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E. B. IVES & C. W. WILLIAMS.

RAILWAY TELEGRAPH.

No. 324,381 Patented Aug. 18, 1885.

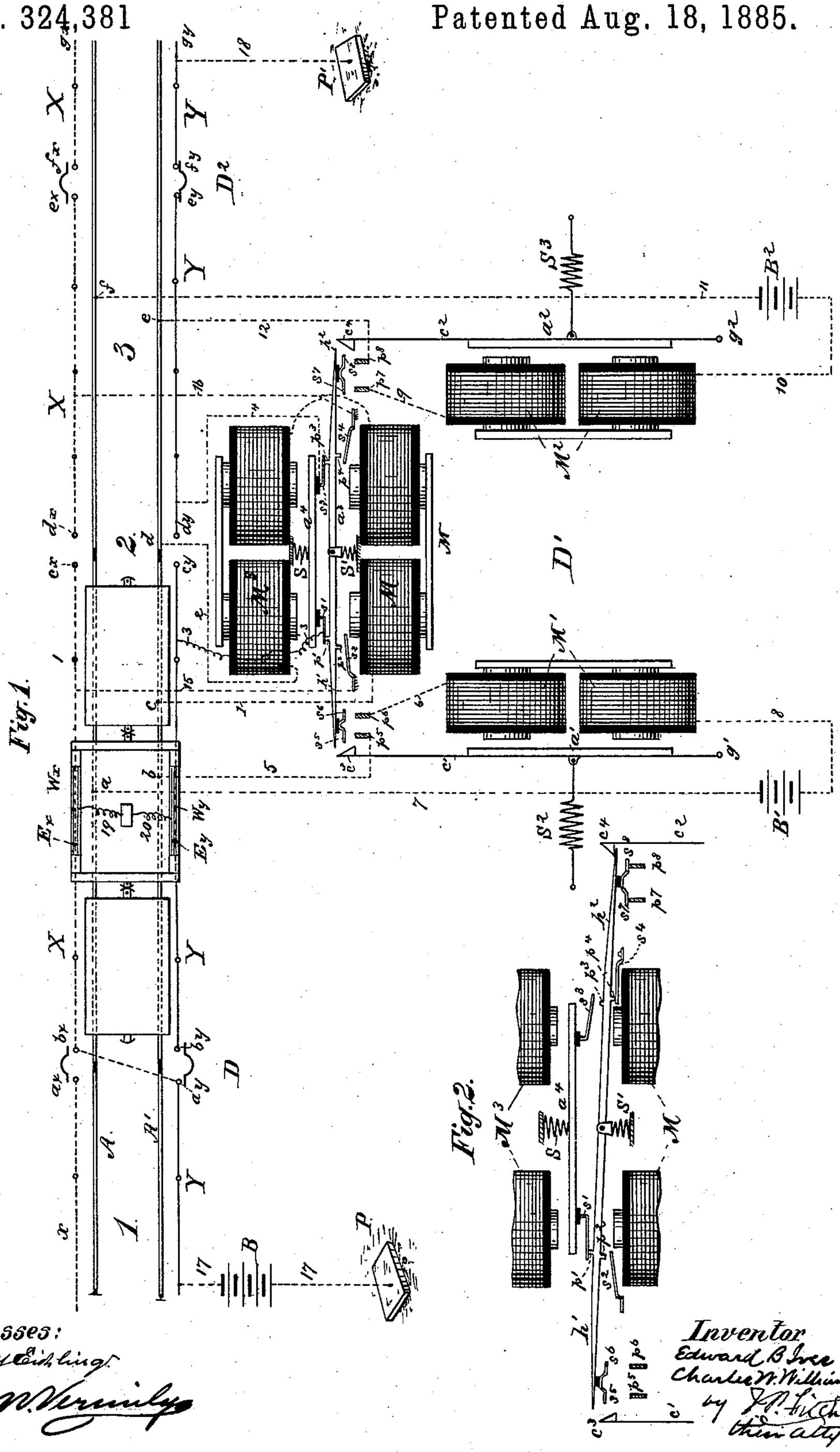

Fig. 1.

Fig. 2.

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Inventor
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(No Model.) 3 Sheets—Sheet 2.

E. B. IVES & C. W. WILLIAMS.

RAILWAY TELEGRAPH.

No. 324,381. Patented Aug. 18, 1885.

Fig. 3.

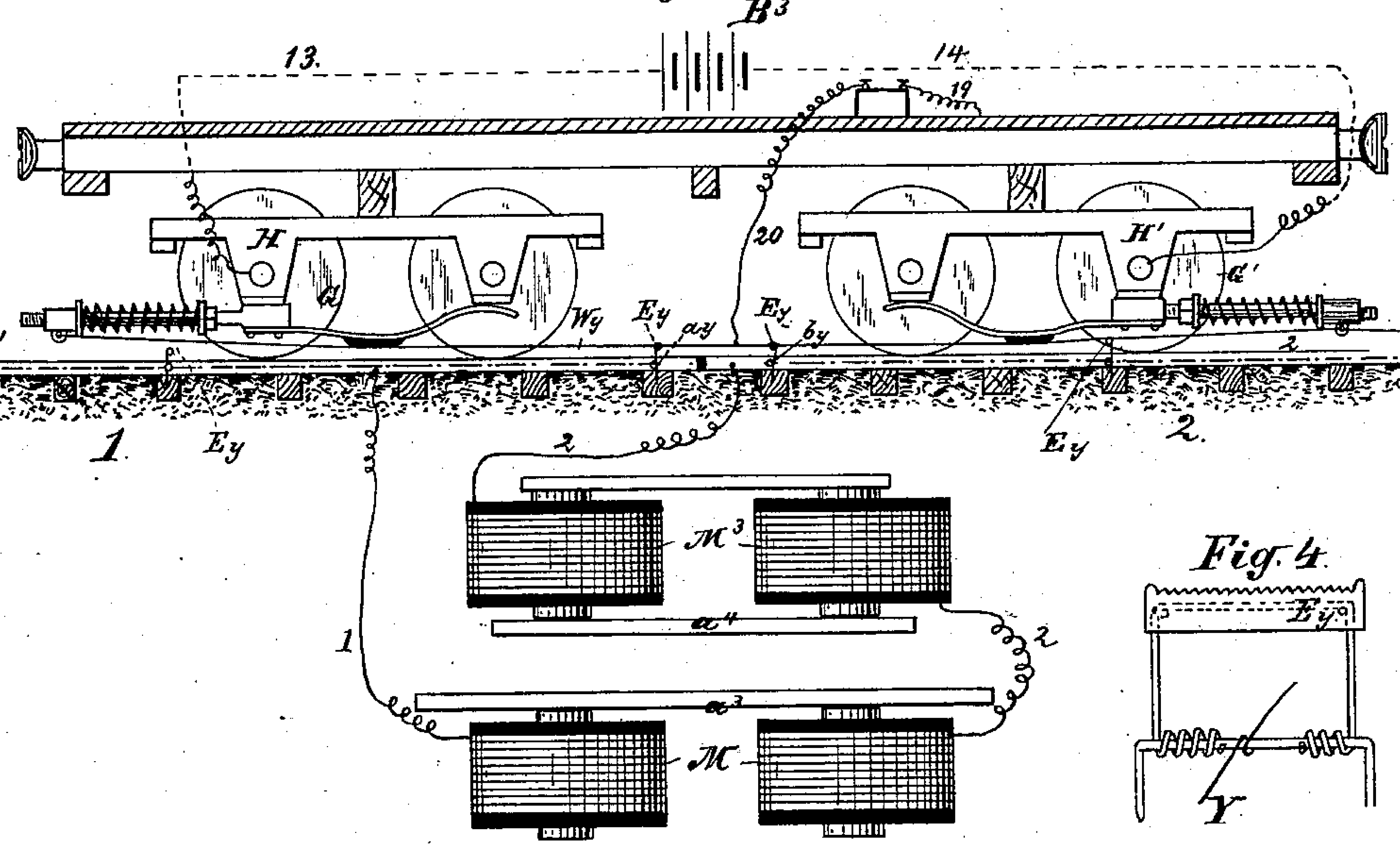


Fig. 5.

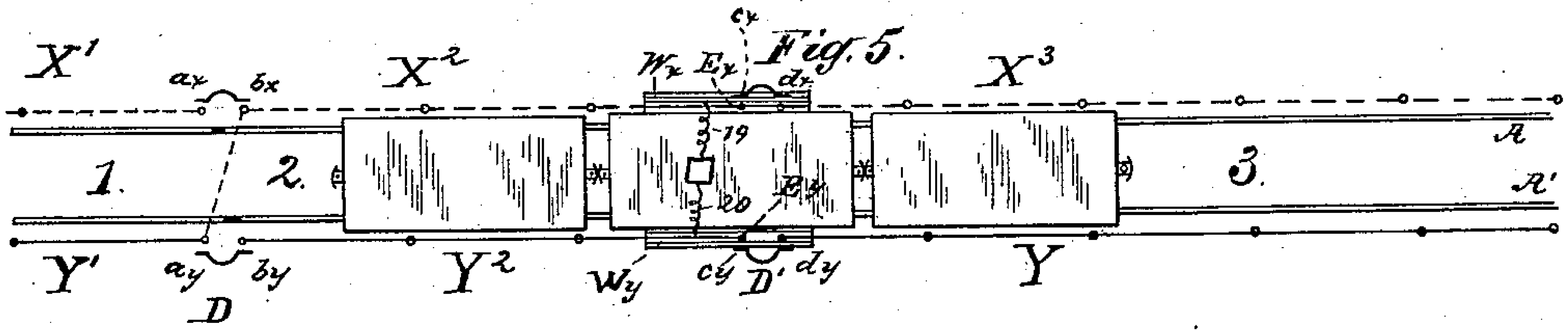


Fig. 6.

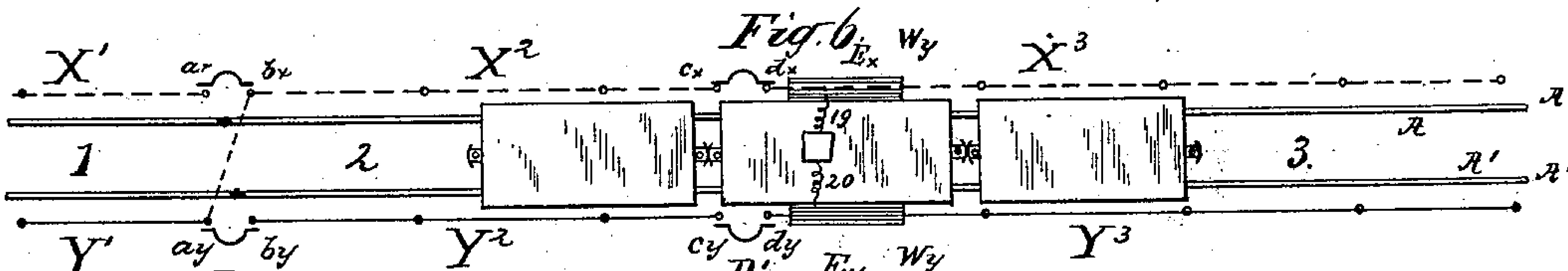


Fig. 7.

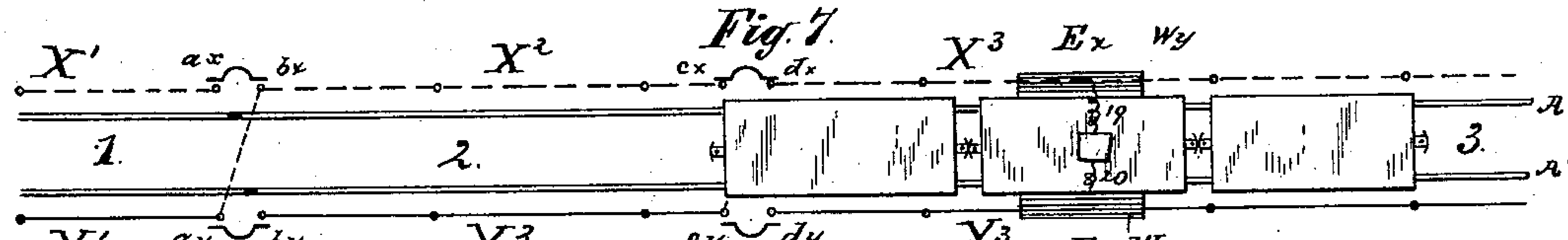
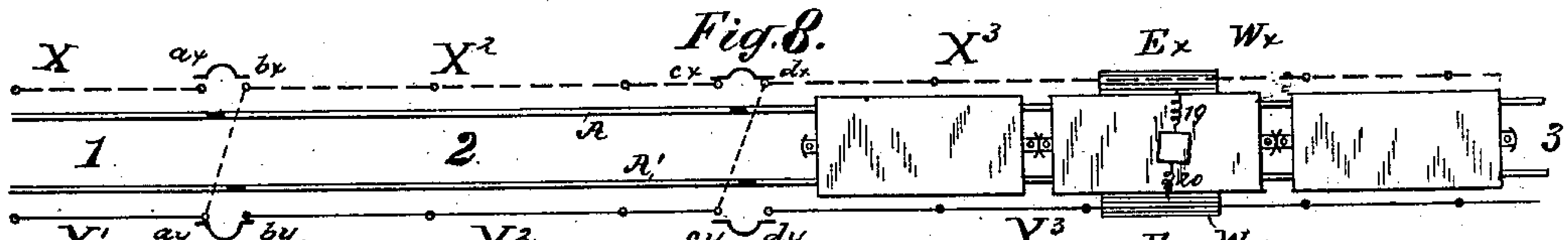


Fig. 8.



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(No Model.) 3 Sheets—Sheet 3.

E. B. IVES & C. W. WILLIAMS.

RAILWAY TELEGRAPH.

No. 324,381. Patented Aug. 18, 1885.

Fig. 9.

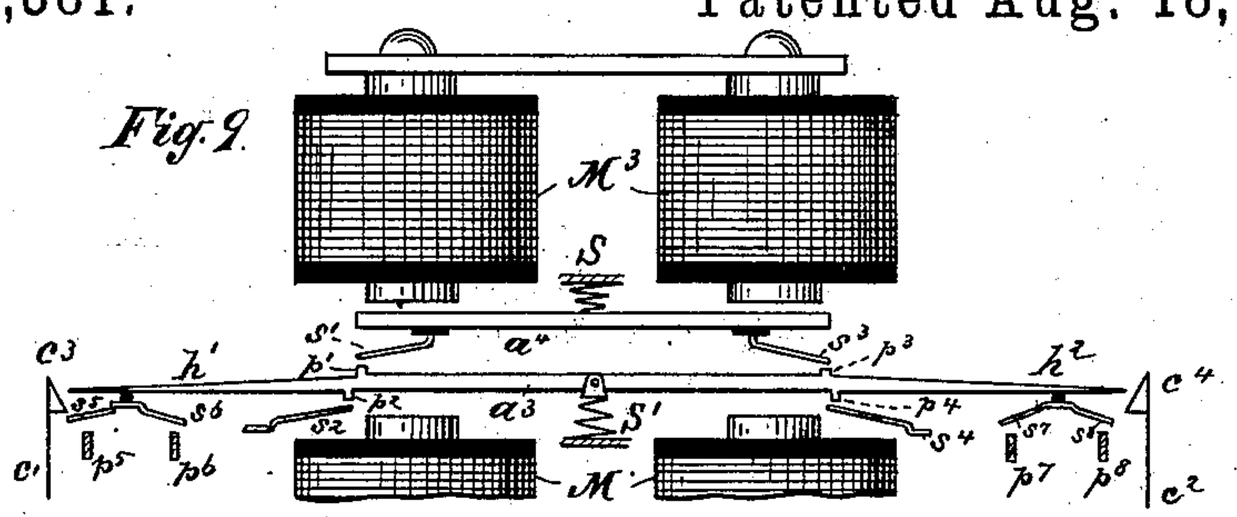


Fig. 10.

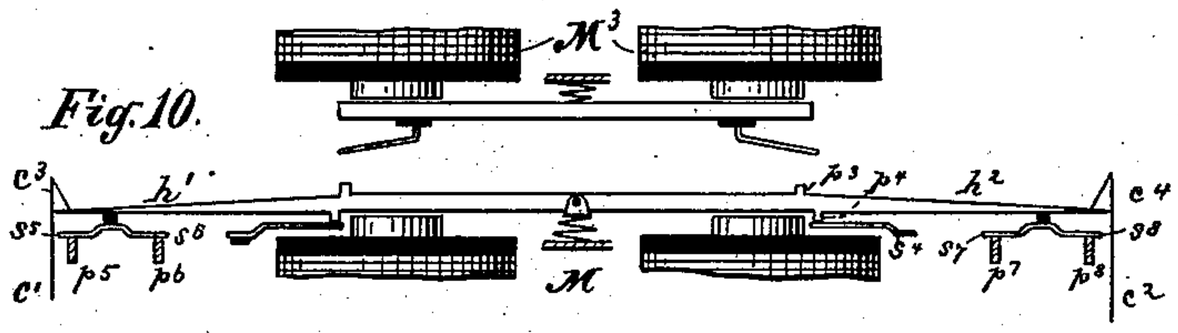


Fig. 11.

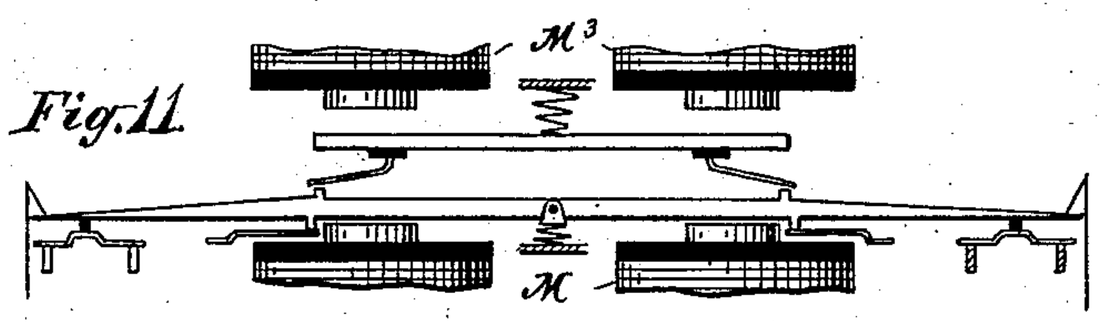


Fig. 12.

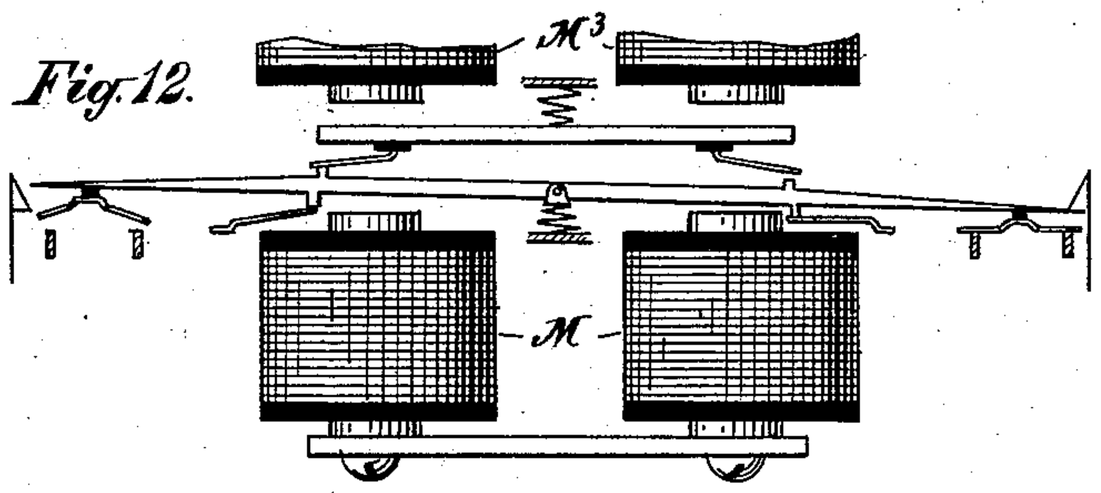
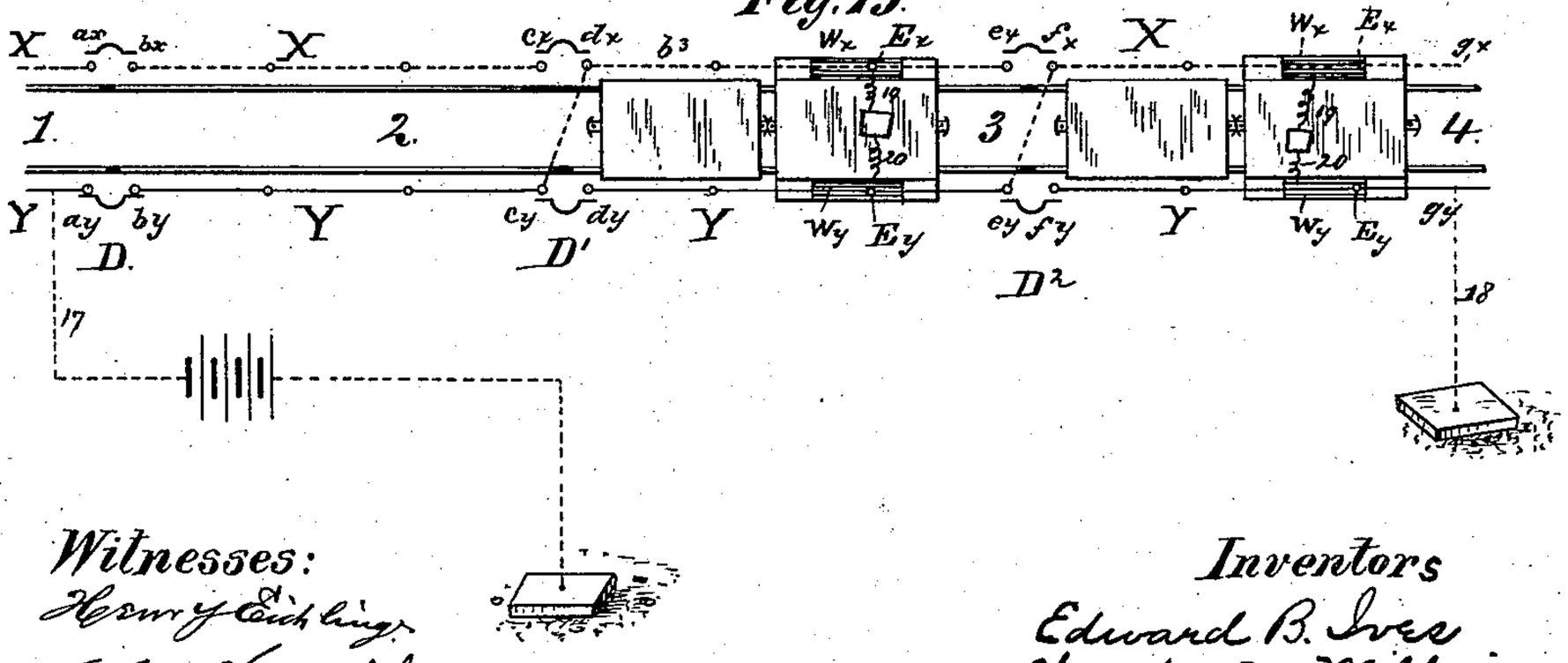


Fig. 13.



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UNITED STATES PATENT OFFICE.

EDWARD B. IVES, OF NEW YORK, N. Y., AND CHARLES W. WILLIAMS, OF CAVE CITY, KENTUCKY.

RAILWAY-TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 324,381, dated August 18, 1885.

Application filed June 17, 1884. (No model.)

To all whom it may concern:

Be it known that we, EDWARD B. IVES, of the City of New York, in the county and State of New York, and CHARLES W. WILLIAMS, of Cave City, Barren county, Kentucky, both citizens of the United States of America, have invented certain Improvements in Railway-Telegraphs, of which the following is a specification, reference being had to the accompanying drawings, forming part of the same.

Our invention relates to a system of railroad-telegraphy in which a continuous electric circuit from one point on the road to another point on said road is established and maintained through a car on the road between said points; and it consists in the peculiar devices and combinations of devices hereinafter described and claimed.

In the drawings which represent such a system containing our present improvements, Figure 1 is a plan view of four sections of the system, upon the second of which is a train passing from left to right, showing also the course of the current at the switch-block last passed over, and a switch-block and its connections in detail placed at the point of division between sections two and three, together with the battery and line connections before and beyond. Fig. 2 is a detailed view of the connections of the switch-block between sections one and two of Fig. 1. Fig. 3 is a side elevation of a car the front trucks of which rest upon one section of the rails and the rear trucks upon another section of the same, showing also two electro-magnets of the switch-block and the contact-conductors, one of which is carried on each side of the car. Fig. 4 represents one of the contact-plates which are placed upon the line-conductors. Figs. 5 to 8, inclusive, are views of several sections of the system, showing the different arrangements of the connections at the switch-blocks during different periods of its working. Figs. 9 to 12, inclusive, are detailed views showing the different positions of parts of the switch-block at the several periods aforesaid, respectively, and Fig. 13 is a view of four sections of the system, showing a train upon each of two adjacent sections.

The two line-conductors used in this system are shown, one in full lines at Y Y Y Y in Figs. 1, 5, 6, 7, 8, and 13, and the other in dotted lines at X X X X in the same figures. Both are provided with contact-surfaces E*x* E*y*, placed thereon at such intervals that the contact-conductors on the car, to be hereinafter described, shall at all times rest upon at least one of such plates. These plates may be formed of wire bent into a loop and with the ends coiled upon a staple, as shown in Fig. 4, which may be driven into an insulated bed-piece located at the side and in the vicinity of the rails of the road, preferably with the loop at right angles to the rails, the said plates being in electrical connection with the line-conductor upon which they are severally placed.

One car of the train is furnished with contact-conductors W*x* W*y*, one on each side, which may be one or more wires or strips of metal secured to and stretched tautly between bars bolted to the front and rear trucks of the car. They should be flexible and yielding, made taut by any suitable device, and insulated from the car. Wire connections are made between these contact-conductors and the respective poles of an instrument on the car, and each conductor must be so placed as to slide along in contact with contact-plates upon the line-conductor on the same side of the road.

It is now evident that if X and Y were continuous, and were connected one to one pole of a battery and the other to the opposite pole of said battery through ground at the other end of the line, a current would flow through the instrument on the car as long as the contact-conductors were sliding upon the contact-surfaces. But it is also evident from the well-known phenomena of electricity that if another train should come upon the track between the battery and the first train, while both instruments on the trains might respond to an instrument at a local station between them and the battery, yet the instrument between the trains and the battery will not respond to either of the instruments on the trains, nor will either of said instruments on the trains respond to the other so long as the key of said other remains closed. To obviate this difficulty we divide the line-conductors and the rails of the road into insulated sections suffi-

ciently short to insure that but one train at a time shall be upon any one section, and place at each point of division a switch-block which when passed over by the car will thereby shift the current at that point from the line-conductor on one side of the road to that on the other side of the road, and continue it in this course so long as any portion of the train remains upon the section of the road it enters upon when operating the switch-block to shift the current as described, whereby the current will flow continuously from one line-conductor to the other alternately through the cars and the adjacent switch-blocks last passed over, thus permitting as many trains to be in communication with each other and with the local stations as there are sections of the road. The rails are also divided into insulated sections corresponding to the sections of the line-conductors, and the points of division between each of the sections of said conductors and of the rails are preferably on a line with each other across the track, the switch-block connections between the different sections of Y being normally closed and those between the several sections of X normally open.

The system as thus far set forth is substantially the same as that shown and described in the drawings and specification accompanying a separate application for Letters Patent filed in the United States Patent Office on the 2d day of May, 1884, by Charles W. Williams, George S. Barnum, and Edward B. Ives.

The invention that we intend herein to claim relates particularly to an improvement in the switch-block by which the shifting of the current is accomplished, as we will now proceed to describe.

In this system the conductor Y is called the "main-line conductor," as all sections of it are at all times in use, while the conductor X is called the "auxiliary-line conductor," as no more than two of its sections are at any one time necessarily employed to complete the circuit through any one train, and it has no battery or ground connections, the successive sections being brought into the circuit only by the action of the switch-block.

A battery, B, Fig. 1, is provided, connected with conductor Y, near *ay*, and ground P, and said conductor Y is also grounded at P', at the other end of the road.

A telegraph-car entering the system passes the switch-block D, actuates it to automatically break the connection between *ay* and *by*, normally closed, and establish one between *ay* and *bx*, normally open, in a manner to be presently described with reference to switch-block D', their action being similar. The course of the current is now battery B, wire 17, conductor Y' to *ay*, through switch-block D (its parts then having the relative arrangement shown in Fig. 2) to *bx*, thence by conductor X to contact-plate E*x*, at the side of the train, to contact-conductor W*x* on the train, wire 19, the instrument on the car, wire 20, contact-conductor W*y*, contact-plate E*y*, and thence by conductor Y through the intervening switch-blocks in their normal condition to *gy*, by wire 18 to P', to P, to battery, as shown in Fig. 1. When the car reaches and is passing switch-block D', the connection between *cy* and *dy* is broken, and that between *cx* and *dx* established. This continues until the last wheels of the train have left section 2. A connection between *cy* and *dx* is then established, that between *ay* and *by* re-established, and immediateby thereafter the connections between *cx* and *dx* and *ay* and *bx*, respectively, are broken. The path of the current is now battery B, wire 17, conductor Y, to *cy*, through D, in normal position, through D' to *dx*, thence by conductor X to contact-plate E*x* at the side of the train to contact-conductor W*x* on the train, wire 19, the instrument on the car, wire 20, contact conductor W*y*, contact-plate E*y*, and thence by conductor Y through the intervening switch-blocks in their normal condition to *gy*, by wire 18 to P', to P, to battery, the course as far as *ey*, switch-block D², being shown in Fig. 13. It is thus evident that so long as no part of any two trains are on the same section all trains will be in telegraphic communication with each other and the local stations.

The switch-block for automatically shifting the current, as has been described, is shown in detail at D', Fig. 1. It consists, essentially, of four electro-magnets, M M' M² M³, which are fixed upon a convenient platform or support in the vicinity of each point of division between the sections of the conductors and rails, magnets M' M² being respectively excited by batteries B' B², conveniently located and connected, respectively, therewith, there also being wire-connection 7 between battery B' and section 2 of rail A at *a*, and wire-connection 11 between battery B² and section 3 of said rail at *f*. The electro-magnets M M³ are connected together, so coiled that a current will traverse them in opposite directions, and one of them is connected to one section of the rail, as at *c*, by wire 1, and the other to the adjacent section of the same rail, as at *d*, by wire 2.

M M³ are excited by a battery, B³, carried on the car, as shown in Fig. 3. The poles of this battery are electrically connected with the rails of the road, preferably by wires 13 and 14, leading to the frames of the front and rear trucks, respectively, of the car, and by electric connection being insured between said trucks and their wheels. The position of the car when the electro-magnets M M³ are being excited by the battery thereon is that shown in said Fig. 3, the wheels of the front and rear trucks being on different sections of the rails, the circuit being battery B³, wire 13, the track, preferably through truck-frame H and wheel G, wire 1 at *c*, magnet M, magnet M³, wire 2, track at *d*, wire 14, preferably through wheel G', and frame H', battery. Only when the car is in the position shown will the magnets M M³ be excited, as at all other times the wheels

G G′ or equivalent battery-connections being both in contact with the same section of track the circuit is directly from one to the other along the said track.

a^3, Fig. 1, is the armature of the magnet M, and a^4 is the armature of the magnet M^3. To the respective ends of the armature a^4 are attached contact-pieces s' s^3, which must be so insulated from said armature that no current can pass from one contact-piece to the other through said armature, and wire-connections extend from conductor Y near *cy* to s', and from conductor Y near *dy* on the opposite side of the point of division to s^3. The two armatures a^3 a^4 are so relatively placed that when neither is attracted by its magnet, but both are held away from said magnets by springs S S′, respectively, provided for that purpose, said contact-pieces s' s^3 will make contact with points p' p^3 on the armature a^3, and when either armature is drawn to its magnet said contacts will be broken. The armature a^3 is so hung that either or both ends, if free, may be forced away from the magnet by the action of the spring S′, and has two other contact-points, p^2 and p^4, and two sets of contact-pieces, s^5 s^6 and s^7 s^8, mounted upon it, one contact-point and two contact-pieces being located on each side of the center of said armature. In the vicinity of the magnet M and in the plane of movement of its said armature are placed two other contact-pieces, s^2 s^4, and four contact-posts, p^5 p^6 p^7 p^8, fixed to suitable supports and in such positions with relation to the contact-points p^2 p^4 and contact-pieces s^5 s^6 s^7 s^8 that when the armature a^3 is drawn to its magnet it will make contact between s^2 and p^2, s^4 and p^4, s^5 and p^5, s^6 and p^6, s^7 and p^7, s^8 and p^8, respectively, and that when either end of a^3 is released, as hereinafter described, and is forced back by the action of the spring S′, the contacts between the contact pieces, points, and posts at that end of the armature will be broken, while those at the opposite end may remain closed. Between the contact-pieces s^2 s^4, the posts p^5 p^6 p^7 p^8, and the conductor X near *cx* and *dx*, the rail A′ at *b*, section 2, the magnet M′, magnet M^2, and the rail A′ at *e*, section 3, respectively, connections are made by the several wires 15, 16, 5, 6, 9, and 12.

The electro-magnets M′ M^2 are furnished with armatures a' a^2, attached to levers c' c^2, each pivoted at one end, g' g^2, and provided with a catch, c^3 c^4, at the other end, and so arranged that when either of the said magnets is charged and attracts its armature the catch on the end of the lever connected thereto will engage one of the ends of the armature a^3, if it is at the same time attracted by its magnet, and will hold said end of a^3 in the same position until the current through magnet M′ or M^2, as the case may be, ceases, when the catch-lever is unlatched by the action of a spring, S^2 S^3, employed therefor, thus permitting the armature a^3 to be moved away from the magnet M.

The operation of the switch-block, thus constituted, is as follows: Let there be a train on any section of the road, as shown in Fig. 1. (There section 2.) The path of the current then is, battery B, wire 17, conductor Y′ to *ay*, switch-block D to *bx*, conductor X^2 to contact-plate E*x* at the side of the car, contact-conductor W*x*, wire 19, the instrument on the car, wire 20, contact-conductor W*y*, contact-plate E*y*, conductor Y^2 to *cy*, wire 3, contact-piece s', contact-point p', armature a^3, contact-point p^3, contact-piece s^3, wire 4, conductor Y^3 near *dy*, and thence to P′ P and battery, as heretofore described, and as shown in said Fig. 1. When the train arrives at such a point that the telegraph-car straddles the insulated joint between sections 2 and 3 of the rails, as shown in Figs. 3 and 5, the switch-block begins to be worked, and the following changes take place in the following order: An electric current from battery B^3 flows through the electro-magnets M M^3, as heretofore described, and they are charged. Armature a^4 is drawn toward its magnet, separating s' from p' and s^3 from p^3, and thus breaking the circuit from *cy* to *dy*, and armature a^3 is drawn toward its magnet, making contact between s^2 and p^2 and s^4 and p^4, thus closing the circuit from *cx* to *dx*. (See Figs. 5, 6, 9, and 10.) At the same time contact is made between s^5 and p^5 and s^6 and p^6, thereby completing the circuit of battery B′ through magnet M′, the described wire-connections, and the wheels and axle of that part of the train still on section 2, thereby charging magnet M′, which attracts its armature a', causing catch c^3 on lever c' to engage and detain end h' of armature a^3, and contact is also made between s^7 and p^7 and s^8 and p^8, completing the circuit of battery B^2 through magnet M^2, the described wire-connections, and the wheels and axles of that part of the train on section 3, thereby charging magnet M^2, which attracts its armature a^2, causing the catch c^4 on lever c^2 to engage and detain end h^2 of said armature a^3, as seen in Fig. 10. As soon as the telegraph-car has passed off from section 2, the current through M M^3 ceases and armature a^4 is returned to its normal position by the stress of the spring S; but armature a^3 is still retained by the catches c^3 c^4, as seen in Figs. 7 and 11. This condition of affairs continues until the last wheels of the train leave section 2 of the rails. Then the circuit of battery B′, which was completed by means of the wheels and axle of a car on section 2, is interrupted, the current through M′ ceases, a' is drawn to its normal position by spring S^2, carrying with it catch-lever c', and thereby releasing end h' of armature a^3 from catch c^3, which end of a^3 is at once forced up by the stress of spring S′, as shown in Fig. 2. End h^2, however, is still held down by catch c^4, and so continues as long as any pair of wheels remain on section 3. The end h' of armature a^3 moving up breaks contact at s^5 p^5, and s^6 p^6 makes contact at s' p', and then breaks it at s^2 p^2, as shown in Figs. 8, 12, and 2. It will be observed that there is a period during which p'

is in contact with s' before p^2 has left s^2, (see Fig. 12,) the contact pieces and points being adjusted to allow this condition of affairs, and therefore connection from cy to dx is established a moment before that from cx to dx is broken. At the time end h' of armature a^3 was moving up the current through magnet M^2 of block D ceased, because the last axle and pair of wheels through which the circuit was completed left section 2 of the rails, and spring S^3 of block D, drawing back armature a^2 and lever c^2 of that block, disengaged catch c^4 from the end h^2 of the armature a^3 therein, and its spring S′ forced up its end h^2 to its normal position, the contact pieces and points thereon being so arranged that point p^3 makes contact with contact-piece s^3 an instant before point p^4 leaves contact-piece s^4, and therefore connection from ay to by is re-established an instant before that from ay to bx is broken, thus preventing any break in the continuity of the flow of the current through the instrument on the car during the working of the various switch-blocks.

The action of the switch-blocks, as is obvious, will be similar when actuated by a train moving from right to left instead of from left to right, the movement of the ends of lever-armature a^3 being simply reversed—that is, h^2 would be first forced up and h' second, instead of vice versa, the connections, whichever way the train is moving, being broken between the adjacent ends of the main conductor and established between the adjacent ends of the auxiliary conductor while parts of the train are on each side of the point of division, and established between the end of the main conductor of the section last passed over and that of the auxiliary conductor upon which the train is running and broken between the adjacent ends of the auxiliary conductor the moment the train is entirely upon that section, and at the same time the connections at the block preceding the one last passed over being restored to their normal conditions, thus insuring the continuous passage of the current from the battery through the main conductor to the last switch-block behind the nearest train, through said switch-block to the auxiliary conductor of the section upon which the train is running, thence to the main conductor through the telegraph-car and its connections, and along said main conductor to its end, either directly or through other switch-blocks and trains, if any others are upon the road, as described, and thence to ground and battery, and rendering it possible for an operator on the telegraph-car to at any time communicate with any other operator, either at a station or upon another train upon the road.

We have described the line-conductors and the contact-conductors as being placed on opposite sides of the track and car; but it is obvious that both line-conductors might be placed on one side between or above the rails of the track, and both contact-conductors on one side above or beneath the car, care being taken to insulate one contact-conductor and one line-conductor from the other contact and line conductors, and to so arrange them that one of the contact-conductors shall slide upon or in contact with the plates on the main-line conductor, and the other upon or in contact with those upon the auxiliary conductor.

What we claim as our invention, and desire to secure by Letters Patent, is—

1. The combination, with two sections of the main and auxiliary conductors and two sections of the rails, of the described switch-block, which consists of two electro-magnets, their described connections, two armatures and their attachments, and two independent contact-pieces and their connections, one of said magnets being connected to one section of one of said rails, the other to the adjacent section of said rail, both connected together, and each provided with an armature, to one of which armatures are secured contact-pieces s' s^3, connected with the said respective sections of the main conductor, and upon the other of which armatures are contact-points p' p^3, adapted to make contact with said last-named contact-pieces, and other contact-points, p^2 p^4, adapted to make contact with the said independent contact-pieces s^2 s^4, which are respectively connected with the said two sections of the auxiliary conductor, and a car on the track carrying a battery, the poles of which are respectively in electrical connection with different points of the track upon which the car is running, all arranged and combined, as described, whereby, when one of the poles of said battery is in electrical connection with one section of the track and the other with an adjacent section of the same, the said magnets will be charged and will attract their respective armatures, thereby breaking the existing connection between the adjacent ends of the said two sections of the main conductor and closing the connection between the adjacent ends of said sections of the auxiliary conductor, all as and for the purpose specified.

2. The combination of a main-line conductor, connected with a battery and properly grounded, and an auxiliary conductor, both running parallel with a railway-track, all divided into suitable corresponding insulated sections, and provided at each point of division with the described switch-block and wire-connections for breaking and closing the circuit at such points, and a railway-car on the track provided with suitable means for establishing and maintaining constant electrical connection between said line-conductors through the car, and the described means for automatically operating said switch-blocks by the movement of the car to break the connection between the adjacent sections of the main conductor and close that between the adjacent sections of the auxiliary conductor while the train is passing said switch-block, and to make connection between the end of the section of the main conductor last passed over and the adjacent end of the succeeding section of the auxiliary con-

ductor, and break the connection between the adjacent sections of the auxiliary conductor as soon as the entire train is upon the succeeding section of the system, all as and for the purpose specified.

3. The combination of a main line conductor connected with a battery and properly grounded and an auxiliary conductor, both running parallel with a railway-track, all divided into suitable corresponding insulated sections, and provided at each point of division with the described switch-block, and wire-connections for breaking and closing the circuit at such points, and a railway-car on the track provided with suitable means for establishing and maintaining constant electrical connection between said line-conductors through the car, and the described means for automatically operating said switch-blocks by the movement of the car to break the connection between the adjacent sections of the main conductor and close that between the adjacent sections of the auxiliary conductor while the train is passing a switch-block, and as soon as the entire train is upon the succeeding section of the system to make connection between the end of the section of the main conductor last passed over and the adjacent end of the succeeding section of the auxiliary conductor and between the adjacent ends of the main conductor at the point of division next preceding that last passed over, and immediately thereafter to break the existing connection between the adjacent ends of the auxiliary conductor at the switch-block last passed over and that between the main and auxiliary conductors at the preceding switch-block, all as described and for the purpose specified.

4. The combination, with two adjacent insulated sections of the rails of a railway, of an electro-magnet, the respective ends of the coil of which are connected to the two sections of said rail, respectively, and having an armature provided at one end with contact-pieces, two posts so placed that said contact-pieces will make contact therewith when the armature is drawn to its magnet, one of said posts being connected to a second electro-magnet and to one section of the rail, a second electro-magnet provided with an armature attached to a lever pivoted to vibrate in the plane of movement of the armature of the first magnet, and having a catch adapted to engage the end of said armature, a battery one of the poles of which is connected to the said second electro-magnet and the other to the other rail of the section with which the contact-post aforesaid is connected, and the wheels and axle of a car having thereon a battery whose poles are electrically connected to the track, as described, all arranged and combined as described, so that when said car rests upon two adjacent sections of said rails the circuit of the battery on the car is closed through the first magnet, which is thereby charged and attracts its armature, causing it to make contact between the contact-pieces and posts, as described, thus completing the circuit of the local battery through the second magnet, which is thereupon charged and attracts its armature, carrying the lever provided with the catch, and causes said catch to engage and hold the end of the armature of the first magnet, as and for the purpose specified.

5. The combination, with the two rails of a section of a railway, of an electro-magnet, a local battery, two contact-posts, with electrical connection between one pole of the battery and the magnet and the other pole and one of the said rails, and between one of the contact-posts and said magnet and the other contact-post and the remaining rail of the same section of the railway, a lever provided with contact-pieces in contact with said posts and each other, said magnet being provided with an armature attached to a lever pivoted to vibrate in a plane of movement of the first lever, and having a catch adapted to engage and hold the end of said first lever, and the wheels and axles of a car on said section of the rails, whereby the circuit through said magnet is completed, and the magnet is charged and holds its armature, keeping the catch on one lever in engagement with the other lever so long as any part of the car remains on the sections of the rails with which the connections are made, all as and for the purpose specified.

6. In a railway-telegraph, the combination of one section of the main conductor and the succeeding section of the auxiliary conductor, a vibrating armature having thereon contact-points arranged to make contact, respectively, with contact-pieces, one in connection with said section of the main conductor and the other with the said section of the auxiliary conductor, said contact-pieces, contact-posts with electrical connection between one of them and an electro-magnet and the other, and the rail in the section corresponding to that of the auxiliary conductor, contact-pieces upon the said vibrating armature electrically connected and arranged to make contact with said posts, and a spring arranged to put and hold one contact-point on said armature against the contact-piece in connection with the main conductor, an electro-magnet provided with an armature, attached to which is a lever pivoted to vibrate in the plane of movement of the first vibrating armature, and having a catch adapted to engage and hold the end of said first armature, a battery connected to said magnet and the other rail of the section, and the wheels and axle of a car thereon, whereby the circuit through said magnet is completed, and the magnet is charged and holds its armature, keeping the catch on its lever in engagement with the end of the first armature-lever, and thereby maintains the circuit from one section of the main conductor to the succeeding section of the auxiliary conductor so long as any part of a car remains on the sec-

tion of the rails with which the connections are made, all as described, and for the purpose specified.

7. The combination, with the described catch-levers, of a vibrating armature, provided with contact-pieces, and attached to a spring pivoted and arranged relatively to said catch-levers as described, whereby, when either end of said armature is held by engagement with the catch-lever adjacent thereto such end of the armature is held in electrical connection with the described auxiliary conductor, and the contact-piece on said end of the armature is held in contact with contact-posts in its vicinity, the other end of said armature being held meanwhile in electrical connection with the adjacent section of the main-line conductor, all as and for the purpose described.

8. The combination, with two sections of the conductors X and Y, of the described switch-block, comprising the armatures a^3 a^4, having contact-points p' p^2 p^3 p^4, and contact-pieces s' s^2 s^3 s^4, and wire-connections between s^2 and conductor X at ax s^4, and conductor X at bx s', and conductor Y at ay and s^3, and conductor Y at by, as and for the purpose specified.

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Witnesses:
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