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M. S. REILEY.

ELECTRIC SIGNALING APPARATUS FOR BLOCK SYSTEMS.

No. 528,444. Patented Oct. 30, 1894.

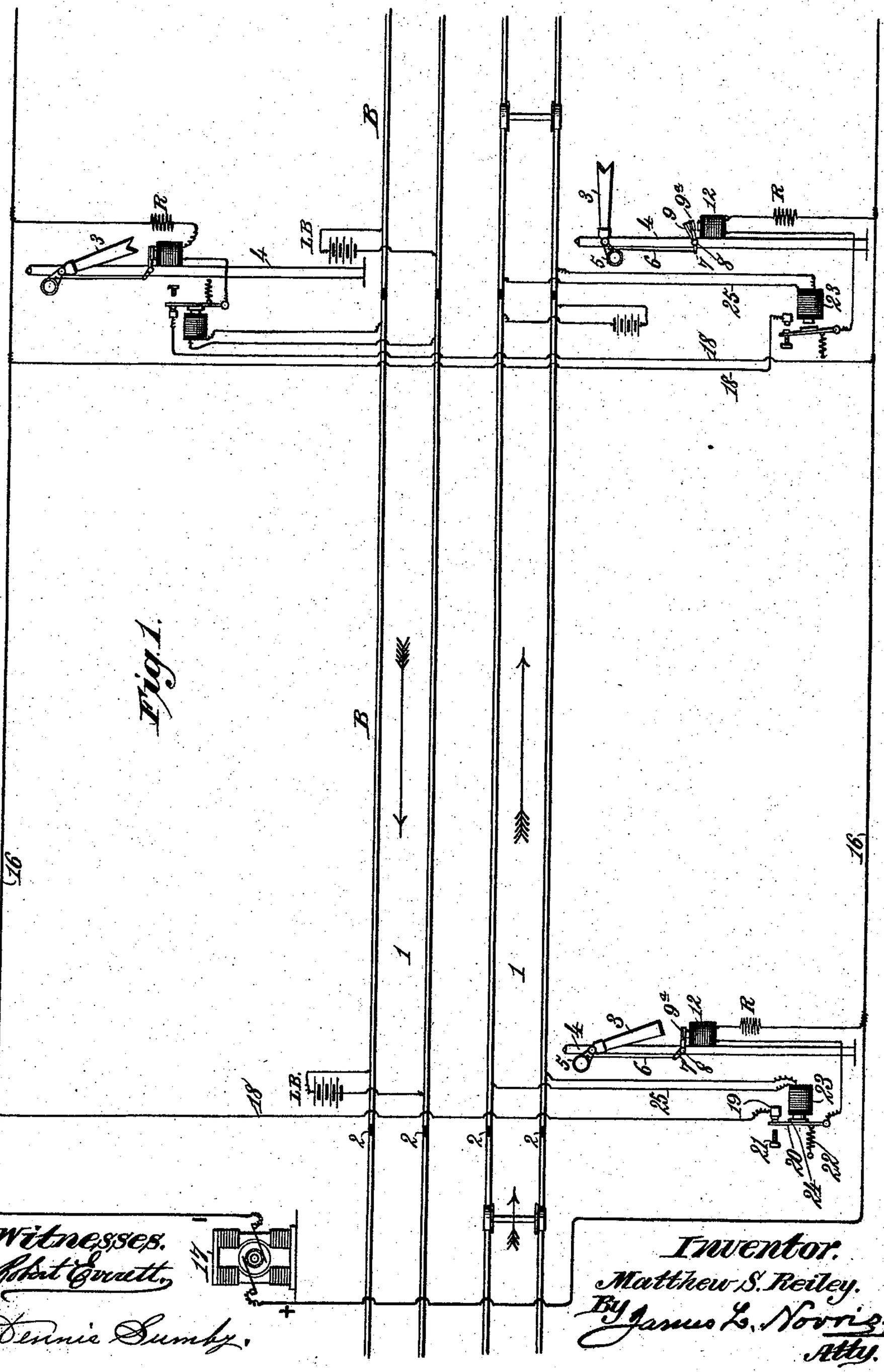

Fig. 1.

(No Model.) 6 Sheets—Sheet 2.

M. S. REILEY.

ELECTRIC SIGNALING APPARATUS FOR BLOCK SYSTEMS.

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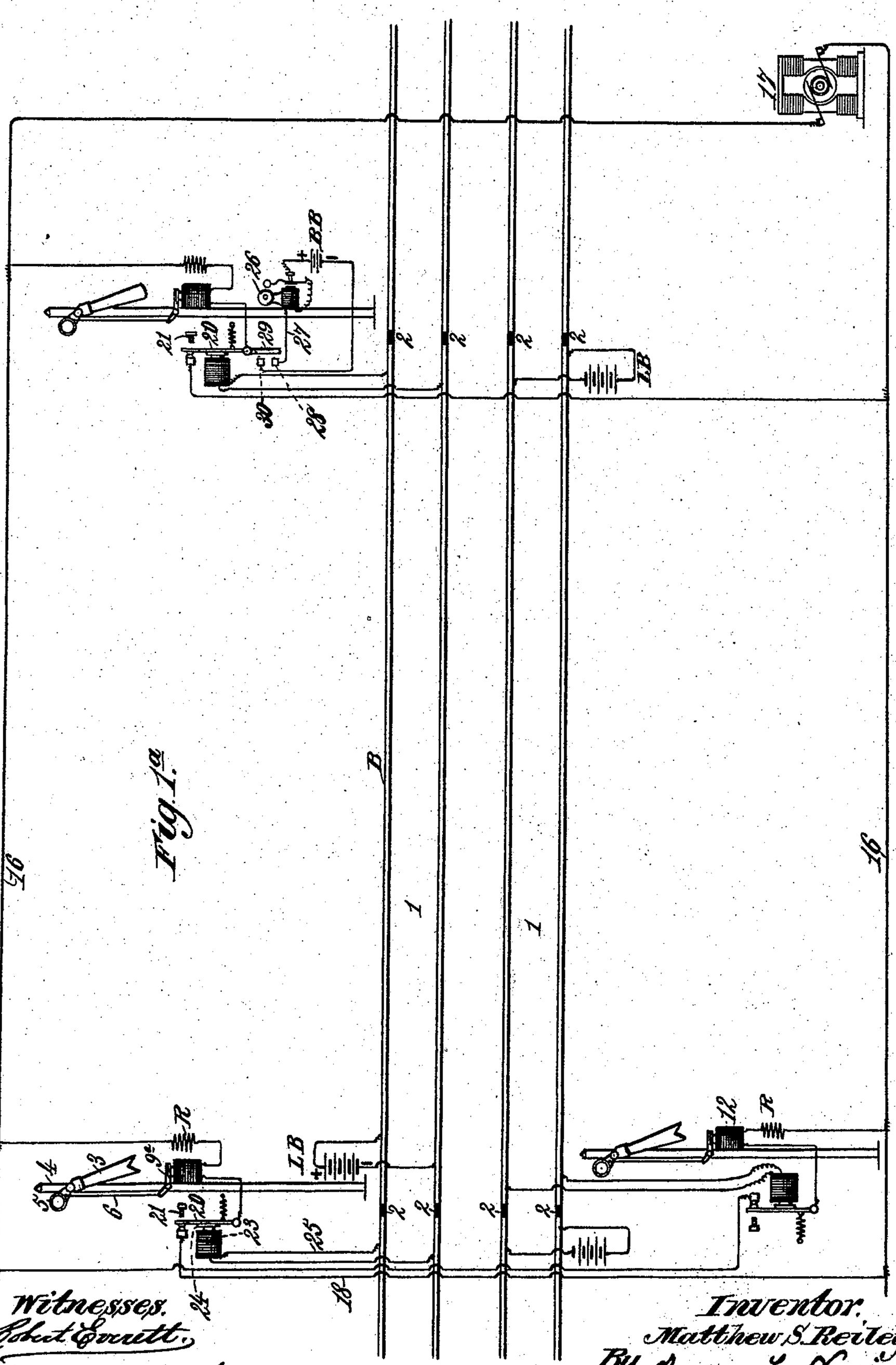

Witnesses.
Robert Everett.
Dennis Sumby.

Inventor.
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By James L. Norris.
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(No Model.) 6 Sheets—Sheet 3.

M. S. REILEY.

ELECTRIC SIGNALING APPARATUS FOR BLOCK SYSTEMS.

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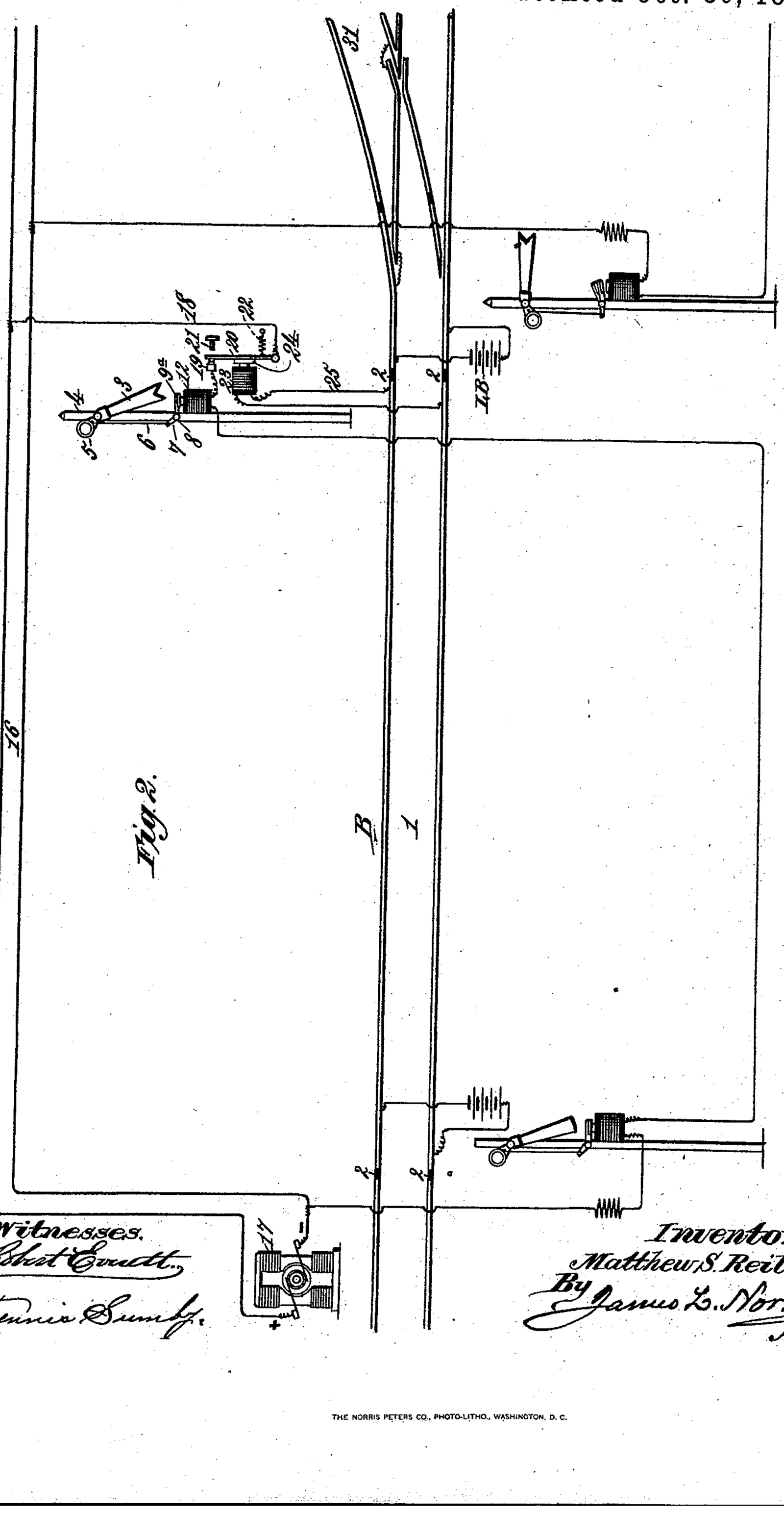

Fig. 2.

Witnesses.
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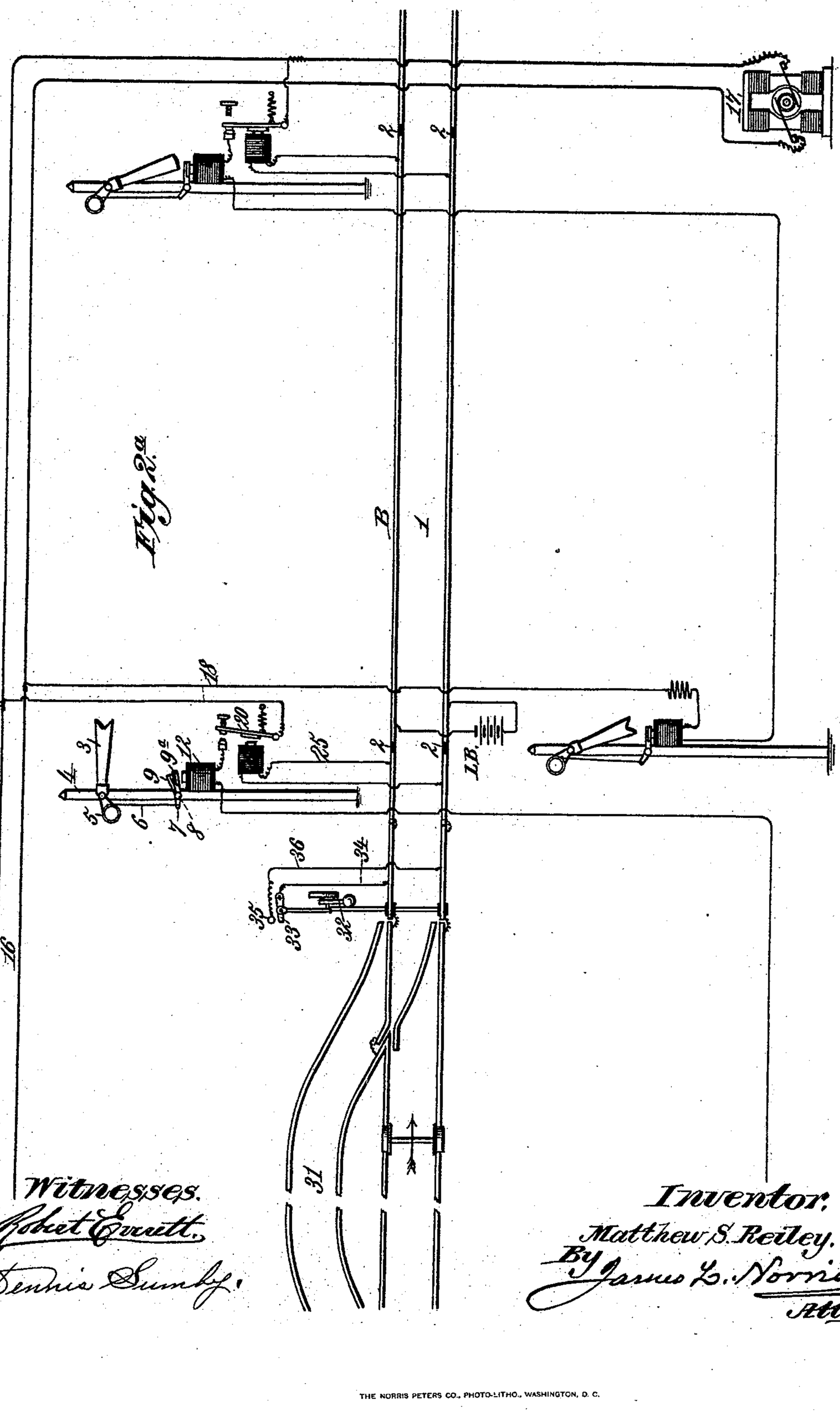
(No Model.) 6 Sheets—Sheet 4.

M. S. REILEY.

ELECTRIC SIGNALING APPARATUS FOR BLOCK SYSTEMS.

No. 528,444. Patented Oct. 30, 1894.



Witnesses.
Robert Ewett.
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(No Model.) 6 Sheets—Sheet 5.

M. S. REILEY.

ELECTRIC SIGNALING APPARATUS FOR BLOCK SYSTEMS.

No. 528,444. Patented Oct. 30, 1894.

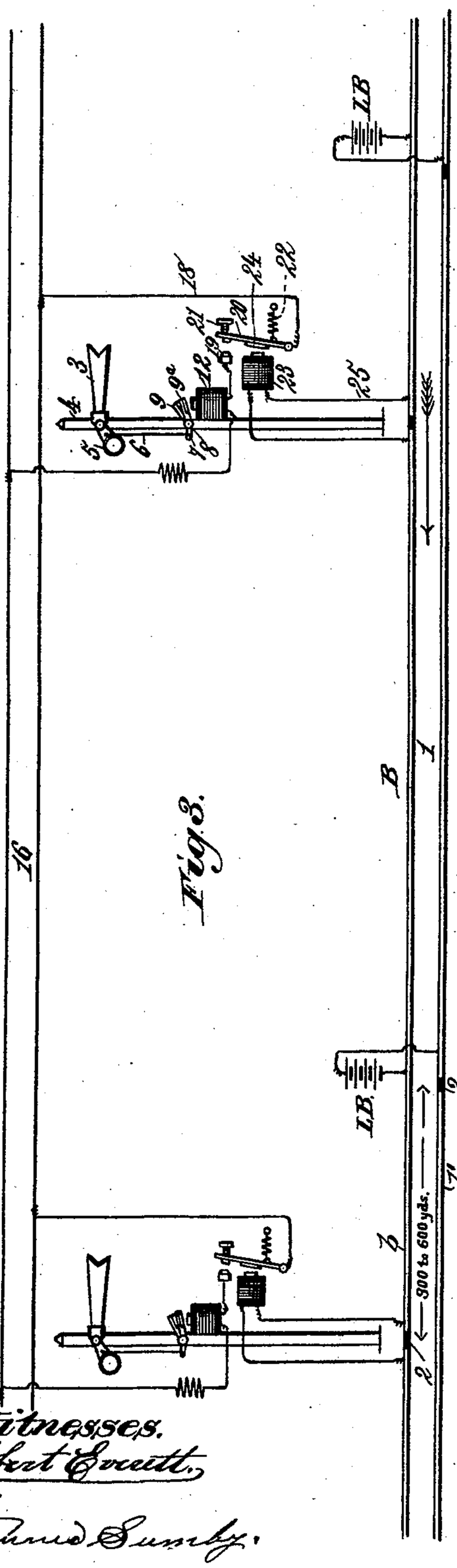

Fig. 3.

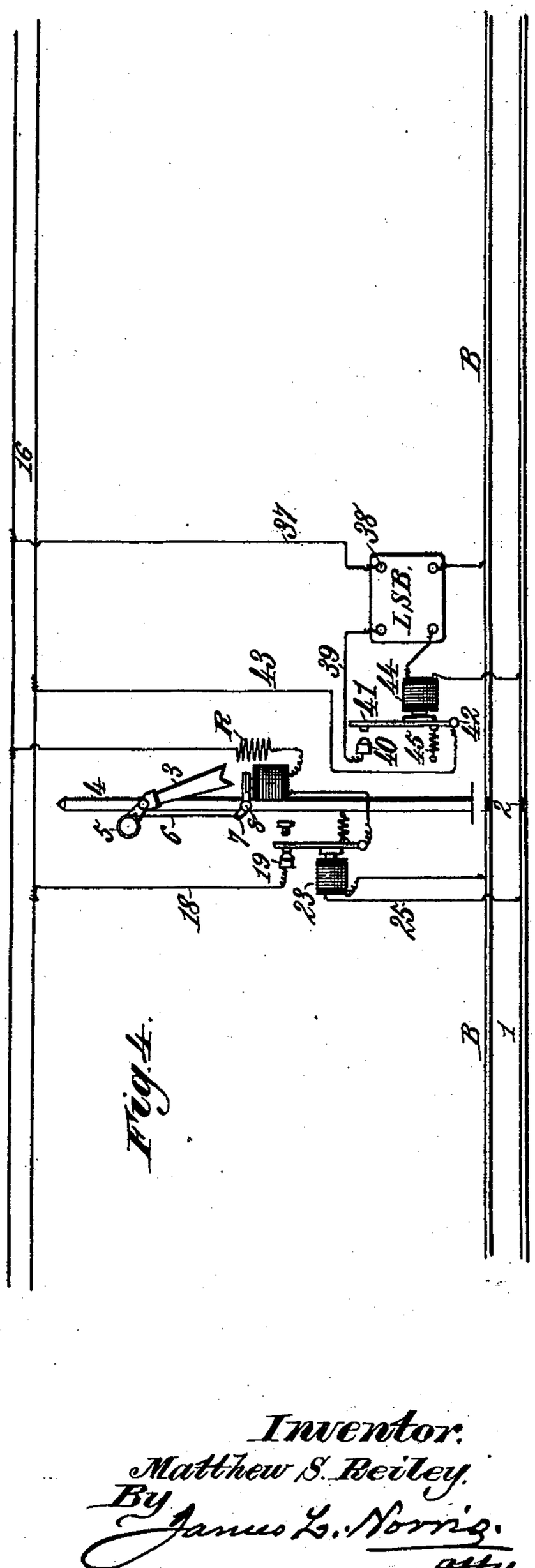

Fig. 4.

Witnesses.
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M. S. REILEY.

ELECTRIC SIGNALING APPARATUS FOR BLOCK SYSTEMS.

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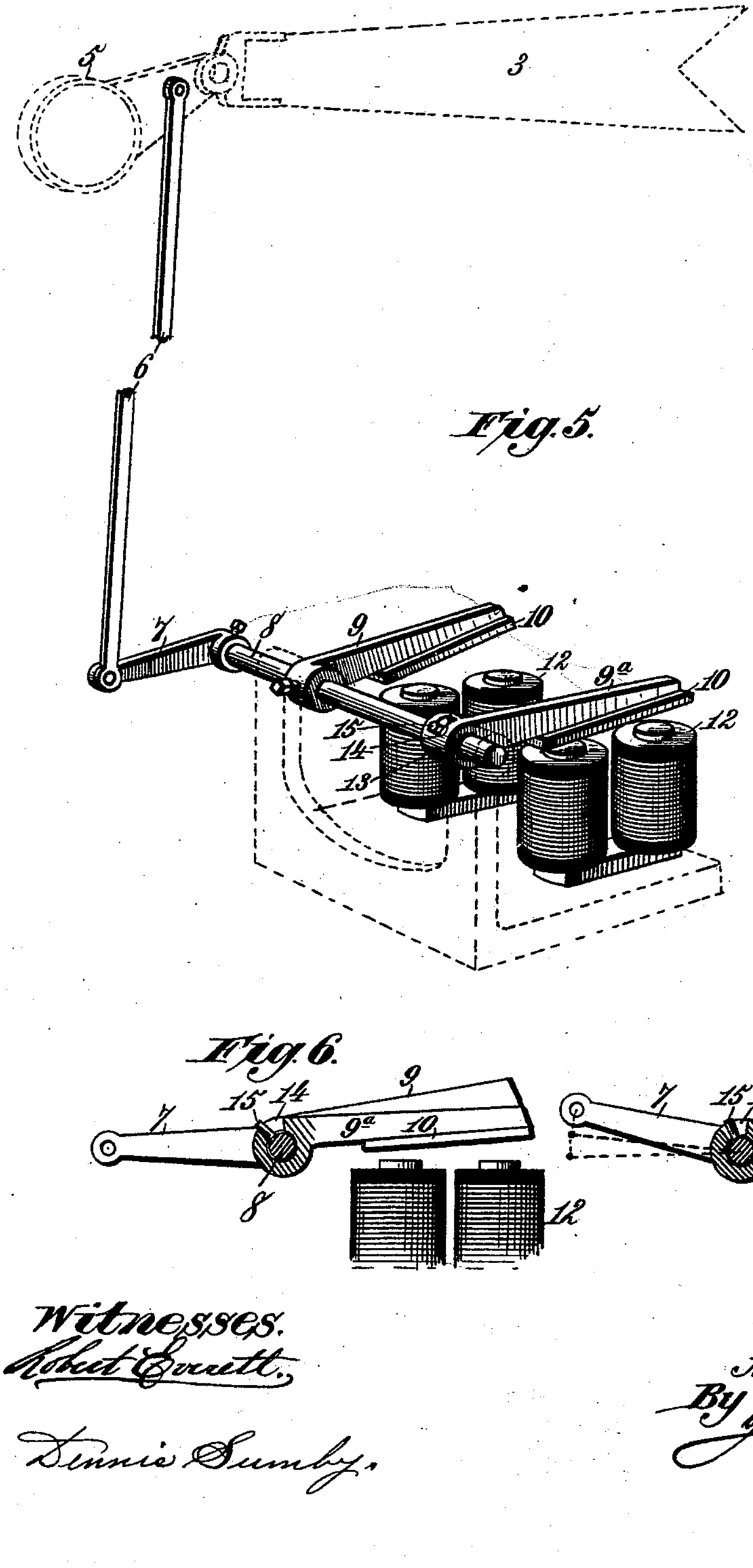


Fig. 5.

Fig. 6.

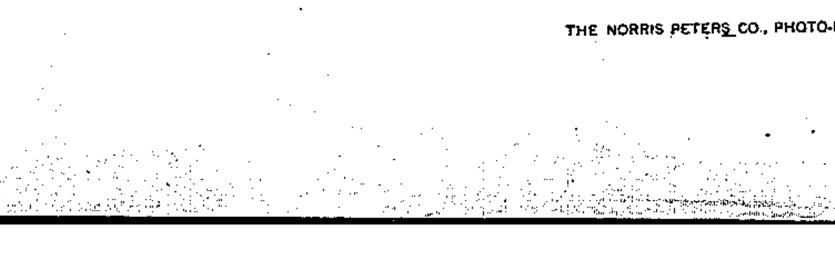
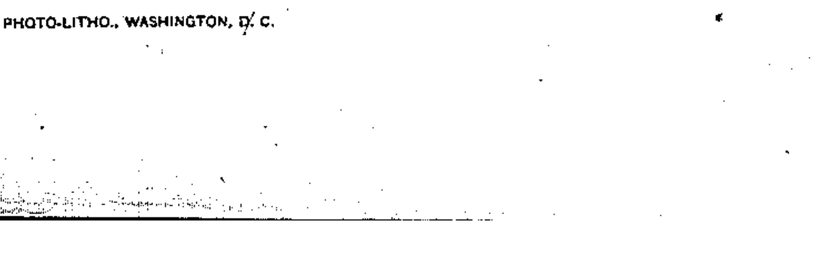


Fig. 7.



Witnesses.
Robert Everett.
Dennis Sumby.

Inventor.
Matthew S. Reiley.
By James L. Norris.
Atty.

UNITED STATES PATENT OFFICE.

MATTHEW SIMPSON REILEY, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR OF SIXTY-SEVEN NINETY-SIXTHS TO ROBERT E. L. WHITE, GEORGE W. WHITE, JAMES M. WHITE, AND FRED. R. MILLER, OF SAME PLACE.

ELECTRIC SIGNALING APPARATUS FOR BLOCK SYSTEMS.

SPECIFICATION forming part of Letters Patent No. 528,444, dated October 30, 1894.

Application filed June 13, 1894. Serial No. 514,459. (No model.)

To all whom it may concern:

Be it known that I, MATTHEW SIMPSON REILEY, a citizen of the United States, residing at Washington, District of Columbia, have invented new and useful Improvements in Electric Signaling Apparatus for Block Systems, of which the following is a specification.

It is the purpose of my invention to provide a system of electrically operated block-signals for railway lines, which shall be capable of automatic action under all the contingencies which affect the safety of the road, or threaten that of the trains and passengers traveling thereon. My object is, in other words, to so organize a system of signals of this type that the presence of a train upon any block-section, the breaking or displacement of a rail, an open switch, or other interruption of normal conditions, shall be indicated at the instant of occurrence by a suitable signal, or signals.

It is my purpose, also, to provide a system of electrically operated block-signals in which a series of local circuits, employed to automatically complete the shunt circuits controlling the signals, shall be supplied with current by secondary or storage-batteries, or accumulators, which are so connected with a dynamo circuit, feeding the shunts, that said batteries shall be re-charged at suitable intervals, the action in this, as well as in all other respects, being entirely automatic, the complete series of signals upon the line being set to danger, or safety, and the local batteries being maintained at proper tension, without intervention of human agency further than the expenditure of the power required to drive the dynamos.

It is one purpose of my invention, also, to provide a system of electrically operated block-signals of the type hereinbefore referred to, which shall be capable of working upon circuits which are normally open, or closed; and which shall be applicable to roads using either single, or double tracks.

The invention consists, to these ends, in the novel features hereinafter fully described and claimed, and to enable others to clearly understand the same I will now describe said invention in detail, reference being had, for this purpose, to the accompanying drawings, in which—

Figures 1 and 1ª, taken together, constitute a diagram showing a portion of a railway line including the terminal block-sections, and one or more intermediate sections, equipped with my system of signals. Figs. 2 and 2ª, taken together, constitute a similar diagram showing the application of the invention to a railway line using a single track, together with means whereby the semaphore is operated by the opening and closing of a switch. Fig. 3 is a diagram showing the adaptation of the invention to work upon a normally open circuit. Fig. 4 is a diagram showing manner of and means for automatically re-charging the secondary batteries which feed the local, or track-circuits. Fig. 5 is a detail perspective showing the means for operating the semaphore by the attraction of a series of electro-magnets. Fig. 6 is a detail section, partly in elevation, of the parts shown in Fig. 5, the line of section being transverse to the rock-shaft and passing through the sleeve of one of the armature levers, which are shown in the position they occupy when the magnets are not in circuit. Fig. 7 is a similar section and elevation showing the same parts in the position they assume after the magnets have been energized and the armature-levers attracted.

The invention will first be described in its adaptation to circuits which are normally closed, upon lines of road using either double tracks, the trains running in the same direction upon the same rails, or single tracks upon which trains must, necessarily, run in both directions. I will then explain the adaptation of the invention to circuits which are normally open, and will then describe other details of the invention in their proper order.

Referring, therefore, to Figs. 1 and 1ª, which may conveniently be placed together, end to end, the reference numeral 1 indicates the parallel tracks of a railway, the trains upon which ordinarily run in opposite direc-

tions, as denoted by the arrows in Fig. 1, those upon either one of said tracks, however, following each other in the same direction. The line is divided into blocks, or sections, of substantially uniform length and electrically separated, or insulated one from another, by non-conducting media 2, interposed between the ends of the rails at the termini of the blocks, or sections. This insulation, however, may be of any suitable kind, and is shown conventionally in the drawings, as the specific means employed are not essential.

The several blocks, or sections, are indicated by the reference-letter B. Their length may be regulated to suit the requirements of the line, and they may extend over the entire length of the latter, or be limited to those portions at, or near, the termini, or elsewhere. Located at, or near the dividing lines which mark the points of separation between adjacent blocks, are visual signals, usually consisting of the semaphores commonly used. I have conventionally indicated this type of signal in the drawings as having an arm 3, pivotally mounted on a post 4, or other suitable form of support, planted in the earth, or otherwise permanently erected beside the track. The semaphore-arm 3 is overbalanced by a weight 5, upon a short arm projecting to the opposite side of the point of pivotal support. This weight may also form part of the lantern of the semaphore. A visual signal of this type is placed on each side of the double track, at, or near, the end of each block, or insulated track-section, their arrangement being substantially similar to that heretofore adopted. It is not essential, of course, that the semaphores be placed exactly opposite each other, or that the terminals of the insulated track-sections shall coincide, in position, as one block may lap over, or alternate with the other, the two tracks being wholly independent, one of another, so far as the operation and indications of the semaphores are concerned. For the purposes of this specification, however, it is more convenient to illustrate the parallel track-sections with their terminals coincident and the semaphores opposite each other, or nearly so.

The semaphore-arms 3 would normally be set to indicate danger by the action of their controlling weights 5, but they are held at "safety" by the following means: Pivotally attached to the short weighted arm is a connecting rod 6, having its other end pivoted to a lever 7, having its fulcrum preferably beneath the semaphore-arm. The fulcrum consists, as shown in Fig. 5, of a rock-shaft 8, mounted on any suitable support and provided with two, or more, arms 9 and 9^a which have armatures 10, arranged to overhang the cores of electro-magnets 12. A supporting bracket for these magnets is shown in dotted lines in Fig. 5 and parts of said bracket may also furnish journal support for the rock-shaft 10. As the field of magnetic attraction is limited, and as the range of movement of the semaphore-arm 3 is relatively very great, I provide simple means whereby the latter movement may be effected with certainty by electro-magnets of moderate power. For this purpose I use two or more magnets 12, arranged at such points that each will attract the armature upon one of the arms 9, 9^a on the rock-shaft 8. One of these arms, as, for example, 9, is rigidly mounted on said rock-shaft, while the other arm 9^a is loose thereon. In the sleeve 13 of the latter arm is formed a segmental slot 14, in which lies a pin 15 which forms a rigid part of the rock-shaft. As the gravity of the arm 9^a and its armature will normally cause said arm to drop as far as it is permitted by the length of the segmental slot 14, it is evident that, to this extent, the interval separating the armature on the arm 9^a, when there is no current in the helices of the two magnets, from the cores of the electro-magnet beneath it, must be less than that between the armature on the arm 9, and the cores of the other magnet, as is clearly shown in Fig. 6. If both magnets are in circuit therefore, the arm 9^a will exert far more power on the rock-shaft 8 than the arm 9 and will turn said shaft until its armature is arrested by the cores of the magnet beneath it. This movement, however, having brought the armature of the arm 9 within the field of strong magnetic attraction, it is acted upon, in turn, by the other magnet and the rotary movement of the rock-shaft 8 continues until the armature of the arm 9 is stopped by the magnet attracting it. The operation of the arm 9 is rendered possible by the segmental slot 19 in the sleeve 13 of the arm 9^a, and the pin 15 lying in said slot, by which the rock-shaft 8 is capable of a limited rotary movement after the arm 9^a is arrested, as shown in Fig. 7. In like manner, a greater number of magnets and lever-arms may be used, if necessary, and a corresponding increase in the range of movement of the rock-shaft will be obtained.

The reference-numeral 16 indicates a dynamo circuit which is co-extensive with that portion of the road controlled by the system of signals. This circuit is supplied continuously with current by a generator 17, at one or more points in said circuit. The electro-magnets 12 are all energized by circuits 18, which are derived from the dynamo circuit. Included in each of these derived circuits is a contact 19 and a circuit-breaker, or switch-arm 20, which is normally drawn off the contact 19 and against a back-stop 21 by a spring 22. It will be noted from Figs. 1 and 1^a that the derived circuits, as well as the dynamo circuit are all normally closed.

In suitable position, with relation to the contacts 19 and circuit-breakers 20 are arranged electro-magnets 23, which, when energized, will exert an attractive force upon armatures 24, mounted upon the circuit-breakers 20, sufficient to overcome the tension of the springs 22 and draw the contacts upon the circuit-breakers against the contacts 19,

thereby completing the derived circuits 18 and enabling the current to flow from the dynamo-circuit through the helices of the magnets 12 which attract the arms 9 and 9ª, rocking the shaft 8 and raising the weighted arms of the semaphores, thereby causing the arms 3 of the latter to sink to a position indicating safety, where they will remain as long as the derived circuits 18 remain closed.

The electro-magnets 23 lie in local circuits 25, each of which includes the rails of one of the insulated track-sections, the terminals of the coil of the magnet being suitably connected to said rails at or near one end of the track-section. Each local circuit is supplied with current by a local battery L B, the opposite poles of which are suitably connected to the respective rails at the end of the block, or section, which is farthest removed from the point where the terminals of the magnets 23 unite with the said rails. As these local batteries all work upon a closed circuit, it is evident that the local circuits 25 will be supplied continuously and that the magnets 23 lying in said circuits being saturated, will hold the circuit-breakers 20 in such position as to complete and normally maintain the derived circuits 18. Under these conditions, when a train enters the block, or section, upon either track, moving in the direction indicated by the arrow, the local battery of the track-section on which the train is moving will be short-circuited by the wheels and axles and the magnet 23 being thus deprived of energy, the circuit-breaker 20 is instantly thrown off the contact 19, thus opening the derived circuit 18 and rendering the electro-magnets 12, which are in said circuit, inert. The weighted end of the semaphore-arm upon the pole at, or near, the entrance to the block, being no longer sustained by the attraction exerted by these magnets, drops and raises the semaphore to the position indicating danger. It will remain in this position as long as the train, or any portion of the same, remains on the block. When the last pair of wheels have passed off the rails of the insulated track-section, the current from the local battery again flows through the coil of the magnet 23, the armatures 24 are attracted and the circuit-breaker 20 is restored to its former position with its contact resting upon the contact 19. The derived circuit 18 being again completed, the magnets 12 receive current from the dynamo-circuit and the semaphore is returned to the position denoting safety, the entire series of operations being automatic.

Audible signals may be employed, either in conjunction with the semaphores, or independently. For example, a gong 26 (Fig. 1ª) may be placed upon the semaphore support standing nearest to a crossing, the bell or gong being sounded by the current from a battery B B, of comparatively low tension. The circuit of this battery is from the positive pole, through the bell coil, thence by a wire 27 to a contact 28, arranged opposite a switch-arm 29, which forms part of the circuit-breaker 20; thence to a second contact 30, also located within the range of movement of the switch-arm 29, and from the contact 30 to negative pole of the battery. When the derived circuit 18 is completed, the switch-arm 29 is drawn off the contacts 28 and 30, and the bell-circuit is broken. When the magnet 23 is short-circuited, the circuit-breaker 20 is thrown by its spring 22 against the back-stop 21, and by this movement the switch-arm 29 is brought against the contacts 28 and 30, thereby completing the bell-circuit, which will remain closed until the train has entirely passed off the block.

In applying the invention to a line of road using a single track, the modification is very slight. The track-sections of the several blocks are laid off and insulated as already explained and the continuous dynamo circuit and the several local circuits, each supplied from an independent local battery and each including the rails of one of the insulated track-sections, are all substantially the same. The semaphores, also, are held in the position denoting safety by means similar to those already described. The principal alteration consists in the manner of connecting the derived circuits with the controlling magnets. Referring to Figs. 2 and 2ª, taken together, which show the terminals and one or more intermediate portions of a single track system of signals, the several parts indicated by reference-numerals already employed, do not differ materially from what has been described heretofore. The semaphores are arranged upon both sides of the track, but those upon one side are not provided with the restoring magnets 23. The derived circuits 18, however, are each traced as follows: from the positive wire of the dynamo circuit to the circuit-breaker 20, thence through the contact 19 and helices of the controlling magnets 12, to the helices of the like magnets on the semaphore located on the opposite side of the track and at the other end of the block, or track-section, and from the magnets last named back to the other or negative wire of the dynamo circuit. Each derived circuit 18, therefore, has an extension, indicated by the reference numeral 18ª, which includes and controls a second semaphore at the other end of the block. Both these signals are set to "danger" at the moment the train enters the block, without regard to the direction in which the train is moving, and both signals remain set until the last pair of wheels in the train pass out of the block. Thus, a following train cannot enter a block until the preceding train has moved out of it, and as a train running in the opposite direction will set the signals in the block toward which the first train is approaching, neither train will get upon the same block at the same time unless the signals are wholly disregarded.

The switches upon both single and double

tracks may be provided with means for automatically setting the signals upon the same block to "danger." In Figs. 2 and 2ª a siding 31 is shown having the ordinary switch-rails which are operated by a switch-lever 32. Connected with the latter is a contact 33 having electrical communication with one of the rails of the insulated track-section by a wire 34. When the switch is opened the contact 33 is brought against a separate contact 35, connected by a wire 36 to the other rail. By opening the switch the local battery is short-circuited and the magnets 23 and 12 are cut out of circuit in the manner already explained, thereby causing the semaphore to move to "danger." It may be remarked that the breaking, removal, or displacement of a rail in any block will have the same result, due to the total interruption of the local circuit which feeds the magnet 23.

In Fig. 3 of the drawings I have shown the invention in a slightly modified form to adapt it to work upon circuits which are normally open. A single track only is shown in said figure, but an installation upon a double track would be merely a duplication of the parts shown.

In using open circuits, I prefer that the insulated track-section shall have one terminal lying between two adjacent semaphores, at some suitable point, while the other terminal occupies about the same relative position between the second and third semaphores. For example, the semaphores (which are denoted by the same reference-numerals already used), are arranged alongside the track at such intervals as circumstances may require. The insulating separations 2 on one side *b* of the track are located at or near the semaphores, but on the other side *b'* of the same track these insulations are placed at a distance of from three to six hundred yards in advance of those on the side *b*. The local batteries L B are connected to the rails of the track-sections in the same way already described in connection with Figs. 1, 1ª, and 2, 2ª. The coil terminals of the electro-magnets 23, however, are connected one to the insulated rails on the side *b* on one side of the insulation 2, and the other terminal to the rails upon the other side of the same insulation. The derived circuits for the magnets 12 are the same as heretofore described.

Let it be supposed that a train, moving in the direction indicated by the large arrow, in Fig. 3, passes the insulation 2 upon the side *b'* of the track, this point being at a distance from the semaphore of from three hundred to six hundred yards. The moment that two wheels come upon the rails between said insulation and the semaphore, the local battery arranged between the two semaphores and connected to the rails, is brought into circuit through the rails on the side *b'*, through the wheels of the train, the rails on the side *b*, at the right of the insulation 2, then through one terminal of the electro-magnet 23, through the coil and other terminal, through the rails of the left of the insulation 2, and back to the other pole of the battery L B. The circuit-breaker 20 is thereby thrown against the contact 19, whereby the derived circuit 18 of the magnets 12 is completed and the semaphore-arm 3 at once moves to safety, thus notifying the engineer that the block is clear. If another train happens to be on the block, at the same time, the local battery L B will be short-circuited and when the approaching train passes the first insulation 2, on the side *b'*, the semaphore-arm, instead of falling to "safety," will remain at "danger," thus warning the engineer in ample time to enable him to stop his train before he passes the semaphore and enters the block.

In order to make the system automatic throughout and in all its details, I may use a suitable type of storage cell, or accumulator, in forming the local batteries L B. A battery of this kind is shown, conventionally, in Fig. 4, and indicated by the reference-letters L S B. In connecting the same I provide a re-generating, or charging circuit by a wire 37 from the positive wire of the dynamo circuit to the negative pole 38 of the battery; thence by a wire 39 from the opposite pole to a contact 40 which also serves as a back-stop for a circuit-breaking armature lever 41, and from the pivotal support 42 of said lever by way of a wire 43 to the negative wire of the dynamo circuit. The battery is connected to the track by wires one of which is connected to one terminal of an electro-magnet 44, arranged to attract the armature on the lever 41. The magnet 44 is of suitable strength, relatively to the magnet 23, so that when the battery becomes so far run down that the attraction of the magnet is not sufficient to overcome the strength of a spring 45, by which the armature-lever 41 is drawn toward the contact 40, the charging circuit will be switched in automatically and will re-charge the storage-battery. When the latter is sufficiently restored the magnet 44 will again attract the armature-lever 41 with sufficient force to overcome the spring 45, breaking the charging circuit thereby, and this operation will take place automatically as often as the condition of the local battery may require. My invention, however, is in no sense restricted to the use of this type of cell, or to automatic regeneration of the same. I have indicated the local batteries in the other figures of the drawings conventionally and I may use primary, or secondary cells therein of any preferred kind.

Resistances R may be interposed in the derived circuits at such points as are deemed best, to equalize the current as far as possible throughout the series and any suitable form of rheostat may be adopted for this purpose.

Among the advantages secured by my invention, I may mention the following as especially prominent. In the first place, by using a continuous dynamo circuit to supply the derived circuits which saturate the elec-

tro-magnets 12, and excluding the track-rails from these circuits, I am enabled to extend a continuous system of signals over a line of considerable length without being compelled to employ generators of very high tension, as would be necessary to overcome the resistance and supply the excessive leakage of current from track circuits. When working upon an open circuit an entire system of signals can be controlled with the expenditure of a low degree of electric energy. By employing a separate local battery for each local circuit I secure much greater certainty and uniformity of action, as the battery can, if necessary, be easily regulated to any material difference in resistance, or tendency to leakage, found to exist in the external, or track circuit, which would be practically impossible in a series of track-circuits all fed with current from a single generator. Again, the semaphores are, by my invention, moved to and held in the position indicating "safety" by the presence of current in the helices of the controlling magnets 12. The semaphores are moved to the positions indicating "danger" by gravity, and are maintained in that position by the same force until the electrical conditions upon which their restoration to "safety" depends have been fulfilled. The danger indications do not, therefore, depend upon the completion of one or more circuits, or the presence of current therein, or in any part of the system. It is impossible for this reason, that disaster should take place due to an absence of any warning signal caused by defects in the circuits, accidental short circuits, or tampering with the wires. The cutting of a wire in any local or derived circuit, the removal, or displacement, of a rail, or the opening of a switch, either by carelessness, or with intent to wreck a train, would simply result in the immediate display of the danger signal and its retention in that position; while the cutting of the dynamo-circuit, should this be done under the impression that the proper action of the signals would be prevented thereby, would immediately result in displaying every danger signal upon the line. The safety of a train does not depend, therefore, upon unvarying accuracy in the apparatus, permanent freedom from accident thereto, and the production of absolutely uniform results from causes which are constantly varying. The most serious effect that can follow any failure in my system is the display of a danger signal without actual cause. This, however, will rarely happen, as ordinary care will insure the accurate operation of the entire system.

What I claim is—

1. In an electrically operated signal for railways, the combination with a semaphore-arm, of a rock-shaft having a lever connected thereto and provided with two or more arma-ture-bearing arms one of which is rigid on said shaft and the other loose, the latter having a segmental slot to receive a pin projecting from the surface of the rock-shaft, and two electro-magnets adapted to attract the armatures on said arms, substantially as described.

2. In an electrically operated system of signals for railways, the combination with a series of blocks, or sections, and insulated track-sections within said blocks, of an external dynamo-circuit co-extensive with the series of blocks, a series of derived circuits, a series of electro-magnets, one for each block, semaphore-arms adapted to be moved by the magnetic attraction of said magnets, a circuit-breaker in each derived circuit, an electro-magnet adapted to attract an armature on said circuit-breaker, a circuit for said magnet including the rails of the insulated track-section in the same block, a local battery connected in series to said rails, an audible signal, a circuit and battery for the same, and a switch-arm on the automatic circuit-breaker adapted to switch the audible signal in when the circuit-breaker opens the derived circuit, substantially as described.

3. In an electrically operated system of signals for railways, the combination with a semaphore and with means for moving the same, of a dynamo circuit, a derived circuit, a circuit-breaker included in the derived circuit, electrical means for closing said circuit, a local circuit, a local storage battery, a charging circuit fed from the dynamo-circuit, and including an automatic circuit-breaker, a back-stop contact for the latter completing the charging circuit, and an electro-magnet included in the local circuit and adapted to attract an armature on the circuit-breaker in the charging-circuit, substantially as described.

4. In an electrically operated signal for railways, the combination with a storage-battery, of a dynamo-circuit, a charging-circuit, an automatic circuit-breaker forming part of the charging-circuit, a back-stop forming a contact which completes the charging-circuit, and an electro-magnet the coil of which is supplied with current from the storage-battery, its core being adapted to attract an armature on the circuit-breaker, substantially as described.

5. In a system of electrically operated signals for railways, the combination with a single track divided into a series of blocks, or sections, insulated from each other, of two series of semaphores, one on each side of said track, a series of levers to hold the signal arms thereon at "safety," electro-magnets to operate said levers, a continuous dynamo circuit to feed the signal-operating circuits of the semaphores on one side of the track, each including a circuit-breaker, electro-magnets to control the circuit-breakers, local circuits for the latter electro-magnets, local batteries to feed the local circuits; and a series of extensions of the signal-operating circuits to the magnets of the semaphores on the other side of the single track, said semaphores be-

ing placed at the farther end of the block, substantially as described.

6. In a system of electrically operated signals for railways the combination with a single line of track divided into blocks which are electrically isolated, from each other, of a series of semaphores on one side of said track, levers to hold the arms of the same at "safety," electro-magnets to operate said levers, a dynamo circuit, a series of derived circuits for the said electro-magnets, each including a circuit breaker, a series of electro-magnets to control the circuit-breakers, local circuits for the latter magnets, local batteries to feed the same, a second series of semaphores arranged on the other side of the track and at the opposite ends of the several blocks, relatively to the other series, a series of electro-magnets holding the signals of the second series at "safety," and a series of extensions of the signal operating circuits from the second terminals of the electro-magnets of the first series of semaphores to the first terminals of the electro-magnets of the second series, substantially as described.

In testimony whereof I have hereunto set my hand and affixed my seal in presence of two subscribing witnesses.

MATTHEW SIMPSON REILEY. [L. S.]

Witnesses:

ALBERT H. NORRIS,

JAMES L. NORRIS.