

2,098,401

6 Sheets-Sheet 1



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Nov. 9, 1937.

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2,098,401

AUTOMATIC RAILROAD SIGNALING AND CONTROL SYSTEM

Filed Sept. 15, 1934

6 Sheets-Sheet 2

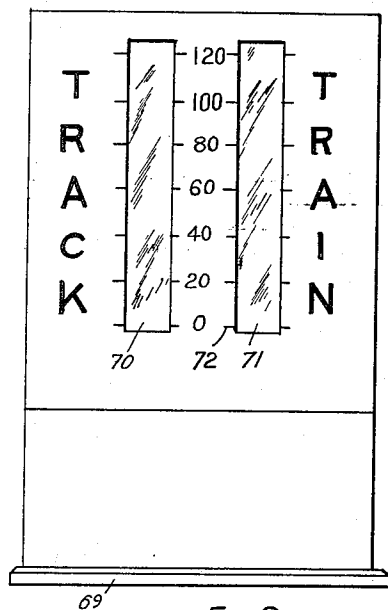


FIG. 3.

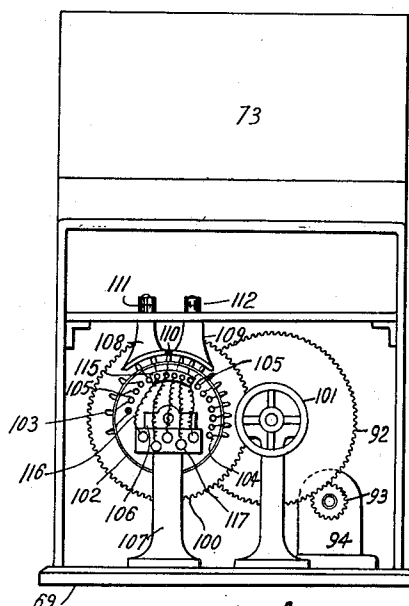


FIG. 4.

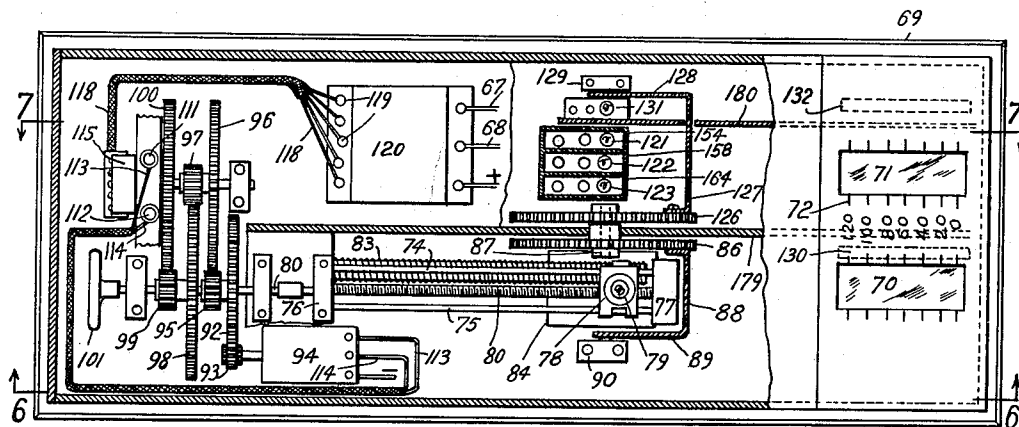


FIG. 5.

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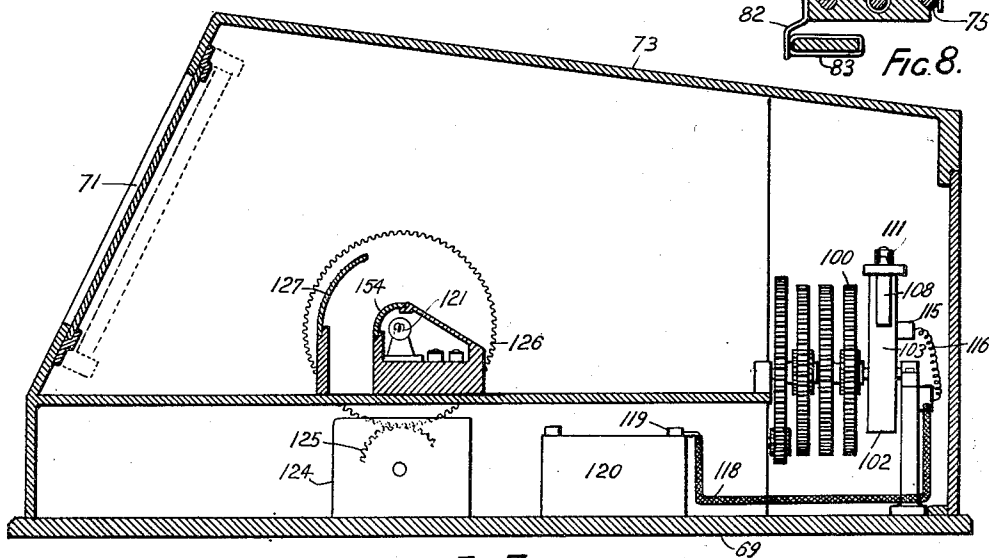
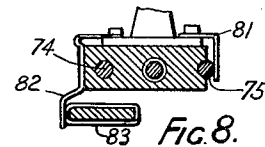
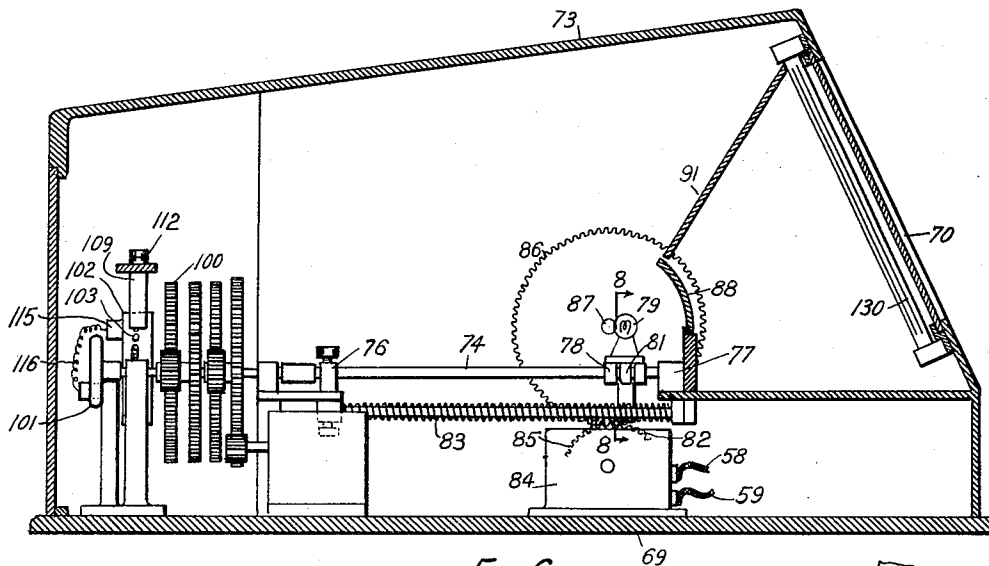
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AUTOMATIC RAILROAD SIGNALING AND CONTROL SYSTEM

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6 Sheets-Sheet 3



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AUTOMATIC RAILROAD SIGNALING AND CONTROL SYSTEM

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6 Sheets-Sheet 4

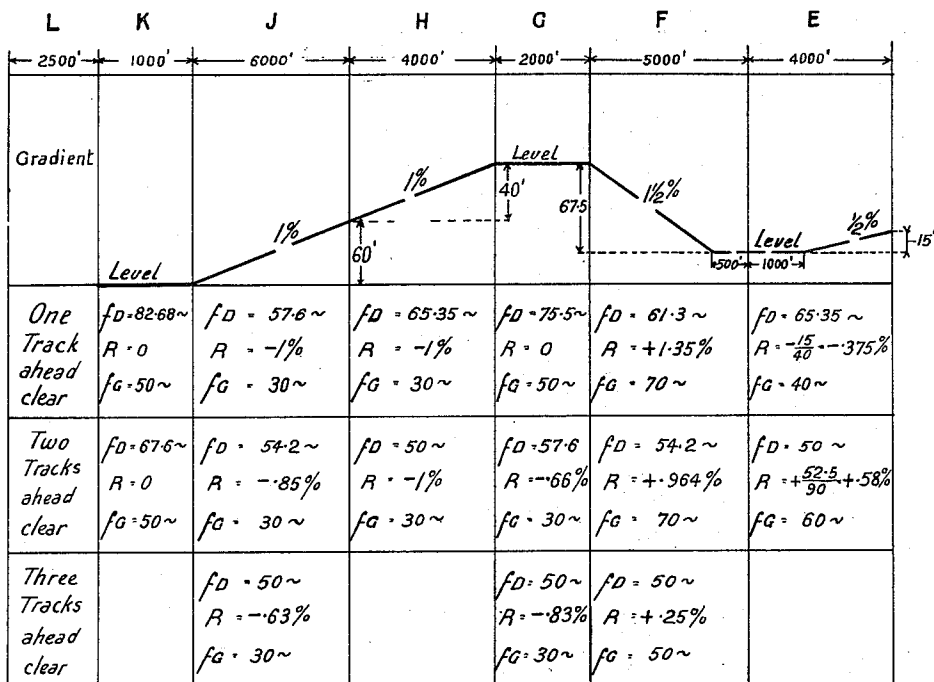


Fig.9.

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AUTOMATIC RAILROAD SIGNALING AND CONTROL SYSTEM

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6 Sheets-Sheet 5

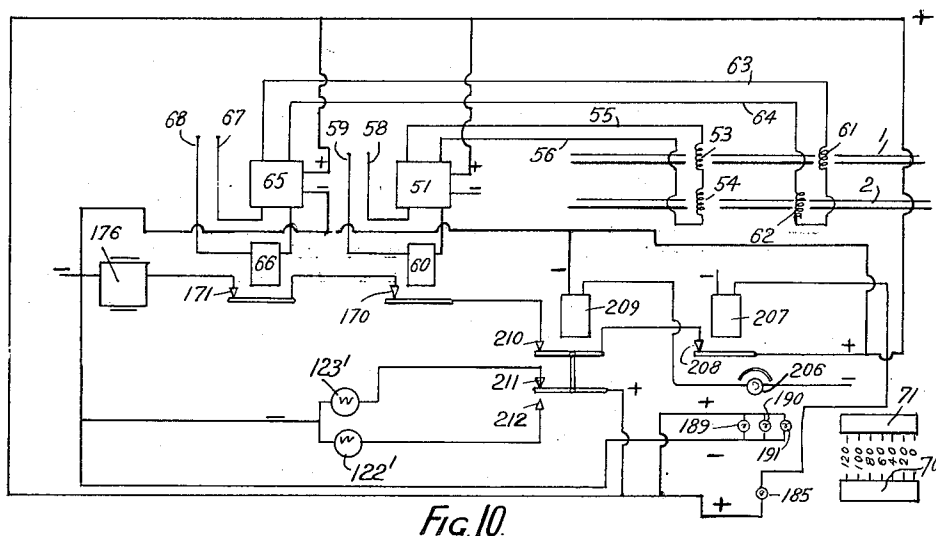


FIG. 10.

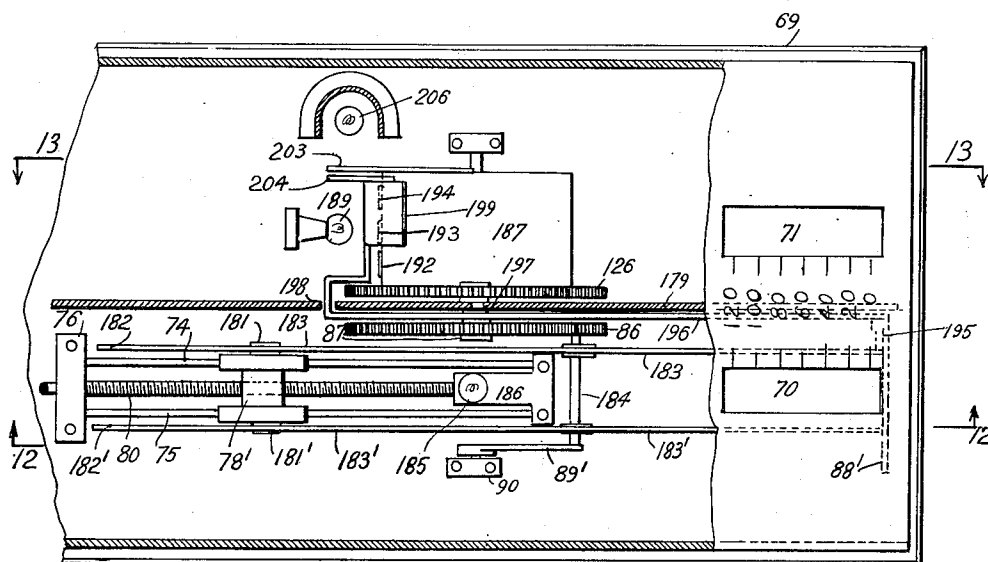


FIG. 11.

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AUTOMATIC RAILROAD SIGNALING AND CONTROL SYSTEM

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6 Sheets-Sheet 6

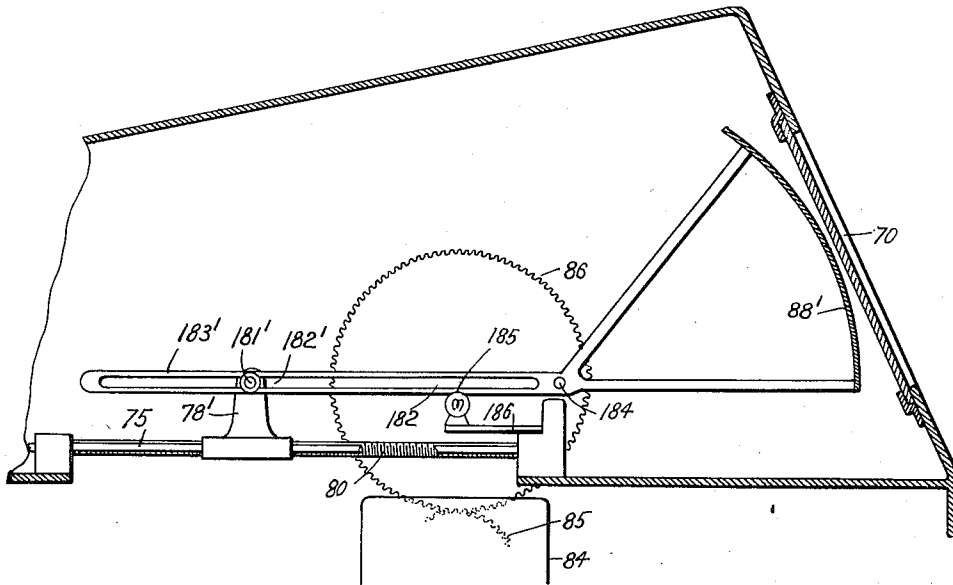


Fig. 12.

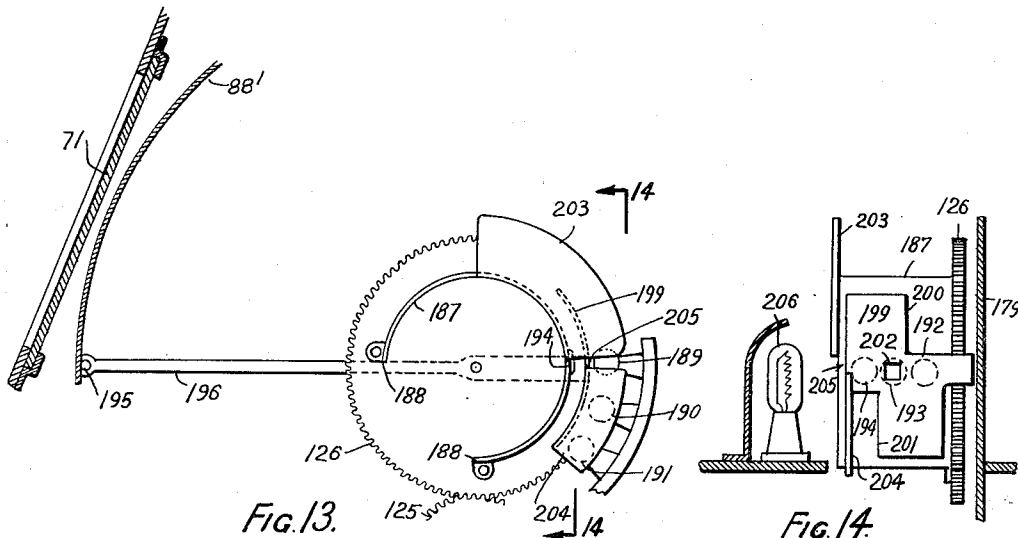


Fig. 13.

Fig. 14.

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UNITED STATES PATENT OFFICE

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AUTOMATIC RAILROAD SIGNALING AND
CONTROL SYSTEMCharles William Walker Prescott, Pymble,
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Application September 15, 1934, Serial No. 744,233

17 Claims. (Cl. 246—6)

This invention relates to railroad signaling and has particular reference to such types of signaling devices and systems which incorporate an indicator carried by the locomotive or vehicle itself, in place of or in conjunction with roadside signals.

The primary object of this invention is to provide means whereby an indicator carried on the locomotive will give the driver a continuous indication of the maximum speed at which the train may safely be driven (termed "track speed") which indication will automatically vary from time to time according to the condition of the track ahead. Having such essential indication, it is a matter of ease for the driver to operate the train with certainty at the correct speed from the point of view of safety and of utilizing the track to maximum capacity by means of the said "track speed" indicator used in conjunction with a train speed indicator.

The most important factors influencing the "track speed" are:

- (a) The length of unoccupied track ahead of the train;
- (b) The gradient and/or curvature of that track;
- (c) The braking characteristics of the train itself, and these factors are continuously employed in conjunction in the present invention to actuate the track speed indicator. Other minor factors may be employed if desired in a similar manner, and in the case of long lengths of level track, factor (b) may be omitted.

The first two factors mentioned are dependent upon the instantaneous condition and nature of the sections of the track ahead of the train, and are conveyed to the locomotive track speed indicator by means of electric currents imposed upon the rails. The third factor, that of the braking characteristics of the train, is one which has always caused considerable difficulty. It has previously been proposed to provide certain mechanical means to approximate changes of this factor, but relatively few fixed settings were available, which at best were approximations, and hence no accurate indication of permissible track speed for all make-ups of trains was practicable. In the present invention, however, this factor which varies with the train make-up, is accurately and readily set in the instrument itself, and will combine with the other factors to give an accurate indication of permissible track speed for each particular train. On lines used only by trains of standard make-up this adjustment may be dispensed with. The varying track gradient (and

curvature) factor which affects the braking of the train is ingeniously combined with the set braking characteristic factor to cause an alteration of the track speed indicator whenever the former factor is altered.

With regard to the factor of the length of unoccupied track ahead of the train, the electric current put on the rails has a frequency which is proportional to the square root of the length of clear track ahead of the train. The expression "frequency" employed in this specification is intended to cover "coded" or "interrupted" current, both A. C. and D. C.

Thus the invention gives the driver all the essential information, namely permissible track speed and actual train speed, in a very simple form on the locomotive, and by a comparison of these two speeds he is thus enabled readily to operate the train in the most safe and efficient manner entirely independently of roadside signals, and hence in all weathers. The advantages thus gained as regards the utilization of the track to maximum capacity by various types of train are obvious.

Various refinements of the fundamental invention may be employed, for instance colour indications (or a warning) may be given when the train speed is below, in the zone of, or above the track speed. If desired this colour comparison of the two speeds may entirely replace one or both of the actual speed indications.

Furthermore, the invention may be employed not only as an indication to the driver, but as an actual automatic train control which will function more completely than such controls hitherto known, even to the extent of push-button operation of the train by an unskilled operator in the case of electric trains. Automatic brake application may be employed, either with or without time element or forestalling factors.

The invention may be carried into effect with different forms of apparatus, but a preferred embodiment thereof is now described. The electrical system incorporates some features known in automatic signaling and is shown in diagrammatic form which is usual in such systems and which will be clearly understood by those skilled in the art.

In the drawings,

Figure 1 is the track circuit wiring diagram,
Figure 2 is the locomotive and instrument wiring diagram,

Figure 3 is a front elevation of the locomotive instrument.

Figure 4 is a rear elevation of the instrument,

Figure 5 is a plan view, in part cross-section of the instrument,

Figure 6 is a cross-sectional elevation on line 6—6 of Figure 5,

Figure 7 is a cross-sectional elevation on line 7—7 of Figure 5,

Figure 8 is a cross-sectional elevation of a detail, on line 8—8 of Figure 6,

Figure 9 is an example of a frequency table,

Figure 10 is a locomotive and instrument wiring diagram for a modified form of the instrument,

Figure 11 is a fragmentary plan view, in part cross-section, of a modified form of the instrument,

Figure 12 is a side elevation taken on line 12—12 of Figure 11,

Figure 13 is a side elevation taken on line 13—13 of Figure 11, and

Figure 14 is a rear elevation, taken, on line 14—14 of Figure 13.

Figure 1 shows the means by which the various frequencies are imposed on the rails, which frequencies are picked up by a train by induction to actuate the instrument and give the indication of the condition of the track ahead, in terms of a "permissible track speed" in miles per hour.

Two sets of currents are imposed on the rails of each track circuit, one being in the opposite direction in the two rails, and having a frequency which is dependent upon, and a function of, the square root of the length of the clear track ahead of this circuit. A method of obtaining the frequencies required for various lengths of clear track is given hereinafter, it being sufficient now to explain that after that length of track in which the worst braked train may be stopped (the "safe" length) is clear, a standard frequency is imposed on the rails of a track circuit.

The other current imposed on the rails travels in the same direction in both rails, and its frequency varies in different track circuits according to the gradient of the clear length of track ahead, and according to the curvature of that track. A method of obtaining these frequencies for different sections of the track is also given hereinafter.

Figure 1 shows a number of adjacent sections A, B, C and D of the track, the insulated rails 1, 2 of which are divided into track circuits by insulators 3, 3, as in known practice. The various track circuits are fundamentally similar, and the train is considered as traveling from right to left.

The current having a frequency which is determined by the length of clear track ahead (termed "clear-track frequency") is fed into one end of track section D from the secondary 4 of a transformer by leads 5 and 6 to the rails 1 and 2 respectively. An adjustable rheostat or impedance 7 controls the maximum current.

The usual track relays 8 and 9 of track circuits A and B are duplicated, through leads 10 and 11, by repeater relays 12 and 13 (fed from a source of supply in known manner), grouped with relay 14 associated with track section C. The relay of section D is indicated by 14¹.

Presuming that sections A, B and C are unoccupied, relays 12, 13 and 14 will be energized and their armatures will close contacts 15, 16 and 17 respectively, as shown in Figure 1. Thus a circuit is established from a positive (+) source of supply, through the closed contacts 17, 16 and 15 and lead 18 to the vibrating contact 19, which is connected to the negative lead of the source of

supply. Thus the vibrating contact 19 is actuated. This vibrating contact 19 and also vibrating contacts 20 and 21, are of the known type which will oscillate at one frequency only when energized, these contacts having a common negative return lead 19'. Presume that contact 19 oscillates at 50 vibrations per second, then its oscillations will cause contact 22 to be closed 50 times per second, and hence current flowing from supply 28 through lead 40 and the vibrator 19 to contact 22 is interrupted or "coded" 50 times per second. From contact 22, this current having a frequency of 50 impulses per second is carried by leads 23, 24 and 25 to the grid 26 of the thermionic valve 27, the filament of which is connected to the negative terminal of battery 28. Then current from supply 29 will flow through valve 27 with a frequency of 50 impulses per second, which current is carried by lead 30 through contacts 17¹, 16¹ and 15¹ which in the present positions are closed by armatures coupled to the armatures of relays 14, 13 and 12, in known manner. From contact 15¹, the coded current is carried by lead 31 to the primary 32 of the transformer incorporating secondary 4, said primary 32 being also connected to supply 29. Consequently a 50 cycle current from secondary 4 is supplied to rails 1 and 2 of section D, and flows in opposite directions in these rails. This frequency will be picked up by a train entering section D.

If, now, section A is occupied relay 8 is short circuited and hence the armature of repeater relay 12 drops, opening contacts 15 and 15¹ and closing the opposite contacts 15² and 15³. The relays 13 and 14 remain closed, and hence the circuit to vibrating contact 19 is broken, while a circuit from the positive source through contacts 17, 16 and 15² and lead 33 is established to vibrating contact 20. This contact 20 will vibrate only, say, at 70 vibrations per second, and interrupted or coded current from contact 34 is supplied through leads 24 and 25 to grid 26 of valve 27. Hence the valve delivers current of a frequency of 70 impulses per second to lead 30, whence it passes by contacts 17¹, 16¹ and 15³ to lead 35 and to a tapping on transformer primary 32. From the secondary 4, a current of 70 cycles is delivered to the rails 1, 2 and is picked up by a train entering section D.

Similarly, it will be clearly seen that if section B of the track is occupied, relays 9 and 13 will be de-energized, and hence contacts 16 and 16¹ will be opened and their opposite contacts 16² and 16³ will be closed. This results in vibrating contacts 19 and 20 being inoperative, and vibrating contact 21 being supplied with energy from the source through contacts 17 and 16² and lead 36, which vibrating contact 21 impresses a current interrupted (say) 90 times per second upon the grid of valve 27. Thus a current having a frequency of 90 impulses per second is impressed by valve 27, through lead 30 and contacts 17¹ and 16¹ and lead 37 onto a second tapping of transformer primary 32, from the secondary 4 of which the 90 cycle current is passed into rails 1 and 2 of section D.

From the foregoing it will be seen that the particular frequency impressed on the rails of any track circuit is a function of the length of the clear track ahead of that section, and will be automatically varied as variations occur in that length of clear track.

The particular arrangement described for feeding track circuit D is repeated for all the other

track circuits of the line, as is usual in high speed signaling.

Figure 1 also shows the manner in which the gradient and curvature current is fed into section D. The particular frequency fed into a track circuit is automatically varied according to the overall gradient and/or curvature of the length of the clear track ahead of that circuit. While sections A, B and C are clear, contacts 16⁴ and 17⁴ are closed by armatures coupled to those of relays 13 and 14, and current from a + supply is taken through these contacts and lead 38 to a vibrating contact 39 which oscillates (say) 50 times per second, and which has a negative return lead 39¹. Thus current from source 28 is fed by leads 40 and 41, coding contact 42 and lead 43 to grid 44 of thermionic valve 45, which is in turn fed by lead 46 from source 28. Since the input to grid 44 is coded at 50 impulses per second, current at this frequency passes from valve 45 by lead 47 to the primary 48 of a transformer, and 50 cycle current will flow from the secondary 49 of this transformer through the usual rail-to-rail impedances 50, 50¹ to flow in the same directions in rails 1 and 2, and to be picked up by a train entering section D. Section A is regarded as having the same gradient as section B, and is not provided with a special gradient oscillator.

If, now, section B is occupied, relays 9 and 13 are de-energized, and contact 16⁴ is opened and contact 16⁵ closed. This results in the disconnection of vibrating contact 39 and the energization of vibrating contact 51 from the source through contact 17⁴ and lead 52. Contact 51 has, say, a period of 40 vibrations per second, and hence grid 44 is energized with this frequency, and hence valve 45 (through transformer 48, 49) will deliver 40 cycle current to the rails, 1, 2.

Thus it will be seen that if sections A and B are clear of traffic, vibrating contact 39 is in operation. If, however, section B is occupied ahead of a locomotive, vibrating contact 39 is cut out of operation and vibrating contact 51 is in operation, as above described.

All track circuits are fed in the same manner, the number of frequencies required for each section being dependent upon the physical nature of the sections ahead, up to the "safe" length of clear track.

Figure 2 shows the manner in which the two frequencies imposed on rails 1 and 2 are picked up by the locomotive. Two similarly wound collector coils 53 and 54 are connected in series in such manner as to be energized (by inductance) by currents in opposite directions in rails 1, 2 in known manner. Leads 55 and 56 connect these coils to an amplifier 57 which is connected by leads 58 and 59, through a proving relay 60, with another part of the apparatus (hereinafter described).

Collector coils 61 and 62 are so connected that they will be energized only by currents in the same direction in rails 1, 2 and these coils are connected by leads 63 and 64 to an amplifier 65, which is connected through a proving relay 66 to another part of the apparatus by leads 67 and 68.

Having been picked up and amplified, the two track circuit currents of variable frequency are taken to the instrument illustrated in Figures 3 to 7 inclusive, which is now described. The base 69 is suitably mounted in a resilient manner in the desired position either in the locomotive cab, or in the driver's line of vision forward. The various parts of the instrument are insulated as required in accordance with practice.

The face of the instrument is shown in Figures 3 and 5, and includes two ground glass windows 70 and 71, one of which is marked "Track" and upon which the maximum permissible track speed for the particular train is indicated, and the other of which is marked "Train", upon which the actual train speed is indicated. A miles-per-hour scale 72 is located between the two windows. The instrument is covered by a detachable top 73.

As seen in Figures 5 and 6, two parallel slide rods 74 and 75 are mounted at their ends in standards 76 and 77 and slidable thereon is a carriage 78 carrying a lamp 79. The carriage 78 is engaged by a rotatable screwed rod 80 (Figure 5) by the rotation of which it is progressed along rods 74 and 75, in either direction. As shown in detail in Figure 8, lamp 79 is fed through a contact 81 wiping on energized rod 75 and connected to one terminal of the lamp while the other terminal feeds through wiper 82 onto a rheostat 83. Lamp 79 is for the purpose of illuminating window 70, and in order that its intensity on this window (and on an adjacent light sensitive strip hereinafter referred to) may remain constant during its displacement towards or from the window on rods 74 and 75, the rheostat 83 is employed to suitably increase the light intensity as the lamp retracts from the scale, and vice-versa.

Mounted on base 69 is a frequency meter 84 of known type, which rotates a pinion 85 meshing with a spur wheel 86 carried on shaft 87. Connected to spur 86 is an arcuate screen 88, which is formed with an arm 89 mounted in a bearing 90 (Figure 5). The function of screen 88 is to shield the light from lamp 79, and by its position to regulate the height of the beam from this lamp passing under it and illuminating window 70. In Figure 6 the screen 88 is shown at its lowest position, and it will be seen that the higher screen 88 is lifted by counter clockwise rotation of spur 86, the higher will be the illumination on window 70, and hence the higher will be the M. P. H. indication of "track speed" on this window. A fixed screen 91 prevents light from lamp 79, in the retracted position, passing over screen 88.

Frequency meter 84 is connected to leads 58 and 59 from amplifier 57 (Figure 2) and hence the position of screen 88 is determined by this frequency meter, which in turn depends upon the "clear track" frequency picked up from the track circuit, this frequency being a function of the length of the clear track ahead of the section occupied by the train. The greater the length of the clear track, the higher will be the position of screen 88, and hence the higher the indication in M. P. H. given on window 70 (up to a certain minimum "safe" distance) other factors remaining constant. The other two factors, gradient (and/or curvature) of the track and the braking characteristics of the train, are combined with the clear track distance in the instrument by adjustment of the position of lamp 79 along its mounting rods. It will be obvious that for any position of screen 88, the indication thrown on window 70 by lamp 79 will decrease if the lamp is retracted from the window, and vice versa. Screwed rod 80 is manually rotated to bring lamp carriage 78 to a calibrated position according to the braking characteristics of the train before a journey commences, and the rod is further rotated automatically during the journey according to the gradient frequency picked up, thus making automatic adjustments from time to time in the track speed indication according as the gradient increases or decreases

the safe track speed. These adjustments are effected as now described.

As shown in Figure 5, rod 80 has mounted thereon a spur wheel 92 which is driven by the pinion 93 of a reversible motor 94. A high reduction train is employed consisting of pinion 95, spur wheel 96, pinion 97, spur wheel 98, pinion 99 and spur wheel 100, the ratio being such that motor pinion 93 rotates spur wheel 92 sufficiently to move carriage 78 from one end to the other of rods 74, 75 while spur wheel 100 makes less than one revolution. Shaft 80 is continued through the gear train and is fitted with a knob 101 for the initial manual setting of carriage 78 according to the braking characteristics of the train.

A controller which actuates motor 94 is best seen in Figures 4, 5, 6 and 7. This controller includes a disc 102 having mounted in its rim a plurality of spring loaded contacts 103 which represent various braking percentages and which are not evenly spaced on this account. The contacts 103 are, however, connected by leads 104 to a plurality of evenly spaced plug sockets 105 on the face of the disc 102.

Disc 102 is mounted for rotation in bearing 106 on standard 107, and is connected to spur wheel 100 to rotate therewith. A number of contacts 103 engage under two contact shoes 108 and 109 in any working position of disc 102, and these shoes are insulated from each other by an insulator 110, and end respectively in terminals 111 and 112 which are connected by leads 113 and 114 (Figure 5) to the two field windings of the reversible motor 94, which motor is also connected to the negative terminal of a source of supply in known manner.

The various sockets 105 represent various retardation percentages such as 5%, 6% and so on, and the controller operates as changes in gradients (or curves) affect this retardation percentage, either decrease or increase. Presuming that two steps of 1% on either side of level only will be met on the track, five of the contacts 103 will be employed. The contact representing the retardation percentage of the train (as made up) on level track is brought under insulator 110, and a five point plug 115 is plugged into sockets 105 connected to this particular contact and the two on either side thereof. The plug 115 is connected by flexible leads 116 to terminals 117 on standard 107, and these terminals are in turn connected by leads 118 (Figure 5) to five adjacent contacts 119 of a known type of contact-making frequency meter 120.

Frequency meter 120 is connected to leads 67 and 68 of the amplifier 65 (Figure 2) fed by the gradient frequency imposed on the line, and is also connected to the positive terminal of the source of supply in known manner.

The operation of this last described portion of the device is as follows:

The rod 74 is calibrated (by a method hereinafter explained) with various percentages representing the retardation of various trains. The braking characteristic or percentage having been determined by the make-up of the train, finger knob 101 is manually adjusted to set carriage 78 to this percentage, which adjustment will simultaneously bring the contact 103 of the controller representing this retardation percentage under insulator 110, by the medium of the gear train. Plug 115 is then inserted to engage the socket 105 connected to this centralized contact 103, and two sockets 105 on either side thereof.

During the journey, the contact making frequency meter is influenced by the varying frequencies impressed on the rails according to gradient, and will therefore from time to time connect one or other of the contacts 119 to a source of supply (+). Thus, through leads 118 and 116, one or other of the five engaged contacts 103 is energized from the source. While only the central contact 103 (under insulator 110) is energized, no effect is felt, but when a contact on one side of this central contact is so energized, current passes therethrough to (say) shoe 108, and by lead 113 to one field coil of reversible motor 94. The motor then sets the gear train in motion, rotating rod 80 to retract lamp 79 from window 70 for a reduction in effective retardation due to a down gradient, and reversely for an up gradient.

The motor also sets the gear train in motion, the direction of rotation being such as to bring the energized contact 103 under insulator 110, which as soon as achieved, cuts off supply to the motor. The mechanism remains in this position until a fresh frequency due to gradient affects frequency meter 120 to change its contact 119 which is energized from the source, and so set motor 94 in motion again, to readjust lamp 79.

Thus it will be seen that the light thrown by lamp 79 on to window 70 to indicate the maximum permissible track speed is adjusted (a) according to the braking characteristic of the train, by initial setting of carriage 78, (b) according to length of clear track ahead of the train, by the clear track frequency adjusting the position of screen 88, and (c) according to gradient and/or curvature of the clear track ahead, by the gradient (and/or curvature) frequency causing an adjustment of the position of lamp carriage 78 during the journey.

The permissible track speed for the particular train being shown on window 70, in M. P. H. against scale 72, it is now required that the adjacent window 71 be illuminated to a height representing instantaneous train speed. Having these two speed indications against scale 72, it is a matter of ease for the driver to maintain his train speed in the zone of the track speed, and thus utilize the track to maximum capacity, but with safety, since he can always stop his train should an obstruction occur, providing his train speed is not greater than the track speed.

The manner in which the train speed indication is thrown on window 71 is illustrated in Figures 5 and 7. Three stationary lamps 121, 122 and 123 are arranged transversely on the instrument, and are adapted to illuminate window 71. A centrifuge (speedometer) 124 is mounted on base 69, and operates a pinion 125 which in turn rotates a spur wheel 126, on which is mounted an arcuate screen 127 normally disposed between lamps 121, 122, 123 and window 71. Spur wheel 126 is freely rotatable on shaft 87, and an arm 128 extending from screen 127 is taken to a bearing 129. An increase in train speed causes speedometer 124 to lift screen 127 and so permit a higher beam of light to pass from lamp 121, 122 or 123 to window 71, thus indicating an increase in train speed against scale 72. In the drawings, screen 127 is shown in its lowermost position.

By this means the actual train speed is given on window 71 for comparison with the track speed on window 70.

Automatic brake application means are provided, whereby the brakes are applied if and

when the train speed exceeds the permissible track speed. The usual time lag would, of course, be incorporated. Furthermore, assistance is given the driver (and by repeater lights, the fireman) by colouring the train speed indication on window 71 green, yellow or red, according to whether it is below, in the zone of, or above the permissible track speed. The manner in which these operations are carried out is best illustrated by Figure 2.

Adjustable lamp 79 also illuminates a light-sensitive strip 130, adjacent window 70 (see also Figures 5 and 6) and a lamp 131 aligned with lamp 121 (Figure 5) illuminates an identical light-sensitive strip 132. These light-sensitive strips are of known type in which their resistance varies according to the length of them which is illuminated. The reason for adjusting the intensity of light from lamp 79 according to its position in relation to the front of the instrument (and hence in relation to strip 130) will now be clear.

Light-sensitive strips 130 and 132 are respectively connected by leads 133 and 134 to the two windings 135 and 136 of a differential three position relay 137 (of known type) these windings also being connected by lead 135¹ to a source of supply. The other terminals of the strips are connected by leads 138 and 139 respectively to two proving relays 140 and 141 in turn connected to the negative terminal of the source.

The lengths of light strips 130 and 132 which are illuminated (and consequently their resistances) are dependent upon the positions of screens 88 and 127 respectively. When the track and train speeds are equal, the heights of the train and track light beams are equal, and hence the resistances of strips 130 and 132 are equal, and relay 137 is not moved from its normal position wherein contacts 142 and 143 are closed through arm 144, while contacts 145 and 146 are open. Current flows from a + source, through contact 142, arm 144, contact 143, lead 147 and through the upper winding of a double-wound relay 148, either winding of which is sufficient to operate the relay, and energization of which holds contact 149 open. From relay 148 the current flows through relay 150 to the negative to the source, thus energizing its contact 151 and supplying current from the source to lamp 121, which feeds back by lead 152 through a proving relay 153.

Lamp 121, as shown in Figures 5 and 7, is covered by a yellow glass 154, and hence the train speed indication thrown on window 71 is coloured yellow.

If, now, the train speed should increase over the track speed, the resistance of strip 132 is decreased over that of strip 130, and hence more current will flow through winding 136 than through winding 135 of the differential relay 137. When this difference is sufficiently great to actuate the relay, flexible arm 144 is moved (in known manner) to open contact 143, while the other contacts thereof remain unaltered. This results in the de-energization of relays 148 and 150, thus closing contact 149 and so connecting lamp 122 to the source, and opening contact 151 and extinguishing lamp 121. The circuit of lamp 122 is completed to the source through lead 156 to relay 157, the purpose of which is hereinafter explained.

Lamp 122 has a red glass 158 (Figure 5) about it, so that the train speed indication on window

71 is coloured red, giving warning of excess of train speed over track speed.

When the train speed drops below track speed, greater current will flow in winding 135 than in winding 136 of relay 137, and arms 144 and 159 of the relay will move to open contact 142 and close contacts 145 and 146. Supply from a + source now flows through contacts 145, 146, lead 160, the second winding of relay 148 (holding contact 149 open) and relay 161 to close contact 162. Thus the positive supply is connected through contact 162 and lead 163 to lamp 123, which completes its circuit through lead 152 to relay 153 and thence to the source. Thereby only lamp 123 is illuminated, and this lamp is covered by a green glass 164 (Figure 5) so that the train speed indication on window 71 is coloured green, readily indicating that the train speed is below the track speed.

It is to be noted that the colouring of the train speed indication to readily show its relation to the track speed is considered secondary only to the actual M. P. H. indications of the two speeds given on windows 70 and 71.

In the event of the fireman requiring an indication of these relative speeds, repeater lamps 121¹, 122¹ and 123¹ are connected in parallel with lamps 121, 122 and 123 across the supply, and are placed conveniently for the fireman.

The circuit for the automatic application of the brakes (with the usual time lag) in the event of train speed exceeding track speed by a certain amount, is also shown in Figure 2. Lamps 79 and 131 are fed from a positive source and complete their circuits through leads 165 and 166 to two windings respectively of a double winding relay 167, energization of both of which windings is necessary to maintain its contact 168 closed. These circuits are completed by a common lead 169 through a contact 170¹ actuated in common with contact 170 of proving relay 60, and through a contact 171¹ actuated in common with contact 171 of proving relay 66, and thence to the negative of the source.

Proving relays 140, 141 and 153 have contacts 172, 173 and 174 respectively, closed on energization of these relays, and proving relay 157 has a contact 175 which is opened on energization of this relay.

The brake circuit is from a + source, through contacts 173, 172, 168, 175, 174, 170 and 171 to an electro-pneumatic valve 176 (of known type) to the negative of the source, said valve holding the brakes off while energized. While lamps 79 and 131 are lighted, strips 130 and 132 energized, either yellow lamp 121 or green lamp 123 lighted, and amplifiers 57 and 65 operating, the circuit to valve 176 is complete, and the brakes are held off. However, should one of these units fail, its associated proving relay will be de-energized and the valve circuit opened, thereby applying the brakes. Similarly, should train speed exceed track speed by a certain amount, relay 157 will be energized and contact 175 opened, thereby interrupting the valve circuit and again applying the brakes automatically, until train speed drops sufficiently to close contact 175 once more, when valve 176 may release the brakes once more.

A partition 179 (Figure 5) prevents interference between train and track lamps, and a second partition 180 segregates the effect of lamp 131 operating light-sensitive strip 132 from the rays of lamps 121, 122 and 123.

Although in the foregoing description one of 75

the currents is described as traveling in the same direction in both rails, while the other travels in different directions in the two rails, it is contemplated that the two currents may be super-
 5 imposed, and travel similarly in the rails, by sufficient differentiation in frequency, in which case the pick-up instrument on the locomotive would necessarily discriminate between currents in different "wavebands".

10 Frequency calculations

Although the application of the invention to track circuits does not present any difficulty to those skilled in the art, it is preferred to give
 15 examples of the manner in which the required frequencies may be calculated. The following are merely by way of example, and other methods may be employed to achieve the same result, provided that the frequencies applied to a track
 20 circuit to indicate the length of clear track ahead of that circuit is proportional to the square root of that length.

Let it be assumed that the worst braked train to be used on the track has a retardation value
 25 of 3% (expressed as a percentage of train weight) at its maximum speed, and that the retardation of the best braked train is 10%. Further, that the maximum track gradients do not exceed $\pm 2\%$.

30 Use is made of the well known formula

$$D = \frac{10V^2}{3(Rt \pm Rg)} \quad (1)$$

Where D=stopping distance in feet.

35 V=speed in M. P. H. at which brakes are applied

Rt=equivalent retardation due to brakes and friction (expressed as % of weight of train)

Rg=equivalent retardation due to gradients and/or curves (curves being expressed as
 40 gradients, that is %).

The extremes of retardation will then be:

$$\begin{aligned} 3\% - 2\% &= 1\% \\ \text{and } 10\% + 2\% &= 12\% \end{aligned}$$

45 As the minimum retardation is so low, steps of $\frac{1}{2}\%$ are used in adjusting for Rg.

In the above formula, if V is taken at 50 M. P. H. and Rt+Rg at 1% then D=8333 ft. that is, the most poorly braked train traveling at 50
 50 M. P. H. requires 8333 feet in which to stop after application of the brakes, and this is consequently the maximum length of the track ahead of any track circuit concerning which it is necessary to apply condition indications by various fre-
 55 quencies to this track circuit.

As previously stated, the clear track frequency (f_D) must be proportional to the square root of D. A convenient scale is given by the arbitrary formula

$$60 \text{ frequency } (f_D) = 100 - \sqrt{3D} \quad (2)$$

This gives a standard frequency of 50 cycles for a clear track distance of 8333 ft. and over.

Again, there would be little necessity to extend
 65 the scale above 120 M. P. H.

From the above formula (2), the following required frequencies (f_D) are obtained for various lengths of clear track (D):

Scale M

70	D (feet) =	300	500	1000	1500	2000
	f_D (cycles) =	90.52	87.76	82.68	78.8	75.5
	D (feet) =	3000	4000	5000	6000	8333
	f_D (cycles) =	70	65.35	61.3	57.6	50

According to the lengths of the track sections (up to 8333 ft.) ahead of any track circuit, the various frequencies which it is necessary to provide by vibrating contacts 19, 20 and 21 (Figure 1) are
 5 determined as above. For "all clear track", that is a clear distance of 8333 ft. or more, only a vibrating contact having a period of 50 oscillations per second (such as 19) (or a direct 50
 10 cycle A. C. supply, if available) would be in operation, but if the clear distance is less than this figure, special frequencies would come into operation.

The frequencies (f_D) applied to the track sections representing gradient and/or curvature may be arbitrarily chosen, a convenient scale being:

Scale N

R = -2%	-1½%	-1%	-½%	Level	+½%	+1%
$f_D = 10$	20	30	40	50	60	70
R = +1½%	+2%					
$f_D = 80$	90					

(Note: The previously described construction shows only two points of adjustment on either
 15 side of level, but obviously more may be employed if desired).

The required gradient frequencies, selected as above, are employed on track circuits as before explained, and are applied by vibrating contacts such as 39 and 51 (Figure 1). Figure 1 being
 20 diagrammatic only, it will be understood that any suitable means of applying the required determined frequencies to the track circuits may be employed.

The calibration of rod 74 to permit of rapid
 35 manual adjustment of lamp carriage 78 when the train make-up is varied, may be carried out as follows:

From formula (1) we obtain

$$V = \sqrt{3D(Rt + Rg)} \quad (3) \quad 40$$

Assuming D=3000 ft. which from the scale M above gives frequency $f_D=70$ cycles per second, and by employing various values for Rt+Rg (indicated below by R) the following scale is obtained:

Scale O

R (%)	1	1½	2	2½	3	3½	4	4½
V (M. P. H.)	30	36.75	42.42	47.4	51.96	57.1	60	63.6
R (%)	5	5½	6	6½	7	7½	8	8½
V (M. P. H.)	66.9	70.35	73.5	76.5	79.3	82.1	84.9	87.3
R (%)	9	9½	10	10½	11	11½	12	
V (M. P. H.)	90	92.4	94.9	97.2	99.45	101.7	103.95	

Since a frequency of 70 cycles has been chosen
 55 for setting purposes, screen 88 (Figure 6) is rotated to the position it will occupy when energized by 70 cycle current from the rails. The train braking characteristics having been determined from the train make-up at (say) 4%,
 60 which from the scale O is equivalent to 60 M. P. H., finger knob 101 is rotated to move lamp 79 to a position wherein its rays will illuminate window 70 up to the 60 M. P. H. division. This position is marked on rod 74, or on controller
 65 disc 102, for future settings of 4% trains. Similarly, by adopting other values of R from (say) 1% to 12% in scale O, the rod 74, or disc 102, may be completely calibrated, and it will then be a matter of facility to make future settings on
 70 the instrument for various values of retardation percentages for various values of train make-up.

It is to be noted that the gearing between screwed shaft 80 and controller disc 102 is such that for every position of carriage 78 of (say)
 75

$\frac{1}{2}\%$ variation of retardation, one of the contacts 103 is under insulator 110, thus synchronizing these units.

A summary of the foregoing calculations is given in the form of a table, calculated for a hypothetical length of track, in Figure 9.

This track consists of sections E, F, G, H, J, K and L of the various lengths given thereon, and the train is considered as moving from right to left. The frequency for clear track (f_D) and for gradient (f_G) calculated for each section of the track according as to whether one, two or more sections ahead are clear, are applied to the immediately preceding track section, as in known practice.

Taking section E as typical, values of f_D for one, two and three tracks clear ahead are obtained from scale M, which gives these frequencies for various lengths of clear track. The gradient frequency f_G is obtained by dividing the total velocity head by the length of clear track in hundreds of feet. In column E with two tracks ahead clear:

$$R = \frac{(67.5' - 15')}{9000} \times \frac{100}{1} \% \text{ rise} \\ = +.58\%$$

A rise being taken to the nearest lesser $\frac{1}{2}\%$, this is taken as $+\frac{1}{2}\%$ (rise), which from scale N gives $f_G = 60$ cycles. Similarly a fall is taken to the nearest greater $\frac{1}{2}\%$, for the sake of safety.

It will therefore be clear from the foregoing that the various frequencies required for indicating length of clear track ahead, and for the gradient and/or curvature of the line, may be readily calculated and applied to the rails of each track circuit, and as readily picked up therefrom and employed in the locomotive instrument. Moreover, since the frequencies applied to one track circuit are in respect of the next and succeeding track sections, the driver will always have the time taken in one track circuit to act on the indicator readings.

The invention therefore provides the essentials of a most complete form of locomotive or rail vehicle indicator, which may also be employed to give automatic brake control. The roadside apparatus is simplified, and it enables a vehicle driver to make the maximum safe speed over any section of the track, thus utilizing the permanent way to the greatest possible degree under all conditions and weathers, and by all types of trains.

In certain cases it may be desirable to replace the electric method of colouring the train speed indication by mechanical means, which are cheaper of construction and result in a simpler electrical circuit. Such mechanical means are shown in Figures 11, 12, 13 and 14 which illustrate the instrument heretofore described, with mechanical differences.

Referring particularly to Figures 11 and 12, the saddle 78¹ is mounted on the rails 74 and 75, and is actuated by screwed rod 80 as previously. Pins 181 and 181¹ on either side of saddle 78¹ pivotally engage respectively in elongated slots 182 and 182¹ of parallel arms 183 and 183¹ which at their forward end carry an arcuate screen 88¹. A cross rod 184, secured in spur wheel 86 driven through pinion 85 by the frequency meter 84, passes through arms 183, 183¹ and is supported by arm 89¹ journaled at 90. Thus it will be seen that rotation of spur wheel 86 due to actuation by frequency meter 84 causes rod 184 to swing arms 183 and 183¹ upwardly about pivot points 181

and 181¹, thus raising the screen 88¹. It will also be seen that adjustment of saddle 78¹ towards or from front window 70 by rotation of screwed rod 80 from the means hitherto described, will result in an increased or decreased lift respectively of the screen 88¹ for a given movement of the frequency meter. Illumination on window 70 is supplied from a lamp 185 mounted on bracket 186 secured to the framing.

The operation of this form of the track speed indicator is similar to that previously described.

The mechanical means of colouring the train speed indication according to its relation to the instantaneous value of the track speed, is best illustrated in Figures 11, 13 and 14. Spur wheel 126, driven through pinion 125 from a frequency meter as previously described, has mounted thereon a drum 187, apertured towards its front side as at 188, which forms a screen for the passage of light from a vertically disposed battery of lamps 189, 190 and 191 on to window 71 to give the train speed indication thereon. Formed in horizontal alignment across the back face of drum 187 are three spaced apertures 192, 193 and 194 which are glazed green, yellow and red respectively, and through any of which rays from lamps 189, 190 and 191 may pass to illuminate window 71 to a height which is determined by the instantaneous position of the upper edge of aperture 188 in the front of drum 187.

The selection of which of the coloured apertures the rays pass through is carried out by shielding, which in turn is dependent upon the instantaneous relation between the track and train speeds, that is the angular relation between screen 88¹ and drum 187.

At the forward extremity of arm 183 (Figure 11) is a pivotal connection 195 between this arm and a lever 196 which is journaled at 197 and is returned through an aperture 198 in partition 179 and carries an arcuate shield 199 disposed about the rear face of drum 187. Shield 199 is of the shape shown in Figure 14, being of generally rectangular shape which is slotted out at the right top corner at 200, and at the lower left corner at 201, these slots being in vertical register respectively with coloured apertures 192 and 194 in drum 187. Centrally shield 199 is apertured at 202 in vertical register with coloured aperture 193 in drum 187.

The operation of this shielding device, is readily seen from Figures 13 and 14. In Figure 14 shield 199 is in the position relative to drum 187 which it will occupy when the train and track speeds are equal, and it will be seen that rays from the lamp 189 in this relative position will pass through aperture 202 in shield 199, and through the yellow aperture 193 only in the drum, and hence illumination thrown on to window 71 will be coloured yellow, indicating the equality of the train and track speeds. In this position the green and red apertures 192 and 194 are blanked off by shield 199, and no light passes therethrough.

If, now, the track speed rises above train speed, shield 199 will be moved downwardly in relation to drum 187, and as will be seen from Figure 14, apertures 193 and 194 will be blanked by the shield, and slot 200 therein will expose green aperture 192 to the lamp rays, thus colouring the train speed indication green to indicate the excess of track speed over train speed.

Similarly, if track speed drops below train speed, shield 199 will rise relatively to drum 187, thus blanking apertures 192 and 193 and exposing red aperture 194, through which the lamp

rays pass to colour red the train speed indication on window 71.

The means for automatic application of the brakes in the case of an excess of train speed over track speed is also illustrated in Figures 13 and 14. An arcuate sector 203 is formed on drum 187 as a flange thereto, and a similar arcuate sector 204 is formed on shield 199. In the in-operative position, and in positions wherein the train speed and track speed are equal, sector 203 lies above sector 204 with the gap 205 left between the two sectors. If track speed is increased over train speed, a downward displacement of shield 199 in relation to drum 187 takes place, which results in a similar relative displacement of sector 204 in relation to sector 203, and hence a widening of gap 205 occurs. Reversely, an increase of train speed over track speed results in gap 205 being closed.

A light-sensitive cell 206 is located in transverse alignment with lamps 189, 190 and 191, and light from these lamps is adapted to fall on this cell, with control exercised by the intervening sectors 203 and 204. The cell 206 actuates a relay which is in the circuit of the electro-pneumatic valve 176 (hereinafter explained) and while illuminated enables this valve to hold the brakes off, but when illumination to the cell is cut off, the brakes are applied in known manner.

Thus it will be clear that while the train speed is less than or equal to the track speed, gap 205 will be present and lamps 189, 190 and 191 will illuminate cell 206 to hold the brakes off. If and when train speed exceeds track speed, gap 205 is closed, and illumination on cell 206 is cut off, and the brakes are applied.

The simplification of the instrument circuit resulting from the mechanism just described is illustrated in Figure 10. The pick-up circuit with its amplifiers 57 and 65, and the proving relays 60 and 66 thereof, is unaltered. Lamps 189, 190 and 191 are connected in parallel to a supply, and the track speed lamp 185 has a circuit across the supply through a proving relay 207 which when energized closes contact 208. The circuit of light-sensitive cell 206 is across the supply through a relay 209 which closes contact 210 when illuminated.

From the supply a circuit is taken through contacts 208, 210 and through contacts 170 and 171 of the proving relays 60 and 66 to the electro-pneumatic valve 176. While the cell 206 is illuminated from lamps 189, 190 and 191 (due to excess of track speed over train speed) the circuit to valve 176 is made through contact 210, and the brakes are held off. When, however, train speed exceeds track speed the illumination on cell 206 is interrupted, and contact 210 opened, thus de-energizing valve 176 and applying the brakes with a suitable time lag.

An armature coupled to that of relay 209 closes contact 211 when contact 210 is closed, and closes contact 212 when contact 210 is open. This armature is connected across the terminals of the source of supply through a "proceed" repeater lamp 123¹ (for the use of the fireman) which is energized when cell 206 is illuminated, and a red ("stop") repeater lamp 122¹ which is energized when the cell is not illuminated, thus indicating to the fireman that the train speed is respectively below or above the permissible track speed.

I claim:

1. An electric system of railroad signaling incorporating a plurality of segregated successive track circuits, means for circulating two electric

currents in each of said track circuits, one of said currents having a frequency which is dependent upon and variable with the length, up to a predetermined maximum length, of clear track ahead of that circuit, and the other of which currents having a frequency which is dependent upon and variable with the overall physical conditions affecting train speed of the said length of clear track, operating in combination with means, carried by a rail vehicle moving over one of said track circuits for separately picking up by induction said two currents in that track circuit, and an indicating instrument, carried by said vehicle, which is operated by said two induced currents in combination.

2. An electric system of railroad signaling according to claim 1, in which said instrument incorporates adjustment means to compensate for variation in the braking characteristics of the train embodying the rail vehicle.

3. An electric system of railroad signaling, including a plurality of track circuits, means for passing through said track circuits two currents, the frequency of one of which is dependent upon the length of clear track ahead of said circuit up to a predetermined maximum and the frequency of the other of which is dependent upon the physical conditions affecting the speed of the train over said length of clear track, and an instrument comprising means to indicate the maximum permissible speed of the train traveling over said track circuits, said means being manually adjustable with reference to the braking characteristics of the train; the instrument also comprising means actuated by the frequency of the physical condition current picked up by the train for automatically adjusting said indicating means, and means actuated by the frequency of the clear track current picked up by the train for controlling the indication furnished by said indicating means.

4. An electric system of railroad signaling, including a plurality of track circuits, means for passing through each of said circuits two currents, the frequency of one of which is dependent upon the length of the clear track ahead of said circuit up to a predetermined maximum, and the frequency of the other of which is dependent upon the physical conditions affecting the speed of the train over the length of the clear track, and an instrument comprising a calibrated scale, a screen, a lamp adapted to illuminate the calibrated scale to varying heights for indicating thereby the maximum permissible track speed of a train traveling over said track, means for initially positioning the lamp with respect to the scale in accordance with the braking characteristics of the train, the instrument also comprising means actuated by the frequency of the physical condition current picked up by the train from the track circuit for automatically varying the position of said lamp from that position to which it has been initially adjusted, and means actuated by the frequency of the clear track current picked up by the train for automatically adjusting the screen to control the height to which said lamp illuminates said scale.

5. An electric system of railroad signaling, including a plurality of track circuits, means for passing through each track circuit two currents the frequency of one of which is dependent upon the length of clear track ahead of said circuit up to a predetermined maximum and the frequency of the other of which is dependent upon the physical conditions affecting the speed of the

train over the length of the clear track, and an instrument comprising a calibrated scale, a screen, a lamp adapted to illuminate the calibrated scale to varying heights to indicate the maximum permissible track speed of a train traveling over said track, means for initially positioning the lamp with respect to said scale in accordance with the braking characteristics of the train, the instrument also comprising means actuated by the frequency of the physical condition current picked up by the train for automatically varying the positioning of said lamp, means actuated by the frequency of the clear track current picked up by the train for automatically adjusting said screen to control the height to which said lamp illuminates said scale, a second lamp, a second calibrated scale illuminated by said second lamp, and means for controlling the illumination of said screen by said second lamp in accordance with the actual speed of the train.

6. An electric system of railroad signaling, including a plurality of track circuits, each of which is energized by two currents, the frequency of one of which is dependent upon the length of the clear track ahead of said circuit up to a predetermined maximum and the frequency of the other of which is dependent upon the physical conditions affecting train speed of the said length of clear track, an instrument comprising a calibrated scale, a screen, a lamp adapted to illuminate the calibrated scale to varying heights to indicate the maximum permissible track speed of a train traveling over said track, means for positioning the lamp initially with respect to said scale in accordance with the braking characteristics of the train, means actuated by the frequency of the physical condition current picked up by the train for automatically moving the lamp to vary the illumination of said scale thereby, means actuated by the frequency of the clear track current picked up by the train for automatically adjusting said screen to control the height to which said lamp illuminates said scale, a second calibrated scale, and means for illuminating said second scale to a height dependent upon the actual speed of the train, and means for automatically controlling the braking of the train in accordance with relative illuminations of said scales.

7. An electric system of railroad signaling, including a plurality of track circuits each of which is energized by two currents, the frequency of one of which is dependent upon the length of clear track ahead of said circuit up to a predetermined maximum, and the frequency of the other of which is dependent upon the physical conditions affecting the train speed over the length of the clear track, and an instrument comprising a calibrated scale, a screen, a lamp adapted to illuminate the calibrated scale to varying heights for indicating the maximum permissible track speed of a train traveling over the track, said lamp being adjustable initially in relation to said scale in accordance with the braking characteristics of the train, the instrument also comprising means actuated by the frequency of the physical condition current picked up by the train for automatically varying the position of said lamp relatively to the scale, means actuated by the frequency of the clear track current picked up by the train for automatically adjusting said screen, whereby the height of illumination of the scale by the lamp is controlled, a second calibrated scale, means under control of the actual train

speed for variably illuminating said second scale, and means for variously coloring said actual train speed indication dependent upon the actual speed of the train being below, in the zone of or above the track speed.

8. An electric system of railroad signaling, including a plurality of track circuits each of which is energized by two currents, the frequency of one of which is dependent upon the length of clear track ahead of said circuit up to a predetermined maximum and the frequency of the other of which is dependent upon the physical conditions affecting the train speed over said length of clear track, and an instrument comprising a calibrated scale, a screen, a lamp adapted to illuminate the calibrated scale to varying heights to indicate the maximum permissible track speed of a train traveling over the track, the position of the lamp being initially adjustable in relation to the scale according to the braking characteristics of the train, said instrument also comprising means actuated by the frequency of the physical condition current picked up by the train from the track circuit for automatically varying the position of said lamp, means actuated by the frequency of the clear track current picked up by the train for automatically adjusting the screen to control the height to which the scale is illuminated by the lamp, a second calibrated scale, another lamp for illuminating said second calibrated scale to varying heights in accordance with the actual speed of the train, a plurality of light sensitive strips, the resistances of which are affected respectively by the illumination projected thereon by said two lamps respectively and means for controlling a brake applying circuit in accordance with the difference in the resistances due to varying illumination of said light sensitive strips.

9. An electric system of railroad signaling, including a plurality of track circuits, each of which is energized by two currents, the frequency of one of which is dependent upon the length of clear track ahead of said circuit up to a predetermined maximum and the frequency of the other of which is dependent upon the physical condition affecting the speed of the train over the said length of clear track, and an instrument comprising a calibrated scale, a screen, a lamp adapted to illuminate the calibrated scale to varying heights in accordance with the maximum permissible track speed over the clear track ahead, means for positioning the lamp initially with respect to said scale in accordance with the braking characteristics of the train, means actuated by the frequency of the physical condition current picked up by the train for automatically varying the position of said lamp with respect to said scale, means actuated by the frequency of the clear track current picked up by the train for automatically varying the position of the screen to vary thereby the height to which said scale is illuminated by said lamp, a second calibrated scale, a second lamp, and means for illuminating said second scale by said second lamp in accordance with the actual train speed, said last named means comprising a pair of light sensitive strips, the resistances of which are affected respectively by the illumination projected thereon in accordance with the actual speed of the train and the illumination projected thereon in accordance with the permissible track speed, said light sensitive strips being adapted to energize different lamps for illuminating said second calibrated scale in varying colors dependent upon the actual

train speed being below, in the zone of or above the permissible track speed respectively.

10. An electric system of railroad signaling, including a plurality of track circuits, means for passing through each track circuit two currents the frequency of one of which is dependent upon the length of clear track ahead of the circuit and the frequency of the other of which is dependent upon the over-all physical conditions affecting the speed of the train over the length of clear track ahead, and an instrument comprising permissible track speed indicating means, means actuated by the frequency of the clear track current picked up by the train for controlling said permissible track speed indicating means, said permissible track speed indicating means being initially adjustable in said instrument in accordance with the braking characteristics of the train, said means for actuating the track speed indicating means including a reversible electric motor, and a selectively adjustable contact device influenced by the physical condition frequency picked up by the train for controlling said electric motor.

11. An electric system of railroad signaling having a plurality of track circuits each of which is energized by two currents, the frequency of one of which is dependent upon the length of clear track ahead of the circuit and the frequency of the other of which is dependent upon the physical conditions affecting the actual speed of the train over the clear track, and an instrument comprising a lamp, a calibrated scale for indicating thereon the maximum permissible track speed of a train, a pivoted screen adapted to be interposed at varying positions between said lamp and said scale, means actuated by the frequency of the clear track current picked up by the train for moving said screen about its pivot, and means actuated by the frequency of the physical condition current picked up by the train for varying the position of the pivot of said screen relatively to said scale.

12. An electric system of railroad signaling having a plurality of track circuits each of which is energized by two currents the frequency of one of which is dependent upon the length of clear track ahead of the circuit and the frequency of the other of which is dependent upon the physical condition affecting the actual train speed over the said length of clear track, and an instrument comprising a calibrated scale, a lamp, means under control of the frequency of the clear track current for controlling the illumination of the scale, a train speed indicator, and means for variously coloring the train speed indication dependent upon its relation to the permissible track speed, and means for automatically controlling the brakes of the train dependent upon the means for variously coloring the track and train speed indications.

13. An electric system of railroad signaling incorporating a plurality of segregated successive track circuits, means for circulating two electric currents in each of said track circuits, one of said currents having a frequency which is dependent upon and variable with the length of clear track ahead of said circuit up to a predetermined maximum and the other of which currents having a frequency which is dependent upon and variable with the over-all physical conditions affecting train speed over the length of clear track, means on a rail vehicle moving over said track circuits for separately picking up by induction said two currents in each track circuit, an indicating in-

strument carried by the vehicle, means operated by the induced currents in combination for actuating said instrument to provide permissible track speed indications, and actual train speed indications, and means in said instrument for adjusting an indicating means to compensate for variation in the braking characteristics of the train embodying the rail vehicle.

14. An electric system of railroad signaling incorporating a plurality of track circuits, means for passing through each track circuit two electric currents, one of the currents having a frequency dependent upon the length of the clear track ahead of said circuit up to a predetermined maximum, the other of which having a frequency dependent upon the physical conditions affecting the actual speed of the train over the length of clear track, and an instrument carried by a rail vehicle traveling over said tracks for determining the maximum permissible speed of the train, said instrument comprising an operative unit for indicating the permissible track speed, means for adjusting said operative unit according to the braking characteristics of the train, and means operated by the frequency of said clear track circuit for controlling said operative unit within said instrument.

15. An electric system of railroad signaling incorporating a plurality of segregated track circuits, means for energizing each of said track circuits by two currents, the frequency of one of which is dependent upon the length of clear track ahead of said circuit up to a predetermined maximum and the frequency of the other of which is dependent upon the physical condition affecting the actual speed of train over the length of clear track, and an instrument carried by a rail vehicle successively traveling over the track sections with which said track circuits are associated, means in said instrument for indicating and determining the maximum permissible speed of a train traveling over the tracks, said instrument comprising an operative indicating unit, means for adjusting said unit according to the braking characteristics of the train, and means operated respectively by the frequencies of the said two currents in the segregated track sections for controlling the operative indicating unit within the instrument.

16. An electric system of railroad signaling incorporating a plurality of segregated successive track sections, circuits associated with each section, each circuit being energized by two currents the frequency of one of which is dependent upon the length of clear track ahead of said circuit up to a predetermined maximum and the frequency of the other of which is dependent upon the physical conditions affecting the actual speed of the trains over the length of clear track, and an instrument carried by a vehicle traveling over said track sections having means for determining and indicating the maximum permissible speed of a train traveling over the track, said instrument incorporating an operative unit, means for controlling the position of said operative unit, said last named means being energized by the frequency of one of said currents picked up by the rail vehicle, means for adjusting said operative unit in accordance with the braking characteristics of the train, means for determining the actual speed of the train, means for automatically indicating the relationship between the actual speed of the train and the maximum permissible track speed, and means for automatically controlling the speed of the train in accord-

ance with the relationship between said indications.

5 17. An electric system of railroad signaling, incorporating in combination a plurality of segregated track circuits, means for circulating in each of said track circuits an electric current, the frequency of which is dependent upon the length of clear track ahead of that track circuit, means

associated with a rail vehicle to pick up said current when the vehicle is traveling over the track circuit, an indicating instrument mounted on said vehicle and operated by said current, and adjustment means incorporated in said instrument to 5 compensate for variation in the braking characteristics of the train embodying the rail vehicle.

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