(No Model.)

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ELECTRIC CIRCUIT FOR RAILWAY SIGNALING.

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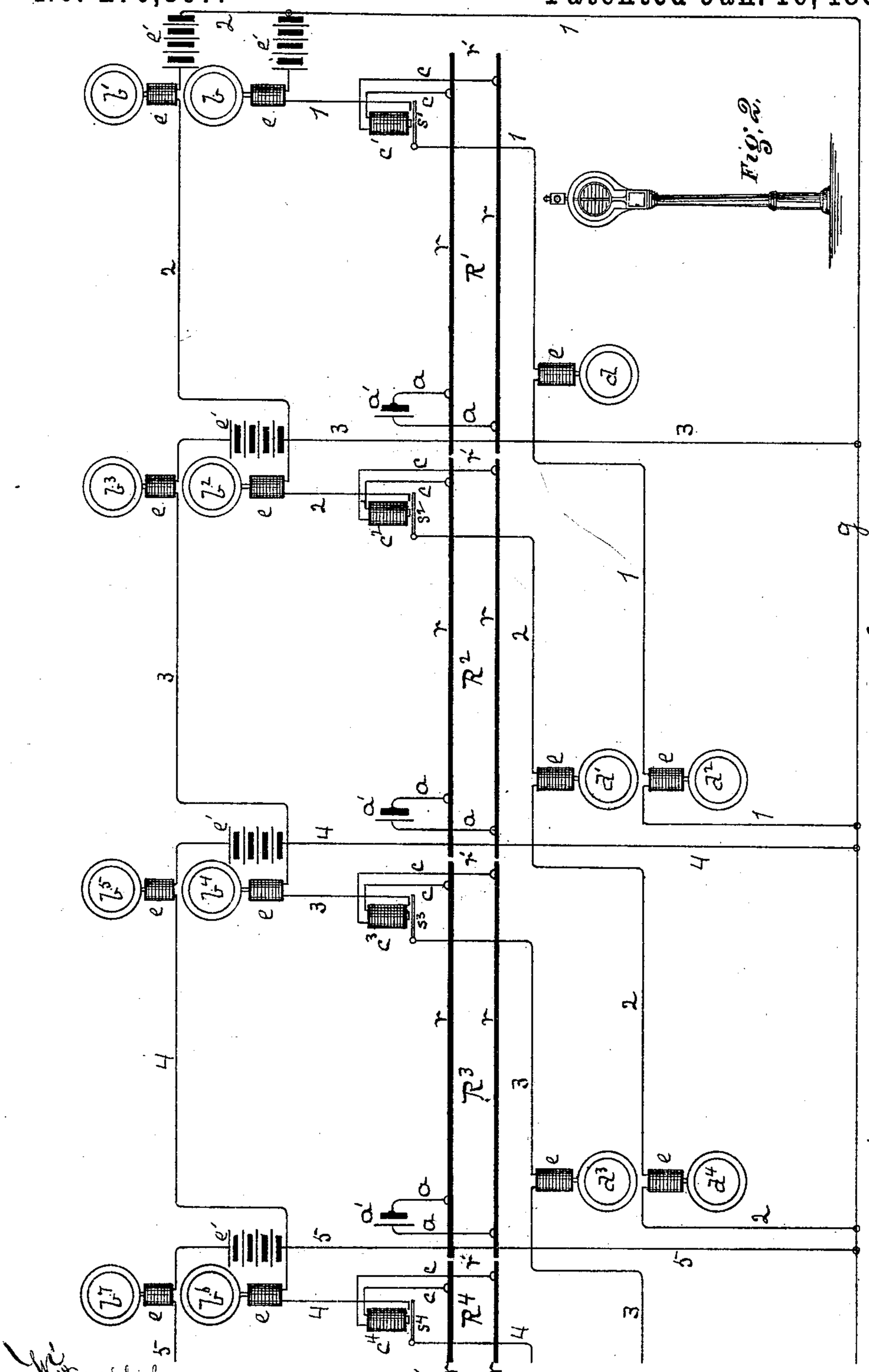

UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., OF PITTSBURG, PENNSYLVANIA.

ELECTRIC CIRCUIT FOR RAILWAY-SIGNALING.

SPECIFICATION forming part of Letters Patent No. 270,867, dated January 16, 1883.

Application filed November 16, 1882. (No model.)

To all whom it may concern:

Be it known that I, GEORGE WESTINGHOUSE, Jr., of Pittsburg, county of Allegheny, State of Pennsylvania, have invented or discovered a new and useful Improvement in Electric Circuits for Railway-Signaling; and I do hereby declare the following to be a full, clear, concise, and exact description thereof, reference being had to the accompanying drawings, making a part of this specification, in which—like letters indicating like parts—

Figure 1 is a diagrammatic view of a portion of a railway-track and electric signaling apparatus illustrative of my present invention, and Fig. 2 is a detached view of a signal-post and banner-signal of one form or style suitable for use in connection with the present invention.

In the construction of electrically-actuated block-signaling apparatus for single-track railways, where the circuit closers or breakers are worked by or from the train, it has been found exceedingly difficult (except, perhaps, at very great expense) to organize the apparatus so that any two trains approaching each other from opposite directions shall under all possible conditions have each its own danger-signal displayed in its own front before it can reach the position occupied by the other train, and at such distance from the other train that (it having also its danger signal displayed in its front) both trains can be stopped before collision can occur. My present improvements, while applicable in some of their features to other like organizations of apparatus, are especially designed to this end.

In the drawings I have shown three blocks or sections of track, R′ R² R³, and a part of a fourth, R⁴, each of which may be of any desired length—say a mile, more or less. The ends of the sections or blocks are to be insulated, as at *r′*, and the successive rails in each line *r*, between insulated points, are to be electrically connected in any suitable way—as, for example, is done in the well-known Robinson closed-track-circuit system; also, the opposite lines of rails of each section are connected by wires *a a* at or near one end with a suitable battery, *a′*, and by wires *c c* at or near the other end with a magnet, and I have shown one of such magnets to each track-circuit, and have lettered them *c′*, *c²*, *c³*, and *c⁴*. This, also, is common in the Robinson system referred to; but instead of using these magnets to actuate signals I employ them as relays. The method of short-circuiting such track-circuits by the connection through wheels and axle from rail to rail is so well known that further description is unnecessary.

My present invention in its preferred form is so organized that each train will as it enters on each block or section shift a signal to "danger" at the entrance or end of the block and in full view of the engineer; also, will shift a signal to "danger" at any desired distance in its rear, and, still further, will shift to "danger" two other signals at any desired distances in front—say one at the other terminus of the same block and the other at the farther terminus of the next block—and so that such danger-signals shall remain at "danger" so long as the supposed train or any part thereof shall remain on that block.

Assuming, now, that the right-hand end of the drawing indicates the end of the road or the terminal station, I proceed in the erection and application of my improved apparatus to erect preferably on each side of the track two sets of signals. These may be of any known or desired construction, and either of the banner form or type, which ordinarily turn on a vertical axis, or of the semaphore type, which move or swing in vertical planes, or of other desired construction. The signal-post and banner-signal thereon, in illustration of one of the many constructions, are represented in Fig. 2. The signals of this or other desired or convenient construction are arranged at *b b′ b² b³ b⁴ b⁵ b⁶ b⁷*, and so on in series along one side of the track, and preferably in pairs at or near the ends of the blocks. A like series may be arranged on the opposite sides of the track at the points *d d′ d² d³ d⁴*, and so on along the series of blocks or sections, and preferably in twos, as indicated. Each signal is provided with a magnet, *e*, and each signal-circuit has a suitable battery, *e′*, by means of which the signal-magnet is caused to actuate, through suitable mechanism, the corresponding signal. Such mechanism I have not thought it necessary to show in the drawings, since the manner of making it in multitudinous forms is well known in the art, both for banner and

semaphore signals. The signal mechanisms and batteries thus represented are connected electrically by suitable wires, as follows: The line *g* may be termed the "ground-wire," which may represent simply ground-connections for several wires leading to the ground. The circuit which I will now term "No. 1" is formed by the wires 1, commencing on the right, passing through the battery and magnet of the signal *b*, thence to a point in such position relative to the armature *s'* and magnet *c'* that the circuit may be broken and closed by the movement of said armature, thence to the magnet of signal *d*, thence to the magnet of signal d^2, and thence to the ground. The circuit No. 2 commences on the right by wires 1, but leads by wires 2 to the battery and magnet of signal *b'*, thence to magnet of signal b^2, thence to a convenient point for the making and breaking of the circuit by the movement of the armature s^2 of the relay-magnet c^2, thence from said armature to the magnet of signal *d'*, and thence to the magnet of signal d^4, and thence to the ground. The circuit No. 3, starting from the ground by wire 3, passes through battery and magnet of signal b^3, thence to the magnet of signal b^4, thence to the contact-point for making and breaking the circuit by the movement of armature s^3 of magnet c^3, thence from said armature to the magnet of signal d^3, and thence to the magnet of the signal at the farther terminus of block-section R^4, thence to the ground. The circuit No. 4, commencing with wire 4, passes through the battery and magnet of signal b^5, thence to magnet of b^6, thence to the contact-point in connection with armature s^4 of relay-magnet c^4, and thence to the other signal-magnets—one at the farther terminus of block-section R^4 and the other to the farther terminus of the next block beyond. The circuit No. 5 commences by wire 5, passes through the battery and magnet of signal b^7, leads to a like series of signal-magnets through the circuit-closing armature of a like relay to those already described.

It will be understood that the several armatures *s' s²*, &c., operate as circuit closers and breakers. When the track-circuits are closed or are not short-circuited, the several relay magnets *c' c²*, &c., are excited, so as to attract their respective armatures, and thereby bring them into engagement with the several wires or contacts in circuits 1 2 3, &c., so as to complete said circuits; but when the track-circuits are short-circuited or broken the relay-magnets *c' c²*, &c., being cut out from the influence of their respective batteries, release their respective armatures, which, acting under the effect of gravity, retractile springs, or other devices, drop from their contact-points, and the corresponding circuits are broken.

In the preferable construction of this apparatus the circuits, when closed, hold the signal thereon to "safety," and when the circuits are broken the signal comes to "danger," either under magnetic influence or as a result of gravity, a spring, weight, or other means suitable for the purpose.

Assuming, now, that the train starts from the right and enters on the first block-section, R', its first effect is to short-circuit the track-circuit, so as to actuate the relay-magnet *c'* from the influence of its battery, and as a result of this the armature *s'* clears the magnetic pole or poles, and circuit No. 1 is broken at that point. As a result of this, the signal at *b* will come to "danger," so as to protect the rear of the train, and the signals *d* d^2, the magnets of which are included in the same circuit, will also come to "danger," and thereby protect the train as against trains coming from opposite direction. This condition of the signals will remain so as long as the train or any part thereof remains on the section R'. As soon as the forward end of the train passes onto the block-section R^2, and even while the rear of the train remains on the section R', it will short-circuit the track-circuit of block R^2, and by cutting out the relay-magnet c^2 from the influence of its battery will cause or permit the armature s^2 to clear the magnet pole or poles, and by breaking contact with the wires or contact of circuit No. 2 will break said circuit and shift the signals thereon to "danger"—to wit, *b'* at the rear of the previous section, R', b^2 at the entrance of section R^2 will come to "danger" to protect the rear of the train, and the signals *d'* at the farther end of the block-section R^2 and d^4 at the farther end of the next section, R^3, will also come to "danger" in such a manner as to protect the train as against a train approaching from the opposite direction. The train thus supposed, so long as it or any part of it remains on block-section R^2, is thus protected by two signals in the rear and two in the front, and the rear signal, *b'*, is at least the length of a block to the rear, and another of said signals, d^4, is at least the length of a block in advance. As soon as the tail of the train clears the first block-section, R', the circuit is restored through the track-circuit, so that its magnet *c'* again comes within the influence of its battery *a'*, whereby its armature *s'* is attracted, so as to make contact with the corresponding wire, 1, of circuit No. 1, and as a result of this the magnets of signals *b*, *d*, and d^2 are excited and the signals go to "safety." Hence a train following, on finding signal *b* at "safety," will know that track-section R' is clear or unoccupied; but finding signal *b'* at "danger" the engineer will know that the next section, R^2, is occupied. As the train leaves block-section R^2 and its forward end enters on section R^3, cutting out the relay-magnet c^3 from the influence of its battery will release its armature s^3, so as to break the circuit No. 3, as a result of which the signals b^3 at the rear end of block-section R^2 and b^4 at the entrance of block-section R^3 will come to "danger," so as to protect the rear of the train, and the signal d^3 at the forward end of said section R^3 and a like signal at the farther end of the next sec-

tion, R^4, will come to "danger," so as to protect the front of the train in the manner already described. As soon as the rear of the train leaves the block-section R^2 the track-circuit will be restored through its relay-magnet c^2, as a result of which the armature s^2 will be attracted, and circuit No. 2 will again be closed, so as to clear signals b', b^2, d', and d^4. Consequently the engineer of a following train, on coming to section R^2 and finding the signal b^2 at "safety," will know that block-section R^2 is unoccupied, but finding signal b^3 at "danger" he will also learn that block-section R^3 is occupied. In the three cases supposed the engineer of a train coming in the opposite direction will be notified by the signal at the left hand in section R^4, or by the signal d^4, or by the signal d^2 that the second block-section beyond himself is occupied by a train, even though he may not know the direction in which it is moving. Assuming, now, a train coming from the opposite direction or from the left-hand end of the drawing, on entering section R^4 it will short-circuit the track-circuit thereof and release the armature s^4, and thereby will set at "danger" a signal in its rear at least a block's length, and another signal at the left-hand end of the block-section R^4, and also will set at "danger" two other signals, b^6, at the right-hand end of block-section R^4, and also the signal b^5 at the right-hand end of block-section R^3, all said signals being on circuit No. 4. Hence such supposed train will move over block-section R^4, be protected by two signals in its rear as against a following train, and by two signals in front as against trains coming in an opposite direction. As the forward end of the supposed train enters on section R^3 it will short-circuit No. 3 in the manner already described, so as to display a danger-signal at the left-hand end of the block R^4, and also set a danger-signal, d^3, at the entrance of block-section R^3, whereby to protect its rear, and will also set a danger-signal, b^4, at the right-hand end of said section, and also signal b^3 at the right-hand end of said section R^2, all said signals being on circuit No. 3. As soon as the rear of the train leaves block-section R^4 circuit No. 4 will be restored and the signals thereon come to "safety." As the train enters on block-section R^2 it short-circuits the track-circuit thereof, so as to release armature s^2, and thereby breaks the No. 2 circuit, and thereby sets at "danger" signals d^4, d', b^2, and b', all of which are on circuit No. 2, whereby it is protected in front and rear, as before, and the engineer of a following train—say on track-circuit R^4—on finding signal d^3 at "safety" and d^4 at "danger," will know that the block-section R^3 is unoccupied and that R^2 is occupied. This orderly movement of the signals will go on regularly as the trains pass from block to block, and at all times every train, whatever way it may be going, will be protected both in front and rear by at least two signals in either direction, one of which in front, and one in the rear at a considerable distance, and while I have described these distances as being a block's length I do not mean to limit myself thereto, as they may be arranged at any desired distance, and the minimum distance should be that at which trains in all cases should be kept apart.

To illustrate, now, the impossibility of an accident by meeting trains, I will assume a train on block-section R', and moving from the right, which I will call "train No. 1," and another train on block-section R^3, coming in opposite direction, and this latter train I will call "train No. 2." Train No. 2 will find signal d^2 at "danger," from which it will know that section R' is occupied, and as train No. 2 cannot in its moving have any effect on the position of this signal, even in case it should run onto section R^2 accidentally or otherwise, there cannot possibly be any conflict of signals, nor any doubt as to what these danger-signals may mean. Hence the train No. 2 is bound to stop or to proceed with caution. At the same time train No. 1, on approaching the left-hand end of track-section R', will find signal b^3 at "danger," and for the reason before stated there can be no conflict between the trains in the setting of this signal, nor any doubt as to its meaning. Hence the engineer of train No. 1 will know that section R^3 is occupied, and that he must either stop or proceed cautiously, as train orders may require. Hence even if both trains come to and run onto the opposite ends of block-section R^2 at the same instant of time, there can be no conflict of signals, for each train having set its own danger-signal in its own front at least a block's length in advance, at a point where it cannot be affected by the movement of the other train, both trains are cautioned or warned each of the other's presence or approach while they are at least a block's length from each other.

The preferable arrangement of the signals is that illustrated in the drawings, whereby the following ends are attained: The signals $b\,b^2\,b^4\,b^6$, which are set to "danger" by the train coming from the right, are arranged at such distance inside the terminals of their respective blocks that as the engineer enters on the block he will see the corresponding signal shift from "safety" to "danger," and thereby will know that the circuit is in working order, and that the distant rear and front signals will also act as described; also, the engineer of the following train will know that the other set of signals, $b'\,b^3\,b^5\,b^7$, are the rear distant signals of the preceding train; also, the engineer of a train when coming in an opposite direction will observe the movement from "safety" to "danger" of signals d^3, d', and d as he enters on the corresponding blocks. Consequently he will accordingly know that his distant front and rear signals are in corresponding position, and the engineer of the train following from the left, knowing that the signals d^4 d^2, &c., are the rear distant signals of the preceding train, will accordingly be guarded in his move-

ments; but this particular order, arrangement, and position of the several signals thus designated may be varied at pleasure without departing from the scope of the present invention.

Preferably each pair of signals b b' and b^2 b^3 are arranged on the same post, one above the other, as also the signals d' d^2, &c.; but I do not consider it essential that more than two signals be employed on each signaling-circuit; but these two which are employed should be the ones above referredto as "front" and "rear" distant signals. Thus, for example, on circuit No. 2 the signals b^2 and d' may be omitted, and on circuit No. 3 the signals b^4 and d^3 may be omitted, and so on through the circuits. The only important difference in operation will be that the engineer will not be advised by the movement of a signal in his face that the circuits are in working order; but if such two middle signals on each circuit be omitted the end or outer signals may, especially if the blocks are long, be brought nearer together, provided only that the rear signal be far enough to the rear to be seen by the engineer of a following train before he enters on the next block to the rear of the block occupied, and that the front signal be far enough in advance to be seen by the engineer of an approaching train before he enters on the next block in front of the block occupied.

The number of blocks or sections is not material, and a dangerous place in a road may be protected by a series of three or more block-sections, each as long as may be desired; also, if desired for purposes of additional protection, additional signals may be added—two or more in each signaling-circuit. If two be added, I arrange them one at any desired point—say between the signals b' and b^2, and preferably about one thousand feet distant from b^2—and the other between d' and d^4, and about a like distance from d', and in like manner as to the other circuits; or the circuits may be lengthened and the two added signals may be arranged farther out on the circuits—say a thousand feet to the right and left of the distant signals shown and described; but it should also be stated that with the apparatus organized with four signals to a circuit the distant signals, instead of being at or near or beyond the extreme ends of the outer of three block-sections, may be inside such ends, but should be far enough—say one thousand feet, more or less—from the outer ends of the block-section from which the relay-magnet of such signaling-line is worked so that an approaching train may with reasonable certainty be stopped before such block-section is reached. Thus, for illustration, b' may be arranged a thousand feet or so from the right-hand end of section R^2, and d^4 a like distance from the left-hand end of said block, it being understood in such case that b^2 and d' are used as above described.

In organizing or erecting my improved apparatus on a double-track road one set of the signals described—say those shown on the upper side of the drawing, b b' b^2 b^3, &c.—may be arranged in connection with the track-circuits of the track on which trains move from the right, and the other set of signals, d d' d^2, &c., in connection with the other track, and the circuits are correspondingly shortened. Then it will be seen that each train will be protected as against following trains by two signals, one of which will be shifted in the face of the engineer as he enters a block, and the other a thousand feet (more or less) to his rear will insure the stopping of a following train in time to avoid a collision, even if the forward train should be disabled immediately after entering the block; and this construction and arrangement of the signals when the electromagnets of both are on the same circuit, so as to be operated by the same track-relay, I believe to be new.

I claim herein as my invention—

1. In a block-signaling system embracing three or more blocks, the combination of a track-circuit extending from end to end of each block, a relay-magnet in each track-circuit, a signaling-circuit operated by each such relay, and at least two signals on each such signaling-circuit, one of which is arranged at, near, or beyond the farther terminus of each next adjacent block, substantially as set forth.

2. In combination with a series of track-circuits electrically connected in blocks, a series of signals, b' b^3 b^5, &c., arranged at or near the entrance terminals of blocks, and each signal of one block being in the same circuit with a make-and-break mechanism operated by a train while passing over the next block, and also having in the same circuit one of a like series of signals, d^2 d^4, &c., at or near the opposite terminal of the third block, substantially as set forth.

3. In combination with a track-circuit and a relay-magnet therein, a signaling-circuit opened and closed by such relay, a signal, as at b^2 d', at or near each end of the track-circuit, and distant signals, as at b' d^4, arranged at the required distance in front and rear for safety, all such signals being on the same signaling-circuit, substantially as set forth.

4. In combination with a track-circuit and a relay-magnet therein, a signaling-circuit opened and closed by such relay, and at least two signals in such signaling-circuit, one of which is arranged at or near the entrance end of such track-circuit and the other at the required distance to the rear for safety, substantially as set forth.

In testimony whereof I have hereunto set my hand.

GEORGE WESTINGHOUSE, JR.

Witnesses:
R. H. WHITTLESEY,
GEORGE H. CHRISTY.