No. 818,133. PATENTED APR. 17, 1906.

B. O. WAGNER.

COMBINED SYSTEM OF ELECTRIC SIGNALING AND SWITCH SETTING FOR RAILROADS.

APPLICATION FILED OCT. 28, 1904.

2 SHEETS—SHEET 1.

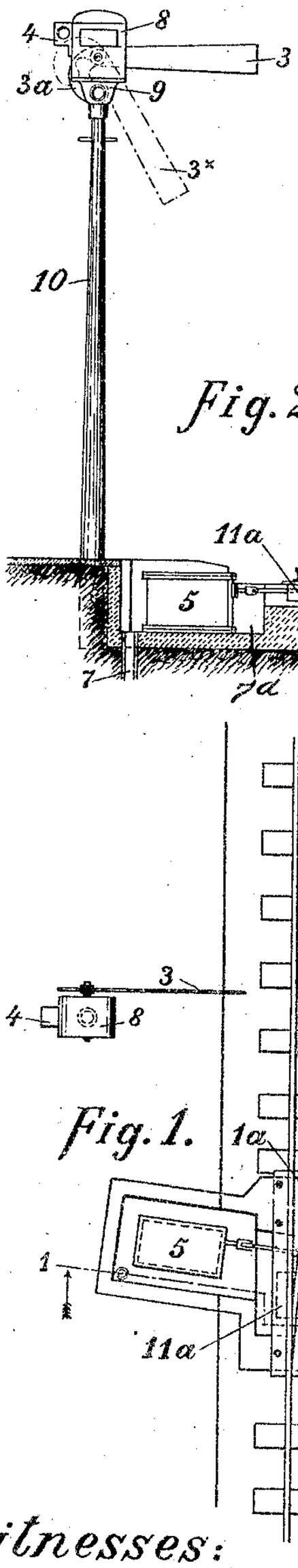


Fig. 2.

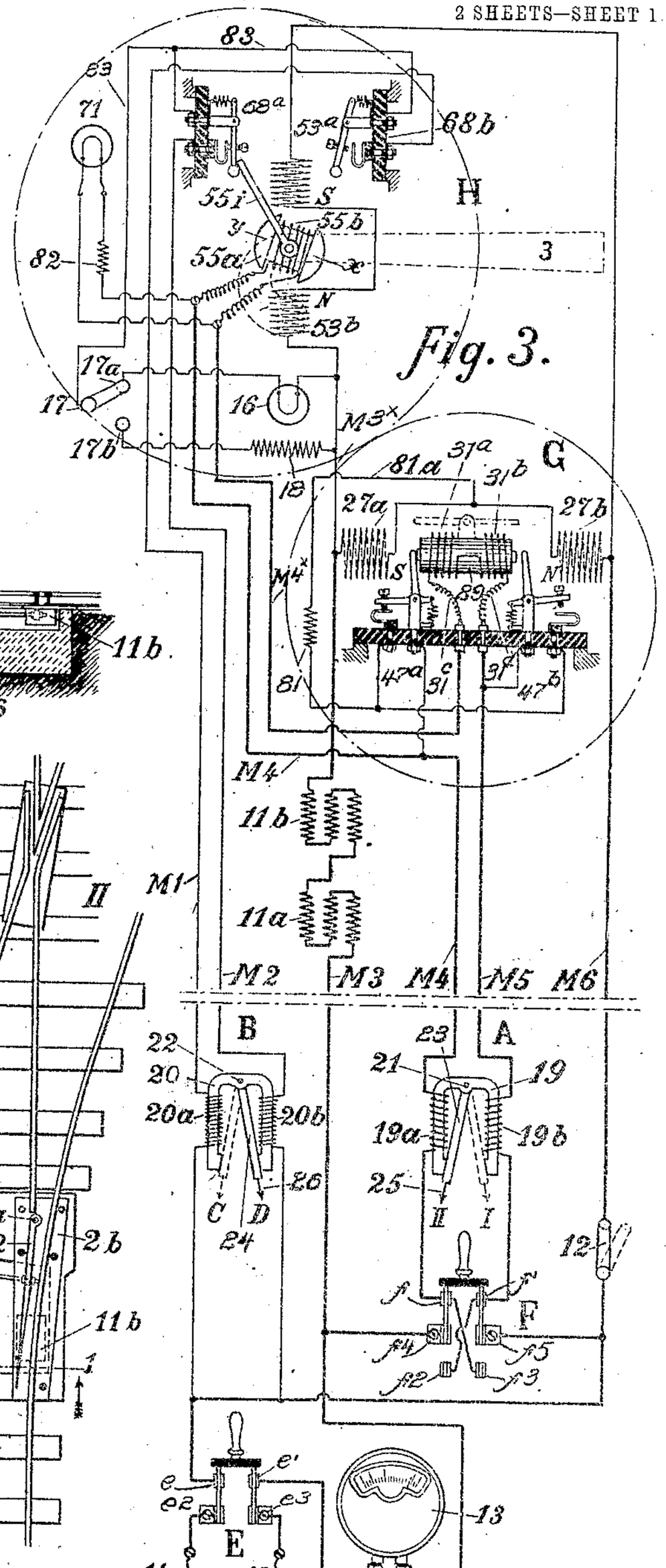


Fig. 3.

Fig. 1.

Witnesses:

Henry Max Goldsitz.

John Benno Goldsitz

Inventor:

Bruno Otto Wagner

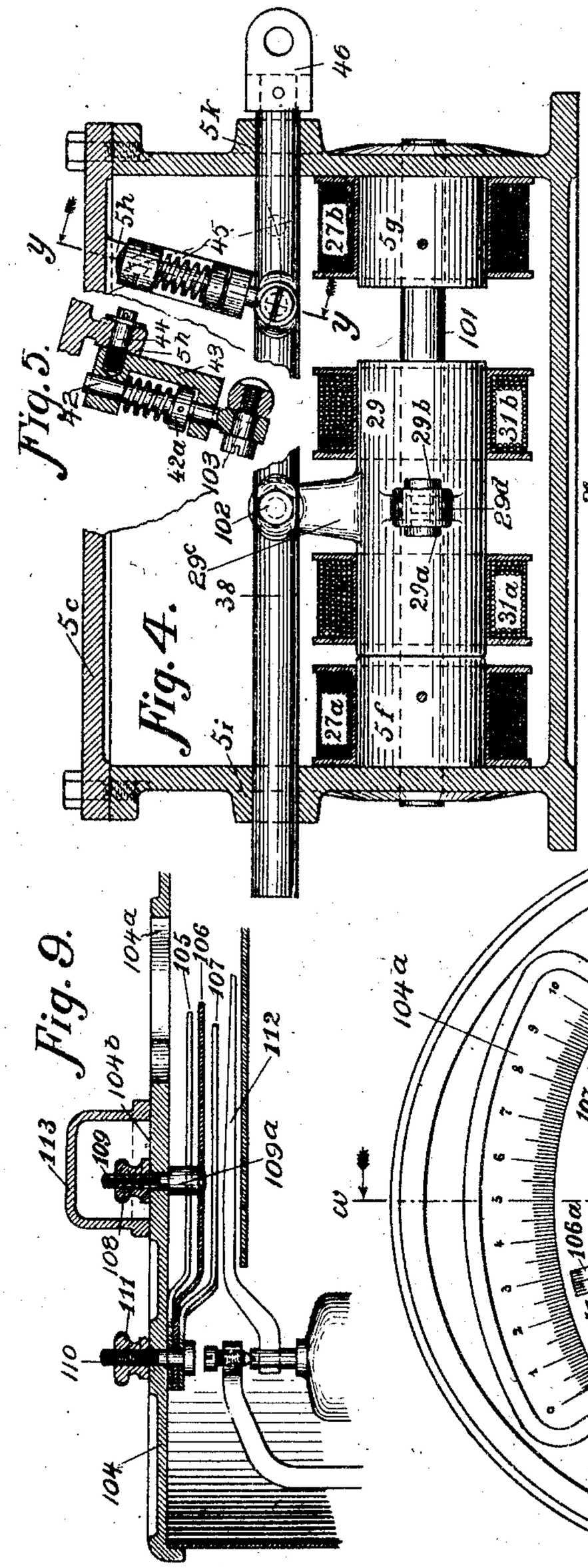
No. 818,133. PATENTED APR. 17, 1906.

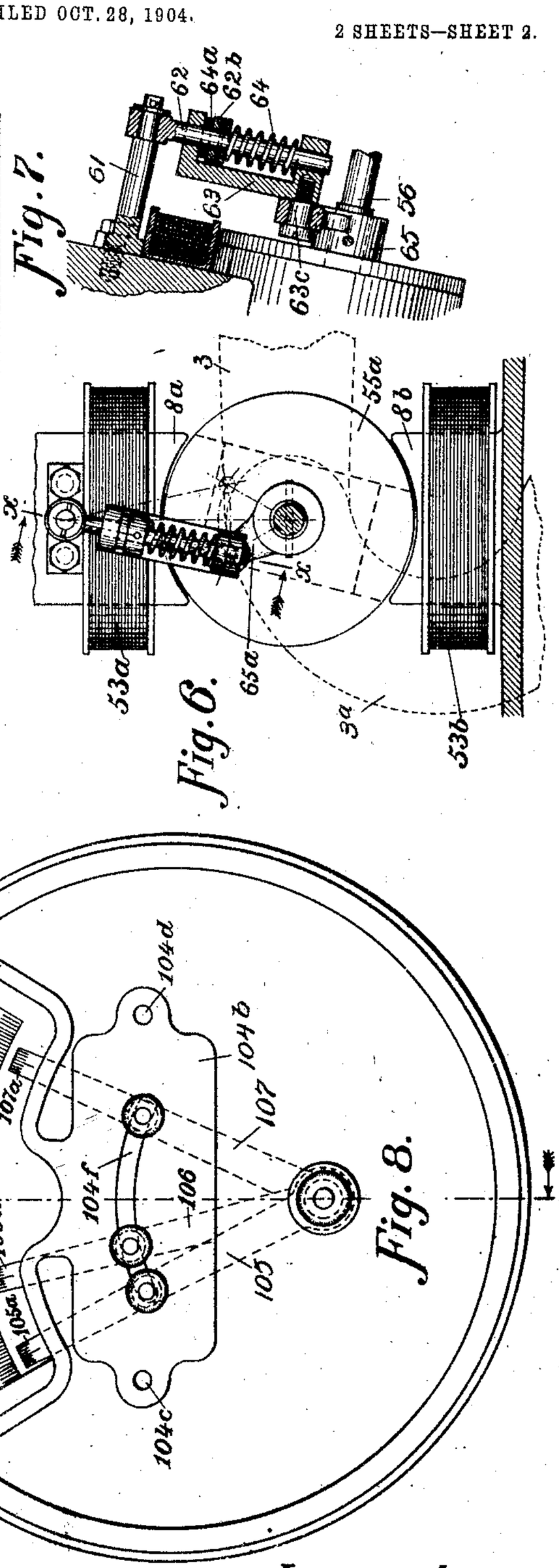
B. O. WAGNER.

COMBINED SYSTEM OF ELECTRIC SIGNALING AND SWITCH SETTING FOR RAILROADS.

APPLICATION FILED OCT. 28, 1904.

2 SHEETS—SHEET 2.





Witnesses:
Ronco Pringle Mason
Louis T. Botto.

Inventor:
Bruno Otto Wagner.

UNITED STATES PATENT OFFICE.

BRUNO OTTO WAGNER, OF EL PASO, TEXAS.

COMBINED SYSTEM OF ELECTRIC SIGNALING AND SWITCH-SETTING FOR RAILROADS.

No. 818,133. Specification of Letters Patent. Patented April 17, 1906.

Application filed October 28, 1904. Serial No. 230,521.

To all whom it may concern:

Be it known that I, BRUNO OTTO WAGNER, at present residing in the city of El Paso, in the county of El Paso and State of Texas, have invented certain new and useful Improvements in Systems of Electrical Signaling and Switch-Setting for Railroads, of which the following is a specification.

My invention relates to certain new and useful improvements in electric signaling and switch-setting systems for railroads; and in its generic nature my invention seeks to provide a system of this character of a simple and positively-operating kind in which means are provided for opening and closing rail-switches, which means are always under the control of the operator, and means for informing said operator automatically by a visible signal at his station when the switch has reached its required position.

The complete system also includes means for operating a semaphore-blade or "dwarf signal" so as to inform the engineer of an approaching train in a visible manner, of the position of the switch and at the same time return the signal to the station to inform the operator that the respective track-signal is clear.

My complete system also includes the use of electric lights in place of oil-lanterns for track signaling during the night and means for instantaneously and automatically reporting to the operator's station when the light has been extinguished.

Again, the system includes means for heating the rail-switches electrically in winter to prevent them from becoming inoperative and clogged by snow and ice and means for allowing the operator or inspector to have a supervisory insight into the working conditions of the entire system at any time to keep him posted on eventual interruptions of the circuits, inform him of short circuits, leakages, and defects in the apparatus, &c., in order that the faults may be quickly discovered and remedied.

In its more detailed nature my present invention includes a source of direct current, a system of six wire lines, and embodies, first, an electromagnetic apparatus for shifting the rail-switch in both directions, keys or circuit-closers in mechanical connection therewith to form branch circuits at predetermined times to effect indicating-signals at the operator's station; second, an electromechanical apparatus for operating track-signals, which apparatus is in direct electrical connection with the rail-switch-shifting apparatus, so that both work together, keys or circuit-closers combined with said track, and signaling apparatus to operate visible signals at the station to correspond with the home signals before mentioned; third, an electric signal-lamp for night service forming a part of the semaphore (track-signal) and being covered by a transparent colored disk when the semaphore-blade is in its danger position, a suitable compensating resistance being provided to take the place of said lamp during the daytime and arranged to be cut out of circuit while the lamp is burning; fourth, an electric lamp held in a lantern near the track-signal, which is so arranged that it will be lighted up during the time the main signals are being changed; fifth, electric heating-boxes connected in the field-circuit of the rail switch and track apparatus and located under those parts of the rail-switch which are to be protected against snow, frost, and ice; sixth, indicating devices for indicating signals in the station and other indicating devices arranged in combination with a measuring instrument for testing the system as to its working conditions and its efficiency.

In its more detailed nature my invention includes certain novel combinations of parts forming a complete electric signaling and switch-setting system, all of which will be first described in detail and then specifically pointed out in the appended claims, reference being had to the accompanying drawings, in which—

Figure 1 is a plan of the switch portion of the railroad-tracks and its immediate coöperating parts. Fig. 2 is a part section and part elevation taken on the line 1 1 of Fig. 1. Fig. 3 is a diagrammatic view of my complete system. Fig. 4 is a detail longitudinal section of the rail-switch-setting apparatus, the parts 47^a and 47^b being omitted. Fig. 5 is a section taken on the line Y Y of Fig. 4, taken in the direction of the arrow. Fig. 6 is a detail view hereinafter specifically referred to. Fig. 7 is a cross-section taken on the line X X of Fig. 6, taken in the direction of the arrow. Fig. 8 is a detail view of the testing instrument shown in Fig. 3. Fig. 9 is a cross-section on the line W W of Fig. 8 and taken in the direction of the arrow.

Referring now to the accompanying drawings, in which like characters of reference designate like parts in all the figures, I desig-

nates the main track, which is connected with the side track II by a switch, as clearly shown in Figs. 1 and 2 of the drawings, by reference to which it will be seen that the switch-points 1 2 are pivoted at 1^a 2^a, respectively, to steel plates 1^b 2^b, respectively, upon which they rest. The switch-points 1 2 are connected to move in unison by the rod or bar 6, which rod 6 is also connected with the rod 38 of the electromagnetic switch-setting apparatus inclosed in the housing 5, which will be more fully referred to later.

As conditions may require, a pit 7^a may be provided to receive the switch-point-connecting rod and the switch-setting mechanism; but when this is the case a suitable off-take 7 connects with the pit 7^a to draw off any water which may accumulate in the pit.

Disposed below the base-plates 1^b 2^b are electric heaters 11^a 11^b, respectively, which are preferably secured directly to the base-plates and have their other or free surfaces covered by a suitable material of poor heat-conducting properties in order that the heat generated by the heaters may be directly applied to the rail-points without unnecessary waste.

The semaphore-blade mechanism is preferably inclosed in a metallic casing 8, while the night-signal 16 is placed in a supplemental casing 9, adjoining the casing 8, and forming, as it were, an integral structure therewith. Both casings 8 and 9 are mounted as an integral structure on the top of a suitable pole 10 when the semaphore form of signal is used.

When my invention is used in connection with dwarf signals of the ordinary type, in which the signal comprises two plates of different colors mounted axially on a short vertical shaft and at right angles to each other, so as to rotate with the shaft through an angle of ninety degrees, and in which a lantern of rectangular shape having different-colored windows is secured at the junction of said plates, so that when turned into its locked position it will throw a corresponding and steady color-signal in the distance, the construction is substantially the same as for the semaphore mechanism. The operating mechanism of the dwarf signal is placed in a weatherproof housing similar to that of the semaphore, as described.

When the switch-blades are in the position shown in Fig. 1, so that a train approaching from K in the direction of L will be switched over to the siding II, the semaphore-blade is held horizontally, as shown in Fig. 2, so as to indicate to trains approaching from L toward the direction of K that the switch has been set for the siding and that there is danger for a train to approach further.

Referring now more particularly to Fig. 3 of the drawings, which designates diagrammatically the complete arrangement of my improved system, it will be seen that the portion indicated below the parallel horizontal dot-and-dash lines constitutes the portion of my improved apparatus within the operator's station, which comprises the switch-indicator A, the signal-indicator B, the circuit-closing switch E, the reversing circuit-closing switch F, the current-indicating ammeter 13, together with the electrical connections between each of said parts and their electrical connections to the line-wires. The line-wires, six in number, which connect the operator's station with the track apparatus, are designated by the reference-letters M′, M^2, M^3, M^4, M^5, and M^6, and these wires may be run either as air-lines or they may be combined into one or more cables and run underground. For convenience of description I shall first describe the general construction and arrangement of apparatus in the operator's station. The track-indicator A comprises a soft-iron horseshoe-magnet 19, between the legs of which, on a pivot 21, the armature 23 is mounted. The armature 23 is provided with an indicating-pointer 25 to coöperate with a suitable dial-plate upon which suitable indicating characters are formed—for instance, the characters "I" and "II"—to indicate that track I is clear or that siding II is open. 19^a and 19^b designate the coils of the magnet 19, one of which, 19^a, is connected with the line-wire M^4 and to the contact-points f and f^3 of the reversing-switch F, while the other, 19^b, is connected to the line-wire M^5 and to the contact-points f' and f^2 of the switch F. The signal-indicator B is of similar construction to the track-indicator A and comprises generally a soft-iron horseshoe-magnet 20, provided with separate coils 20^a and 20^b, the coil 20^a being connected with the line-wire M′ and the coil 20^b being connected to the line-wire M^2, while both coils 20^a and 20^b are also connected with the contact-point e of the switch E. The magnet 20 is mounted on its panel in a vertical position, similarly to magnet 19 of the indicator A, and midway between the legs of the magnet 20 I suspend, on a pivot 22, an armature 24, which in its normal position is held equidistant from the pole-pieces of the magnet 20 and is provided with an indicator-pointer 26 to coöperate with a suitable dial upon which suitable indicating characters are formed—as, for instance, "C" and "D"—to designate "clear" and "danger," respectively. The indicator B not only indicates the position of the signals but also indicates defects in the line. The indicator A not only indicates the position of the track-switch, but also defects in its respective line, as will be more fully understood hereinafter. The switch F is in the nature of a double-throw reversing-switch, and it has its knife-contacts f^4 and f^5 connected with the line-wires M^3 and M^6, respectively. The contact-

point *e* of the switch E and the contact-point f^5 of the switch F are both connected with the line-wire M^6 through a cut-out switch 12, as shown, and the contact-point *e'* of the switch E connects, through the ammeter 13, to the line-wire M^3. The contact-points e^2 e^3 of the switch E connect, through safety-fuses 14 and 15, respectively, with the negative and positive bus-bars, (not shown,) respectively, of the power-station.

The ammeter 13 (shown in detail in Figs. 8 and 9) comprises a casing in which the ammeter-operating mechanism is mounted, all of which parts may be of any approved construction, with the exception that I provide the ammeter 13 with a few adjustable indicating devices, (shown in detail in Figs. 8 and 9,) by reference to which it will be seen that on the cover-plate 104 are fastened, by means of screws 110 and milled nuts 111, three hands 105, 106, and 107, each one being concentrically mounted with respect to the spindle of the pointer 112 and each being capable of being turned on the screw 110 with sufficient clearness above such pointer and the scale 104^a of the instrument. To each hand 105, 106, and 107 is fastened a stud having a head 109^a and a screw-shank 109 to receive the mill-nut 108, and the said studs 109 are slidable in the curved slot 104^f in the cover-plate 104, thereby allowing adjustment of the hands to any desired position. The ends of the hands 105, 106, and 107 are squared and provided with small scales 105^a, 106^a, and 107^a to measure deflections of the pointer 112 from the adjusted position of the hands. A cover 113 may be placed over the slot 104^f and secured to the top, at 104^c and 104^d, by small screws or otherwise to prevent entry of dust and dirt into the ammeter-casing.

The rail-switch-setting apparatus (designated generally by G in Fig. 3 of the drawings) comprises a stationary magnetic field energized by a pair of field-magnet coils 27^a 27^b, connected in series with each other and across the line-wires M^3 and M^6. Mounted to reciprocate between the coils 27^a 27^b is an armature 28, provided with a pair of energizing-coils 31^a 31^b, connected in series with one another, and one, 31^b, connects, through a flexible conductor 31^d, to the main-line wire M^5, while the other coil, 31^a, has its free terminal conductor 31^c connected in series with the armature-coil 55^b of the semaphore-operating mechanism, hereinafter again referred to, to the line-wire M^4. The armature-coils 31^a 31^b are wound in opposite directions to each other, so as to produce like magnetic poles at the opposite ends of the armature 29.

47^a 47^b designate circuit-closers operated by the movement of the armature 29, and these circuit-closers 47^a 47^b are normally held open by counterweights or springs, as shown in Fig. 3 of the drawings. One terminal of each circuit-closer 47^a 47^b is connected together and to the cross-wire which connects the field-coils 27^a 27^b together by a wire 81^a, in which a resistance 81 is joined. The other terminal of the circuit-closer 47^a is connected to the line-wire M^4, while the other terminal of the circuit-closer 47^b connects with the line-wire M^5, as shown. Each circuit-closer 47^a and 47^b is preferably constructed upon the principle of an angular lever with a fulcrum at its center, its vertical arm being engaged by the armature 29 and pushed back to cause its horizontal arm to make contact with a fixed terminal to close the circuit.

In its general features the switch-setting mechanism comprises a housing 5, in which the magnets 27^a 27^b are immovably mounted on cores 5^f and 5^g, which are bored out to form bearings for the axial rod 101 of the armature 29, which armature 29 carries the coils 31^a 31^b, hereinbefore referred to.

38 designates a rod reciprocatingly mounted in bearings 5^i 5^k of the casing 5, which is joined with the armature 29 by an arm 29^c and screw 102 and which connects with the switch-rod 6 through a coupling 46, as shown.

Fulcrumed to a bracket 5^h on a pivot 44 is a bracket 43, having bearing to receive a sliding rod 42, which rod 42 is provided with a collar 42^a, between which and one of the bearings of the bracket 43 the coil-spring 45 is held. The rod 42 is pivoted at 103 to the rod 38. The members 42 and 43 and their connection with the rod 38 and casing-top 5^c serve as a toggle-spring attachment for locking the switch-points to their final position when they have been set.

The rail-heaters 11^a 11^b are preferably connected in series in the main-line wire M^3 between the switch-setting apparatus G and the line-wire M^3.

The semaphore mechanism H comprises a rotatable iron armature 55^a of the Siemens shuttle type, upon which the armature-coil 55^b is wound. The armature 55^a is secured to the semaphore-shaft, which is journaled in the front and rear walls of the housing 8 and to which the signaling-arm 3 and tail-plate 3^a of the semaphore are attached.

53^a and 53^b designate a pair of stationary field-magnet coils for coöperating with the armature 55^b, and these coils are connected in series to produce north and south polarity (designated by N and S, respectively) on opposite sides of the armature 55^a to coöperate with the magnetic poles *x* and *y* of the said armature. The coils 53^a and 53^b are connected in series with one another and across the line-wires M^3 and M^6 and in multiple with the field-coils 27^a and 27^b of the switch-setting mechanism G.

68^a 68^b designate a pair of circuit closers or keys similarly constructed to those 47^a 47^b before mentioned, and the lever or movable contact portion of each circuit-closer 68^a 68^b is electrically connected together by a wire

83, which connects with a two-branch switch 17, one contact 17^a of which connects, through a signaling-lamp 16, with the line-wire M^3, while the other contact 17^b of the snap-switch 17 connects, through a resistance-coil 18, to the line-wire M^3. The circuit-closers 68^a and 68^b are normally held open by springs or other equivalent devices.

55^1 designates a lever fastened to but insulated from the armature 55^a, which when the semaphore-blade-moving armature reaches the limit of its movement engages one or the other of the movable contact or lever portions of the circuit-closers 68^a 68^b to cause it to close the circuit.

The fixed contacts of the circuit-closer 68^b is joined to the line-wire M', while the fixed contact of the other circuit-closer 68^a is connected to the line-wire M^2.

To limit the angle of movement of the semaphore-blade and lock it to its final position to prevent it from turning backward when current is cut off from the apparatus, I provide a toggle-spring attachment for the armature 55^a, which is connected in the manner shown in detail in Figs. 6 and 7, by reference to which it will be seen a short lever 65^a is fixedly secured to the armature-shaft 56 and engages with a bolt 63^c of the swinging bracket 63. Mounted for longitudinal movement in bearing portions of the bracket 63 is a rod 62, which carries a collar 62^b, between which and one of the brackets a coil-spring 64 is mounted. 64^a designates a rubber washer between the collar 62^b and the other bearing member of the bracket 63 for the usual purposes. The lever 62 is fulcrumed on a stud 61, secured to the pole-piece 8^a of the field-magnet core of the coil 53^a. Owing to continuous pressure of the spring 64 and the general arrangement of the toggle devices, the tendency thereof will be to take an angular position to the vertical center line of the apparatus, (see Fig. 6,) thereby locking armature 55^a and the signal-blade 3 to their final position, the ring 64^a serving as a buffer to weaken the impact of the mechanism and to limit the spring movement of the semaphore-blade.

The snap-switch 17 is preferably mounted at any convenient place on the signal pole 10, so that the same may be operated to cut out the lamp 16 and cut in the resistance 18, or vice versa, as conditions may require, it being understood that the ohmic resistance of the lamp 16 and that of the resistance 18 must be the same. The lamp 16 and resistance 18 are disposed within the casing 9, as before mentioned.

When the armature 55^a is in motion, the keys 68^a 68^b are both set free and the circuit containing the lamp 16 is thereby opened. A protraction in this period or a failing of the contact-making devices would allow the lamp 16 to remain cut out, and thereby cause severe accidents to happen. To overcome this, I provide a second lamp 71, which is inclosed in a colored lantern 4 of the semaphore-casing, which lamp 71 I connect across the terminals of the armature-coil 55^b and in parallel with the armature-coil 55^b, the lamp 71 being rated at a voltage equal to the difference of potential at the terminals of the armature-coil 55^b. A small resistance or reactance coil 82, connected in series with the lamp 71, serves to compensate the excessive voltage and flow of current at the moment of closing the armature-circuit, so as to protect the said lamp from injury—as, for example, supposing the semaphore-blade to be in an inclined position (see Fig. 2) and the switch 12 closed, so that the stationary field-coils 27^a 27^b of the switch apparatus G and those 53^a 53^b of the semaphore mechanism H are excited, the armature 55^a of the semaphore mechanism being in such a position with respect to the field-coils 53^a 53^b that the maximum number of lines of force are traversing the said armature in the direction of 53^b x y 53^a. Now when the lever of the reversing-switch F is thrown onto contacts f f' the armature of the rail-switch-setting apparatus moves from right to left and the semaphore-blade from its position $3^\times$ to 3. Looking toward the pole y of the armature 55^a the current will flow clockwise in wire turns of coil 55^b and produce a magnetic flux in the direction y to x in the iron body of the armature, which flux, because it is opposite to the flux of the coils 53^a 53^b, causes the armature to rotate counter-clockwise. Decreasing the magnetic field results in exciting an electromotive force which causes a clockwise current to flow in the coil-windings when looking in the direction of the magnetic flux through the armature, and thereby increases the electrical potential at the terminal in the armature 55^b. At the moment of closing the circuit by the switch F the lamp takes the electrical pressure at the armature-terminals, which will be equal to the drop in voltage in the armature-coil (due to its internal resistance) plus the inductive electromotive force, whose strength depends on the number of wire turns, which weaken the active field of the magnetic circuit and the time in which the change is brought about. (The coils of the armature 29 of the switch-setting apparatus G will cause no inductive reaction in the armature, as said coils are wound in opposite directions to each other.)

Supposing the number of turns in the armature-coil to equal eight hundred, the number of lines of force produced in this coil (by a working current of 4.4 amperes in this branch) to equal forty thousand centimeter gram second-units, the time of changing the flux by this amount assumed to be one-fifteenth of a second, copper resistance of armature-coil to amount to nine ohms, then the effective

voltage at the lamp-terminals at the moment the armature-circuit is closed will be 44.4 volts. In this case an incandescent lamp rated at forty volts would be used, (because 39.6 volts is the electrical pressure at the armature-terminals after the inductive action of the coils has ceased,) and in view of the fact that excessive voltage shortens the life of a lamp, particularly when the lamp is cut in and out many times a day, a small reactance-coil 82 is connected in circuit with the lamp 71 to absorb the eleven per cent. of excessive voltage at the moment of closing the armature-circuit.

Having thus generally described the circuits and operative arrangement of the parts constituting my complete system, I shall now proceed to explain in detail the consecutive steps of operation thereof.

Operation: Assume that a night-train is expected to come over track L in the direction from L to K and the position of the rail-switch and semaphore-blade being as shown in Figs. 1 and 2. As the track I is still broken by the switch-points 1 and 2, (being set to direct a train into the siding,) the signal-arm 3 of the semaphore stands in a horizontal position and the colored-glass disk in the tail-plate 3^a, which plate is in conjunction with the signaling-arm 3, covers the rear opening in the casing 9, thereby throwing a colored-light signal in the direction toward L to warn the engineer of an approaching train that there is danger. The armature 29 of the switch-setting apparatus G is now in the position shown in Fig. 3, whereby the circuit-closer 47^a is closing a branch circuit from the double-pole-reversing switch F, through the coil 19^a, the line-wire M^4, the resistance 81, the wire 81^a, the field-coil 27^b, and the main-line return-wire M^6. At the same time an additional current from switch F passes through the coil 19^a of the indicator A and line-wire M^4 to the terminal block of the semaphore-armature, where it is split into two branches, one part of the current passing through the armature-windings 55^b, the other part passing through the lamp 71 and resistance-coil 82, so that the sum of both currents will flow through wire M^4, the armature-coils 31^a 31^b of the switch-setting apparatus, the line-wire M^5, the coil 19^b of the indicator A, the other pole f' of the reversing-switch F, to the main return-wire M^6. It is obvious that under these conditions the coil 19^a is producing a stronger magnetic pull toward the armature 23 than the coil 19^b, and therefore the armature 23 is moved into the position shown in Fig. 3 to direct its pointer 25 over the indicating member "II" to signify that the side track II is free for passage while the main track I is broken. Another current is passing at the same time through the main wire M^3 and the electrical heaters 11^a 11^b to a main terminal plate inside of the housing 5 of the switch-setting apparatus G, where it is divided into two branch circuits, one portion of the current passing through the field-coils 27^a 27^b and the other portion through the line-wire $M^{3\times}$ to the semaphore apparatus in the semaphore-housing 8, where the current again divides as follows, one portion passing through the lamp 16 to the contact 17^a and across the switch 17, through wire 83, to the circuit-closer 68^a, which being closed permits the current to flow through line-wire M^2 and coil 20^b of the indicator B to contact e of the switch E across the switch-blade to contact e^2 and through fuse 14 to the negative bus-bar of the power-station. Another portion of the current passes through the field-coils 53^b 53^a of the semaphore-operating mechanism to the line-wire M^6 and through the line-wire M^6 and switch E to the negative bus-bar of the power-station. When, however, the switch 17 is turned to close with the contact 17^b, the portion of the current which was flowing through lamp 16 will then flow through resistance 18, and the lamp 16 will be cut out. As the current flows through the coil 20^b the armature 24 will be attracted toward the right until its indicator 26 points to the dial-letter "D" to indicate that the semaphore-blade is in its horizontal position, to which it has just been moved, it being understood that the toggle devices connected with the armature of the semaphore-operating mechanism, together with the action of the magnetical fields of the armature-coil 55^b and the field-coils 53^a and 53^b, sustain the semaphore-blade in its set position. In the switch-setting apparatus G a magnetic field of constant polarity is produced by its two field-coils, so that, for instance, the inside end of the coil 27^a forms a south pole and that of the coil 27^b a north pole. In order to force the armature 29 into the left-handed position, as shown in Fig. 3, its outer ends had to be rendered with north magnetic poles, which was done by throwing the lever of the reversing-switch F into the position shown in Fig. 3 to engage with the contacts $f f'$. When the switch 12 is open, the current-flow through coil 27^b, 53^a, and 53^b is reduced to a minimum, while still a somewhat stronger current from the line-wire M^3 through the heaters 11^a 11^b is passing the field-coil 27^a, wire 81^a, resistance 81, and then joining the main branch flow in the armature-windings 55^b 31^a 31^b, line-wire M^5, and indicator-coil 19^b, to slightly increase the attractive power of that pole of the indicator-magnet 19, which lies above the dial-letter "I." The armature, however, will not change its position, since the same is practically out of the sphere of the attractive power of said stronger magnet-pole. Neither will switch 12 affect the functions and positions of the other operating devices, so that no visible changes will be noticed in the whole system except in the

reading of the ammeter 13, which shows a reduced current consumption. After breaking the armature-circuit by lifting the lever of the switch F the armature 23 of the indicator A will drop to its perpendicular position, whereas the armature 29 of the switch-setting apparatus and the armature 55^a of the semaphore mechanism remain in their said positions, due to the action of their toggle-spring devices. and a small current will pass through the line M^3, heaters 11^a 11^b, line-wire M^{3x}, lamp 16, switch 17, wire 83, circuit-closer 68^a, line-wire M^2, coil 20^b of the indicator B, through contacts e e^2 of switch E, and fuse 14 to the negative bus-bar of the station. The lamp 16 will therefore be lighted. The armature 24 of the indicator B still points to the indicating-letter "D" on the indicating-plate to indicate "danger" and the ammeter 13 indicates the amount of current consumed by the lamp 16, the lamp 71, however, being now extinguished. The operator is thus informed of the condition of the semaphore mechanism, and by again throwing in the switch F and by observing the reading of the indicator A and the ammeter 13 he can determine the condition of the track-switch. Should any of the apparatus in connection with the line M^3 or M^2 suddenly fail in its functions—for instance, should the lamp 16 burn out—the armature 24 of the indicator B will take a perpendicular position and the hand of the ammeter 13 will rest at its zero-mark. In such exceptional cases the signal operator will have the apparatus in such condition inspected and until the fault is remedied he will throw the lever of the reversing-switch F back into its former position to close with contacts f f', thereby relighting lamp 71 in lantern 4, thus giving a warning-signal to the approaching train. Supposing now that the track I is to be opened and arranged for an arriving train from L, the signal operator will first close the switch E in case the plant had been shut off from the current-supply source, whereupon the ammeter 13 shows the amount of current taken by signal-lamp 16. The indicator B will then point to the index "D" to indicate "danger," and thus assures the operator that the semaphore-arm 3 is in its horizontal or danger-indicating position and the colored-glass disk of the tail-plate 3^a covers the lamp 16 to also indicate "danger." By thus closing the switch 12 the magnetic fields of the switch-setting apparatus G and the semaphore mechanism H will be excited—*i. e.*, a flux of lines of force will take its way through the armatures 29 and 55^a in the direction of 27^b to 27^a and 53^a to 53^a. That the said circuit is perfect and that the fields are excited is shown by the increased deflection of the ammeter 13, the hand of which should coincide with the distinctly-marked index upon its scale. By throwing the lever of the reversing-switch F onto the metallic contacts f^2 and f^3 the ammeter 13 will indicate the current consumption of the whole plant. The pointer of the instrument should also cover the index-mark of the scale. In regard to the indexes on the scale of the ammeter 13 they must consist either of distinguishing division-lines on the scale of the instrument or they may be in the nature of small plates with engraved index-lines, as shown in Figs. 8 and 9, which plates should be adjustable upon the scale and provided with means for securing them in their adjusted positions with reference to the scale. The various indexes of the ammeter 13 are set to the normal reading of the instrument, so that when current is flowing in the ammeter 13 the operator can readily tell whether the system is using the normal amount of current by observing whether the pointer of the ammeter 13 corresponds to the proper indicating-mark on the ammeter-index, and therefore he is able to determine whether or not the system is in its normal condition. Owing to the reversed current of the armature-circuit the coils 31^a 31^b of the switch-setting apparatus G will render the outer ends of the armature 29 south poles, consequently moving the armature to the right to release the circuit-closer 47^a and close the circuit at circuit-closer 47^b to form a branch circuit from the line-wire M^3, contacts f^4, f^{2*}, and f' of switch F through the coil 19^b, line-wire M^5, circuit-closer 47^b, resistance 81, wire 81^a, field-coil 27^b, main return-wire M^6, back to the current source. Under this arrangement the magnetic field of the coil 19^b exceeds that of the coil 19^a, so that the armature 23 of the indicator A is pulled to the right, as shown in dotted lines in Fig. 3, so that its pointer 25 coincides with the indicating-letter "I" on the dial and indicates that the rail-switch has arranged track I for traffic, as required. At the instant that the coils of the armature 29 are energized a flux of lines of force in the semaphore-armature 55^a is also produced by the coil 55^b, and as this magnetic flux is across the armature-field in the direction x to y—*i. e.*, in the same direction as the flow of magnetism through the stationary coils 53^b 53^a—the armature will be turned clockwise until the semaphore-blade reaches the position at 3^x (shown in Fig. 2) and the lever 55^1 releases the circuit-closer 68^a and closes the circuit at the circuit-closer 68^b, thereby closing the circuit through the lamp 16, snap-switch 17, wire 83, circuit-closer 68^b, line-wire M', coil 20^a of the indicator B, and return-wire to the current source. The armature 24 will be pulled to the left and its pointer 26 will then coincide with the indicating-letter "C" on its dial to indicate that the semaphore has taken its proper safety position and a clear-light signal is sent out by the lamp 16 from the casing 9. When the switch F is again opened, the armature 23 of the in-

dicator A swings back to its perpendicular position, the current-flow through the two armatures is broken off, and the lamp 71 extinguished, while lamp 16 is kept burning. The switch-setting apparatus and the semaphore-operating mechanism H are locked to their present positions by the toggle-spring attachments before referred to. By means of the snap-switch 17 the signal operator is further enabled to observe at his station whether and at what time the lamp 16 is turned out of circuit and the resistance 18 substituted therefor, and vice versa, by simply observing the time when the indicator B shows this change, it being understood that the circuit including the lamp 16 or the resistance 18 is momentarily broken as the switch is changed from one contact 17^a to the other contact 17^b, thus altering the balance of the indicator and causing a fluctuation in the movement thereof which can be observed by the signal operator.

The principal object of switch 12 is to open and close the heating and field circuits for any period of time without causing changes in the signals.

From the foregoing description, taken in connection with the acccompanying drawings, it is thought that the complete construction, operation, arrangement, and many advantages of my invention will be readily understood by those skilled in the art to which my invention appertains.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a system of the character stated, a source of electric energy, a semaphore mechanism and a switch-setting mechanism, said semaphore mechanism and said switch-setting mechanism each including armature and field magnets, the armature-magnets of the switch-setting mechanism and semaphore mechanism being connected in series with each other substantially as shown and described.

2. In a system of the character stated, a source of electric energy, a semaphore mechanism and a switch-setting mechanism, said semaphore mechanism and said switch-setting mechanism each including armature and field magnets, the armature-magnets of the switch-setting mechanism and semaphore mechanism being connected in series with each other, the field-magnets of the switch-setting mechanism being connected in multiple with the field-magnets of the semaphore mechanism, all being arranged substantially as shown and described.

3. In a system of the character stated, a semaphore mechanism including field and armature magnets, a switch-setting mechanism including field and armature magnets, said armature-magnets all being connected in series with each other, and a semaphore-lamp connected in shunt with the armature-magnet circuits substantially as shown and described.

4. In a system of the character stated, a semaphore mechanism and a switch-setting mechanism each including field and armature magnets, the said armature-magnets being connected in series with each other, a source of electric energy connected to the armature-circuit, and an indicator in the armature-circuit, substantially as shown and described.

5. In a system of the character stated, a semaphore mechanism and a switch-setting mechanism each including field and armature magnets, the said armature-magnets being connected in series with each other, a source of electric energy connected to the armature-circuit, and an indicator in the armature-circuit, a supplemental indicator-circuit, means controlled by the semaphore mechanism for controlling said supplemental indicator-circuit, an indicator in said supplemental indicator-circuit, substantially as shown and described.

6. In a system of the character stated, a source of electric energy, a semaphore mechanism having an armature-coil, a switch-setting mechanism having an armature-coil, an armature-circuit connected to the source of electric energy, said semaphore and said switch-setting mechanisms having their armatures connected in series in the armature-circuit, a semaphore-lamp in shunt with the armature-circuit, an indicator in the armature-circuit, means controlled by said switch-setting mechanism for operating said indicator, a supplemental indicator-circuit connected with the source of electric energy and with the semaphore mechanism, means controlled by the semaphore mechanism for admitting current to the supplemental indicating-circuit, a supplemental indicator in the supplemental indicator-circuit, a second lamp and a resistance adapted to be connected, one at a time, to the supplemental indicator-circuit, substantially as shown and described.

7. In a system of the character stated, a source of electric energy, a semaphore mechanism having an armature-coil, a switch-setting mechanism having an armature-coil, an armature-circuit connected to the source of electric energy, said semaphore and said switch-setting mechanisms having their armatures connected in series in the armature-circuit, a semaphore-lamp in shunt with the armature-circuit, an indicator in the armature-circuit, means controlled by said switch-setting mechanism for operating said indicator, a supplemental indicator-circuit connected with the source of electric energy and with the semaphore mechanism, means controlled by the semaphore mechanism for admitting current to the supplemental indicating-circuit, a supplemental indicator in the supplemental indicator-circuit, a second

lamp and a resistance adapted to be connected, one at a time, to the supplemental indicator-circuit, said semaphore and said switch-setting mechanism each including a field-magnet, a field-magnet circuit connected with said field-magnets and to the source of electric energy and electric heaters in said field-magnet circuit, substantially as shown and described.

8. In a system of the character stated, a source of electric energy, an electromagnetic semaphore mechanism, and an electromagnetic switch-setting mechanism connected in series, means for controlling the current as it flows from the source of electric energy to operate the switch-setting and semaphore mechanisms substantially as shown and described.

9. In a system of the character stated, a source of electric energy, an electromagnetic switch-setting mechanism and an electromagnetic semaphore mechanism connected in series with each other to said source of electric energy, an electromagnetic indicator for said switch-setting mechanism controlled thereby, and electromagnetic indicator for said semaphore-operating mechanism controlled thereby, all being arranged substantially as shown and described.

10. In a system of the character stated, a source of electric energy, an electromagnetic switch-setting mechanism and an electromagnetic semaphore mechanism connected in series with each other to said source of electric energy, an electromagnetic indicator for said switch-setting mechanism controlled thereby, an electromagnetic indicator for said semaphore-operating mechanism controlled thereby, and electric heaters connected with said source of electric energy, substantially as shown and described.

11. In a system of the character stated, a source of electric energy, a semaphore mechanism, said semaphore mechanism including a semaphore-blade and an operating means, said operating means including an electromotor having field and armature magnets, the field-magnet coils being connected in series to the source of electric energy, and the armature-coil being connected to the source of electric energy, a circuit-closer operatable by the armature and connected to one terminal of the source of energy, an indicator in circuit with said circuit-closer and the other terminal of the source of energy to operate when the armature closes the circuit, and a supplemental lamp connected across the armature-terminals.

12. In a system of the character stated, a source of electric energy, a semaphore mechanism, said semaphore mechanism including a semaphore-blade and operating means, said operating means including an electromotor having field and armature magnets, the field-magnet coils being connected in series to the source of electric energy, and said armature-coil being connected to the source of electric energy, a circuit-closer operatable by the armature and connected to one terminal of the source of energy, an indicator in circuit with said circuit-closer and the other terminal of the source of energy to operate when the armature closes the circuit, and a supplemental lamp connected across the armature-terminals, and means for choking the current through the supplemental lamp at times.

13. In a system of the character stated, a source of electric energy, a semaphore mechanism, said semaphore mechanism including a semaphore-blade and an operating means, said operating means including an electromotor having field and armature magnets, the field-magnet coils being connected in series to the source of electric energy, and the armature-coil being connected to the source of electric energy, a circuit-closer operatable by the armature and connected to one terminal of the source of energy, an indicator in circuit with said circuit-closer and the other terminal of the source of energy to operate when the armature closes the circuit, a supplemental lamp connected across the armature-terminals, and means for choking the current through the supplemental lamp at times, said means comprising a reactance-coil in series with the supplemental lamp.

14. In a system of the character stated, a source of electric energy, a semaphore mechanism including a semaphore-blade and an operating mechanism therefor, said semaphore-operating mechanism including an electric motor having field and armature electromagnets, the field-magnet coils being connected in series to the source of electric energy, the armature-coil being connected to the source of electric energy, a pair of circuit-closers each operatable by the armature and each having one of their terminals connected together and to one terminal of the source of electric energy, a signal-lamp, a substitute resistance, a snap-switch in series with the lamp and resistance, said lamp, said resistance, and said switch being connected in series in said circuit-closer connection, an indicator including a pair of coils one of which is connected in circuit with one circuit-closer and the other connected in circuit with the other circuit-closer, both of said coils being also connected to the other terminal of the source of electric energy, said indicator being arranged to operate when the circuit is closed at said circuit-closers.

15. In a system of the character stated, a source of electric energy, a semaphore mechanism including a semaphore-blade and an operating mechanism therefor, said semaphore-operating mechanism including an electric motor having field and armature electromagnets, the field-magnet coils being connected in series to the source of electric

energy, the armature-coil being connected to the source of electric energy, a pair of circuit-closers each operatable by the armature and each having one of their terminals connected together and to one terminal of the source of electric energy, a signal-lamp, a substitute resistance, a snap-switch in series with the lamp and resistance, said lamp, said resistance, and said switch being connected in series in said circuit-closer connection, an indicator including a pair of coils one of which is connected in circuit with one circuit-closer and the other connected in circuit with the other circuit-closer, both of said coils being also connected to the other terminal of the source of electric energy, said indicator being arranged to operate when the circuit is closed at said circuit-closers, and a supplemental lamp connected across the armature-terminals.

16. In a system of the character stated, a source of electric energy, a semaphore mechanism including a semaphore-blade and an operating mechanism therefor, said semaphore-operating mechanism including an electric motor having field and armature electromagnets, the field-magnet coils being connected in series to the source of electric energy, the armature-coil being connected to the source of electric energy, a pair of circuit-closers each operatable by the armature and each having one of their terminals connected together and to one terminal of the source of electric energy, a signal-lamp, a substitute resistance, a snap-switch in series with the lamp and resistance, said lamp, said resistance and said switch being connected in series in said circuit-closer connection, an indicator including a pair of coils one of which is connected in circuit with one circuit-closer and the other connected in circuit with the other circuit-closer, both of said coils being also connected to the other terminal of the source of electric energy, said indicator being arranged to operate when the circuit is closed at said circuit-closers, a supplemental lamp connected across the armature-terminals, and a reactance-coil in series with said lamp.

17. In a system of the character stated, a semaphore including a blade-operating mechanism and a semaphore-blade operatable thereby, said operating mechanism including armature-magnet and field-magnets, a source of electric energy, a pair of line-wires connecting the armature-coil with the source of energy, a second pair of line-wires connecting the field-coil to the source of energy, circuit-closers each including a movable and a fixed contact, one contact of each circuit-closer being connected together to one field-coil line-wire, a signal-lamp and a switch in said last-named connection, a double-coil indicator, one coil of the indicator being connected to one contact of one circuit-closer and the other coil being connected to one contact of the other circuit-closer, both indicator-coils being also connected to the other field-coil line-wires, and means controlled by the armature for operating said closers.

18. In a system of the character stated, a semaphore including a blade-operating mechanism and a semaphore-blade operatable thereby, said operating mechanism including an armature-magnet and field-magnets, a source of electric energy, a pair of line-wires connecting the armature-coil with the source of energy, a second pair of line-wires connecting the field-coil to the source of energy, circuit-closers each including a movable and a fixed contact, one contact of each circuit-closer being connected together to one field-coil line-wire, a signal-lamp and a switch in said last-named connection, a substitute resistance in series with said switch, a double-coil indicator, one coil of the indicator being connected to one contact of one circuit-closer and the other coil being connected to one contact of the other circuit-closer, both indicator-coils being also connected to the other coil line-wire, and means controlled by the armature for operating said closers.

19. In a system of the character stated, a semaphore including a blade-operating mechanism and a semaphore-blade operatable thereby, said operating mechanism including armature-magnets and field-magnets, a source of electric energy, a pair of line-wires connecting the armature-coil with the source of energy, a second pair of line-wires connecting the field-coils to the source of energy, circuit-closers each including a movable and a fixed contact, one contact of each circuit-closer being connected together to one field-coil line-wire, a signal-lamp and a switch in said last-named connection, a double-coil indicator, one coil of the indicator being connected to one contact of one circuit-closer and the other coil being connected to one contact of the other circuit-closer, both indicator-coils being also connected to the other field-coil line-wire, and means controlled by the armature for closing said circuit, as the armature reaches the end of its movemene in either direction.

20. In a system of the character stated, a semaphore including a blade-operating mechanism and a semaphore-blade operatable thereby, said operating mechanism including an armature-magnet and field-magnets, a source of electric energy, a pair of line-wires connecting the armature-coil with the source of energy, a second pair of line-wires connecting field-coil to the source of energy, circuit-closers each including a movable and a fixed contact, one contact of each circuit-closer being connected together to one field-coil line-wire, a signal-lamp and a switch in said last-named connection, a substitute resistance in series with said switch, a double-coil indicator, one coil of the indicator being connected to

one contact of one circuit-closer and the other coil being connected to one contact of the other circuit-closer, both indicator-coils being also connected to the other coil line-wire, and means controlled by the armature for operating said circuit-closers, as the armature reaches the end of its movement in either direction.

21. In a system of the character stated, a semaphore including a blade-operating mechanism, and a semaphore-blade operatable thereby, said operating mechanism including armature-magnet and field-magnets, a source of electric energy, a pair of line-wires connecting the armature-coil with the source of energy, a second pair of line-wires connecting the field-coil to the source of energy, circuit-closers each including a movable and a fixed contact, one contact of each circuit-closer being connected together to one field-coil line-wire, a signal-lamp and a switch in said last-named connection, a double-coil indicator, one coil of the indicator being connected to one contact of one circuit-closer and the other coil being connected to one contact of the other circuit-closer, both indicator-coils being also connected to the other field-coil line-wire, and means controlled by the armature for operating said circuit-closers, and a supplemental signal-lamp connected across the armature-terminals.

22. In a system of the character stated, a semaphore including a blade-operating mechanism, and a semaphore-blade operatable thereby, said operating mechanism including armature-magnet and field-magnets, a source of electric energy, a pair of line-wires connecting the armature-coil with the source of energy, a second pair of line-wires connecting the field-coil to the source of energy, circuit-closers each including a movable and a fixed contact, one contact of each circuit-closer being connected together to one field-coil line-wire, a signal-lamp and a switch in said last-named connection, a double-coil indicator, one coil of the indicator being connected to one contact of one circuit-closer and the other coil being connected to one contact of the other circuit-closer, both indicator-coils being also connected to the other field-coil line-wire, and means controlled by the armature for operating said circuit-closers, a supplemental signal-lamp connected across the armature-terminals, and means connected in said supplemental lamp-circuit for choking back the current when an abnormal voltage is present at the armature-terminals.

23. In a system of the character stated, a semaphore including a blade-operating mechanism and a semaphore-blade operatable thereby, said operating mechanism including an armature-magnet and field-magnets, a source of electric energy, a pair of line-wires connecting the armature-coil with the source of energy, a second pair of line-wires connecting the field-coils to the source of energy, circuit-closers each including a movable contact and a fixed contact, one contact of each circuit-closer being connected together to one field-coil line-wire, a signal-lamp and a switch in said last-named connection, a substitute resistance in series with said switch, a double-coil indicator, one coil of the indicator being connected to one contact of one circuit-closer and the other coil being connected to one contact of the other circuit-closer, both indicator-coils being also connected to the other coil line-wire, means controlled by the armature for operating said circuit-closers, as the armature reaches the end of its movement in either direction, a supplemental signal-lamp connected across the armature-terminals and means connected in circuit with said signal-lamp for choking down the current when an abnormal voltage is present at the armature-terminals.

24. A system of the character stated, comprising in combination with a railway-switch and semaphore, electromagnetic means for opening and closing the rail-switches, controlling means for said electromagnetic means, means for indicating the position of the switch, electromagnetic semaphore-operating means connected with and operating in unison with said first-mentioned means and controlled by said controlling means, supplemental indicating means controlled by said semaphore-operating means for indicating the position of the semaphore, and an electric semaphore-light in the semaphore-indicating circuit, controlled by the semaphore operating means.

25. A system of the character stated, comprising in combination with a railway switch and semaphore, electromagnetic means for opening and closing the rail-switches, controlling means for said electromagnetic means, means for indicating the position of the switch, electromagnetic semaphore-operating means connected with and operated in unison with said first-mentioned means and controlled by said controlling means, supplemental indicating means controlled by said semaphore-operating means for indicating the position of the semaphore, an electric semaphore-light in the semaphore-indicating circuit, controlled by the semaphore-operating means, said semaphore-operating means including an electric motor having field and armature magnets, a supplemental signal-lamp connected across the armature-terminals of said motor, and means for indicating when the first-mentioned signal-lamp is lighted or extinguished.

26. A system of the character stated, comprising in combination with a railway switch and semaphore, electromagnetic means for opening and closing the rail-switches, controlling means for said electromagnetic

means, means for indicating the position of the switch, electromagnetic semaphore-operating means connected with and operatable in unison with said first-mentioned means and controlled by said controlling means, supplemental indicating means controlled by said semaphore-operating means for indicating the position of the semaphore, an electric semaphore-light in the semaphore-indicating circuit, controlled by the semaphore-operating means, said semaphore-operating means including an electric motor having field and armature magnets, a supplemental signal-lamp connected across the armature-terminals of said motor, and means for indicating when the first-mentioned signal-lamp is lighted or extinguished, and switch-rail heaters connected in circuit with said switch and semaphore operating mechanisms.

27. A system of the character stated, comprising in combination with a railway switch and semaphore, electromagnetic means for opening and closing the rail-switches, controlling means for said electromagnetic means, means for indicating the position of the switch, electromagnetic semaphore-operating means connected with and operatable in unison with said first-mentioned means and controlled by said controlling means, supplemental indicating means controlled by said semaphore-operating means for indicating the position of the semaphore, an electric semaphore-light in the semaphore-indicating circuit, controlled by the semaphore-operating means, said semaphore-operating means including an electric motor having field and armature magnets, a supplemental signal-lamp connected across the armature-terminals of said motor, means for indicating when the first-mentioned signal-lamp is lighted or extinguished, switch-rail heaters connected in circuit with said switch and semaphore operating mechanisms, and an ammeter connected in series with all of said means to measure the current consumption.

28. In an apparatus of the character stated, electromagnetic switch-rail-shifting devices, circuit-closers controlled thereby, branch circuits controlled by the circuit-closers, indicators controlled by said branch circuits, electromagnetic track signaling apparatus in direct electrical connection with the rail-switch-shifting apparatus and working in unison therewith, circuit-closers controlled by said track signaling apparatus, supplemental indicating circuits controlled by said last-named circuit-closers, indicators in said circuits, an electric signaling-lamp coöperatively connected with the track signaling apparatus, a compensating resistance, means for substituting said compensating resistance for said signal-lamp, a supplemental electric lamp connected with the track-signal-operating mechanism to be lighted while the track-signals are being changed, electric heaters connected in circuit with said switch-setting and track signaling apparatuses and arranged under the rail-switch, and measuring instruments connected in circuit with all of the aforesaid devices for testing the system as to its working conditions and efficiency substantially as shown and described.

29. In a system of the character stated, a source of electric energy, an electromagnetic switch-setting mechanism including field and armature magnets, a pair of line-wires connecting said armature-magnets to the source of electric energy, a reversing-switch for reversing the current in said armature line-wires, a balanced double-coil electromagnetic indicator having one coil in series with one armature line-wire and the other coil in series with the other armature line-wire, means controlled by the switch-setting mechanism for varying the electric current in one or the other armature line-wires to unbalance the indicator, a semaphore-operating mechanism comprising field-magnets and an armature-magnet, said last-named field-magnets being connected in parallel with the field-magnets of the switch-setting mechanism, said last-named armature-magnets being connected in series with the armature-magnet of the switch-setting mechanism, a pair of line-wires for connecting all of said field-magnets to the source of electric energy, supplemental indicating-circuits for said semaphore-operating mechanism, a balanced indicator in said supplemental signaling-circuits, and means controlled by the semaphore-operating mechanism for upsetting the balance in the supplemental signal-circuit substantially as shown and described.

30. In a system of the character stated, a source of electric energy, an electromagnetic switch-setting mechanism including field and armature magnets, a pair of line-wires connecting said armature-magnet to the source of electric energy, a reversing switch for reversing the current in said armature line-wires, a balanced double-coil electromagnetic indicator having one coil in series with one armature line-wire and the other coil in series with the other armature line-wire, means controlled by the switch-setting mechanism for varying the electric current in one or the other armature line-wires to unbalance the indicator, a semaphore-operating mechanism comprising field-magnets and an armature-magnet, said last-named field-magnets being connected in parallel with the field-magnets of the switch-setting mechanism, said last-named armature-magnet being connected in series with the armature-magnet of the switch-setting mechanism, a pair of line-wires for connecting all of said field-magnets to the source of electro-energy, supplemental indicating-circuits for said semaphore-operating mechanism, a balance-indi-

cator in said supplemental signaling-circuits, and means controlled by the semaphore-operating mechanism for upsetting the balance in the supplemental signal-circuit, an electric lamp and a resistance connected to one field-magnet line-wire, and a switch connected in circuit with said lamp and resistance and with the supplemental signaling-circuit, substantially as shown and described.

31. In a system of the character stated, a source of electric energy, an electromagnetic switch-setting mechanism including field and armature magnets, a pair of line-wires connecting said armature-magnets to the source of electric energy, a reversing-switch for reversing the current in said line-wires, a balanced double-coil electromagnetic indicator having one coil in series with one armature line-wire and the other coil in series with the other armature line-wire, means controlled by the switch-setting mechanism for varying the electric current in one or the other armature line-wires to unbalance the indicator, a semaphore-operating mechanism comprising field-magnets and an armature-magnet, said last-named field-magnets being connected in parallel with the field-magnets of the switch-setting mechanism, said last-named armature-magnets being connected in series with the armature-magnet of the switch-setting mechanism, a pair of line-wires for connecting all of said field-magnets to the source of electro-energy, supplemental indicating-circuits for said semaphore-operating mechanism, a balance-indicator in said supplemental signaling-circuits, and means controlled by the semaphore-operating mechanism for upsetting the balance in the supplemental signaling-circuit, an electric lamp and a resistance connected in parallel with each other to one field-magnet line-wire, a switch connected in circuit with said lamp and resistance and with the supplemental signaling-circuit, a supplemental lamp connected across the armature-terminals of the semaphore-operating mechanism, and an indicating-ammeter in series with the source of electric energy for indicating the current consumption substantially as shown and described.

32. In a system of the character stated, a switch-setting mechanism comprising a source of electric energy, field-magnets and an armature-magnet, means connected with the armature-magnet and adapted to be connected to the switch-rails for imparting the motion of the armature-magnet to the switch-rails, a pair of armature line-wires and a pair of field line-wires connecting the armature-magnet and the field-magnets respectively to the source of electric energy, a pair of circuit-closers operable by the armature and each having one of their contacts connected to the field-circuit between the field-magnets, a resistance in said last-named connection, said circuit-closers each having one of their terminals connected to the armature line-wires, a double-pole double-coil indicator having one of its coils connected in series with one armature line-wire and the other coil in series with the other armature line-wire, a reversing-switch in said armature-circuit, electric rail-heaters in series with the field-magnet circuit in one field-magnet line-wire, a cut-out switch in the other field-magnet line-wire, a semaphore-operating mechanism including an electric motor having field and armature magnets, said last-named field-magnets being connected in parallel with the field-magnets of the switch-setting mechanism, said armature of the semaphore-operating mechanism being connected in series with the armature of the switch-setting mechanism, a signal-lamp, and an inductive resistance connected across the armature-terminals of the semaphore-operating mechanism, a pair of circuit-closers operatable by the semaphore-operating mechanism and each having one of their terminals connected together and to one of the field-magnet line-wires, a switch, a semaphore electric lamp and a resistance adapted to be separately connected in series with said last-named connection, said semaphore electric lamp and said last-named resistance being connected in parallel with each other, a pair of supplemental line-wires, one of which is connected to the other contact of one of the semaphore-mechanism circuit-closers, the other of which is connected to the other terminal of the second semaphore-mechanism circuit-closer, a double-pole double-coil indicator having one coil connected in series with one of the supplemental line-wires and the other coil connected in series with the other supplemental line-wire, said indicator having both coils connected with one of the field-magnet line-wires, a cut-out switch and an ammeter connected in circuit with the source of electric energy, substantially as shown and described.

33. In a combined system of electric signaling and switch-setting for railroads of the character stated, the combination with a plurality of hermetically-closed resistance-boxes to be arranged underneath the metallic rail-switch base-plates for electrically heating the switch-points in the winter, said heating-boxes being joined into one of the main wires to the parallelly-connected field-circuits of the rail-switch-setting apparatus and the track signaling mechanism, a signal-pole switch connected in the common field return-wire to disconnect the heaters and field-coil from the circuit without disturbing the track-signals and causing changes in the position of the rail-switch.

34. In a combined system of electric signaling and switch-setting for railroads, the combination with electromagnetically-operated switch-setting devices having field and

armature circuits and electromagnetically-operating semaphore-operating devices common to said field and armature circuits, of a plurality of hermetically-sealed resistance-boxes to be arranged beneath the rail-switch base-plates for electrically heating the switch-points, said heating-boxes being connected in series with said field-circuit of the aforesaid switch-setting apparatus and semaphore-operating apparatus, a switch connected in the return field-circuit wire for disconnecting the heater and field-coils from the circuit without disturbing the track-signals or causing changes in the position of the rail-switch.

35. In a system of electromagnetically-operated rail-switch-setting apparatus and an electromechanical track signaling mechanism of the character stated, each including armature and field magnets, all of said armature-magnets being connected in series with each other and disposed in a circuit, an indicator of the character stated in said armature-circuit, a current-reversing switch also in said armature-circuit, said armature of the track signaling mechanism being rotatable, an arm movable by said armature, contact-making devices stationarily mounted adjacent the armature and adapted to be engaged by said armature-arm as it reaches the limit of its movement in each direction, supplemental electric circuits for said contact-making devices, an electric semaphore-lamp and a resistance, a switch connected with said lamp and resistance and to said contact-making devices, a second indicator of the character stated including a pair of coils one of which is connected to one contact-making device and the other connected to the other contact-making device of the semaphore-operating mechanism, said indicator consisting of a U-shaped soft-iron magnet with downwardly-opening legs upon which the coils are mounted, an iron armature loosely suspended at the magnet-yoke, centrally between said legs, said armature arranged to be pulled from its perpendicular positions by the magnet-pole which is energized by the branch circuit established when the contact-making devices of the track signaling mechanism are closed substantially as set forth.

36. In a system of the character stated, an electromagnetic switch-setting apparatus, and an electromechanical track signaling apparatus of the character stated, both being in electric connection with each other and a source of electric energy, the combination with the two series-connected armature-windings of said apparatuses, of an electromagnetically-operating indicator in the operator's station, said indicator consisting of a U-shaped stationary soft-iron magnet with downwardly-pointing legs, a wire coil on each leg, each coil connected in the line-wire of said armature-circuit, an iron armature loosely suspended at the magnet-yoke centrally between said legs, said armature being deflected from its perpendicular position when the magnetic equilibrium between the two coils is disturbed due to the branch circuits effected by the contact-making devices that are operated by the rail-switch-setting apparatus at the moment when one or the other final positions of movement is reached, substantially as shown.

37. In a combined system of electric signaling and switch-setting apparatus for railroads comprising in combination with a source of direct current, means for breaking the current automatically in case of other circuits, means to open, close and reverse circuits by hand, an ammeter for measuring and controlling the current consumption, said ammeter having a number of adjustable hands which are provided with an indicating-scale slidable in front of the pointer and main scale of the instrument, a system of six wires to be arranged either in open air or underground cables, a track signaling apparatus consisting of a stationarily-mounted magnet-field of constant polarity, a rotatable iron armature directly and fixedly secured to the signal-plate of the semaphore, and toggle-spring devices connected with the armature for limiting the angle of rotation and locking the signal-blade mechanically to its final positions, said armature being provided with a coil of insulated copper wire and mounted to rotate in both directions, circuit-closing devices, an insulated lever fastened to the armature to engage said armature-closing devices to operate the same when the signaling positions of the apparatus are reached, said circuit-closing devices being stationarily fastened and insulated from the housing of the signaling apparatus, an electric incandescent lamp, a resistance or reactance coil in series therewith, said lamp-coil being connected across the terminals of the aforesaid armature-coil to be lighted when current is passing the armature, a rail-switch-setting apparatus including a stationary magnetic field of constant polarity, an iron armature mounted for alternate motion in line with the magnetic flux between the poles of the field, a pair of oppositely-wound armature-coils for energizing said armature to produce like poles at its outer ends, said armature-coils being connected in series to the armature-coil of the track signaling apparatus, both armatures being in a separate circuit from the field-coils, a reversible switch at the operator's station in said armature-circuit adapted to change the direction of current in said armatures to change the direction of motion of both apparatuses, circuit-closing devices for said rail-switch-setting mechanism adapted to be engaged by the armature therein, branch circuits for said last-named circuit-closers, said branch circuit including one

field-magnet coil of the switch-setting apparatus and said circuit-closers being so arranged that when closed a branch current will flow from the said field-magnet coil through a cross-wire to one armature-wire or the other according to which circuit-closer was actuated upon, a resistance in said cross-wire, an electromagnetic indicator at the station in said armature-circuit, said branch current disturbing the equilibrium of said electromagnetic indicator to produce signals therein substantially as shown and for the purposes specified.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

BRUNO OTTO WAGNER.

Witnesses:

JOHN BENNO COLDITZ,

FREDERICK OTTO SPIESKE.