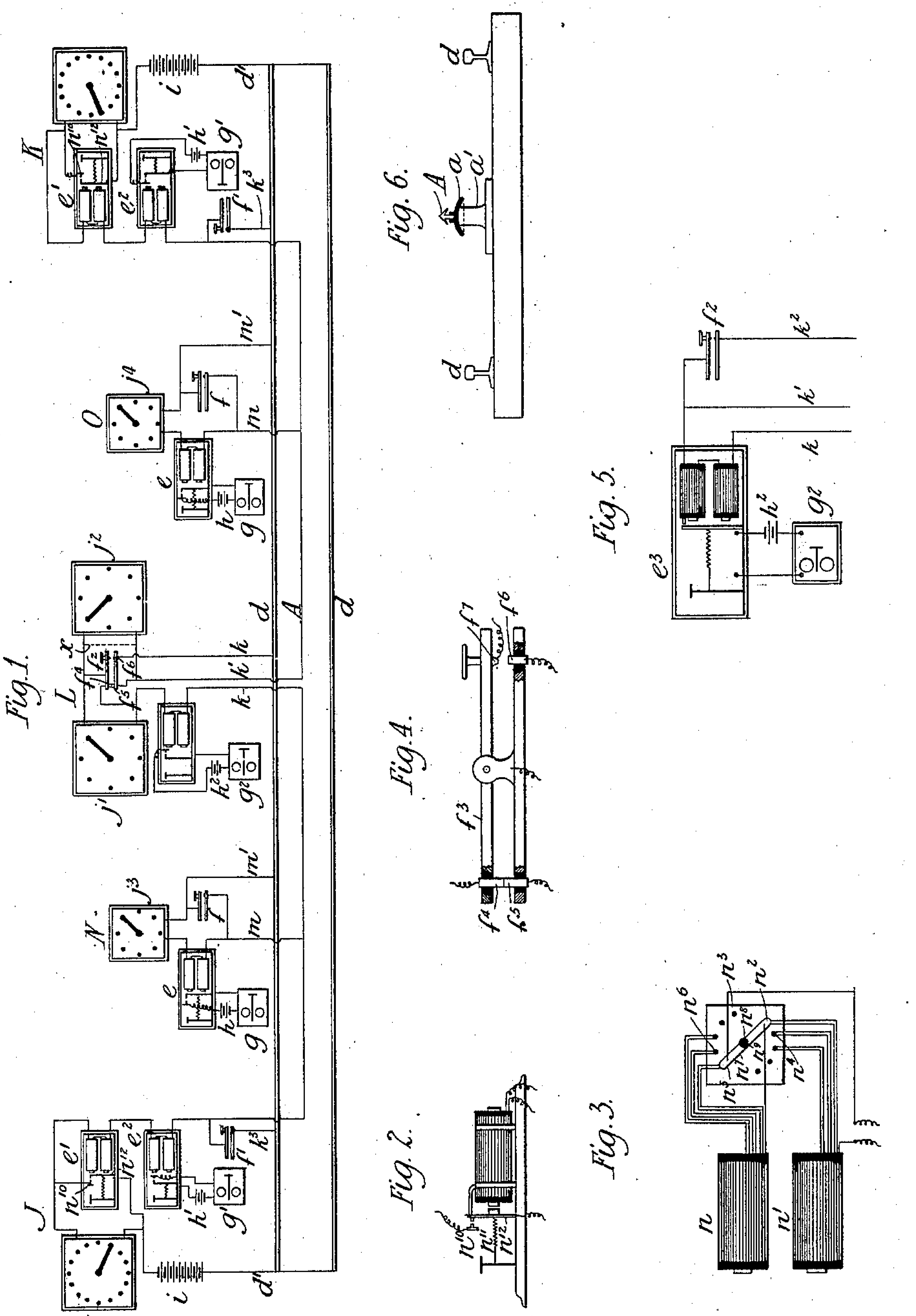
No. 613,080. **Patented Oct. 25, 1898.**

C. D. & W. A. ROYSE.

TELEGRAPHY.

(Application filed Aug. 11, 1897.)

(No Model.) 2 Sheets—Sheet 1.



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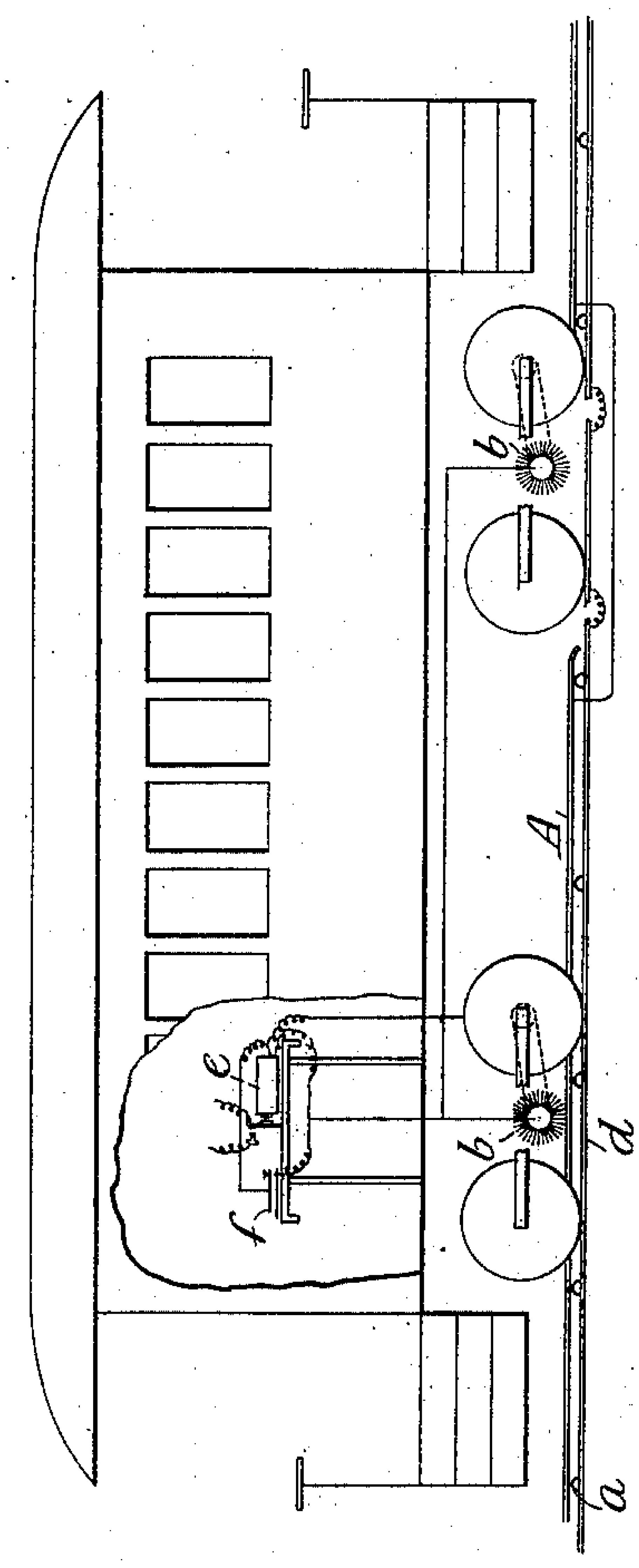

Fig. 7.

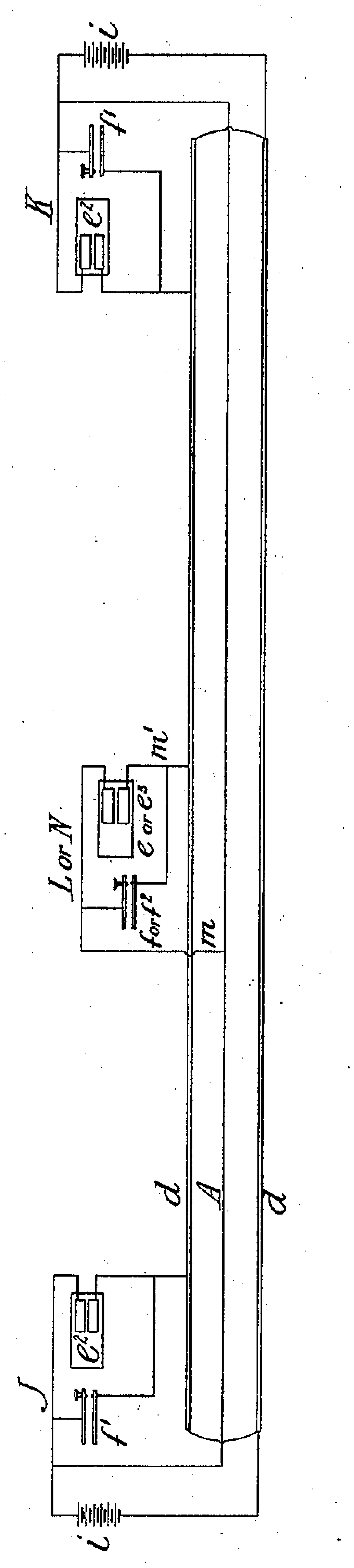

Fig. 8.

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TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 613,080, dated October 25, 1898.

Application filed August 11, 1897. Serial No. 647,883. (No model.)

To all whom it may concern:

Be it known that we, CLARENCE D. ROYSE, of Greencastle, in the county of Putnam, and WALTER A. ROYSE, of Indianapolis, in the county of Marion, State of Indiana, citizens of the United States, have invented certain new and useful Improvements in Telegraphy; and we do 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 the letters of reference marked thereon, which form a part of this specification.

Our invention relates to telegraphy, and is directed more particularly to improvements in telegraphic systems which are applicable for employment in establishing communication between fixed station-offices and railroad-trains and between the trains themselves if more than one train is at a time being operated on the line.

Our invention in its nature is, however, susceptible of utilization wherever it is desired to establish intercommunication between points, and while in the following description and the accompanying drawings we have set forth and shown our invention as embodied in what might be termed a "railway telegraphic system" yet we do not wish it understood that we confine ourselves to such specific application, but that such embodiment constitutes but one of a number of uses to which our invention may be advantageously applied. By its use every station telegraph-office and every train on the road is in constant telegraphic communication with every other telegraph-office and train without the use of any switches or loops or any other means whatever that requires the assistance of some one not on the train for establishing such communication with the train. Trains on sidings can likewise be in communication, and the system may be extended so as to place all of the trains on any number of tracks, whether parallel or otherwise, in communication with each other and with the stations, all of which is hereinafter fully set forth.

In the accompanying drawings, Figure 1 is a diagrammatic view illustrating an application of our invention to what we term a "railway-telegraph." Fig. 2 is a view in elevation of what we term a "train-relay." Fig. 3 is a plan view of a train-relay, showing the means for effecting a variable resistance. Fig. 4 is a detail view of the key employed at way-stations. Fig. 5 is a diagrammatic view of the connections at way-stations where no extra resistance is employed. Fig. 6 is a sectional view of a railway-track, showing the preferred construction and location of the main-line rail or wire. Fig. 7 is an elevation, partly in section, of a railway-car fitted to be employed in our improved telegraphic system and of the track and electrical conductor at a railway-crossing, the view showing the method of establishing connection between the main-line rail or wire and the running-rails or ground and the method of crossing railway-tracks and highways without obstructing them or interfering with the perfect working of our system. Fig. 8 is a diagrammatic view of the system embodying some modifications.

Referring to said drawings by letter, in Fig. 1, J and K are terminal-station offices, L is a way-station office, and N and O are train-offices. *i* and *i* are main-line batteries of approximately equal strength and opposed to each other. h, h', and h^2 are local batteries for energizing the sounders in their respective offices. g, g', and g^2 are the sounders. f and f' are ordinary telegraphic keys having one main-line and one ground connection. f^2 is a special telegraphic key, as shown in Fig. 4, to be used at way-stations. e^2 and e^3 are ordinary telegraphic relays connected in series in the main line. e is a special telegraphic relay connected with one wire to the main line and one to the ground and is shown in Figs. 2 and 3. e' is a telegraphic relay similar to relay e with respect to the peculiarity shown in Fig. 2 and is connected in series at terminal stations to control the opening and closing of a shunt around resistance-box j. x is a wire the use of which will be hereinafter explained. j, j', j^2, and j^3 are resistance-boxes. A is the main line of the system, which may be a rail or wire of any suitable shape and size in cross-section and may be located conveniently to be engaged by one or more metallic brushes or other suitable collectors carried by a car. d and d represent the track-rails through which the ground connection is formed. d' represents the connection between the battery i and the ground d. k and k' are connections between way-station offices and the main lime. k^2 is the connection between way-station-office keys and the ground. k^3 is the connection between terminal-station keys and the ground. m is the main-line connection, and m' the ground connection, with train-offices. Other lines in the drawings not otherwise explained represent electrical connections.

In Fig. 2, n^{11} is the retractile spring of the relay. n^{10} is a metallic point having electrical connection with one side of the sounder-circuit, and n^{12} is the armature-lever of the relay, having a metallic connection with the other side of the sounder-circuit and having also a metallic point adapted to come in contact with point n^{10} when the armature of the relay is released, thus energizing the sounder, and adapted also to break this contact when the relay is energized and the armature drawn toward the magnet, thus deënergizing the sounder. This peculiarity belongs both to the resistance-relays e' and the train-relays e.

Fig. 3 shows the preferred form of varying the resistance in train-offices. In order to accomplish this, we use a switchboard on the train-relays, by the use of which the current may be thrown into or out of any desired number of coils of the electromagnets of the relay. In the figure, n and n' are the relay-electromagnets. n^3 is a switchboard having a lever n^7 centrally pivoted at n^9 and having its two ends insulated from each other by n^8. n^2 and n^4 are contact-points in the path of one end of the lever n^7, and n^5 and n^6 are contact-points in the path of the other end of the lever. For the purpose of varying the resistance of the electromagnets n and n' the coils are wound in layers and arranged so that as many layers of the coils as desired may be switched into the circuit. A wire from one binding-post of the relay enters the coil of n', and after as many windings as may be desired the wire is brought out and connected with contact-point n^2 on switchboard n^3. The wire then leads from contact-point n^2 into the electromagnet n', and another layer of coils is wound and the wire brought out and connected with contact-point n^4. It again returns in the manner as described before, connecting with still another layer of coils and back again to the switchboard, and so on until the desired number of layers are wound. From the end of lever n^7 that is in contact with point n^2 a wire leads into the electromagnet n and connects with a layer of coils and returns to contact-point n^5. Layers of the coil are connected to contact-points n^6, &c., in the same manner as described for the connection of the various layers of the electromagnet n'. m and m' are connecting-wires, as heretofore explained. The switch-lever n^7 has its ends in the path of the various contact-points of the switchboard, and by being moved it can be made to connect into the circuit as many of the layers of the coils as desired, having at all times the same number of layers of the coil of each magnet in the circuit.

Fig. 4 represents in detail the special key f^2 that is used at way-station offices. f^3 is the key bar or lever. f^5 is a contact-point in the back end of the base of the key insulated from said base. f^4 is a contact-point in the end of the bar of the key opposite the point f^5, insulated from said bar and adapted to form electrical connection with point f^5 when the lever of the key stands in its normal position with the button end raised, as shown in the figure, and adapted also to break the connection with contact-point f^5 when the button end of the lever f^3 is depressed.

Fig. 5 corresponds in lettering to the way-station L, (shown in Fig. 1,) except as to the key f, the difference being that no resistance-boxes are used, and consequently only the ordinary type of key instead of the special one shown in Fig. 4 for throwing resistance into the line.

In Fig. 6, d and d are track-rails. A is the main line, as shown in Fig. 1. a and a' show the preferred form of insulation. a' is the main stem of the insulator, and a is a circular bell-shaped hollow hood to prevent a sleet or ice connection between the main line and the ground. These insulators may be placed at any desired intervals, or the entire main line may be placed on wooden stringers, being properly insulated from said stringers.

Fig. 7 shows a car equipped with our system and represented as crossing another railroad-track. The lettering of the instruments, wiring, track, and main line is the same as shown in Fig. 1 for the same purposes. b and b are metallic wheel-brushes attached to the trucks of the car and geared to the car-axle, so as to move at the same circumferential speed as the car-wheel. To each of these brushes is connected a wire leading to the train-relay and to the train-key, as shown by m in Fig. 1. The connection m' with the ground d is through the car-wheels. The brushes b and b are so placed as to be in constant contact with the main-line conductor A, except as shown in the figure for spanning crossings, where the conductor A is carried under the crossing by means of a wire, shown as A'. The breaks in the running-rails at railroad-crossings are connected by wires, as shown by d^2. The connection between the brushes b b and the main line is thus broken while the car is crossing a highway or another railroad; but both connections are never broken at the same time.

Fig. 8 shows all offices, whether train or station, connected in the manner as shown in

Fig. 1 for train-offices. J and K represent terminal stations. L or N represents any way-station or train office. Lettering in this figure similar to that in Fig. 1 indicates instruments in similar position, but not necessarily of the same form. All keys are of the simple type, and all relays are of the kind shown in Figs. 2 and 3 for train-offices.

In the foregoing description it will be observed that two methods of connecting the telegraphic relays are shown. In Fig. 1 the relays at J, L, and K are connected in series in the main line. Those at N and O and all of the offices in Fig. 8, whether train or station, have each one connection with the main line and one connection with the ground. These may be said to be connected in multiple between the main line and the ground. Station-relays may be connected either in series or in multiple, or part of them each way, the proportion of each to be determined by the total main-line resistance and the number of offices, both train and station, probably required on each particular line. Train-relays must be connected in multiple. In our description and explanations the relays connected in series are called "station-relays," and the relays connected in multiple are called "train-relays," though it is understood that all the connections and conditions of train-relays may be used for part or all of the stations.

Further explanation of the instruments shown in Figs. 1, 5, and 8 is necessary for the perfect understanding of the working of the system. The batteries i and i at J and K are each of sufficient strength to operate the whole line, but have like metals to the ground and other like metals to the main line, thus neutralizing each other, and where there is no intermediate ground connection depriving the main line of current; but it is evident that when any portion of the main line is grounded by connection with the railway-rails a current is established in the entire main line through a flow from each battery to the point of grounding. In the explanation of instruments reference will be made to offices J, N, and L, and it will be understood that all that is said concerning J and N will apply also to K and O, respectively. At station J the resistance-box j is connected directly in the main circuit, but a shunt around the resistance-box passes through the contact-points n^{10} and n^{12} of resistance-relay e'. Reference to Fig. 2 will show that this shunt will be complete, and consequently the resistance shunted out, when the relay e' is deënergized and the armature drawn back by the retractile spring. This retractile spring is so adjusted that the contact between n^{10} and n^{12} stands normally closed and remains so until the current in the main line becomes strong enough to prevent the ready action of the relay e^2. When such strength of current is attained, the contact between n^{10} and n^{12} is broken by the resistance-relay e' attracting its armature, and the main-line current is caused to pass through the resistance-box j. This resistance may be changed from time to time, according to necessity, by the operator; but the limits within which a stated resistance will give satisfactory results are very great and little change will be required. Relay e^2 is also connected in series in the main circuit. It is desirable to have this relay of as low resistance as will give satisfactory results. The retractile spring of relay e^2 is so adjusted that the relay stands normally inactive and remains so until the wire is grounded through a key or some other means of effecting a ground connection without resistance interposed. The ground connection at N through wire m, relay e, resistance-box j^3, and wire m' establishes a current in the main line; but on account of the resistance offered by the relay and resistance-box the current is insufficient to overcome the retractile spring of relay e^2. It has been previously stated that the grounding of the main line at any point establishes a current in the main line. Consequently the method used for transmission of a message is that of alternately grounding and disconnecting the ground. The key f' has one wire k^3 connecting with the ground and one with the main line. It normally stands open and is adapted when closed to ground the main line through its contact-points. This explanation will also apply to key f at office N and to the front contact-points f^6 and f^7 of key f^2 at station L.

At office N relay e is of the type shown in Figs. 2 and 3. j^3 is any kind of adjustable resistance-box and is shown in the drawings merely to show how it should be connected in case a relay not embodying the features shown in Fig. 3 should be used at e. The relay e has its retractile spring so adjusted that its armature is attracted by the low amperage that is established in the main line by the ground connection through the relay e or through the relay and the resistance-box j^3; but as relay e^2 is intended to not respond to this low amperage and yet to be energized by the higher amperage established by a ground connection through a key it is necessary that the difference between these two current strengths should be sufficient to admit of the ready adjustment of relay e^2 for this purpose. Consequently it is necessary that barely enough current should be normally established through all the relays connected as relay e to satisfactorily energize the relays with such connections. To regulate this normal current strength, sufficient resistance is interposed either in the relays e, as shown in Fig. 3, or by an additional resistance-box j^3 as to make the joint resistance of all such ground connections great enough to keep the amperage at the low point indicated. It is obvious that as the number of offices connected in this manner varies the interposed resistance must be varied to get the best results. This may be done by the use of the box-resistance j^3; but it is better to use a relay of variable resistance, as shown in Fig. 3. It is also advisable to have a relay of greater sensitiveness than is used in station-offices. It is also advisable to have a relay for this use in which the magnetic power of the coils will remain approximately the same when the resistance is changed as suggested above. This will be accomplished if instead of using a resistance-box to vary the resistance we use a switchboard n^3, Fig. 3, by which a greater or less number of the coils of the electromagnets can be thrown into the circuit, thereby varying the resistance and the sensitiveness of the magnets in approximately the same ratio. The relay e, as already explained, stands normally energized; but a reference to Fig. 2 will show that the contact-points controlling the sounder are normally out of contact. By the closing of any key, however, a direct ground connection is offered, and as currents will divide through several avenues of outlet in inverse ratio to the resistance offered practically all of the current is grounded through the key which is closed, thus withdrawing it from relay e, causing it to be deënergized and release its armature, which brings together the contact-points that control the sounder-circuit and energizes the sounder. At station L relay e^3 and sounder g^2 act in the same manner as relay e^2 and sounder g' at station J. Resistance-box j' is permanently set to throw into the circuit an amount of resistance equal to the total resistance of that part of the main line including station-relays east of key f^2, and resistance j^2 is permanently set to throw into the circuit an amount of resistance equal to the total resistance of that part of the main line including station-relays west of key f^2. The amount of resistance in each of these boxes is determined, therefore, by the location of the station in the main line. The total resistance of the two boxes will in every case be just equal to the total resistance of the whole main line, and will be so proportioned that when the main line is grounded by the key f^2 an amount of resistance is thrown into each end just equal to the amount cut off from that end by the grounding. The key f^2 is more fully shown in Fig. 4. The contact-points f^6 and f^7 have already been explained. Contact-points f^4 and f^5 are connected with wires that shunt out resistances j' and j^2 when these points are in contact as they normally stand, but upon depressing the button end of the key the contact at f^4 and f^5 is broken and the current west of the grounding passes through resistance j' and the current east of the grounding passes through resistance j^2. At some stations it may be desired to use only one resistance-box, and that on the side of the stronger current. In such cases, supposing station L to be nearer to station J than to station K, the resistance j^2 would be removed and its connecting-wires connected as shown by the dotted line x; but on lines where the main-line resistance is low, either by reason of the line being short or the conductor of low resistance or having few relays connected in series in the circuit, it will be possible to obtain satisfactory results without the use of any resistance-boxes at way-station offices. In such cases an ordinary key f will be used instead of the special key shown in Fig. 4, and the wires will be connected as shown in Fig. 5, k and k' leading to the main line and k^2 to the ground.

The modification shown in Fig. 8 is simply the connection of all offices, both train and station, in the same manner as is shown in Fig. 1 for the connections of train-offices. In such cases no resistance whatever is used, except j^3, as shown in train-offices N and O in Fig. 1, which may be used either with a relay of a certain set resistance or with the special variable-resistance relay shown in Fig. 3, or may be dispensed with entirely by the use of the latter relay. In any event the relay contact-points will be reversed, as shown in Fig. 2. In still other cases a part of the station-offices may be connected as shown in Fig. 8 and all of the other station-offices connected as shown in Fig. 5, resistances j, j', and j^2 all being dispensed with.

Below is a description of the operation of the system. The main line stands normally as follows: Referring to Fig. 1, we trace the circuit from the ground d at station J through battery i, through the contact-points of relay e', shunting out resistance j, through the coils of relay e', through the coils of relay e^2 by way of the main line to station L, over line k, through the coils of relay e^3, through the back contact-points of key f^2, (see Fig. 4, f^4 and f^5,) shunting out resistances j' and j^2; to the main line over k', and, leaving offices N and O for later explanation, through station K in a manner similar to station J, thence to the ground d. The batteries i and i at J and K are each of sufficient strength to operate the whole line, but being opposed to each other by having like metals to the ground and other like metals to the main line the relays at J, L, and K are all normally inactive when there is no ground connection other than at the terminals, though the circuit is complete. The connections as shown at N and O are required for train-offices and may be used, as already stated, for stations. The relays e at offices N and O are of sufficient resistance or additional resistance is to be added in the circuit with each of them, so that the joint resistance of all of the ground connections through the relays at such offices as N and O shall be great enough that the amperage established in the line by such groundings is quite low as compared with the amperage established by grounding the main line without any interposed resistance. The train-relays are wound to be more sensitive to a small current than those at stations, and the retractile springs are so adjusted that the small amount of current which normally passes through these train-relays excites them, and their armatures are attracted by the magnets. The station-relays are not so sensitive, and the retractile springs are so adjusted that the low amperage of current normally in the line by the grounding through the train-relays is not sufficient to attract their armatures. All keys stand normally open and, having in every case at the front contact-points one connection with the main line and one with the ground, are adapted to ground the line whenever closed. Hence all of the station-relays stand normally inactive and all of the train-relays stand normally excited. All of the sounders, both train and station, stand normally inactive. Resistances j, j', and j^2 are normally shunted out. Now suppose the operator at J wishes to send a message. He closes the key f', thus grounding the wire without any resistance being interposed in the ground connection. The effect of this on the station-relays is to charge them with a current of a higher amperage than is normally in the line, so that their armatures are attracted and the sounders are closed in such offices. By this grounding all the power of battery i at station J is thrown into use within the office J, giving a current of very high amperage, which would not ordinarily permit the armature of relay e^2 to be withdrawn by its retractile spring immediately on the subsequent opening of the key f'; but this strong current sufficiently energizes the coils of resistance-relay e' as to overcome the high tension of its retractile spring. The armature n^{12} is drawn forward and its contact with n^{10} is broken, thus throwing the main-line circuit through the resistance-box j. This instantly reduces the amperage sufficiently that the armature of relay e^2 is readily released on removing the ground connection. At the same time the retractile spring of resistance-relay e' is again stronger than the magnet, and the armature is drawn back without having been drawn forward the whole limit of its path. The effect on the resistance-relay is not a series of clicks corresponding to the clicks of relay e^2, but simply a buzz. The effect upon train-relays of the closing of key f' is that the small amount of current that normally passes through them now finds a more direct avenue to the ground through the contact-points of the key f', and the current dividing through all of the ground connections in inverse ratio to the resistance offered by the various avenues practically all of the current is now diverted from the train-relays. This releases their armatures, and these being drawn back by the retractile springs the train-sounders are energized. Hence by the closing of key f' all the station-relays are energized and the sounders connected therewith also energized. At the same time all of the train-relays are deënergized, but the sounders connected therewith energized. The resistance-box j is also thrown into the circuit by the resistance-relay e' when needed. The opening of the key f' restores all the relays and sounders to their normal positions and shunts out resistance j. Now suppose the operator on train N wishes to send a message. He depresses the key f, thus making a direct ground connection with the main line through the car-wheels, line m', the contact-points of the key f, line m, and brush b. This simply shunts out relay e at N, and this relay is therefore deënergized, but the sounder at N is energized. Relay e at O is also deënergized, because the current, finding a more direct ground connection through the key than through the relay e and resistance j^3, is practically all diverted from said relay, but the sounder connected therewith is energized. By the direct grounding through the key f a current is established in the main line of sufficient amperage to energize all station-relays, and hence all station-sounders are energized also. This train being near to station J the current established west of the point of grounding at key f would probably be sufficient to act upon the resistance-relay e' in the manner already described by the closing of key f'. Hence by the closing of key f all station-relays are energized and their sounders also energized. At the same time all train-relays are deënergized and their sounders energized. Resistance-box j at station J is thrown into the circuit by resistance-relay e' when needed. On the opening of the key f all relays and sounders resume their normal positions and the resistance j stands shunted out of the circuit. Suppose the operator at L wishes to send a message. He closes the key f^2. This grounds the wire through contact-points f^6 and f^7 without any resistance being interposed in the ground connection. This would energize all station-relays and deenergize all train-relays, causing all sounders to be energized in the manner described in the closing of key f'; but here the resistance needed to regulate the current is thrown in in a different manner than when operators at J and N close their keys. The depression of key f^2 at L breaks the contact between points f^4 and f^5, which opens the shunt around resistances j' and j^2, thus throwing into the line on each side of the point of grounding an amount of resistance equal to the amount cut off from that end by the grounding. This equalizes the strength of the current without the use of the relay e'. On the opening of the key f^2 the ground connection is thereby broken, all relays and sounders resume their normal positions, and resistances j' and j^2 are again shunted out by the closing of contact-points f^4 and f^5.

In way-station offices connected, as already explained, for the use of one resistance-box the effect of closing the key f^2 is the same as in offices just explained, except that the current east of the ground connection passes through wire x instead of resistance j^2.

In offices connected as shown in Fig. 5 the closing of the key f is similar in effect to the closing of key f^2 at station L, except as to throwing in the resistances f' and f^2. Where this connection is used, resistance j will be thrown into the line by resistance-relay e', if the office so connected be near enough to either terminal that by closing the key a sufficient amperage is established in the line to affect the resistance-relay e'. Otherwise no resistance would be thrown into the line by the closing of the key in such offices.

The modification shown in Fig. 8 amounts to having a main line, batteries at each end opposed to each other, ground connections at each end, and having keys and high-resistance relays separately connected in multiple between the main line and the ground at various intervals. The keys all stand normally open and the relays all normally closed by the current that is normally established in them by reason of their ground connections. The closing of any key gives a more direct avenue for the current and practically deprives all relays of current, deënergizing the same and energizing their sounders. The opening of the key restores all the relays and sounders to their normal positions. The operation of all of these offices is similar to the operation of train-offices, as previously described. Under this modification all train-offices and way-station offices are connected in the same manner.

What we claim as our invention is—

1. In a telegraphic system the combination of a main line, batteries or the like at each end thereof provided with connections with the said line and ground to neutralize each other and normally deprive the main line of current when there are no ground connections except those with the batteries or other source of electromotive force, a number of relays connected with said main line and the ground in multiple and adjusted to be normally excited by a current of low amperage and to cause a current of low amperage to flow through said main line on account of such connections and the resistance interposed, a number of normally-inactive relays connected in said main line in series and adjusted to be excited by an increase in the amperage of the current, normally open keys connected in multiple with the main line and ground and adapted, when operated, to ground the main line and increase the amperage of the current therein, thereby increasing the magnetic power of the relays connected in series, and decreasing the amperage of the current in the relays connected in multiple; a resistance at each terminal station connected in series form and normally shunted out of the main circuit, a relay adapted to automatically break the shunt connection and throw into the main line the resistance when needed; a resistance or resistances at way-stations connected in series in the main line, but normally shunted out, and a key adapted to break the shunt and throw such resistance into the main circuit when needed, substantially in the manner and for the purposes set forth.

2. In a telegraphic system the combination of a main line, batteries or the like at each end thereof provided with connections with said line and the ground to neutralize each other and deprive the main line of current when there are no ground connections except those with the batteries or other source of electromotive force, a number of relays connected with said main line and the ground in multiple and adjusted to be normally excited by a current of low amperage and to cause a current of low amperage to flow through said main line on account of such connections and the resistance interposed, a number of normally-inactive relays connected in said main line in series and adjusted to be excited by an increase in the amperage of the current, normally open keys connected in multiple with the main line and ground and adapted, when operated, to ground the main line and increase the amperage of the current therein thereby increasing the magnetic power of the relays connected in series and decreasing the amperage of the current in the relays connected in multiple; a resistance at each terminal station connected in series form and normally shunted out of the main circuit, a relay adapted to automatically break this shunt connection and throw into the main line the resistance when needed, substantially in the manner and for the purposes set forth.

3. In a telegraphic system the combination of a main line, batteries or the like at each end thereof provided with connections with the said line and ground to neutralize each other and deprive the main line of current when there are no ground connections except those with the batteries or other source of electromotive force, a number of relays connected with said main line and the ground in multiple and adjusted to be normally excited by a current of low amperage and to cause a current of low amperage to flow through said main line on account of such connections and the resistance interposed, a number of normally-inactive relays connected in said main line in series and adjusted to be excited by an increase in the amperage of the current, normally open keys connected in multiple with the main line and ground and adapted, when operated, to ground the main line, and increase the amperage of the current therein, thereby increasing the magnetic power of the relays connected in series and decreasing the amperage of the current in the relays connected in multiple, substantially in the manner and for the purposes set forth.

4. In a telegraphic system the combination of a main line, batteries or the like at each end thereof with main-line and ground connections to neutralize each other, a number of relays connected in multiple between the main line and ground and adapted to normally establish a current in said relays on account of such connections, and means for grounding at will the main line between the batteries, thus greatly decreasing the amper-

age of the current in said relays, substantially in the manner and for the purposes set forth.

5. In a telegraphic system resistance-coils connected in the main line in series, a shunt around said resistance-coils adapted to normally shunt out said resistance-coils, and a telegraphic key, adapted, when operated in its usual capacity, to break the shunt around the resistance-coils at each depression of said key and throw the current through said coils and adapted to again complete the shunt when the key is released, substantially in the manner and for the purposes described.

6. In a telegraphic system resistance-coils connected in series in the main circuit with a shunt around said resistance-coils adapted to be normally closed by the contact-points of a relay that is adjusted to automatically break said contact-points and throw the current through said resistance-coils when the amperage of the current rises too high for the proper operation of the telegraphic line, and also adjusted to automatically complete the shunt when the amperage has been reduced, all substantially in the manner and for the purposes set forth.

7. A telegraphic relay having the coils of its electric magnets wound in separate layers with the ends of the wire of each layer brought out to contact-points in a switchboard, a switch-lever the arms of which are insulated from each other and the switchboard and movable with relation to said contact-points, whereby all of the coils may be thrown into the circuit while any number of coils or all but the main coil may be thrown out of the circuit, the two magnets always having an equal number of coils in the circuit, substantially as described.

8. An improvement in a telegraphic relay for the purpose of maintaining its magnetic power approximately constant under various changes in the amperage of the current passing through it, by means of a switchboard n^3, a switch-lever n^7, the arms of which are insulated from each other and from the switchboard, contact-points n^2, n^4, n^5, n^6, &c., arranged in the paths of said arms of the lever, connections between the several layers of the coils of the relay-magnets and the said contact-points severally, a line connection to one of said magnets, a connection between the other magnet and one of the arms of the lever and a ground or line connection with the other arm of the lever, substantially in the manner and for the purposes set forth.

9. In a railway telegraphic system the combination with a main line, batteries or other electromotive force at each end thereof with main-line and ground connections to neutralize each other, a relay connected with said line and the ground, said relay adjusted to be normally active by a current of low amperage, a sounder, and a key having connection with said line and the ground and adapted, when operated, to ground the main line and greatly decrease the current in the aforesaid relay, causing its armature to be released, thereby energizing said sounder, substantially in the manner and for the purposes set forth.

10. In a railway telegraphic system the combination of an insulated rail or other conductor constituting the main line, the railway-rails forming the ground connection, a car provided with a collector in contact with said insulated rail or other conductor, a relay in the relay-circuit on the car connected with said collector and the car-wheels, said relay to be normally excited, a sounder, a battery for the operation of said sounder, and a key connected with said collector and wheels and adapted, when operated, to ground the main line and greatly decrease the current in the aforesaid relay, causing its armature to be released, thereby energizing said sounder, substantially in the manner and for the purposes set forth.

11. A telegraphic key comprising a bar pivotally mounted on a base constituting an electric terminal, a terminal contact-point insulated from the base and arranged in the path of a terminal contact-point at the front end of the bar, a terminal contact-point mounted in but insulated from the other end of the bar and normally in contact with an insulated terminal contact-point in said base, substantially as described.

In testimony whereof we affix our signatures, in the presence of two witnesses, this 2d day of August, 1897.

CLARENCE D. ROYSE.
WALTER A. ROYSE.

Witnesses:
J. F. FESLER,
L. DANIELS.