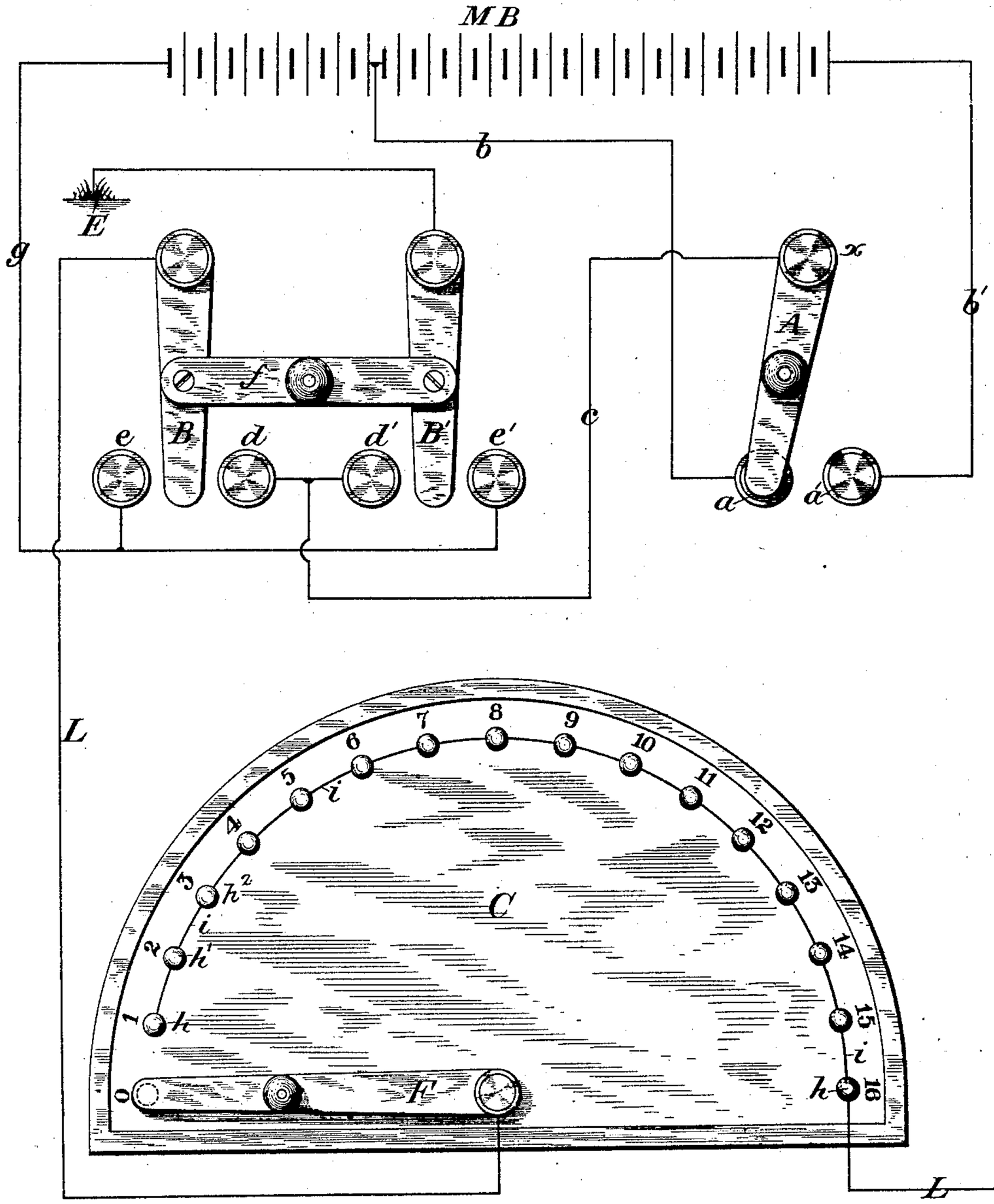
(No Model.) 3 Sheets—Sheet 1.

T. D. WILLIAMS, G. M. EITEMILLER & J. S. LUCOCK.

RAILWAY SIGNAL.

No. 353,393. Patented Nov. 30, 1886.

Fig. 1.



Witnesses.
H. L. Gill.
N. B. Corwin

Inventors.
Thomas D. Williams
George M. Eitemiller
John S. Lucock
by Bakewell & Kerr
their Attorneys

(No Model.) 3 Sheets—Sheet 2.

T. D. WILLIAMS, G. M. EITEMILLER & J. S. LUCOCK.

RAILWAY SIGNAL.

No. 353,393. Patented Nov. 30, 1886.

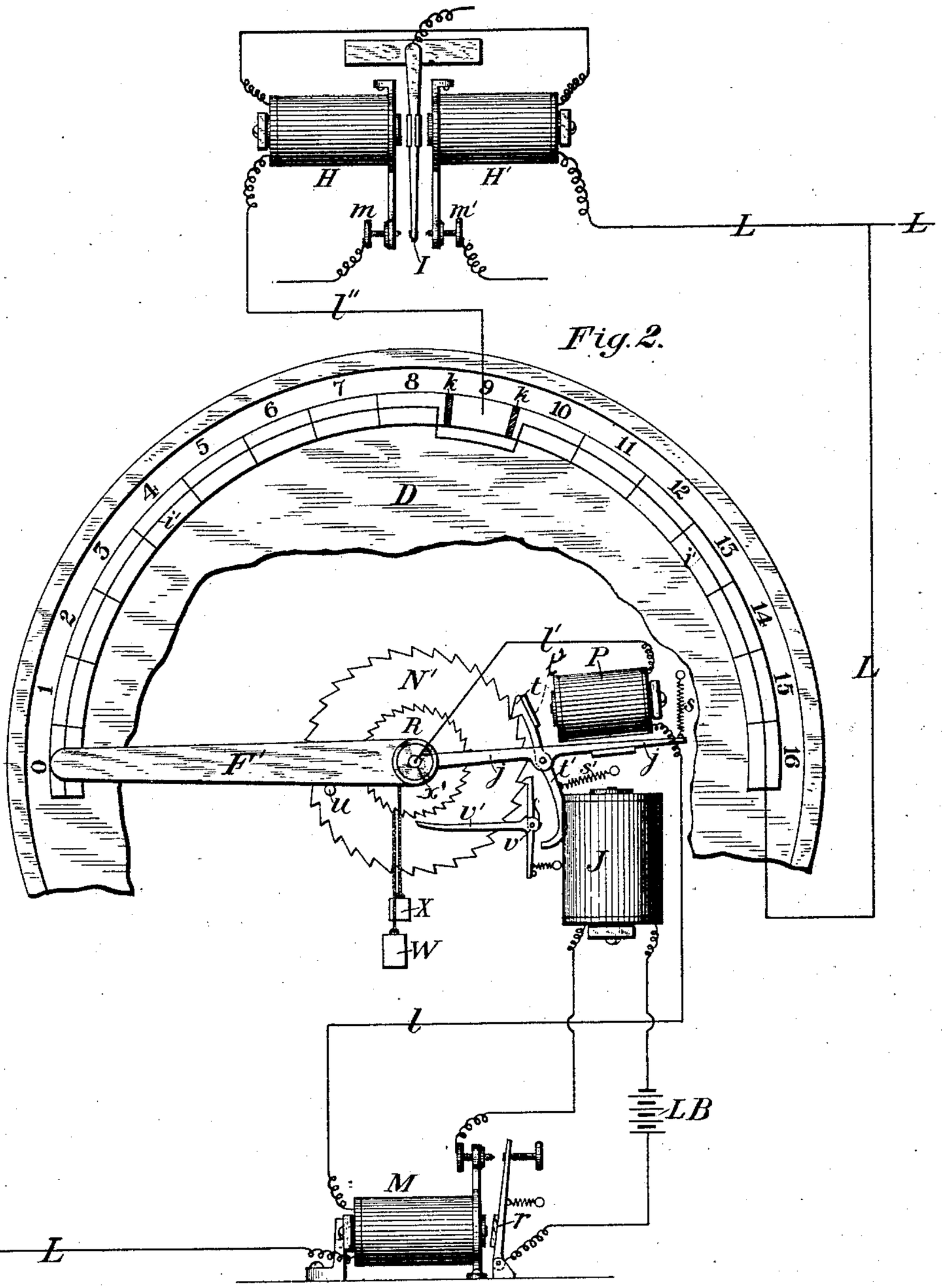


Fig. 2.

Witnesses.

H. L. Gill.

W. B. Corwin

Inventors.

Thomas D. Williams

George M. Eitemiller

John S. Lucock

by Bakewell & Kerr

their Attorneys

(No Model.) 3 Sheets—Sheet 3.

T. D. WILLIAMS, G. M. EITEMILLER & J. S. LUCOCK.

RAILWAY SIGNAL.

No. 353,393. Patented Nov. 30, 1886.

Fig. 4.

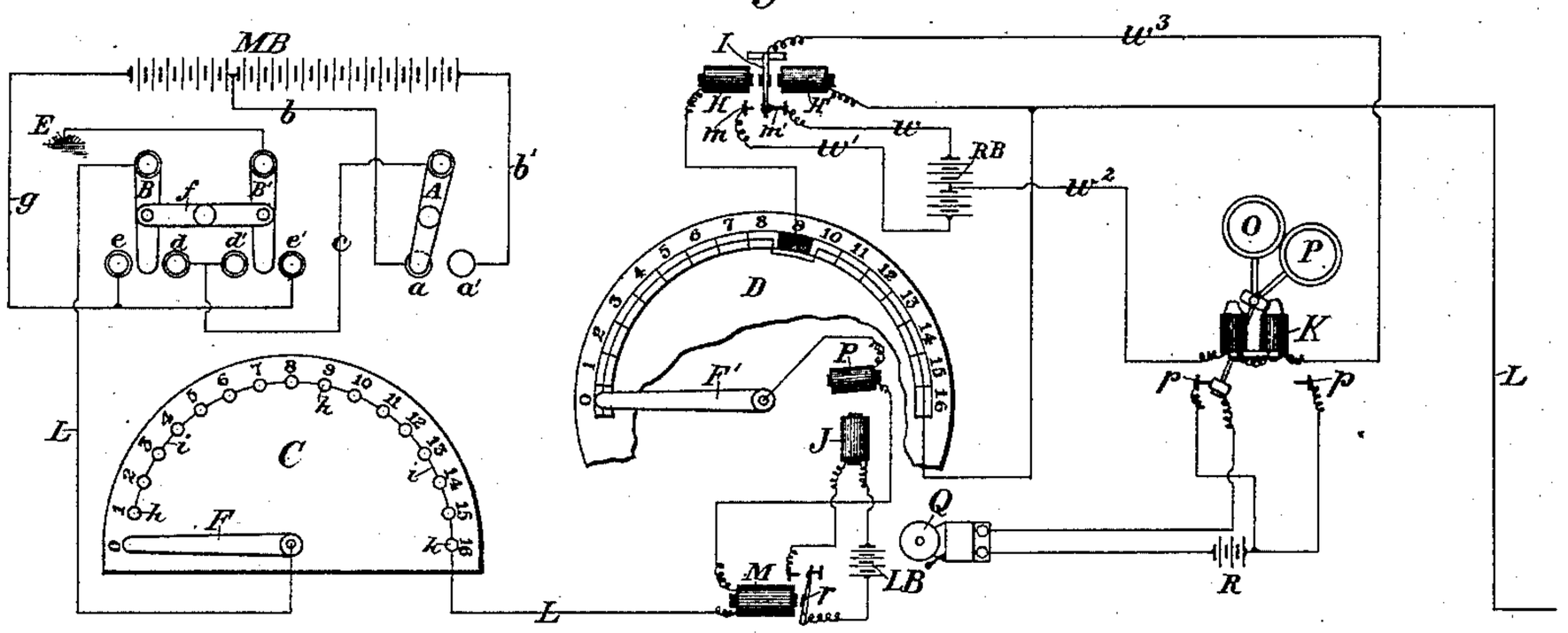
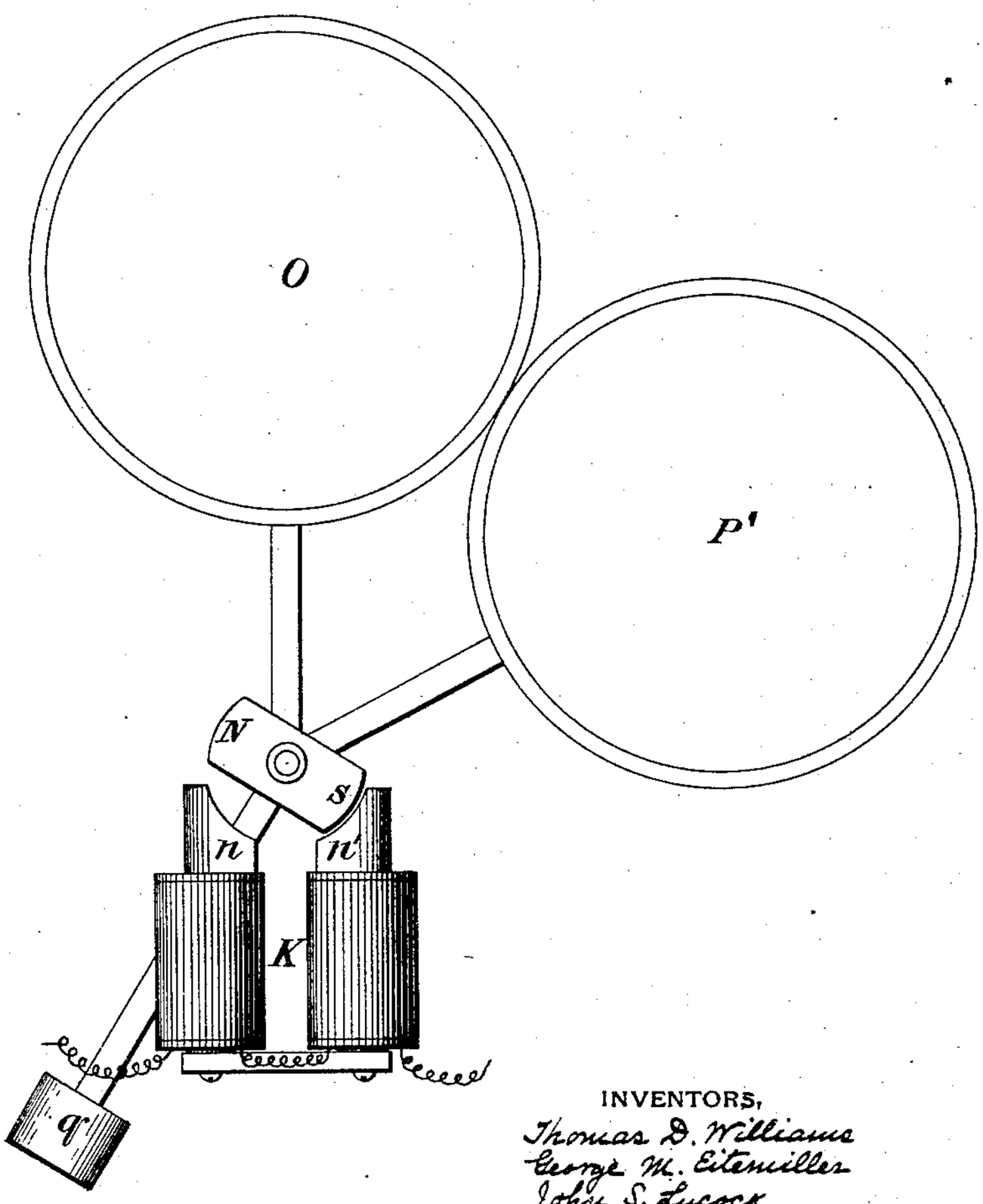


Fig. 3.



WITNESSES:

H. C. Gill

N. B. Conover

INVENTORS,

Thomas D. Williams
George M. Eitemiller
John S. Lucock
by Bakewell & Kerr Att'ys.

UNITED STATES PATENT OFFICE.

THOMAS D. WILLIAMS, OF BELLEVUE BOROUGH, AND GEORGE M. EITE-MILLER AND JOHN S. LUCOCK, OF ALLEGHENY CITY, PENNSYLVANIA.

RAILWAY-SIGNAL.

SPECIFICATION forming part of Letters Patent No. 353,393, dated November 30, 1886.

Application filed February 26, 1886. Serial No. 193,270. (No model.)

To all whom it may concern:

Be it known that we, THOMAS D. WILLIAMS, of Bellevue Borough, and GEORGE M. EITE-MILLER and JOHN S. LUCOCK, of Allegheny City, all in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Electric Signaling Apparatus; and we do hereby declare the following to be a full, clear, and exact description thereof.

Our invention relates to the operation of signals—such as are used on railroads—by means of an electric current sent from the terminal operating-station, the object of our invention being to operate at pleasure the signals at any one of a number of stations, situate at any desired distance from each other, in such manner that the signal at each station shall be operated independently of and without in any way affecting the signal or signals at any other of the stations on the line, and to effect this by means of a single line-wire extending from the terminal station and running through each of the several signal-stations. This we accomplish by means of a transmitting-instrument at the terminal station, which is furnished with a series of electrical contacts corresponding in number with the number of signal-stations at which signals are to be operated, and an index arm or lever, which, as it is moved by the operator successively from one contact point to another, operates similarly and simultaneously the index-arm of the corresponding instrument at each and all of the several signal-stations by breaking and making the line-current, and thereby operating the station-instruments. At each signal-station the instrument is divided into numbered sections corresponding with the contact-points on the instrument at the terminal or transmitting station. Each of these sections at every station is in electrical connection through the line wire with the transmitting-instrument, excepting a single section of each signal-instrument, which is not included in the line-circuit. The section out of circuit corresponds at each signal-station with the number of that station, so that a different section is disconnected from the line-circuit at each station. When the index-arm of the instrument at the transmitting-station is moved by the operator so as to cover the contact-point corresponding in number with the station at which the signal is to be set and rests there, the index-arm of the receiving-instrument at all of the signal-stations points to the same section of the receiving-instrument. The section on the receiving-instrument at each station which is out of circuit is the only one at that particular station which is connected with the electro-magnet which operates the signal at that station, and as soon as the index-arm reaches that section of the instrument the circuit is made and the current passes to the line through the signal electro-magnet, and would operate the signal if the current were sufficiently powerful. In order to prevent the operation of the signal at any other station when the index-arm of the receiving-instrument passes over the section of the instrument which is out of circuit at such other station, the instruments at the various signal-stations are operated by a battery-current which is not sufficiently powerful to operate the electro-magnet which works the signal, so that while the index-arms of all the receiving-instruments are being set to a number corresponding with that of the station at which the signal is to be operated no effect whatever is produced on the signal at any of the stations. When, however, the index-arms are set at the desired number a stronger battery-current is turned onto the line which operates the signal electro-magnet at the desired station only, because, as before described, when the signal electro-magnet at one signal-station is in circuit the signal electro-magnet at each of the other signal-stations remains out of circuit. The kind of signal to be displayed is determined by sending either a positive or negative current over the line, the positive current turning the signal in one direction and the negative in the reverse direction, as will be hereinafter explained.

Our invention, then, consists in a method of operating signals by electricity at any one or more of a number of stations by first setting the instruments at the signal-stations by means of an electrical current which is too weak to operate the signal mechanism, and then operating such mechanism by means of a stronger current; in placing the electro-magnet which operates the signal at each sta-

tion in a normally broken circuit, which can only be closed by the index-arm of the instrument at the station where the signal is to be set (hereinafter called the "receiving-station") reaching and forming contact with the wire of such broken circuit, said index-arm being actuated electrically in consonance with the movement of a similar index-arm on the instrument at the transmitting-station; in employing a weak battery-current for setting the index-arm at the receiving-station at the required point to close the circuit connecting the signal and its electro-magnet with the line-wire and current, so that the signal may not be set at other stations when the index-arms at those stations traverse the point where the circuit is closed to the signal-instrument, and then when the receiving-instrument is set at the desired station turning onto the line a much stronger battery-current for the purpose of actuating the signal at that station; in the operating of the signal in either of two directions by sending a positive current or a negative current over the line; in reversing the signal by means of an electro-magnet having projecting pole-pieces and an interposed pivoted and polarized armature, and in certain improvements in electrical signal apparatus hereinafter described.

In the accompanying drawings, forming part of this specification, Figure 1 represents the apparatus used at the terminal or transmitting-station, consisting of a battery, a battery-switch for increasing the strength of the current when the signal is to be operated, a reversing-switch for changing the character of the signal, and the transmitting-instrument. Fig. 2 represents the station-instrument, the mechanical devices for setting its index, the electro-magnets and local battery for operating those devices, and the electro-magnet which actuates the armature which brings into circuit a local battery by which the signals are operated. Fig. 3 is an enlarged view of the signal apparatus. Fig. 4 is a plan view of the entire apparatus, showing the relative connection of the several parts.

In the several figures like letters of reference are used to designate the same parts of the apparatus.

In Figs. 1 and 4 M B is the main battery at the terminal station, from which the signal are worked by an operator. This battery consists of a number of elements, so as to have sufficient electro-motive force to operate the instruments at the several signal-stations. This battery is divided into two parts by a wire, *b*, connecting with the battery between two cells at a point about one-third of the distance from the negative end of the battery, the wire *b* also connecting with one of the contact-points, *a*, of the battery-switch. Another wire, *b'*, connects the positive end of the battery with the other contact-point, *a'*, of the battery-switch, and the other or negative end of the battery connects with the contact-points *e* and *e'* of the reversing-switch. In describing a divided battery having a switch by which the whole or only a part of the total current may be transmitted, we desire it to be understood that the substitution of two batteries of unequal strength may be regarded as an equivalent device. The switch-arm A of the battery-switch is pivoted at *x*, and can be shifted from contact-point *a* to contact-point *a'*, but does not lose contact with one until it touches the other, so that the current is uninterrupted by shifting the arm A. If arm A rests on contact *a*, as shown in Fig. 1, only a few cells of the battery are in connection with the line; but if the arm A be shifted to contact *a'* all of the elements of the battery M B are in circuit. If preferred, two separate batteries (one weak and the other strong) may be employed; but the use of a single battery thus divided is more simple and preferable. The switch-arms B' B and contacts *d d' e e'* constitute the signal-switch, by which the signal is reversed so as to display either of two signals—for example, red or white—as may be desired. The kind of signal displayed by our instrument is determined by sending a positive or negative electrical current over the line, and this is regulated by shifting the switch-arms B B', (which move together, being connected by a line, *f*,) so as to cover the contacts *d d'* or *e e'*, as will be understood by reference to Fig. 1. In this figure the switch-arms B B' are placed in a position intermediate between the contacts *e d* and *e' d'*, in which position no current passes over the line-wire L from the battery M B. If the switch-arms B B' are shifted to the right, so as to cover contacts *d* and *e'*, the current from the positive end of the battery passes over wire *b* or *b'*, (as the case may be,) arm A, wire *c*, and switch-arm B, to the line L, whereas if the switch be reversed, so as to bring arms B B' over contacts *d'* and *e*, the current from the negative end of the battery flows through wire *g* to contact *e*, and through switch-arm B to the line L. The switch-arm B', being connected with the ground at E, conducts the return-current in either case to the opposite end of the battery.

From the above description it will be plain that according as the reversing switch-arms B B' are shifted to one side or the other, either a positive or negative current is sent over the line-wire L, and according as the battery switch-arm A is shifted to the right or left, either the current from the entire battery or only from a few cells of the battery, and therefore a strong or weak current is transmitted.

We will now proceed to describe the instruments which we employ.

In Fig. 1 C is the transmitting-instrument, which we shall call the "regulator." It is shown of semicircular shape, but may be a greater or smaller arc of a circle, as may be desired. It is divided near the circumference into as many divisions as there are signal-stations to be operated, and at each division is a metallic contact-point, *h*. These contact-points may be numbered, successively, 1 2 3, &c.,

corresponding to the signal-stations on the line, which are referred to by the same numbers. These contact-points *h h* are separated by insulating material, (or the plate C may be made entirely of some non-conducting substance,) and they are connected together by a wire, *i*. The line-wire L is connected with the last contact-point *h*, (numbered 16 in Fig. 1,) and also with the pivotal-point of the index F, at the center of the plate C of the regulator. The index F is made of brass or other good conductor, or has a wire extending from its pivotal point to a knob projecting from the under side at its outer end. The zero-point on the margin of the plate C is not connected with the line-wire L, so that until the index F, is moved into contact with one of the contact-points *h* the line-current is broken; but whenever the end of the index is in contact with any of the contact-points *h* the current is restored. In the drawings, Fig. 1, the wire *i* is represented as connecting the contact-points *h;* but in practice the wire should be embedded in or placed under the plate C, so as to prevent the contact of the index F with the wire *i*. By this construction, as the index F is moved around the plate C of the regulator, the battery-current is alternately made as the index touches the several contacts *h* in succession, and broken as it passes from one to another. When a signal is to be set at any one of the stations, the operator moves the index F around, touching each of the contacts *h* in succession, until he reaches the contact bearing the same number as that of the required signal-station. In this specification we shall suppose signal-station No. 9 to be that at which the signal is to be operated, and shall so refer to it.

In Fig. 2 D represents the signal-instrument at "station 9," (which, for convenience, we shall call the receiving-instrument.) An instrument exactly similar in construction (with one exception, hereinafter to be noted) is placed at each signal-station on the line. The receiving-instrument is very similar to the regulator C, having a graduated arc numbered successively to correspond with the numbers indicating the signal-stations on the regulator. There are, however, no metallic contact-points on the graduated arc of the receiving-instrument, and the wire *i'*, which connects at the last section, No. 16, with the line-wire L, is placed so as to be constantly in contact with the under side of the metallic index F', excepting at section 9, where the wire *i'* is carried under the plate, or so located as not to come in contact with the index F'. It must be understood that at each of the several signal-stations the section of the graduated arc of the plate D which corresponds with the number of that station is similarly arranged, so that when the index F' reaches the section on the arc corresponding with the number of that particular station the contact of index F' with the wire *i'* is broken. If the graduated arc on plate D is metallic, the piece of metal forming the section at which the contact of the index and wire is to be broken is separated by insulating-strips *k k*. All of the other sections of the arc of instrument D are electrically connected by the wire *i'* with the line-wire L. The pivotal point *x'* of the index F' is electrically connected by the wires *l' l* with the line-wire L, and through index F' and wire *i'* with the line-wire L at the farther end of the receiving-instrument; but when index F' reaches section 9 on the arc of the receiving-instrument this electrical connection is broken, and another connection is made by the index F' coming in contact with the wire *l''*, which connects with one coil, H, of the bipolar electro-magnet H H'. The other coil, H', of this electro-magnet connects with the line-wire L. This bipolar magnet has a pivoted armature, I, placed between the opposing poles of the electro-magnet, the armature I being attracted either to the core of the electro-magnet H or to that of the electro-magnet H', accordingly as a positive or negative current is passed over the line-wire from the main battery M B at the transmitting-station. Attached to the front end of each of the electro-magnets H H' are arms carrying contact screws *m m'*, and the armature I, extending down between them, forms contact with one or other of these contact-screws *m* or *m'*, according as it is attracted to the core of the magnet H or H'. To the contact-screws *m m'* are attached wires *w w'*, connecting with opposite poles of a relay battery, R B, (see Fig. 4,) from which battery a wire, w^2, extends to one of the coils of the electro-magnet K, and a wire, w^3, connects the upper end of the armature I of the bipolar electro-magnet H H' with the other coil of the electro-magnet K, by which the signal is operated.

An enlarged representation of the signal apparatus is given in Fig. 3. The electro-magnet K consists of two coils connected together in the usual way, and having the fine wire forming the coils so wound that when a current of electricity is passed through the coils the cores or pole-pieces of both shall have the same polarity—that is to say, if a positive current of electricity is passed through the coils, both of the pole-pieces shall have north polarity, and if a negative current, then the pole-pieces shall have south polarity. The pole-pieces *n n'* extend beyond the coils, and are so curved, as shown in the drawings, as each to form the arc of a circle, at the center of which is pivoted to a suitable standard the armature N S. This armature is made of steel and polarized, so as to be permanently magnetic, and owing to its position between the pole-pieces *n n'* of the electro-magnet K, and having (by reason of its being a permanent magnet) a north and south pole, (marked N S,) it results that when a positive current of electricity is passed through the electro-magnet K, giving to both of its poles a north polarity, the north end, N, of the armature will be repelled and the south end, S, of

the armature will be attracted, causing the armature to assume the position shown in Fig. 3; and if the current of electricity is changed to negative, giving a south polarity to the poles *n n'*, the armature N S will reverse its position, the south pole of the armature being repelled and the north pole attracted. To the armature N S are rigidly attached two colored disks, O and P', one of which is usually white and the other red; and they are so attached to the armature, as shown in the drawings, Fig. 3, that when a positive current is sent over the line-wire L and the south pole, S, of the armature N S is attracted the disk O will assume a vertical position, and when a negative current is used the north pole, N, of the armature is attracted and the disk P' assumes a vertical position, while, in either case, the other disk falls to one side. A small counterbalancing-weight, *q*, attached to the lower side of the armature N S, serves to keep the disk in position when set.

From the foregoing description it will be manifest that either of the disks O or P' may be set, at pleasure from the terminal or transmitting station by merely shifting the battery-switch, as before described, so as to send a positive or a negative galvanic current over the line-wire.

An electrical bell, Q, located in the receiving-station and furnished with its own battery, R, may be connected by wires with two contact-points, *p p'*, placed within range of the oscillation of the arm of the counter-weight *q*, and by connecting a wire in the bell-circuit to the counter-weight, as shown in Fig. 4, the bell will be rung whenever either of the signals is set.

It remains to be explained how the index F' of the receiving-instrument D at each station is set from the transmitting-station, so as to operate the signal and to prevent the operation of the signal at any other than the desired station.

In operating the regulator and receiving-instruments the entire battery-current is not employed, but only the current from a few of the cells of the main battery, which is effected by means of the battery-switch, as before described. If preferred, however, a separate battery of a comparatively small number of cells may be employed for this purpose. The reason for using a comparatively weak battery-power for setting the receiving-instruments at the several signal-stations and a much stronger battery-power for operating the signal will be explained presently.

When the index F of the regulator stands at the zero-point on the plate C, as shown in Fig. 1, no current passes over the line-wire L, because there is no contact-point there, and the wire *i* does not extend between the zero-point and the first contact-point, *h*. When, however, the index F is moved to contact *h'*, the circuit is closed, the current flowing from the line-wire L through index F to contact *h'*, and thence by wire *i* to the line-wire L at the other end of the instrument. As the index is passing from *h'* to *h*² the circuit is opened, and closed again when it reaches *h*², being thus rapidly opened and closed as the index passes from one contact-point to another. Now, referring to Fig. 2, the current passes along line L to the relay electro-magnet M, magnetizing its core, which attracts its armature *r*. This closes the circuit of the local battery L B, in circuit with which is the electro-magnet J. The core of the electro-magnet J thus becomes magnetized and draws down its armature *j*, which is pivoted at *x'* on the same center as the index F'. To the armature *j* is pivoted a pawl, *t*, which engages one of the teeth of a ratchet-wheel, N', and causes it to rotate the distance of one tooth, and thereby raises the index F', (by means of a pin, *u*, projecting from the side of the ratchet-wheel N',) causing it (the index F') to traverse the distance of one of the divisions of the arc D. When, however, the index F on the regulator has passed away from contact-point *h'*, the circuit is broken, the magnets M and J are demagnetized, and the armature *j* is retracted or raised by a spring, *s*, and the pawl *t* is raised and engages another tooth on the ratchet-wheel N'. Then, when index F of the regulator, Fig. 1, reaches contact-point *h*², the current is restored, magnet M again retracts its armature, restores the local circuit of battery L B, magnet J draws down its armature *j*, and the wheel N' is rotated the distance of another tooth and the index F' of the receiving-instrument passes the distance of another division of the arc D, and so on, the motion of the regulator-index F from one contact-point to another on the arc of the regulator C causing a similar motion of index F' of the receiving-instrument, until the index F of the regulator points to station 9, when the index F' of the receiving-instrument covers the insulated section marked "9" on the receiving-instrument. The effect produced thereby is that the line-current from the main battery M B passes over wire *l*, Fig. 2, to the electro-magnet P and magnetizes its core, and thence by wire *l'* to the index F', and thence to the wire *l''*, which terminates at section 9 of the arc D of the receiving-instrument, and making contact with it, the current passes to the bipolar magnet, magnetizing its cores as before explained; but the electro-magnets P and H and their armatures *t*² and I are so adjusted that the weak current which operates the electro-magnets M is insufficient to operate the electro-magnets P and H, and therefore those magnets do not become operative until a stronger current is turned onto the line, as before described, by means of the battery-switch A, Fig. 1. When this is done, however, the cores of the electro-magnets P and H H' are magnetized, and by means of the latter the signal is set, as already fully described.

The object of operating the relay-magnet M with a weak current, sufficient only to bring into action the local battery L B, as before de-

scribed, is that if a current strong enough to operate the signal were used while the index of the receiving-instrument was being set the signals at all stations between zero and number 9 would be operated whenever the index F′ of the receiving-instrument came over the section corresponding with the number of each signal-station; but by using a current too weak to operate the signal the index F′ passes over the insulated section at each station without affecting its signal.

The function of the electro-magnet P remains to be explained. This magnet, being adjusted, as before stated, to be operated only by a strong current, remains inactive until the signals are set by the switching onto the line of the entire current of the main battery. When this is done the core of the magnet P attracts its armature t^2, (which is also the pawl by which the wheel N′ is rotated,) and thereby disengages the wheel N′. The pawl *t* has a downward extension, *t′*, which strikes the lower vertical arm of a three-armed lever-catch, *v*, and causes the third arm, *v′*, of this lever to engage a toothed wheel, R, which, being fastened to the spindle of the index F′, holds it in place over the section 9 of the arc D, while the wheel N′, which is now free to rotate, returns to its first position, which is effected by a weight, W, attached to a cord wound around the spindle of the wheel N′, or by means of a suitable spring. So long as the current passing from battery M B continues unbroken the index F′ remains set in its position over section 9 of the receiving-instrument; but when the current is broken (which is done by the operator at the transmitting station by placing the signal-switch in an intermediate position between its contact, as in Fig. 1) the armature t^2 of electro-magnet P is released and recedes, being drawn back by spring *s′*, the pawl *t* engages a tooth on the wheel N′, thereby also releasing the lever-latch *v′* from the wheel R, and permits the index F′ to be rotated backward to its first position at zero on the arc D by means of a weight, X, or suitable spring, when it again rests against the pin *u* on the ratchet-wheel N′, and is in position for repeated action.

As each of the stations has one section of the arc of the receiving-instrument cut out of circuit of the line-wire L, (similarly to section 9 in Fig. 2,) the signal at that station is operated in like manner by bringing the index F′ of the receiving-instrument at that station over the corresponding section of the arc D, and then turning on the stronger battery-current, and this without in any way affecting the signal at any of the other signal-stations.

The operation of these instruments will be readily understood from the preceding description without much further explanation. Supposing that the signal-disks be so arranged that by turning the signal-switch to the left and causing a negative current from battery M B to pass over the line the red signal will be set, the mode of operation is as follows: The switch-arms B B′ are moved to the left until they cover the contacts *d′* and *e* and the battery-switch arm A is set over the contact *a*, whereby a weak current passes over the line which is strong enough to operate the relay-magnet M, but not to operate the electro-magnets P and H H′. Then turn the index F of the regulator from zero to contacts *h′* h^2, &c., in succession, and stop at h^9. Then reverse the battery-switch arm A, so as to cover contact *a′*, which will turn the whole current of the battery M B onto the line L, and the signal will be at once set at station 9. The current should be left on for a few seconds to insure perfect action. The switch-arms B B′ are then drawn back into the position shown in Fig. 1 between the contacts, and then the index F of the regulator is returned to the zero-point on the arc, and lastly the switch-arm A of the battery-switch is reversed, so as to cover contact *a*, and the instruments, both at the transmitting-station and at all of the signal-stations, are in a condition for repeated use at the same or any other station on the line.

It is advisable to use a very weak current for operating the receiving-instruments and a comparatively very strong current for operating the signals, so as to allow a large margin for wire trouble, &c. By using this precaution the instrument is certain in operation, not liable to get out of order, and requires very little attention.

The device of the electro-magnet K, with extended poles and polarized armature, may be applied conveniently as a shifting or reversing device for various purposes other than that stated in this specification.

Having thus described our improvement, what we claim as our invention, and desire to secure by Letters Patent, is—

1. The combination of a transmitting-instrument at the terminal station, having a series of electrical contacts corresponding in number with the outlying signal-stations, and an index-arm connected with the line-circuit, which on being moved by the operator from one contact to another makes and breaks the line-circuit, a number of similar receiving-instruments, one of which is located at each of several outlying signal-stations, having suitable mechanism, substantially as described, to cause the index-arm of each receiving-instrument, in response to the making and breaking of the main circuit, to move step by step in correspondence with the motion of the index-arm of the transmitting-instrument, the index-arms of the receiving-instruments being normally in electrical connection with the transmitter through the main-line circuit, an electro-magnet at each outlying station for operating the signal, which electro-magnet is placed in a derived circuit connected with the main line and by a normally open circuit connection with the transmitting and receiving instruments, such connection being at each outlying station at a different point in the arc of motion of the index-arm of the receiving-instrument, so that said

index-arm on reaching that point at any station shall close the derived circuit of the signal-instrument at that station only, operating the signal, substantially as described, when a battery-current of sufficient force is switched onto the line to operate the signal-instrument the armature of which is so adjusted as not to operate when its electro-magnet is subjected only to the ordinary current used for operating the transmitting and receiving instruments.

2. A transmitter located at a transmitting-station, having a defined number of contact-points, an electric circuit from said transmitter to a series of outlying stations each having a receiving-instrument furnished with a contact-making arm, and mechanism for advancing it step by step in unison with the transmitting-arm, a signal mechanism located at each station in a normally open derived circuit connected with the main line through the receiving-instrument, such point of connection being located at a different point in the arc of motion of the contact-making arm at each station, whereby on the making of contact by the contact-arm at any station the alarm-signal will be operated at that station and not at any of the other stations, substantially as described.

3. The combination, with a transmitting-instrument, of a series of receiving-instruments, each having its index-arm, and all arranged in the line-circuit, so that the movement of the arm shall be synchronous, the movement of the arms of the receiving-instruments being produced by electric pulsations from the main line, an open circuit differently placed in each receiving-instrument and adapted to be closed by the index-arm of said instrument, and a signal arranged in said open circuit, whereby the signal at any one of several distant stations may be operated without affecting the signals at any other stations, substantially as specified.

4. The combination, with a battery and line circuit, of a transmitting-instrument having a series of contacts on a graduated arc, said contacts connected together by a conducting-wire, and also connected at one end of the arc with the line-circuit and having a movable index or pointer capable of conducting the current and connected with the line-wire for successively opening and closing the circuit at the contacts, and a receiving-instrument having a graduated arc divided into sections corresponding with the series of contacts on the transmitting-instrument, an index or pointer traversing the graduated arc and having a ratchet-wheel on its axis or shaft, and an electro-magnet, said armature being furnished with suitable mechanism for rotating the ratchet-wheel, before mentioned, as an apparatus for repeating at a distant station or stations the movements at the terminal station of an index or pointer over a graduated arc.

5. The combination, in apparatus for the electrical operation of signals, of a battery, a switch by which the whole or a portion only of the electric current may be transmitted over the line, a switch and wire connections with the battery and line-wire for reversing the current on the line, a transmitting-instrument for the terminal station having a separate contact-point (connected with the line-wire) for each of several signal-stations, an index-arm connected with the line-wire from the battery, which index-arm opens and closes the circuit as it passes from one contact-point to another, a receiving-instrument (for each signal-station) having suitable mechanism, substantially as described, operating by the line-current to cause the index-arm to pass from one point to another on the receiving-instrument corresponding with the contact points on the transmitting-instrument, an electro-magnet having an armature which operates in different directions under the influence of a positive or negative current, and a signal operated in different directions by means of and in accord with the armature of the said electro-magnet, said signal and electro-magnet being placed in a broken or incomplete circuit connected with the line-wire, so that when the index-arm of the receiving-instrument reaches and comes in contact with the free or unconnected end of the wire of such broken circuit the circuit from the main battery to the signal-instrument shall be closed, substantially as described.

6. The combination of a pair of electro-magnets so wound that the cores shall have the same polarity when magnetized by the electric current, with cores projecting beyond the spool to form pole-pieces, and a permanently-polarized steel armature pivoted midway between the pole-pieces, whereby the forces of attraction and repulsion are utilized in operating the signal, substantially as described.

In testimony whereof we have hereunto set our hands this 23d day of February, A. D. 1886.

THOMAS D. WILLIAMS.
GEORGE M. EITEMILLER.
JOHN S. LUCOCK.

Witnesses:
W. B. CORWIN,
J. K. SMITH.