No. 663,376. Patented Dec. 4, 1900.

L. C. WERNER.

ELECTRICAL RAILWAY SIGNALING SYSTEM.

(Application filed Nov. 8, 1899.)

(No Model.) 5 Sheets—Sheet 1.

Fig. 1.

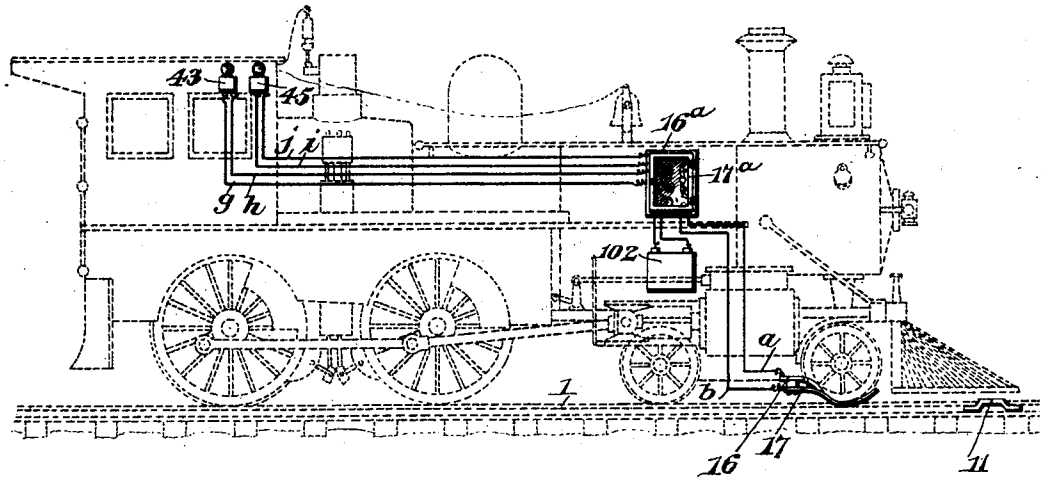


Fig. 4.

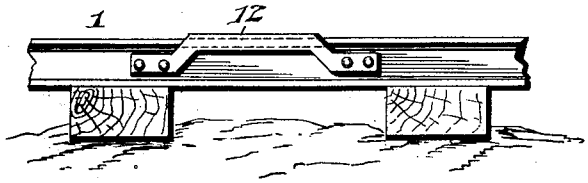


Fig. 5.

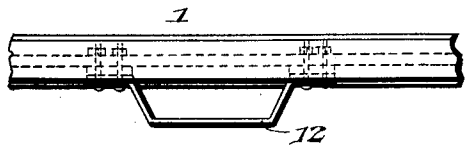
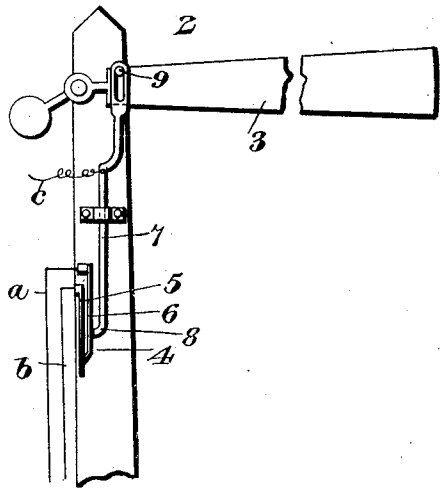


Fig. 6.

Fig. 7.



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(No Model.) 5 Sheets—Sheet 2.

Fig. 2.

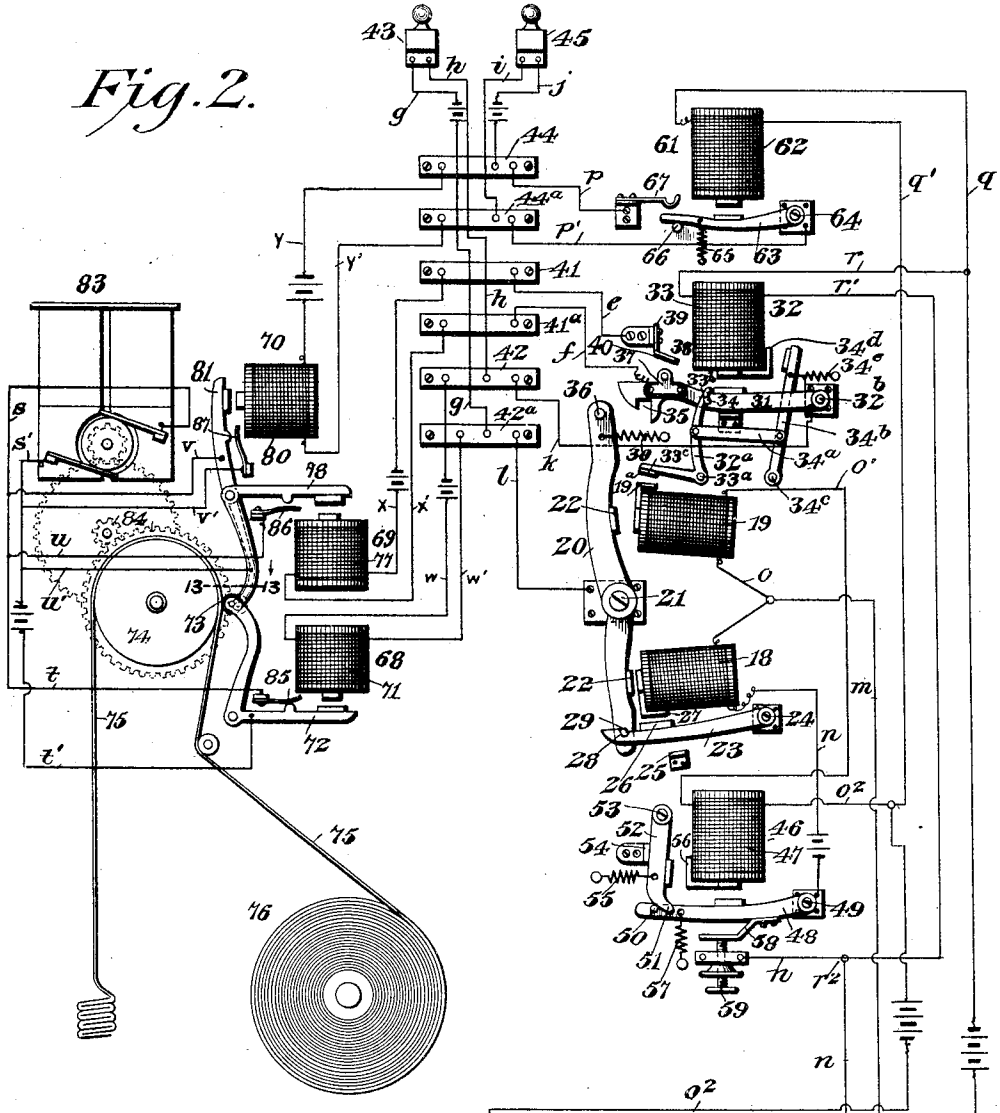
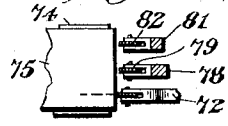


Fig. 13.



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(No Model.) 5 Sheets—Sheet 3.

Fig. 3.

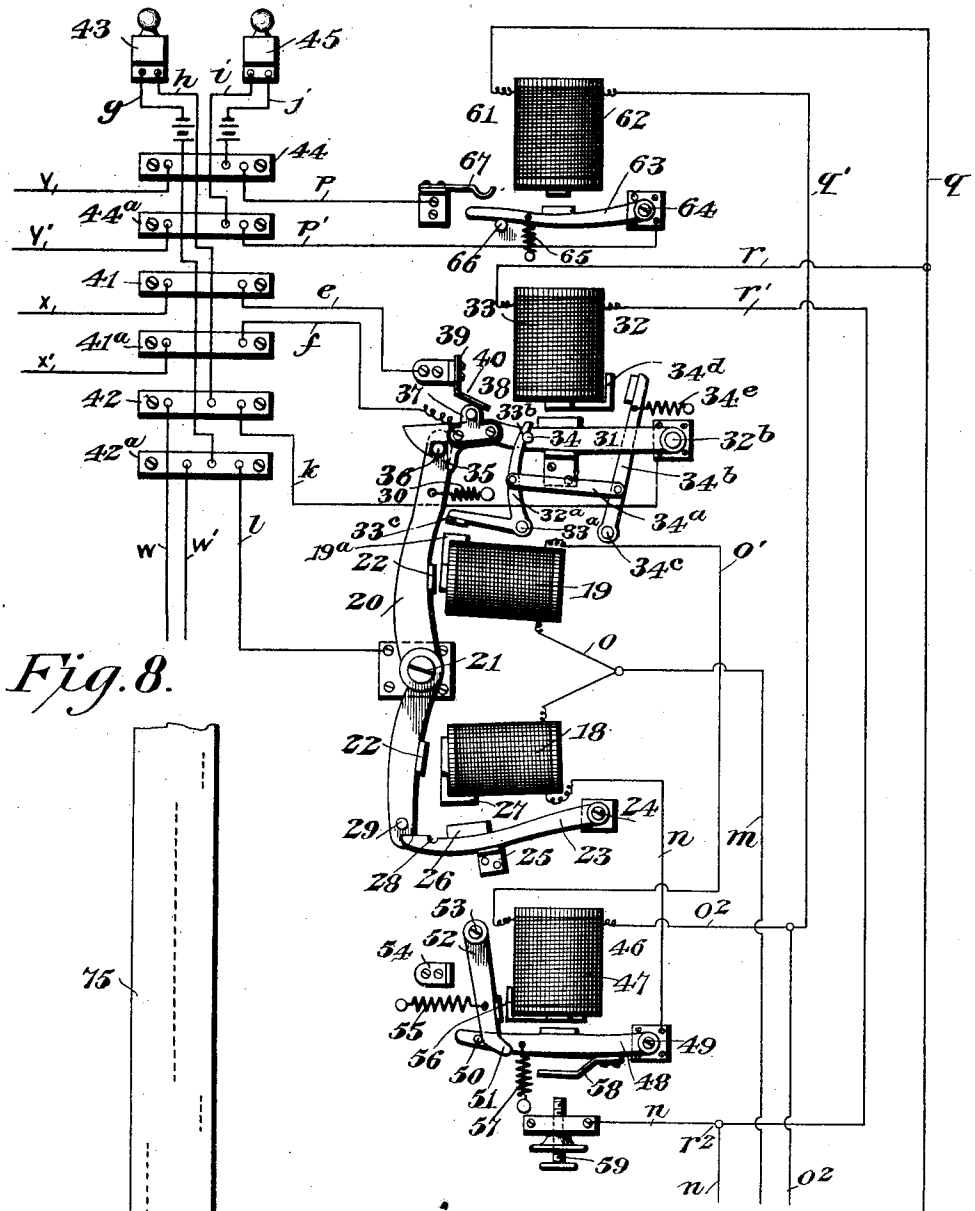

Fig. 8.

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(No Model.) 5 Sheets—Sheet 4.

Fig. 9.

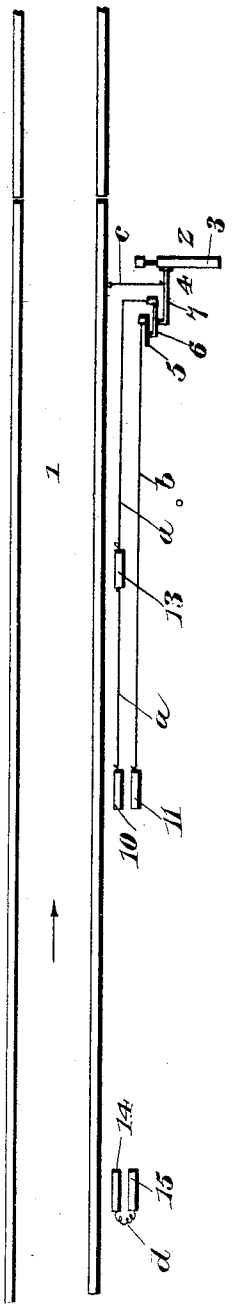
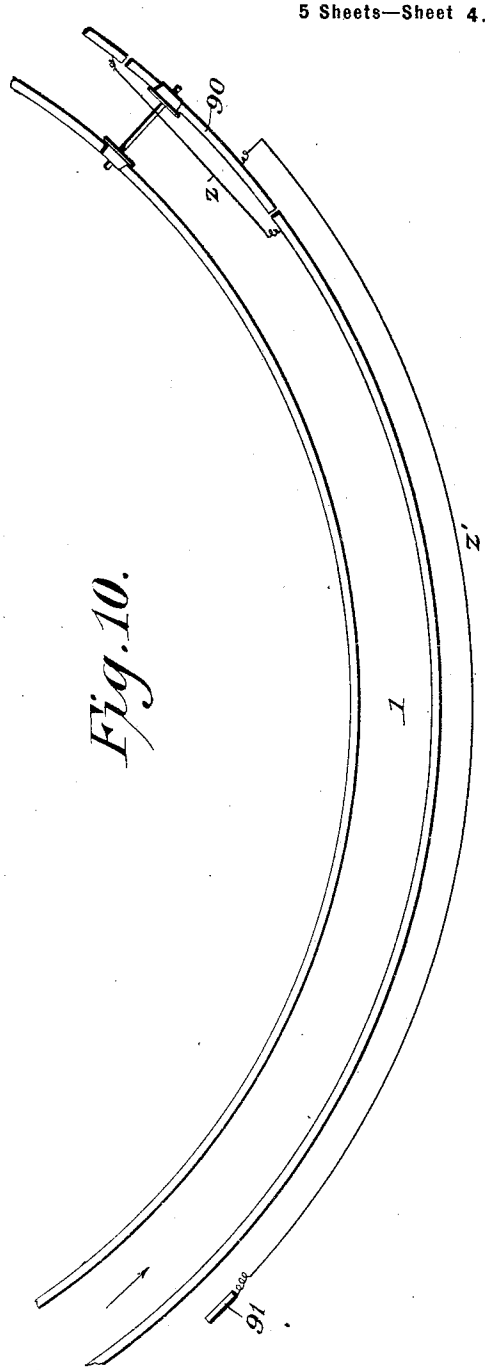


Fig. 10.



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(No Model.) 5 Sheets—Sheet 5.

Fig. 11.

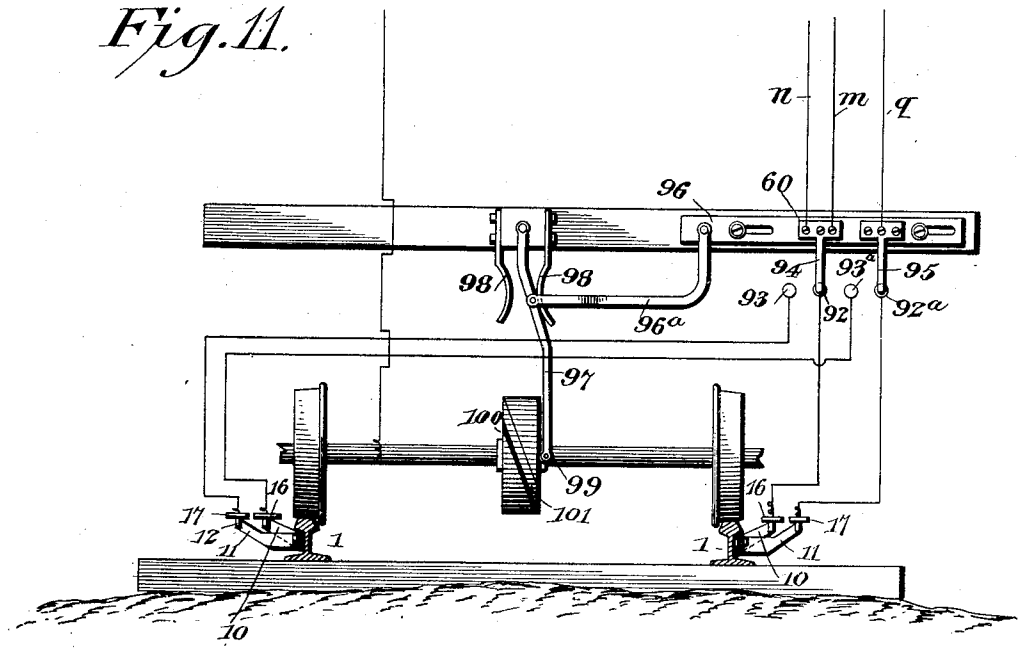
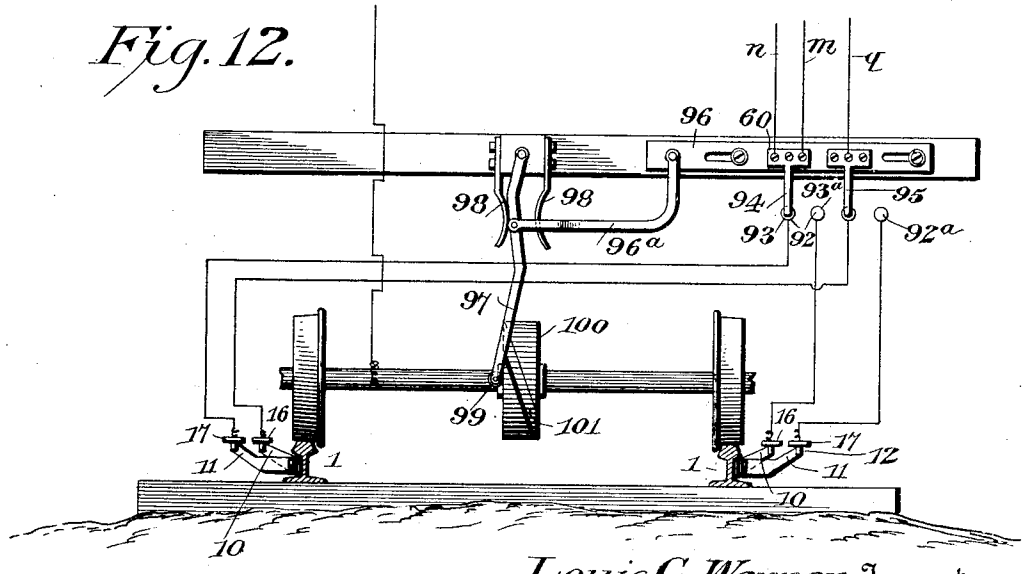


Fig. 12.



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UNITED STATES PATENT OFFICE.

LOUIS C. WERNER, OF LOUISVILLE, KENTUCKY.

ELECTRICAL RAILWAY SIGNALING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 663,376, dated December 4, 1900.

Application filed November 8, 1899. Serial No. 736,274. (No model.)

To all whom it may concern:

Be it known that I, LOUIS C. WERNER, a citizen of the United States, residing at Louisville, in the county of Jefferson and State of Kentucky, have invented a new and useful Electrical Railway Signaling System, of which the following is a specification.

This invention relates to electrical railway signaling systems; and it has for one object to equip a train with improved signaling mechanism, associated with suitable track devices, to provide reliable means for transmitting to the engineer in the cab a positive safety or a positive danger signal, thereby enabling the engineer to stop the train in time to avoid accidents.

A further object of the invention is to combine with the signal mechanism improved recording mechanism operating synchronously therewith and providing means for recording upon a suitable recording-tape the duration and intervals of the different signals, thereby providing a complete and accurate record of the action of the apparatus, and consequently providing means for keeping a tally upon the handling of the train by the engineer.

Another object of the invention is to make provision for automatically throwing into action different sets of contact devices, according to the direction in which the engine or train is moving, so that the apparatus will be caused to operate when the train is run backward as well as forward.

Another general object of the device is to provide the apparatus with a positive and efficient make-and-break circuit-closing device associated with the controlling-magnets for the safety and danger circuits and combined with means for positively holding the separate circuits locked against accidental disturbance.

With these and many other objects in view, which will readily appear as the nature of the invention is better understood, the same consists in the novel construction, combination, and arrangement of parts hereinafter more fully described, illustrated, and claimed.

While the essential features of the invention are necessarily susceptible to various modifications without departing from the spirit thereof, still the preferred embodiment of the improvements is shown in the accompanying drawings, in which—

Figure 1 is a side view of a locomotive, showing the preferable arrangement of the parts of the apparatus or system associated therewith. Fig. 2 is a diagrammatic view of the signal and recording mechanisms, showing the former with the parts thereof in the safety normal position. Fig. 3 is a similar view of the signal mechanism, showing the parts thereof adjusted in the danger position. Fig. 4 is a detail elevation illustrating a preferred form of track-contact used in carrying out the invention. Fig. 5 is a detail plan view of the construction shown in Fig. 4. Fig. 6 is a detail sectional view showing the manner of supporting a pair of the track-contacts at one side of a track-rail. Fig. 7 is a detail view of a track-signal or semaphore arranged for use in connection with the system as a part thereof. Fig. 8 is a detail plan view of a portion of the recording-tape used in connection with the recording mechanism. Fig. 9 is a diagrammatic plan view showing the usual arrangement of the track-contacts in connection with the track-signal or semaphore. Fig. 10 is a diagrammatic plan view illustrating a track-curve arranged to provide for actuating the signal mechanism to provide for notifying an engineer of his approach to a second train around a curve. Figs. 11 and 12 are enlarged detail views showing the preferable form of contact devices associated with the several circuits of the system and the track-contacts to provide for automatically throwing the different sets of contacts respectively at opposite sides of the track into action, according to the direction of movement of the train. Fig. 13 is a detail view on the line 13 13 of Fig. 2.

Like numerals of reference designate corresponding parts in the several figures of the drawings.

In carrying out the present invention the apparatus is designed to operate in connection with the usual track-signals employed in the block system of signaling and is therefore intended to render this system more accurate and reduce to a minimum the possibility of an engineer not observing the danger-signal of a block when the same is displayed.

To provide for the proper action of the apparatus forming the subject-matter of the present application, each track-block is equipped with the said devices, which coöperate with the parts of the system carried by the locomotive, and for illustrative purposes there is shown in Fig. 9 of the drawings a section of a track 1, showing contiguous portions of separate blocks, with the usual block-signal 2 at one side of the track. As illustrated in Fig. 7 of the drawings, this block-signal is of the semaphore type and consists of the usual semaphore blade or signal-arm 3, which is thrown to danger and safety positions by the means well known in the art; but in the present invention there is combined with the signal 2 a circuit-closer 4, which may be arranged at one side of the signal-pole and which consists of the fixed and movable contact-plates 5 and 6, respectively. The movable contact-plate 6 is secured fast at one end, and the other free end thereof is adapted to normally spring away from the fixed plate 5 when the semaphore-blade is in the safety position; but to provide for moving the free end of the contact-plate 6 against the fixed plate 5 when the semaphore-blade is moved up to a danger position an actuating-rod 7 is employed. This rod is slidably mounted in suitable supports at one side of the signal-pole and is provided at its lower end with a foot 8, adapted to engage against one side of the contact-plate 6, and the upper end of said actuating-rod 7 is pivotally connected, as at 9, to the semaphore-blade 3, so that the rod will move with the said blade to provide for opening and closing a circuit by means of the circuit-closer 4. The circuit-closer 4 is included in an incomplete track-circuit formed by the wires *a b*, the wire *a* being connected at one end with the movable contact-plate 6 and the wire *b* being similarly connected to the fixed plate 5. The other ends of the separate wires *a b* are respectively connected to a pair of track-contacts 10 11, arranged at one side of one of the track-rails a suitable distance beyond the block or track signal 2. The track-contacts 10 11 are duplicates in construction and are preferably arranged in spaced relation and offset from the adjacent track-rail. Each of the said track-contacts 10 11 is preferably in the form of a substantially U-shaped bracket having the leg portions thereof bolted to and insulated from the track-rail, while the horizontal bar portion 12 of the bracket is disposed parallel with the track-rail.

The two track-contacts 10 11 are preferably secured to the adjacent rail by the same fastening-bolts to maintain a fixed relation to each other, and in addition to the said pair of contacts 10 11 there is employed between these contacts and the signal 2 the single track-contact 13. The single track-contact 13 is similar in construction to the other contacts and is arranged substantially in line with the contact 10 nearest the track-rail, so as to be engaged by the same brush carried by the locomotive, as will be hereinafter more fully explained, and the said single contact 13 has separate portions of the circuit-wire *a* connected therewith, so as to form a portion of the circuit in which the said wire *a* is included. In connection with the single track-contact 13, and the circuit of which this contact forms a part, there is utilized a circuit-wire *c*, having its terminals connected, respectively, to the actuating-rod 7 for the track-circuit closer and the adjacent track-rail, and the function of this wire will be fully explained in connection with the operation of the apparatus carried by the locomotive. There is also associated with each block a pair of spaced track-contacts 14 15, having a bridge-wire connection *d* and similar in construction and arrangement to the track-contacts 10 11, previously described; but it will be observed at this point that the pair of contacts 14 15 are isolated in the block between the separate signals to provide for resetting the apparatus carried by the locomotive.

In the practical operation of the system, particularly on a single-track road, the track devices just described must be duplicated at each side of the track; but as such duplication is well understood in the art it is not deemed necessary to illustrate the same in detail in the drawings; but to provide for the necessary electrical connection between the track devices and the apparatus carried by the locomotive the latter has suitably supported thereon, at each side thereof, a pair of contact-brushes 16 17, respectively, arranged in parallel relation corresponding to the arrangement of the track-contacts 10 11 and 14 15, so that the said brushes will respectively engage with separate contacts. While in Figs. 11 and 12 of the drawings the duplication of the contact-brushes respectively at opposite sides of the locomotive is shown, still, in order that a clear and comprehensive understanding of the invention may be had, only one set of these brushes will now be described in connection with the operation of the signal and recording mechanisms of the apparatus, and for the same purpose only one pair of brushes and the wire connections therewith are shown in Fig. 2 of the drawings, to which particular reference will be made in explaining the action of the different local circuits associated with the several elements of the two mechanisms.

The main working parts of the signal and recording mechanisms of the apparatus are preferably mounted in a casing or boxing 16^a, supported in a convenient position and preferably provided with a door 17^a, permitting ready access to the interior thereof. Referring particularly to the signal mechanism of the apparatus and the parts associated therewith, the numerals 18 and 19 designate, respectively, safety-circuit and danger-circuit controlling magnets, which are arranged for use in connection with a common make-and-

break lever 20, which, under the attractive influence of the said controlling-magnets, is designed to automatically make and break a local danger-signal circuit. At this point it may be observed that the controlling-magnets 18 and 19 are in pairs, as well as all of the other electromagnets used in carrying out the system; but as it is common in the art to pair electromagnets it is not deemed necessary to illustrate the same, except in diagram in Figs. 2 and 3 of the drawings, so it will be understood that in referring to the different magnets singly such term will comprehend the usual pair.

The separate controlling-magnets 18 19 are arranged a suitable distance apart to provide for actuating the make-and-break lever respectively at opposite sides of its pivotal support, and said magnets are also arranged obliquely to insure a proper attraction of the make-and-break lever and are included in separate circuits, so as to be separately and independently energized under different conditions. To provide for the proper positioning of the make-and-break lever 20, the same is pivotally mounted intermediate its ends on a fixed support 21, located between the exposed core ends of the controlling-magnets 18 19, and at opposite sides of its pivot the said lever is provided with keepers 22, coöperating with the adjacent core ends of the magnets 18 19.

To provide for holding the make-and-break lever 20 locked in the safety position, to which it is attracted by the controlling-magnet 18, there is associated with this magnet a locking-lever 23. The locking-lever 23 is pivotally supported at one end, as at 24, below the magnet 18, and is prevented from dropping out of an operative position by means of a stop-plate 25, arranged therebeneath. Contiguous to its free unpivoted end the locking-lever 23 is provided with a keeper 26, coöperating with the lateral extension 27 of the exposed core end of the magnet 18, and beyond the keeper 26 the said locking-lever 23 is provided in its free end with a notch 28, adapted to be drawn into interlocking engagement with a stud 29, fitted to the make-and-break lever 20, at the lower end thereof. When the safety-circuit-controlling magnet 18 is energized, the same not only attracts the lower arm of the make-and-break lever 20, but also simultaneously attracts and elevates the locking-lever 23, so as to bring the same into interlocking engagement with the make-and-break lever, and thereby provide for locking this lever in the safety position against the tension of the retractile actuating-spring 30, connected with the upper arm of the lever and tending to draw the same in a direction toward the danger-circuit-controlling magnet 19 and also toward the contact-armature 31 of a release-relay 32, which is used in connection with the danger-signal circuit. The release-relay 32 consists of a magnet 33 and the contact-armature 31, the latter being arranged in an approximately horizontal position beneath the magnet 33, which is arranged in an upright position above the plane of the danger-circuit of the controlling-magnet 19.

The contact-armature 31 is pivotally supported at one end, as at 32^b, and is normally locked in its depressed inoperative position by means of the bell-crank locking-lever 32^a. The bell-crank locking-lever 32^a is pivotally supported at its angle, as at 33^a, above the plane of the danger-circuit-controlling magnet 19, and the upstanding arm of said lever is provided with a locking-notch 33^b, coöperating with a locking-stud 34, projecting laterally from one side of the armature 31 at a point between the ends of the latter. The other arm of said bell-crank lever 33 carries a keeper 33^c and forms an armature coöperating with a lateral extension 19^a of the exposed core end of the danger-circuit-controlling magnet 19. The upright locking-arm of the bell-crank lever 32^a has a link connection 34^a with an armature-lever 34^b, pivotally supported at its lower end, as at 34^c, and having the upper free end thereof playing opposite the lateral extension 34^d of the exposed core end of the magnet 33, and the said upper free end of the armature-lever 34^b is normally drawn away from the core extension 33^a by a retractile spring 34^e. When the magnets 19 and 33 are deënergized, so as to permit the contact-armature 31 to drop to its depressed inoperative position, the tension of the spring 34^e serves to draw the armature-lever 34^b in a direction which pulls the upright arm of the bell-crank lever 32^a against the stud 34, thereby holding the notch 33^b in interlocking engagement therewith. The contact-armature 31 of the release-relay 32 is thus locked in its inoperative position and prevented from being moved, except by the action of the make-and-break lever 20 and the release and controlling magnets 33 and 19. By reason of the construction described it will be observed that when either of the magnets 19 or 33 become energized the movement of the armatures associated with the upright locking-arm of the bell-crank lever 32^a toward their respective magnets will serve to move said locking-arm out of engagement with the stud 34, so as to permit free movement of the contact-armature 31 in an upward direction.

At its free unpivoted end the contact-armature 31 of the release-relay is provided with a hook 35, with which is adapted to interlock a contact-pin 36 at the upper end of the oscillatory make-and-break lever 20, and contiguous to the hooked extremity 35 thereof the contact-armature 31 carries a contact-plate 37. This contact-plate 37 is insulated from the contact-armature 31 and is adapted to form one element of a circuit-closer 38, the other element of which consists of a pendent contact-arm 39, secured at its upper end to a fixed point of attachment and having an angled lower end 40, adapted to be engaged by

the plate 37, carried by the armature 31. The contact-arm 39 of the said circuit-closer 38 has connected therewith one terminal of a wire *e*, the other terminal of which is connected to one of a pair of binding-plates 41 41ª, arranged in a convenient position for wiring within the box or case containing the mechanisms, and the plate 37 of said circuit-closer has connected thereto one terminal of a circuit-wire *f*, which is connected to the other plate 41ª of said pair, and this pair of binding-plates will be hereinafter more particularly referred to in connection with the recording mechanism of the apparatus.

Three pairs of binding-plates similar to the plates 41 41ª are employed in carrying out the invention, the second pair of said plates, 42 42ª, having respectively connected thereto the terminals of the signal-circuit wires *g h*, which wires lead to the main signal-bell 43, arranged within the cab of the locomotive. The third pair of said binding-plates, 44 44ª, have respectively connected thereto the terminals of the auxiliary-signal-circuit wires *i j*, which lead to an auxiliary signal-bell 45, also located within the cab of the locomotive, as plainly shown in Fig. 1 of the drawings.

What may be termed the "main" binding-plates 42 42ª, which are included in the bell or signal circuit *g h*, also have respectively connected thereto the local-signal-circuit wires *k l*, the wire *k* having a connection with the contact-armature 31 of the release-relay 32 and the wire *l* having a metallic connection with the make-and-break lever 20, so that when this lever moves to a position to engage the contact-pin 36 with the hooked extremity of the armature 31 a local circuit will be completed over the wires *k l*, binding-plates 42 42ª, wires *g h*, and main signal-bell 43.

As already explained, the normal position of the apparatus is at "safety," with the make-and-break lever 20 in a position out of contact with the relay-armature 31 and interlocked with the locking-lever 23, associated with the safety-circuit-controlling magnet 18, and to provide for maintaining the safety-circuit closed to prevent the jar of the engine or locomotive from opening it there is introduced in the system a safety-circuit relay 46. The safety-circuit relay 46 is arranged below the safety-circuit-controlling magnet 18 and essentially consists of a magnet 47 and a contact-armature 48, arranged beneath the magnet and having a play contiguous to the exposed core end thereof. The contact-armature 48 is pivotally supported at one end, as at 49, and carries at its opposite free end a stud 50, which is adapted to be engaged by the cam end or foot 51 at the lower end of the locking-lever 52. This locking-lever 52 is pivotally supported at its upper end, as at 53, and is normally drawn in a direction toward a stop 54 by means of a retractile spring 55, whose tension is sufficient to normally draw the cam end or foot 51 over the stud 50 to provide for locking the contact-armature 48 in its depressed position when the magnet 47 is not energized. The said locking-lever 52 cooperates with a lateral extension 56 of the exposed core end of the magnet 47, so that when the latter is energized it will not only attract and elevate the armature 48, but will also attract the said lever 52 and move it out of the path of the locking-stud 50. The said contact-armature 48 is normally moved away from its magnet 47 under the influence of a retractile spring 57, connected therewith, and said armature carries at the under side thereof an offset contact-spring 58, adapted to bear against the contact-screw 59, which is included in the safety-circuit of the apparatus, to which circuit particular reference will now be made.

The safety-circuit of the apparatus of course includes therein the controlling-magnet 18, and consists principally of the safety-circuit wires *m n*, which wires at one terminal are bridged together, as at 60, and have a common connection with the innermost contact-brush 16, as plainly shown in Figs. 2 and 11 of the drawings. The opposite terminals of the circuit-wires *m n* are connected with the terminals of the controlling-magnet 18, and separate portions of the circuit-wire are connected, respectively, with the armature 48 and contact-screw 59, forming a part of the safety-circuit relay, so that in the normal position of parts the safety-circuit will be completed through the wire *m*, magnet 18, wire *n*, armature 48, contact-screw 59, and bridge connection 60 for the two circuit-wires, as plainly shown in Fig. 2 of the drawings.

The danger-circuit associated with the danger-controlling magnet 19 is partly formed by the safety-circuit, said danger-circuit including the wire *m*, a branch wire *o* from the wire *m* to one terminal of the magnet 19, a wire *o'*, connected with the other terminal of the controlling-magnet 19 and one terminal of the relay-magnet 47, the wire o^2 leading from the other terminal of said relay-magnet 47 and having metallic connection with the axle of the locomotive, so as to complete the circuit through the ground.

In addition to the main danger-circuit, including the magnets 19 and 47, and the main local signal-circuit, including the bell 43, there is employed an auxiliary-danger-circuit relay 61, which is conveniently arranged within the boxing or casing above the release-relay 32 for the make-and-break lever 20. The auxiliary-danger-circuit relay 61 consists, essentially, of an upright magnet 62 and a contact-armature 63. The contact-armature 63 is pivotally supported at one end, as at 64, and the other free end thereof is normally retracted, by means of the pressure of the spring 65, against the stop 66, and this free end of the armature 63 is adapted to be moved under the influence of the magnet 62 when the latter is energized against the contact-spring 67, having a wire connection *p* therewith, which also connects with the binding-plate 44 of the pair 44 44ª, the other of which plates

44ª has a wire connection p' with the contact-armature 63. This armature, in connection with its magnet 62, therefore provides for closing an auxiliary-local-bell circuit over the wires $p\ p'\ i\ j$ and the single auxiliary bell 45 for a purpose which will be hereinafter more fully explained.

The wiring for the magnet of the relay 61 includes a circuit-wire q, having a connection at one terminal with the outermost contact-brush 17 of the pair 16 17 and at its other terminal with one terminal of the magnet 62, the other terminal of which magnet has connected therewith a circuit-wire q', which may be conveniently coupled to the danger-circuit wire o^2, so as to have a ground connection through the axle of the locomotive. A portion of this circuit for the said magnet 62 is also utilized for the circuit of the magnet 33 of the release-relay 32, it being observed that one terminal of the magnet 33 has connected thereto a branch wire r, connected to the circuit-wire q, while the other terminal of the magnet 33 has connected therewith one terminal of a wire r', which is connected at r^2 to the portion of the safety-circuit wire n which is connected with the contact-screw of the relay 46.

In carrying out the present invention there is associated with the several local circuits $e\ f$, $l\ k$, and $p\ p'$ a plurality of recording instruments forming part of the recording mechanism of the system. This mechanism, together with the signal mechanism already described, is housed in the same casing or boxing, so that ready access may be had thereto at any time for inspection of the record-tape. The several recording instruments are suitably grouped together, so that there will be no interference in their operation, and the said instruments are designated, respectively, by the numerals 68, 69, and 70, the instrument 68 being properly termed the "danger-recording relay," the instrument 69 the "circuit-test-recording relay," and the instrument 70 the "auxiliary danger-relay." The danger-recording relay 68 consists of the magnet 71 and the bell-crank armature 72, playing opposite the exposed core end of the magnet, and one arm of which armature has journaled therein a marking-disk 73, working at one side of the tape-feeding roll 74, mounted in suitable supports and arranged to receive thereover the record-tape 75. The record-tape 75 is wound upon a suitable reel 76 and is preferably provided with a suitable scale of minutes or other intervals adapted to be crossed by the marks of the marking-disks of the recording mechanism, and at this point it may be observed that the marking-disk 73 of the danger-recording relay 68, as well as the other marking-disk, which will be referred to, may be of a toothed or serrated formation to provide for placing a distinctive mark upon the record-tape as the latter is drawn over the feeding-roll 74. The surplus portion of the tape, which is punctured or marked, accumulates or falls within the bottom part of the box or casing, from which it may be readily removed and examined whenever desired.

The circuit-test-recording relay 69 is similar in construction to the relay 68, and consists of a magnet 77 and a bell-crank armature 78, one arm of which also carries a revoluble or equivalent marking disk or wheel 79, disposed at one side of the plane of the marking-disk 73, but also working at one side of the tape-feeding roll 74 to operate against the graduated record-tape 75, which is wound thereon. The auxiliary danger-recording relay 70, like the other recording-relays, consists of a magnet 80 and an armature 81, which armature is pivotally supported between its ends and one arm of which carries a revoluble marking-disk 82, disposed in a transverse plane to the other marking-disks 73 and 79, so as to operate upon the record-tape at a different point from said other disks. It will therefore be observed that each marking-disk of the separate recording-relays operates upon the record-tape in its own path, so that the different marks may be easily read on the tape to show the duration or interval thereof. This is plainly shown in Fig. 8 of the drawings, in which figure a section of the tape is shown with marks thereon respectively from the disks 73, 79, and 82.

As a part of the recording mechanism of the apparatus there is employed an electric motor 83, the armature-shaft of which is geared with the tape-feeding roll 74 through the medium of the speed-reducing gearing 84 and which motor is included in the motor-circuit $s\ s'$, which circuit has parallel connections $t\ t'$, $u\ u'$, and $v\ v'$. The parallel connections $t\ t'$ are respectively connected to the armature 72 of the relay 68 and a spring contact-plate 85, coöperating therewith, the connections $u\ u'$ to the armature 78 of the relay 69 and a spring contact-plate 86, coöperating therewith, and the connections $v\ v$, to the armature 81 of the relay 70 and a spring contact-plate 87, coöperating therewith. By reason of these connections the attraction of the armatures of any of the recording-relays will close a local circuit and provide for starting the motor and causing the rotation of the tape-feeding roll 74.

The wiring for the several recording-relays is as follows: The magnet 71 of the relay 68 has wire connections $w\ w'$, respectively, with the binding-plates 42 42ª, the magnet 77 of the relay 69 wire connections $x\ x'$, respectively, with the binding-plates 41 41ª, and the magnet 80 of the relay 70 wire connections $y\ y'$, respectively, with the binding-plates 44 44ª, which are associated with the auxiliary bell 45.

Referring to the operation of the system in different positions, it will be observed in the first place, as already stated, that normally the instrument will indicate "safety," inasmuch as the circuit $m\ n$ is closed, causing an energization of the controlling-magnet 18, with a

consequent attraction of the make-and-break lever 20 and the locking-lever 23, in which position of parts the pin 36 of the make-and-break lever is out of contact with the contact-armature 31 of the release-relay 32, thereby keeping open the local signal-circuit *l k*. With the parts thus positioned when the engine approaches the track-signal 2, which is set at "danger," as indicated in Figs. 7 and 9 of the drawings, the signal-operated circuit-closer 4 will be closed, so that when the brushes 16 17, carried by the engine, come in contact with a pair of track-contacts 10 11 an initial circuit will be closed over the wire *q*, branch wire *r*, magnet of relay 32, wire *r'*, portion of safety-circuit wire *n*, track-contact 10, wires *a b*, and track-contact 11. The completion of this circuit energizes the magnet 33, which during the period of contact of the brushes attracts its two armatures 34^b and 31, the latter armature moving up into contact with the contact-arm 39, thereby completing the local circuit *e f* and the recording-relay circuit *x x'*, which provides for the energization of the magnet 77 of the relay 69 and the closing of the motor-circuit through the connections *p p'* and the movement of the marking-disk 79 against the record-tape. This will indicate that the track connections are intact. At the time of the contact of the brushes 16 17 with the track-contacts 10 11 a second idle circuit may be completed from the brush 16 as follows: *m*, *o*, magnet 19, *o'*, magnet 47, wire o^2, axle, track, *c*, 7, 6, *a*, 10, to *m*. This circuit unlocks 47, and 19 attracts the make-and-break lever 20; but inasmuch as the armature 31 has been previously attracted by the magnet 33 the movement of said lever 20 will be an idle one, and no alarm-circuit will be completed through the said lever and the armature 31, and immediately upon the brushes 16 17 leaving the contacts 10 11 the circuit is opened through magnets 19 47 and the safety-circuit again becomes closed, causing the parts to resume normal positions. At the same time the armature 31 falls away from the magnet 33. Now when the engine has thus passed the said track-contacts 10 11, with the track or block signal still set at "danger," the innermost contact-brush 16 will engage with the single track-contact 13, thereby completing the danger-circuit over the wire *m*, branch wire *o*, danger-circuit-controlling magnet 19, wire *o'*, safety-circuit-relay magnet 47, wire o^2, axle of engine, track, track-wire *o*, actuating-rod 7 for the circuit-closer 4, wire *a*, and single track-contact 13. The closing of this danger-circuit through the contact 13 in the first place provides for the energization of the magnet 47 of the safety-circuit relay, with a consequent attraction of the two armatures 48 52, and the opening of the safety-circuit between the contacts 58 59. Simultaneously with this opening of the safety-circuit the armature of the locking-lever 23 fall away from the stud 29 of the make-and-break lever 20, thereby permitting the latter lever to be attracted by the magnet 19, so as to bring the contact-pin 36 into locking engagement with the hooked extremity of the contact-armature 31, thus closing the local signal-circuit *l k*, which includes therein the circuit-wires *g h*, main signal-bell 43, and the relay-wires *w w'* for the danger-recording relay 68. It will thus be seen that the main signal-bell 43 will be caused to sound an alarm in the cab of the engine, while at the same time the recording-relay 68 will become energized, so as to close the motor-circuit through the connections *p p'* and to move the marking-disk 73 against the record-tape 75 to make a danger-mark upon the tape as long as the danger-circuit remains closed. The apparatus remains in this condition until the brushes 16 17 come in contact with the isolated track-contacts 14 15, which will serve to close a release-circuit over the wires *q r*, magnet 33, wire *r'*, portion of safety-circuit wire *n*, brush 16, contact 14, and bridge-wire *d*. This release-circuit energizes the magnet 33, thereby elevating the armature 31, so as to disengage it from the pin 36 of the make-and-break lever 20, at the same time opening the local signal-circuit *l k*, &c. The safety-circuit, which has now become closed on account of the opening of the danger-circuit *m*, *o*, *o'*, and o^2, will come into play by causing the safety-circuit controlling magnet 18 to attract the make-and-break lever 20 against the tension of the spring 30, it of course being understood that this connection could not take place as long as the make-and break lever is locked in engagement with the contact-armature 31.

In connection with the operation just described it may be observed in connection with the local signal-circuit that in the event of the battery failing which maintains the safety-circuit, so as to release the locking-lever 23 from the make-and-break lever 20, the latter is drawn into contact under the influence of the spring 30 with the armature 31, thereby closing the signal-circuit *l k*, &c., and notifying the engineer in the cab, as well as registering the fact on the record-tape.

The apparatus is automatically tested whenever the brushes 16 17 come into engagement with the track-contacts 10 11 and 14 15, causing the completion of the circuit through the release-relay and the consequent closing of the local testing-circuit *e f*, which includes therein the circuit-test-recording relay 69, the operation of which relay in connection with said circuit has already been described.

At this point it may be further explained that the isolated track-contacts 14 15 are located beyond each block-signal, and therefore in a position to be engaged by the brushes 16 17 before the train reaches the contacts 10 11, associated with the next signal, and in Fig. 9 of the drawings the said contacts 14 15 are indicated as occupying an intermediate posi-

tion within the block a material distance in front of the contacts 10 11. (Also illustrated in said figure.)

To provide for detecting the presence of a second train around a curve, the track-curve is provided with an insulated rail-section 90, the portions of the rails contiguous to which section are bridged by the wire z, so as to not interfere with the usual block-signals. The said rail-section 90 on a curve has a wire connection z' with a single track-contact 91, located remote from the rail-section 90 and at a sufficient distance to give an approaching train due warning. The said single track-contact 91 is similar to the track-contacts previously described and is arranged a sufficient distance beyond the adjacent rail so as to be engaged by the outermost contact-brush 17, which is included directly in the circuit with the wire q. When an engine equipped with the apparatus herein described is approaching a curve having the rail-section 90, the presence of another train on this rail-section will provide for the completion of the circuit through the brush 17, wire q, magnet 62 of the relay 61, wire q', wire o^2, axle of engine having metallic connection with the track-contact 91, one rail of the curve, axle of the other engine in contact with the rail-section 90, through said section 90, and the wire connection z' therewith. The completion of this circuit causes the energization of the magnet 62, with a consequent attraction of the contact-armature 63, and the closing of the local circuit $p\ p'$, which includes the auxiliary signal-bell 45 and the relay connections $y\ y'$ for the auxiliary danger-recording relay 70. The energization of this relay provides for the completion of the motor-circuit over the connections $v\ v'$ and the movement of the marking-disk 82 against the record-tape to provide for the proper marking thereof.

In connection with the circuit described it may be explained that the batteries included in the line of the wires q and o^2 are properly arranged so as not to be in opposition, and therefore do not interfere with the completion of the circuit for causing the detecting of a train around a curve.

In carrying out the invention, especially on a single-track road, it is necessary to provide means whereby the apparatus herein described will be thrown into action when the engine is running backward. To secure this result, I have devised the shifting mechanism shown in Figs. 11 and 12 of the drawings, which shifting mechanism is carried by the truck or framework of the engine. In connection with the shifting mechanism it will first be observed that the contact-brushes 16 17 are duplicated at opposite sides of the engine, so as to respectively engage with the contacts arranged at opposite sides of the track, and each pair of the brushes 16 17 have separate wire connections with a pair of switch-points. The pair of switch-points for the brushes 16 17 at one side of the engine are designated by the numerals 92 92^a, and the pair of switch-points for the brushes 16 17 at the opposite side of the engine are designated by the numerals 93 93^a. The several switch-points are arranged in alinement and are adapted to be engaged by a pair of contact-plates 94 95, the contact-plate 94 forming the bridge connection 60 for the wires $m\ n$ and the contact-plate 95 having connected therewith the wire q of the system. The two contact-plates 94 95 of the switch are attached to a sliding switch-bar 96, having a link connection 96^a at one end with a shifting arm 97. The shifting arm 97 is pivotally supported at its upper end on a fixed part of the truck and is arranged to play between a pair of depending pressure-springs 98, and the lower end of the shifting arm 97 is fitted with a roller or equivalent projection 99, normally held at one side of a cam-wheel 100, mounted fast on the axle of the engine, so as to be rotated therewith. The wheel or equivalent projection 99 on the shifting arm works adjacent to the periphery of the cam-wheel 100, in which is formed an oblique or inclined groove 101, extending from side to side thereof. When the engine is running in one direction, the disposition of the groove 101 will be such that the roller on the shifting arm 97 will not enter the same; but upon the backward movement of the engine the pressure-spring 98, bearing against the shifting arm, will cause the roller thereof to enter the groove 101, so that as the cam-wheel 100 continues to turn backward it will carry the roller 99 entirely through the same, and thereby swing the shifting arm 97 to the opposite side of the cam-wheel, as may be plainly seen in Figs. 11 and 12 of the drawings. This swinging movement of the shifting arm provides for the reciprocation of the switch-bar 96 and the consequent movement of the contact-plates 94 95 from one pair of switch-points to another, so as to provide for automatically throwing the opposite pairs of contact-brushes 16 17 into the circuit of the apparatus, according to the direction in which the engine is running.

For illustrative purposes the different circuits are shown provided with their individual batteries; but it will be understood that these may also designate battery connections, as in the practical carrying out of the system a storage battery 102 may be employed and connected in multiple with all of the circuits except the bells in the cab, which are provided under all circumstances with their individual batteries.

From the foregoing it is thought that the construction, operation, and many advantages of the herein-described system of railway signaling will be readily understood by those familiar with the art without further description, and it will be understood that various changes in the form, proportion, and minor details of construction may be resort-

ed to without departing from the principle or sacrificing any of the advantages of this invention.

Having thus described the invention, what is claimed as new, and desired to be secured by Letters Patent, is—

1. In an electrical railway signaling system, a train apparatus comprising a normally-closed safety-circuit, a local signal-circuit, a bell included in said signal-circuit, a danger-circuit, means, included in the danger-circuit, for closing the local signal-circuit and for opening said safety-circuit, and means for causing an automatic closing of the said danger-circuit, substantially as set forth.

2. In an electrical railway signaling system, a train apparatus comprising a normally-closed safety-circuit, a local signal-circuit, a bell and an electrically-operated recording instrument included in the local signal-circuit, a danger-circuit, means, included in the danger-circuit, for closing said local signal-circuit and for opening the safety-circuit, and means for causing an automatic closing of the danger-circuit, substantially as set forth.

3. In an electrical railway signaling system, a normally closed and locked safety-circuit, a normally-open local signal-circuit, a bell for the signal-circuit, a normally-open danger-circuit, means, included in said danger-circuit, for closing the local signal-circuit and for releasing the lock for and opening the safety-circuit, and means for causing the automatic closing of said danger-circuit, substantially as set forth.

4. In an electrical railway signaling system, a train apparatus comprising a normally-closed safety-circuit, a normally-open local signal-circuit, a bell, included in said signal-circuit, a danger-circuit, means, included in said danger-circuit, for closing the local signal-circuit and opening the safety-circuit, a locking device for holding the danger-signal circuit closed, means for causing an automatic closing of the danger-circuit, and separate means for releasing the locking device for the danger-circuit to restore the parts to the normal safety position, substantially as set forth.

5. In an electrical railway signaling system, a train apparatus comprising a normally-closed safety-circuit, a locking device for holding the safety-circuit closed, a local signal-circuit, a bell, included in said signal-circuit, a danger-circuit, means, included in said danger-circuit, for closing the local signal-circuit and for releasing the locking device for the safety-circuit, a locking device for the danger-circuit, means for automatically closing the danger-circuit, and separate means for releasing the locking device for the danger-circuit, substantially as set forth.

6. In an electrical railway signaling system, a train apparatus comprising a normally-closed safety-circuit, a circuit-locking device, included in said safety-circuit, a local signal-circuit, a bell and a circuit-locking device, included in said local signal-circuit, a danger-circuit, means, included in said danger-circuit, for closing the local signal-circuit, and for releasing the safety-circuit-locking device, separate means for releasing the locking device for the local signal-circuit, and means for causing an automatic closing of the danger-circuit, substantially as set forth.

7. In an electrical railway signaling system, a train apparatus comprising a normally-closed safety-circuit, a normally-open local signal-circuit, a bell and a danger-recording instrument included in said local signal-circuit, a locking device for the local signal-circuit, a danger-circuit, means, included in the danger-circuit, for closing the local signal-circuit and for opening the safety-circuit, means for automatically closing the danger-circuit, release mechanism for releasing the locking device for the local signal-circuit, a local circuit controlled by the release mechanism, and a circuit-test-recording instrument included in the latter circuit, substantially as set forth.

8. In an electrical railway signaling system, a train-apparatus signal mechanism comprising a make-and-break lever, a normally-closed safety-circuit, means included in said safety-circuit, for moving the said lever in one direction, a normally-open danger-circuit, means, included in said danger-circuit, for moving said lever in the opposite direction, a local signal-circuit including said make-and-break lever, and a bell also included in said local signal-circuit, substantially as set forth.

9. In an electrical railway signaling system, a train-apparatus signal mechanism comprising a single make-and-break lever, a normally-closed safety-circuit, means, included in said safety-circuit, for actuating said lever in one direction, a normally-open danger-circuit, means, included in said danger-circuit, for actuating said lever in the opposite direction, a local signal-circuit including said make-and-break lever, a bell also included in said local signal-circuit, a locking device for holding the lever in the danger position, said locking device also being included in the local signal-circuit, and a separate locking device for holding the lever in the safety position, substantially as set forth.

10. In an electrical railway signaling system, a train-apparatus signal mechanism comprising a single make-and-break lever, a normally-closed safety-circuit, means, included in said safety-circuit, for actuating said lever in one direction, a danger-circuit, means, included in said danger-circuit, for actuating said lever in the opposite direction, a local signal-circuit including said lever, a bell also included in said local signal-circuit, a locking device for holding the lever in the danger position, and also included in the local signal-circuit, a separate locking device for holding the lever in the safety position,

and an actuating-spring connected with the lever and arranged to draw the same to the danger position, and close the local signal-circuit upon a failure of the battery, substantially as set forth.

11. In an electrical railway signaling system, a train-apparatus signal mechanism comprising a single make-and-break lever, a normally-closed safety-circuit, means, included in said safety-circuit, for actuating said lever in one direction, a normally-open danger-circuit, means, included in said danger-circuit, for actuating the lever in the opposite direction, a local signal-circuit including said make-and-break lever, a bell also included in said local signal-circuit, a locking device for holding the lever in the danger position and included in the local circuit therewith, a separate locking device for holding the make-and-break lever in the safety position, said latter locking device being actuated by the same means for moving the lever to the safety position, and separate means for releasing the locking device for holding the make-and-break lever in a danger position, substantially as set forth.

12. In an electrical railway signaling system, a train-apparatus signal mechanism comprising a single oscillatory make-and-break lever, a normally-closed safety-circuit, a controlling-magnet included in said safety-circuit, for actuating said lever in one direction, a normally-open danger-circuit, a controlling-magnet included in said danger-circuit, for actuating said lever in the opposite direction, a local signal-circuit including said make-and-break lever, a bell also included in said local signal-circuit, a release-relay having a contact-armature adapted to interlock with the make-and-break lever and hold it in a danger position, said contact-armature being also included in the local signal-circuit, a separate locking-lever actuated by the safety-circuit-controlling magnet and engaging with the lever to hold it in a safety position, and means for separately energizing the release-relay, substantially as set forth.

13. In an electrical railway signaling system, a train-apparatus signal mechanism comprising a single oscillatory make-and-break lever, a normally-closed safety-circuit, a controlling-magnet, included in said safety-circuit, for actuating the said lever in one direction, a danger-circuit, a controlling-magnet, included in said danger-circuit, for actuating the said lever in the opposite direction, a local signal-circuit including said make-and-break lever, a bell also included in said local signal-circuit, a release-relay whose armature is adapted to interlock with the make-and-break lever to hold it in the danger position, said armature being included in the local signal-circuit, a separate locking device for the armature of the release-relay, said separate locking device including armatures coöperating respectively with the danger-circuit-controlling magnet, and the magnet of the release-relay, and a separate magnetically-controlled locking device for holding the make-and-break lever in the safety position, substantially as set forth.

14. In an electrical railway signaling system, a train-apparatus signal mechanism comprising a single make-and-break lever, a normally-closed safety-circuit, a controlling-magnet included in said safety-circuit, for actuating the said lever in one direction, a danger-circuit, a controlling-magnet, included in said danger-circuit, for actuating the said lever in the opposite direction, a local signal-circuit including said make-and-break lever, a bell also included in said local signal-circuit, a release-relay having a contact-armature adapted to interlock with the make-and-break lever to hold it in a danger position, said contact-armature being also included in the local signal-circuit, a separate locking device for the said contact-armature, which locking device includes a single locking-arm having engagement with the contact-armature, and a pair of armature-levers coöperating respectively with the danger-circuit-controlling magnet and the magnet of the release-relay, and a locking-lever actuated by the safety-circuit-controlling magnet and having an interlocking engagement with the make-and-break lever to hold the latter in a safety position, substantially as set forth.

15. In an electrical railway signaling system, a train-apparatus signal mechanism comprising a normally-closed safety-circuit, a local signal-circuit, a bell included in said local signal-circuit, circuit-closing devices for said local signal-circuit, a safety-circuit relay having a contact-armature and a contact-point included in the safety-circuit, said relay also having a spring-retracted locking-lever actuated in one direction by the magnet of the relay, and provided at one end with a cam portion coöperating with the armature to hold it locked in contact with said contact-point, a danger-circuit including the magnet of said relay, and means, also included in the danger-circuit, for closing the local signal-circuit, substantially as set forth.

16. In an electrical railway signaling system, a train-apparatus signal mechanism comprising a normally-closed safety-circuit, a local signal-circuit, a bell included in said local signal-circuit, circuit-closing devices for the local signal-circuit, a danger-circuit, means, included in said danger-circuit, for actuating said circuit-closing devices and also for opening the safety-circuit, means for automatically closing the danger-circuit, an auxiliary local signal-circuit, a bell, included in said auxiliary local signal-circuit, and an auxiliary-danger-circuit relay having its circuit-closing members included in said auxiliary signal-circuit, substantially as set forth.

17. In an electrical railway signaling system, a normally-closed safety-circuit, a local signal-circuit, a bell and a danger-recording instrument included in said local signal-cir-

cuit, a danger-circuit, means, included in said danger-circuit, for closing the local signal-circuit and for opening the safety-circuit, a release-relay having an armature included in said local signal-circuit, a circuit-test local circuit, a circuit-closer included in said circuit-test circuit, said circuit-closer being controlled by the armature of the release-relay, a circuit-test-recording instrument also included in said circuit-test local circuit, an auxiliary-danger-circuit relay, an auxiliary local signal-circuit, a bell and an auxiliary-danger-recording instrument included in the auxiliary local signal-circuit, and a circuit-closer controlled by the armature of said auxiliary-danger-circuit relay, substantially as set forth.

18. In an electrical railway signaling system, the combination with the signal mechanism, of the recording mechanism comprising a tape-feeding roll, an electric motor operatively connected with said roll, a record-tape actuated by the roll, a plurality of recording-relays, each relay having an armature-arm carrying a marking element arranged to work against the record-tape, and a circuit-closer actuated by each relay-armature, and included in the circuit of the motor, substantially as set forth.

19. In an electrical railway signaling system, the combination of the signal-operated circuit-closer, a pair of track-contacts arranged at one side of the track and having separate wire connections with the signal-operated circuit-closer, a single track-contact included in the line of one of said wire connections and arranged in advance of the pair of contacts, and a train-apparatus signal mechanism comprising a plurality of local circuits, signals and recording instruments included in said local circuits, a series of actuating-circuits for said several local circuits, and a pair of contact-brushes included in said actuating-circuits and coöperating with said track-contacts, substantially as set forth.

20. In an electrical railway signaling system, the combination of the signal-operated circuit-closer, a pair of track-contacts arranged at one side of the track and having separate wire connections with the signal-operated circuit-closer, a single track-contact included in the line of one of said wire connections, and arranged in advance of the pair of contacts, a pair of isolated track-contacts having a bridge connection and arranged within each block in advance of the circuit-closer, and a train-apparatus signal mechanism comprising a plurality of local circuits, signals and recording instruments included in said local circuits, a series of actuating-circuits for said several local circuits, and a pair of contact-brushes included in said actuating-circuits, and coöperating with said track-contacts, substantially as specified.

21. In an electrical railway signaling system, the combination with separate sets of track-contacts arranged respectively at opposite sides of the track, separate contact-brushes coöperating respectively with said separate sets of track-contacts, a train apparatus, a switch, wire connections between the switch and the operative parts of the train apparatus, similar connections between the switch and the oppositely-arranged contact-brushes, and shifting mechanism having means for automatically causing the position of the switch to be shifted by the movement of the train itself when reversed from one direction of travel to the other, substantially as set forth.

22. In an electrical railway signaling system, the combination with separate sets of track-contacts arranged respectively at opposite sides of the track, of separate contact-brushes carried by the train and coöperating respectively with the separate contacts, the train signal apparatus, a switch consisting of fixed and movable members, wire connections between the movable members of the switch and the train apparatus, similar connections between the fixed members of the switch and the separate sets of contact-brushes, and a shifting device actuated from an axle and having means for automatically causing the movable members of the switch to be shifted by the movement of the train itself when reversed from one direction of travel to the other, substantially as set forth.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

LOUIS C. WERNER.

Witnesses:
S. G. BLACKBURN,
HART VANCE.