

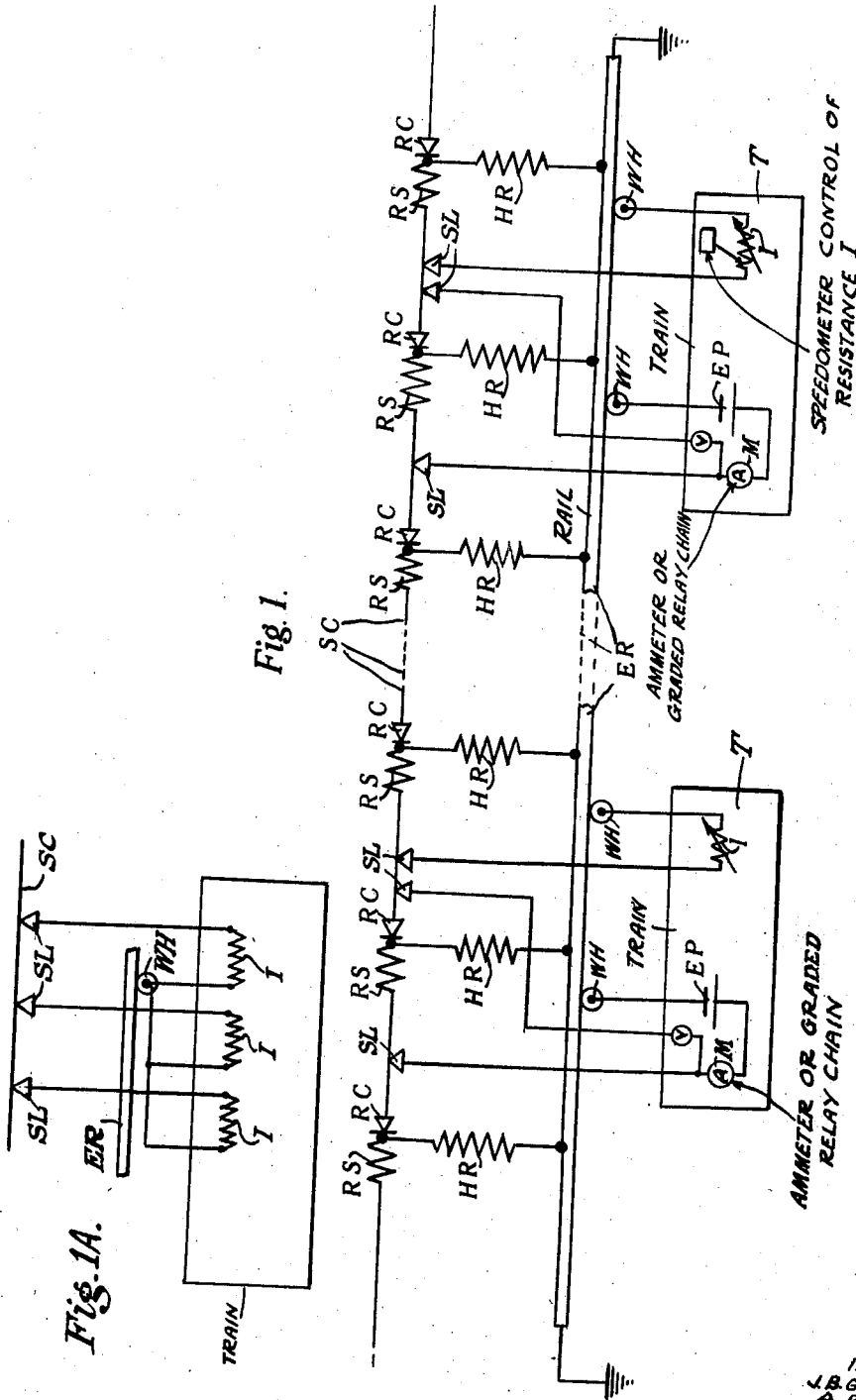
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RAILWAY SIGNALING SYSTEM

2,214,924

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2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 2.

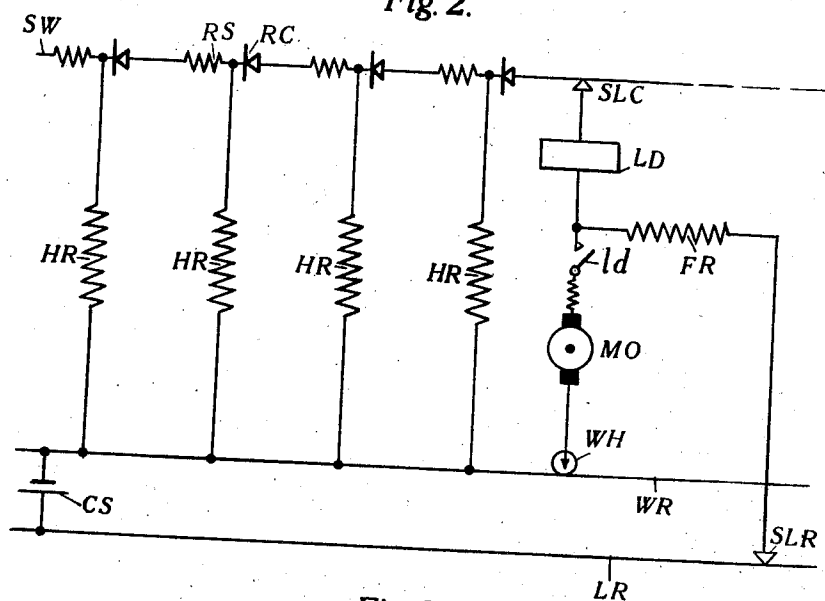
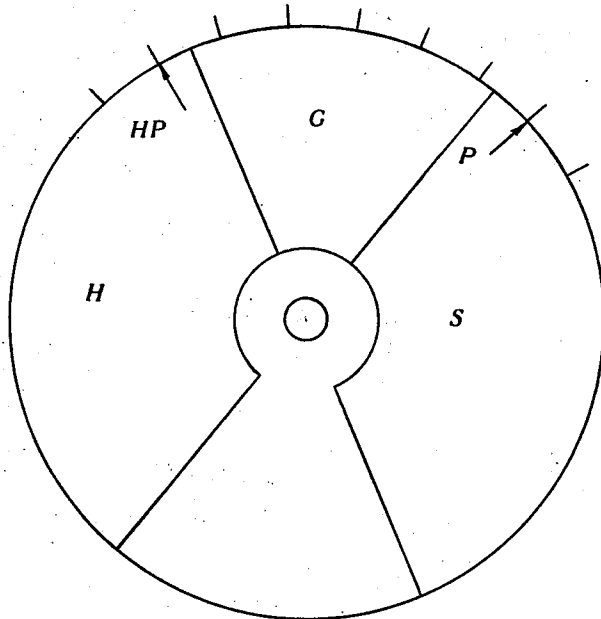


Fig. 3.



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RAILWAY SIGNALING SYSTEM

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25 Claims. (Cl. 246—67)

This invention relates to railway signaling systems.

It is universal practice at present to divide the track into predetermined blocks or sections and to indicate by means either on the track or on the train to the driver the state of each succeeding track section in turn as that section is approached. In such arrangements the stopping point of one train is determined not by the actual position of the train ahead, but by the position of the beginning of the section in which a preceding train or any part of the preceding train happens to be standing. Further, the signals for stopping of a train are not controlled dependent on the speed at which the preceding train is moving in question, nor on its own speed.

It is the object of the present invention to provide a system of train signaling and/or control in which trains are allowed to follow one another at the shortest intervals which are proved to be safe taking into account the distance apart of the trains irrespective of their positions on the track and/or the speed of a train itself and/or the speed of the preceding train.

The main feature of the invention comprises a railway signaling system characterised by a continuous electrical signaling circuit along a track, electrical transmitting equipment on each train on the track arranged to be connected to said signaling circuit to transmit information along the circuit in the opposite direction to which the train is travelling on the track, electrical receiving equipment on each train arranged to receive said information from the preceding train and to determine therefrom information concerning the relative positions of the two trains on the track, and control and/or indicating equipment on each train adapted to function under control of the receiving equipment to give an indication to the driver or to control the train in accordance with its safe margin of travel as determined by the distance between the trains irrespective of their positions on the track with respect to particular divisions thereof.

The invention will be clearly understood from the following description of the embodiments thereof shown in the accompanying drawings, in which:

Fig. 1 shows a continuous signaling circuit SC connected at intervals to the earthed rails ER and also to trains T each provided with control circuits at the front and rear shunted between the continuous signal circuit SC and the rails ER;

Fig. 1A shows a modified form of part of the apparatus of Fig. 1.

Fig. 2 shows a modification of the signaling circuit shown in Fig. 1, arranged for direct control of the driving motors of a train; while

Fig. 3 shows a train driver's speed indicator.

Referring first to Fig. 1, the control circuit at the front of each train comprises a source of electric potential EP and a meter M the reading of which will be influenced by the distance between the train and the preceding train. The control circuit at the rear of each train is either a direct short circuit or an impedance connection I which may if desired be variable under control of a speedometer.

The continuous signal circuit is divided into sections the length of which is determined by the shortest individual vehicle or train which must pass over the track, under full control of the signaling equipment.

At the junction point between each pair of sections a resistance RS and rectifier RC in series are inserted into the signal circuit SC. The rectifiers RC are so inserted that they pass current through the circuit SC in the direction in which traffic passes along the track. At the junction point of each resistance and rectifier pair (or at any other point in each section) a connection is made through high resistance HR to the rails ER or other dead earth. The resistances in the signal circuit are very small compared with the high resistance shunts but are large compared with the resistance of the rectifiers. For instance, an ordinary dry rectifier in the "go" direction has a resistance of about 3 ohms. The resistance in series therewith will be about 17 ohms, while the shunt resistance will be about 5000 ohms. When a train passes along the track with no other train in front of it a circuit is formed through the meter, through all of the shunts HR of the signal circuit sections ahead through the rails and the battery EP.

The resistances and the battery voltage are so chosen that in the worst condition a certain minimum current should pass through the meter and unless this minimum current is indicated by the meter the train is not allowed to move. This minimum current value is determined by the current which would be allowed to flow by the shunt resistances of a number of signal circuit sections, which cover the maximum braking distance of a train.

It will be appreciated that the rectifiers in the sections behind the train prevent the shunt resistance of these sections having any effect upon the meter current.

When a train is on the track in front of the train under consideration, the meter current will

be determined by the shunt on the rear of the preceding train through which a much greater current can pass than would be passed through the shunt resistances HR between the trains, or by all the shunt resistances HR where no train is present. The reading of the meter will increase as the distance between the trains becomes less and the reading of the meter will be used to indicate to the driver the maximum safe speed at which he can proceed or to control the speed of the train in accordance with safe limits or automatically to prevent the train travelling at a speed greater than the safe speed.

If, as has been suggested previously, the shunt resistance on the rear of the preceding train is increased under control of a speedometer as the speed of the train increases, it will be seen that the reading of the meter on the following train will be correspondingly decreased enabling that train to proceed at a greater speed and run closer behind the train in front by virtue of the fact that the preceding train is itself moving.

For the purpose of varying the resistance of the shunt placed on the signal circuit according to the speed of the train, a series of governor-controlled contacts for cutting in and out resistance may be used.

If the driver attempts to run his train at a speed greater than that indicated under control of the meter or if the reading of the meter reaches a certain maximum, the train will be automatically stopped by any known means.

Let us assume as an example, that the maximum braking distance of the trains is 600 ft. and that the signaling circuit section length is 40 ft., then the number of sections corresponding to the maximum braking distance is 15. The signal circuit resistance of 15 sections at 20 ohms per section is 300 ohms and this corresponds roughly to fifteen 5000 ohm shunts in parallel.

The fundamental purpose of the shunt resistance is to guard against a disconnection ahead of the signal circuit. For this purpose it is necessary for the meter to show the minimum current reading before a train is allowed to move, whether or not there is a train on the track ahead.

It will have been noted that the resistance of each rectifier in the signal circuit is small compared with the value of its series resistance. The reason for this is to prevent small changes in the rectifier resistance effecting the system. However, it is possible for the resistance of a rectifier in the go direction to increase to a value of the order of 200 or 300 ohms although this is very unlikely as the rectifier usually either becomes short-circuited or completely disconnected instead. However, if such a remote contingency did arise the response of the meter, circuit or train via the shunt of the preceding train would be artificially increased so that the preceding train appears much farther away than it actually is. This of course is a wrong side fault. In order to take care of this, the front control circuit on each train may be connected to the signal circuit SC by a pair of sliders SL, between which a voltmeter V is connected and which are spaced so as to bridge each resistance and rectifier pair RS, RC, so that the voltmeter will read the voltage drop across each rectifier and resistance pair in turn. The voltmeter reading will be compared with the reading of the ampere meter M to show the actual resistance of each rectifier resistance pair. If this is high an alarm will be given and if considered necessary the train will be stopped.

The shunt connection on the rear of the train is a possible source of a wrong side fault because if it became disconnected the presence of the preceding train would no longer be indicated. In order to guard against this, several parallel shunt connections may be provided on each train as shown in Fig. 1A, so that if one such connection comes adrift, no appreciable change in the resistance of the circuit between the two trains will arise. Provision can be made at suitable points on the track for testing that all the parallel circuits were intact.

As an alternative to the ammeter indicator, a chain of relays may be provided, the response of which would be graded so as to operate in turn as the signal channel resistance decreases.

Another alternative is to control the driving motor or motors of trains directly by the signal channel resistance. Such an arrangement is shown in Fig. 2, and is a modification of the D. C. system described above. A source of direct current, CS, is connected between a wheel rail WR and a live rail LR. Between WR and the mid-points of the resistance-rectifier pairs RS, RC in the signal wire SW, the shunt circuits HR are connected.

The driving motor MO is also connected between WR and SW by wheel WH and slider SLC in series with normally open contacts *ld* and the relay LD controlling said contacts. Between *ld* and LD is connected a current feed circuit via resistance FR and slider SLR.

For a train to start, a circuit for operating LD is completed via SLC, SW, shunt circuits HR, CS, LR, SLR and FR. LD will only operate if the signal channel is in order, thereby closing contacts *ld* to complete the circuit for motor MO. A shunt on motor MO is maintained via LD, SLC, SW shunt circuits HR and WR, so that the excitation of the motor decreases as the resistance of the shunt decreases. In this way the speed of the trains may be automatically controlled.

Automatic train speed control could of course be obtained by the provision of an intermediate control relaying means between an ammeter or relay chain and a motor shunt or other automatic control means. For instance, the meter could be provided with power operated means to operate one of a number of control circuit pairs via the meter needle according to the position of the needle, the contacts being used to control a motor shunt or other motor control device.

Fig. 3 shows a train driver's speed indicator designed to give him detailed speed information and a very simple maximum speed check device. The indicator comprises two red indicator segments H and S on a common axis so arranged that when diametrically-opposed their edges are spaced to expose a green background G.

The segment H is controlled by the meter measuring the available headway and is rotated clockwise as the headway decreases. By headway is meant the distance a train could be allowed travel if the preceding train at that instant applied full braking power. The segment S is controlled by the speedometer and rotates anticlockwise as the speed increases. The pointer HP on H indicates on a scale the maximum permissible speed while pointer SP on S indicates the actual speed of the train.

As the train speed approaches the maximum allowable speed, the visible green background G decreases in size and is blotted out completely when the train reaches the maximum speed. The indicator is arranged to operate contacts

C and T when the green disappears to cause automatic application of the brakes. The main features of the indicator are the variable indication of the margin of speed and the automatic
5 brake control.

Signaling between trains may be performed by measuring the resistance of a direct current circuit via the intervening signal circuit between two trains, or the resistance or phase angle of
10 an alternating current circuit.

Inductive connections between the trains and the signal circuit may be used.

Instead of using a constant potential to measure variable line resistance or impedance, it is
15 possible for each signal section to insert additional D. C. or A. C. voltage in the circuit between two trains so that the voltage is a measure of the degree of freedom ahead.

It is sometimes necessary to apply either temporary or permanent speed restrictions on a portion of a track, for instance a newly-laid portion or a sharp curve. A condition can then be connected to the signal channel near the beginning of the section in question, which will cause a
20 train to slow down to the required speed before entering the section. If the section is long, it may be necessary to apply two or more such conditions spaced along the section to be restricted. In the case of the D. C. system, this condition
25 could be a resistance leak by additional resistance units HR.

If it is desired to pass locomotives or trolleys shorter in length than the signal channel sections along the track, they can be provided with
35 equipment for short-circuiting the channel for instance, to safeguard their rear, but will not be provided with detector equipment for testing the condition of the portion of the signal channel ahead.

An important facility offered by the system is the possibility of governing the approach speed and distance of trains according to the gradient of the track. This facility is obtained in the D. C. system for example, by varying the values
40 of the shunt resistances across the signal channel to allow relatively greater speeds and shorter spacings on up-gradients than on level track sections, and on level sections than on down-gradients.

What is claimed is:

1. A railway signaling system comprising a continuous electrical signaling circuit along a track including as a part thereof the track rails, means in said circuit for conducting current in one direction only along a portion of said circuit, electrical receiving means and a current source on each train connected to said circuit, a transmission modifying means on each train connected to said circuit for modifying the current path for the current source on a following train, said receiving means on each train for receiving current from the current source of a preceding train, and responsive to its position relative to the transmission modifying means on said preceding train for indicating the distance between
50 said trains in accordance with the safe margin of travel under control of said current source.

2. A railway signaling system as claimed in claim 1, wherein means is provided to control said transmission modifying means according to the speed of travel of the train on which it is mounted and said receiving equipment is arranged to control the indicating equipment in accordance with the combined distance from the
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preceding train and the speed of movement of the preceding train.

3. A railway signaling system as claimed in claim 1, characterised in this that said indicating and control equipment includes a maximum
5 safe speed indicator for the driver.

4. A railway signaling system as claimed in claim 1, characterised in this that said indicating and control equipment includes a maximum safe speed indicator, and automatic braking equipment brought into operation in response to speeds exceeding said maximum safe speed.

5. A railway signaling system as claimed in claim 1, characterised in this that the continuous signaling circuit comprises a first continuous electric conductor formed by short conductor sections each adjacent pair comprising a rectifier, a second continuous electrical conductor parallel to said interconnected conductor sections, and a high resistance bridge per section of the first conductor between the first and second conductors, that said transmission modifying means on each train comprises a movable bridge connection between the two conductors of the continuous signaling circuit, and that the receiving equipment is also bridged across the conductors.
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6. A railway signaling system characterised by a continuous signaling circuit comprising a first continuous electric conductor formed by short conductor sections each adjacent pair of which is connected by a resistance and rectifier in series said rectifiers being poled to transmit current in one direction only along said conductor, a second continuous electrical conductor parallel to said interconnected conductor sections, and a high resistance bridge per section of the first conductor between the first and second conductors, the resistances in the first conductor being small compared with the bridge resistances, transmission modifying equipment on the rear of each train comprising a movable bridge connection between the two conductors of the continuous signaling circuit and equipment on the front of each train also bridged across the conductors of the signaling circuit comprising a source of direct current potential and an indicator, the rectifiers in the first conductor of the continuous signaling circuit being poled to allow current to flow therein from the direct potential source of one train over the transmission modifying equipment of the preceding train and to the indicating means of said one train.
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7. A railway signaling system as claimed in claim 6, characterised in this that said second conductor is formed by the running rails.
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8. A railway signaling system as claimed in claim 6, characterised in this, that each high resistance bridge on the continuous signaling circuit is connected to the first conductor at the junction between a resistance and rectifier interconnecting a pair of conductor sections.
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9. A railway signaling system as claimed in claim 1, characterised in this that the receiving means is provided with means responsive to the received currents to automatically control the speed of the train.
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10. A railway signaling system as claimed in claim 6 characterised in this that each section of the continuous signaling circuit is arranged to insert D. C. voltage into the circuit between adjacent trains, the indicating equipment on each train comprising a voltmeter.
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11. A railway signaling system as claimed in claim 1, characterised by receiving equipment which is provided with means to measure the
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resistance of a direct current circuit, between two trains.

12. A railway signaling system as claimed in claim 6, characterised in this that the indicating equipment of each train is connected to the first conductor by two sliders spaced sufficiently to bridge each rectifier in the first conductor in turn, and a voltmeter connected between said sliders by means of which the condition of the rectifiers may be determined.
13. A railway signaling system as claimed in claim 6, characterised in this that each transmission modifying equipment comprises a plurality of parallel bridge connections.
14. A railway signaling system as claimed in claim 6, characterised by a variable resistance in said bridge connection of each transmission modifying equipment and means for varying said resistance in accordance with the speed of the train.
15. A railway signaling system as claimed in claim 1, characterised in this that the signaling circuit is divided into sections each of which is shorter than the distance between transmitting and receiving equipment on the shortest train which is to pass over the track under full control of the system.
16. A railway signaling system as claimed in claim 6 characterised in this that the signaling circuit is divided into sections each of which is shorter than the distance between transmitting and receiving equipment on the shortest train which is to pass over the track under full control of the system, and in this that a rolling stock unit or group of units which is to pass over said track and which is shorter than a signaling circuit section is provided with transmitting equipment only.
17. A railway signaling system as claimed in claim 1 characterised in this that the electrical characteristics of the signaling circuit vary from portion to portion of said circuit in accordance with the gradient of the track for instance.
18. A railway signaling system as claimed in claim 6 characterised in this, that the indicating equipment on a train comprises a chain of relays graded to operate in turn as the distance between trains decreases.
19. A railway signaling system as claimed in claim 1 characterised in this that means are provided to control the driving motor or motors of an electric train directly by the variable resistance of the signaling circuit between said train and the preceding train.
20. A railway signaling system as claimed in claim 6 characterised by an electric driving motor for each train forming part of an indicator bridge circuit, a live rail together with the second conductor of the signaling circuit forming the driving current feed circuit and a feed connection from a point on the indicator bridge circuit of each train between the first signaling circuit conductor and the motor to a shoe contacting with the live rail.
21. A railway signaling system as claimed in claim 6, characterised by an electric driving motor for each train forming part of the receiving bridge circuit, a live rail which together with the second conductor of the signaling circuit

forming the driving current feed circuit and a feed connection from a point on the receiving bridge circuit of each train between the first signaling circuit conductor and the motor to a shoe contacting with the live rail, a relay connected in the indicating equipment of each train between the first conductor of the signaling circuit and said feed connection, and contacts controlled by said relay, closed when the relay is energised, in the motor feed circuit portion of indicator equipment bridge.

22. A railway signaling system as claimed in claim 1, characterised by an indicator on each train comprising two pointers, one controlled by the receiving equipment to indicate maximum permissible speed, the other controlled by a speedometer to indicate actual speed.

23. A railway signaling system as claimed in claim 6, characterised by an indicator on each train comprising two pointers, one controlled by said indicating equipment to indicate maximum permissible speed, the other controlled by a speedometer to indicate actual speed, said pointers of the indicators carrying screens which approach one another when the margin between train speed and permissible speed decreases, and by doing so decrease the amount of a background visible between said screens, so that the safety margin indication is reduced to an arbitrary minimum when the train is travelling at the maximum permissible speed.

24. A railway signaling system as claimed in claim 6, characterised by an indicator on each train comprising two pointers, one controlled by said receiving equipment to indicate maximum permissible speed, the other controlled by a speedometer to indicate actual speed, said pointers of the indicators carrying screens which approach one another when the margin between train speed and permissible speed decreases, and by doing so decrease the amount of a background visible between said screens, so that the safety margin indication is reduced to an arbitrary minimum when the train is travelling at the maximum permissible speed, and contacts on said indicator closed when the maximum permissible speed is reached and which cause application of the train brakes.

25. A railway signaling system as claimed in claim 6, characterised by an indicator on each train comprising two pointers, one controlled by said receiving equipment to indicate maximum permissible speed, the other controlled by a speedometer to indicate actual speed, said pointers of the indicators carrying screens which approach one another when the margin between train speed and permissible speed decreases, and by doing so decrease the amount of a background visible between said screens, so that the safety margin indication is reduced to an arbitrary minimum when the train is travelling at the maximum permissible speed, and means, controlled by the indicating equipment to indicate that the signal circuit is out of order, comprising a section of the background which is of different color displayed independently of the position of the screen which indicates actual speed.

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