

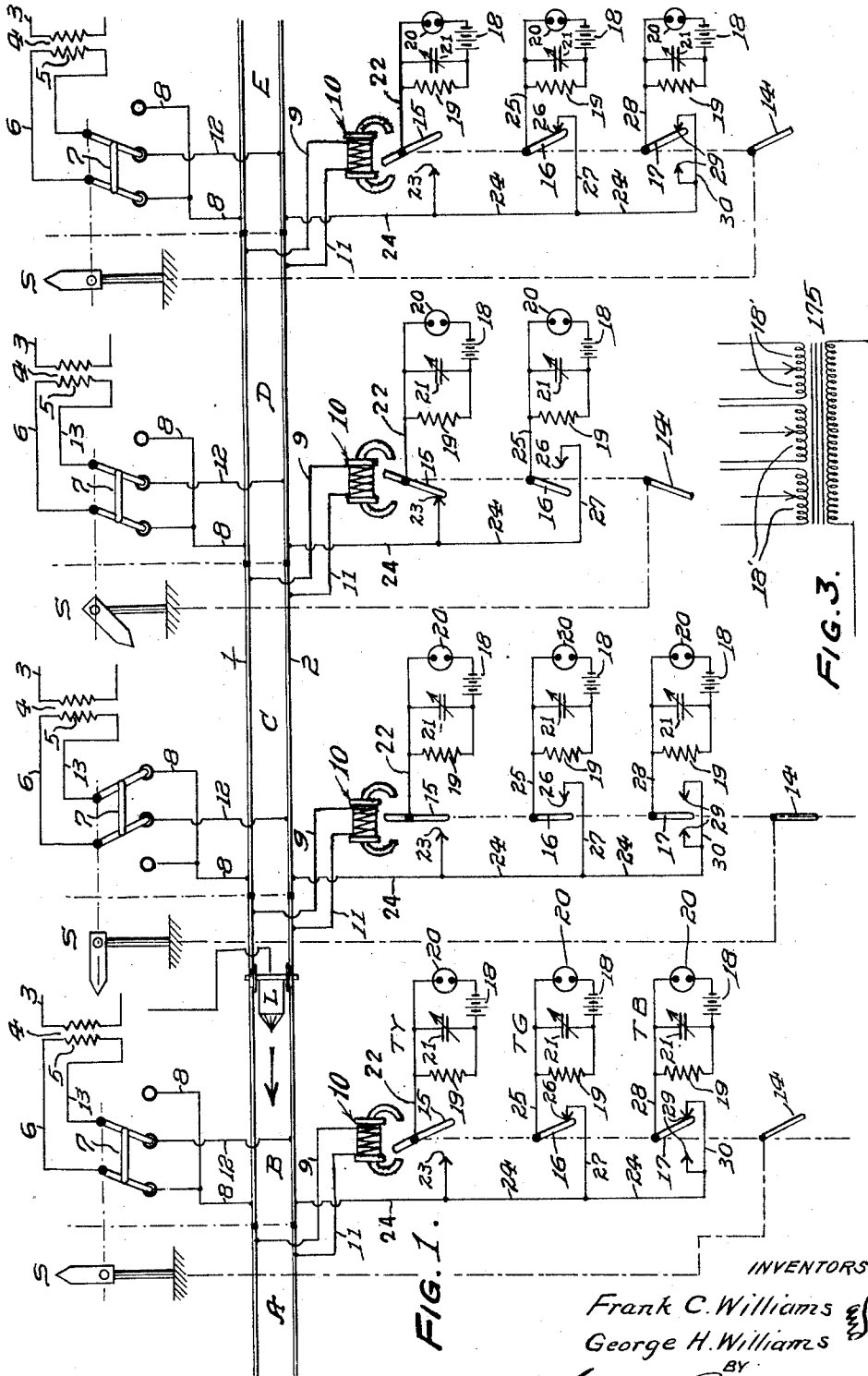
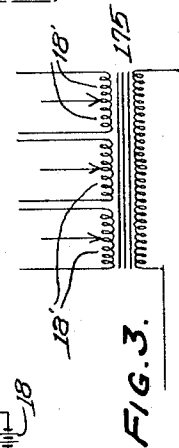
April 14, 1931.

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TRAIN STOPPING AND SPEED CONTROLLING MECHANISM

Original Filed July 28, 1926 3 Sheets-Sheet 1



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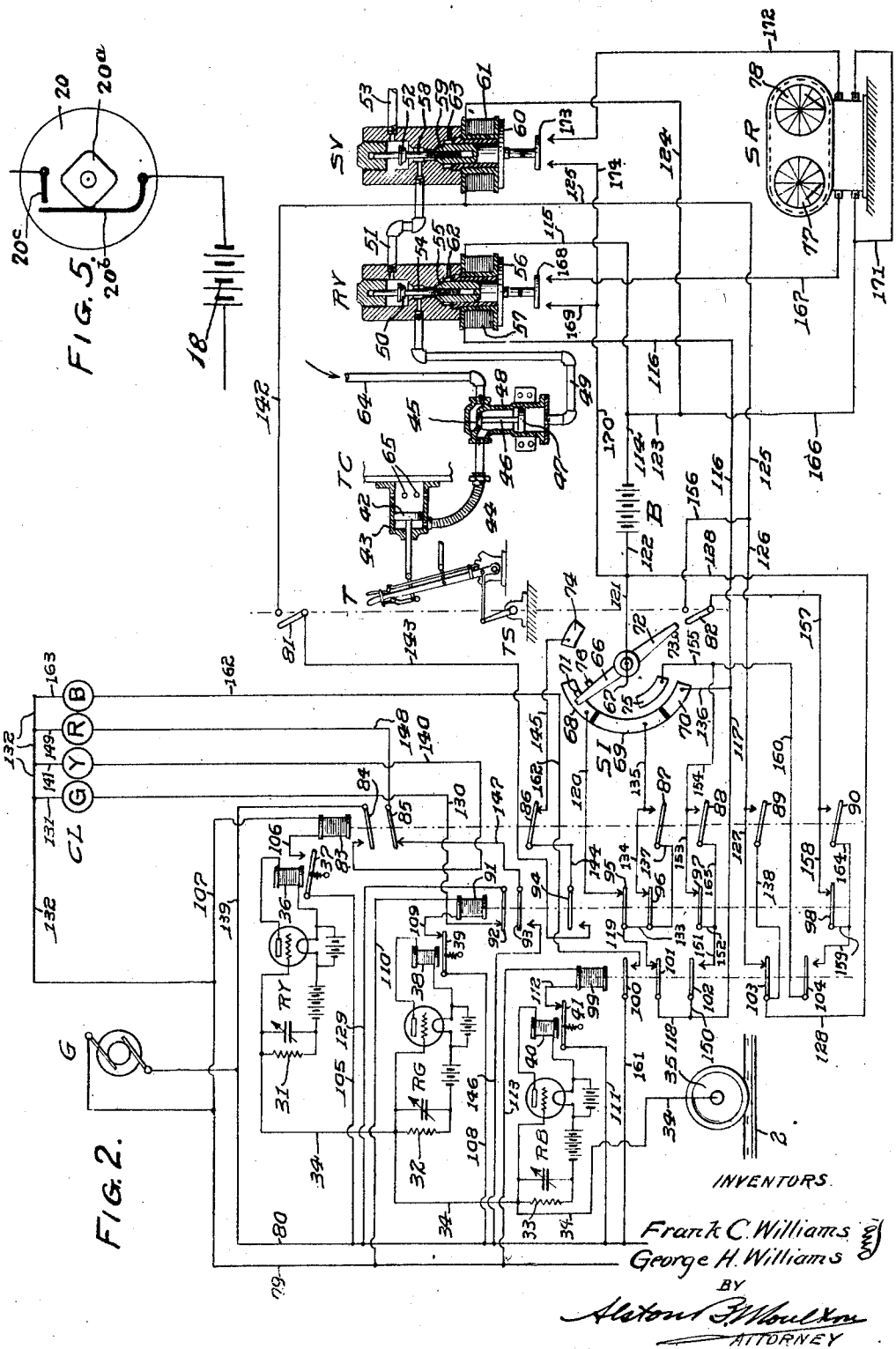
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TRAIN STOPPING AND SPEED CONTROLLING MECHANISM

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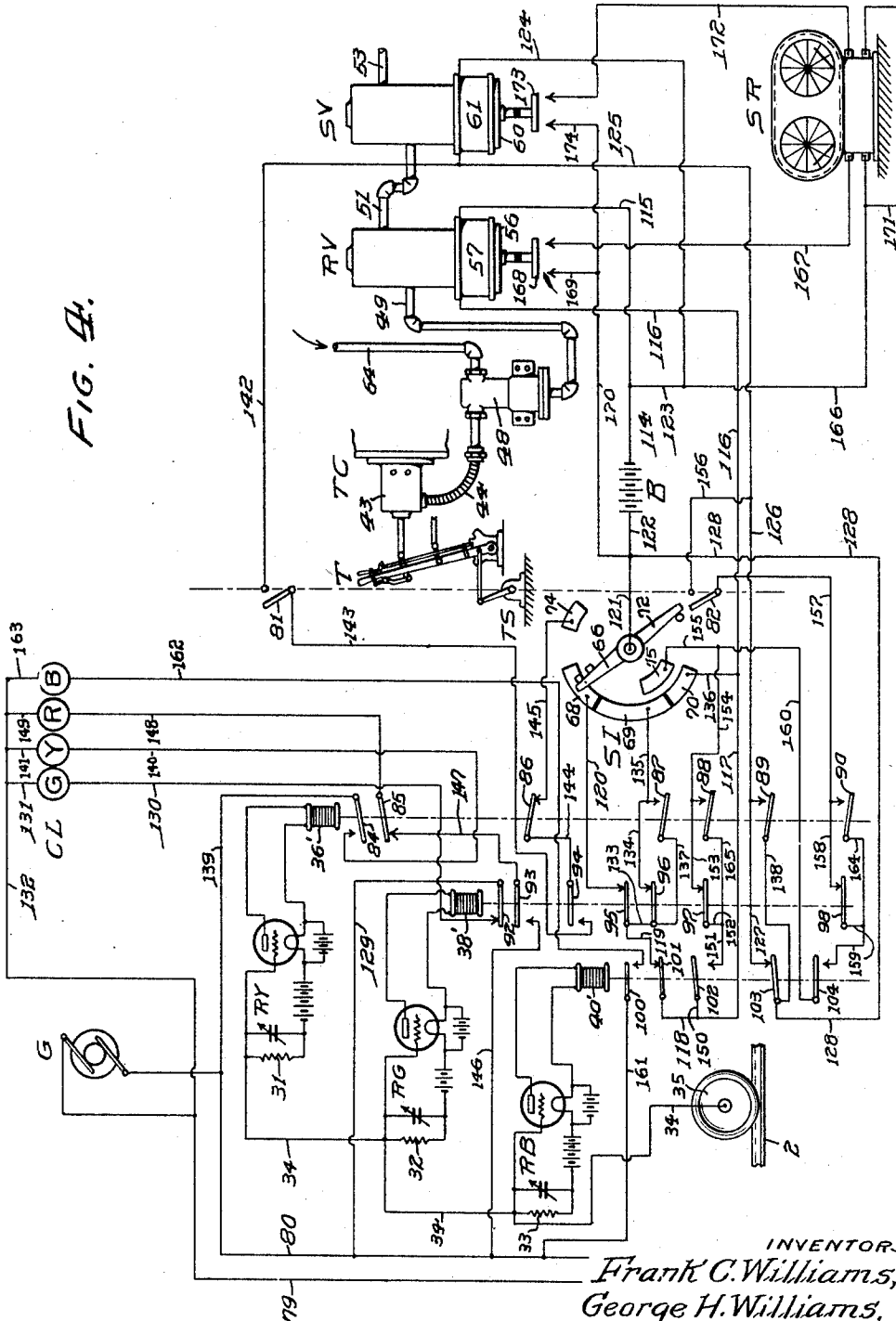
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TRAIN STOPPING AND SPEED CONTROLLING MECHANISM

Original Filed July 28, 1926 3 Sheets-Sheet 3

FIG. 4.



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TRAIN STOPPING AND SPEED-CONTROLLING MECHANISM

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Our invention relates to train stopping and speed controlling mechanisms operating automatically and independently of human interference, to reduce the speed of a train to predetermined speeds whenever the engineer attempts to drive the train at a speed faster than predetermined for the block under the then existing conditions, as may be indicated by the block signal system for the block in which the train may be, or is about to enter, and will stop the train or reduce the speed of the train to a "stop" or very slow speed if the engineer attempts to pass a "danger" signal.

A further object of our invention is to provide a mechanism of the character above referred to which is operated by waves of predetermined uniform frequency or length transmitted directly to the rails or to a rail at the far or departure end of the block, the transmitter for each block being controlled by the block-signal system and being operative to control the train speed when the train is in the block with which the transmitter is connected.

A further object of our invention is to provide a train with a plurality of radio receiving sets, each of which is tuned to and will respond only to one set of waves sent out from the transmitting station of the block in which the train may be, said waves being received by the radio receiving set directly from the track through the wheels or truck and a wire or metal connection from the wheels or truck to the tuned receiving coils of the receiving sets.

A further object of our invention is to continuously produce from a transmitting station located substantially at the departure end of each block, waves or oscillations of two distinct and different lengths or frequencies and to transmit, to the rail, waves of one of said lengths or frequencies so long as the block signals are set for one position, e. g., "safety"; to cut off the transmission of said waves when the signal is set to another position, e. g., "caution" and to simultaneously transmit, to the rail, waves or oscillations of another frequency or length; and to cut off and transmit no waves whatever to the rail when the signal of the block signal system is

set to another position, e. g., "danger"; and to control the transmitting and cutting off of the waves to the rails entirely automatically and by the block signal system itself.

A further object of our invention is to control and vary the kinds or lengths or frequencies of waves transmitted to a rail from a field transmitting station at the departure end of a block by the block signal system of said block.

In order to illustrate the manner in which our train controlling mechanism is operated, it may be stated that one of the most commonly used block systems of the present time is an automatic system, so operated that the presence of a train in a particular block will throw the signal at the beginning or entrance end of that block to "danger" (red) position; will throw the signal at the beginning of the block next in the rear thereof to "caution" (yellow) position; and the one behind that to "clear" (green) position. Thus a train controls three signals, namely, that last passed by the train and which is "danger" (red); the next behind the "danger" signal which is "caution" (yellow); and the next behind the "caution" signal which is "safety" or "clear" (green). This system is called the "normally clear" block signal system.

It is the object of the present invention to control the transmission of waves from each transmitting station, by the block signal of the block to which the transmitting station is connected so that when the signal is set to "danger" no waves will be transmitted from the transmitting station to a rail of that block; when said signal is set to "caution" only one kind, length or frequency of wave will be transmitted to the rail from said transmitting station; and when the signal is set to "clear" another kind, length or frequency of wave will be instantaneously transmitted to the rail, and the transmission of the other said kind or frequency of wave will be simultaneously automatically discontinued.

A further object of our invention is to provide a train with two radio receiving sets, each tuned to respond to but one of the two kinds, lengths or frequencies of waves transmitted to the track from the transmitting station

of the block in which a train may be, and to operate cab signals thereby, said receiving sets being operative to display one signal light in the cab indicative of the track condition when waves of one frequency are being transmitted to the track; to display another cab signal light when the other receiving set is receiving oscillations or waves of another frequency and indicative of track conditions, and to display a third cab signal when neither set is receiving oscillations to which it is attuned; said receiving sets, in like manner being operative to actuate an automatic speed controlling mechanism for the train to prevent the train from traveling at a higher speed than that predetermined for a train under the signal conditions indicated by the signal of the block.

A further object of our invention is to provide two radio receiving sets, each tuned to respond to but one of two lengths, kinds or frequencies of waves transmitted from the field or track transmitting station, said two receiving sets being operative to display cab signal lights which may be the standard signals, viz., green for "safety", yellow for "caution" and red for "danger", the display of signals being dependent upon whether one or the other or neither of the sets is receiving waves from the transmitting station; and to provide also a fourth cab signal light which, for instance, may be blue and which will be illumined only when a block or a block section must be traversed at a predetermined reduced speed of, for instance, twelve miles an hour, as in passing through yards, around sharp curves and just prior to traversing a cross over, which track condition may not be indicated by the block signal system.

A further object of our invention is to provide a train with two radio receiving sets, so combined and so cooperating with an automatic speed responsive device, the throttle or controller handle, and the brake applying mechanism, as to automatically apply the brakes and control the throttle when a train enters a block controlled by the block signal system at a speed higher than that predetermined for that signal and to hold the brakes applied until the speed of the train has been reduced to that predetermined speed and to automatically release the brakes when the speed has been reduced to the proper speed so that the engineer may proceed so long as he proceeds no faster than the speed predetermined for that block or under the then existing conditions indicated by the block signal.

A further object of our invention is to provide the locomotive or train or motor of a train with radio receiving sets responsive only to waves transmitted to a rail from a transmission station connected to the departure end of the block in which a train may be,

and to make the sets operative to control, by their alternate action or their combined inaction, an automatic brake applying mechanism, a throttle controlling mechanism and a recording mechanism, the latter being a mechanism for automatically making a record of every time that the speed of the train has been automatically reduced, or the train has been automatically stopped.

A further object of our invention is to provide an arrangement whereby if the speed indicator, which cooperates with the brake applying mechanism, indicates that the train is moving in a block at a speed higher than that corresponding to the block signal of that block the brakes will be applied and the speed of the train automatically reduced to the proper speed.

A further object of our invention is to provide an arrangement whereby if the speed indicator which cooperates with the train controlling mechanism sticks, or breaks or falls to its lowest position, which would, under proper operation, hold the stop valve energized, and permit the engineer to run at any speed regardless of the signal, then the control of the train is taken out of the hands of the engineer or motorman and the speed of the train is automatically reduced to "stop" or slowest speeds (for instance, three miles an hour), and the train cannot thereafter be driven at a speed higher than that until the indicator is repaired.

A further object of our invention is to provide a train stopping mechanism wherein the speed of the train may be automatically reduced to a "safety" speed of say twelve miles an hour (which is the speed at which trains usually travel through yards, around sharp curves or stretches of track immediately in advance of a crossover) independent of the block signal system. In other words, the block signal may indicate that the track is "clear" but the speed controlling mechanism will operate to automatically reduce the speed of the train to, for instance, twelve miles an hour over such stretches or section of the track, if the engineer attempts to traverse the same at a higher rate of speed than the twelve miles an hour or yard speed.

A further object of our invention is to provide a transmitter station, at the departure end of a block, with two tuned circuits, each excited by a reed vibrator, vibrating at a fixed constant frequency, but different each from the other and to alternately connect said tuned circuits with a rail of the track by and in accordance with the block signal system, whereby one or the other of said tuned circuits alternately will transmit, to the rail, oscillations of the frequency of the respective tuned circuit and to provide the train with two radio receiving sets, the tuned coils of which are electrically connected to the track; said two receiving sets

being operative to control three cab signals and to restrict the speed of the train to one of three speeds ("high", "caution" and "slow" or "stop speed"), dependent upon whether one, the other or neither of the receiving sets is receiving oscillations from the transmitting station of the block to which the receiving sets are connected.

Other objects of our invention will appear in the specification and claims below.

Referring now to the drawings forming a part of this specification and in which substantially the same reference characters are used throughout the various views to designate the same parts,

Fig. 1 is a diagrammatic view of a track divided into three complete blocks and parts of two more blocks with four signals (one for the beginning of each block) and four transmitting stations (one at the departure end of each block), the signals being automatic block signals (the control circuits of which are not completely shown, but which may be of any approved type) each signal at the beginning or entrance end of a block controlling, through the rails, relays connected to the entrance end of the block, the relays being operative each to throw a set of switch arms to one of three positions. The mechanism for effecting this throw of a set of switches by a relay is the ordinary block signal relay such as is commonly in use and we utilize this block signal relay to electrically connect the train control transmission circuits alternately to a rail at the departure end of the block next preceding the block in which the signal is, or to interrupt the transmission of said waves thereto.

Fig. 2 is the radio receiving apparatus carried by a train and the train speed controlling mechanism, the receivers being electrically connected to a wheel of the truck which in turn is, of course, in contact with the rail. In this figure is also shown the cab signal system and the recorder which is operative to automatically make a record of the number of times the train stopping and speed controlling mechanism is operated.

Fig. 3 shows a modified way of obtaining a current for the tuned transmission circuits by a step-down transformer.

Fig. 4 is a modified construction similar to that of Fig. 1, but in which the radio relays in the radio circuits directly control the train speed-controlling mechanisms and cab signal circuits.

Fig. 5 is a diagrammatic view illustrating one type of reed vibrator which may be used at the equipment in the field transmitting station of each block.

At the outset, and for the sake of clearness, we may state that in the ordinary block signal system, the signals are set to three positions, namely, (1) "clear", (2) "caution" and (3) "danger or stop". In the system herein de-

scribed, the signal, when set to "clear" or green, connects one tuned transmitting circuit to a rail of the track. The signal, when set to "caution" or yellow, disconnects the tuned circuit last above referred to from the rail and instantaneously connects the second tuned circuit to the rail, and the signal, when set to "danger" or red, disconnects both tuned circuits from the rail so that no oscillations are communicated to the rail. Two transmitting circuits only are needed at each station to control the three train speeds.

Under these conditions but two receiving sets are necessary on the train, one responsive to the waves transmitted when the signal next ahead is green, the other of which is responsive to the waves or oscillations transmitted when the signal next ahead is yellow or "caution"; said receiving sets are, of course, inoperative to receive waves from the transmitting station when the transmitting circuits are disconnected from the rail.

Each of these two receiving sets includes and controls an electromagnet. When a set is receiving oscillations or waves it energizes an electromagnet. When it is not receiving, the magnet is not energized. These magnets actuate armatures which control electrical circuits. When one magnet is energized by reason of the reception of waves (e. g. those transmitted whenever the track signal is a green signal) the circuits are controlled to show a corresponding light (in the example given, green) in the cab and to maintain the train speed controlling mechanism inoperative. When the other receiving set is receiving oscillations to which it is tuned (e. g. corresponding to a yellow caution signal) its radio magnet is energized while the first-mentioned magnet is de-energized, and the circuits controlled thereby display a "caution" light in the cab and actuate the speed-controlling mechanism to reduce the speed of the train to "caution" speed, which may be assumed to be twenty-five miles an hour. When neither receiving set is responding to waves from the transmitting station and both magnets are consequently de-energized, the armatures of the radio magnets are operative to close an electric circuit to display a red or a "danger" light in the cab and to actuate the speed controlling mechanism to bring the train to stop or to a very slow speed of, for instance, three miles an hour.

But, in addition to these three track conditions there is a fourth condition which is not usually displayed by the automatic block signal system, and which calls for "yard" or sharp curve speed. It may, for convenience, be called a predetermined speed of twelve miles an hour. It is now the duty of the engineer to traverse such portions of the track to which this condition applies at a speed of not more than twelve miles an hour. We have therefore provided and have herein

shown, a third transmitter and a third receiving set respectively generating and tuned to waves of different length or frequency from those of the two transmitters and receivers above referred to, and this third transmitter is installed at stations of every block in which the twelve mile or yard speed limit regulation or condition does not apply. Over any section of track wherein the twelve mile condition applies, the third transmitter is omitted. To cooperate with this third transmitter we provide the third receiving apparatus with a tuned circuit which, as has been above indicated, will be maintained energized all the time except when the train is passing over a twelve mile yard speed section. Over such sections the radio electromagnet, controlled by the third radio receiving set, will become de-energized, and when the armature switches controlled by said magnet fall, they will close an electric circuit to display a fourth light (twelve mile speed limit light) in the cab, and will also actuate the speed controlling mechanism to reduce the train speed to twelve miles an hour if, in traversing such a section, the speed of the train be higher than the said predetermined speed of twelve miles an hour.

Thus, for controlling the speed of the train in accordance with the automatic block signal system now in use on tracks but two transmitting circuits and two receiving circuits are necessary but when it is desired to control the speed of the train independently of the block signals to a fourth speed of, e. g., twelve miles an hour, (around curves, through yards and preparatory to or in making a crossover) we simultaneously transmit to the rails waves of two different frequencies at all times, except over what we have termed twelve mile sections of track and over these twelve mile sections there will be but one set of oscillations or waves imposed upon the rail at any time, or no oscillations or waves at all.

In referring to the track it is assumed that the track shown in the drawings is a one-way track and that the trains traverse it from right to left. By the "beginning" or "entrance end" of a block is meant that part of the track first traversed by a train on entering the block and the "exit end" or "departure end" of a block is that portion of a block last traversed by a train in leaving the block.

The field equipment includes the block signal system, the wave transmitting stations and the electric circuits for operating the same diagrammatically shown in Fig. 1. The train equipment includes the automatic brake applying mechanism, an automatic cab signal system, a speed indicating and controlling mechanism and a radio receiving apparatus, comprising a plurality of radio receiving sets, each tuned and responsive only

to one of the wave lengths sent out from the field transmitter, the electric circuits carried by the train, and the throttle controlling mechanism and preferably an automatic recorder on which is made a record of the number of times the speed controlling mechanism is automatically operated, all as diagrammatically indicated in Fig. 2 or Fig. 4.

The automatic block signal system of the railroad operates in the usual manner, and, therefore, a diagram only of the same is shown in Fig. 1 wherein there are indicated the beginning of block A, three complete blocks B, C, D and the departure end of block E. Between the rails 1, 2 of each block there is inserted suitable insulating material.

The rails 1, 2 of each block are preferably provided with a low voltage two-phase alternating current which may be obtained from the high voltage line 3 and transformer 4. The low voltage signal circuit includes the secondary coil 5, the lead 6 to the reversing switch 7, the lead 8 to the rail 1 and through rail 1 to wire 9 at the beginning of or entrance end of a block, to a two-phase clockwork polarized track relay 10 of block signal S positioned at the beginning or entrance end of said block, thence by wire 11 through rail 2 and lead 12 to said reversing switch 7 and thence by wire 13 back to the secondary coil 5. The connections 8 and 12 from the reversing switch are at the "end" of each block and the wires 9 and 11 are at the "beginning" of each block. When the reversing switch 7 is in one position, such as is indicated in block B (Fig. 1), the low voltage current will be sent through the rails in one direction; when the reversing switch is in the opposite position, such as is shown in block C, then the low voltage signal current will be sent through the rails in the opposite direction. The reversing switch is operated from its adjacent signal S, that is to say, the switch 7 connected to the rails at the exit end of block B is operated by the signal S located at the beginning of block A, and so on throughout the length of the track. The direction of the flow of the current in the track rails is the same under the "caution" indication of the signal S as it is under the "clear" indication of signal S and this direction may be called the normal direction. When, however, the signal S is in "danger" position, such as is indicated in connection with the exit end of block C, (or the entrance end of block B), then the reversing switch 7 will be thrown to the position shown in block C and the current will be fed through the rails in a direction reverse to that of the normal direction to throw the signal S at the beginning of block C to "caution" position. A further description of this mechanism and operation will be given below. When the current flows through this circuit in one direction, the polarized relay 10 will throw the armature 14

of the signal system (shown in dotted lines) to the position shown in connection with the relay 10 of block A. When the current flows through the said circuit in the opposite direction, then the armature 14 will be thrown to the limit of its movement in the opposite direction, that is to say, to the position shown under the relay 10 connected to the rails of block C. When, however, a train T is in a block, as illustrated in block B, then the trucks 15 short-circuit the signal current supplied thereto from the transformer 4 of the block irrespective of the direction of the current in the rails and the relay 10 of that block is de-energized with the result that the armature 14 of the signal system occupies a neutral position, such as is shown at the beginning of block B, (or exit end of block C).

This movement of the armature 14 is operative to throw the signal S connected thereto as indicated by the dotted lines, to "safety", "danger" and "caution" positions, as is respectively shown in the signals in the beginning of blocks A, B, C. Thus it is that the relay 10 (and the train when it is in the block) control the position of its signal S and the signal S controls the position of the reversing switch 7. Whenever the signals S are in "safety" or "caution" position, the current supplied to the rails at the exit ends of the blocks will flow in the normal direction but whenever a relay 10 is de-energized then the signals S will throw the reversing switch to a position to reverse the current supplied to the block controlled by the relay 10 to throw the succeeding signal of the block next in the rear to "caution" position. We utilize these polarized relays 10 of the block signal system to control the transmission of waves from the transmitting stations by making each relay actuate at least two, and, if desired, three, other switches 15, 16 and 17, the movement of which will be exactly like that of armature 14. The switch 17, may, however, be entirely omitted for it is the switch which controls the transmission of waves or oscillations to effect the operation of the twelve mile or yard speed limit control, which control is generally not effected by the block signal system. When it is employed, however, its function is to supply waves of a predetermined frequency to the track except in those blocks or sections of a track wherein the train speed should not be over twelve miles an hour. In the transmitting stations of such blocks, the switch 17 may be omitted together with the circuits controlled thereby as will be referred to again below. Such a block is indicated in Fig. 1 as block D. In every block there are two transmitters TY and TG, each of which includes a circuit comprising a battery 18, a coil 19, a reed vibrator 20 and a variable tuning condenser 21 bridging the coil 19. The reed vibrator may be of any approved commercial type. In Fig. 5 we have shown, in a diagram-

matic manner, one type of reed vibrator wherein a rotatable cam 20^a having a predetermined number of cam projections thereon actuates a vibrator arm or reed 20^b. When a projection on the cam 20^a lifts or forces the reed 20^b, it separates the free end of the arm from a contact point 20^c to break the circuit and when the projection on the cam passes out from under or against the reed 20^b, the reed, which may be of a resilient character, will move into engagement with the stationary contact point 20^c. It is obvious that the three reed vibrators at each transmitting station must be effected to produce two or three different tuned circuits for each transmitter station. This may be effected by providing each of the reed vibrators of a station with cams 20^a having a different number of projections thereon, the cams all being rotated at the same speed, or the cams may be all alike and the shafts on which the cams are rotated may be revolved at different constant speeds. But the preceding description is not to be construed as limiting this application to this particular type of reed vibrator, for an electromagnet interrupter, such as is used for interrupting a primary circuit of an induction coil, may be used as the reed vibrator when desired. The circuits of the vibrators may be tuned and adjusted to produce oscillations therein of any predetermined and desired frequency. From the transmitting circuit TY (yellow transmitter) a lead 22 extends to the pivot of the switch 15 controlled by the relay magnet 10. This switch 15, in one of its extreme positions or at the limit of its motion in one direction, is maintained out of engagement with its contact point 23, but in its other extreme position, it engages said contact point 23 which is connected by wire 24 to the rail 2. When the switch 15 is in engagement with its contact point 23, the oscillations of the transmitting circuit TY are transmitted to rail 2.

Similarly, the transmitter TG (and the transmitter TB when employed) comprises the same arrangement of battery 18, coil 19, reed vibrator, and tuning condenser 21. A wire 25 from the oscillating circuit of the transmitter TG (green transmitter) is connected to the pivot of the switch 16 which is a single contact switch and its contact point 26 is connected by wire 27 to the wire 24 leading to the track 2. The switch 16 is in engagement with its contact point 26 in one of its extreme positions and that is always when the switch 15 is in its extreme position and out of engagement with its contact point 23.

And when the transmitter TB (blue transmitter) is employed it is connected by wire 28 to the pivot of switch 17 which is a two-point switch and this switch 17 is adapted to engage with one or the other of its bridged contacts 29, 29. Whenever the switch arm 17 is at the limit of its throw in either direction a contact 29 (and consequently the

tuned circuit of transmitter TB) is connected by wire 30 to wire 24 leading to the track rail 2. In the arrangement shown in Fig. 1 and in connection with the beginning of block A and the signal S there located, when the signal S is in the "clear" position, then the switch arm 15 of transmitter TY is in its remote position from its contact point 23 and no oscillations are transmitted to the rail 2 from transmitter circuit TY. But switch arm 16 is in engagement with its contact 26 and transmitter TG is connected to rail 2 and the oscillations of the circuit of transmitter TG (green) are communicated to the rail 2. When a transmitter TB is employed, then switch 17 will be in engagement with one of its contact points 29 and the oscillating circuit of the transmitter TB will also be impressed on the rail 2. As shown in the signal system at the beginning of block B, when the signal S is in "danger" position, (as due to the presence of a train in block B), then the relay 10 will be de-energized and the armatures 15, 16 and 17 will be out of engagement with any of their contact points and none of the transmitters will be connected to the rail.

As shown at the beginning of block C, when the signal S is in "caution" position, then the switches 15 and 16 will be in their extreme positions opposite to that shown at the beginning of block A, the transmitter TY will be connected to the rail 2 and the transmitter TG will be disconnected from the rail. Under these conditions, however, whenever there is a transmitter TB it will also be connected to the rail under "caution" conditions.

To briefly recapitulate, when the signal S is in "safety" position, which is indicated by a green signal, then the transmitter TG (green) is connected to the corresponding rail and the transmitter TY (yellow) is disconnected from the corresponding rail 2; when the signal S is in "danger" (red) position, then both the transmitter, TY, and the transmitter TG are disconnected from the corresponding rail; and when the signal S is in "caution" (yellow) position, then the transmitter circuit TY (yellow) is connected to the corresponding track rail 2 and the transmitter TG (green) is disconnected from the corresponding track rail 2. These three positions are the conditions indicated by the usual ordinary automatic block signal system. Whenever our "yard" speed controlling mechanism is installed on the train, then there will also be a yard speed transmitter TB always connected to the rail, whenever either of the transmitters, TY or TG, are connected to said rail, (in all blocks where the twelve mile limit does not apply), and the connection of which to the rail, will be always broken when the transmitters TY and TG are disconnected from the rail.

Over a block or a section of a block in which there is a twelve mile or yard limit speed, the transmitter TB will be omitted in the transmitting station.

The above is a brief and yet comprehensive explanation of the radio transmitting stations and the manner in which the two, and at times three, wave transmitting circuits are connected to and disconnected from the track. It will be understood that by reason of the adjustment of the tuning of the transmitters TY, TG and TW, said circuits will oscillate regularly continually, but at different frequencies. They are adjusted to oscillate continually at a predetermined constant frequency, and for "clear" and "caution" positions, one or the other of the transmitters TG or TY, (the appropriate one) will be electrically connected to the track and will impress oscillations of the same frequency as that of the transmitter circuit upon the track.

The receiving apparatus which is carried by the train is shown in Fig. 2. When the apparatus is arranged to control the train in accordance with the automatic block signal system only, that is, to respond only to (1) "clear", (2) "caution" and (3) "danger" or "stop" positions of the block signal system, then there will be only two radio receiving sets installed in the receiving apparatus, namely, the "yellow" or "caution" receiver RY and the "green" or "safety" receiver RG. When, however, the twelve mile or yard speed control forms a part of the controlling system, then there will be a third radio receiving set RB (blue receiver) which is responsive only to the waves impressed upon the track by the transmitter TB. These receiving sets RY, RG and RB may be of any approved type and are respectively tuned to respond only to the waves transmitted to the rail from the transmitters TY, TG and TB respectively. The variable oscillation coils or inductors 31, 32 and 33 of the circuits of the receiving sets RY, RG and RB respectively, are all electrically connected to the rail 2, as by a wire 34 connected to the truck 35, i. e., they are grounded to the truck or wheel 35 and are thus connected directly to the rail 2. In this manner the oscillations impressed upon the rail 2 from the transmitters TY, TG or TB are directly electrically connected to the coils 31, 32 and 33 of the radio receiving sets TY, TG and TB and since the circuits including these coils 31, 32 and 33 are respectively tuned to respond only to one of these three radio wave frequencies, when transmitter TY is impressing its waves or oscillations upon the track, the receiving set RY will respond thereto and the other sets will not respond thereto. When transmitter TG is impressing its waves or oscillations upon the track or rail then the receiving set RG only will respond thereto and when transmitter TB is impressing its waves

or oscillations upon the rail, then the receiving set RB only will respond thereto. Each receiving set will cease to oscillate when the transmitter to which it responds or is attuned is disconnected from the track or rail 2.

In each receiving set circuit is a sensitive radio relay magnet which may act as a master relay controlling stronger circuits for operating the various mechanisms included in the train installation. The master relay radio magnet 36 is in the circuit of the receiver RY and it controls a switch armature 37. In the circuit of the receiving set RG is similarly a master relay radio magnet 38 which controls an armature switch 39 and in the circuit of the receiving set RB is a master relay radio magnet 40 which controls an armature switch 41. These master radio relays 36, 38 and 40 are respectively energized when the circuit of the receiving set in which they are respectively connected, is responding to the waves received of the frequency to which it is tuned as from one of the transmitter sets and is de-energized when such waves are not being so received (when its transmitter is disconnected from the rail). These three master radio relays 36, 38 and 40 may be of any approved form and are used to control the electric circuits which operate the cab signal system, the brake applying mechanism and the throttle controlling mechanism.

The several cooperating mechanisms carried by the train and which are controlled by the radio receiving sets RY, RG and RB will be now briefly described.

The throttle T is provided with a throttle controlling mechanism TC, whereby the control of the throttle may be taken entirely out of the hands of the engineer if he disregards the signals. This throttle controlling mechanism, TC, comprises a piston 42 in a cylinder 43 to the rear of which is connected an air pressure pipe 44 which puts the space in the cylinder to the rear of the piston 42 in communication with a chamber beneath the valve 45 carried on the upper end of a rod 46, the lower end of which is rigidly secured to a piston 47 in a cylinder 48. A chamber above the valve 45 is in communication with the air under pressure of the air brake system through the train pipe 64. In the normal operation of the device, the valve 45 is closed and when opened relieves the pressure in the train pipe 64 to apply the brakes.

Below the piston 47 the cylinder 48 is connected by a pipe 49 to the chamber below the valve 50 of the automatic speed reducing valve 50 RV, which is normally held open as will be referred to below, and the space above the valve 50 is connected by a pipe 51 to the space below the valve 52 of the train stop valve SV which is normally held in its upper open position, the space above said valve 52 being connected by a pipe 53 with a suitable

source of air pressure in the air brake system. The normal open position of the throttle T, the throttle controlling mechanism TC, the speed reducing valve RV and the stop valve SV are all as are shown in Fig. 2, the track being assumed to be "clear" and the train running at a high speed. In this position, the air pressure from the pipe 53 around the valve 52 through the pipe 51 around the valve 50 through the pipe 49 to the underside of the piston 47, maintains the valve 45 closed. Under these conditions the throttle T may be manually closed and opened as desired in the usual manner.

The valve 50 is preferably carried by a rod 54, the lower end of which is threaded into a lower valve 55 which is secured to an armature 56 passing through and extending below an electromagnet 57. Similarly, the valve 52 is preferably mounted on a rod 58, the lower end of which is screw-threaded into a lower valve 59 attached to an armature 60 extending through and extending below the electromagnet 61. The space or chamber below the lower valve 55 communicates by a vent or passage 62 with the atmosphere and the space below the lower valve 59 similarly communicates through a vent or passage 63 with the atmosphere. These two valves RV and SV are preferably alike in construction but are operated respectively under different track conditions as indicated by the signals beside the track and the speed of the train relative thereto. When for any reason the armature of the speed controlling valve RV falls, it closes the upper valve 50 and opens the lower valve 55, whereupon the space above the valve 50, which space is in communication with the source of air pressure from the pipe 53, is cut off from the space below the valve 50. When this occurs, the air below the valve 50 and in the pipe 49 and below the piston 47 leaks out now through the vent or passage 62, whereupon the pressure in the train pipe 64 forces the valve 45 down off its seat. When the valve 45 is thus opened air from the train pipe 54, and under pressure passes the valve 45, enters the pipe 45 and the cylinder 43 to the rear of the piston 42, throws the throttle T forwardly closing it, and when the piston 43 clears the openings 65 in the cylinder 43 the pressure of the air in the train pipe is reduced and operates in the usual manner to apply the brakes.

Similarly, if valve 52 falls, and valve 50 does not, the air under pressure will flow from the lower end of the cylinder 48, through pipe 49, past valve 50, into pipe 51 and past valve 59 to vent 63. Thus the throttle will be forced to closed position and the brakes will be applied upon the operation of either the speed reducing valve RV or the stop valve SV. The circuits for maintaining the magnets 57 and 61 energized will be described below.

Also carried by the train is the speed responsive device or speed indicator SI which may be of any well known or approved construction wherein an arm 66 swings on its pivot 67 to various positions dependent on and in accordance with the speed of the train. This arm 66 is adapted to swing over and consecutively make contact with a series of three metal segments 68, 69 and 70, each insulated from the others and arranged in a circular arc. Preferably, the arm 66 has a brush 71 which consecutively sweeps over these segments 68, 69 and 70 as the speed of the train varies.

Preferably rigid with the unitary arm 66 and extending in the opposite direction is an arm 72 which is also provided with a brush 73 adapted to cooperate with a fourth short segment 74 preferably diametrically opposite the segment 70. Extending parallel to and adjacent one end of the segment 69 is a fifth metal segment 75 with which another brush 76, carried by the arm 66, at times makes contact.

When the train is running at high speeds which, for instance, we will assume to be at speeds higher than twenty-five miles an hour, the arms 66 and 72 will be in the position shown in Fig. 2. When the train is running at a speed of, for instance, more than three miles an hour and not more than twenty-five miles an hour, the arm 66 will be in engagement with the segment 69. When the train is running at the "slow" or "stop" speed of, for instance, three miles an hour, the arm 66 will be in engagement with the segment 70 and at such time the arm 72 will be in contact with the segment 74. When the train is running at a speed not greater than twelve miles an hour, the arm 66 will be in engagement through its brush 76 with the segment 75.

Also carried by the train and cooperating with the mechanisms above set forth is preferably installed an automatic stop recorder, SR, having two recording dials 77 and 78. When the speed reducing valve RV falls, it is adapted to close a circuit and make a record of that operation on the dial 77 and when the stop valve SV falls, it also closes an electric circuit and a record of that operation is recorded on the dial 78, as will be referred to again below.

The source of electrical energy for energizing the electric magnets 57 and 61 is a battery B and the electric energy for operating the cab signal system and illumining the cab lights CL is preferably an electric generator G adapted to maintain energized two busbars 79 and 80.

Connected to the throttle T is a throttle switch TS in which are two switch arms 81 and 82, respectively; the switch arm 81 of the throttle switch TS is open whenever the throttle is open to a position to drive the

train at a speed of more than three miles an hour and the switch arm 82 is open whenever the throttle is open to a position to drive the train at a speed of more than twelve miles an hour. The function and operation of this throttle switch TS will be referred to in connection with the description of the electric circuits employed herein.

The master relay 36 controls the electromagnet 83 which in turn controls and operates seven switch arms 84, 85, 86, 87, 88, 89 and 90; the master relay 38 controls the electromagnet 91 which in turn controls and operates seven switches 92, 93, 94, 95, 96, 97 and 98; and the master relay 40 controls and energizes the electromagnet 99 which in turn controls and operates five switches, namely, 100, 101, 102, 103 and 104. When the magnet 83 is energized the seven switch arms thereunder are lifted to their uppermost position and when de-energized, they fall to their lowest position. Similarly, when the electromagnet 91 is energized the seven switch arms thereunder are lifted and when said magnet is de-energized they fall to their lowest positions. In the same manner the electromagnet 99 holds the five armatures thereunder in their uppermost position when said magnet 99 is energized and when it is de-energized the switch arms fall to their lowest position.

Assuming the train or locomotive L to be in the block B and the signal S at the beginning of the block A to be in "clear" position, as shown in Fig. 1 and the train to be moving at a high speed, which we will assume to be higher than twenty-five miles an hour, then the transmitter TY will be disconnected from the rail 2 of block B and the transmitter TG will be connected to the said rail. If there is a twelve mile or yard speed control and the block A is not a twelve mile speed block, then the transmitter TB will be also connected to the rail, and oscillations of two different frequencies (of the transmitters TG and TB) will be impressed upon the rail 2 of block B. The train L being in block B, the waves or oscillations will be transmitted from the rail 2 and truck 35 through the lead or wire 34 to coils 31, 32 and 33 of the radio receiving sets RY, RG, RB. The radio receiving circuits of the receiving sets RG and RB will be set into oscillation but set RY will not respond to either of said wave lengths and will therefore not be oscillated. As a result of the oscillation of the radio receiving circuits RG and RB, the master radio relays or magnets 38 and 40 will be energized but since the receiving set RY is not receiving oscillations or waves, the master relay 36 will not be energized and its armature will be in its lowest position, all as shown in Fig. 2. The armatures 39 and 41 will be held against their upper contacts. The armature 37 will, therefore, break the circuit which includes busbar 80, lead 105, armature 37, wire 106,

coil 83, and wire 107 back to busbar 79, thus de-energizing the magnet 83, and the seven armatures or switches 84 to 90 inclusive will be in their lowest positions. The master relay 38 will be energized and its armature 39 will be held in its uppermost position thereby energizing the electromagnet or coil 91 by a circuit from busbar 80, lead 108, armature 39, wire 109, coil 91, wire 110, back to busbar 79. The energized coil 91 will hold the seven armatures or switches 92 to 98 inclusive in their upper positions.

The master coil 40 of set RB will be energized because the circuit is responding to waves from transmitter TB, to which it is attuned and therefore the armature 41 will be held in its upper position and the circuit from busbar 80, wire 111, armature 41, wire 112, coil 99, wire 113 to busbar 79 will be closed and the coil 99 controlled thereby will be energized and its five switch armatures 100 to 104 inclusive will be in their upper positions as shown in Fig. 2.

For a clear understanding of the operation and the reasons therefor, it should be made plain that so long as the electromagnets controlling the speed reducing valve RV and the stop valve SV are energized, the engineer is free to control the speed of the train as he may desire but that when the electromagnet 57 of the valve RV is deenergized, the falling of its armature 56 is operative to reduce the speed of the train and that when the electromagnet 61 of the valve RV is de-energized the falling of its armature 60 will be operative to apply the brakes to effect an emergency stop or a reduction of the speed of the train to three miles an hour as will be explained below. When then, track conditions are clear, both electromagnets of the valve RV and RS will be energized and held in their uppermost position.

With the parts and circuits in the positions indicated in Fig. 2 (high-speed clear track) the circuit, to maintain the electromagnet of the valve RV energized is from battery B, wire 114, wire 115 to the electromagnet 57, thence by wire 116, wire 117, wire 118 to armature 101, wire 119 to armature 95, wire 120 to segment 68 by arm 66 and wires 121, 122 to battery B.

The armature 60 of the valve SV will also be maintained energized by the following circuit: from battery B, wire 114, wire 123, wire 124 to coil 61, thence by wire 125, 126, 127 to armature 103 thence by wire 128 and wire 122 to battery B.

Under these conditions the green light G of the cab signal lights CL will also be illuminated to correspond with the green track signal S next in advance of the locomotive, for the receiving set RG being energized, its radio magnet 38 is energized and the armature 39 elevated to close the circuit passing through and including the electro-

magnet 91 which will be energized as above described, and in this position the armature 92 will close a circuit from busbar 80 through wire 129, armature 92, wire 130 to light G thence through wires 131 and 132 to busbar 79. It will be observed that when the coil 36 is de-energized and the armature 84 has fallen, the circuit to cab signal light Y is broken and that the circuit to cab signal light R is broken by the armature 93 and that the circuit to cab signal light B is broken at the armature 100. Under these conditions cab signal light G is the only one displayed in the cab. These circuits will, however, be specifically stated in connection with the operation of the device under different track conditions.

With the track conditions the same but with a mere reduction in the speed of the train whereby the arm 66 swings to a position so that its brush 71 is in contact with the segment 69, the circuit of the electromagnet 57 of the valve RV will still be maintained closed from wire 119, through wire 133, armature 96, wire 134, wire 135 to segment 69 and arm 66 instead of through armature 95, wire 120 and segment 68.

If the speed of the train be the slowest speed and the arm 66 be in contact with the segment 70, the circuit to magnet 57 will be closed from wire 116 through wire 136 and segment 70 to arm 66.

If the signal next in advance of the locomotive or car L be a "caution" signal (yellow) then receiving set RY will be energized, receiving set RG will be de-energized, and if there be no twelve mile speed regulation for the block, the receiving set RB will be energized and electromagnets 83 and 99 will be energized lifting the switches controlled thereby to their uppermost positions. If the train now enter that block at a speed greater than 25 miles per hour, the circuit of the electromagnet 57 heretofore described and which was heretofore completed by the armature 95 will now be broken at 95 and the electromagnet 57 will become de-energized and allow its armature 56 to fall, thus applying the brakes and closing the throttle in the manner above described and the speed of the train will begin to be reduced until the arm 66 swings into contact with the segment 69, whereupon the circuit will now be re-established from wire 119 through wire 133, wire 137, armature 87 and wire 135 back to segment 69 and the closing of the circuit will re-energize the magnet 57 and release the brakes by admitting air, under pressure, to the underside of the piston 47 as heretofore described.

It is to be understood that the pipe 53 may be connected to the auxiliary air tank, or to any suitable air tank carried by the train and in which the pressure may be maintained in any suitable manner now in

use for the purpose, so long as the air brake system installation operates upon the principle that the opening of the train pipe 64 effects a fall in the pressure of the air therein and that fall in pressure is operative to release air from the auxiliary air containers on the train to actuate the brakes, and that as soon as the train valve is closed, the pressure of air in the train pipe and any fall of pressure in the auxiliary tank is restored to the normal high pressure in any well known manner. This is the usual manner of operating the present day air brake systems to which my invention is applicable and therefore it follows that when the armatures 56 and 60 are held in their uppermost position air under pressure is admitted from the pipe 53 under the valve 52, through the pipe 51 under the valve 54 and through the pipe 49, and, as a result thereof, the piston 47 is lifted to close the valve 46. The re-energizing of the magnets 57 and 61, and the holding of the armatures up against them is, in effect, operative to release the brakes by reason of the closing of the valve 45.

Under these conditions, the electromagnet 61 will also continue to be maintained energized through the same circuit as that heretofore described, because the lifting of the armature 89 merely closes the circuit through another path. The current has two paths to follow from wire 126 to wire 128, namely through wire 127 and armature 103 to wire 126, the other being from wire 126, armature 89, wire 138 to wire 128. There will be no interruption to the circuit of the electromagnet 61 by reason of the energizing or de-energizing of the magnet 83.

The track conditions still being "caution" or "yellow," it will be observed that since the electromagnet 91 is now de-energized, the circuit to the green light G through wire 130 will be broken at the armature 92 and that the circuit to the yellow light Y of the cab signal system will now be closed from busbar 80, wire 139, armature 84, wire 140 to yellow light Y and wire 141 and wire 132 to busbar 79. The circuit to the red light R is broken by armature 85 and that to light B will remain broken by armature 100.

When the signal next ahead of the train is red or "danger," then all the transmitters of the transmitting station will be disconnected from the rail as shown in Fig. 1 under magnet 10 connected to block B.

All of the receiving sets RY, RG, RB will be inactive and the electromagnets 83, 81 and 99 (if the latter be utilized) will be de-energized permitting all of the armature switches controlled thereby to be in their lowest positions. Considering first the speed reducing valve RV, the circuit thereto through wire 120 and armature 95 will be broken by falling of the armature 95. The circuit from segment 69 to valve RV through wires 134

and 135 will be broken by the dropping of the armatures 87 and 96. If, moreover, the engineer attempts to enter this block against the danger signal and at a speed exceeding the slow or stop speed of the three miles per hour, the circuits of the stop valve SV through the lead 126 from the coil 61 of the stop valve SV will be broken at 103 and 89 and the brakes will be applied. When the arm 66 by reason of the reduction of the speed of the train falls or moves to a position where it contacts with segments 70 and 74 and which has been assumed to occur at a speed of three miles an hour, then the arms 81 and 82 of the throttle switch TS will be closed and the circuit to electromagnet 57 will be re-established as follows: battery B, wire 114, wire 115, coil 57, wire 116, wire 136, plate 70, arm 66, wire 121 and wire 122 to battery B. Moreover, the circuit to coil 61 of stop valve SV will be broken by armatures 89 and 103, as above stated, but since now the throttle has been closed and the switch arm 81 has been closed a circuit will be established or closed through coil 61 as follows: battery B, wire 114, wires 123 and 124, coil 61, wire 142, switch 81, wire 143, armature 94 (dropped), wire 144, armature 86 (dropped), wire 145 to plate 74 through arm 72 and wires 121 and 122 back to battery. Should, however, the engineer undertake to open the throttle wider than that which is required to impel the train at a speed of more than three miles an hour, that will immediately open the switch arm 81 and will de-energize the electromagnet 61 of the stop valve SV and immediately apply the brakes to bring the train to a stop.

A red signal S of the track is also operative to display a red signal R in the cab as follows: from busbar 80, through wire 146 to armature 93 (dropped) thence by wire 147 to armature 85 (dropped) and thence by wire 148 to red light R through wire 149 to wire 132 and back to busbar 79.

When there is a yard limit speed in a block, the transmitter TB will be omitted from the transmitting station, as indicated by the third station in Fig. 1. Consequently, throughout this block no radio oscillations of the length transmitted by a transmitter TB will be imparted to the rail and consequently over that block, the receiver RB will be de-energized, although either of the other two receiving sets RY or RG may be receiving wave lengths to which they are attuned. Assuming the signal to be clear and the receiving set RG energized and the receiving sets RY and RB de-energized, then the armatures controlled by the magnet 99 will be in their lowest positions. The circuit to segment 68 will be broken by the armature 101. The circuit to segment 69 through wire 135 will also be broken by armature 101 and, therefore, magnet 57 will become de-energized, and the valve RV will become operative to apply the brakes

until the speed of the train is reduced to twelve miles an hour at which time the arm 66 will be in engagement with the segment 75, whereupon the circuit will be then closed through the electromagnet 57 as follows: battery B, wire 114, wire 115, to coil 57, wire 116, wire 117, wire 150 to armature 102 (dropped), then by wires 151, 152, armature 97, wire 153, wire 154, wire 155 to plate 75, arm 66, wires 121 and 122 back to battery which will re-energize the magnet 57 to place the automatic brake applying system in a condition to release the brakes.

If, on the other hand, the track signal be "caution", then the receiving set RY will be energized and the receiving set RG and RB will both be de-energized. The relay magnet 83 will be energized holding armature 88 in its upper position with the circuit closed there-through, while the armature 97 will be dropped. Under these conditions, the circuit to magnet 57 will be closed as follows: wire 117, wire 150, armature 102 (dropped), wire 151, wire 165, armature 88 (lifted), and wires 154 and 155 to segment 75.

The de-energizing of the coil 99 will also break the circuit to the electromagnet 61 of the stop valve SV at the armature 103 but after the speed of the train has been reduced to the predetermined speed of, for instance, twelve miles an hour, then the switch arm 82 of the throttle switch TS will be closed and the circuit through the coil 61 will be reestablished through the following circuit: battery B, wires 114, 123, 124 to coil 61, thence by wire 125, wire 156, switch 82, wires 157 and 158, switch 98, wire 159, armature 104 (dropped), wire 160, wire 155, plate 75, brush 76, arm 66 to wires 121 and 122 to battery. Should, however, the engineer open the throttle to drive the train at a speed higher than twelve miles an hour, then the switch 82 will break that circuit and the electromagnet SV will become de-energized to stop the train.

The twelve mile per hour speed, although not indicated by the track signals, may be readily indicated by the cab light B of the cab signal system, for a circuit will be established from busbar 80, wire 161, armature 100 (dropped), wire 162 to light B and by wires 163 and 132 back to busbar 79. If the signal of the block be a green signal, then the receiving set RG will be energized and the green light will also be displayed in the cab and if the signal ahead be yellow, the yellow light will also be displayed simultaneously with the blue.

And with respect to the stopping mechanism or the control of the electromagnets 57 and 61 of the valves RV and SV respectively, at the twelve miles per hour condition, if the signal be yellow instead of green, as above described, then the armature 90 will be lifted and armature 104 dropped to close the circuit of the valve SV from wire 157 through armature 90 and wire 164 to wire 159 and armature 104 and the circuit from valve RV to the segment 75 will be closed through armature 102, wires 152 and 165 to armature 88, thence to wires 154 and 155, to segment 75 instead of through wires 152 and 153 through armature 97.

Whenever the armature 56 of the coil 57 falls, it is adapted to close a circuit from battery B through wires 114, 123, 166 to the speed recorder SR to make a record on dial 77 thereof, the circuit being completed through wire 167, contact 168, wire 169, wire 170 and wire 122 back to battery B. Whenever the armature 60 of electromagnet 61 falls, it also closes a circuit to make a record on the dial 78 of the speed recorder SR by closing a circuit from battery B, wire 114, wire 123, wire 166, wire 171 to recorder SR and thence by wire 172, contact 173, wire 174, wire 170 and wire 122 back to battery B.

It is to be understood that the transmitting stations TY, TG and TB are merely diagrammatically shown in Fig. 1; that any suitable commercial transmitting set capable of continuously producing oscillations of a predetermined frequency or waves of a predetermined length in a tuned circuit may be employed and that the receiving sets RY, RG and RB are also merely diagrammatically shown to indicate a receiving set which is capable of being accurately tuned to respond only to waves of a given or predetermined frequency or length and to no other.

If the line or track to be equipped with our signals is one in which there is a high potential power line paralleling the tracks and it is desired to replace the batteries of the transmitting sets by power derived from the high tension lines, a transformer 175 of any suitable design, but provided with as many secondary stepped-down coils 18' as there are transmitters in a station, may be employed. A secondary coil 18' would be substituted for each battery 18 of the tuned circuits TY, TG and TB.

Since the oscillations produced in the transmitters are communicated directly to the metallic rails and thence by a metallic connection through the wheels and truck or trucks directly to the coils 131, 132 and 133, those oscillations or waves are relatively strong as compared with those transmitted through the air. The tuned circuits of the receiving sets will, therefore, respond with certainty thereto and to the exclusion of all other waves or waves of the same length transmitted from other points and not communicated to the rails.

In the foregoing description of the apparatus it has been assumed that the radio relay magnets 36, 38 and 40 though sensitive were relatively weak and that heavier or stronger secondary magnets 83, 91 and 99 operated by stronger currents and controlled

by the relay magnets 36, 38 and 40 are necessary or desirable.

However, strong radio-relay magnets, certain in their responsiveness may be readily procured on the market and when it is desired to use such a strong magnet in a radio receiving set circuit, the secondary magnets or relays 83, 91 and 99 may be dispensed with. Such a modification is illustrated in Fig. 4 wherein the radio relay magnet 36' operates and controls the armatures or switches 84 to 90 inclusive directly; the radio relay magnet 38' controls the armatures or switches 92 to 98 inclusive and the radio relay 40' directly controls the armatures or switches 100 to 104 inclusive. This modification is in every other respect exactly like that illustrated in Fig. 2 and its operation is exactly like that of Fig. 2. The circuits controlled by the armatures or switches operate in exactly the same manner as that previously described in connection with Fig. 2.

I have also briefly referred to the block signal system as one in which all the signals ahead of the train if the track be clear are green. There is another block signal system in use at the present time known as the "normally red" or "normally danger" system, wherein the block signals of a clear track, except those signals of the block immediately ahead of the train and immediately at the rear of the train are all normally set to "danger" or "red" position. In this system when a train enters a block and the track for several blocks ahead is "clear", the entry of a train into the block swings the signal at the beginning of the block next in advance of the engineer from "danger" to "safety" or "green", and if the train is two blocks ahead of a second train entering a block, then the second train will swing the signal at the beginning of the block next ahead or from "red" to "caution".

But our automatic speed controlling stop mechanism and cab signaling device operates in this "normally red" block signal system exactly as it does in the "normally green" system which was first above described. The signal next in advance of the engineer and which he is about to enter will be either green or caution or danger, and the signals in the cab and the train speed controlling mechanism will operate in conjunction therewith in the manner above described in connection with these two signals, for it is to be understood, of course, that if a train is in the block next in advance of a block in which is a second train, the second train will not be able to swing the signal at the entrance of the block in which is the first train from its red position and the stop mechanism and the cab signal will operate in the same manner as that heretofore described.

Having thus described our invention, what

we claim and desire to protect by Letters Patent of the United States, is:

1. In an automatic train speed controlling system, the combination with a track, the rails of which are divided into insulated blocks, a field radio transmitting station for each block having two continuously operating radio-frequency transmitter circuits, each tuned to a frequency substantially different from that of the other, and means to continuously maintain one of said transmitter circuits in direct metallic electrical connection to a rail at the departure end of its block when the track condition is "clear"; to disconnect said circuit from said rail and to place and maintain the other of said circuits in direct metallic electrical connection with said end of said rail when the track condition is "caution" and to maintain both of said circuits disconnected from said rail when said track condition is "danger".

2. In an automatic train speed controlling system, the combination of a track, the rails of which are divided into insulated blocks, an automatic block signal system for said track and blocks, a field radio transmitting station for each block, each station having two continuously operating radio-frequency transmitter circuits, each tuned to a frequency substantially different from that of the other and means to continuously maintain one of said transmitter circuits in direct metallic electrical connection to a rail at the departure end of its block when the signal of the block next adjacent said departure end is "clear"; to disconnect said circuit from said rail and to place and maintain the other of said circuits in direct metallic electrical connection with said rail at said end when said signal is "caution" and to maintain both circuits disconnected from said rail when said signal is "danger".

3. In an automatic train speed controlling system, the combination of a track, the rails of which are divided into insulated blocks, an automatic block signal system for said track and blocks, a field radio transmitting station for each block, each station having two continuously operating radio-frequency transmitter circuits, each tuned to a frequency substantially different from that of the other and means operated by said block signal system to continuously maintain one of said transmitter circuits in direct metallic electrical connection to a rail at the departure end of its block when the signal of the block next adjacent said departure end is "clear"; to disconnect said circuit from said rail and to place and maintain the other of said circuits in direct metallic electrical connection with said rail at said end when said signal is "caution" and to maintain both circuits disconnected from said rail when said signal is "danger".

4. In an automatic train speed controlling

system, the combination of a track divided into insulated blocks, a field radio transmitting station for each block, each station having two tuned transmitter circuits of high frequency actuated by reed vibrators and each circuit tuned to a frequency substantially different from that of the other transmitter circuit, and means to continuously maintain one of said transmitter circuits in direct metallic electrical connection with the track at the departure end of its block when the track condition is "clear"; to disconnect said circuit from said track and to place and maintain the other of said circuits in direct metallic connection at said departure end of said block when the track condition is "caution", and to maintain both circuits disconnected from said track when said signal is "danger".

5. In an automatic train speed controlling system, the combination of a track divided into insulated blocks, an automatic block signal system for said track and blocks, a field radio transmitting station for each block, each station having two transmitter circuits continuously oscillated by vibrators, one for each circuit respectively, each of said circuits being tuned to a frequency substantially different from that of the other, and means to continuously maintain one of said transmitter circuits in direct metallic electrical connection with said track at the departure end of its block when the signal of the block next adjacent to said departure end is "clear", to disconnect said circuit from said track and to place and maintain the other of said circuits in direct metallic electrical connection of said track at said departure end of said block when said signal is "caution", and to maintain both circuits disconnected from said track when said signal is "danger".

6. In an automatic train speed controlling system, the combination of a track divided into insulated blocks, a field radio transmitting station for each block, each station having two continuously oscillating transmitter circuits, each tuned to a frequency substantially different from that of the other, means to continuously maintain one of said transmitter circuits in direct electrical connection with the track at the departure end of its block when the track condition is "clear", to disconnect said circuit from said track and to place and maintain the other of said circuits in direct metallic connection with said track at said departure end of said block when said signal is "caution", and to maintain both circuits disconnected from said track when said signal is "danger", and a third continuously oscillating transmitter circuit in each block in which the train is normally free to travel at a speed higher than yard speed and tuned to a frequency substantially different from that of said two above mentioned transmitter circuits and maintained continuously

in direct metallic electrical connection with said track at said departure end of its block.

7. In an automatic train speed controlling system, the combination with a track divided into insulated blocks, an automatic train signal system, a field radio transmitting station for each block, each station having two continuously oscillating transmitter circuits, each circuit being tuned to a frequency substantially different from that of the other, and automatic means to continuously maintain one of said transmitter circuits in direct metallic electrical connection to the track at the departure end of its block when the signal of the block next adjacent said departure end is "clear", to disconnect said circuit from said track and to place and maintain the other of said circuits in direct metallic electrical connection with said track at said departure end of said block when said signal is "caution" and to maintain both circuits disconnected from said track when said signal is "danger", of a train equipment comprising an automatic brake applying mechanism and two radio receiving sets, the receiving circuit of each set being at all times in direct metallic electrical connection to said track and each tuned to one of said transmitter circuits respectively, said radio receiving sets being operative to hold said brake applying mechanism from operating to apply the brakes when the circuit of one receiving set is receiving oscillations from the transmitting station in which the train may be; to actuate said automatic brake mechanism to reduce the speed of the train when the circuit of the other of said receiving sets is receiving oscillations from the transmitter of said block and to actuate said brake applying mechanism to substantially stop the train when the circuit of neither receiving set is receiving vibrations from the transmitting station in which the train may be.

8. In an automatic train speed controlling system, the combination with a track divided into insulated blocks, a field radio transmitting station for each block, each station having two continuously oscillating transmitter circuits, each tuned to an oscillation frequency different from that of the other, and automatic means to continuously maintain one of said transmitter circuits in direct metallic electrical connection with the track at the departure end of its block when the track conditions of the block next adjacent said departure end is "clear"; to disconnect said circuit from said track and to place and maintain the other of said circuits in direct metallic electrical connection to the track at said departure end of said block when the track condition is "caution" and to maintain both circuits disconnected from said track when said track condition is "danger", of a train equipment comprising an automatic brake applying mechanism and two radio receiving

sets, the inductance coil of the receiving circuit of each being continuously in direct metallic electrical connection with said track, each of said receiver circuits being tuned to respond only to one of said transmitter circuits respectively and operative to hold said brake applying mechanism inoperative when the circuit of one receiving set is responding to the transmitter circuit of the block in which the train may be; to actuate said automatic brake applying mechanism to reduce the speed of the train when said circuit of said receiving set is not responding to the transmitter of the block to which it is tuned and the other radio receiving set is responding to the transmitter of the block to which it is tuned, and operative to actuate said brake applying mechanism to substantially stop the train when neither circuit of the receiving sets is receiving oscillations from the said transmitting station.

9. In an automatic train speed controlling system, the combination of a track divided into insulated blocks, an automatic block signal system, a field radio transmitting station for each block, each station having two continuously oscillating transmitter circuits, each tuned to oscillate at a frequency substantially different from that of the other, and means operated by said block signal system to alternately place and maintain one of said transmitter circuits in direct metallic electrical connection with the track at the departure end of the block when the track conditions are "clear" and "caution" respectively, and to maintain both circuits disconnected from said track when the track condition is "danger", of a train equipment comprising an automatic track applying mechanism and two radio receiving sets, the receiving circuits of which are at all times directly electrically connected to the track and each tuned respectively to respond to the oscillations of one of said transmitter circuits respectively, said receiving circuits being operative when one is receiving oscillations from the transmitter of the block in which the train may be and to which it is tuned to prevent the automatic actuation of said brake applying mechanism; and operative when the other of said receiving sets is receiving oscillations from the transmitting station of the block in which the train may be and to which it is tuned to actuate said automatic brake applying mechanism to reduce the speed of the train to "caution" speed and said receiving sets being operative when neither is responding to the transmitter station in which the train may be to actuate said brake applying mechanism to substantially stop the train.

10. In an automatic train speed controlling system, the combination with a track divided into insulated blocks, a field radio transmitting station for each block, each station having two continuously oscillating transmitter

circuits, each tuned to an oscillation frequency substantially different from that of the other, automatic means operative to maintain said transmitter circuits in direct metallic electrical connection with the track at the departure end of its block alternately when the track condition is "clear" and "caution" respectively, and to maintain both of said circuits disconnected from said track when the track condition is "danger" and a third continuously oscillating transmitter circuit tuned to an oscillation frequency substantially different from that of either of said other said two transmitter circuits and located in the transmitting station of every block in which the train is normally free to travel at a speed higher than "yard" speed, of a train equipment comprising an automatic brake applying mechanism, two radio receiving sets each continuously directly electrically connected to said track and respectively tuned to one of said two transmitter circuits first above mentioned respectively, said radio receiving sets being operative to hold the brake applying mechanism inoperative when the circuit of one of said receiving sets is being actuated; to actuate said brake applying mechanism to reduce the speed of the train when the other of said two receiving sets is being actuated, and to actuate said brake applying mechanism to substantially stop the train when neither of said receiving sets is being actuated, and a third radio receiving set, the receiving circuit of which is also continuously electrically connected to said track and which is tuned to respond to said third radio transmitter circuit and is operative, when it is not receiving oscillations, to which it is tuned, from the transmitting station of the block in which the train may be, to actuate said brake applying mechanism to reduce the speed of the train to yard speed.

11. In an automatic train speed controlling system, the combination with a track divided into insulated blocks, an automatic train signal system, a field radio transmitting station for each block, each station having two continuously oscillating transmitter circuits, each circuit being tuned to a frequency substantially different from that of the other, and automatic means to continuously maintain one of said transmitter circuits in direct metallic electrical connection to the track at the departure end of its block when the signal of the block next adjacent said departure end is "clear", to disconnect said circuit from said track and to place and maintain the other of said circuits in direct metallic electrical connection with said track at said departure end of said block when said signal is "caution" and to maintain both circuits disconnected from said rail when said signal is "danger", of a train equipment comprising an automatic brake applying mechanism, an

automatic cab signal system having "clear", "caution" and "danger" signals and two radio receiving sets, the receiving circuit of each set being at all times in direct metallic electrical connection to said track and each tuned to one of said transmitter circuits respectively, said radio receiving sets being operative to hold said brake applying mechanism from operating to apply the brakes when the circuit of one receiving set is receiving oscillations from the transmitting station in which the train may be and to simultaneously display the "clear" signal of the cab signal system; to actuate said automatic brake mechanism to reduce the speed of the train when the circuit of the other of said receiving sets is receiving oscillations from the transmitter of said block and to simultaneously display the "caution" signal of the cab signal system; and to actuate said brake applying mechanism to substantially stop the train and to simultaneously display the "danger" signal of the cab signal system when the circuit of neither receiving set is receiving vibrations from the transmitting station in which the train may be.

12. In an automatic train speed controlling system, the combination of a track divided into insulated blocks, an automatic block signal system, a field radio transmitting station for each block, each station having two continuously oscillating transmitter circuits, each tuned to oscillate at a frequency substantially different from that of the other, and means operated by said block signal system to alternately place and maintain one of said transmitter circuits in direct metallic electrical connection with the track at the departure end of the block when the track conditions are "clear" and "caution" respectively, and to maintain both circuits disconnected from said track when the track condition is "danger", of a train equipment comprising an automatic track applying mechanism, an automatic cab signal system having "clear", "caution" and "danger" signals and two radio receiving sets, the receiving circuits of which are at all times directly electrically connected to the track and each tuned respectively to respond to the oscillations of one of said transmitter circuits respectively, said receiving circuits being operative when one is receiving oscillations from the transmitter of the block in which the train may be and to which it is tuned to prevent the automatic actuation of said brake applying mechanism and to simultaneously display the "clear" signal of the cab signal system; and operative when the other of said receiving sets is receiving oscillations from the transmitting station of the block in which the train may be and to which it is tuned to actuate said automatic brake applying mechanism to reduce the speed of the train to "caution" speed and to simultaneously display

the "caution" signal of the cab signal system, and said receiving sets being operative when neither is responding to the transmitter station in which the train may be to actuate said brake applying mechanism to substantially stop the train and to simultaneously display the "danger" signal of the cab signal system.

13. In an automatic train speed controlling system, the combination with a track divided into insulated blocks, a field radio transmitting station for each block, each station having two continuously oscillating transmitter circuits, each tuned to an oscillation frequency substantially different from that of the other, automatic means operative to maintain said transmitter circuits in direct metallic electrical connection with the track at the departure end of its block alternately when the track condition is "clear" and "caution" respectively, and to maintain both of said circuits disconnected from said track when the track condition is "danger" and a third continuously oscillating transmitter circuit tuned to an oscillation frequency substantially different from that of either of said other said two transmitter circuits and located in the transmitting station of every block in which the train is normally free to travel at a speed higher than "yard" speed, of a train equipment comprising an automatic brake applying mechanism, an automatic cab signal system having a "clear", a "caution", a "danger" and a "yard speed" signal, two radio receiving sets each continuously directly electrically connected to said track and respectively tuned to one of said two transmitter circuits first above mentioned respectively, said radio receiving sets being operative to hold the brake applying mechanism inoperative and to simultaneously display the "clear" signal of the cab signal system when the circuit of one of said receiving sets is being actuated; to actuate said brake applying mechanism to reduce the speed of the train and to simultaneously display the "caution" signal of the cab signal system when the other of said two receiving sets is being actuated, and to actuate said brake applying mechanism to substantially stop the train and to simultaneously display the "danger" signal of the cab signal system when neither of said receiving sets is being actuated, and a third radio receiving set, the receiving circuit of which is also continuously electrically connected to said track and which is tuned to respond to said third radio transmitter circuit and is operative, when it is not receiving oscillations, to which it is tuned, from the transmitting station of the block in which the train may be, to actuate said brake applying mechanism to reduce the speed of the train to yard speed and to simultaneously display the "yard speed" signal of the cab signal system.

14. In an automatic train speed controlling system, the combination with a track divided into insulated blocks, a field radio transmitting station for each block, each station having two continuously oscillating transmitter circuits, each tuned to an oscillation frequency different from that of the other, and automatic means to continuously maintain one of said transmitter circuits in direct metallic electrical connection with the track at the departure end of its block when the track conditions of the block next adjacent said departure end is "clear"; to disconnect said circuit from said track and to place and maintain the other of said circuits in direct metallic electrical connection to the track at said departure end of said block when the track condition is "caution" and to maintain both circuits disconnected from said track when said track condition is "danger", of a train equipment comprising an automatic brake applying mechanism, an automatic cab signal system having a "clear", a "caution", and a "danger" signal and two radio receiving sets, the inductance coil of the receiving circuit of each being continuously in direct metallic electrical connection with said track, each of said receiver circuits being tuned to respond only to one of said transmitter circuits respectively and operative to hold said brake applying mechanism inoperative and to simultaneously display the "clear" signal of the cab signal system when the circuit of one receiving set is responding to the transmitter circuit of the block in which the train may be; to actuate said automatic brake applying mechanism to reduce the speed of the train and to simultaneously display the "caution" signal of the cab signal system when said circuit of said receiving set is not responding to the transmitter of the block to which it is tuned and the other radio receiving set is responding to the transmitter of the block to which it is tuned, and operative to actuate said brake applying mechanism to substantially stop the train and to simultaneously display the "danger" signal of the cab signal system when neither circuit of the receiving sets is receiving oscillations from the said transmitting station.

15. In an automatic train signal system, the combination with a track, the rails of which are divided into insulated blocks, a field transmitting station for each block and having two transmitters arranged to produce high frequency impulses, each of a frequency substantially different from the other, means to continuously maintain one transmitter in direct metallic electrical contact with the rail at the departure end of the block as long as a train is in the block and the track is "clear", to disconnect said transmitter from the rail and to continuously maintain the other transmitter in direct metallic electrical contact

with the rail at the departure end of the block as long as the train is in the block and the track condition is "caution"; and to disconnect both transmitters from the rail when the track condition is "danger".

16. In an automatic train signal system, the combination with a track divided into insulated blocks, an automatic train signal system, a field transmitting station for each block, each station having two high frequency transmitters, each tuned to a frequency substantially different from that of the other, automatic means controlled by the signal system to continuously maintain one of said transmitters in direct metallic connection with the track at the departure end of its block, while a train is in the block, and the signal of the block next adjacent the departure end of the first-mentioned block is "clear", to disconnect said transmitter from the track and to place and maintain the other of said transmitters in direct metallic electrical connection with said track at the departure end of said block, while said train is in the block and said signal is in "caution" position and operative to disconnect both transmitters from said track when said signal is in "danger" position, of a train equipment comprising a cab signal device and two receiving sets, the receiving circuit of each being at all times in direct metallic electrical connection with said track, one tuned to one transmitter and the other tuned to the other transmitter, one of said receiving sets being operative to close a circuit through a "clear" signal when one receiving set is being energized from the track, the other receiving set being operative to close a circuit through the "caution" signal in the cab when it is receiving oscillations to which it is tuned from the rail, and both receiving sets being operative to close a circuit through a "danger" signal when neither receiving set is receiving oscillations from the track.

17. In an automatic train signal system, the combination with a track divided into insulated blocks, an automatic train signal system along the track, a field transmitting station for each block, each station having two transmitters each tuned to a frequency substantially different from the other, automatic means controlled by the track signal system to continuously maintain one transmitter in direct metallic contact with the track at the departure end of the block, while a train is in the block and the signal of the block next adjacent the departure end is "clear", to disconnect said transmitter from the track and to place and maintain the other of said transmitters in direct metallic electrical connection with the track at the departure end of the block while a train is in the block and said signal is in "caution" position and to disconnect both circuits from the

track when said signal is in "danger" position, of a train equipment comprising an automatic brake applying mechanism and two receiving sets, the receiving circuit of which is at all times in direct metallic electrical connection with said track, each of said receiving sets being tuned to one of said transmitters respectively, said receiving sets being operative to hold said brake applying mechanism from operating to apply the brakes when one receiving set is receiving impulses from the transmitting station in which the train may be; to actuate said automatic brake applying mechanism to reduce the speed of the train when the other of said receiving sets is receiving impulses from the transmitter of the block in which the train may be and to actuate said brake applying mechanism to substantially stop the train when the circuit of neither receiving set is receiving impulses from the transmitter station in which the train may be.

18. In an automatic train speed controlling system, the combination with a track divided into insulated blocks, a field transmitting station for each block, each station having two high frequency transmitters each tuned to a frequency substantially different from the other, automatic means to operatively maintain said transmitters in direct metallic electrical connection with the track at the departure end of its block alternately, when the track is in "clear" and "caution" condition respectively and to maintain both of said circuits disconnected from said track when said track condition is "danger", of a train equipment comprising an automatic brake applying mechanism and an automatic cab signal system having a "clear", a "caution" and a "danger" signal, two receiving sets, both having a continuous metallic connection directly to said track and respectively tuned to said two transmitters, one of said receiving sets being operative to display the "clear" signal of the cab signal system when said set is being actuated from the rail by impulses to which it is attuned, the other of said receiving sets being operative to display the "caution" signal of the cab signal system, when it is receiving impulses from the rail to which it is attuned, both receiving sets being operative to display a "danger" signal of the cab signal system when neither receiving set is being actuated and to automatically actuate said brake applying mechanism.

19. In an automatic train speed controlling system, the combination with a track divided into insulated blocks, a transmitting station for each block, each station having two transmitter circuits each tuned to a frequency substantially different from that of the other, automatic means operative to maintain said transmitter circuits in direct metallic electrical connection with the track at the

departure end of its block alternately when the block condition is "clear" and "caution" respectively, and to maintain both of said circuits disconnected from said track when the block condition is "danger", of a train equipment comprising an automatic brake applying mechanism and two receiving sets having their receiver circuits tuned each to respond to only one of said transmitter circuits respectively and then only when the transmitter circuit to which it is tuned is connected to the track, said receiving sets being operative to prevent the automatic actuation of said brake applying mechanism when one receiving circuit is receiving oscillations from the transmitter of the block in which the train may be and to which it is tuned; to actuate the brake applying mechanism to reduce the speed of the train to "caution" speed when the other of said circuits is receiving oscillations from the transmitter of said block and to which it is tuned and the train is moving faster than at "caution" speed and to actuate the brake applying mechanism to substantially stop the train when neither circuit is receiving oscillations from the transmitter station of said block.

20. In an automatic train speed controlling system, the combination with a track divided into insulated blocks, a transmitting station for each block, each station having two transmitter circuits each tuned to a frequency substantially different from that of the others, and automatic means operative to maintain said transmitter circuits in direct metallic electrical connection with the track at the departure end of its block alternately when the block condition is "clear" and "caution" respectively, and to maintain both of said circuits disconnected from said track when the block condition is "danger", of a train equipment comprising an automatic brake applying mechanism, an automatic cab signal system having a "clear", a "caution" and a "danger" signal, and two radio receiving sets, the receiving circuit of each being continuously in electrical relation with said track, each of said receiver circuits being tuned to respond to only one of said transmitter circuits respectively and operative to hold said brake applying mechanism inoperative and to simultaneously display the "clear" signal of the cab signal system when the circuit of one receiving set is responding to the transmitter circuit of the block in which the train may be; to display a "caution" signal of the cab signal system when said circuit is not responding to the transmitter circuit of the block in which the train is and the other radio receiver is responding to the said transmitter of said block to which it is tuned; and operative to actuate said brake applying mechanism and to substantially stop the train and to simultaneously display the "danger" signal of said

signal system when neither of the receiving sets is receiving oscillations from the transmitter station of said block.

In witness whereof, we have hereunto set
5 our hands this 26th day of July, 1926.

FRANK C. WILLIAMS.
GEORGE H. WILLIAMS.

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