No. 617,325. Patented Jan. 10, 1899.

F. C. ESMOND.

RAILWAY SIGNAL SYSTEM.

(Application filed Mar. 17, 1896.)

(No Model.) 6 Sheets—Sheet 1.

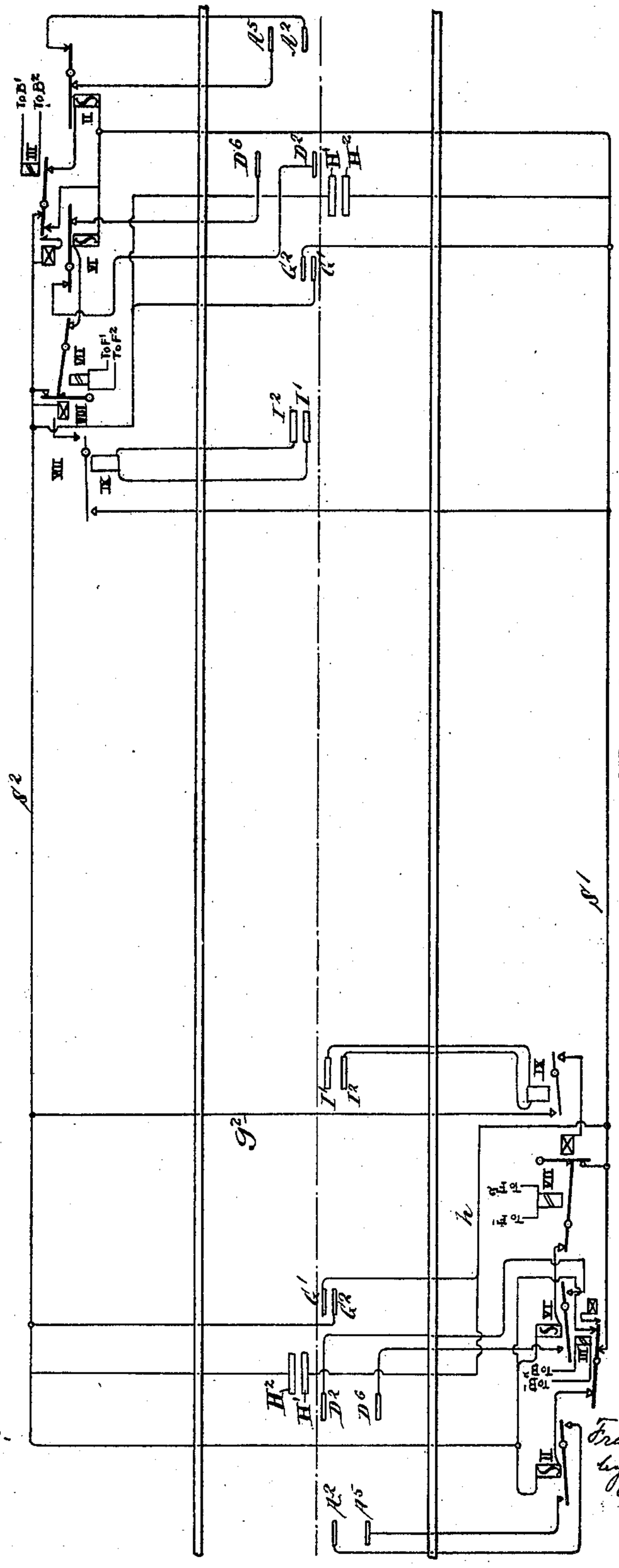


FIG. 1.

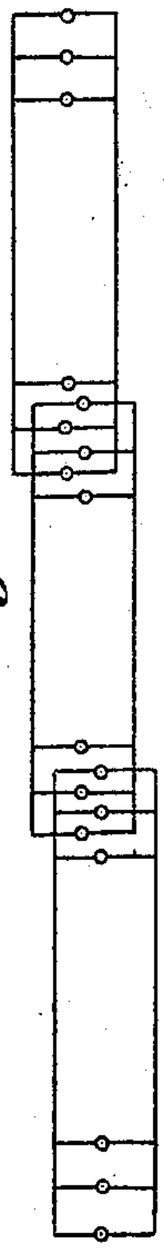


Fig. 3.

WITNESSES.
A. F. Macdonald.
L. T. Shaw.

INVENTOR.
Frederick C. Esmond
by Edward M. Bentley
Atty.

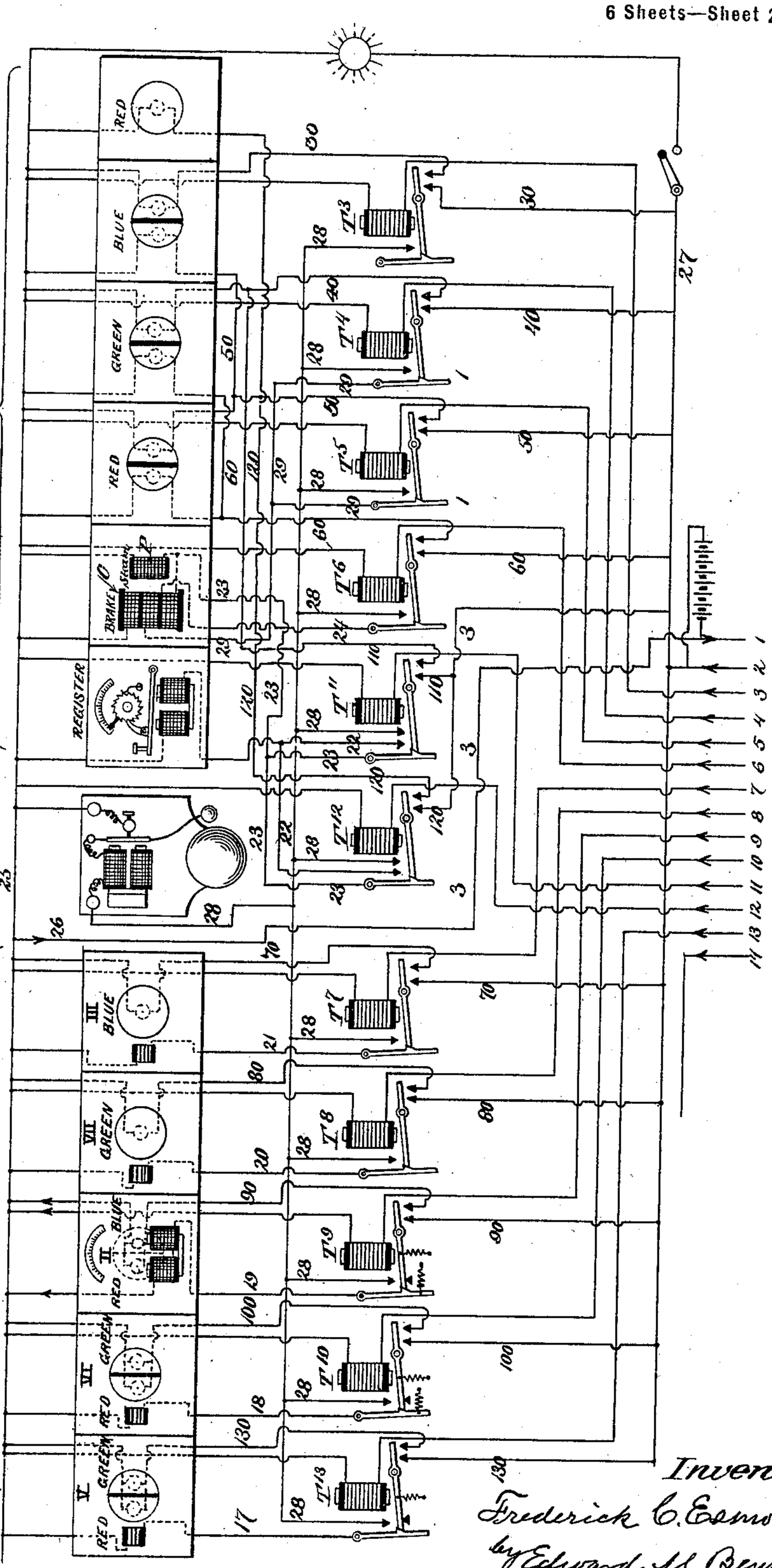
No. 617,325. Patented Jan. 10, 1899.

F. C. ESMOND.

RAILWAY SIGNAL SYSTEM.

(Application filed Mar. 17, 1896.)

(No Model.) 6 Sheets—Sheet 2.



Witnesses:
Raphael Netter.
A. D. Macdonald.

Inventor
Frederick C. Esmond
by Edward M. Bentley
Atty.

No. 617,325. Patented Jan. 10, 1899.

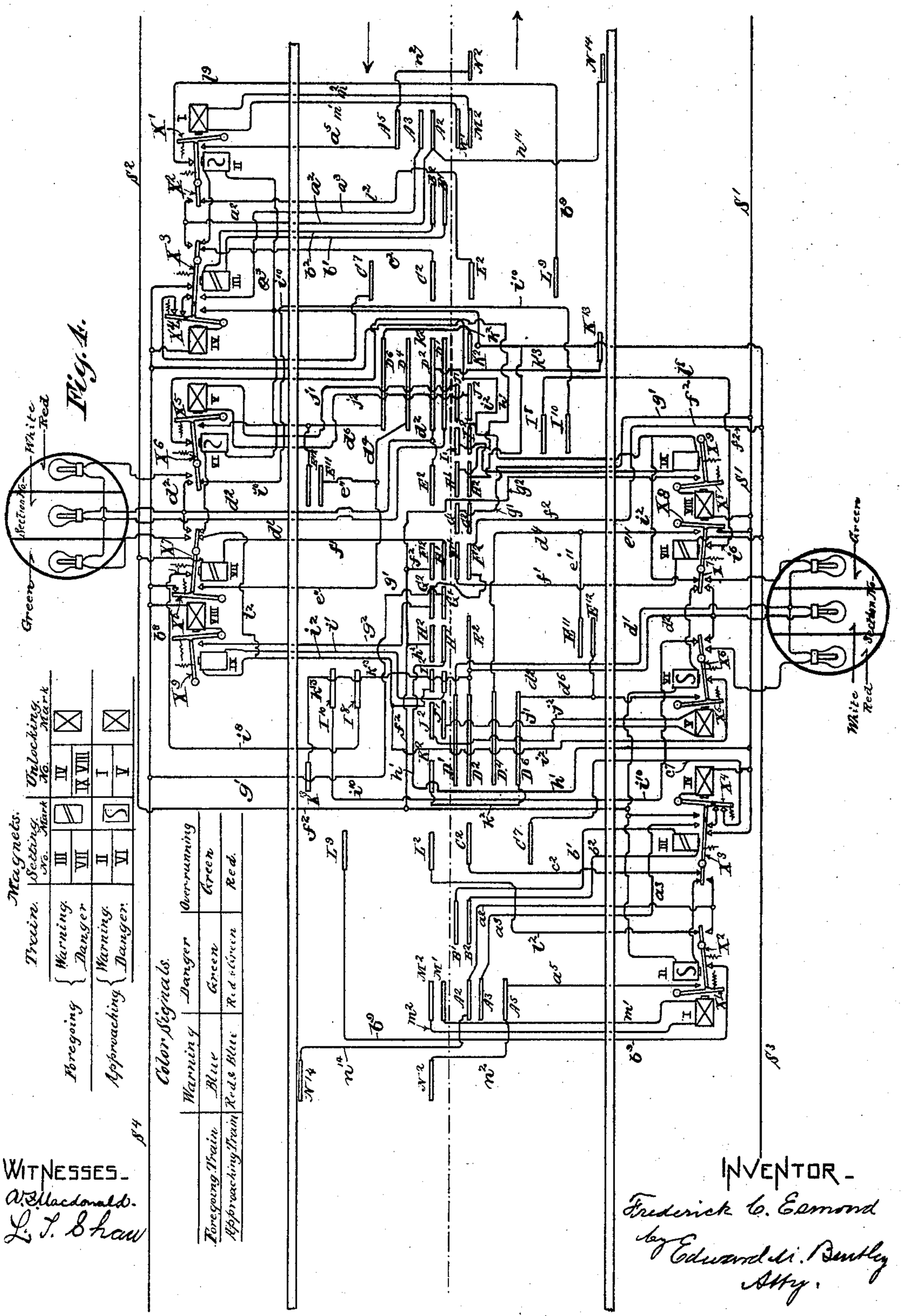
F. C. ESMOND.

RAILWAY SIGNAL SYSTEM.

(Application filed Mar. 17, 1896.)

(No Model.) 6 Sheets—Sheet 3.

Fig. 4.



WITNESSES—
A. Z. Macdonald.
L. T. Shaw

INVENTOR—
Frederick C. Esmond
by Edward M. Bentley
Atty.

No. 617,325. Patented Jan. 10, 1899.

F. C. ESMOND.

RAILWAY SIGNAL SYSTEM.

(Application filed Mar. 17, 1896.)

(No Model.) 6 Sheets—Sheet 4.

Fig. 7.

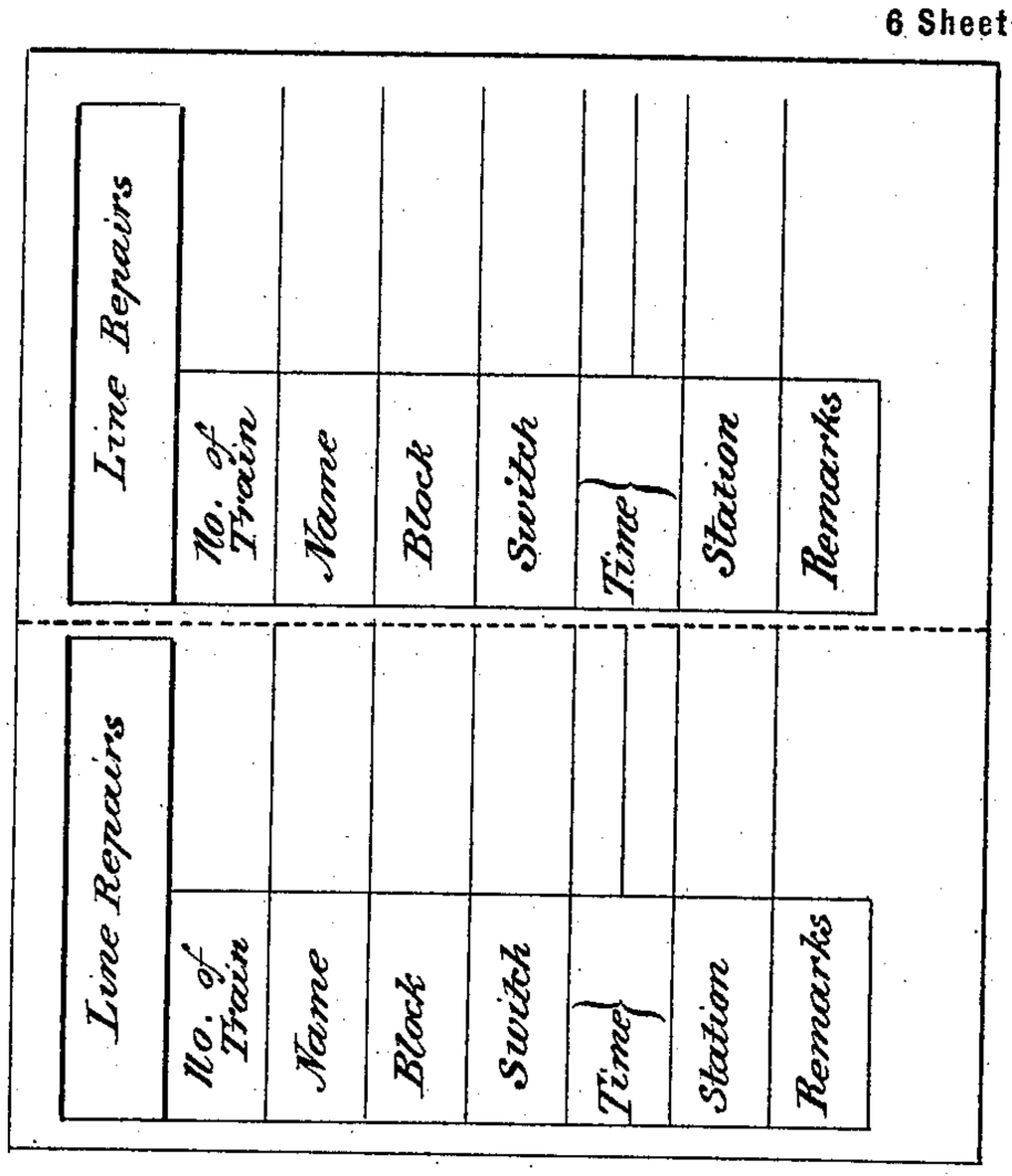


Fig. 5.

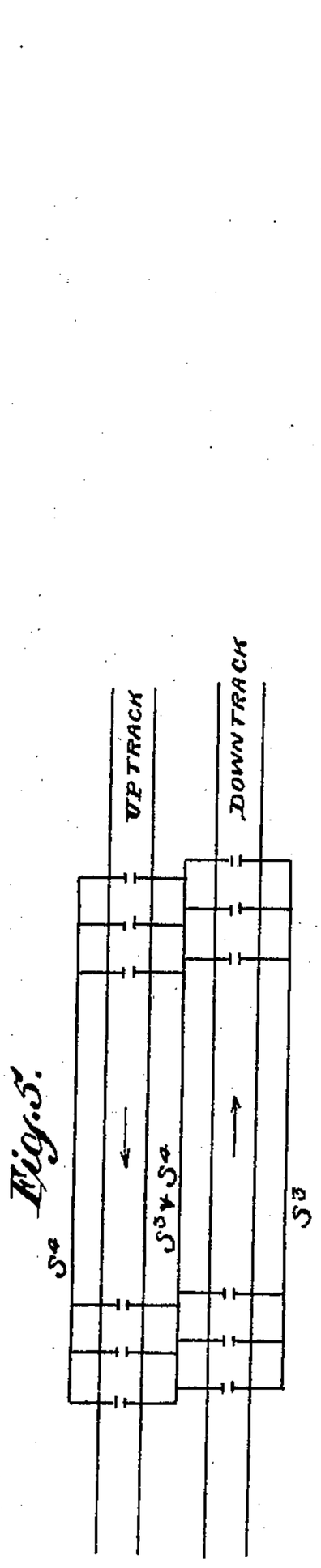
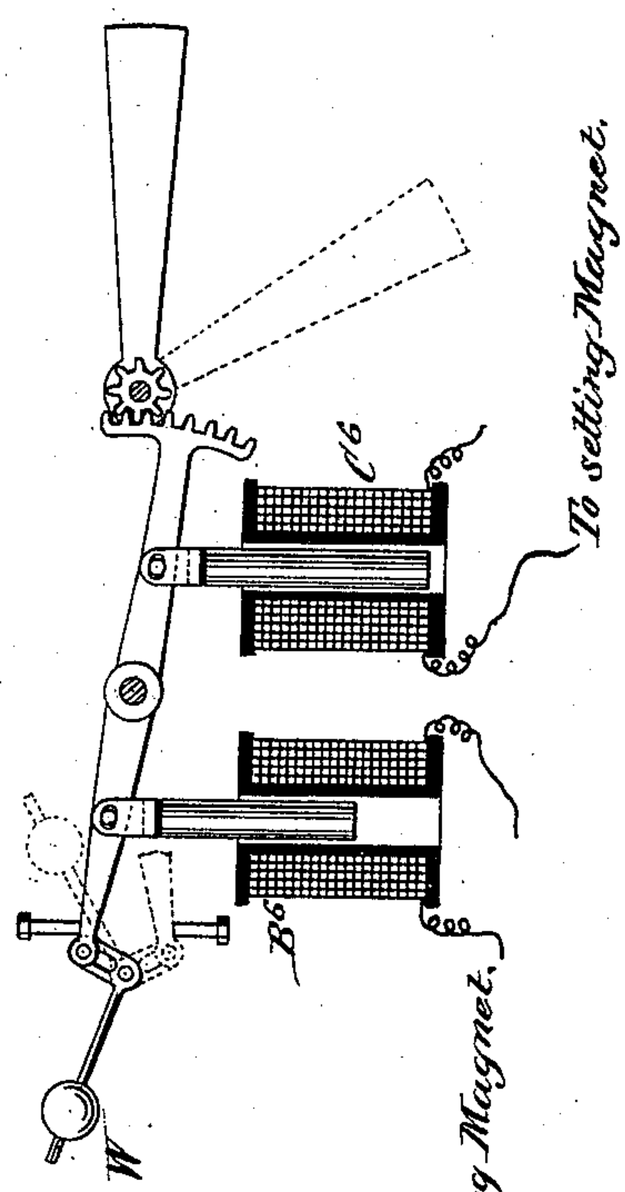


Fig. 6.



Witnesses:
A. E. Macdonald.
L. L. Shaw

Inventor
Frederick C. Esmond
by
Edward M. Bentley
Atty.

No. 617,325. Patented Jan. 10, 1899.

F. C. ESMOND.

RAILWAY SIGNAL SYSTEM.

(Application filed Mar. 17, 1896.)

(No Model.) 6 Sheets—Sheet 5.

Fig. 8.

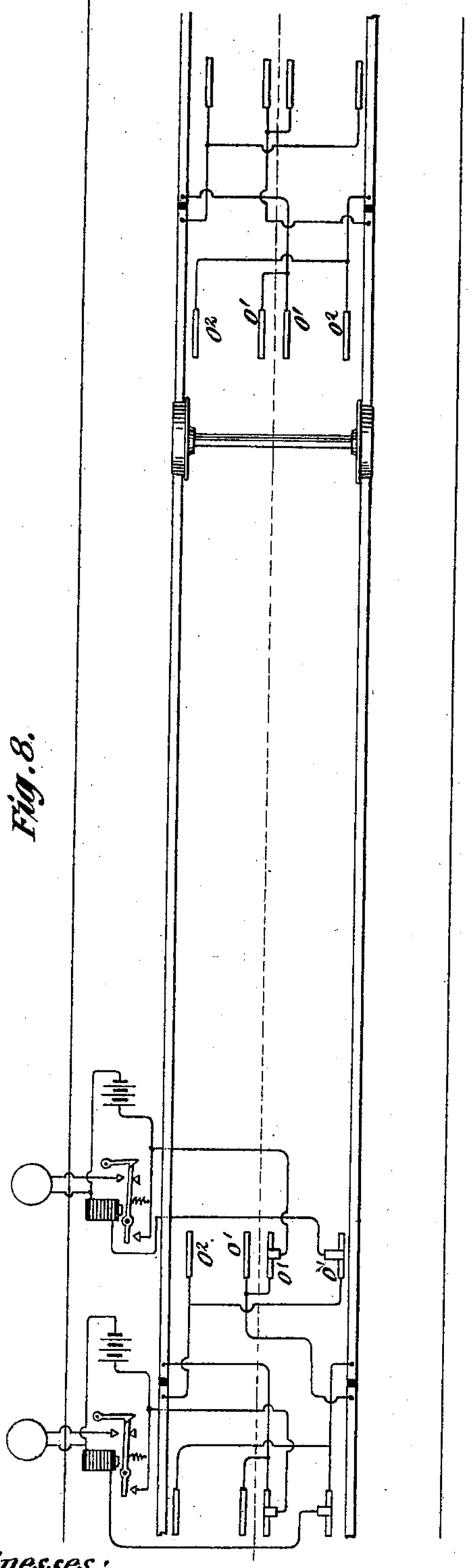
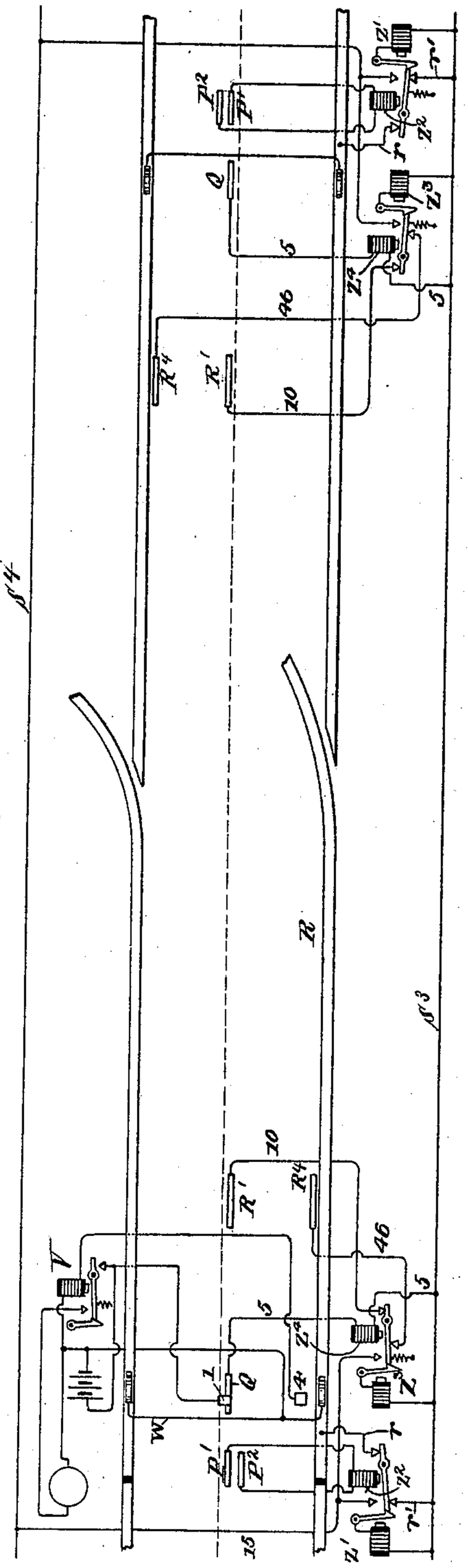


Fig. 9.



Witnesses:
L. F. Shaw
D. W. Andrews

Inventor
Frederick C. Esmond
by Edward M. Bentley Atty

No. 617,325. Patented Jan. 10, 1899.

F. C. ESMOND.

RAILWAY SIGNAL SYSTEM.

(Application filed Mar. 17, 1896.)

(No Model.) 6 Sheets—Sheet 6.

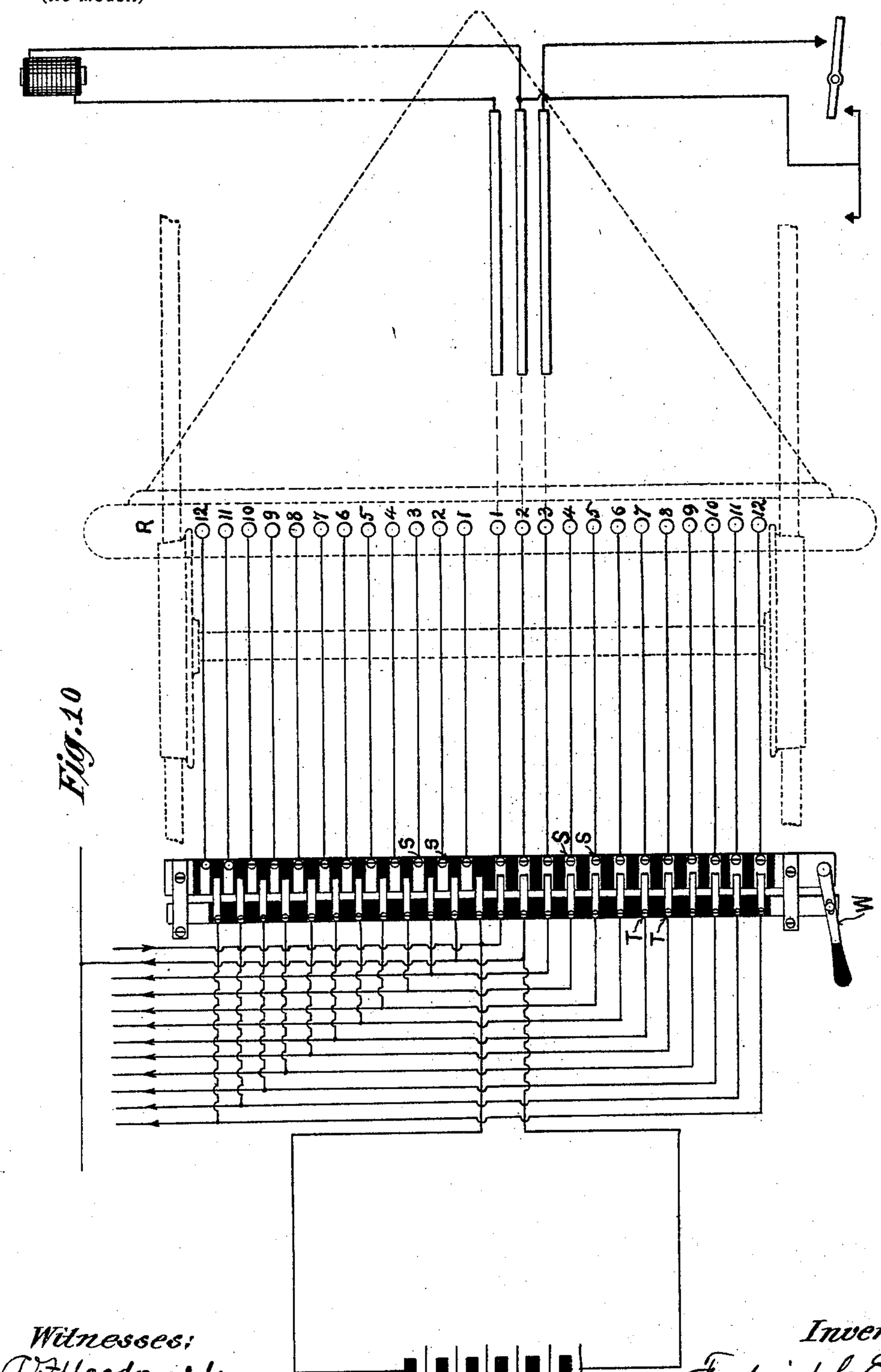


Fig. 10

Witnesses:
A. Z. Macdonald.
L. T. Shaw.

Inventor:
Frederick C. Esmond
by Edward M. Bentley
Atty.

UNITED STATES PATENT OFFICE.

FREDERICK C. ESMOND, OF NEW YORK, N. Y., ASSIGNOR TO THE ESMOND ELECTRIC TRACTION AND SIGNAL COMPANY, OF WEST VIRGINIA.

RAILWAY SIGNAL SYSTEM.

SPECIFICATION forming part of Letters Patent No. 617,325, dated January 10, 1899.

Application filed March 17, 1896. Serial No. 583,557. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK C. ESMOND, a citizen of the United States, residing at New York, (Brooklyn,) State of New York, have invented new and useful Improvements in Railway Signal Systems, of which the following is a specification, reference being made to the accompanying drawings, in which—

Figure 1 is a diagram illustrating the line-circuits and fundamental features of my invention. Fig. 2 is a diagram illustrating train apparatus. Fig. 3 is a diagram showing three successive blocks. Fig. 4 is a general plan of the local track-circuits. Fig. 5 illustrates a double-track system. Fig. 6 is an illustration of the supplementary semaphore-arm. Fig. 7 shows the report-blank used in my system. Fig. 8 illustrates the arrangement for indicating detached cars. Fig. 9 illustrates the method of indicating a break in the track. Fig. 10 illustrates the arrangement of brushes on the locomotive and the method of shifting the train-circuits from one set of brushes to the other.

My invention relates to a system of electric railway signaling which is automatic in every respect and not only enables the engineer of a train to be notified of the presence of a foregoing or approaching train ahead of him, but also is automatically tested at each operation, so that any disarrangement of the system is immediately noted and provision made for at once advising the nearest station-master, so that it may be repaired. My system, moreover, provides both a warning and a danger signal to the engineer, distinguishable according as the threatening train is a foregoing—that is, one preceding, in the same direction—or an approaching one—that is, one coming in the opposite direction—and also makes a record in a locked register in the event of his overrunning a danger-signal.

My system also involves the employment of but two line-wires for a single-track road, although a variety of signals are transmitted and trains run in either direction, this being accomplished by having at each station terminating a block several branch circuits between the two main lines, in each of which there are circuit-controlling devices which may be manipulated so that either one of the branch circuits may be employed at a given moment in conjunction with the main lines and with such corresponding branch at the next station as may be closed at the same moment to send an impulse of current for a distinctive purpose, the other branch circuits at both stations being open at the time.

It is to be noted that I designate as a "block" in this specification the space between two succeeding stations, at each of which is located the apparatus by means of which a train upon arriving thereat sets at that point apparatus for giving a signal to a succeeding train and also sets at the station in advance apparatus for giving a signal to an approaching train from the opposite direction. Each block has two line-wires coextensive with the block, which, together with the several cross branches between them at each station, form a distinct insulated system, although the cross branches at the end of one block overlap to a certain extent the cross branches at the beginning of the next block. Therefore the circuits of succeeding blocks are related somewhat like the links of a chain.

The source of current for operating the system consists of a storage battery or other suitable generator placed upon each locomotive, and the current therefrom is delivered to the circuits along the road by means of brushes on the locomotives adapted to bear on contact plates or sections set in the track and connected to the main-line wires and to local circuits along the track. There is a series of such contact-brushes carried by the locomotive and adapted to engage respectively with the contact-plates as the train passes along. These contact-plates are variously located in the track with relation to the rails and are variously connected to the "track-circuits," by which term I include both line and local circuits, while on the locomotive two of the series of contact-brushes, which may be termed "battery-brushes," are connected, respectively, to the two terminals of the battery, while the remaining brushes of the series are all connected to one battery-terminal, each

brush including in its respective circuit a magnet arranged to produce a characteristic signal when the corresponding brush comes in contact with its contact-plate in the track. These latter brushes may be distinguished as "magnet-brushes." It will be understood that by reason of the various track-circuits connecting the contact-plates a circuit will be at times completed from one battery-terminal and its brush to the opposite battery-terminal either directly by way of the other battery-brush or else by way of one of the remaining brushes and its corresponding signal-magnet. Part of this circuit will be external to the train and the remaining part will be within the train. It is further characteristic of my system that an advancing train on reaching a certain point establishes certain of these partial external circuits at points immediately preceding and also at advance points, which circuits will be completed by a following or by an approaching train and certain signals thereby operated, provided that the following or approaching train comes too close to the other. These conditions, which have been established by the train, are subsequently removed when the said train reaches the next station, so that the following train will be free to proceed without interruption, or if it has been blocked and brought to a standstill it will be released and allowed to proceed, while an approaching train will have been stopped and side-tracked or otherwise taken out of the way.

I will also add that such seeming complications of circuits and apparatus as are unavoidable in so comprehensive a system are placed so as to cause no trouble to the engineer, fireman, and others unskilled in such matters. It is their duty simply to learn the indications, which are very simple, and not concern themselves about the details of the system.

Signals to be Given.

The indications given by my system are all received by the engineer and fireman of the train and are mostly received in the cab by means of the aforesaid brushes and corresponding magnets, although certain indications are or can be given by track-lights or semaphores in a track-circuit between the plates corresponding to the two battery-brushes. These signals in the cab are divided into two classes—engineers' signals and firemen's signals.

Engineers' signals.—The engineers' signals are given by different-colored lamps on the train, thrown into circuit with the generator by the means described, and each is accompanied by the ringing of a bell to attract attention. Although, if desired, a different assignment of colors for the several indications may be made, I have for illustration chosen the following, to wit: Blue light—notice of a foregoing train received by the engineer upon arriving at the warning-point. Green—notice of a foregoing train received by the engineer upon arriving at the danger-point, also that the train has overrun a danger-signal of a foregoing train and the fact registered. Red and blue combined—notice of an approaching train received by the engineer upon arriving at the warning-point. Red and green combined—notice of approaching train received by the engineer upon arriving at the danger-point. Red alone—notice that train has overrun a danger-signal of an approaching train and the fact registered. The warning-signals are received first and simply ring the bell and light the blue lamp for a foregoing and the red and blue lamps for an approaching train. The danger-signals, however, not only ring the bell and illuminate the green light for the foregoing and red and green lights for an approaching train, but also partially set the brakes, while if the engineer should run over a signal of this kind the red light would appear for an approaching and the green light for a foregoing train. The brakes would also be fully set, the steam shut off, and a record made against him in the register.

Firemen's signals.—These signals are in general the testing-signals which give notice of any disarrangement or failure to act of the apparatus at any point. There are a series of lamps corresponding to those in the engineers' signals, which when lighted give notice that the corresponding engineer's signal has failed to act and that something is wrong. Each failure is not only signaled, but recorded in the fireman's register, and it is his duty to immediately fill out a printed blank, giving the number of his train, the number of the block where the trouble has been encountered, and the time and the station at which the blank is delivered. These blanks are in duplicate, one kept by the fireman until the end of his run and the other delivered to the nearest station-master, so that the one serves as a check upon the other, while the registers afford a check upon both. Additional communications can be provided for by additional contact-brushes on the locomotive and additional contact-plates in the track arranged to coöperate therewith.

Train apparatus.—I will first describe in detail the apparatus on the train, it being understood, as above mentioned, that it includes a battery or other source of current and a series of brushes adapted to sweep along a corresponding series of plates in the track at certain times. It should also be mentioned that on a single-track road, such as this system is primarily adapted for, the contact-plates for trains in one direction are all set in the track at one side of a central line between the rails, while those for trains in the opposite direction are set in the space on the other side of said central line. I therefore provide that the set of brushes on the train may be shifted from side to side, so as to cover always the right-hand half of the inter-rail

space in the direction of movement. The same result may be attained by having a double set of permanently-placed brushes and switching the train-circuits from one set to the other upon reversal of direction. This latter arrangement I have illustrated in Fig. 10.

Each magnet-brush forms, as mentioned above, the terminal of an independent branch circuit leading from one pole of the battery—for instance, the negative—and including a magnet. The same pole of the battery is also connected to one of the two battery-brushes for delivering current in like manner to lamps or semaphores along the track, while the opposite or positive pole is connected to the other battery-brush, so that for any indication the positive battery-brush and at least one other must bear on their track contact-plates and the circuit be completed through such connections between the contact-plates as are provided for the particular indication to be given. Therefore in describing the train apparatus it will be understood that there is always a partial or incomplete track-circuit of some kind between each of the contact-plates corresponding to the positive battery-brush (referred to herein as brush 2) and one or more of the plates corresponding to the respective signal-brushes, it being also noted that the plates are arranged in sets (distinguished as A B C to N) and that the set at any one point comprises the two or more plates corresponding to the indication it is desired to produce at that point.

The train apparatus is fully illustrated in the diagram of Fig. 2. At the bottom of the figure are the circuits leading to the several brushes and numbered from 1 to 14. The battery is included between 1 and 2, the latter receiving the positive and the former the negative end. If we trace the several brush-circuits 3 to 13, we find that each proceeds to a corresponding magnet T^3 T^4 to T^{13} and passes thence to the common line 25 at the top of the diagram, which is connected by the line 26, passing down at the left of the ball to the negative pole of the battery. Each magnet acts as a relay to close one or more branch circuits, including lamps, brake-magnet, register, or other devices employed in its particular indication and also in every case a branch circuit including a bell or other audible attention-caller. Thus circuit of brush 3 leads first to magnet T^3 and thence to line 25 and by line 26 to negative battery-pole, and whenever the brush 3 is connected by a track-circuit to brush 2 a complete circuit will be formed by the two partial circuits, and magnet T^3 will become active, and its armature will close two branch circuits between the common positive line 27 and the common negative line 25—to wit, branch 30, including engineer's blue lamp, and branch 28, including the bell. In like manner magnet T^4, in circuit with brush 4, controls branch 40, including engineer's green lamp, bell branch 28, and also branch 29, including the upper third of the coils of brake-magnet O. Magnet T^5, in circuit with brush 5, controls branch 50, including engineer's red and blue lamps and also bell branch 28 and brake branch 29. Magnet T^6, in circuit with brush 6, controls branch 60, including engineer's red and green lamps, branch 24, including the upper and middle thirds of the coils of brake-magnet O, and bell branch 28. Magnet T^{11}, in circuit with brush 11, controls branch 110, which, like branch 40, includes engineer's green lamp, branch 22, which includes engineer's register, branch 23, which includes all the coils of brake-magnet O and steam-magnet P, also bell branch 28. Magnet 12, in circuit with brush 12, controls branches 22, 23, and 28 just like magnet 11, but also controls branch 120, including a red lamp. The remaining magnets control the fireman's signals, as follows: Magnet T^7 controls branch 70, including fireman's blue lamp, bell branch 28, and register branch 21. Magnet T^8 controls branch 80, including fireman's green lamp, bell branch 28, and register branch 20. Magnet T^9 controls branch 90, including two lamps, red and blue, and register branch 19, including also bell branch 28. Magnet T^{10} controls branches 100 and 18, including fireman's red and green lamps and register, also bell branch 28. Magnet T^{13} controls branches 130 and 17, including fireman's red and green lamps and register, also bell branch 28, and in like manner additional indications can be given by additional brushes and magnets. These fireman's signals are distinguished also by the Roman numerals II III V VI VII, respectively, these numerals indicating the track-magnet whose action is tested and the test indicated (in the event of a failure) by the corresponding fireman's signal. By reference to the tables accompanying Fig. 4 the function of the several track-magnets may be learned, as well as the colors corresponding thereto. From these tables it appears that magnet V is the unlocking-magnet of a danger-signal of an approaching train and that the colors for this signal are red and green. The fireman's signal for this magnet V is the one at the extreme left, controlled by magnet T^{13} and brush 13. From the tables it appears also that track-magnet VI is the setting-magnet for the same signal of which magnet V is the unlocking-magnet. Therefore the corresponding fireman's signal will have the same colors, but will be distinguished by the Roman numeral VI and by the indication of the register. In the same way the other fireman's signals (marked, respectively, II, VII, and III) should have the several colors marked on the drawings, Fig. 2.

I have not shown in detail the signal controlled by brush 14; but it is just like those which are shown, having, however, its own distinguishing-marks. As will be described hereinafter, it is a signal indicating a failure of track-magnet I, which, as appears from the

tables, is the unlocking-magnet for a warning-signal of an approaching train, with red and blue colors.

Track contact-plates.—As above mentioned, there are at succeeding points along the track respective sets of contact-plates, each set including plates corresponding to two or more brushes. These sets are lettered A B, &c. Thus set A includes plates A^2, A^3, and A^5, corresponding to brushes 2, 3, and 5, and at this point (known as the "warning-point") if the partial track-circuit is closed between plates A^2 and A^3 or between A^2 and A^5 the above-described signals produced by brush 3 or brush 5 will be given. Thus when the partial track-circuit is closed between plates A^2 and A^3 by wire a^2, armature X^3, and wire a^3 there will be produced the following signal, to wit: the bell and engineer's blue lamp, which, as above mentioned, is a cautionary signal indicating to the engineer when he arrives at the warning-point that there is a foregoing train in the block ahead. If the partial track-circuit is closed between A^2 and A^5 by wire a^2, armature X^2, and wire a^5, the engineer receives the signal controlled by brush 5 and magnet T^5, which operates his red and blue lamps, rings the bell, and throws on his brakes to a slight extent. This is a danger-signal, giving notice to the engineer when he arrives at this warning-point that there is an approaching train on the block ahead.

Set B. This set includes plates B′ and B^2, corresponding to brushes 1 and 2. This simply delivers the battery-current by wires b' b^2 to a track-magnet III, but does not produce a signal in the cab. The function of this magnet is to set the warning-signal for a following train, which that train will receive upon arriving at plates A^2 and A^3.

Set C. This set includes plates C^2 and C^7, and the partial circuit between these two plates is closed through armatures X^3 and X^4 whenever there has been a failure in the action of the preceding set B, and in that event there will be a signal given in the cab, to wit: the one controlled by brush 7, in connection with brush 2 and magnet T^7, consisting of the fireman's blue lamp and bell. This notifies the fireman that there has been a failure to set the blue warning-signal for the engineer of the succeeding train, and the fireman will at once proceed to notify the nearest station-master that there has been a disarrangement or failure of the apparatus.

Set D. This set includes plates D′, D^2, D^4, and D^6, which plates should be a quarter or half mile in length and placed at what is known as the "danger-point." In the first place, by means of the plates D′ and D^2 and the corresponding brushes 1 and 2, connected to the battery-terminals, a current will be delivered to the track-circuit by wires d' and d^2. This track-circuit, as shown in Fig. 4, includes a white semaphore-lamp, this being the only function of the circuit, which simply illuminates a dial-plate, giving the number of the section, so that both the engineer and fireman can know to what point they have arrived, and in the event of any disarrangement being indicated the fireman will know what is the number of the section he is to report. In the second place, if the partial track-circuit between plates D^2 and D^4 is closed it will indicate that there is a foregoing train on the block ahead in dangerous proximity. The said track-circuit when closed is from plate D^2, by wire d^2, to armature X^7 of magnet VII, (setting magnet, "danger, foregoing train,") thence by wire e^{11}, wire d^4, to plate D^4. This will give a signal in the cab controlled by brush 4 and magnet T^4, which includes the engineer's green lamp, ("danger from foregoing train,") the bell, and a section of the brake-magnet. The same conditions will also throw into circuit the green semaphore-light on the track, thus giving an additional notice to the engineer. The circuit for this green lamp is from plate D^2, by wire d^2, to armature X^7 of magnet VII, (setting magnet, "danger, foregoing train,") to green lamp, to wire d', to plate D′. In the third place, if the partial track-circuit is closed between plates D^2 and D^6 it will be due to the presence of an approaching train on the block ahead in dangerous proximity. This circuit is from plate D^2, by wire d^2, to armature X^6 of magnet VI, (setting magnet, "danger, approaching train,") to wire d^6, to plate D^6. This will set the signal controlled by the corresponding brush 6 and magnet T^6, which comprises the red and green lamps, ("danger from approaching train,") the bell, and two-thirds of the brake-magnet. The red light will also appear in the semaphore by reason of a branch current from the circuit last traced, starting at armature X^6 and passing to the red lamp, to wire d', to plate D′. These indications, produced at the set D, (the danger-point,) from a threatening train will be continued so long as the train signaled is on the quarter or half mile covered by the plates, and it will be the duty of the engineer to stop and wait until the lamps go out, his bell stops ringing, and his brake is released, which notifies him that the conditions produced by the dangerous proximity of the other train have been removed and that he is free to proceed.

Set E. This set includes plates E^2, E^{11}, and E^{12}, corresponding to brushes 2, 11, and 12, and is for the purpose of stopping the train and registering against the engineer if he should overrun the danger-point D while a foregoing or approaching train is on the block ahead. In the first place, if the partial track-circuit is closed between plates E^2 and E^{11}, through wire d^2, armature X^7, and wire e^{11}, by reason of the presence of a foregoing train the signal controlled by brush 11 and magnet T^{11} will be given—that is, the green lamp will show, the engineer's register will be operated, the steam will be shut off, and the brakes fully applied. In the second place, if the in-

terfering train is an approaching one the partial track-circuit will be closed between plates E^2 and E^{12} by wire d^2, armature X^6, and wire d^6, and the signal controlled by brush 12 and magnet T^{12} will be given—that is, the red lamp only will show and, just as the signal 11, the engineer's register will be operated, the steam shut off, and the brakes fully applied.

Set F. This set includes plates F′ and F^2, corresponding to brushes 1 and 2, to which plates the battery-current is delivered, just as in set B and set D. The track-circuit between these plates F′ and F^2, as will be more fully described hereinafter, includes, by wires f' f^2, a magnet VII, which closes by armatures X^7 and locks the partial circuit between plates D^2 and D^4 of preceding set D, so that a succeeding train will be signaled upon arriving at said point D, in the manner already described, unless the train which did the locking has passed off the block and thereby, as will be described later, has unlocked the circuits which it locked when passing over the set F.

Set G. This set, again, is one comprising but the two battery track-plates G′ and G^2, and the current from the train is received by these two plates and transmitted ahead over the main circuit-wires S′ and S^2 if the train is proceeding from left to right, or S^3 and S^4 if it is proceeding from right to left, Fig. 4, to the end of the block, where it there acts on setting-magnets II and VI on the opposite side of the track to set the warning and danger signals for an approaching train—that is, each train when at G sets signals ahead of itself, which signals are unlocked when a train reaches the succeeding set J.

Set H. This is also one including only the battery contact-plates H′ and H^2, and by means of them an impulse is sent rearward over the main line S^3 and S^4 for a train proceeding from left to right, Fig. 4, or S′ and S^2 for a train proceeding from right to left, to unlock the warning and danger signals, (by means of magnets IV and VIII, Fig. 4,) which had been set and locked by the train at set B and set F at the preceding station.

Set I. This comprises plates I′ and I^2 and I^8 and I^{10}. The first two include in their circuit, by wires i' and i^2, a magnet IX, whose function is to close a branch circuit through magnet VIII, armature X^8, and wires g^2 f^2 between the two main lines, by means of which the signal set in advance of the train by set G at the beginning of the block can be subsequently unlocked when the train reaches the succeeding set J. For convenience the wire g^2 is shown in Fig. 4 as connected on one side to the line S^3 by way of plate G^2, plate F^2, and wire f^2, and on the other side to line S^2 by way of wire f^2. Plates I^2 and I^8 produce the signal controlled by brush 8 and magnet T^8 when the circuit between the plates is closed by wire i^2, armature X^7 and wire i^8, and this circuit is closed only when there has been a failure at set F on the part of magnet VII to lock the danger-signal at set D for a following train. This gives the fireman a green light, (controlled by brush 8 and magnet T^8,) notifying him that the engineer's green signal ("danger, foregoing train") is out of order or has failed to act. Plates I^2 and I^{10} afford a similar test by wires i^2, armature X^6, and wire i^{10} on the operation of magnet VI, when energized from set G of the preceding end of the block, by means of which the signal was set for an approaching train ahead on the opposite side of the track by the train itself when passing set G at the preceding end of the block. If there has been a failure to set this signal, (engineer's red and green, "danger, approaching train,") the circuit between plates I^2 and I^{10} is closed at armature X^6 and the fireman gets the signal from brush 10, magnet T^{10}, red and green lamps, which shows him that the corresponding engineer's signal is out of order or has failed.

Set J. This set also has but the two plates corresponding to brushes 1 and 2—to wit, plates J′ and J^2. These plates in like manner receive a current from the battery on the train, and the track-circuit between them includes wires j' and j^2, a magnet V, which, like the second magnet in set F, is on the opposite side of the track, and its function is to unlock, when the train reaches this set J, the danger-signals which the train had set in advance of itself upon entering the block for the purpose of signaling an approaching train coming to meet it. This magnet is on the other side of the track from its plates J′ and J^2, because, as already stated, the approaching train receives its signals from that side.

Set K. This set includes plates K^2 and K^{13}, and the track-circuit between these plates, including wire k^2, plate D^6, wire d^6, armature X^6, wire d^2, wire k^{13}, is not closed unless there has been a failure of the magnet V, connected with plates J′ and J^2, to perform its duty and unlock the armature of magnet VII, controlling the danger-signal which had been set in advance by the train in passing over the preceding set G. This gives the fireman a test or check on the operation of this part of the apparatus, and if it has not acted the red and green lamps appear, showing him that this danger-signal for an approaching train is out of order.

Set L. This set includes plates L^2 and L^9, and the circuit between them, including line l^2, armature X^2, and line l^9, is only closed in the event of a failure at G to set the signal ahead by means of magnet II.

Set M. This set comprises plates M′ and M^2, and the track-circuit between them includes wires M′ M^2 and a magnet I on the other side of the track, which serves to unlock the combinations established by the train itself at the point G in the preceding block through the agency of magnet II—that

is, the train upon entering the block set signals, both "warning" and "danger," in advance of itself to head off a train coming in the opposite direction, and now it is necessary to unlock such signals, which is done by the magnet I, included between plates M′ and M², for the warning-signal, and the magnet V, between plates J′ and J², for the danger-signal.

Set N. This set comprises plates N² and N¹⁴, and the circuit between them, including wires n^2 a^5, armature X², and wires a^2 n^{14}, is only closed in the event of a failure of magnet at point M to do its duty and unlock the circuits. If there has been such a failure, the fireman gets a red and blue lamp, as already described, showing him that there has been a miscarriage in the action of the warning-signal for approaching trains.

Having now described the various signals on the train and along the track and having also described their meaning and the general character of the track-circuits controlled by the different sets of contact-plates, I will now take up these circuits in detail and describe their exact arrangement.

Line-circuits.—In Fig. 1 will be found a diagram which includes these circuits separated out from the local circuits, so as not to be confused thereby, although certain local circuits immediately controlling or controlled by the line-circuits are also shown to assist in the illustration. From this diagram the general underlying principle of my system may be readily understood. Referring to this drawing, it will be understood that a single block is shown with the apparatus at each end, the two ends being duplicates of each other. I have left out all of the apparatus pertaining to the block behind and the block ahead of the one illustrated; but it will be understood that in general the line-circuits of succeeding blocks overlap one another somewhat like the links of a chain, as appears in Fig. 3, wherein three sections or blocks are shown with the two main lines for each block and the various branch circuits. The latter are not carried out in detail, it simply being understood that in each branch a circuit-controller of some kind is included and that each circuit-controller is designed to operate and close its branch circuit at a moment when all the others at the same end of the block are open, but at a moment when one of those at the opposite end of the block is closed. Thus the circuit-controllers act successively or at different periods of time as regards those at the same end of the block, but simultaneously with one or more of those at the opposite end.

In Fig. 1 it appears that the contact-plates which have been chosen to illustrate the line-circuits are in G′ and G² in set G, and, on the other side of the system, H′ and H² in set H. Beginning at either the right or the left, it will be seen that the circuit leading from plate A² to plate A⁵ passes through the armature of magnet II and is only closed when the armature of this magnet is in its attracted position. It therefore follows that on the arrival of the train at set A, which is the warning-point, no signal will be received by the brush 5 (warning of an approaching train, red and blue lamp) unless said approaching train upon entering the block from the opposite end has in some manner caused setting-magnet II to close the partial signal-operating circuit between plates A² and A⁵. This the approaching train does when it reaches the set G upon entering the farther end of the block, the plates G′ and G² being of course on the opposite side of the track from the magnets controlled thereby. From the battery of the approaching train a current is sent from the plates G′ and G² over the line-wires S′ and S², energizing setting-magnets II and VI, which are in branch circuits. The armatures of these magnets are locked in their attracted position and remain so until the train which set them arrives and unlocks them in passing off the block by exciting momentarily the unlocking-magnets. So long, however, as they remain locked a train upon arriving at A² and A⁵ from another block will receive warning of the approaching train which set the signal and upon arriving at the point D will receive from plates D² and D⁶ in like manner a danger-signal. If no approaching train has energized the magnets II and VI and set the partial signal-operating circuit, no signal of course will be received. The function which I have just described as performed by the plates G′ and G² at one end of the block is exactly the same as that performed by the same plates at the other end—that is, they set the warning and danger signals ahead on the opposite side of the track for the purpose of notifying an approaching train coming in the opposite direction. If, therefore, a train has passed a warning-point and a danger-point without being signaled and in passing over G′ and G² has set warning and danger signals ahead of itself to head off an approaching train, the next contact-plates encountered which affect the line-circuit are I′ and I² in set I. The circuit between I′ and I² includes the magnet IX, and its function is simply to close and lock a cross-circuit between line-wires S′ and S², including unlocking-magnet VIII for releasing armature of magnet VII, for it will be remembered that the train in passing plates F′ and F² has set, by means of magnet VII, the partial signal-operating circuits connected with plates D′ and D⁴ at the danger-point, so that a following train will receive a danger-signal upon arriving at set D, indicating a foregoing train. It is therefore obvious that some means must be provided for unlocking this danger-signal set by magnet VII when the train which set the signal has reached the end of the block, otherwise the track will be permanently blocked. This is the function of the branch circuit including magnet VIII, which I have just described as closed by the magnet IX, in circuit

with the plates I′ and I². This closed branch circuit is, as it were, left by a train behind itself with an unlocking-magnet VIII for the danger-signal included therein, so that when it reaches the farther end of the block it will have a line-circuit in the rear, which can be used for unlocking the danger-signal which the train itself set upon entering the block to head off a following train. In like manner magnet III when operated by a train passing plates B′ and B² closes a circuit through its own unlocking-magnet IV. The next and last contact-plates to be considered are H′ and H², upon the opposite end of the block from those already described, so that a train will not reach them until it approaches the end of the block. It is by means of these contacts H′ and H² that a current is sent rearward over the main line to unlock by means of magnet IV the warning-signals for a foregoing train which the train itself set by means of magnet III when passing over plates B′ and B², and also to unlock by means of magnet VIII the danger-signal which the train itself set by means of magnet VII, as just described, in passing over plates F′ and F². By this device the train upon reaching the end of a block clears the block behind of both warning and danger signals, so that a following train may proceed without interruption.

Local track-circuits.—Coming now to the track local circuits, for which it will be necessary to refer to Fig. 4, the first one to be noted is the partial signal-operating circuit included between contact-plates A² and A³. This is a warning of a foregoing train, just as A² and A⁵ gave a warning-signal for an approaching train. This circuit is from plate A² by wire a^2 and (if magnet III has been actuated) to the armature X³ of the said magnet to the wire a^3, plate A³. The next circuit to be considered is that between B′ and B². This circuit simply includes the magnet III by means of the wires b' b^2. This sets the partial circuit for a warning-signal which each train leaves behind it to be received by a following train at plates A² and A³, unless the train which set the signal has passed off the block and unlocked it. We next come to contact-plates C² and C⁷. Between them is the circuit which tests the operation of magnet III in setting the warning-signal for the following train, as just described. If this magnet has failed to act, its armature X³ will be left in the position shown in the drawings, and the circuit will then be completed between plates C² and C⁷ by means of wires c^2, armature X³, armature X⁴, wires e^7, and plate C⁷. In that event the fireman will receive a signal from brush 7 notifying him that the engineer's warning-signal to the train behind him has not been set. If the magnet III has acted properly, there will of course be no circuit between plates C² and C⁷. The next local circuit is that between plates D′ and D². As already indicated, this circuit simply includes the white semaphore-light by means of wires d' and d^2, leading thereto from plates D′ and D². The next local circuit is between D² and D⁴. This is the partial signal-operating circuit which gives notice at the danger-point of a foregoing train, just as D² and D⁶ give notice at the same point of an approaching train. This circuit is by line d^2 to armature X⁷ (assuming that magnet VII has been set by a preceding train in passing over plates F′ and F² and its armature still unlocked) by wire e^{11} and d^4 to plate D⁴. In the same event plates E² and E¹¹ will be connected through a circuit by the wire d^2, armature X⁷, and wire e^{11}. This will notify the engineer that he has run over his danger-signal and will also operate his register, throw on his brakes, light the green lamps, and shut off steam. This is accomplished by means of the brushes 2 and 11 on the locomotive, including magnet T¹¹, which operates the signal already described. On the other hand, if the threatening train is an approaching one the setting-magnet VI instead of VII will have its armature attracted and locked, and there will then be a circuit between plates E² and E¹² by means of line d^2, armature X⁶, and wire d^6. This will give the same result, except that the red lamp will be lighted instead of the green. This is due to the operation of the signal controlled by magnet T¹² on the locomotive, included in circuit between brushes 2 and 12.

Plates F′ and F², as I have already stated, are the ones by means of which a train sets the danger-signals for a following train. The circuit between these two plates includes the magnet VII, the circuit being by wire f' to magnet VII, thence for a short distance to the right, over rearward main line s^3, to wire f^2, which leads to plate F².

Plates G′ and G² are, as I have already explained, the ones by means of which the train sets the signals ahead of itself, by means of magnets II and VI, to warn and to block an approaching train.

Plates J′ and J² lead to unlocking-magnet V for magnet VI on the opposite side of the system, the function of which is to unlock the signal which the train had set in advance of itself to head off an approaching train by setting a danger-signal for said train through the agency of magnet VI. The circuit between plates J′ and J² includes simply the wires j' and j^2 and the magnet V.

Plates K² and K¹³ test the operation of magnet V, included in the circuit between plates J′ and J², whose function is, as just stated, to unlock the danger-signals which the train had previously set ahead of itself on entering the block. If this magnet has not operated properly, there will be a circuit between plates K² and K¹³, as follows: by line k^2 and d^6 to armature X⁶ on the opposite side of the system, to wire d^2, to wire k^{13}, to plate K¹³. This will give the fireman a signal from brush 13, already described, indicating that the danger-signal for an approaching train has not been unlocked. If the magnet has acted in its

proper fashion, the described circuit will of course be opened by the armature X^6.

I have already described the operation at plates I′ and I^2 and at II′ and H^2. There will, however, be a circuit between plates I^2 and I^8 which tests the operation of magnet VII at plates F′ and F^2, which, as I have already described, sets the danger-signal to block a following train. If magnet VII has not acted properly there will be a circuit by line i^2, armature X^7, line i^8, and plate I^8.

Plates L^2 and L^9 include between them a circuit which tests the action of magnet II in setting a warning-signal for an approaching train. It will be remembered that the train, which we are assuming has reached the plates L′ and L^9, set this signal ahead of itself when entering the previous block and passing over plates G′ and G^2 therein. The train having now arrived at the point where the advanced signal had been set now makes a test, by means of plates L′ and L^9, of its own action upon entering the block. If magnet II has failed to act, there will be a circuit from plate L^2 by line l^2 on the opposite side of the system to armature X^2, by line l^9 to plate L^9, and this will give the fireman a signal from brush 9, (already described,) indicating to him the failure of the signal at the warning-point to an approaching train. Of course if magnet II has acted properly the fireman will receive no such signal. Plates M′ and M^2 simply include between them the unlocking-magnet I for magnet II by means of lines m' and m^2. This magnet unlocks the signal just described as having been tested at plates L^2 and L^9. Plates n^2 and n^{14} simply test the action of magnet I, included between plates M′ and M^2. If this magnet has acted as intended, there will be no circuit between plates n^2 and n^{14}. If, however, it has failed to act, there will be a circuit from plate N^2 by lines n^2, plate A^5, line a^5, armature X^2, lines a^2, line n^{14}, plate N^{14}.

The signal controlled by brush 14, which connects with plate N^{14}, has been already described. It is the same as that controlled by brush 13, except for the number and register record.

In Fig. 10 I have illustrated the method of bringing into circuit only the contact devices upon the right-hand side of the locomotive which connect with corresponding contact-plates in the right-hand half of the track. In this figure, R represents the pilot of the locomotive, which carries a double set of brushes 1 2 3, &c., which may be of any desired construction and which are arranged, as shown in the drawings, with the numbers running from the center outward in each direction. Each brush is electrically connected to a plate S on a switchboard. Opposite the series of plates on the switchboard is a corresponding series of contact-fingers T, which are connected in pairs to the wires leading to the various indicator-magnets in the cab. The lower half of the series of contact-fingers are shown as bearing against the corresponding lower half of the plates S, while the upper set of contact-fingers and plates are out of engagement with each other. This brings into circuit the series of brushes on the right-hand side of the locomotive, but leaves those on the left-hand side open-ended. If, however, the movement of the locomotive is to be reversed, the handle W is thrown and the series of contact-fingers thereby shifted to bring the upper set into contact with the corresponding plates S. This will bring into circuit the brushes on the other side of the locomotive, which, in the manner already described, will coöperate with the track contact-plates on the corresponding side of the track. Three of these contact-plates are shown in the drawings in position to engage, respectively, with the brushes 1, 2, and 3. Between these plates 1 and 2 a track-magnet is indicated, while between plates 2 and 3 a partial circuit is shown with its continuity interrupted by an armature-lever.

It will be understood that so far as concerns the mechanical details of my system I make no claim herein to any particular forms. Thus any desired connection between the brake O, Fig. 2, and the lever in the cab controlling the brake-valves may be employed, while the same is true of the magnet P and the steam-valves. Likewise I make no claim herein to any particular form of register for the engineer or the fireman. In Fig. 2 I have indicated a register consisting simply of a ratchet-wheel carrying a pointer and operated by a pawl on the armature-lever. Any other suitable form may be utilized. The same general remark is true of the semaphore-lamps indicated in Fig. 4. The different-colored lamps will simply be grouped behind a disk of differently-colored glass corresponding to the color of the respective lamp-signals.

In Fig. 4, as already noted, I have placed at the upper left-hand corner two tables, one giving a schedule of the colored signals and the other giving a schedule of the track-magnets with their respective functions and distinguishing-marks. In a double-track road the arrangement which I have described will simply be duplicated, a system like that shown in Figs. 1 and 4 being provided for each of two parallel tracks; but instead of employing two distinct line-wires for each track I use but three, one for each track—for instance, S^4 for one track and S^3 for the other—and the third a common wire for the two tracks, combining the opposite S^3 of the one track and S^4 of the other. Such an arrangement is simply indicated in Fig. 5, the several branch circuits between the line-wires at each end of a block being represented with their track-plates or other circuit-controlling devices. The operation will be readily understood from the foregoing specification.

I have shown in Fig. 6 a semaphore-arm to be used in conjunction with the semaphore-lamps above described. This semaphore-arm

is positively operated by two magnets B^6 and C^6, the latter being included in the circuit of a setting-magnet—for instance, VII—and the former in the circuit of the corresponding unlocking-magnet—for instance, VIII. A weight is provided on the end of an angle-lever, the shorter arm of which consists of a link engaging with a pin on one end of the armature-lever. The movement of the armature-lever throws the weight from one side to the other over a dead-center, so as to hold the semaphore-arm positively in its upper or lower position after it has been actuated by one or the other of the two magnets. In the position shown by the full lines in Fig. 6 the semaphore has been operated and thrown into its upper position by magnet C^6, included in the circuit of the setting-magnet, indicating "danger" from a foregoing train. It will obviously remain in this position until the unlocking-magnet has acted, when the magnet B^6, included in the same circuits with the unlocking-magnet, will drop the semaphore into the position shown by dotted lines in Fig. 6, indicating "safety," and it will remain in this position until again set by the operation of the magnet C^6. A similar semaphore-arm may be provided at the warning-points as well and also for the signals of an approaching train, one magnet being included in the setting-circuit for a signal and the other in the unlocking-circuit. These will be supplementary to the cab-signals.

In Fig. 7 I have shown a duplicate report-blank to be used by the fireman upon receipt of any indication from his testing apparatus that there has been a failure in the operation of any part of the system. It will be his duty to fill out both blanks, keeping one for himself and delivering the other to the nearest station-master. The blank which he keeps will be delivered to the superintendent at the end of the run and will be checked by the indications in his registers.

In some cases it will be necessary to provide also special indicating apparatus on the train of the kind already described for detecting the presence of loose cars on the line or the event of a broken rail or washout. For this purpose the apparatus shown in Figs. 8 and 9 will be used. In Fig. 8, as an addition to the devices already described, the two rails of the track are shown as electrically divided into sections of any desired length. Near each end of the rail-section will be placed contact-plates O' and O^2, a pair of such plates being set in each half of the track and the plates on one block being connected, respectively, to the rails on the next block—that is, plate O' connected to one rail and plate O^2 to the opposite rail. On each locomotive will be carried contact-brushes corresponding to the plates in the track, and these brushes will be connected to indicating apparatus of the kind already described, but provided with distinguishing characteristics. In the event of the two rails in any section being connected electrically by any unwarranted obstruction—for instance, by the wheels and axles of a car dropped by a train—the partial circuit between O' and O^2 will be closed, and upon the approach of a train in either direction carrying brushes corresponding to said plates O' and O^2 the partial circuit will be completed, as hereinbefore described, by the train apparatus, and a signal will be received by the fireman or by the engineer. In Fig. 9 is illustrated the additional devices for indicating a broken rail. In this arrangement the track-rail to be tested will be electrically divided into sections and each section will be connected to one of the described line-wires, so as to form part of a closed circuit, which will be interrupted and an indication thereby given whenever the rail is broken or its continuity otherwise interrupted, as by an open drawbridge. In Fig. 9 the lower rail R is normally connected to line-wire S^3 by a wire r passing to the armature of magnet Z^2 at each end of the section and wire r' connecting said armature to S^3. The line-wire will also be connected to track contact-plates R' and R^4 through the armature of magnet Z^4, the same circuit, including magnet Z^3 and two wires 10 and 46, branching from the said armature to plates R' and R^4, respectively. A third circuit from the line-wire S^3 extends through the magnet Z^4 to contact-plates Q and is marked 5. The magnet Z^2 is included between contact-plates P' and P^2. On the train will be brushes corresponding to the contact-plates after the manner already described, while one terminal of the battery will also be connected to the axle W of the locomotive. If we now assume a train moving from left to right with the parts in position shown in the figure, it will first encounter plates P' and P^2, and in the manner already described a current will be delivered to these plates and the magnet Z^2 will be operated. This will interrupt at this point the connection between the rail R and the line S^3, but it will establish and lock a new connection between the lines S^3 and S^4 by wire 15, including unlocking-magnet Z'. The brush 1 will then encounter plate Q, and if the rail R is continuous, as it normally should be, a circuit will be established from the battery on the train to brush 1, and thence by plate Q and magnet Z^4 to the line S^3 and at the other end of the section from the line S^3 to the rail R by the wires $r\,r'$ and thence to the car-wheels and the opposite terminal of the said battery on the train. This will operate magnet Z^4, which acts to break the described circuit between plates R' and R^4 and at the same time to establish a connection through magnet Z^3 from line S^3 to line S^4 by wire 15. If, however, the rail R is broken, the described circuit cannot be made and the circuit will remain closed between plates R' and R^4, so that when the train reaches the said plates the partial circuit between said plates will be completed by the cab-circuit, terminating in brushes 1 and 4, and including

magnet V, which, in the manner already described, will close a branch circuit and give an indication. If the train does not receive any indication of a broken rail because of the interruption between R′ and R⁴, it will proceed until it reaches the plates H′ and H² in the manner described and sends rearward the unlocking-current for all of the signals which it set upon entering the block. The same current will energize magnets Z′ and Z³ and the parts will be restored to their normal condition. The contact plates and brushes for this break-detecting feature will be placed so as not to interfere with the plates and brushes already described, being located to this end at points relative to the track-rails that are not covered by other plates and brushes. The same is true also of the devices illustrated in Fig. 8.

What I claim as new, and desire to secure by Letters Patent, is—

1. In a railway signal system the combination of two contact-plates along the track at or near the beginning of a block and insulated from each other and from the ground, an electrical connection between said plates, including a setting-magnet, a second pair of contact-plates, a partial circuit between said second pair of contact-plates, which is normally open, but arranged to be closed in the event of a signal being given, a circuit-closer in said partial circuit controlled by the setting-magnet in such manner as to close the partial circuit when the magnet is energized, and apparatus on each train consisting, first, of a generator of electricity having its opposite terminals connected respectively to two brushes adapted to bear on the first pair of plates respectively, so as to deliver current thereto, and, secondly, signaling devices responsive to current passing therein placed in a circuit including a generator and having its terminals connected respectively to two brushes adapted to bear on the second pair of contact-plates respectively, so as to thereby complete the partial circuit between them whenever the said partial circuit is closed by the action of the setting-magnet.

2. In a railway signal system the combination of two contact-plates along the track at or near the beginning of a block and insulated from each other and from the ground, an electrical connection between them including a setting-magnet, a second pair of contact-plates, a partial circuit between said second pair of plates, a circuit-closer in said partial circuit controlled by said setting-magnet in such manner as to close the partial circuit when the magnet is energized, means for locking the setting-magnet during the passage of a train through the block, an unlocking-magnet therefor, a distinct circuit for said unlocking-magnet provided with contact-plates, and apparatus on each train consisting, first, of a generator of electricity having its opposite terminals connected respectively to brushes adapted to bear on the first-mentioned pair of contact-plates respectively and also upon the contact-plates connected to the said unlocking-magnet, so as to deliver current thereto and, secondly, signaling devices responsive to current passing therein placed in a circuit including a generator and having its terminals connected respectively to brushes adapted to bear on the second pair of contact-plates respectively, so as to thereby complete the partial circuit between them whenever the said partial circuit is closed by the action of the setting-magnet.

3. In a railway signal system the combination with a partial circuit having track contact-plates and controlled by a passing train through the medium of said contact-plates, of a setting-magnet in said circuit, a second partial circuit having track contact-plates, a circuit-closer therein controlled by said setting-magnet, a third partial circuit also having track contact-plates and provided with a circuit-closer controlled by the operation of said setting-magnet, and train apparatus comprising, first, a generator and contact-brushes for delivering current to said circuit which contains the setting-magnet, secondly, signal-receiving devices having brushes for connecting with the track contact-plates in said second circuit, and, thirdly, indicating devices having brushes for connecting with the track contact-plates in said third circuit.

4. In a railway signal system the combination with a partial circuit having track contact-plates and containing a setting-magnet, of a second partial circuit having track contact-plates and controlled by said setting-magnet, a third partial circuit having track contact-plates and containing a circuit-closer controlled by the operation of said setting-magnet, a fourth circuit having track contact-plates and containing an unlocking-magnet for the said setting-magnet, together with train apparatus comprising, first, a generator and contact-brushes for delivering current to the circuit containing the said setting-magnet and also to the said third and fourth circuits, secondly, signal-receiving devices having brushes for connecting with the track-contacts in said second circuit and, thirdly, indicating devices having brushes for connecting with the track-contacts in the said third circuit.

5. In a railway signal system the combination of two contact-plates along the track at or near the beginning of the block, an electrical connection between them including a setting-magnet, a locking device for said setting-magnet, a magnet controlling said locking device, a line-circuit and a second pair of contact-plates therefor at the end of the block adapted to receive current from the train, a third pair of contact-plates at a point adjacent to the first pair at or near the beginning of the block, an electrical connection between the third pair of plates controlled by the said setting-magnet and constituting, when closed, a partial circuit, and apparatus on each train

consisting first, of two contact-brushes and a generator of electricity having its opposite terminals connected respectively to said brushes which are adapted to bear on the first pair of plates respectively so as to deliver current thereto and secondly, of signal-receiving devices in a circuit having its terminals connected respectively to brushes on the train adapted to bear on the third pair of contact-plates respectively, so as to thereby complete the partial circuit between them whenever the said partial circuit is closed by the action of the setting-magnet.

6. In a railway signal system the combination of a partial electric circuit terminating at contact-plates located at a warning-point at or near the beginning of a block, a second partial electric circuit terminating at contact-plates located at a danger-point succeeding the said warning-point, means controlled by a passing train for closing said partial circuits, and distinctive signaling devices included in separate circuits on a following train adapted respectively to complete the said partial circuits at succeeding points and be thereby operated.

7. In a railway signal system the combination of a local warning-circuit, a local danger-circuit, means for setting and locking them by a passing train, distinctive signal-receiving devices on a following train, a line-circuit, unlocking-magnets, and contacts for controlling the said line-circuit and unlocking-magnets from the end of the block.

8. In a railway signal system the combination of a local warning-circuit, a local danger-circuit, means for setting and locking them by a passing train, distinctive signal-receiving devices on a following train, a line-circuit extending to the end of the block, unlocking-magnets in said line-circuit, testing devices for the unlocking action and indicating apparatus controlled thereby.

9. In a railway signal system the combination of a partial electric circuit terminating at contact-plates located at a warning-point at or near the beginning of a block, a second partial electric circuit terminating at contact-plates located at a danger-point succeeding the said warning-point, a setting-magnet for closing each partial circuit controlled by a passing train, a circuit for each setting-magnet having a pair of contact-plates, both pairs being located at a point succeeding the point at which the corresponding signal is to be received.

10. In a railway signal system the combination of contact-plates B' B^2, setting-magnet III, and lock therefor, contact-plates A^2 A^3, circuit-wires a^2 a^3, unlocking-magnet IV, line-wires S^3 and S^4, contact-plates H' and H^2 at the opposite end of the block, contacts 1 and 2 on a foregoing train with a generator connected thereto, and contacts 2 and 3 on a following train with signal apparatus in circuit therewith.

11. In a railway signal system the combination of a partial warning-circuit and contact-plates therefor, a partial danger-circuit and track contact-plates therefor, means for setting and locking said circuits by a passing train, a third partial circuit and track contact-plates therefor placed at a succeeding point and train apparatus consisting of distinctive warning, danger and overrunning signals with corresponding contact-brushes adapted to connect respectively with the aforesaid contact-plates and thereby receive corresponding signals in the event of such having been set by a foregoing train.

12. In a railway signal system the combination of a partial warning-circuit, a partial danger-circuit, means for setting and locking the said circuits by a passing train, a third partial circuit at a succeeding point and apparatus on the train consisting of distinctive warning and danger signals and register, and train-controlling devices operated by the said third partial circuit in the event of the train passing a received danger-signal.

13. In a railway signal system, the combination of a signal apparatus adapted to be set and locked by a passing train to signal a following train, of a register for the following train, operating apparatus for said register placed at a point succeeding that at which the said signal is received and adapted, in like manner, to be set by a passing train simultaneously with the signal apparatus.

14. In a railway signal system the combination of a signal apparatus adapted to be set and locked by a passing train to signal an approaching train, of a register for the approaching train and operating apparatus for said register placed at a point succeeding that at which the said signal is received and adapted in like manner to be set by a passing train simultaneously with the signal apparatus.

15. In a railway signal system, the combination with a line-circuit, of contact-plates therefor at or near the beginning of a block, the said plates being placed upon one side of the track, a setting-magnet in said circuit at the farther end of the block, a partial circuit controlled thereby, a circuit-closer in said partial circuit operated when said magnet is energized, contact-plates for said partial circuit on the opposite side of the track from the aforesaid contact-plates and at the farther end of the block, train apparatus provided with brushes on one side of the track for delivering the current to the first-mentioned track contact-plate and brushes on the opposite side of the train to be signaled for receiving current from the other contact-plates.

16. In a railway signal system, the combination of a line-circuit, contact-plates therefor at or near the beginning of a block, a setting-magnet in said circuit at the farther end of the block, a partial circuit controlled by

said setting-magnet, an unlocking-magnet and a testing device and indicator for the unlocking operation.

17. In a railway signal system, the combination of a line-circuit, contact-plates therefor forming its two terminals and placed on one side of the track at the beginning of a block, a setting-magnet in said circuit at the farther end of the block, a partial circuit normally open, but closed by said setting-magnet when energized, contact-plates for said partial circuit on the opposite side of the track, a lock for said partial circuit, an unlocking-magnet for said lock and contact-plates for said unlocking-magnet placed on the same side of the track with the first-named contact-plates.

18. In a railway signal system the combination of a line-circuit, contacts therefor at or near the beginning of a block, two magnets in separate branches from said circuit at the farther end of the block, a partial circuit controlled by each of said magnets respectively and contact-plates for the said partial circuits placed respectively at succeeding points and adapted to deliver warning and danger signals to an approaching train in the event of the respective partial circuits being closed by the action of their controlling-magnets.

19. In a railway signal system the combination of line-wires S^3 and S^4, contact-plates G' and G^2 at the beginning of a block, setting-magnets II and VI at the farther end of the block, partial circuits controlled by said magnets, contact-plates A^2 and A^5 terminating one partial circuit and contact-plates D^2 and D^6 terminating another partial circuit and train apparatus having brushes 1 and 2 connected to opposite battery-terminals and adapted to connect with said plates G' and G^2 respectively, and having also brushes forming terminals adapted to connect with plates A^2 and A^5 and contacts 2 and 6 connected respectively to distinctive warning and danger signaling apparatus.

20. In a railway signal system the combination of line-wires S^3 and S^4, contact-plates G' and G^2 at or near the beginning of a block upon one side of the track, a magnet VI included in said circuit at the farther end of the block, a partial circuit controlled by said magnet, contact-plates D^2 and D^6 forming the terminals of said partial circuit and placed on the opposite side of the track and train apparatus provided with battery-brushes adapted to deliver current to plates G' and G^2 and with signaling apparatus adapted to connect with plates D^2 and D^6.

21. In a railway signal system the combination of two sets of contact-plates at a common point along the track, one set forming the terminals of a partial circuit controlled by a foregoing train, and the other set forming the terminals of a partial circuit controlled by an approaching train, and train apparatus comprising distinctive signals having terminals adapted to connect with the two sets of contact-plates respectively, whereby the direction of movement of an obstructing or threatening train is indicated.

22. In a railway signal system the combination of two sets of contact-plates at a warning-point, two corresponding sets of contact-plates at a succeeding danger-point, one set at each point to be controlled by a foregoing and the other set by an approaching train, and train apparatus comprising distinctive warning and danger signals both for foregoing and approaching trains, and contact-brushes forming the circuit-terminals of the respective signals and adapted to connect with the corresponding contact-plates along the track.

23. In a railway signal system the combination of contact-plates forming the terminals of a local circuit, contact-plates forming the terminals of a line-circuit extending to the succeeding block, a setting-magnet in the local circuit controlling a partial circuit at the same point and a setting-magnet in the line-circuit controlling a partial circuit at the farther end of the block, contact-plates for the said partial circuits respectively and train apparatus having generator-terminals adapted to deliver current to the setting-magnets and signaling-terminals adapted to connect with and complete the said partial circuits respectively and thereby operate corresponding signals.

24. In a railway signal system the combination of two line-wires extending along the block, one or more branches at each end of the block normally closed and containing signal-setting magnets, a branch circuit at each end having normally open terminals adapted to receive current from a generator on a passing train, and circuit-breakers in each of the normally closed circuits arranged to be operated by a passing train before the delivering of current therefrom to the terminals of the normally open branch, whereby the said train may operate the setting-magnets in the normally closed circuits at the farther end of the block without operating the corresponding magnets at the beginning of the block.

25. In a railway signal system the combination of two line-wires, one or more normally closed branches between them including signal-setting magnets, a normally open branch at each end of the block adapted to receive current from a passing train, one or more local circuits also arranged to receive current from a passing train, and containing signal-setting magnets controlling local partial circuits for operating signals on a following train, and circuit-breakers in the normally closed branch circuits controlled by the setting-magnets in the local circuit, whereby the setting of local signals for a following train automatically opens the normally closed branch circuits at the beginning of a block, and permits the delivery of current to terminals of the normally open branch at the same point for the purpose of operating the

signal-setting magnets in the normally closed branch circuits at the farther end of the block.

26. In a railway signal system the combination with indicating apparatus of automatic testing devices for the operation of said apparatus, one or more indicators controlled by said testing devices and a recording-register for each of the said indicators.

27. In a railway signal system the combination with a series of visual indicators distinctively colored, a series of testing-indicators corresponding to the said visual indicators respectively and correspondingly colored and a separate recording-register for each of said testing-indicators.

28. In a railway signal system the combination with one or more semaphore-lamps adjacent to the track, of a circuit therefor, contact-plates connected thereto, a setting-circuit with a magnet therein controlling the said lamp-circuit, a train-generator connected to brushes adapted to deliver current to the said setting-circuit and a second train-generator with brushes adapted to bear upon the said plates and deliver current to the said lamp-circuit.

29. In a railway signal system the combination with a partial track-circuit including a semaphore-lamp and normally open, a circuit-closer therein, a second partial track-circuit at a succeeding point containing a magnet placed in proximity to said circuit-closer so as to operate it and train apparatus comprising a generator and two contact-brushes connected respectively to its terminals and adapted to complete the two partial circuits in succession so as to deliver the generator-current to the said second partial circuit invariably and to the said normally open partial circuit whenever it is closed by the action of the said magnets.

30. In a railway signal system the combination with two partial electric circuits terminating in contact-plates located at the same point along the railway, of circuit-closing devices for each of said partial circuits, one being controlled by a foregoing and the other by an approaching train, distinctive signals on the receiving-train, included respectively in circuits having contact-brushes arranged to connect with the plates terminating the respective partial circuits, and corresponding semaphore-signals controlled by the said partial circuits respectively, whereby the direction and movement of a threatening train is indicated, both by the semaphore and by the train signals.

31. In a railway signal system the combination of electrical indicating apparatus on a train, track-signal-setting circuits terminating at contact-plates placed upon one side of the track, similar signal-operating circuits terminating at contact-plates located on the opposite side of the track for approaching trains and on the same side of the track for following trains, and a series of train-brushes connected to the signaling apparatus thereon and provided with shifting devices for reversed direction of movement of the train, whereby each train always makes connection with the contact-plates on the same side of the track, with reference to the movement of the train.

32. In a railway signal system for a double-track road the combination of three line-wires, one for each track and the third a common line for the two tracks, two or more branch circuits at each end of a block between the common line-wire and each of the individual line-wires, and circuit-controllers in the said branches operated at different times with respect to the branches at one end of the block, but during the same period of time with respect to the branches at the opposite end of the block, whereby distinct signals may be transmitted successively over the respective individual line-wires in either direction.

33. In a railway signal system for a double-track road the combination of three line-wires, comprising an individual wire for each track and a common wire for the two tracks, a normally open branch between the common wire and one of the individual wires at one end of the block and terminating in contact-plates arranged to receive current from a passing train, one or more normally closed branch circuits at the opposite end of the block on each track containing a signal-setting magnet, and signal-circuits, one for each track controlled by the said magnets respectively.

34. The train apparatus herein described consisting of a generator, a contact-brush connected to one terminal thereof, two or more additional brushes connected to the opposite terminal thereof and a brake-magnet having its coils divided into sections controlled respectively by the said two or more brushes.

35. The combination with magnet T^{11} placed on the train and forming part of the train apparatus, a generator on the train, a circuit therefrom including the said magnet T^{11}, a corresponding contact-brush, a track-circuit for completing the generator-circuit, a brake-magnet and a register-magnet in separate branches from the generator, and a circuit-closer in each branch controlled by the said magnet T^{11}.

36. The combination with magnet T^{12} placed on the train and forming part of the train apparatus, of the train-generator, a circuit therefrom including the said magnet T^{12}, a contact-brush connected to the said circuit, a brake-magnet, a steam-magnet and a register-magnet each having an individual circuit, circuit-closers in said individual circuits respectively, all controlled by the said magnet T^{12} and a track-circuit for completing the generator-circuit through the said magnet T^{12}.

37. The combination with a series of engineer's signals arranged to give distinctive indications, of corresponding setting and unlocking magnets for the several signals, distinct testing-circuits for the several setting

and unlocking magnets, and a corresponding series of indicators controlled by the several testing-circuits, each indicator being provided with an individual recording-register.

38. The combination with signaling devices arranged to be set by a passing train and to give a signal to a following train, of a testing-circuit, a circuit-controller therein arranged to be operated by the said passing train in setting the said signaling device, and an indicator controlled by the said testing-circuit and arranged to be operated at a succeeding point.

39. The combination with a signaling device arranged to be set by a passing train and to give a signal to an approaching train, of a testing-circuit, a circuit-controller therein arranged to be operated by the said passing train in setting the said signaling device, and an indicator controlled by the said testing-circuit and arranged to be operated at a succeeding point.

In witness whereof I have hereunto set my hand, in the presence of two subscribing witnesses, this 14th day of March, 1896.

FREDERICK C. ESMOND.

Witnesses:
CHARLES C. DODGE,
L. T. SHAW.