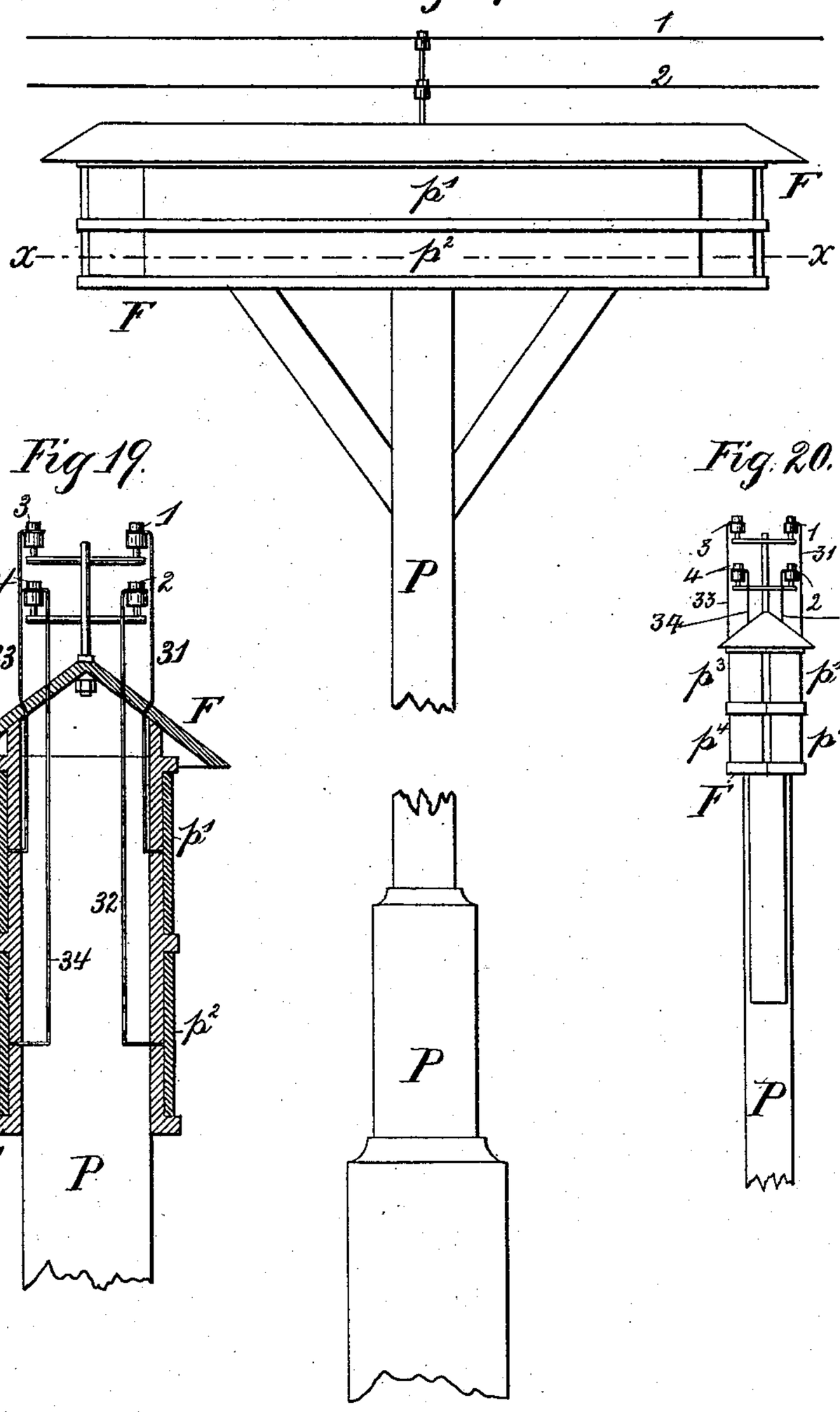


Fig. 19.

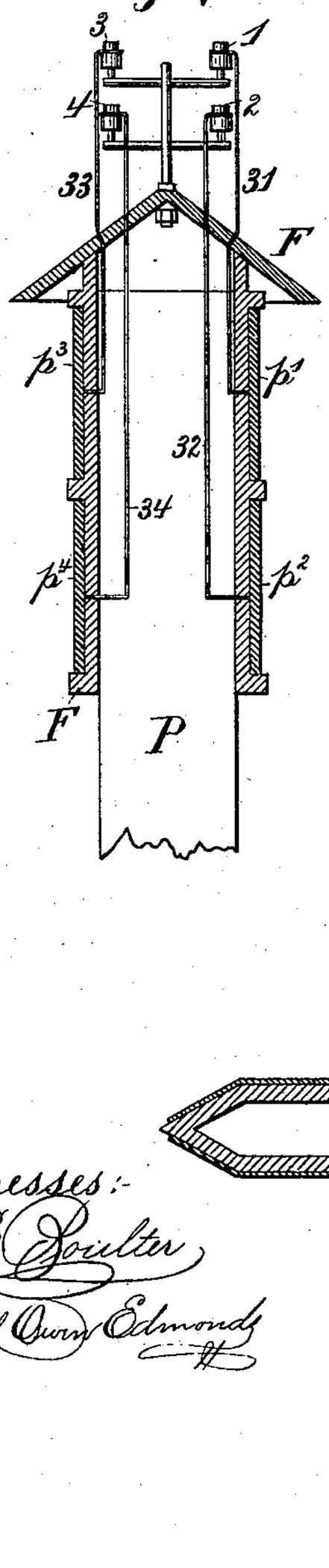
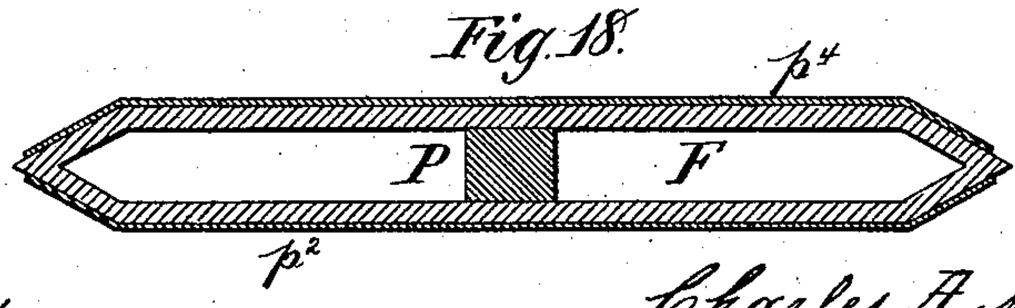


Fig. 20.

Fig. 18.



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(No Model.) 11 Sheets—Sheet 11.

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No. 324,476. Patented Aug. 18, 1885.

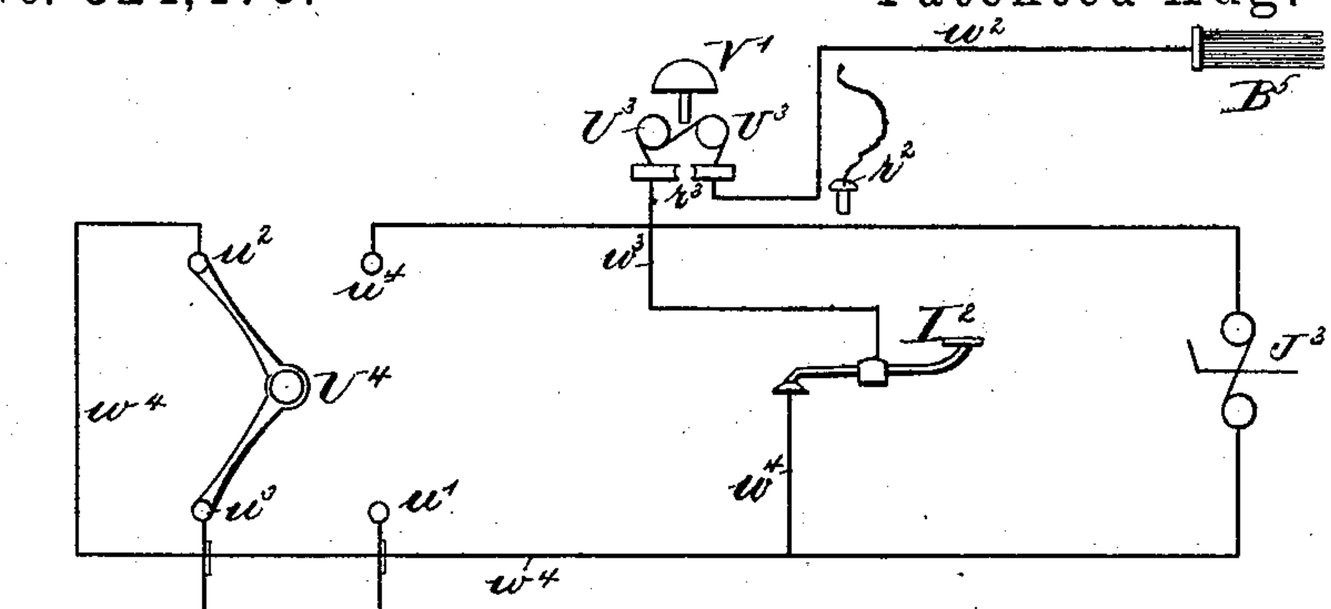

Fig. 23.

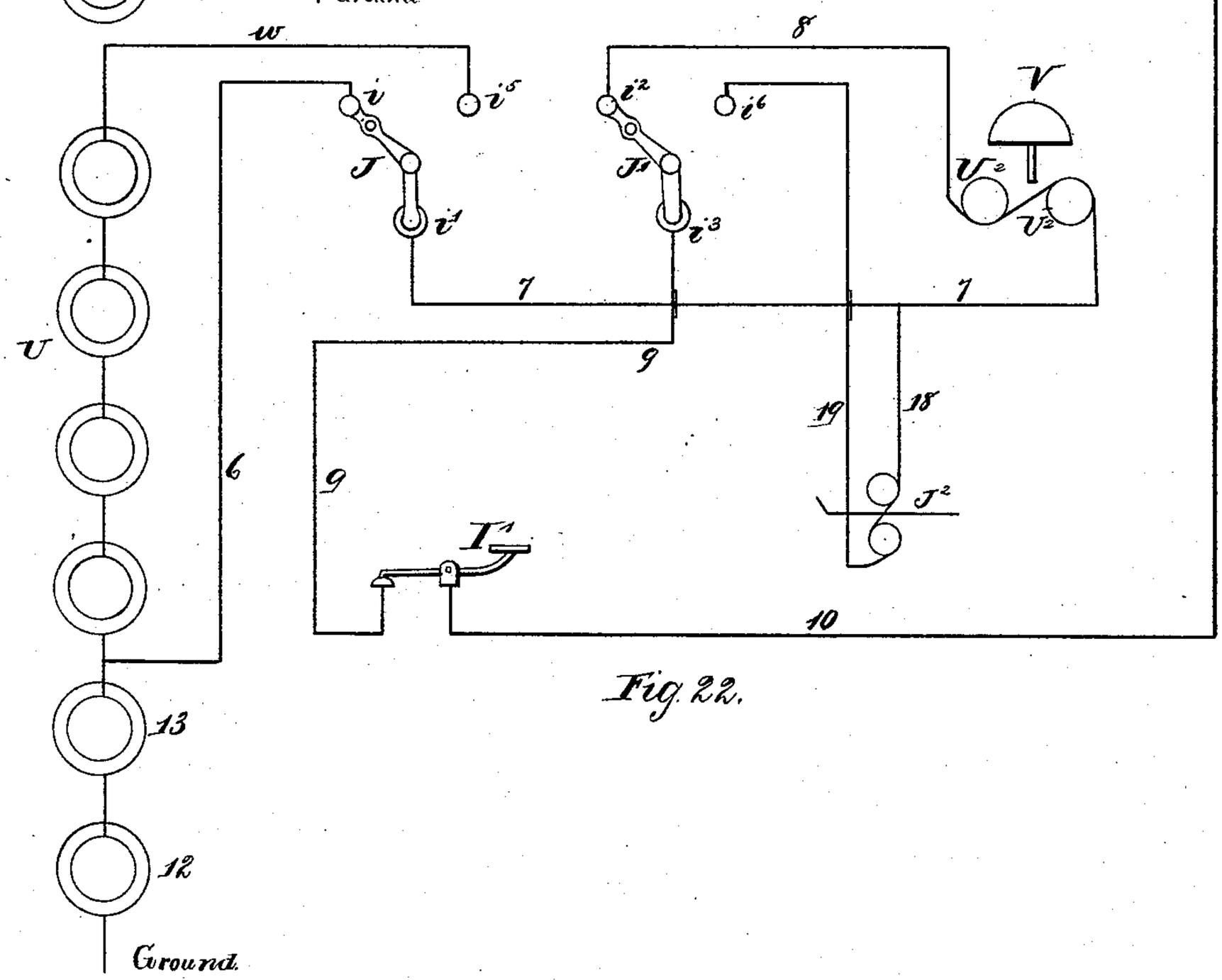

Fig. 22.

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UNITED STATES PATENT OFFICE.

CHARLES ALBERT MAŸRHOFER, OF VIENNA, AUSTRIA-HUNGARY, ASSIGNOR OF ONE-HALF TO CARL DIENER, OF SAME PLACE.

ELECTRIC RAILWAY-CONTROLLING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 324,476, dated August 18, 1885.

Application filed November 29, 1884. (No model.) Patented in Belgium October 20, 1884, No. 66,642; in England October 30, 1884, No. 14,377; in France September 27, 1884, No. 164,517; and in Austria-Hungary April 3, 1885, No. 39,15 and 18,521.

To all whom it may concern:

Be it known that I, CHARLES ALBERT MAŸRHOFER, a subject of the Emperor of Austria-Hungary, residing at Vienna, in the Province of Lower Austria, in the Empire of Austria-Hungary, have invented certain new and useful Improvements in Electric Railway-Controlling Systems; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

This invention relates to a system for controlling the circulation of railroad-trains, and has for its object to provide means whereby the danger of accidents by collision is or may be avoided.

In the accompanying drawings, Figure 1 is an elevation showing the general arrangement of the apparatus for use at a station. Fig. 2 is a diagram of the electrical connections. Fig. 3 is a side elevation of one of the index-operating mechanisms. Fig. 4 is an end elevation thereof. Figs. 5, 6, 7, and 8 show, respectively, by a top plan view, a front, rear, and end elevation, the arrangement of index-carriers and their operative mechanisms, the inclosing-case being removed. Figs. 9 and 10 are detail views thereof. Figs. 11 and 12 are detail views of mechanism for starting the clock-movement by hand. Figs. 13, 14, and 15 show, repectively, by opposite side elevations and an end elevation, the construction of the recording mechanism or chronograph. Fig. 16 is a detail view thereof. Fig. 17 shows one of the contact-posts in elevation. Fig. 18 is a horizontal section on line *x x* of Fig. 17. Fig. 19 is a vertical transverse section of the upper end of the post. Fig. 20 is an end elevation of the same on a reduced scale. Fig. 21 is a schematic view of a double-track road, a contact-post, and the means for closing the main-line circuit by a passing locomotive or train of cars. Figs. 22 and 23 illustrate diagrammatically the electric circuits for placing the main station in communication with a train on the road.

In order that the invention may be better understood, I will first give a brief general description of the system, the relation of the various instruments, and their electric connections.

The road is divided into sections, each section being placed under the supervision of an official at a main station, and in each road-section are arranged a series of contact-posts at known or predetermined distances apart. Each post carries a separate contact-plate for each train that arrives at or leaves the main station, and each of said plates is in a separate electric circuit, in which is included an electro-magnet that controls an index hand or pointer that indicates the number of the post the train has passed by the closing of the main-line circuit through the medium of a contact carried on the locomotive or a car, said circuit being closed either through an earth-return to a suitable generator of electricity at the main station or through a generator on the said locomotive or car connected with the contact device carried thereby. In said main-line circuit is also included a galvanometer, for purposes presently explained. The electro-magnet in the line-circuit that controls the index or pointer also controls a recording-instrument or chronograph in a local circuit, whereby a permanent record of the electric impulses sent to line is made.

The mechanism for moving the pointer is arranged to be started by hand, and for two reasons—first, by reason of atmospheric disturbances it may happen that impulses insufficient to actuate the pointer are sent to line, consequently the pointer would not indicate such impulses and the chronograph would not make a permanent record thereof; secondly, it may happen that by reason of atmospheric electrical phenomena impulses sufficiently strong to actuate the pointer and chronograph or recording-instrument may pass over the line when no contact between the stationary and moving contacts had been made. In either event the galvanometer per-

forms an important function, inasmuch as the official is enabled thereby to shunt the electro-magnet that controls the mechanism of the pointer out of the line-circuit and shunt the galvanometer into said circuit, and in the first instance start the pointer-actuating mechanism by hand by the indications of the galvanometer-needle, and in the second instance to keep the instruments shunted out to avoid injury thereto by strong atmospheric electric currents. Provision is also made for establishing communication with the trains on the road, so that in case of a delay occasioned by an accident to a train or from any other cause in one of the sections covered by the contact-posts the officer in charge at the main station may be enabled to communicate with the next train following the one delayed and prevent a collision.

Having thus outlined the general arrangement of the system and its component parts, I will now describe the electrical connections in detail, referring more particularly to Fig. 2, Sheet 1, of the accompanying drawings, in connection with a double-track road and a main station, from which two trains are supposed to leave and at which two trains are supposed to arrive, the contact-posts placed between the tracks having, therefore, two superposed contact-surfaces facing each track, one for each train, said surfaces being each connected with a line-circuit, four such circuits being therefore necessary, as well as four sets of instruments at the main station. This is given as an illustration of the practical working of the system, it being understood that the arrangement may be made for any number of trains arriving at or leaving said main station. The two main lines 1 2 for the two trains arriving at the station enter the apparatus at $z' z^2$, and the two main lines 3 4 for the two trains that leave the station enter said apparatus at $z^3 z^4$, and as the circuit through the various instruments for each line is substantially the same it will be necessary to describe one of them in order that all the others may be understood, the same letters having numerals corresponding to the respective main lines indicating the several circuits. Main line 1 is connected by wire s' to galvanometer A', and the latter is connected on the one hand by wire t' with the commutator C, and on the other hand by wire y' with the electro-magnet M', that controls the movement of the pointer, said electro-magnet being also connected by wire v' with the commutator C, and thence to earth by means of the usual arrangement of connections when the line-battery is arranged on the locomotive or a car of the train, or to a suitable battery when the circuit is closed through an earth-return, thus completing the circuit. The electro-magnet M' and the mechanism operated thereby are supported from a metallic base-plate, Z, (common to all the electro-magnets M' M^2 M^3 M^4 that control the pointers,) which is included in a local circuit, in which is also included the electro-magnet m' that controls the style of the recording-instrument. The base-plate Z is connected by wire w' with one pole of a local battery, Y, the opposite pole of which is connected by wire X and a branch wire, x', with the electro-magnet m', that controls the style of the recording-instrument or chronograph. The electro-magnet m' is connected by wire y' with circuit-closing devices controlled by the electro-magnet M' that controls the movement of the pointer, this being, as hereinafter more fully described, an insulated spring, (indicated by 11 in the diagram.)

It is obvious that when a train of cars passes by a contact-post, P, Fig. 21, and the contacting device, which is preferably a metallic brush, B^5, secured to the locomotive, or a car brushes, for instance, over the contact-plate p' of the post, the circuit will be closed, the electro-magnet M' will, through the attraction of its armature, set in movement a mechanism whereby the pointer 21 is moved from one indication on table T to the next, said indications or graduations having numbers indicating each a given contact-post within the section of road under control. At the same time a circuit-closer controlled by said electro-magnet closes the local circuit, whereby the electro-magnet m' of the recording-instrument, through its armature, causes a style to make a permanent record of the contact—that is to say, of the passage of the train at a given post—upon a moving fillet of paper, the distance between said records indicating also the time required by the train to travel from one post to the other, consequently the speed at which such train travels. Should an accident occur between any two contact-posts, by which a train is delayed, the table T will indicate the exact location of the train, while the fillet of paper will indicate the time during which the train has remained, and enable the official in charge to warn trains following of the danger ahead by signaling the said train or the station nearest to the accident. The same indications will be given if a train is delayed at a station within the section under control of the main-station apparatus.

The manner in which the speed of the train or the delay in its movements is indicated will be more fully described hereinafter.

C', Fig. 1, is a time-piece for the use of the official in charge of the apparatus, operating independently thereof, and is or may be of any approved or desired construction.

From what has been said the object and practical working or operation of the system will be fully understood, and I will now describe in detail the construction of the instruments, and first the mechanism for controlling the movements of the pointer 21 and for closing the local circuit, referring to Figs. 3 to 12, inclusive, Sheets 2, 3, 4, 5, and 6.

The operative mechanisms of the apparatuses B' B^2 B^3 B^4 for moving the pointers 21 22 23 24 through their respective electro-magnets M' M^2 M^3 M^4 in the four line-circuits, 1 2 3 4,

are alike in construction, and I will therefore only describe one of them—nanely, that B′, having its electro-magnet M′ in line-circuit 1.

Z indicates the metallic base-plate common to all the apparatuses B′ B², &c., and hereinbefore referred to, said base-plate being secured to a suitable support arranged on a table, T′, and adapted to receive the inclosing-casing C², Figs. 5, 6, 7, and 8, the four apparatuses, B′ B², &c., being inclosed in a common casing, C³, Fig. 1, from which project brackets C⁴, that support the galvanometers A′ A² A³ A⁴, and on top of which common inclosing-case is arranged the time-piece or clock C′.

Upon opposite sides of the case C³ are arranged the recording-instruments D′ D² D³ D⁴. Any other arrangement may, however, be resorted to, the arrangement shown being designed to place in view as many of the component parts of the system as possible.

The operating mechanism of the apparatus for moving the pointer 21 is supported from suitable plates, *a* and *a′*, and is constructed and arranged as follows:

M′ is the electro-magnet, secured to a bracket, a^2, projecting from plate *a′*.

L is a three-armed armature-lever, the arm *l* of which carries an armature, A, the movement of which from the electro-magnet is limited by an adjusting-screw, a^8. The lever has its fulcrum in a bracket, a^3, projecting from frame-plate *a′*.

Upon the free end of the arm *l′* of lever L is pivoted a pallet, *p*, the movement of which in one direction is limited by a lug, l^3, projecting from lever-arm *l′*, and in the other direction by a spring, *s*, secured to said lever-arm *l′*. The lever L is retracted into its normal position after being moved out of it by the attraction of the electro-magnet M′ by a spring, s^5, secured to an arm, l^2, on the lever-fulcrum pin and to an adjusting-screw, a^5, working in a bracket, a^4, projecting from plate *a′*, by means of which screw the tension of the spring may be regulated.

Upon plate *a′* is pivoted at b^3 a lever, B, the forward end of which carries a pallet, p^5, adjustable in a socket, b^2, by means of a set-screw, b^4, said pallet resting on the upper face of the pallet *p*. The lever is provided with a pin, p^6, (shown in dotted lines in Fig. 3,) and has in its under side two notches, *b b′*, for purposes presently explained. Upon the plate *a′* is also pivoted at e^4 a four-armed lever, E, upon the arm e^2 of which bears the pin p^6, that projects from the inside of lever B. The arm *e′* of lever E carries a prism-shaped lug, e^5, in normal engagement with one of four notches, *d*, formed in the periphery of a disk, D.

Between each two peripheral notches *d* of disk D is arranged a pin, *d′*, that projects from the face of the said disk.

From the lower end of the arm *e* of lever E projects a stop pin, e^6, that extends through an aperture in plate *a′* into the path of the fly E′, of any suitable train of clock-gearing, E², driven from a spring-motor, E³, or other suitable motor, which pin normally locks the said train of clock-gearing out of operation.

To the arm e^3 of lever E is connected one end of a retracting-spring, s^6, the other end of which is attached to plate *a′*, said spring serving to retract the lever E into its normal position when depressed, for purposes presently explained.

The notched disk D is mounted upon a shaft, S, that has its bearings in the frame-plates *a′ a*, and carries at its inner end, near plate *a*, a gear-wheel, W, and at its outer end a disk, C⁵, of any suitable non-conducting material, having a number of metallic contacts, c^3, arranged on or in its periphery equal to the number of notches and pins of disk D.

Upon the plate *a′* is secured a metallic bracket, a^6, to which is secured a plate-spring, 11, already referred to in the description of the electric connections of the local circuit, the wire *y′* of which is connected to binding-post y^5, and by wire y^6 to spring 11, which constitutes one terminal of the local circuit, and said spring 11 bears upon the periphery of the circuit-closing disk C⁵.

To bracket a^6, and in metallic connection therewith, is secured a plate-spring, 5, that bears upon the shaft S, upon which the disk C⁵ is mounted, said spring forming the other terminal of the local circuit through bracket a^6, metallic plate *a′*, and metallic base-plate Z, to which is connected the wire *w′* of the local circuit.

Upon a suitable bracket, a^7, projecting from the inner face of plate *a′*, is arranged a vertical shaft, S′, that carries a contrate-wheel, W′, driven by the train of clock gearing through the wheel W on shaft S. The latter shaft also carries a pin wheel, W², or a cog-wheel, the pins or cogs of which engage slots or holes formed in an endless metallic or other suitable belt, F′, which belt carries on its face the pointer 21.

In Figs. 6, 7, and 8 I have illustrated the four mechanisms, B′ to B⁴, for moving the pointer-carriers F′ to F⁴, with their respective pointers 21 to 24 belonging, respectively, to the four line-circuits 1 to 4, the corresponding contact-plates P′ to P⁴ on post P, and the going and coming trains on the two tracks already referred to. These pointer-carrier belts travel in rear of the slots *t*, formed in table T, on which are indicated by number the contact-posts of the section connected with the apparatus.

f f are standards that carry guide-pulleys *f′*, over which the pointer-carriers travel, and by which they are properly guided; and f^2 are like standards, carrying guide-pulleys f^3, for a similar purpose.

The operation of the described mechanism is as follows: When a train of cars passes by a contact-post and the brush B⁵ on the locomotive, or a car closes the line-circuit for that train, say, by contact with plate *p′* on post P, Fig. 21, the electro-magnet M′ attracts its arma-

ture, the arm l' of the armature-lever L moving rearward and disengaging the pallet p^5 of lever B from pallet p of said lever L. The lever B being freed, drops down between disks C^3 and D, and its pin p^6, bearing on arm e^2 of lever E, will cause said lever to partially rotate on its fulcrum, which partial rotation of lever E has the following results: The pin e^6 that locks the clock-movement E^2 releases the fly E' thereof, such movement being set in motion by the spring-motor E^3 to rotate the contrate-wheel W' through the driving-wheel W of the clock-movement. The rotation of the shaft S' that carries the contrate-wheel W' causes the pin-wheel W^2, mounted thereon, to rotate with it to move the pointer-carrier F', and with it its pointer 21 from one contact-post indication on table T to the next one, the clock-movement being timed to move the pointer-carrier and pointer exactly that distance, as will presently appear. The arm e' of lever E, as the latter is rotated on its fulcrum, moves the pin e^5 out of the recess d of disk D, with which recess said pin is for the time being engaged, thus releasing the disk D simultaneously with the release of the fly E', so that the train of clock-gearing will rotate the shaft S through gear-wheel W in gear with said train. The disk D will now rotate with its shaft as well as the disk C^5, mounted thereon, until one of the pins d', projecting from the face of disk D engages the notch b' in lever B, thus arresting the further movement of disk D and shaft S, and consequently locking the clock mechanism out of operation. The partial rotation of shaft S causes a like partial rotation of the circuit-closing disk C^5, one of its contacts, c^3, coming in contact with the metallic plate-spring 11, and closing the local circuit through the recording-instrument, as hereinabove described, the armature of said instrument being attracted by its electro-magnet m' to cause a permanent record of the passage of the train by that post to be made upon a traveling fillet of paper. As soon as the main-line circuit is again interrupted, the armature-lever L, with its armature A, is retracted into its normal position by the spring s^5. A moment after one of the pins d' engages the notch b' of lever B, the next succeeding pin enters the notch b, riding along the inclined rear face thereof and lifting the lever B back into its normal position, with its pallet p^5 upon the pallet p of lever L. It is obvious that if the pallet p were rigidly connected with lever L the pallet p^5 of lever B could not pass by the nose of the pallet p without rotating the lever L on its fulcrum, which may have disadvantageous results, and for this reason I pivot the pallet p upon lever L and hold it against rearward movement by a yielding pressure exerted thereon by the plate-spring s. Thus as the lever B is moved upward its pallet p^5 strikes the inclined under face of the pallet p and forces it back against the tension of the spring s, which again moves the said pallet to its normal position against the limiting-lug l^3 as soon as the pallet p^5 has passed above it, thereby insuring the proper engagement between the pallets under all circumstances. As the lever B is lifted into its normal position by one of the pins d', as explained, the circuit-closer C^5 will have rotated sufficiently to carry the contact by which the local circuit was closed out of contact with the spring 11, thus again interrupting the local circuit. In the upward movement of the lever B its pin p^6 will carry the arm e^2 of lever E upward also, thus imparting a partial rotation to said lever on its fulcrum. The pin e^5 on its arm e' will move into engagement with the next succeeding notch in disk D, while its arm e will move back to bring its pin e^6 into the path of the fly E' of the train of clock-gearing, the parts being then again in their normal position. (Shown in Fig. 3.)

From the construction described it will be readily seen that the disk D, lever B, and lever E constitute an escapement for the train of clock-gearing, and that the arrangement is such that at each quarter-rotation of the escapement-wheel—*i.e.*, the disk D—the pointer-carrier will be moved to carry its pointer from one contact-post indication on table T to the next succeeding. It follows that a glance at the table will give the situation of the trains circulating within the section under the control of the main station. It may, however, happen that by reason of atmospheric electric disturbances the line-circuit is not closed, which may be observed by the pointer of a given train not being moved to position in the required time. It is therefore necessary that means should be provided to start the train of clock-work by hand in order to maintain control over the road. This is done by first cutting the instrument out of the line circuit and shunting its corresponding galvanometer into said circuit, as above described, and by means of the following mechanism, referring to Figs. 3, 11, and 12.

At any convenient point of the inclosing-casing C^3 of the instruments B' B^2, &c., on the base that supports the same is arranged a button, c, secured to the arm l^4 of an angular lever, L^4, pivoted to a suitable bracket, c', and held in its normal position by a spring, s^7. The arm l^5 of lever L^4 bears against an arm, l^6, of an angle-lever, L', pivoted to a bearing, c^2, said arm l^6 carrying a plate-spring, s^8, the free end of which bears upon the armature A of the electro-magnet M'. The arm l^7 of the angle-lever L' is connected to a guide-rod, l^8, to guide lever L' properly, and said lever is returned into its normal position on the release of the button by a plate-spring, s^9, Fig. 3.

As above stated, the electro-magnet M' controls the electro-magnet of the recording-instrument or chronograph that operates the style or other device by which a permanent record of the contacts at the contact-posts is obtained.

The chronograph, of which there is one for each line-circuit 1 2 3 4, as already explained, and indicated, Fig. 1, by D' D^2 D^3 D^4, is con-

structed as follows, referring to Figs. 13 to 16, inclusive:

The mechanism is supported from a suitable base, Z', and frame-plates *g g'*, and G is a train of clock-gearing, of any desired or suitable construction, which is normally in continuous operation and is stopped only under certain circumstances, hereinafter referred to.

G' is the winding-arbor, and G^2 G^3 the usual ratchet-and-pawl locking devices therefor.

H is the balance-wheel, and I the lever-escapement of said clock-movement.

K is a drum upon which is wound a fillet or strip of paper, N, that passes over a guide-bar, *n*, thence over a driving roll, K', and between said roll and a pressure-roll, K^2, out of the apparatus. The latter roll is held with a yielding pressure upon the fillet of paper N by means of a spring, k^2, bearing on the under side of an arm, *k'*, secured to the stud *k*, that carries the bearing k^3 for said roller K^2. The driving-roll K' is mounted upon an arbor, *h*, that carries a gear-wheel, *h'*, driven by the clock-movement.

M is a standard secured to the base Z' of the instrument, to the upper end of which is pivoted an armature-lever, O, to the arm *o* of which is secured the armature Q of the electro-magnet *m'*. Near the outer end of the arm *o'* of lever O is arranged a style, R, adjustable vertically in the lever-arm and relatively to the roll K', said style occupying a position immediately opposite a groove, g^2, formed in the periphery of roll K'. The downward oscillation of the arm *o'* of lever O is adjusted and limited by means of an adjusting-screw, O', upon which said lever-arm rests, and said lever is brought back to its normal position on the interruption of the local circuit by a spring, O^2, the tension of which may be adjusted by the sleeve o^2, working on screw o^3, to which one end of said spring is attached.

I have hereinbefore stated that the electro-magnet of the recording-instrument, which is included in a local circuit, is controlled by an electro-magnet in the line-circuit, and I have fully described the manner in which said magnet of the recording-instrument is controlled. I have also stated that the fillet of paper is under normal circumstances in continuous motion, and that there is not only a visible record made on the paper of the contact made by the passage of a train by a contact-post, but also that the speed of the train will be indicated upon the paper fillet.

The record of the contact is made by the style, as above described. The speed of the train is indicated by the fillet of paper, as follows: The fillet of paper is provided with graduations, each representing a unit of distance traveled over by a train as well as a unit of time in which said distance has been traveled over, and if the speed of the clock-movement is regulated so that the fillet of paper will move in unison with the train it will be readily seen that the units of time and distance indicated upon the fillet of paper from the point of its being set in motion to the point of its being stopped will exactly indicate the distance traveled over by the train in a given time from a point of starting to a point of stoppage, or from one contact-post to another. Assuming the distance from the contact-post at the main station to the next contact-post to be one kilometer, that all the other contact-posts are at a like distance from one another, and the speed of the fillet of paper to be at the rate of one millimeter a second: a train running at a speed of fifty kilometers an hour will travel a distance of one kilometer in seventy-two seconds, and as the fillet of paper moves in unison with the train, it will have advanced seventy-two millimeters in seventy-two seconds, as indicated on the fillet of paper in the interval between the first and second record made by the style.

From what has been said it is obvious that it is not necessary that the contact-posts should be equidistant from one another, provided the distance between each two posts is known to the official in charge of the apparatuses. It will also be seen that a delay at a station will be duly recorded, since no record by the style will be made of the starting of the train from said station. The fillet of paper, however, moving on, will indicate in seconds by its millimeter-graduations the elapsed time from the arrival of the train to its starting from the station. The same will take place in case of an accident to a train on a section of the road between any two contact-posts, thus enabling the official to inform the nearest station of such delay, ascertain its cause, stop trains, &c., and thereby avoid further accident.

The clock-movement of the recording-instrument is provided with a stop mechanism, and said movement is automatically started by the first closure of the local circuit and kept in motion continuously, as follows:

Upon the fulcrum-pin o^4 of the armature-lever O is secured an arm, N', that bears upon a pin, *n'*, projecting from an arm or lever, n^3, secured to an arbor, n^2, that has its bearings in the frame-plates *g g'* of the apparatus. The arbor n^2 also carries a brake-lever, P', and a lever, N^3, by means of which said lever P' may be controlled by hand, as presently explained, to stop the clock-movement. To the lower end of lever P' is secured a brake spring, Q', the free end of which bears upon the periphery of the balance H of the clock-movement, Figs. 13 and 16, the movement of said lever toward the balance being limited by a stop, o^5. When the armature is attracted by its electro-magnet *m'*, and the arm *o* of the lever moves downward to carry the style on arm *o'* upward to make an impression on the fillet of paper, the arm N' on fulcrum o^4 of the armature-lever will move the arm n^3, so as to cause the brake-lever P' to carry the brake-spring Q' out of contact with the balance H, thus releasing the clock-movement.

The arbor n^2 is provided with an annular groove, in which lie the branches of the fork

r' at the free end of a plate-spring, R′, secured to frame-plate g, said branches of the fork r' bearing with sufficient force against the shoulder formed by the annular groove in arbor n^2 to hold said arbor against movement under the weight of the brake-lever P′, thus preventing said lever, after having been moved out of contact with the balance, to return and again stop the clock-movement.

In case of too great a delay of a train from any cause, it may be desirable to stop the movement of the fillet of paper, the cause of the delay to the train having been ascertained, in order to avoid a waste of paper fillet. This stoppage may be readily effected by means of the spring-actuated button H′, bearing against the lever N^3, thereby imparting a partial rotation to arbor n^2, which will cause the brake-lever to move toward the balance H, and carry the brake-spring Q′ in contact with the periphery of said balance to arrest the movement of the train of clock-gearing, which will remain stationary until an electric impulse again attracts the armature to release the clock mechanism, as above described.

Having described the arrangement, construction, and operation of the recording-instruments, together with their electrical connections, I will now describe, in completion of the system, the means for communicating with a train on the road in case a preceding train is compelled to stop in one of the road-sections covered by the contact-posts by reason of an accident or from any other cause. When the officer at the main station desires to communicate with a train on the road, in case of a delay in the progress of a preceding train, of which he is apprised by the stoppage of the pointer and the failure of the recording-style to produce the necessary record within the specified time, he will signal the train following the one delayed to stop, and this is effected as follows: U, Fig. 22, indicates a battery at the main station, and U′ a battery on the locomotive or a car. The former is connected with the line-circuit and the latter with the contact-brush B^5, the normal condition of the circuit at the main station being as follows: A short circuit from elements 12 13 of the battery by wire 6 to contact i, by shunt J to contact i', thence by wire 7 to the electro magnets U of a signal or call bell, V, wire 8 to contact i^2, shunt J′, contact i^3, wire 9 to key I′, thence by wire 10 to line-circuit 1 and contact-plate p', for instance, the call-bell V remaining unaffected by reason of the feeble current. From contact-plate p' the current passes over brush B^5 of a passing train as soon as the same brushes over the plate p', thence by wire w^2 to electro-magnets U′ of the signal or call bell V′, which also remains unaffected by reason of an insufficiency of the power of the battery-current. From bell V′ the current passes by wire w^3 to key I^2, wire w^4, to double shunt U^2, to contacts u^2 u', by wire w^5, to earth. When the train is, however, to be signaled, the officer at the main station shunts the lever J from contact i to contact i^5, and the lever J′ from contact i^2 to contact i^6. The full battery-current will now pass by w to i^5, over J to i', by wires 7 and 18 to telegraph apparatus J^2, by wire 19 to contact i^6, over J′ to i^3, wire 9 to key I′, and wire 10 to line 1, thence to contact-plate p', brush B^5, over wire w^2 to the electro-magnets U′ of the signal-bell V′, which, on the attraction of the armature-lever of said electro-magnets, will be set in operation to notify the officer or engineer on the train that there is danger ahead. From the electro-magnets U′ the current will pass over the route above described to earth by wire w^5. The signal thus given will notify the officer or engineer on the train to stop, and he will at once place himself in communication with the main station by backing his train to the contact-post he has just passed, with the contact-brush in contact with plate p', or passes on to the next contact-post, and in case either is impracticable he establishes direct communication in a well-known manner by connecting the line-circuit with his battery-circuit or his brush. He then inserts the contact-pin r^2 in hole r^3 to throw the signal-bell out of operation, and places the double switch or shunt lever U^2 upon contacts w^3 w^4, to shunt his battery Y′ into the line-circuit, whereby the telegraph apparatus J^3 is also shunted into circuit, so that he is enabled to open communication with the main station ahead, as well as in rear of him.

The object of providing a local battery on the train is to enable the officer in charge or the engineer to communicate with the stations, and when he places his shunt or switch lever from w' w^2 to w^3 w^4 the full battery-current will pass to the electro-magnets U of the signal-bell at the main station and notify the operator in charge there that he is in a condition to communicate with him. In this manner the officer or engineer of a train may be signaled on the passage of his train at any one of the contact-posts, and said officer or engineer may signal and enter into telegraphic communication with the nearest station in front or in rear of his train.

From the description given above of the construction of the recording instrument or chronograph and the operation of its several component parts, and from what has been said hereinbefore, the function of the instrument or apparatus will be readily understood.

With the described system the official in charge of a section of railway is enabled at a glance to ascertain the circulation of trains, their speed, the distances between trains moving in the same direction, the duration and spot of stoppages, time of stopping, and the place where the stoppage occurs, the crossing of trains—in short, everything that takes place on the section of the road in his charge. He is also enabled, in case of a delay or stoppage of a train, to signal the same and place himself in telegraphic communication with the officer in charge, thus having under his control all the means required to control the serv-

ice of his section, and thus prevent serious accidents.

In practice the contact-brush B^5 is adjustably secured to its support on the locomotive or a car. Such support may consist of an angular bracket, I′, in the vertical arm of which are formed a series of holes for the reception of the brush stock or holder.

Any other suitable circuit-closing devices than those hereinbefore referred to may be employed and placed along the track. I prefer, however, those referred to and shown in Figs. 18 to 21, inclusive, on account of their simplicity and solidity. In these figures, P indicates the posts, to the upper end of which is secured a roofed frame, F, of wood or other non-conductor of electricity, the longer side of the frame facing the tracks and having the contact-plates p' p^2 p^3 p^4, respectively connected with the line-wires 1 2 3 4 by wires 31, 32, 33, and 34.

Having now particularly described my invention, what I claim is—

1. In an electric railroad-controlling system, in combination, a line-circuit adapted to be closed by a moving train, an electro-magnet in said line-circuit, a local circuit, an endless-carrier belt and index carried thereby, a train of gearing for moving said carrier-belt controlled by the electro-magnet, a shunt for shunting the electro-magnet out of the line-circuit, and actuating mechanism, substantially such as described, adapted to be operated by hand for controlling the movements of the index-belt and cause the index thereof to indicate the line-circuit closures, for the purpose specified.

2. In an electric railroad-controlling system, in combination, a line-circuit adapted to be closed by a moving train, an electro-magnet in said line-circuit, a local circuit, an electro-magnet in said local circuit controlled by the electro-magnet in the line-circuit, a style, a fillet of paper having time and distance indices, and a clock-movement for imparting continuous motion to said fillet of paper, said parts being controlled by the electro-magnet in the local circuit, as described, for the purpose specified.

3. In an electric railroad-controlling system, in combination, a line-circuit adapted to be closed by a moving train, an electro-magnet in said line-circuit, a circuit-closer controlled thereby, a local circuit, an endless-belt carrier, an index secured thereto, and a clock-movement in said local circuit controlled by the line-circuit magnet to intermittingly move said carrier, an electro-magnet and a style controlled thereby also in the local circuit and controlled by the line-circuit magnet, a fillet of paper, and a clock-movement for imparting a continuous motion to said fillet of paper, as described, for the purpose specified.

4. In an electric railroad-controlling system, in combination, a line-circuit adapted to be closed by a moving train, an electro-magnet in said line-circuit, an index adapted to indicate the line-circuit closures controlled by the electro-magnet, a galvanometer-needle, and shunt for shunting the electro-magnet out of the line-circuit and shunting the galvanometer-needle into said line-circuit, whereby said needle is made to indicate the line-circuit closures instead of the index, for the purposes specified.

5. In an electric railroad-controlling system, in combination, a line-circuit adapted to be closed by a moving train, an electro-magnet in said line-circuit controlled by said electro-magnet, a galvanometer-needle, a shunt for shunting the electro-magnet out of the line-circuit and for shunting the galvanometer-needle into the same, and actuating mechanism for controlling the index by hand, whereby the closures of the line-circuit are indicated by the galvanometer-needle, and whereby said closures may be indicated by the index by manual control, for the purposes specified.

6. In an electric railroad-controlling system, in combination, a line-circuit adapted to be closed by a moving train, an electro-magnet in said circuit, a fillet of paper, an independent power for moving the same, a style adapted to make a permanent record of the closures of the line-circuit upon said fillet of paper, said elements being controlled by the electro-magnet, and controlling mechanism for controlling the movements of the fillet of paper independently of said electro-magnet to impart to the fillet of paper a continuous movement, for the purposes specified.

7. The combination, with the electro-magnet M′ in a line-circuit, its armature A, armature-lever L, a circuit-closer controlled thereby, a clock-movement, and the wheel W thereof, of the shaft S′, crown-wheel W′, pulleys W^2 f', an endless carrier-belt, a pointer secured thereto, the slotted table T, and a local circuit in which said parts are included and controlled by the electro-magnet M, as described, for the purpose specified.

8. The combination, substantially as herein described, with the shaft S′, the index-carrier F′, a train of gearing for operating said carrier, and the electro-magnet M′, that controls the operation of the carrier, of an escapement for locking and releasing the train of gearing controlled by said electro-magnet, for the purposes specified.

9. The combination, substantially as herein described, with the shaft S′, the index-carrier F′, a train of gearing for operating said carrier, and the electro-magnet M′, that controls the movements of the carrier, of an escapement consisting of the notched disk D, carrying pins d', the lever B, controlled by the electro-magnet, and the lever E, controlled by the lever B, said parts being arranged for operation, for the purposes specified.

10. The combination, substantially as herein described, with the electro-magnet M′ in

the line-circuit, a fillet of paper, and a clock-movement in a local circuit controlled by said electro-magnet and adapted to respond to the electric impulses influencing said magnet, and a shunt for shunting said clock-movement out of control of said electro-magnet, whereby said movement is maintained in continuous operation, of a friction-brake for arresting the motion of the clock-movement by hand, for the purposes specified.

11. The combination, substantially as herein described, with the electro-magnet M′ in the line-circuit, a fillet of paper, and a clock-movement in a local circuit controlled by said electro-magnet and adapted to respond to electric impulses influencing the said magnet, and a shunt operating automatically to shunt the clock-movement out of the control of the electro magnet, of a friction-brake adapted to be operated by hand for arresting the motion of the clock-movement, for the purposes specified.

12. In an electric railroad-controlling system, the combination, substantially as described, of a vertically-adjustable moving contact, with a series of superposed stationary contacts, arranged in the path of the moving contact, a corresponding series of line-circuits, each comprehending a pointer adapted to indicate the electric impulses sent to line, controlled by the moving contact, a shunt, a galvanometer, and electric connections, whereby the pointer may be shunted out of and the galvanometer shunted into said line-circuit, for the purposes specified.

13. In an electric railroad-controlling system, the combination, substantially as described, of a vertically-adjustable moving contact, with a series of superposed stationary contacts arranged in the path of the moving contact, a corresponding series of line-circuits, each comprehending a pointer adapted to indicate the electric impulses sent to line, and a recording-instrument in a local circuit, both controlled by the moving contact, a shunt, a galvanometer, and electrical connections, whereby said pointer may be shunted out of and the galvanometer shunted into said line-circuit, for the purposes specified.

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

CHARLES ALBERT MAYRHOFER.

Witnesses:
JAMES RILEY WEAVER,
GEO. WIRTH.