No. 880,136. PATENTED FEB. 25, 1908.

J. A. GEHRUNG.

SIGNAL SYSTEM.

APPLICATION FILED FEB. 2, 1907.

Fig. 1.

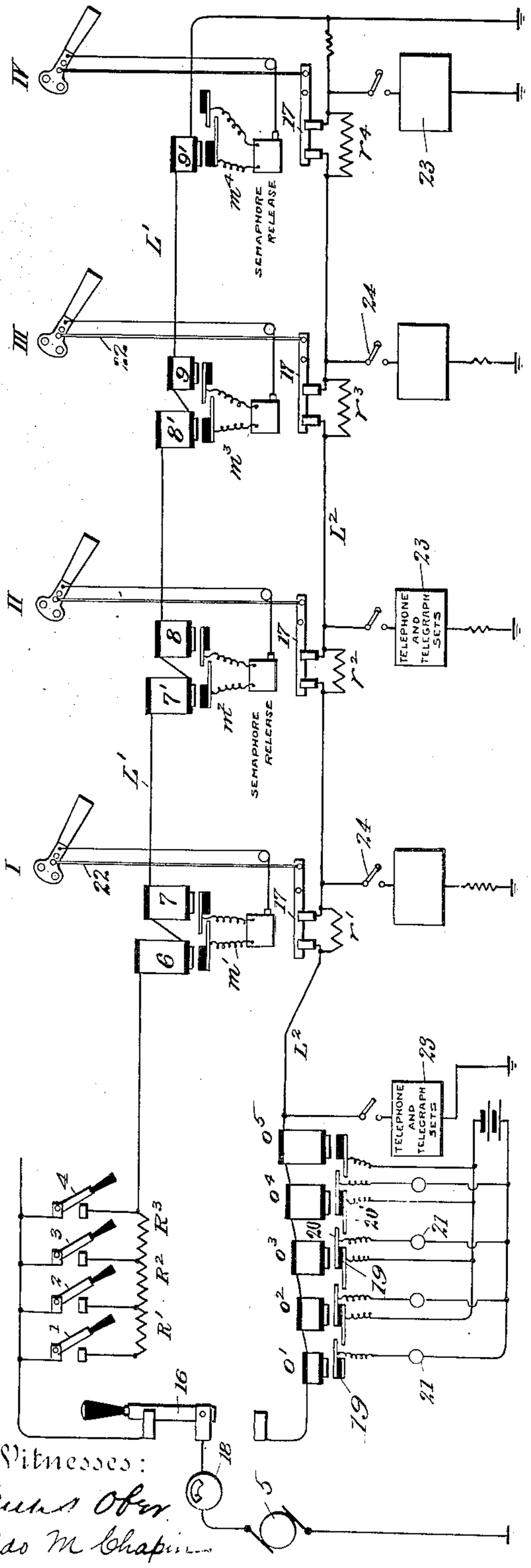


Fig. 3.

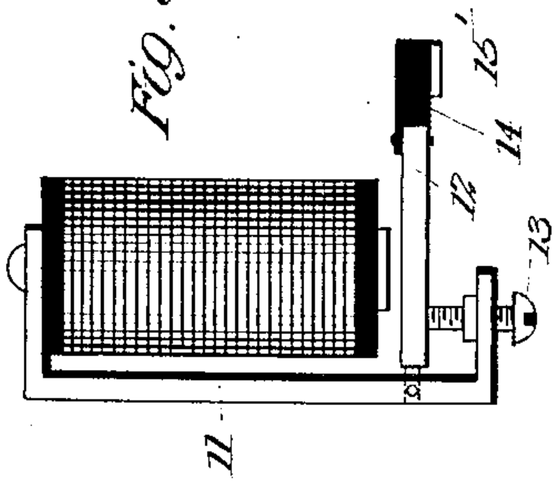
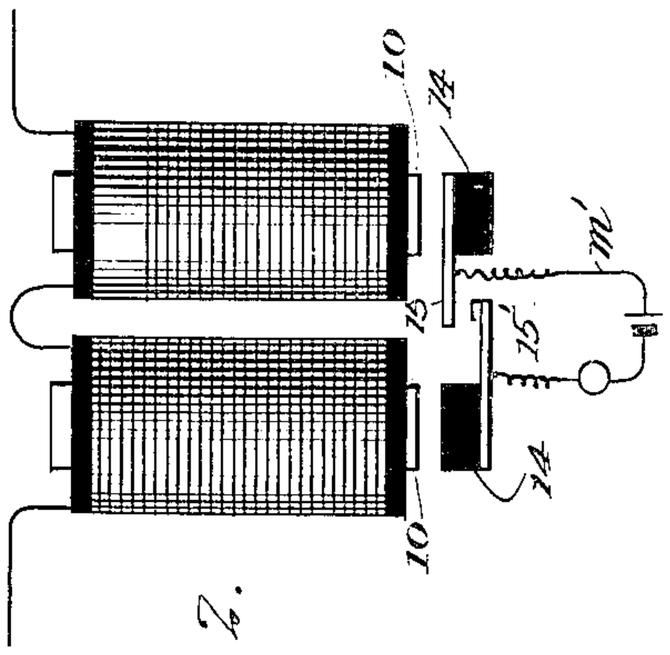


Fig. 2.



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SIGNAL SYSTEM.

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Application filed February 2, 1907. Serial No. 355,369.

To all whom it may concern:

Be it known that I, JULIEN A. GEHRUNG, a citizen of the United States, residing at the city of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Signal Systems, of which the following is a full, clear, and exact description.

My invention relates to signal systems, particularly for railroads where it is desired to have the entire traffic over a single division in the hands of one responsible train despatcher.

It is impractical, especially in the more thinly populated sections of the United States, to have the block signals and stations and operators at as frequent intervals, as are provided in more thickly settled communities. As a matter of fact, nearly all the railroad mileage of the United States is unprotected by signals of any sort.

It is the purpose of the present invention to provide a signal system adapted to suit all the requirements of railroad traffic, and which is so simple in its installation, and which requires so little superintendence, that it is adapted to the most rural and undeveloped sections of the country where railroads are used. The system which I have developed secures a semaphore control of the railroad line under the entire surveillance of the despatcher at a city terminus, and further provides for telegraphic communication to the train at whatever point of the line it may be. This is further accomplished by two simple wires or conductors extending along the roadway. Finally, and as I consider most important of all, the system is such as to always provide an indication or check on its accuracy, so that any condition, such as broken wires, or short circuited wires, or leakage, or any other defect, is at once notified to the despatcher's office, who is thereupon able to have it promptly repaired. These are all the absolutely essential requirements of a railroad signal system, namely, that it should answer traffic conditions by a limited number of wires, and give notification to all parties in case of any failure, defect or breakage whatsoever.

Incidental and additional features of the invention will appear in connection with the following description, particularly the way in which all inductance and electrostatic capacity features of the line are wholly done away with, and also the manner of controlling the circuits by which a high potential break, liable to cause a spark, is never made at any point, or in any delicate instrument where it is liable to cause damage.

In the drawings: Figure 1 is a diagrammatic view showing a complete installation embodying the principles of my invention; Figs. 2 and 3 are detail views of certain apparatus employed.

The showing in Fig. 1 is, of course, almost exclusively diagrammatic, it being evident that in practice many details and appurtenances would be desirable, and would be added to secure special functions which might be desired for any particular conditions. For example, in practice it might be thought desirable to have electric bells at all the semaphore signals, which would ring whenever the semaphore was at danger. It might also be thought desirable to have special automatic telephone and telegraph sets at each semaphore station for establishing telegraphic or telephonic communication with the despatcher's office therefrom. It also might be thought desirable to have special devices for ringing alarm signals in the engine cab, or actuating train stops, in case a semaphore signal at danger was passed. But all of these appurtenances and details are always applicable wherever they are desired, and although I contemplate their use in practice I have eliminated all of them from the present description of the invention, since the essential features, in other words, the fundamental idea or principle, operates in identically the same way whether or not these additional details and appurtenances are adopted. In my companion application, Serial No. 357,514 filed herewith, I have, however, illustrated some of these embellishments in order that their mode of application may be perfectly clear.

In order to make the essential principles of the invention plain, four semaphore stations will be considered. These stations are represented in Fig. 1, at I, II, III and IV, it being understood that in practice as many stations as desired would be provided, and located at suitably spaced intervals along the division or line of railway, the traffic of which is desired to be entirely controlled from a single despatcher's office at a city terminal of the line. A indicates the despatcher's office in Fig. 1.

Means are provided at the despatcher's

station A for generating a continuous electric current, and for reasons which will hereinafter appear, a current of quite high voltage. The voltage would, of course, vary with different installations; 500, or even 1,500, volts is not an unreasonable figure. I have shown a dynamo 5, at the despatcher's station for this purpose. Extending from the despatcher's office are two lines L′ and L², which parallel the track throughout the entire length of the railroad. At the required points these lines connect with the semaphore stations I, II, III and IV. Each semaphore station includes magnetic devices in the circuit of the line L′ and signal transmitting devices in the circuit of the line L². The magnetic devices in the circuit of the line L′ constitute selective signaling means. For this purpose there may be provided ordinary electro magnets 6, 7, 7′, 8, 8′, 9 and 9′, all in series with one another, and with the line L′. The magnets 6 and 7 are at station I, 7′, 8, at station II, 8′, 9, at station III, and 9′ at station IV. Each of these pairs of magnets coöperate in a special way together to control local circuits at the semaphore stations. A practical arrangement of these magnets is shown in Figs. 2 and 3. Each magnet has a central iron core 10, and an L-shaped extension 11, to which is pivoted an armature 12. 13 denotes a stop or adjustment by which the normal position of the armature is regulated with respect to the core or pole 10. Each armature has a block 14 of fiber or insulating material and each of these blocks has a metallic clip, denominated 15 and 15′, for the respective armatures, each of which projects toward the other, but in overlapping relation, as shown in Fig. 2. The relation is such that the clips make electrical contact when the lowermost one is alone attracted, but in case both armatures are simultaneously attracted, the open circuit relation between the clips is maintained. In Figs. 2 and 3 each armature has a pair of clips which in some cases have a special function as will later appear in connection with the recording apparatus o', o^2, o^3, o^4, o^5. One magnet is wound with a greater number of turns of wire than the other, or one may be shunted by resistances, or its armature more strongly restrained, so as to be less sensitive. In the drawings this is indicated by having the winding of one magnet longer than that of the other. Since all the magnets are connected in the same series circuit, they are best wound with wire of unvarying diameter. The relation of their resistances is immaterial, so long as they are all in the same series circuit.

Referring now again to Fig. 1, it will be seen that the winding 7 has fewer turns than the winding 6. The winding 7′ is, however, exactly like the winding 7, or wound to be actuated by the same strength of current. The winding 8 has fewer number of turns than 7 or 7′, but 8′ is exactly like 8. In like manner 9 and 9′ are alike, but of fewer turns than windings 8 and 8′. The line L′ is grounded beyond the final winding 9′, or otherwise connected to a return wire or circuit.

At the despatcher's station A there is provided a switch or equivalent device 16, by which the current from the dynamo 5 can be connected to pass through the line L′ and the ground return, if desired. In the drawings the switch 16 is shown thrown into a position to accomplish this result. The details of the switch 16 are, of course, unimportant, since any desired form of controlling switch for connecting the line L′ or L² to a source of potential is all that is required. There is also provided at the despatcher's station A a resistance or current varying device. This is most conveniently in the form of switches 1, 2, 3, 4, which are capable of cutting resistances R′, R² and R³ in and out of the circuit of the line L′. It is evident that if switch No. 4 is closed, all of the resistances R′, R², and R³ will be cut out of the circuit and the maximum current will flow. If, however, switches 1, 2 or 3 are operated, a different resistance is included in the circuit, and a different current will flow in each case. Now the resistances R′, R², R³, and the windings of the magnets 6, 7, 7′, 8, 8′, 9 and 9′, are so adjusted and related to one another that when all of the resistances R′, R² and R³ are cut out of the circuit, that the current is strong enough to actuate all of said magnets, but if the resistances R′, R² and R³ are in the circuit, the current is diminished, so that only the magnets having a large number of windings will attract their armatures. If the switch 1 is alone closed, the magnet 6 is alone operated; if switch 2 is closed, magnets 6, 7 and 7′ are alone operated; if switch 3 is closed, magnets 6, 7, 7′, 8 and 8′ are operated, and if switch 4 is closed, all of the magnets are energized to attract their armatures, as already stated. The same result could, of course, be secured by varying the current in any way, and by having the efficiency of the different electro-magnets varied in any way, as, for example, by having them varying distances from their armatures, or by having them shunted by resistances. I prefer, however, to make use of a varying number of ampere turns for this purpose. If magnet 6 attracts its armature, and magnet 7 does not, which we have seen occurs only when switch No. 1 is closed, the metallic clips 15 and 15′ at the first semaphore station come in contact with one another, and these clips are respectively connected to a local circuit m', so as to close the same. If, however, the current is a little stronger, caused by closing switch No. 2, instead of switch No.

1, the magnets 6 and 7 of station I, both attract their armatures, and the local circuit m' is not closed. The local circuit m^2, at station II, is, however, closed under these circumstances, because magnet 7′ attracts its armature, while magnet 8 does not. This is because 7 and 7′ always work together, being of similar strength, but magnet 8 is weaker than magnet 7′. In this way a local circuit at station No. II is closed by the closure of switch No. 2 at the despatcher's station A. In like manner the local circuits m^3 and m^4 of stations III and IV are closed by the movement of switches 3 and 4 at the despatcher's station. I have, therefore, secured the closure of any selected circuit of the series of semaphore stations by the manipulation of properly numbered switches at the despatcher's station. These local circuits may be used to start motors or compressed air devices, or to merely trip the semaphore signals to danger. Many devices are in common use for actuating a semaphore upon the closure of a local circuit, and I do not deem it necessary, or a part of my invention to describe a particular mechanism for this purpose. It is evident that the local circuit which trips the semaphore is closed only as long as the line current is passing, so that any local batteries in the line circuits m', m^2, m^3 and m^4 are not exhausted, provided batteries are used. The above system of control enables the setting of any desired signal along the line.

I will now described the checking, return signaling or notification device by which any failure, defect, leakage, open circuiting or short circuiting, exhaustion of batteries, or any other cause whatever, will be properly noticed at the despatcher's station, so that he may take proper steps to have the mechanism repaired, and also to prevent any immediate disaster. For this purpose line L^2 entirely separate from the line L′ is untilized. The essential characteristic of the line L^2 is that it is capable of being placed in a circuit with a source of current, and with current varying devices at each one of the semaphore stations. The current varying devices illustrated comprise resistances r', r^2, r^3 and r^4, each of which is capable of being bridged or cut out by a switch 17. In the normal condition of the line L^2, all of these resistances are cut out so that the line is practically continuous from end to end. All of the resistances r', r^2, r^3 and r^4, are different from one another, so that when any switch 17 is opened, the line resistance becomes a certain value, which allows a definite current to flow. Means are provided at the despatcher's station for indicating which switch 17 is opened by virtue of this change in the current strength. An ammeter 18 alone might be used, but it is very much preferable to have a recording device at the despatcher's office, which will indicate more plainly the particular semaphore station at which a switch 17 is opened. A series of magnets o^1, o^2, o^3, o^4 and o^5, disposed in a row, side by side, and each having a different number of ampere turns, and embodying the principles of my invention, may be very conveniently used. Each of these magnets o', o^2, etc., are generally similar to the magnets 6, 7, 7′, 8, etc., already described. Each has an armature 19, with metallic clips 20, 20′, generally similar to the clips 15, 15′, of the devices 6, 7, etc., already described. The clips 20 and 20′ of adjacent armatures form the terminals of local circuits, including lamps 21. It is evident that when any two adjacent magnets are both energized, that the circuit of the corresponding lamp 21 is not closed, but if only one of two adjacent magnets is energized, then the circuit of one of the signal lamps 21 will be completed, and the lamp lighted. In practice it is best to have the first magnet o' of few ampere turns; the second o^2 of more ampere turns; the third, of a still larger number, etc. The resistances r', r^2, r^3 and r^4, are progressively greater than one another; for example, r' may be 500 ohms; r^2, 1000 ohms; r^3, 1500 ohms; and r^4, 2000 ohms. The purpose of having the return signaling currents in the line L^2 varied in a diminishing ratio for the progressive stations, while the transmitting current in the line L′ varies in an increasing ratio for the progressive stations, will be later more particularly set forth. The arrangement is made in order to avoid any combination of circumstances producing a false signal and false return at the same time. When all of the switches 17 are closed as shown, the current is great enough to energize all of the magnets o', o^2, o^3, o^4 and o^5, which all attract their armatures, so that none of the local circuits containing lamps 21, is closed, and no lamp is displayed. If, however, switch 17, at station No. I is opened, the current is cut down to a certain extent, and the adjustment is such that the reduced current is just sufficient to energize magnet o^2, but not sufficient to energize magnet o'. The armature of magnet o^2 accordingly is drawn upward to close the circuit of the first signal lamp 21. Similarly, if switch 17 of station No. II is opened, the current is cut down still more, so that it is just strong enough to energize magnet o^3, but not magnets o' and o^2. Under these circumstances, the second signal lamp 21 will be displayed. In this way a signal lamp is displayed in every case to correspond with the particular semaphore station at which a switch 17 is opened.

The switches 17, or any equivalent current varying device used in lieu thereof, are preferably actuated by as direct a connection as possible with a semaphore arm. I have

shown a rod or link connection 22 for this purpose. The idea is to have a simple direct connection so that whatever else about the installation goes wrong, the movements of the switch arm 17 will always correspond to the movements of the semaphore arms.

The operation is as follows: Supposing a railroad line to be properly equipped with the above installation, and trains proceeding thereon under the direction and supervision of the train despatcher at a city terminal. Under these circumstances, it constantly becomes necessary for him to give orders to one train and another; for example, to allow a passenger train to pass a freight, or to sidetrack a freight at any point for any purpose, or to give a special a clear track, or the various other traffic orders which are required, and for which special telegraph operators at stations along the line are in ordinary cases provided. The train despatcher at station A, wishing, for example, to talk to a train at semaphore station III, closes switch No. 3, and thereby causes a current to flow through the line L′, which is just sufficient to energize the magnet 8′, but not the magnet 9, in the manner already described. The local circuit m^3 of station III is thereby closed, and the semaphore released. This is the normal operation, but in case of fogs, tangling of the wires, sticking of the semaphore arm, or any other influences, it might happen that the wrong, or no, semaphore signal was actuated. In order that such a condition might be at once notified to the despatcher's office, the return signal comes into use. The switch 17 of station No. III, mechanically connected in a direct way with the semaphore arm, is opened, and the resistance r^3 of station III is thrown into the line L^2, so as to make this resistance suitable to the actuation of the third lamp 21, at the despatcher's station A. When, therefore, the despatcher moves switch 16 over on to the contact of line L^2, the return signal is at once given, and he is informed that the required semaphore has been properly set. Inasmuch as the current flow for the actuation of the signals is a continuous one, it is inconceivable that induction or capacity, or any cause, except open circuiting of the lines, or short circuiting or leakage, would have any effect on the signals. I will now show that either of these conditions is at once indicated to the despatcher's office. Supposing the line L′ was interrupted by the breakage of the wires, or any cause. Under these circumstances, no current would flow through ammeter 18 when the actuating switches were closed. This would show conclusively that the line was broken. Similarly, if the line L^2 was broken, the same ammeter would indicate no current when the switches were closed for the return signal. This would show conclusively that the line L^2 was broken. The third conceivable condition is that line L^2 might be grounded at the same point of its length, either completely by resting on the ground, or partly through defective insulators, fogs, rains, etc. The effect of leakage would be to dissipate the current so that the semaphore would be displayed at an earlier station than would be the case otherwise. But the return signal over the line L^2 would at once show the fact that the wrong semaphore had been displayed. Even conceiving that leakage or improper conditions occurred simultaneously in both lines L′ and L^2, it is evident that under no circumstances could the error in the return signal offset the error in the outgoing signal. Leakage in line L′ would give the actuation to an earlier semaphore than the one intended, and leakage in the line L^2 would cause the actuation of an earlier signal at the despatcher's station than the one intended. Thus the two defective conditions could not so work together as to give a proper return when an improper semaphore arm had been displayed. In case of improper conditions in both lines, all the errors therefrom become added together by the checking or proving signals received by the despatcher. I regard this as an exceedingly important feature of the invention, and it is the purpose for which the resistances r', r^2, r^3, etc., are made increasing for the progressive semaphore stations, instead of diminishing, in their value. The above are all the line conditions which can occur to influence the apparatus. By tripping the semaphores one after the other throughout the series, and noting the display lamps 21, it is, of course, possible for the despatcher to test out his complete system at any moment, and in practice he will, of course, make this test from time to time as found necessary. Should any defects be found, they are at once remedied.

Semaphore signals after having been tripped to danger are returned to safety, either by the officers of the train which is stopped thereby, or by any special circuit (not shown), which may operate motors or any required device, for the purpose. The despatcher's station A is always capable of being put in telegraphic or telephonic communication with any semaphore station through the line L^2, which is continuous or uninterrupted throughout the line in its normal condition. I have indicated telephone and telegraph stations 23, at the despatcher's station, and at the various semaphore stations, which may be connected into a common circuit when desired by switches 24. In this way the officers of any train receive their instructions from the despatcher's office as soon as the train has been stopped by the display of the semaphore. They may then re-position the semaphore to safety and pro-

ceed on their way under the instructions received.

It is noted that not only does my system provide for properly repeating or checking the operation of a semaphore which is intentionally displayed by the manipulation of the switches at the despatcher's station, but the system also gives a prompt indication of the display of any semaphore by an accidental cause. For example, if the mechanism should become broken in storms or high winds, or any person tampering therewith should so close or establish electrical circuits as to release any particular semaphore, this fact will be promptly signaled in the line L^2 so as to operate the recording device o', o^2, o^3, o^4, o^5, at the despatcher's station. In order that the apparatus may be constantly in condition to receive repeating signals of this sort, the switch 16 may be left on the contact of the line wire L^2 in its normal state.

What I claim, is:—

1. In a signal system, a line having a plurality of signals selectively operated by different strengths of current, means for transmitting currents of varying strength to the line, and means for automatically sending back a current of varying strength to send a repeat or checking signal back to the transmitting station.

2. In a signal system, a line having a plurality of signals selectively operated by different strengths of current, means for transmitting currents of varying strength to the line, a second line having devices therein at each signal for sending currents of varying strengths back to the transmitting station, and indicating means at the transmitting station in said second line, whereby the particular signal displayed is indicated at the transmitting station.

3. In a signal system, a line having signals each with a plurality of separate contacts selectively closed by different strengths of current, means for transmitting currents of varying intensity over said line to actuate any selected signal, and means operated by the signal displayed for repeating or checking the action thereof at the transmitting station.

4. In a signal system, a line having signals selectively operated by different strengths of current, means for transmitting currents of varying intensity over said line to actuate any selected signal, a second line, and means at the signal actuated for transmitting a current of varying strength over said second line to check or repeat the actuation at the transmitting station.

5. In a signal system, a line having signals selectively operated by different strengths of current, means for transmitting currents of varying intensity over said line to actuate any selected signal, and means at the signal actuated for causing a current of predetermined strength to flow at the transmitting station.

6. In a signal system, a line having signals selectively operated by different strengths of current, means for transmitting currents of varying intensity over said line to actuate any selected signal, and means at the signal actuated for causing a current of predetermined strength to flow at the transmitting station, the remote signals being actuated by the maximum transmitting currents and retransmitting the minimum currents of all the signals, as and for the purpose set forth.

7. In a signal system, a line having signals selectively operated by different strengths of current, means for transmitting currents of varying intensity over said line to actuate any selected signal, and means for returning currents of varying intensity to the transmitting station, depending on the signal actuated.

8. In a signal system, a line having signals selectively operated by different strengths of current, means for transmitting currents of varying intensity over said line to actuate any selected signal, and means for returning currents of varying intensity to the transmitting station, depending on the signal actuated, the order of the stations with respect to the current increase being reversed for the return or repeat signals.

9. In a signal system, a line having signals selectively operated by different strengths of current, a second line having recording signals at the transmitting station which are selectively actuated by different strengths of current, means at the transmitting station for sending currents of any required strength over the first line, and means at the signals for sending return currents of predetermined strength different for each station, over the said second line.

10. In a signal system, two lines, signals in one of said lines adapted to be selectively operated by currents of different strengths, means in the second line for changing the resistance thereof to different values depending on the signal actuated, recording devices at the transmitting station in said second line, and means at the transmitting station for connecting either line with a source of current.

11. In a signal system, a pair of line wires one of which is in a series circuit with a plurality of magnetic signaling devices selectively actuated by different current strengths, means for transmitting currents of varying strengths over said line, and means operated by the actuation of any particular device for transmitting a current of predetermined strength through the second line, the different devices transmitting currents of different strengths, and recording means at the transmitting station.

12. In a signal system, a despatcher's station and a plurality of semaphore signals, a pair of line wires traversing all of the semaphore stations, means at each semaphore station selectively actuated by currents of predetermined strength in one of said wires, and means at each station for causing currents of different strengths to flow in the other line for the purpose of transmitting a repeat or checking signal to the transmitting station.

13. In a signal system, a despatcher's station and a plurality of semaphore stations, magnets at each semaphore station each having a different number of turns, a line including all of said magnets in a series circuit, a second line including a plurality of resistances of different values at the respective stations, and means operated by the magnets at the different stations for cutting the resistances at the corresponding station into the circuit of the second line wire.

14. In a signal system, a despatcher's station and a plurality of semaphore stations, a pair of line wires, means at the despatcher's station for transmitting currents of varying strengths over one of said line wires, and means at the despatcher's station for indicating currents of varying strength in the other line wire, and means at each semaphore actuated by a current of predetermined strength in the first line wire for causing a current of predetermined strength to flow in the second line wire.

15. In a signal system, a despatcher's station, and a plurality of semaphore stations, means at the despatcher's station for transmitting currents of varying strength to the various semaphore stations, the strength of current being greater in proportion to the remoteness of the station, and means at each semaphore station for causing a current of predetermined strength to flow at the despatcher's station, the strength of said last named current being less in proportion to the remoteness of the semaphore station.

16. In a signal system, a despatcher's station having a dynamo of comparatively high voltage thereat, a plurality of semaphore stations, a pair of line wires terminating at the despatcher's station one of said line wires including a magnet at each semaphore station adapted to be selectively energized to attract its armature by currents of different strength therein and the other wire having resistances adapted to be cut into the line at any station by the actuation of the magnet thereat, and means at the despatcher's station for connecting the dynamo to either line wire.

17. In a signal system, a despatcher's station having a source of current thereat, a plurality of semaphore stations, a pair of line wires terminating at the despatcher's station one of said line wires including a magnet at each semaphore station adapted to be selectively energized to attract its armature by currents of different strength therein and the other wire having resistances adapted to be cut into the line at any station by the actuation of the magnet thereat, and means at the despatcher's station for connecting the source of current to either line wire.

18. In a signal system, a despatcher's station and a plurality of semaphore stations, a pair of line wires one including a magnet at each station, and the other including a resistance at each station normally short circuited, and means whereby a telegraph set may be connected to said last named line at the despatcher's station and at any semaphore station for establishing telegraphic communication therethrough.

19. In a signal system, a despatcher's station and a plurality of semaphore stations, a pair of line wires one including a magnet at each station, and the other including a resistance at each station normally short circuited, and means whereby a telephone set may be connected to said last named line at the despatcher's station and at any semaphore station for establishing telephonic communication therethrough.

20. In a signal system, a plurality of magnets each having a different number of magnet turns, armatures therefor, clips fixed to said armatures, said clips overlapping in a continuous series and normally out of contact, whereby two adjacent clips are electrically connected by the energization of one predetermined magnet of the pair corresponding to said clips.

21. In a signal system, a plurality of magnets, polar extensions therefrom each bent around in proximity to the other pole of the magnet, an armature on each extension, a clip fixed to each armature, said clips overlapping in a continuous series, whereby any two clips may be brought into electrical contact by the energization of one of a pair of adjacent magnets.

22. In a signal system, a plurality of magnets each having a polar extension bent around in proximity to the other pole, an armature pivoted to the polar extension, a pair of clips on each armature, said clips overlapping in a continuous series for all the magnets, the arrangement of clips on each armature being similar for all the magnets throughout the series, whereby any pair of clips may be exclusively brought into electrical contact by the exclusive energization of all the magnets to one side of the point or division produced by said clips.

23. In a signal system, a plurality of magnets each adapted to be operated by a current of predetermined strength different from the rest, armatures therefor and clips on said armatures, said clips overlapping in a continuous series, whereby any desired clips may be exclusively brought into contact by

the passage of current of predetermined strength in the circuit of the electromagnets.

24. In a signal system, a despatcher's station, a plurality of signals at spaced stations along the road, means whereby a current of different strength for each signal is caused to flow at the despatcher's station when each signal is displayed either accidentally or intentionally by a transmitted current from the despatcher's station.

In witness whereof I subscribe my signature, in the presence of two witnesses.

JULIEN A. GEHRUNG.

Witnesses:

WALDO M. CHAPIN,

MAY BIRD.