T. MAC. DOUGAL & J. McK. CHAMBERS.

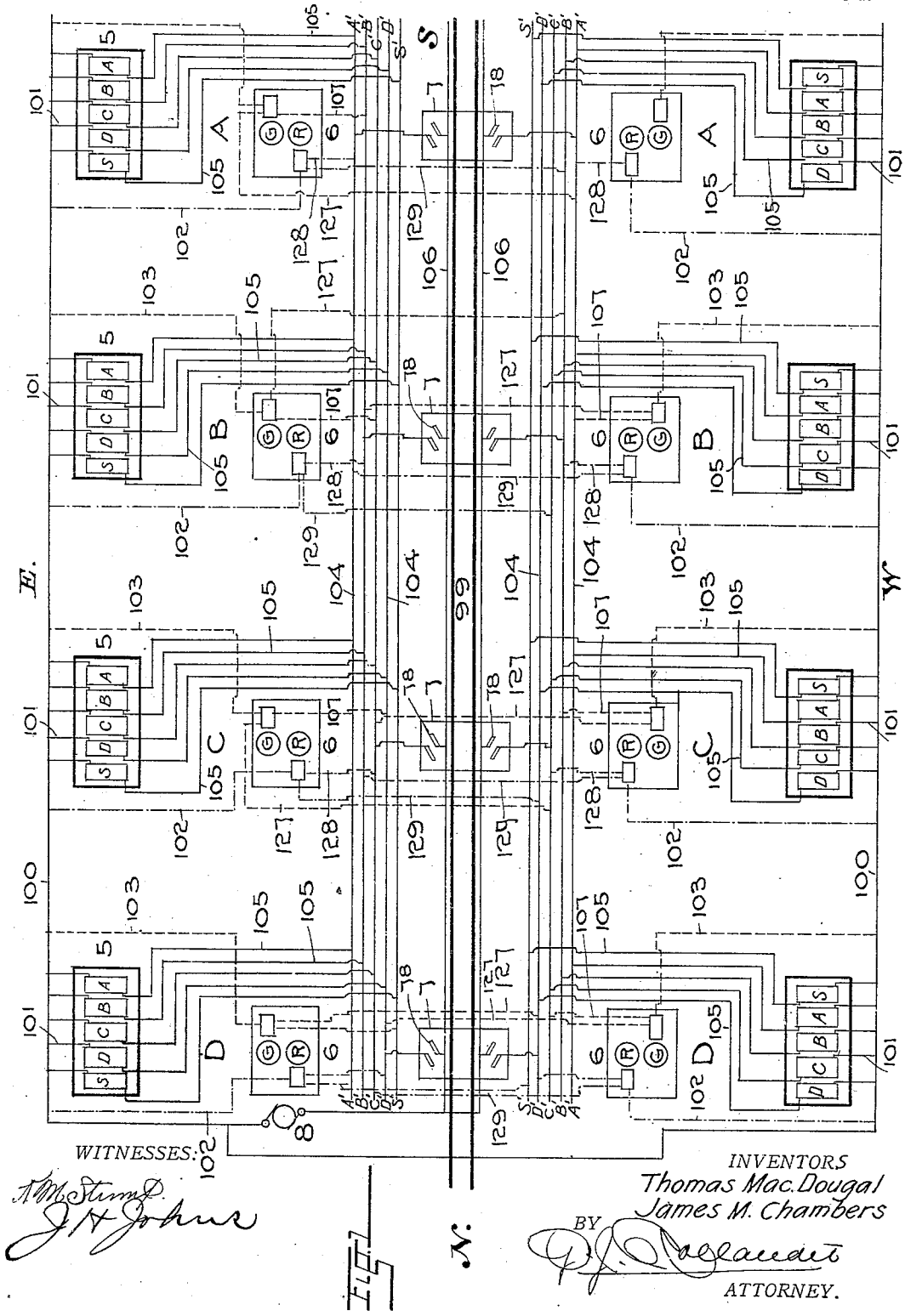
RAILWAY SIGNALING SYSTEM.

APPLICATION FILED JUNE 16, 1908.

941,263.

Patented Nov. 23, 1909.

8 SHEETS—SHEET 1.



WITNESSES:

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J. H. Johns

INVENTORS

Thomas Mac. Dougal

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FIG. 1.

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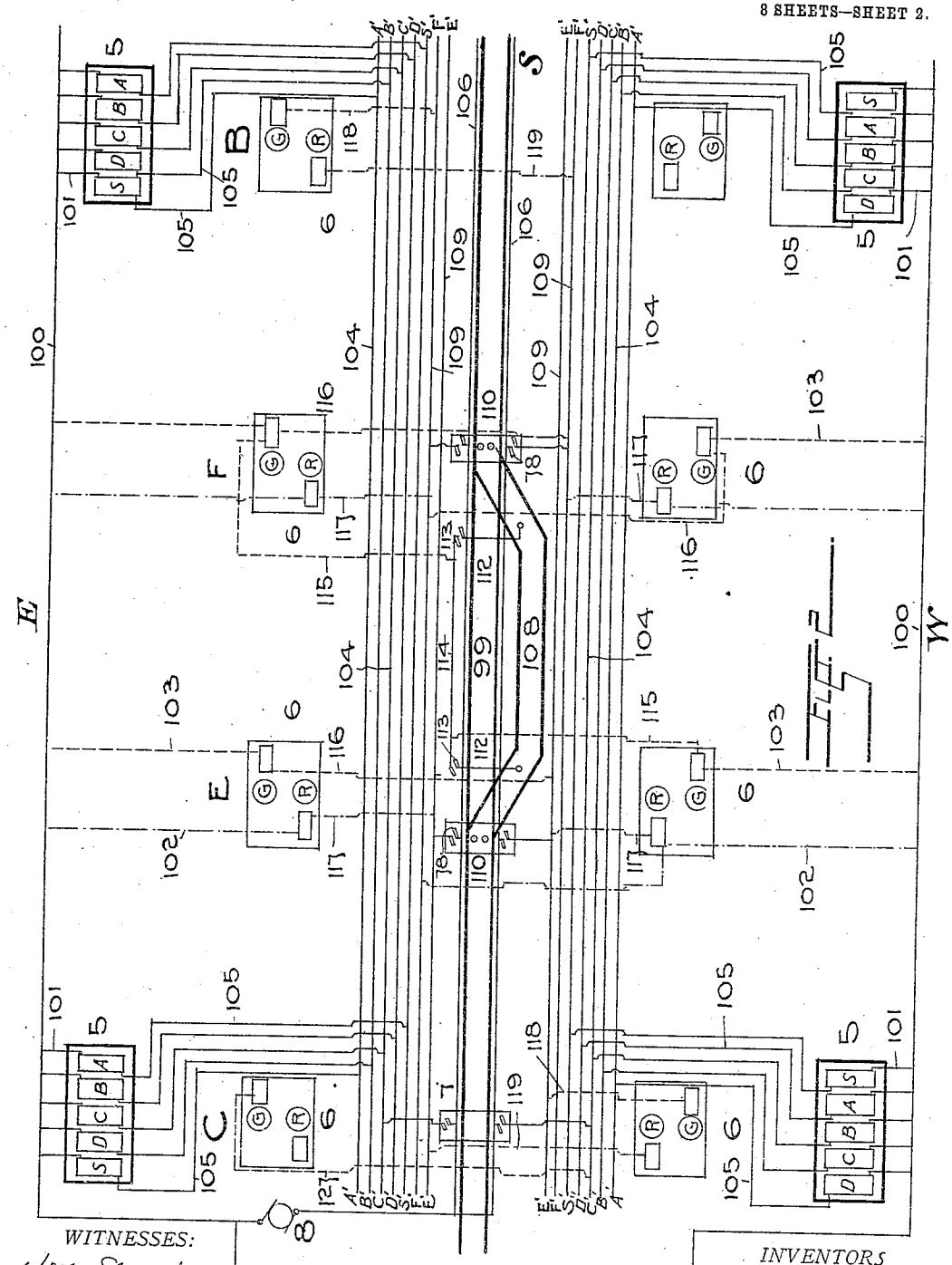

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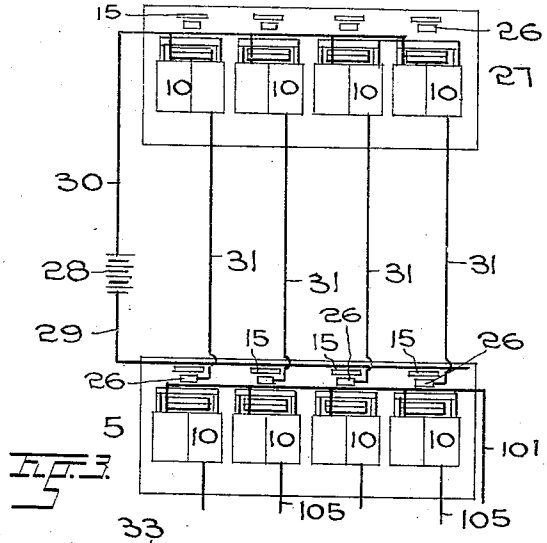

FIG. 3.

FIG. 4.

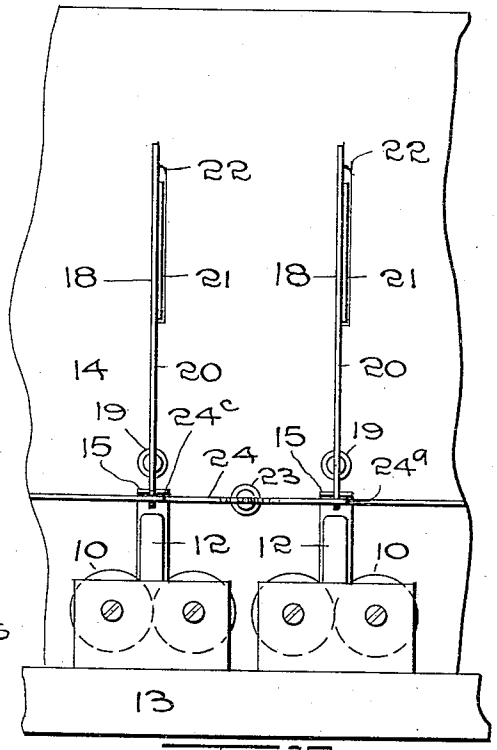

FIG. 10.

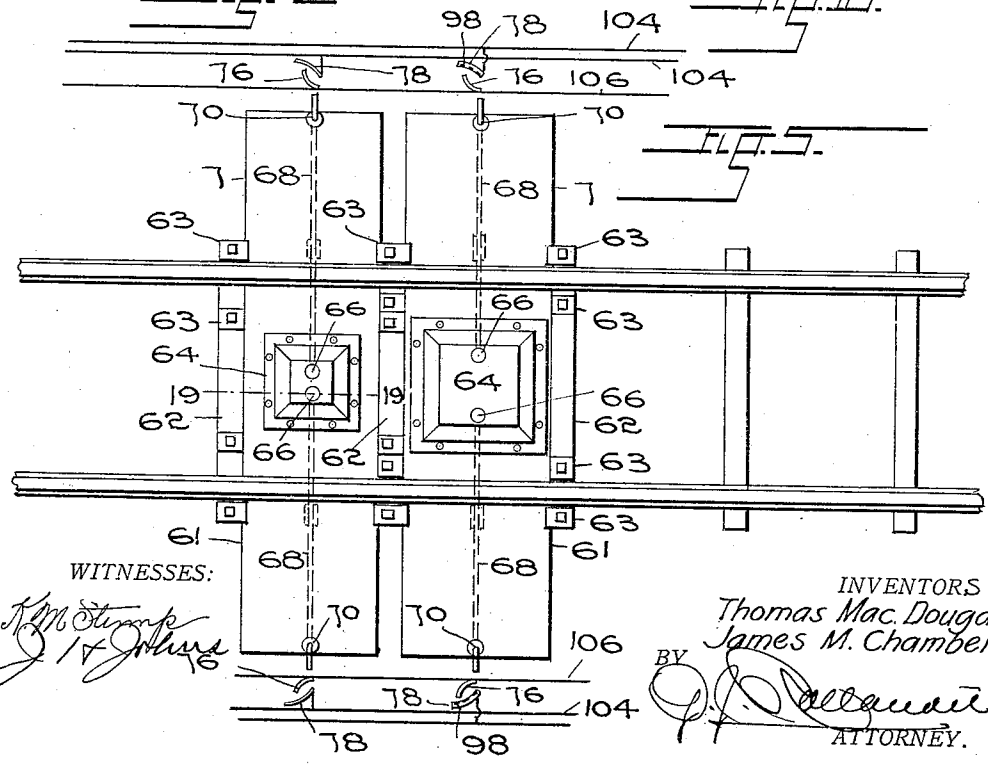

FIG. 5.

WITNESSES:

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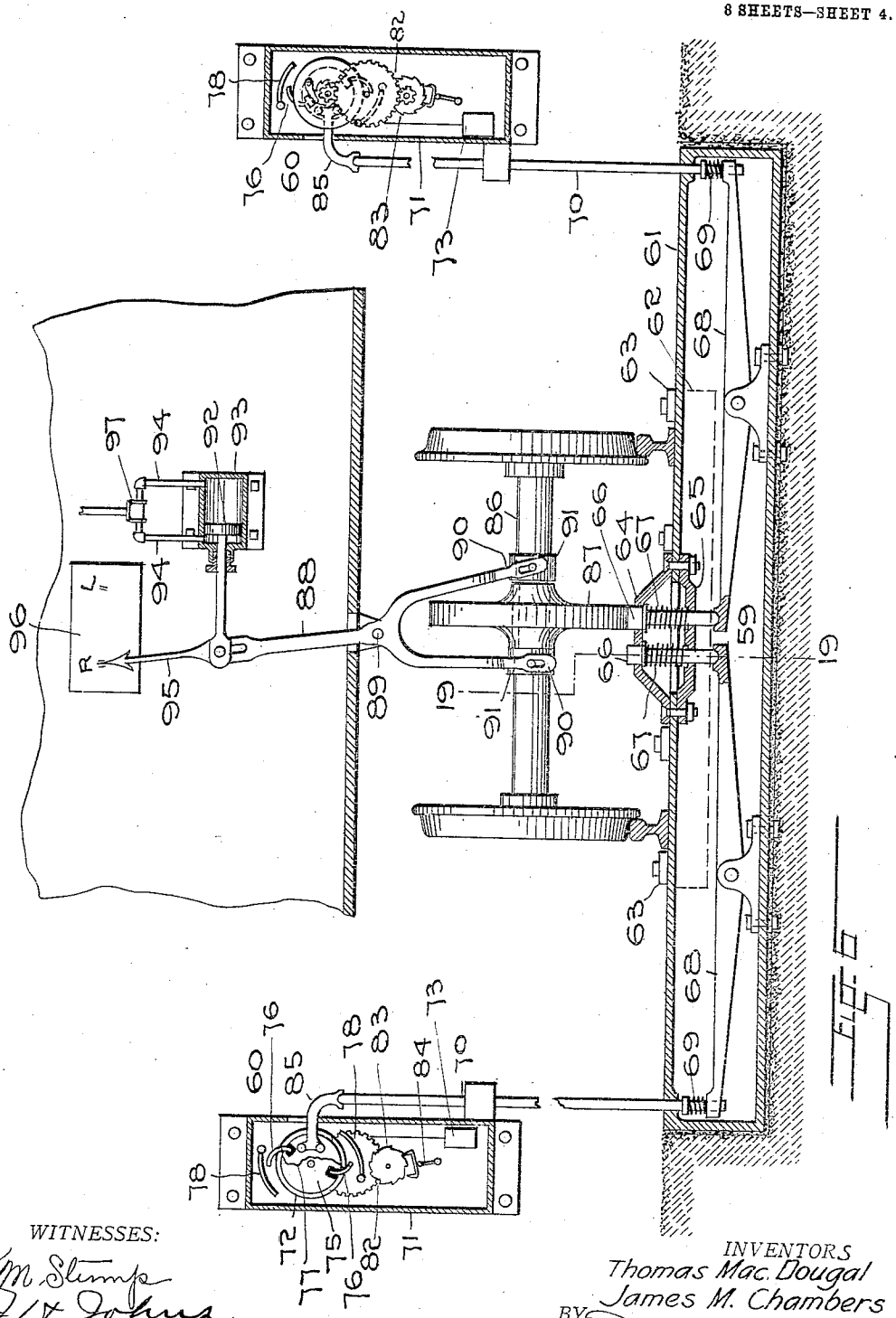
8 SHEETS—SHEET 4.



WITNESSES:

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8 SHEETS—SHEET 5.

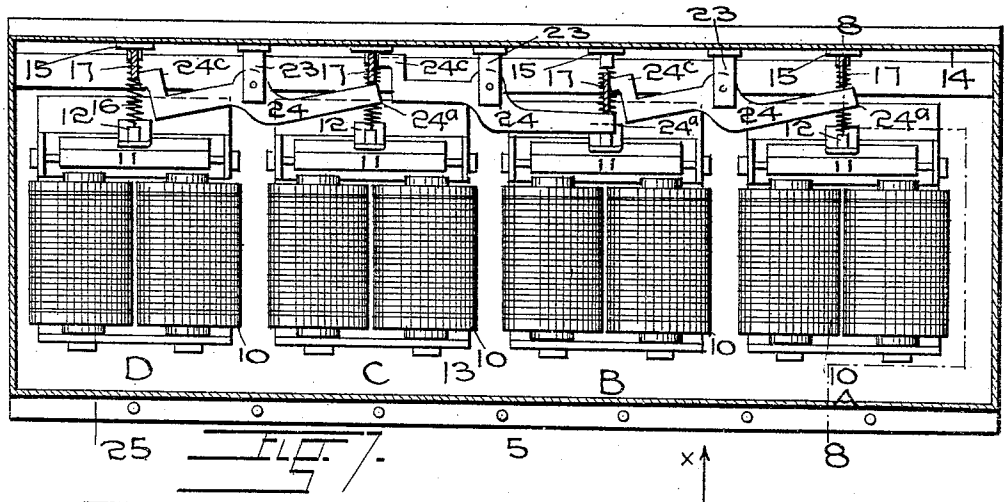

FIG. 7.

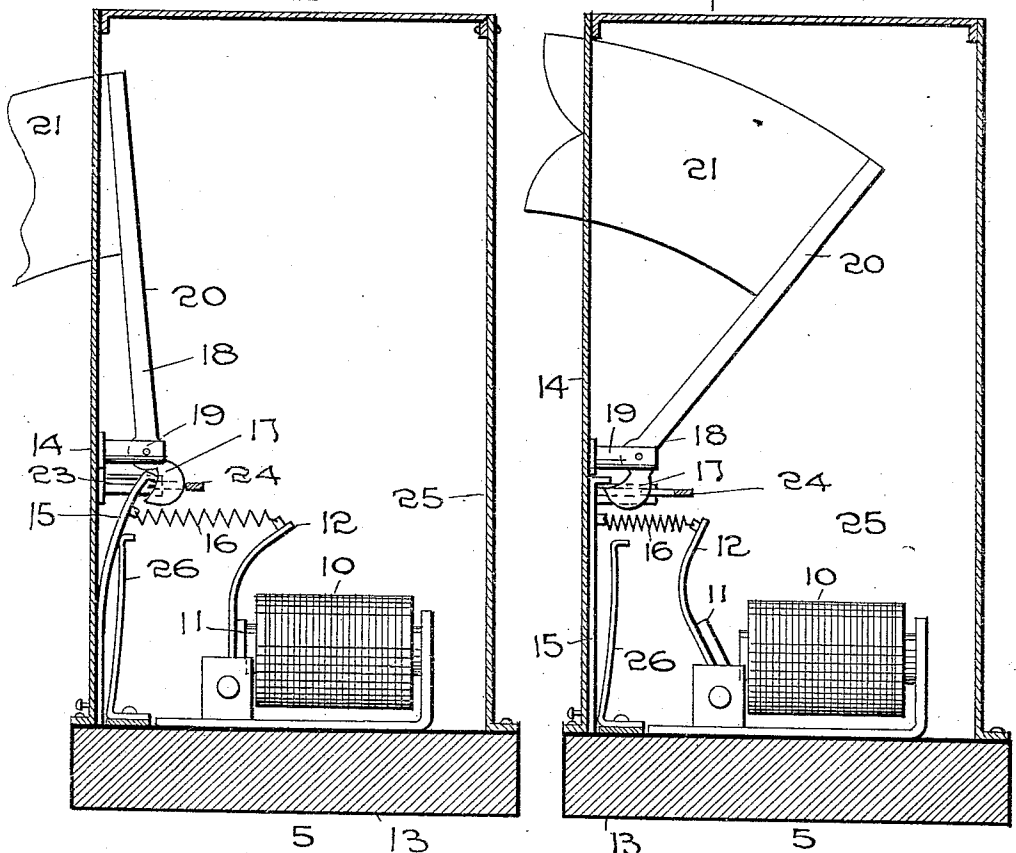

FIG. 8. FIG. 9.

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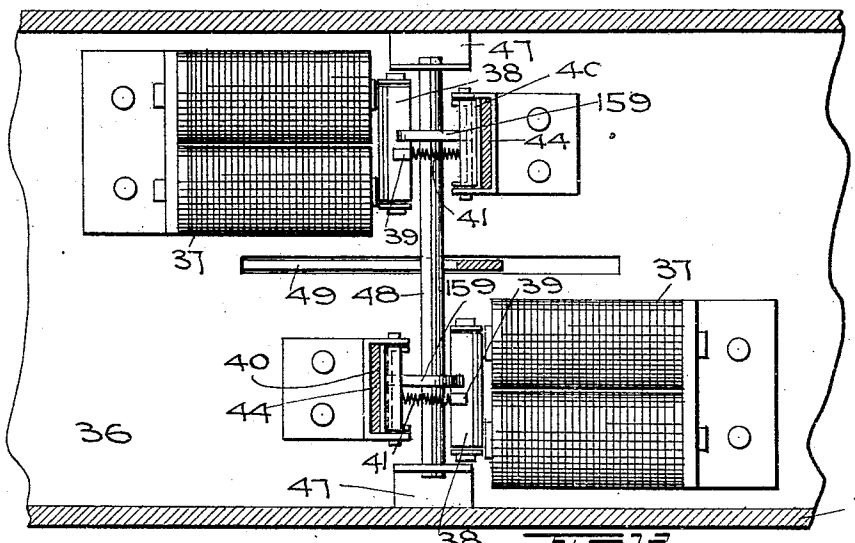

FIG. 12

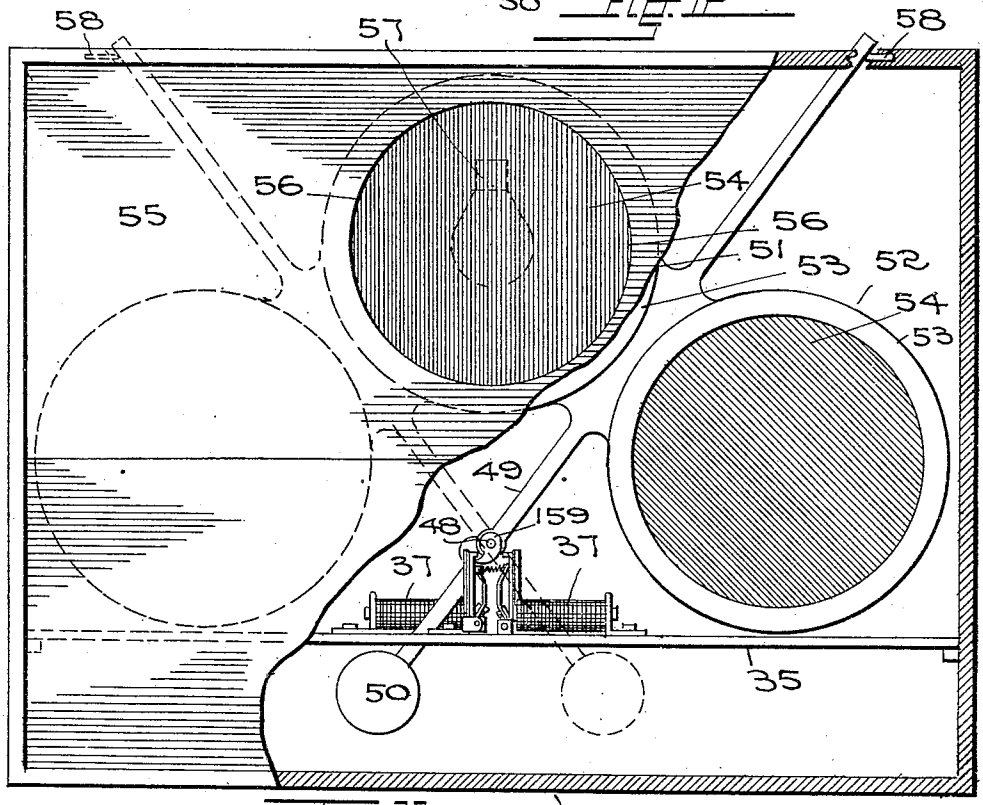

FIG. 11

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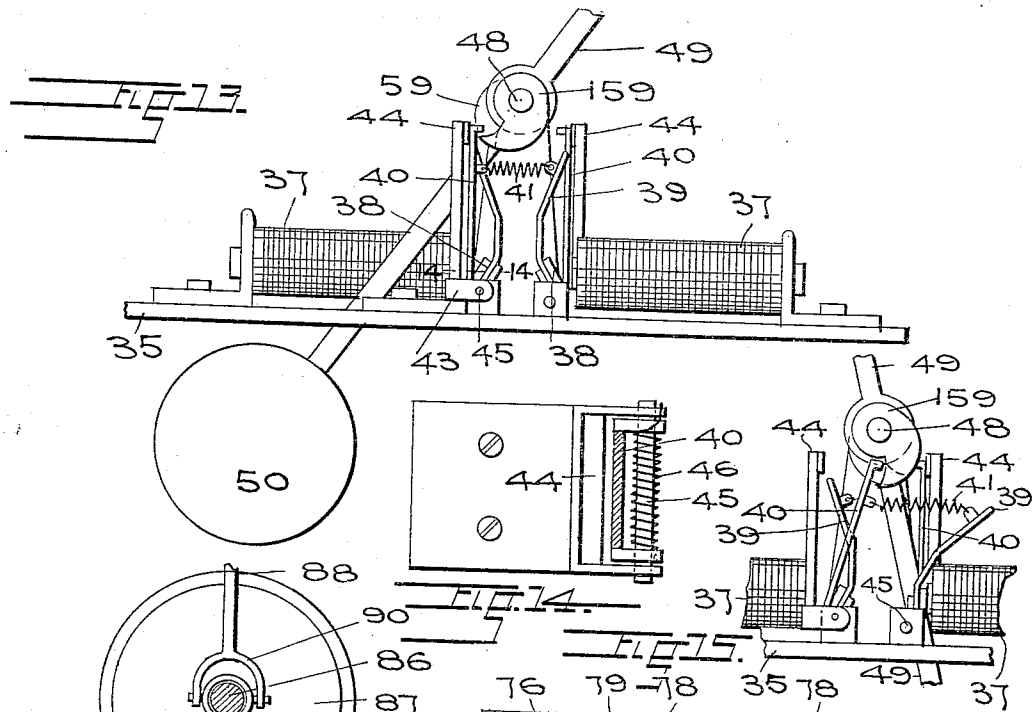

FIG. 13.

FIG. 14.

FIG. 15.

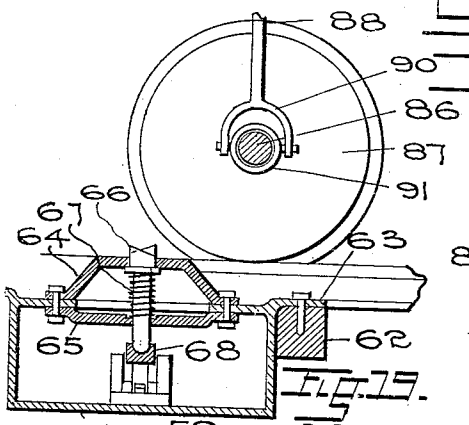

FIG. 19.

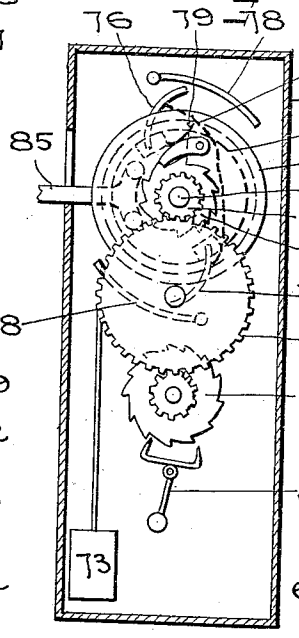

FIG. 16.

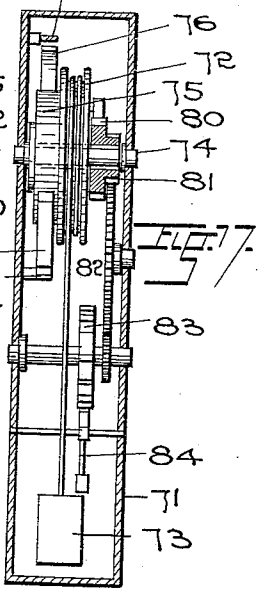

FIG. 17.

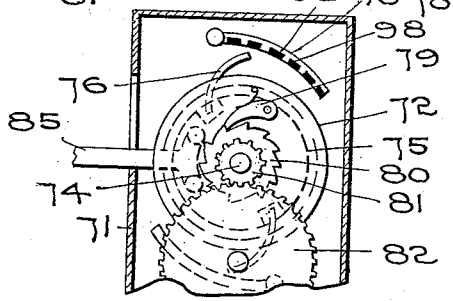

FIG. 18.

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APPLICATION FILED JUNE 16, 1908.

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8 SHEETS—SHEET 8.

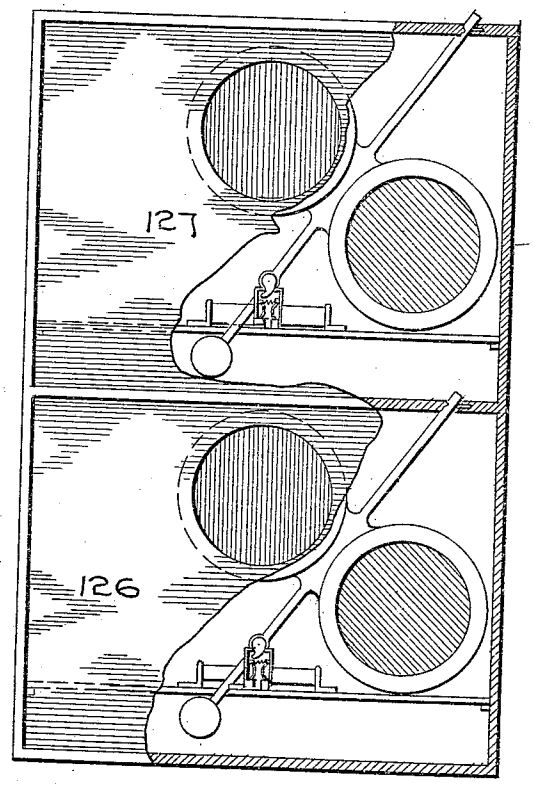

FIG. 20

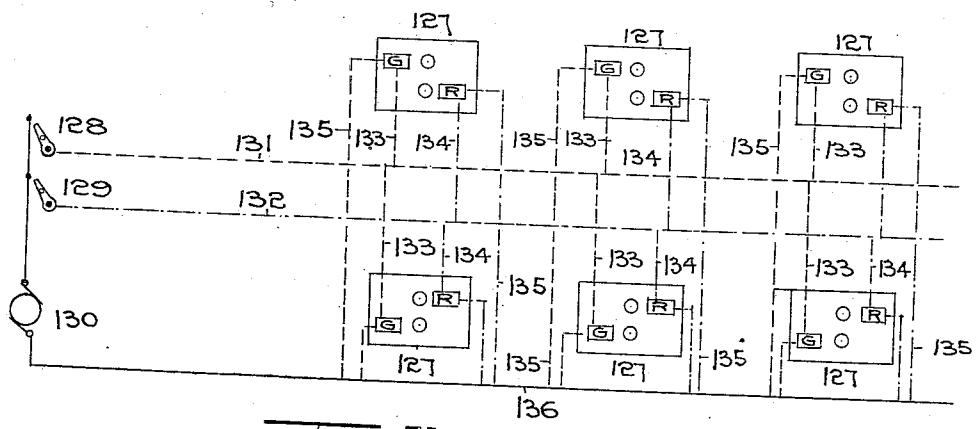

FIG. 21

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UNITED STATES PATENT OFFICE.

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RAILWAY SIGNALING SYSTEM.

941,263. Specification of Letters Patent. **Patented Nov. 23, 1909.**

Application filed June 16, 1908. Serial No. 438,852.

To all whom it may concern:

Be it known that we, THOMAS MAC. DOUGAL and JAMES M. CHAMBERS, citizens of the United States of America, residing at Boulder, in the county of Boulder and State of Colorado, have invented certain new and useful Improvements in Railway Signaling Systems, of which the following is a specification.

Our invention relates to certain new and useful improvements in signaling systems for use on railroads and its principal object is to provide an organization of indicatory instruments and electrical actuating means, which are simple in construction and positive in operation, and by means of which the location of one or more trains in relation to one or more predetermined points on the line of a railway, may be indicated at each station in a division and signaled to the engineers of following or oppositely moving locomotives.

The various annunciating and signaling instruments are automatically actuated by the passing trains through instrumentality of circuit closing mechanisms which are disposed in proximity to the stations and at intermediate points along the track.

The indicatory instruments, comprised in our system, are divided into two classes, viz: composite or station instruments and unitary or track instruments, all of which, although necessarily somewhat different in construction, operate on the same principle and by similar impellent means.

The composite or station instruments comprise, as the name implies, a plurality of indicatory units, which singly and coöperatively denote the location of a train relative to one or two stations in the railway division, and they are employed, firstly, in the station offices to aid and instruct the officials who direct the movements of the various trains, and further, in the waiting rooms, at hotels and other public places for the information of travelers and others interested in the arrival and departure of the trains at and from the various stations comprised in the division.

The unitary instruments are disposed in proximity to the line of the railway at the stations, and at the entrances and exits of switches and railroad yards, or at side tracks, crossings and all points where following or oppositely moving trains can pass each other. If the distances between stations are large, the track instruments and the therewith associated circuit-closing devices may be placed at intermediate points, in which case the line of railway is divided, as in the so-called "block systems" now in use, into a series of successive sections of convenient length.

The circuit-closing appliances comprised in our system are constructed so as to insure an effective connection between the terminals of the conductors included therein, irrespective of the speed of the trains by which they are actuated and this, as well as other advantageous features of our improved system and the mechanical devices comprised therein will be brought out in the following description, reference being had to the accompanying drawings in the various views of which like parts are similarly designated and in which—

Figure 1—represents a diagrammatical view of the various appliances and electrical connections as arranged in a railway division which comprises four stations, Fig. 2—a similar view illustrating the arrangement of annunciators and electrical connections at the entrance and exit of a railway switch, Fig. 3—a diagrammatical view showing the electrical connections between principal and supplemental station annunciators, Fig. 4—a similar view illustrating an alarm associated with a station instrument to audibly announce the arrival of the trains at the various stations in the division, Fig. 5—a plan view of a railway track showing the arrangement of two circuit-closing devices which are respectively adapted to be actuated by passing passenger and freight trains, Fig. 6—a sectional view of a railway track, the circuit-closing appliance associated therewith and a car truck which carries the mechanism by which the said appliance is actuated, Fig. 7—a sectional plan view of a composite or station annunciator, Figs. 8 and 9—enlarged transverse sections taken along a line 8—8, Fig. 7, showing the movable parts comprised therein, in their extreme positions, Fig. 10—a fragmentary

elevation of the annunciator shown in Fig. 7, looking in the direction of the arrow X, Fig. 11—a front view, partly in section, of a track signaling instrument, Fig. 12—an enlarged plan view of the operating mechanism comprised in the said instrument, Fig. 13—a side elevation thereof, Fig. 14—an enlarged horizontal section through one of the standards and adjoining parts included in the said mechanism, taken along a line 14—14, Fig. 13, Fig. 15—a fragmentary view, similar to Fig. 13, illustrating the position of the parts while the oscillating signal arm is being reversed, Fig. 16—an enlarged side elevation of one of the electric circuit closers included in our system, Fig. 17—a partly sectional end view thereof, Fig. 18—a fragmentary view similar to Fig. 16, showing a modified form of the stationary brushes, Fig. 19—an enlarged section taken along a line 19—19, Fig. 6, Fig. 20—a partly sectional front view of a track instrument of modified construction, and Fig. 21—a diagrammatic view illustrating the electrical connections between the instruments shown in the preceding view and the office of the train despatcher.

Referring to the drawings by numerals, let the reference character 5 designate the station instruments, 6 the track signaling instruments, 7 the circuit closing devices and 8 the generator or other source which supplies the electric fluid used in the operation of the various appliances comprised in our system.

The four stations of the railway division, illustrated in Fig. 1, are respectively denoted by the letters A, B, C and D and for the purpose of clearer illustration, the units of which the station instruments are composed and which respectively relate to the said stations, are likewise designated by the letters A, B, C and D, while the service wires which connect the circuit-closing devices at the stations with the various indicatory instruments are distinguished by the reference characters A′, B′, C′ and D′.

The intermediate signaling stations, which in Fig. 2 are shown at the entrance and exit of a switch, have been designated by the letters E and F and the service wires which connect the track signaling instruments, located at these stations with the respective circuit closers, by the characters E′ and F′. The conductors which lead from the service wires to the track signaling instruments, to reverse the position of the signal arms included therein, from the position indicatory of "safety" to that which announces "danger", have been drawn, in the diagrammatical views, in dash dot lines (—. —. —. —.) and those employed in the opposite movement of the said arms are indicated in a broken line (— — — — — — — —).

The composite or station instruments, illustrated in Figs. 7, 8, 9 and 10 of the drawings, are each composed of as many units as there are stations in the railway division and one supplemental unit, the function of which will hereinafter be described.

In the diagrammatical views the supplemental units are designated by the letter S and the service wires associated therewith by the character S′. Each unit comprises an electromagnet 10, the armature 11 of which is pivotally mounted contiguous to its poles and provided with an upwardly extending arm 12. The various electromagnets are mounted in parallel relation to each other, upon the non-conductive base 13 of a casing 25, one side, 14, of which constitutes the face plate which bears the names of the stations included in the division and such other reading matter as may aid in the intelligent interpretation of the signals.

As the arrangement and wording of the matter upon the face of the instrument is arbitrary, no illustration of the same has been given in the drawings.

Secured upon the base in juxtaposition to the face-plate 14 and opposite the various electromagnets 10, are resilient uprights 15, the upper portions of which are connected with the free extremities of the arms 12 on the respective armatures 11, by means of coiled springs 16. The upper extremities of the uprights 15 are arranged to engage, in practice, with the lower arms 17 of levers 18 which are fulcrumed upon bearings 19 secured upon the inner surface of the plate 14. The opposite, long arms 20 of the levers 18 carry the laterally extending signal blades 21 which project through vertical slots 22 in the face plate 14.

Fulcrumed to move about a vertical axis, in a bearing 23 between each two successive units of the instrument, is a lever 24, one arm 24^a of which extends in the path of the short arm 17 of the lever 18 of one of the said units, while the opposite arm 24^c is arranged to engage the upper portion of the resilient upright 15 of the next succeeding one.

When one of the electromagnets 10 is rendered temporarily magnetic by the closing of the electric circuit in which it is located, its armature 11, being attracted toward its poles, moves about its fulcrum and, by means of the connection 18, bends the upper portion of the respective, resilient upright 15 away from the plate 14, as is shown in Fig. 8, to engage the short arm 17 of the lever, which latter is, in consequence, impelled to move about its fulcrum until it has assumed a substantially vertical position, when by the influence of the disproportionate gravity of its upper arm, its oscillatory movement is automatically continued until arrested by the simultaneous engage-

ment of the extremities of the corresponding lever 24, with the outer edge of the arm 17 and with the upright 15 of the next succeeding unit, as is shown at "B" in Fig. 7, in which position the blade 21 on the lever 20, projects outwardly beyond the face of the plate 14 as is illustrated in Fig. 8.

Now, when the train, passing the next station, closes the circuit in which the electromagnet of the corresponding unit (C), is located, the movement of the arm 15, in unison with its armature, will be communicated to the lever 24 which is fulcrumed between the said unit and the preceding one (B), and whose extremity 24^a is in engagement with the lower arm 17 of the latter's indicatory lever 18. The result is that the last named lever is returned to its original, retracted position, shown in Fig. 9, and it will thus be seen that each time the long arm 20 of the lever 18 of one of the units comprised in a station instrument, is projected outwardly to indicate by the position of its blade 21 in relation to the face plate 14, that a train has passed the station with which the said unit corresponds, the said blade will be automatically withdrawn, synchronously with the outward movement of that of the next succeeding unit, when the therein comprised electromagnet is energized by the closing of the circuit, controlled by the circuit closing device at the next station. After the train has passed the last station in the division, the indicatory blades of the thereto relating units in the station instruments are retracted by the action of the levers 24 which are associated with the before mentioned supplemental units S (not shown in Fig. 7), the electromagnets in which are energized in a manner identical to that of the station units A, B, C and D.

Mounted upon the insulating base 13 of each station instrument in operative proximity to the uprights 15 of the various units, are contact blades 26 which are engaged by the respective uprights 15 when the latter are in their bent position, as is illustrated in Fig. 8, for the purpose of closing an independent electric circuit such as is shown in Figs. 3 and 4. This circuit is, in the first named figure, employed to operate a supplemental station instrument 27, which may be placed at any desired distance from the principal instrument 5. The two instruments 5 and 27 are identical in construction and operation, the uprights 15 of the various units in the principal one, being connected with a source of electricity 28, by means of a conductor 29, while the opposite terminal of the said source connects with the electromagnetic coils of the units in the supplemental instrument by means of a conductor 30. Wires 31 serve to connect the contact blades 26 of the instrument 5 with the opposite ends of the electromagnetic coils in the corresponding units of the instrument 27 so that when, by the movement of an armature in one of the units of the principal instrument, the thereto attached resilient member 15 is brought in contact with the corresponding blade 26, the therewith electrically connected electromagnet of the supplemental instrument will be energized and the corresponding signaling blade moved into its projected position. The motions of the various signaling blades in the one instrument will thus be duplicated by those in the other, so that the passing of a train by a station in the division may be indicated simultaneously at a plurality of places, it being manifest that, in the manner described, an unlimited number of instruments may be electrically connected to operate in unison.

In the construction illustrated in Fig. 4 the uprights 15 connect likewise with a source of electricity 32, whose opposite terminal connects with an electric alarm 33, which is also connected by means of wires 34 with the various contact blades 26 of the instrument 5. The outward movement of each of the signaling blades comprised in the annunciator will thus be accompanied by a sounding of the alarm, which audibly directs the attention of those in charge of the station where the instrument is installed, to the fact that a train has passed a certain point in the division of which the said station forms part.

The unitary track signaling instrument, which is illustrated in Figs. 11 to 15 inclusive, operates in a manner identical to that of the units of the composite instruments, varying therefrom only in the arrangement of its operative parts.

The instrument consists of a base 35 which forms part of or is supported in, a casing 36, by which the operating mechanism is surrounded. The latter comprises two opposite electromagnets 37, the armatures 38 of which are, like those of the composite instrument, pivotally mounted upon the base and provided with upwardly extending arms 39.

Pivotally mounted by means of pins 45, upon stationary upright supports 44, opposite to the electromagnets 37, are bars 40 which are resiliently maintained in a substantially vertical position by means of springs 46.

The bars 40, which, in the function they perform, are the equivalent of the resilient members 15 of the station instruments, are connected with the arms 39 of the respective armatures, by means of coiled springs 41, so that when the said armatures are attracted toward the respective coils, the bars 40 will be moved about their pivotal axes in the same direction.

A transverse rocker shaft 48, dispised at equal distances from the two magnets, is rotatably supported in bearings 47 and car-

ries an arm 49 which extends in opposite directions therefrom and whose lower portion projects through a slot in the base 35, and is provided with a weight 59, which serves to render its movement equable.

The upper arm of the bar 49 carries two oppositely disposed, laterally extending signal blades 51 and 52, each of which is composed of a circular frame 53 and a therein secured pane 54 of stained glass or other translucent material.

The face plate 55 of the casing 36 is provided with a window 56, which is arranged to expose one or the other of the panes 54 to view when the oscillating arm 49 is in its extreme positions. The panes 54 in the blades 51 and 52 are of different colors, preferably red and green, which, as in the semaphores now in use, are symbolic of "danger" and "safety" and by their position in relation to the window 56, instruct the engineers of approaching trains whether or not to enter the section at the entrance of which the instrument is located. A lamp 57, shown in broken lines in Fig. 11, is disposed within the casing, opposite the window 56, for the purpose of rendering the signaling instrument available for night service. The upper extremity of the oscillating arm 49, extending beyond the signal blades, projects through a slot in the top of the casing 36 and engages, when in its extreme positions, buffers 58, which being composed of resilient material, will deaden the jar caused by the collision of the arm with the ends of the slot when the position of the former is reversed.

Mounted upon the rocker shaft 48, respectively in the path of the two pivoted bars 40, are cams 159 through the instrumentality of which the forward movement of either of the said bars is transposed into a rotative motion of the shaft in opposite direction.

The operation of the track signaling instrument is similar to that of the units of the station annunciator and will be readily understood. When, by the action of a passing train, one or the other of the electromagnets 37 is energized, the respective armature 38, being attracted thereto, will turn about its pivot, and the therewith connected bar 40 will move in unison therewith. The consequent engagement of the upper extremity of the said bar with the corresponding cam 159 on the shaft, will cause the latter to rotate in its bearings until the arm 49 has been brought past its line of equilibrium, when the disproportionate weight of the upper portion of the said arm will impel it to continue in its movement until arrested by engagement of its extremity with the stop 58. To reverse the position of the arm 49, the diagonally opposite magnet is energized and the consequent movement of its armature transposed, by means of the other cam, into a rotative motion of the shaft 48, in the opposite direction.

As has been mentioned at intervals in the course of the foregoing description, the magnets comprised in the various track signaling and station instruments are energized by the temporary closing of electric circuits, which is automatically accomplished by the passing trains through the instrumentality of suitable circuit-closing apparatus the construction and operation of which will now be described.

The apparatus above referred to, which, in the diagrammatical views are designated by the reference numerals 7, comprise cooperative elements 59 and 60, the former of which is disposed beneath the railroad track to be actuated by contact with the passing train, while the other is preferably mounted upon an adjacent pole or other suitable support and includes the switch mechanism proper.

Two identical circuit closing devices are, in practice, disposed at opposite sides of the track, to be respectively actuated by trains running in opposite directions and the elements 59 of these two devices are inclosed in a common housing 61 which is secured by means of laterally projecting lugs 63, upon two adjacent ties 62 in transverse relation to the rail-road track. The housing 61 has in its top a centrally disposed, circular opening covered by caps 64 and 65 which are secured at opposie sides thereof, and which serve as guides and supports for the track buttons 66 of the two elements 59 which project through registering openings in the two caps at equal distances from the center of the track. The buttons 66 whose beveled heads protrude above the upper surface of the cap 64, are formed with collars which normally engage the inner surface thereof to limit the upward motion of the members of which they are part.

Coiled springs 67, which surround the buttons in engagement with the caps 64 and 65, serve to resiliently maintain them in their normal, protruding position. The lower extremity of the button in each circuit closer occupies a correspondingly formed depression in the inner extremity of a lever 68 which is fulcrumed within the casing and whose outer arm connects, by means of a spring 69, with the lower end of a vertically movable rod 70 which is instrumental in transmitting the downward movement of the track button 66 to the circuit closing element 60, the construction of which will now be described.

A casing 71 incloses a clock-work which includes a drum 72 upon which is wound the rope of a weight 73 and which is revolubly supported upon an arbor 74. A disk 75, rigidly connected with the drum, carries

two opposite, outwardly projecting brushes 76, the extremities of which are secured in blocks of non-conductive material let into the peripheral edge of the disk, and which are electrically connected by means of a wire 77. Stationary contacts 78 are secured within the casing, in the path of the brushes 76 and are respectively connected with the lead wires included in the electric circuit by which the signaling system is operated.

A spring controlled pawl 79, pivotally mounted upon the outer vertical surface of the drum 72, engages the teeth of a ratchet wheel 80, which is secured upon the arbor 74, and which is integral with a pinion 81. The latter connects, through the instrumentality of a gear train 82, with an escape wheel 83, the peripheral teeth of which are engaged by the pallets of an oscillatory anchor-shaped verge 84.

An arm 85, projecting outwardly from the disk 75, through a slot in the side of the casing 71, is engaged by the upper extremity of the vertical rod 70, whose upward movement is thus communicated to the circuit closing mechanism. When, by contact with a projecting element on the passing train, one of the buttons 66 is depressed, the outer arm of the therewith connected lever 68 is raised and its upward movement transposed into a rotary motion of the disk 75 and the therewith associated drum 72 which, in consequence, winds the rope from which the weight 73 is suspended. The moment the button 66 is disengaged, the lever 68 as well as the rod 70, return to their normal position while the drum 72 and the disk 75, whose brushes 76 were brought in engagement with the contacts 78, are held against immediate retrograde movement by the engagement of the spring actuated pawl 79 with the teeth of the ratchet wheel 80 and the contact of the stationary brushes 78 with those on the disk will thus be prolonged until by the gravitative action of the weight 73 which is restrained by the gear train 82 and the escapement 83, the disk 75 is returned to its original position with the extremity of the arm 85 in engagement with the upper end of the rod 70. The result of this operation is that the length of time during which the brushes in the switch mechanism are in engagement, is independent of the period during which the corresponding track button 66 remains in the depressed position when operated by a passing train, so that an effectual closing of the electric circuit and an effective operation of the therein located signaling instruments is insured, irrespective of the speed of the train by which the circuit closing mechanism is operated.

Slidably and rotatably mounted upon an axle 86 of one of the trucks of the locomotive, or other car of the railway train is a wheel 87 which is adapted to engage the protruding beveled portions of the heads of the track buttons 66. A lever 88, which is fulcrumed at 89 in a bearing secured to the bottom of the car, has a forked lower arm, the bifurcated extremities 90 of which connect with trunnions which extend laterally from collars 91 which encircle the axle 86 in engagement with the sides of the hub of the wheel 87. The upper arm of the lever 88 connects with the rod of a piston 92 which has a reciprocating movement in a cylinder 93 disposed in the cab of the engine or in the car which carries the apparatus, and which connects, at its ends, by means of conduits 94, with a convenient source of motive fluid. The upper extremity of the arm 88, terminates in a pointer 95 which indicates on a scale 96, the position of the wheel 87 in relation to the buttons on the track.

A valve 97 in the pipe 94 is adapted to admit and exhaust the motive fluid, alternately at opposite sides of the piston 92, and the engineer of a train is, by these means, enabled to speedily and effectively reverse the position of the wheel in relation to the center of the track.

The two buttons 66 are designed to be respectively engaged by trains running in opposite directions and the wheel 87 is normally positioned on the right hand side of the center of the track, and reversed only when, as is often the case at switches or in railway yards, the train is moved in a rearward direction.

If it is desired to separately indicate the movements or location of passenger and freight trains, the system of electrically connected mechanical devices hereinbefore described, is duplicated, with the possible exception of the track signaling instruments, and two duplex circuit closing apparatus including two sets of buttons are employed as is illustrated in Fig. 5 of the drawings, the buttons which are intended to be actuated by the passing freight trains being disposed at a greater distance from the center of the track than those which are depressed by engagement with the tread of the wheels 87 on the passenger trains.

Should it be required to employ a single station annunciator to signal the location of both passenger and freight trains moving in one direction, the one may be distinguished from the other by a distinctive sounding of the alarm 33.

In Fig. 18 is illustrated a modification of the circuit closing apparatus which is especially adapted to the above purpose.

The stationary contacts 78 have in their faces a series of insulating strips 98, so that during the movement of the disk 75 the electrical connection of the said contacts with the brushes 76 will be broken at integrals, with the result that the corresponding electromagnet and the alarm associated

therewith will be intermittently vitalized and the latter give forth a series of short sounds, in contrast with the uninterrupted sound produced by the contact of the brushes in the switch mechanism illustrated in Figs. 16 and 17.

Having thus described the construction of the various mechanical devices which are included in our invention, we will now explain their electrical connections and the manner in which our system operates to effectively control the movements of the various trains running in opposite directions in a railway division, and to consequently reduce to a minimum the chances of collisions and other accidents, as well as the loss of time due to delays at meeting places of oppositely moving trains.

Referring to Fig. 1 of the drawings, let the numeral 99 designate the railroad track of a division which comprises the four stations A, B, C and D.

Each station has two composite instruments 5 which respectively indicate the location of trains going in opposite directions; two track signaling instruments are located at opposite sides of the track, in proximity to each station and a circuit closing apparatus as illustrated in Fig. 6, is also disposed at a near by point.

Assuming the track to extend in the direction of the true meridian, the left hand side of the drawing being the north point, the unitary instruments on the east side of the track face south and those on the west side north, or, with other words, the trains are guided at all times by the instruments on the right hand side of the track along which they move. The station instruments at the upper portion of the drawing are those that indicate the movements of the trains moving in a northerly direction, while those at the bottom of the sheet denote the approximate location of those traveling in opposite direction.

We wish it understood, however, that the instruments have been drawn in this position only to promote the clearness of the illustration and that, in practice, the two instruments are placed in close proximity to each other and preferably in one, common casing. It is for this same reason that the return wires, which in the drawings are indicated by the numeral 100, have been duplicated whereas, in practice, but one conductor is employed to connect with the leading out wires 101, 102 and 103 of the various instruments.

Of the circuit closing devices, only the two terminals 78 and the track buttons 66, have been shown in the diagrammatical views and, as has been explained hereinbefore, the wires which lead to the electromagnets of the track signaling instruments by means of which the red or danger blade is moved in front of the window in its face, have been shown in a dash dot (—.—.—.) line, while those which connect with the electromagnet coils by means of which the green or safety blade is exhibited, are indicated by a broken (— — — —) line.

It has been explained hereinabove that each instrument contains as many units as there are stations in the division and in addition thereto one supplemental unit to effect the withdrawal of the last signaling blade after the train has passed the last station in the division.

Placed along the track, over poles, in subterranean conduits or in any other suitable manner, are as many service wires 104 as there are units in each station instrument and each of these service wires connects by means of the leading in wires 105, with one of the electromagnetic coils of each composite instrument.

As has been indicated in the drawings by the corresponding letters, the various units in each station instrument are arranged in the same order as the stations in the division and those in the several instruments which correspond with one station, are connected with the same service wire. The corresponding units and service wires have, for convenience, been designated in the drawings, by the same reference character as the station to which they pertain.

One of the terminals 78 of each circuit closer 7 connects with a lead wire 106 which connects with a terminal of the source of electricity 8 whose opposite pole is connected with the return wire 100 which, as above explained, connects with the electromagnets of the various instruments comprised in the system, by the leading out wires 101, 102 and 103. The opposite terminal 78 of the circuit closers 7 are connected separately with the service wires which correspond with the stations at which the said circuit closers are located, for example, the terminal of the electric switch at station A connects with the service wire A′ associated with the units A in the different station instruments, that at B with the wire B′ connected with the electromagnets B and so on to the service wire S′, which connects with the auxiliary units S and which may be connected with an independent circuit closer, located beyond the last station or with a manually operated switch disposed at any convenient point.

It will be understood that the arrangement of instruments and electrical conductors thus described, relates only to those instruments which indicate the approximate location of trains going in one direction; the annunciators which denote the movements of trains running in opposite direction, are connected with an independent series of service wires, the two series having been placed in the drawings at opposite sides of the track.

As the connections between the stations and track signaling instruments with the respective service wires is the same in each series, and at each station, the description of the method of connecting at one station and on one side of the track will be sufficient to convey a complete understanding of the entire system.

To facilitate the description of the electrical connections which control the movements of the track signaling instruments, the electromagnets by means of which the green signals are displayed will be termed the "green" magnets and those by which the position of the oscillating signaling arm is reversed, the "red" magnets, while in the drawings they are designated respectively by the letters "G" and "R".

The series of service wires which connect with the instruments which denote and guide the movements of north bound trains are designated in the following description by the words "north" or "north bound" and those which relate to trains moving in the opposite direction by the term "south" or "south bound".

The green magnet at each station is connected by means of conductors 107 and 127, with the service wire corresponding with the next succeeding station and with the service wire of the series connecting the instruments denoting the movements of trains running in opposite direction, which corresponds with the station at which the instruments are located. The red magnet at each station connects by means of wires 128 and 129 with that service wire of its own series which corresponds with the station at which it is located and with that of the opposite series which corresponds with the next succeeding station. Thus the green magnet at the east side at B connects with service wire C′ of the north bound series and with wire B′ of the south bound series, while the red magnet at the same side of the same station connects with wire B′ of the north bound series and with wire C′ of the south bound series; the green magnet at the west side of the same station is connected with the A wire of the south bound series and with the B wire of the north series and the red magnet at the same side of the track connects with the B wire of the south bound and with the A wire of the north bound series.

In Fig. 2 of the drawings is illustrated the arrangement of instruments, circuit closers and electrical connections at a switch 108, which arrangement is identical to that employed in connection with side tracks and railroad yards or at any place where trains can deviate from the line of track along which they move under normal conditions. The same system may furthermore be employed when, owing to the great distance between stations, it is advisable to create a number of intermediate signaling stations by dividing the line into a series of sections or blocks at the divisional lines of which track instruments are disposed at opposite sides of the track, the same as at the regular stations or stopping places included in the division.

In the drawing, let the letters E and F designate the intermediate signaling stations, 109 the additional service wires and 110 the circuit closing devices associated therewith.

The connections of the red and green magnets at E and F and the terminals of the circuit closers, with the service wires and in relation to each other and the succeeding and preceding stations, is identical to those described in connection with the regular system illustrated in Fig. 1 and no further connections are required if the intermediate stations are located on an uninterrupted track. If, however, they are disposed at the entrance and exit of a switch or yard as is shown in Fig. 2, we employ, in addition to the circuit closing devices which are located at opposite ends of the said switch, two or more circuit closers 112 which are disposed in between the terminals of the switch. The elements 112 comprise but one track button and one circuit closing mechanism, in variance with those illustrated in Fig. 6 which include two such devices to be actuated, independently by trains running in opposite directions. One of the terminals 113 of each of the circuit closers 112 connects, like those of the elements 7, with the lead wire 106, while their opposite poles are interconnected by means of a wire 114. A conductor 115 leads from the last named wire to the green magnets of the stations E and F, which face the approaching trains, (*i. e.* the magnet of the east instrument at F and the west instrument at E). The green magnets of the two instruments at the stations E and F are furthermore connected with the corresponding service wires 109 of the opposite series, by wires 116, (for example, the east magnet at E is connected with the wire E of the south bound series) and the red magnets at the said stations connect with the corresponding service wires of their own series, by wires 117 (east magnet at E with north bound E wire, west magnet at F with south bound F wire, etc.). At the regular stations B and C, between which the switch is located, the green magnets of the instruments which face the approaching train, are connected with the service wire of its own series which corresponds with the nearest intermediate station by means of wires 118 and the red magnets of the said instruments connect with the service wires of the opposite series, corresponding with the nearest intermediate stations by wires 119, (in the drawing the west green magnet at C connects

with southbound E wire, and the red magnet with northbound E wire, while the east green magnet at B connects with the northbound F wire and the red magnet with the south bound F wire).

Having thus described the mechanical devices comprised in our invention as well as the system of electrical connections by which they are operated, we will now describe the operation thereof.

Before any train has entered the railway division in which our system is installed, the signaling blades 21 in all the station instruments are in the withdrawn position (Fig. 9) and all the track signaling instruments display the green or safety signal to indicate that the track is clear. When the train passes one of the terminal stations of the division (A and D, in the drawings) the circuit closed by the contact of the wheel 87 on the engine, with the respective track button 66, energizes the magnets of the units corresponding with the said station, of all the composite instruments in the series arranged to indicate the movements of trains running in the same direction, thereby placing the blades connected therewith in the projected position, (Fig. 8). The throwing of the signal is accompanied by the sounding of the alarm 33 (Fig. 4) and the operators at the various stations are thus simultaneously informed that the train has entered the portion of the line between the first and second stations in the division. When the train passes the second station and by actuation of the adjacent circuit closing apparatus, closes the circuit in which the corresponding units of the station instruments are included, the blades 21 of the latter are thrown in the projecting position, while those in the immediately preceding units, which remained in the projected position while the train traversed the distance between the two stations, are retracted and returned to their normal, withdrawn position through the instrumentality of the levers 24, which being engaged by the outwardly moving signal levers, impart by the pressure exerted by their opposite arms upon the short arm of the signal levers of the preceding units, an inward motion to the upper arms thereof. The various indicatory blades of the several instruments included in the series, are thus progressively projected and withdrawn until the train has passed the last station in the series, after which the supplemental magnet S is energized to return the blades related to the said station, to their original positions. Trains moving in the opposite direction actuate in a similar manner the instruments of the other series, and the occupants of the stations can by these means ascertain, at a glance, between which two stations the various trains are located.

In case the double system is employed to separately indicate the location of freight and passenger trains, the circuit closing device illustrated in Fig. 18, will, by causing the alarm to sound intermittently, enable the operator whose attention was called to other matters, to determine which of the two instruments was actuated.

When the train passing the first station in the division, closes the circuit by which the station instruments are vitalized, it reverses synchronously the position of the signaling arms of the track signaling instrument which faces the train at the said station and that which faces in opposite direction at the next succeeding station and the danger signals thus exhibited, inform engineers of following and approaching trains that the track between the first and second stations is occupied. After the train has passed the second station and the corresponding circuit closing mechanism has been actuated thereby, the instrument at the preceding station and that at the present station which both display the danger signal, are reversed, while at the station which the train passed, the instrument facing the train and at the next station, that facing in opposite direction, both of which displayed the safety signal, are simultaneously set to exhibit the danger sign. As each successive station is passed, the above described operation is repeated, until the end of the division has been reached, when all the instruments will display the safety signal unless other trains are moving between the terminal stations.

For example;—A north bound train entering the division at A in Fig. 1, reversed the east instrument at A and the west instrument at B to red, passing B it reverses the east instrument at A and the west instrument at B to green and that at the east side of B and the west side of C to red; passing C, the east instrument at B and the west instrument at C are changed to green and the east one at C and the west one at D to red and so on, the same action taking place in reversed order when the trains, moving in a southerly direction, enter the division at D.

It will thus be observed that, after a train has entered the division, each time a station is passed, four track signaling instruments are reversed, to wit, the one facing the train and that facing in opposite direction at the present station, respectively to danger and safety, that which faced the train at the preceding station, to safety and that facing oppositely at the next succeeding station to danger.

A train passing a switch at whose entrances track signaling instruments are located, as is illustrated in Fig. 2 of the drawings, will set the signal at the entrance passed and that at the opposite end of the switch, as well as those at the preceding station in a manner identical to that described

in relation to the regular stations. If the train enters the switch, however, and actuates one or the other of the circuit closing devices 112, the instrument facing at the entrance to the switch and that facing oppositely at the other end thereof, both of which had been set at danger, while the train passed the circuit closer 110 at the said entrance, will be reversed to safety, as will also the instrument which faced it at the preceding station and which was set at danger by the same operation. The track being clear and all the signals being set at safety, trains may pass until the train on the switch returns to the main track, when by contact with the button of the circuit closing device at the end of the switch, through which it passes, the instrument which faces it at the said end and that facing in opposite direction at the next succeeding station, will be reversed to display the danger signal.

For example, a south bound train passing E returns the west instrument at C and the east one E to "safety" and sets the west one at E and the east one at F at "danger". After entering the switch it actuates one of the circuit closers 112, and reverses the west instrument at E and the east instrument at F to "safety". On leaving the switch, northbound, the circuit being closed at E, sets the east instrument at E and the west instrument at C at "danger", or if the train leaves the switch at the south end, the west instrument at F and the east one at B are reversed to "danger". The buttons of the single circuit closing devices 112 are preferably placed in the center of the track, so as to compel trains running in opposite directions, to engage the same when the wheel 87 is positioned midway between the wheels of the vehicle.

It will be manifest that if the engineers of trains guided by the signals thus displayed, are not permitted to pass a danger signal, a collision between trains moving either in the same or in opposite direction, becomes an impossibility and this feature, in connection with the fact that the employees at the various stations are at all times informed regarding the location of trains moving in their division, constitutes an effective safeguard against accidents, while it reduces the responsibilities of train despatchesrs and others who control the movements of the various trains, to a minimum.

In Fig. 20 of the drawings is illustrated a modified construction of the track signaling instrument 6. The casing 125 in this form, contains two separate signaling mechanisms each identical to that shown in Fig. 11.

The lower mechanism 126 of each duplex instrument is connected with the circuit closers 7 of the system in a manner identical to that hereinbefore described while the upper mechanism 127 is arranged to be actuated by the closing of a circuit at the train despatcher's office, its object being to signal to engineers of moving trains in case an emergency such as a break in the track, renders further movement unsafe.

In the diagrammatic view shown in Fig. 21, the reference numerals 127 designate the emergency units of the track signaling instruments at three successive stations, the "red" and "green" magnets being distinguished by the letters R and G.

The characters 128 and 129 denote circuit closing devices installed in the office of the train despatcher and 130 the source of electricity. One pole of the latter connects with the contacts of the two circuit closers whose blades constitute the terminals of two conductors 131 and 132 which extend the entire length of the division. The conductor 131, which leads to the circuit closer 128, is connected, by means of wires 133, with the various "green" magnets of the emergency signaling devices, while their "red" magnets connect by wires 134 with the conductor 132 of the switch 129. The opposite extremities of the various electromagnetic coils comprised in the several units 127, are connected by means of wires 135, with the return wire 136 which leads to the opposite pole of the source 130. It will be readily understood that, by these means, the train despatcher can at any time display a red or danger signal at all stations in the division and thus arrest the progress of the trains until the track has been restored to its original state when by actuation of the respective circuit closer the green signals of the emergency units are again exhibited.

While we have shown and described the various mechanical devices and electrical connections in their preferred form and arrangement, we do not limit ourselves to the precise construction herein set forth since various changes relating to minor details of construction may be resorted to without departing from the principle of our invention and it will be understood that the current for actuating the series of instruments may be supplied from a single common generator or source of electricity, as is shown in the drawings, which may either be a dynamo-electric machine or a battery of sufficient capacity, or it may be supplied from a local battery or dynamo at each station, or the electricity derived from the common generator, may be reinforced at the various stations by means of independent circuits and interposed relays.

Having thus described our invention what we claim is:—

1. In a railway signaling system, the combination with a circuit closer, of an electromagnet in the circuit controlled thereby, an indicatory element operatively associated

with the armature of the magnet, so as to display a signal when the latter is energized, and non-electric means coöperative with the armature of the said magnet to retract the said signal.

2. In a railway signaling system, the combination with a circuit closer, of an electro-magnet in the circuit controlled thereby, a resilient member connected to move in unison with the armature thereof, a signal device including a lever whose short arm projects in the path of the said member, and a stationary contact placed to be simultaneously engaged by the said member to close an independent electric circuit.

3. In a railway signaling system, the combination with a series of circuit closers placed successively along a railway and adapted to be actuated by a passing train, of an element comprising a corresponding succession of indicatory units, separately located in circuits controlled by the respective circuit closers, and adapted to separately display a signal when the respective circuit closer is actuated, and means associated with each two successive units whereby the actuation of one will be automatically transposed into a retraction of the signal in the next preceding one.

4. In a railway signaling system, the combination with a series of circuit closers placed successively along a railway, of an element comprising a corresponding succession of units each composed of an electro magnet located in a circuit with the respective circuit closer, and a signaling device adapted to be actuated by the attractive properties of the said magnet, and means associated with each two succeeding units whereby the action of the magnet in one will be transposed into a retractive movement of the signaling device in the next preceding one.

5. In a railway signaling system, the combination with a series of circuit closers placed successively along a railway, of an element comprising a corresponding succession of units each composed of an electro magnet located in a circuit with the respective circuit closer, a member connected to move in unison with the armature of the magnet and an oscillatory signal arm adapted to be actuated by the movement of the said member, and levers arranged to simultaneously engage the actuative member in one unit and the oscillatory arm in the next preceding one whereby the movement of the said member toward the magnet, is transposed into a retractive movement of the said arm.

6. In a railway signaling system, the combination with a series of circuit closers placed successively along a railway, of an element comprising a corresponding succession of units each composed of an electro magnet located in a circuit with the respective circuit closer, and including a pivoted armature, a normally upright member connected to move in unison with the armature and an oscillatory signal arm projecting into the path of the said member, and levers fulcrumed between each two succeeding units and adapted to simultaneously engage the actuative member in the one and the arm in the next preceding one.

7. In a railway signaling system, the combination with a series of circuit closers, placed successively along a railway, and adapted to be actuated by a passing train, of an element comprising a corresponding succession of indicatory units separately located in circuits controlled by the respective circuit closers, and an alarm in an electric circuit with normally separated contacts in each of the said units, the said contacts being arranged to engage by actuation of the respective magnet.

8. In a railway signaling system, two circuit closers adapted to be separately actuated by trains moving in one direction, an electro magnetic signaling device in a circuit with both said circuit closers, an electric alarm circuit controlled by said signaling device, said circuit closers being adapted to respectively close said circuit continuously and intermittently during a predetermined period.

9. In a railway signaling system, the combination of a plurality of circuit closers placed at successive points along the railway and adapted to be actuated by passing trains, track instruments adjacent the said points, station instruments each comprising a plurality of indicatory units successively arranged in correspondence with the said circuit closers, the said units, instruments and circuit closers being electrically connected whereby actuation of one of the latter will be communicated synchronously to the corresponding units, to the adjacent track instrument and to the track instruments at next preceding or succeeding points.

10. In a railway signaling system, the combination of a plurality of circuit closers at successive points along a railway and adapted to be actuated by a passing train, two oppositely facing instruments at each point, each adapted to separately exhibit two kinds of signals, the instruments and circuit closers being electrically interconnected whereby the actuation of a circuit closer at one point will cause the instrument which faces the moving train at the said point and that facing oppositely at the next succeeding point to display like signals of one kind and the other instrument at the first named point and that which faced the train at the next preceding point to exhibit like signals of the other kind.

11. In a railway signaling system the combination with a railway including a main line and a subsidiary line connecting therewith, of circuit closers adapted to be actuated by passing trains, located at successive points along the main line and at the entrance to the subsidiary line, two oppositely facing signaling instruments at each point of location of the said circuit closers, supplemental circuit closers at points along the subsidiary line, the various instruments and circuit closers being electrically interconnected whereby the closing of the circuit by any one of the supplemental circuit closers will actuate the instrument facing the moving train at the point of entrance and that facing oppositely at the next succeeding point, and the subsequent closing of the circuit at the point of entrance by a train entering the main line will actuate the instrument facing the train at the said point and that facing oppositely at the point in advance of the train.

12. In a railway signaling system, two series of circuit closers arranged successively in pairs along a railway, those in each pair being adapted to be separately actuated by trains moving in opposite directions, two series of annunciators respectively associated with the said series of circuit closers, each annunciator comprising a plurality of indicatory units arranged successively in correspondence with the respective circuit closers, two oppositely facing signaling instruments at the point of location of each pair of circuit closers, the various annunciators, instruments and circuit closers being electrically interconnected whereby the actuation of one of the latter will be communicated to the respective units in the respective series and to instruments at the point of its location and at that of the next preceding and succeeding closers.

13. In a railway signaling system, the combination of a series of circuit closers arranged successively along a railway, of an annunciator comprising a corresponding succession of coöperative indicatory devices, electrically connected with said circuit closers whereby the actuation of one of the latter by a passing train will cause simultaneous projection of the corresponding device and retraction of the preceding one.

14. In a railway signaling system, the combination with circuit closers placed at successive points along a railway, of annunciators each comprising a corresponding succession of indicatory units, and signaling instruments adjacent the various points, the circuit closer at each point being in an electric circuit with the adjacent instrument and that at the next succeeding point and with the corresponding units in the annunciators.

15. In a railway signaling system, the combination with two circuit closers, of two indicatory elements in circuits controlled thereby and adapted to exhibit signals when the respective closers are actuated, and a means coöperative with the two elements whereby the exhibitory movement of the one is transposed into a retractive movement of the other.

16. In a railway signaling system, the combination with two circuit closers, of electro-magnets respectively, in circuits controlled thereby, indicatory elements operatively associated with the armatures of the magnets and adapted to exhibit signals when the respective magnets are energized, and means coöperative with said elements whereby the exhibitory movement of the one is transposed into a retractive movement of the other.

17. The combination with a circuit closer, of an oscillatory lever having a target at its long arm, an electro magnet in the circuit controlled by said closer, means whereby the movement of the armature of said magnet is transmitted to the short arm of said lever so as to move the latter about its fulcrum, and a means independent of said magnet adapted to engage said short arm whereby the lever is returned to its original position.

In testimony whereof we have affixed our signatures in presence of two witnesses.

THOMAS MAC. DOUGAL.
JAMES McKINNON CHAMBERS.

Witnesses:
JOHN A. HALL,
O. H. LIPPOLDT.