June 30, 1931. L. E. MELHUISH 1,811,857

RAILWAY TRAFFIC CONTROLLING SYSTEM

Filed Nov. 30, 1926 3 Sheets-Sheet 1

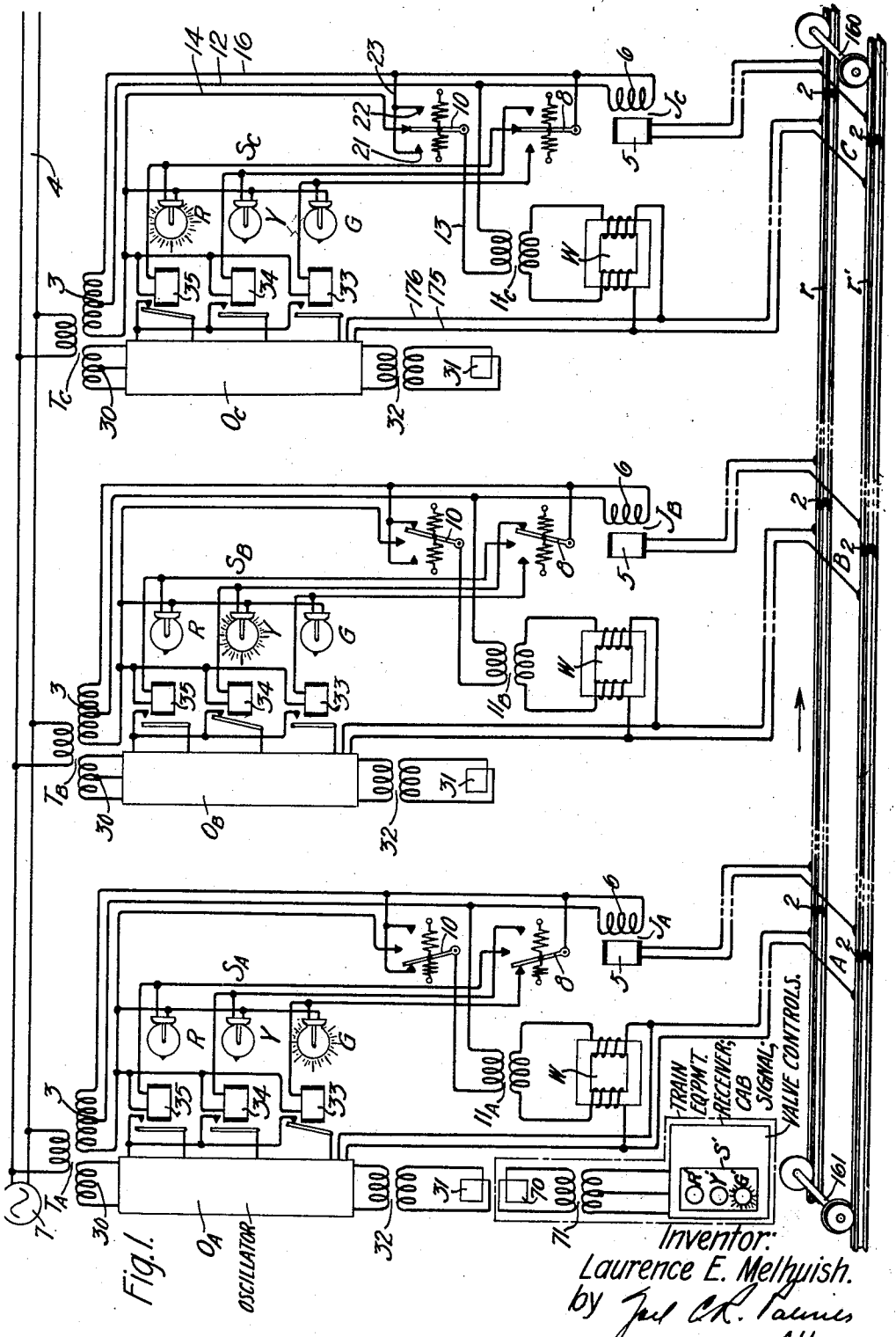


Fig. 1.

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RAILWAY TRAFFIC CONTROLLING SYSTEM

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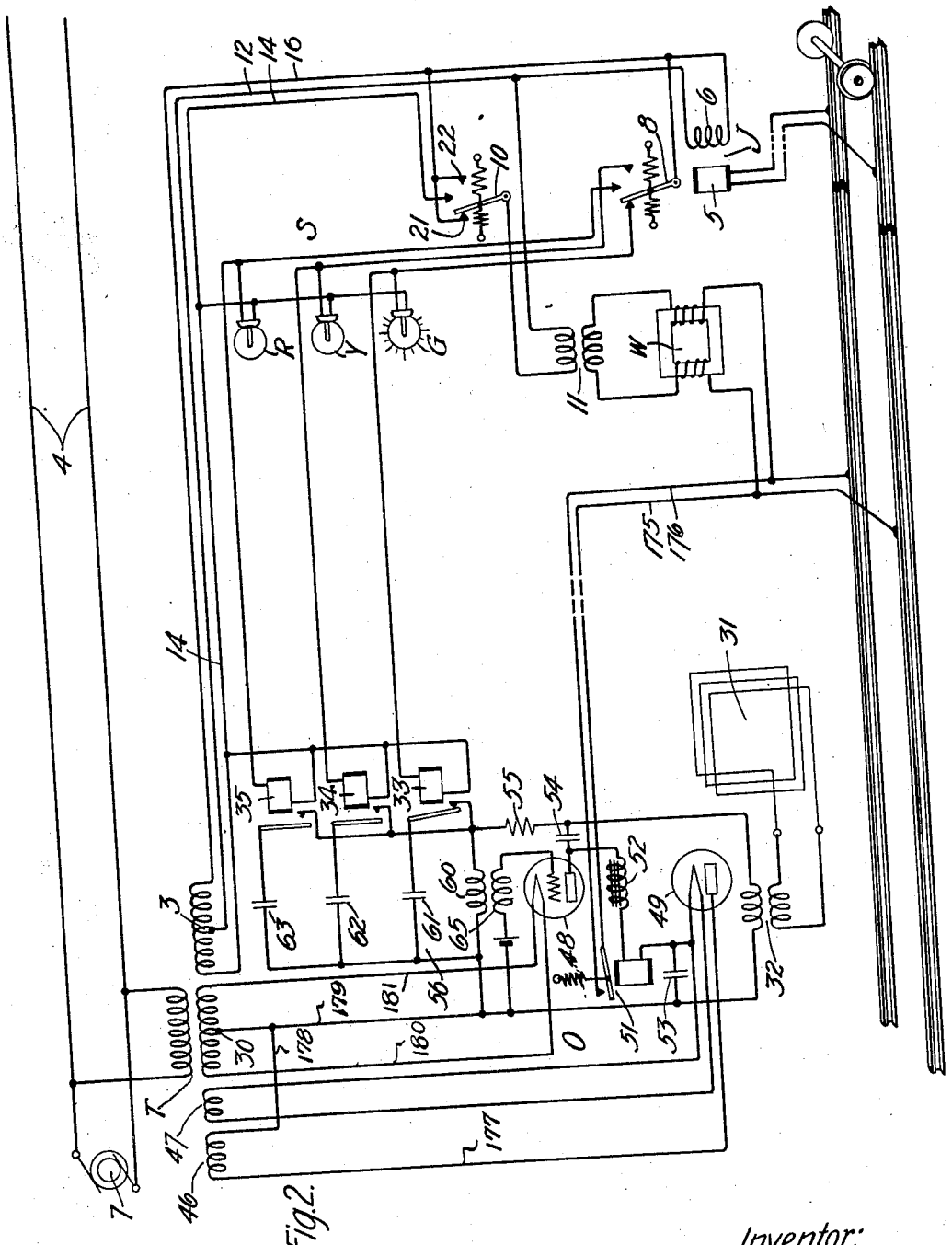


Fig. 2.

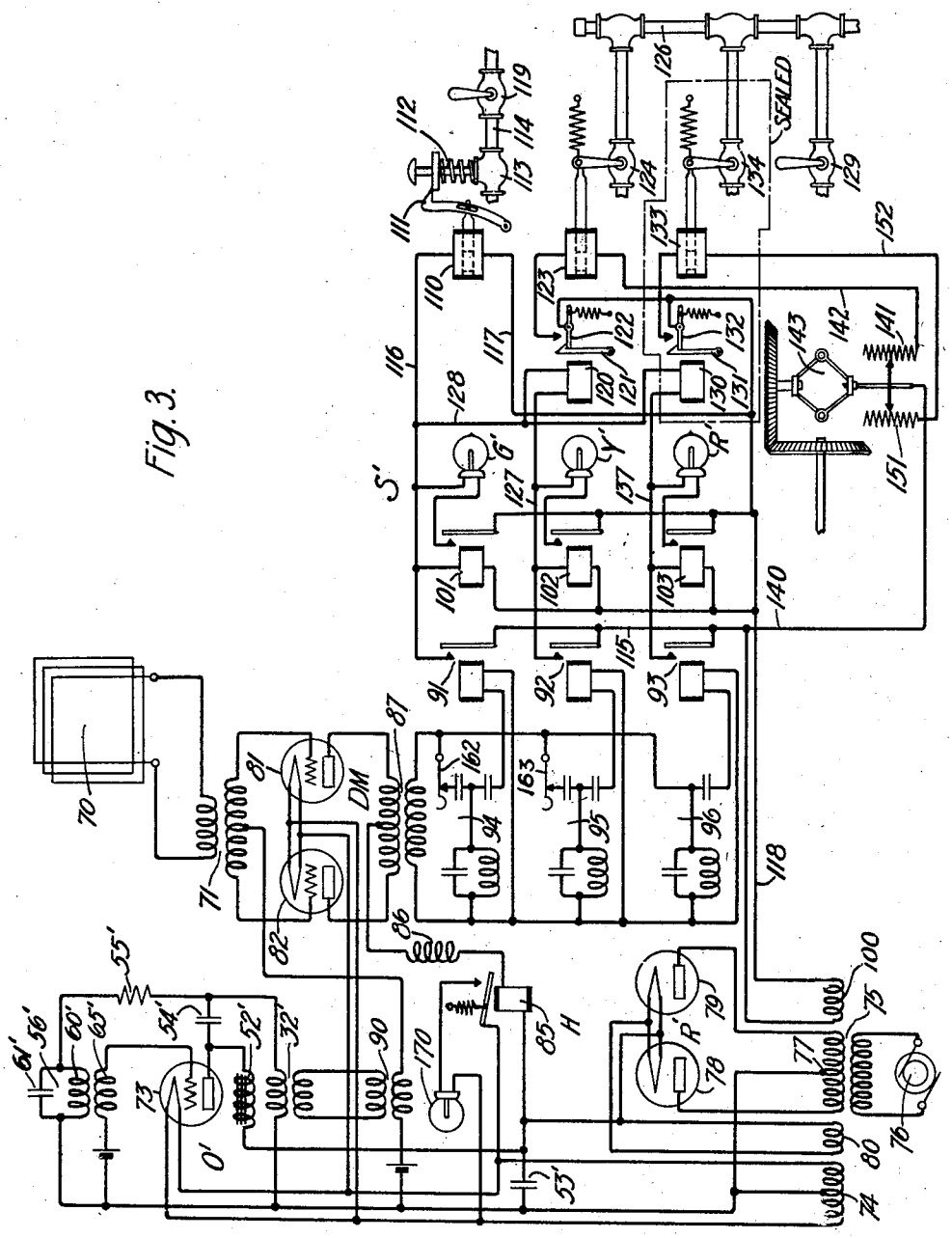
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RAILWAY TRAFFIC CONTROLLING SYSTEM

Filed Nov. 30, 1926 3 Sheets-Sheet 3

Fig. 3.



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Patented June 30, 1931

1,811,857

UNITED STATES PATENT OFFICE

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RAILWAY TRAFFIC CONTROLLING SYSTEM

Application filed November 30, 1926. Serial No. 151,664.

This invention relates to communication between relatively movable bodies, and especially to automatic train control.

According to this invention, each track relay of a block signaling system controls the frequency of waves radiated from an antenna provided near the relay, in response to track conditions, and the waves are picked up by the antenna of a heterodyne detector on the train as the train passes the transmitting loops. The frequency of the oscillator in the heterodyne detector is fixed. The detected waves differing from each other in frequency pass through respectively corresponding frequency selective circuits in the output of the detector and control the power supply and the brakes for the train in accordance with the track conditions.

Fig. 1 shows schematically a system embodying the invention;

Fig. 2 shows wayside signaling and wave generating apparatus such as is located near each of the insulated rail joints which, as usual, divide the train rail into successive signaling blocks; and

Fig. 3 shows equipment such as is carried by each train for receiving and detecting the waves generated by the wayside apparatus of Fig. 2 and controlling the power supply and the brakes of the train in accordance with the received signals.

Referring first to Fig. 1, the reference characters r and r' designate the track rails of a railway, which rails are divided by insulated joints to form blocks A—B, B—C, and so forth. Traffic along the railway is normally in the direction indicated by the arrow.

Each block has a track circuit comprising the track rails of the block, means for applying alternating signaling electromotive force across the rails adjacent the exit end of the block and a track relay adjacent the entrance end of the block. The source of E. M. F. for each track circuit is a secondary winding 3 of a transformer which is designated T with a subscript corresponding to the location, and the relay for each track circuit is designated by the reference character J with a subscript corresponding to the location. For example, the track circuit for block BC includes the secondary winding 3 of transformer T_C and relay J_B.

The primary windings of the several transformers T are connected with transmission mains 4 which extend along the railway and to which alternating signaling current is supplied by suitable means, such as by a generator 7.

Each track relay is of the three-position type, comprising two windings 5 and 6. The former is connected directly with the track rails and receives track circuit current which at times is reversed in relative polarity with respect to the current of the transmission line 4 in a manner pointed out presently. The other winding is constantly supplied with alternating current directly from the right hand section of secondary winding 3 of the adjacent transformer T. Each of these relays, therefore, responds to reversals of the relative polarity of the current in the corresponding track circuit with respect to that of the transmission line 4; in other words, the contact fingers 8 and 10 of each relay are swung to the left when the relative polarity of the track circuit current is normal, and to the right when the relative polarity of the track circuit current is reverse, and these contact fingers are spring biased to the vertical or intermediate positions when the track winding of the relay is deenergized.

Located at the entrance of each block is a roadside signal which is designated by the reference character S with a subscript corresponding to the location of the signal. As here shown, these signals are of the type known as "light signals", each comprising three electric lamps G, Y and R, indicating "proceed", "caution" and "stop", respectively, when illuminated. Each signal S is controlled by contact finger 8 of the adjacent track relay in such a manner that lamp G is illuminated when the relay is energized in the normal direction, lamp Y is illuminated when the relay is energized in reverse direction, and lamp R is illuminated when the relay is deenergized. These lamps are supplied with current from the secondary wind-

ing 3 of the adjacent transformer T, and the circuits will be obvious from the drawing without further explanation.

The relative polarity of current supplied to the track circuit of each block is controlled by contact finger 10 of the track relay for the succeeding block, in such manner that the relative polarity of the track circuit current is normal when the relay is energized in either direction, and reverse when the relay is deenergized. The immediate source of supply for each track circuit is a transformer designated by the reference character 11 with a subscript corresponding to the location, the secondary of which transformer is connected across the track rails through a reactor W. The circuit for the primary winding of the transformer 11_C, when relay J_C is deenergized, is from the middle terminal of secondary winding 3 of transformer T_C, through conductor 12, primary winding of transformer 11_C, conductor 13, contact finger 10 of relay J_C, and conductor 14 to the left hand terminal of transformer secondary 3. The current thus supplied to the track circuit of block B—C is of reverse relative polarity. When relay J_C is energized in either normal or reversed direction, the circuit for the primary winding of transformer 11_C is from the middle terminal of secondary winding 3 of transformer T_C, through conductor 12, primary winding of transformer 11_C, conductor 13, contact finger 10, contact 21 or 22, conductor 23 and conductor 16 to the right-hand terminal of transformer secondary 3. The current then supplied to the track circuit of block B—C is of normal relative polarity.

The reactor W comprises two windings so arranged on an iron core that, when track circuit current flows through either winding to the rails and back through the other winding, the windings are in series aiding relation, and so the device W offers considerable impedance to such current flow and prevents abnormal flow of current from secondary winding 3 when the track rails are short-circuited by the wheels and axles of a car or train.

Located near the entrance to each block is an electric space discharge oscillator designated by O with a subscript corresponding to the location of the oscillator. As described presently with reference especially to Fig. 2, each oscillator has its filament energizing circuit suppled with energy derived from a secondary winding 30 of the adjacent transformer T, and supplies oscillating E. M. F. to an adjacent antenna 31 through an adjacent transformer 32, and each oscillator has three frequency determining circuits controlled by three relays 33, 34, 35, respectively, which have their windings in parallel with the adjacent lamps G, Y and R, respectively. Thus, each antenna 31 radiates waves of three different frequencies, say 29,000, 28,000 and 27,000 cycles per second, when the movable contact 8 of the adjacent track relay occupies its left-hand, right-hand and center positions, respectively.

Referring now to Fig. 2 especially, current from line 4 is supplied to the primary winding of transformer T which has four secondary windings, 3, 30, 46 and 47. Winding 46 supplies uni-directional space current to an electric space discharge oscillation generating tube 48 of oscillator O through an electric space discharge rectifier tube 49. Winding 47 supplies A. C. for heating the filament of tube 49.

The input circuit to rectifier tube 49 is traced from winding 46, conductor 177 to the plate of the tube and conductors 178 and 179 and condenser 53 to the filament. The D. C. output of the rectifier flows from the filament of tube 49 to the plate of tube 48 over an obvious circuit including the winding of relay 51 and choke coil 52. The space current return extends from the filament of tube 48 over conductors 180 and 181 to the mid-point of winding 30 and thence to winding 46 over conductor 178. The windings of relay 51 and choke coil 52 are of high impedance to the frequencies generated by tube 48, and condenser 53 readily by-passes the input current to the rectifier and thereby prevents it from reaching tube 48. Oscillations generated by tube 48 are supplied to the antenna 31 through a condenser 54 and the transformer 32, the condenser 54 preventing flow of D. C. from the plate to the filament of tube 48 through the primary winding of transformer 32 or preventing the flow through a parallel path consisting of a resistance 55 and a tuned circuit 56 connected in series with each other. The circuit 56 determines the frequency of the oscillations generated by oscillator O, and comprises an inductance coil 60 and condensers 61, 62 and 63, the condensers being connected across the coil, only one at a time, by the armatures of relays 33, 34 and 35, respectively. The grid and the filament of the tube 48 are connected by a circuit including a coil 65 which is inductively associated with the coil 60, whereby oscillating current of a frequency determined by the constants of circuit 56 is fed back from the output circuit to the input circuit of the tube so that sustained oscillations are produced by the oscillator O. As pointed out in United States patent to D. M. Terry, No. 1,573,948, February 23, 1926, in order to produce oscillating current of sinusoidal wave form of the frequency determined by the constants of the circuit 56, the resistance 55 should preferably be sufficiently large to limit the amplitude of the gener-

ated waves to such a value that the oscillator operates on the most nearly linear portion of its characteristic curve representing the relation between input voltage and output current.

Referring now to Fig. 3 especially, which shows equipment such as is carried on each train, that is, to be controlled in response to track conditions, an antenna 70 receives waves transmitted by the antennæ 31 as the train passes the respective antenna 31. Preferably, the antenna 70 and each of the antennæ 31 are directional in such manner that the antenna 70 receives and each of the antennæ 31 transmits with maximum efficiency in a plane at right angles to the track rails and with relatively low efficiency in the direction followed by the rails, so that the antenna 70 on a given train cannot effectively receive waves from a given antenna 31 at any considerable distance therefrom, and cannot effectively receive waves from more than one antenna 31 at a time. For example, the antenna 70 and each antenna 31 may be a loop in a plane at right angles to the track rails.

The waves received by antenna 70 are delivered to the primary winding of an input transformer 71 of a balanced demodulator DM of a heterodyne radio receiver H which includes a single frequency heterodyne oscillator O'. The oscillator comprises an electric space discharge oscillation generating tube 73, and is of the same general type as oscillator O. Filament heating current for tube 73 is supplied from a secondary winding 74 of a transformer 75 which has its primary winding connected to an A. C. generator 76 which may employ any type of power i. e. steam or electric, available on the train. Unidirectional space current for tube 73 is supplied from a secondary winding 77 of transformer 75 through a full wave rectifier R', and a choke coil 52' which functions similarly to the choke coil 52. The rectifier R' comprises two electric space discharge rectifying tubes 78 and 79 which have their filaments connected in parallel and supplied with filament heating current from a secondary winding 80 of the transformer 75. In oscillator O', elements 32', 52', 53', 54', 55', 56', 60', 61' and 65' are similar in structure and function to the elements of oscillator O which are designated by the same reference characters, respectively, without the prime mark. The demodulator DM comprises two electric space discharge tubes 81 and 82, and is of the general type of the balanced duplex modulator disclosed in the U. S. patent to Carson, 1,343,307, June 15, 1920. The filaments of tubes 81 and 82 are connected in parallel with the filament of tube 73, for energization from the secondary winding 74. For supplying unidirectional space current from winding 80 and rectifier R' to the space paths of tubes 81 and 82, a circuit including those paths is connected in parallel with the path through choke coil 52' and the discharge space of tube 73, that circuit extending from the filaments of rectifier R' through the winding of a relay 85, a choke coil 86, and thence to the filaments of the demodulator through two parallel branches, one of the branches containing one half of the primary winding of a demodulator output transformer 87 and the space discharge path in tube 81, and the other branch containing the other half of the transformer primary winding and the space discharge path in tube 82. The filaments of tubes 81, 82 and 73 are connected to the midpoint of the winding 77 through the two halves of the winding 74 which has its midpoint connected to the midpoint of winding 77.

The secondary winding of the output transformer 32' of the oscillator O' is connected, through a transformer 90, to the common portion of the two similar input circuits of the demodulator tubes 81 and 82. The duplex demodulator suppresses transmission of unmodulated current of the frequency of oscillator O' to the secondary winding of the output transformer 87 of the demodulator, but combines the waves received by antenna 70 from the antenna 31 with the waves from oscillator O' to produce in that winding, wave components having frequencies equal respectively, to the differences between the frequency of oscillator O' say 30,000 cycles per second, and the frequencies of oscillator O corresponding to the connection of the condensers 61, 62 and 63 in circuit. These components are transmitted to the windings of relays 91, 92 and 93 respectively, through frequency selective circuits 94, 95 and 96 respectively, which are shown by way of example, as narrow band filters of a type disclosed in Fig. 2 of U. S. patent to Campbell, 1,227,113, May 22, 1922. Energization of the relays 91, 92 and 93 causes relays 101, 102 and 103 respectively to become energized and to light a green light G', a yellow light Y' and a red light R', respectively, of a cab signal S'. The current for operating relays 101, 102 and 103 and lamps G', Y' and R' is supplied from a secondary winding 100 of the transformer 75 through circuits which are obvious from the drawing without further explanation.

When relay 91 operates, its armature causes energization of an electromagnet 110 for releasing a catch 111 which thereupon allows a spring 112 to close a steam cut-off valve 113 in steam line 114 and thereby cut off the motive power of the train. In the case of electric motive power valve 113 corresponds to a circuit breaker or similar device. The circuit for energizing magnet 110

extends from the left hand end of secondary winding 100, through conductor 115, armature of relay 91, conductor 116, winding of magnet 110, and conductors 117 and 118, to the right hand end of winding 100. When valve 113 has thus been tripped, it can be manually restored to its open position. The normal manually operable throttle in the steam line 114 or control handle for electric power is shown at 119.

When relay 92 operates, its armature causes energization of the electromagnet 110 for cutting off steam and an electromagnet 120 for releasing a catch 121 which thereupon allows spring operated switch 122 to close a circuit for energizing a magnet 123 which thereupon operates an air valve 124 in the usual air line or train pipe 126 of the air brake system, so that in addition to the cutting off of steam, the air brakes are applied for bringing the train to rest. The circuit for magnets 110 and 120 extends from winding 100 through conductor 115, armature of relay 92, conductor 127, magnet 120, conductors 128 and 116, magnet 110, and conductors 117 and 118, to winding 100. The circuit for magnet 123 extends from winding 100 through conductor 140, a variable resistance 141, conductor 142, magnet 123, switch 122, and conductor 118, to winding 100. The magnet 123 operates valve 124 against the tension of a spring, as shown and the resistance 141 is varied by a fly-ball governor 143 which is driven by the running gear of the locomotive, so that the resistance decreases and the intensity of the application of the braking means increases as the train speed decreases. The resistance is adjusted and proportioned so that the current in the circuit at the instant the braking means is operated in response to the tripping of latch 121 at any train speed, produces the maximum desirable value of brake pressure for normal braking. As the speed of the train decreases the brake pressure safely may be increased and this is accomplished automatically by the variable contacts carried by the governor varying resistances 141 and 151 as already described. The normal manually operable air valve is shown at 129.

When relay 93 operates, its armature causes energization of the electromagnet 110, for cutting off steam, and an electromagnet 130 for releasing a catch 131 which thereupon allows a switch 132 to close a circuit for energizing a magnet 133 which thereupon opens an air valve 134 in the air line 126 so that, in addition to the cutting off of the steam, the air brakes are applied for bringing the train to rest. The circuit for magnets 110 and 130 extends from winding 100 through conductor 115, armature of relay 93, conductor 137, magnet 130, conductors 128 and 116, magnet 110, and conductors 117 and 118, to winding 100. The circuit for magnet 133 extends from winding 100 through conductor 140, a variable resistance 151, conductor 152, magnet 133, switch 132, and conductor 118, to winding 100. The magnet 133 operates valve 134 against the tension of a spring, as shown, and the resistance 151 is varied by the flyball governor 143, so that the resistance decreases, and the intensity of the application of the braking means increases as the train speed decreases. The resistance is adjusted and proportioned to cause the initial value to be of such intensity when the braking means is operated in response to the tripping of latch 131 at any train speed as to have the maximum safe value for that speed. This braking is emergency braking, and decelerates the train, from any initial train speed at which it is applied, along a different time-speed curve from that which would obtain for normal braking initiated by the tripping of latch 121.

Assuming a train 160 (Fig. 1) in the block to the right of C, while a train 161 passes from the block to the left of A to the exit end of block BC, the operation of the system is as follows. Train 160 short circuits winding 5 of track relay J_C. Therefore, the contact fingers 8 and 10 of the relay are on their middle contacts. Finger 8 causes the relay 35 and the lamp R at location C to be energized, relay 35 connecting condenser 63 of oscillator O_C in circuit, so that the oscillator causes its antenna 31 to send out waves of 27,000 cycles per second, which is the frequency corresponding to the emergency stop signal lamp R. Finger 10 causes the relative polarity of the track current supplied to the track rails of block BC, which is the current supplied to winding 5 of relay J_B, to be reversed with respect to the current in power transmission line 4, so that relay J_B operates its fingers 8 and 10 to their right hand positions.

Finger 8 of relay J_B causes the relay 34 and the lamp Y at location B to be energized, relay 34 connecting condenser 62 of oscillator O_B in circuit, so that the oscillator causes its antenna 31 to send out waves of 28,000 cycles per second, which is the frequency corresponding to the caution signal lamp Y. Finger 10 of relay J_B causes the relative polarity of the track current supplied to the track rails of block AB, which is the current supplied to winding 5 of track relay J_A to be normal with respect to the current in transmission line 4, so that relay J_A operates its contact fingers 8 and 10 to their left hand positions.

Finger 8 of relay J_A causes the relay 33 and the lamp G at location A to be energized, relay 33 connecting the condenser 61 of oscillator O_A in circuit, so that the oscillator causes its antenna 31 to send out waves of 29,000 cycles per second, which is the

frequency corresponding to the safety signal lamp G.

The signals S and antennæ 31 corresponding to the locations A, B, C, etc., are placed a distance in advance of those respective locations equal to the maximum distance required for stopping a train by emergency braking. The engineer on train 161, seeing the safety light G at location A may open the circuit of the winding of relay 91 by a normally closed cab switch 162, and hold the switch open until the train antenna 70 reaches and passes beyond the field of effective influence of the antenna 31 corresponding to location A. However, if the engineer fails to see the safety signal and acknowledge it by opening switch 162, the waves of 29,000 cycles per second emanating from the antenna 31 near location A and received by the antenna 70 in passing that antenna 31 and detected by the heterodyne receiver H, will cause a current of 1000 cycles per second to pass through the switch 162 and the 1000 cycle filter 94 and operate relay 91 and therefore cause cab lamp G′ to light and steam valve 113 to cut off steam, so that the train decelerates and the engineer or another member of the train crew is informed that a green or safety signal has been passed without acknowledgment. If the failure to acknowledge the signal was not due to any physical disablement of the engineer, he can manually reset the catch 111 and proceed, knowing that the block AB which he is entering is clear and that the succeeding block is clear.

Train 161, upon entering block AB, short circuits track relay J_A, which then moves its contact fingers 8 and 10 to their mid-positions. Due to the movement of finger 8 to its mid-contact, near location A, the lamp G becomes dark and lamp R becomes lighted and relay 35, instead of relay 33, becomes energized, with the consequence that the antenna 31 radiates waves of the 27,000 cycle danger indicating frequency instead of the 29,000 cycle safety frequency. Due to the movement of finger 10 of relay J_A to its mid-contact, the relative polarity of the track current supplied to the track rails of the block in the rear of location A and to the winding 5 of the track relay of that block now becomes reverse of normal, and consequently that relay causes the extinguishing of the red light associated therewith and the lighting of the yellow or caution lamp associated therewith, and causes the antenna 31 associated therewith to radiate the 28,000 cycle caution indicating frequency instead of the 27,000 danger indicating frequency. Thus, the train 161, while in block AB is protected by the danger signals near the entrance of that block and by the caution signals near the entrance of the preceding block.

When train 161 reaches a point from which the lighted caution lamp Y near location B is visible, the engineer may open the circuit of the winding of relay 92 by a normally closed cab switch 163, and hold the switch open until the train antenna 70 reaches and passes beyond the field of influence of the antenna 31 near location B. However, if the engineer fails to see the caution signal and acknowledge it by opening switch 163, the waves of 28,000 cycles per second emanating from antenna 31 and received by the antenna 70 in passing and detected by the heterodyne receiver H on the train, will cause a current of 2,000 cycles per second to pass through the 2,000 cycle filter 95 and operate relay 92 and therefore cause cab lamp Y′ to light and steam valve 113 to cut-off steam and air valve 124 to apply the air brakes for normal braking, so that the train decelerates and the engineer or another member of the train crew is informed that a yellow or caution signal has been passed without acknowledgment. If the failure to acknowledge the signal was not due to physical disablement of the engineer he can manually reset the catches 111 and 122 and proceed, knowing that the block BC which he is entering is clear but that the next succeeding block is not clear.

As train 161 passes from block AB to block BC, winding 5 of track relay J_B becomes deenergized. Consequently, winding 5 of track relay J_A becomes energized, but with current of relative polarity the reverse of normal, so that the contact fingers 8 and 10 of the relay J_A move from their center or danger positions to their right hand or caution positions. This movement of finger 10 causes the relative polarity of the track current supplied to the track rails of the block in advance of location A and to the winding 5 of the track relay of that block to change from reverse of normal to normal. The latter relay then causes the extinguishing of the yellow caution light associated therewith and the lighting of the green safety lamp associated therewith, and causes the antenna 31 associated therewith to radiate the 29,000 cycle safety indicating frequency instead of the 28,000 cycle caution indicating frequency.

The movement of contact finger 8 of track relay J_A from its center position to its right hand position causes the extinguishing of the red light associated therewith and the lighting of the yellow caution lamp associated therewith, and causes the antenna 31 associated therewith to radiate the 28,000 cycle caution indicating frequency instead of the 27,000 cycle danger indicating frequency.

The deenergization of winding 5 of track relay J_B and the consequent movement of its contact fingers from their right hand posi-

tions to their center positions causes the aspect of the associated signal S_B to change from the yellow or caution condition to the red or danger condition, and causes the frequency radiated from the antenna 31 associated therewith to change from the 28,000 cycle caution indicating frequency to the 27,000 cycle danger indicating frequency.

Thus the train 161 while in block BC is protected by the danger signals near the entrance of that block and by the caution signals near the entrance of the preceding block.

When the train 161 reaches a point from which the lighted danger lamp R near the location C is visible, the engineer should close valve 119 and open valve 129 or otherwise bring the train to a stop before the train antenna 70 reaches the field of influence of the antenna 31 near that location. Upon a failure to so stop the train, the waves of 27,000 cycles per second emanating from that antenna 31 and received by the antenna 70 in passing and detected by the heterodyne receiver H on the train, will cause a current of 3,000 cycles per second to pass through the 3,000 cycle filter 96 and operate relay 93 and therefore cause cab lamp R′ to light and steam valve 113 to cut off steam and air valve 134 to apply the air brakes for emergency braking, so that the train is brought to rest before entering the block to the right of C and the engineer is informed that he has passed a danger signal. The switch 132 and valve 134 are preferably in a locked or sealed inclosure, so that they can be reset only after the lock has been opened or the seal has been broken. The train conductor may be authorized to reset them.

In case of failure to supply space current to the demodulator tubes 81 and 82, the relay 85 releases its armature and causes a cab lamp 170 to be energized from secondary winding 74, to notify the engineer of the failure.

In case of failure to supply space current to tube 48 of the oscillator O at any location such as A, B or C, the relay 51 which has its winding in the space current supply circuit of the oscillator releases its armature and, through conductors 175 and 176, short-circuits the track rails of the block behind that location and the track relay winding 5 connected to that block. The system thereupon operates in the same manner as though the short circuit were due to presence of a train in that block.

Although it will be clear that trains may be automatically controlled in accordance with the invention without necessity of visible signals, the invention is applicable to railways already equipped with signaling systems of types now in satisfactory operation. Preferably, in applying the invention to such systems the track circuits of the systems are employed to control a radio transmission system of the general type of the one specifically disclosed herein, the radio transmission system and the automatic train control devices which it operates serving as an adjunct to the existing signaling system. Thus the invention can be used with or instead of any existing standard railway block signaling system, without entailing changes in clearances or structural details on either the rolling stock or the right of way. The train equipment can be installed on as many units as desired without affecting other units; the track equipment can be installed on as many signal blocks as desired without affecting other blocks or interrupting traffic; and equipped and unequipped trains and track may be used indiscriminately (except that the automatic train control will function only when equipped trains are passing over equipped track.)

What is claimed is:

1. In combination, a source of waves differing in frequency, a body movable relatively to said source, means responsive to said waves for controlling the motion of said body, said means comprising a source of waves of frequency differing from said other frequencies, means for combining said waves from said sources to produce resulting waves of frequencies different from the frequencies of said combined waves, and means responsive to said resulting waves for controlling the motion of said body.

2. The combination with a block system comprising blocks of track insulated from each other, a three position track relay connected to each of said blocks at the beginning of the block, means for applying electromotive force to the end of the block, each of said track relays normally assuming a given one of its three positions, and means controlled by deenergization of each track relay for causing the preceding track relay to assume a second of its three positions, of means in the neighborhood of each relay controlled by the relay for directionally radiating waves of frequencies corresponding respectively to the positions to which the relay is operated, a body movable on said track, power supply means for causing motion of said body, normal braking means for said body, emergency braking means for said body, a detector carried by said body, for detecting said waves differing in frequency to produce respectively corresponding detected waves differing from each other in frequency, means responsive to the detected waves corresponding to the normal positions of said relays to control said power supply means, and responsive to the detected waves corresponding to said second positions of the relays to control said power supply means and said normal braking means, and responsive to the detected waves corresponding to the third positions

of the relays to control said power supply means and said emergency braking means, and self-restoring means, on said body, manually operable for preventing said detected waves corresponding to the normal positions of said relays from controlling said power supply means, and self-restoring means, on said body, manually operable for preventing said detected waves corresponding to said second positions of the relays from controlling said power supply means and said normal braking means.

3. A system comprising a track, means at a fixed point on the trackway but independent of the rails of the track, for directionally transmitting radio waves differing from each other in frequency, directional radio receiving means, movable past said point, for effectively receiving said waves in the immediate neighborhood of said point only, and means responding to said received waves of different frequencies selectively in accordance with their frequencies.

4. A system comprising means for generating unmodulated waves differing from each other in frequency, a single detector for detecting said waves to produce corresponding detected waves differing from said first mentioned waves and from each other in frequency, frequency selective circuits selective respectively to said different detected waves, and means connecting all of said frequency selective circuits in operative relation to said detector at the same time.

5. The combination with means for transmitting sets of waves, said sets differing from each other with respect to frequency, of means movable relatively to said transmitting means and comprising a single detector for detecting all of said waves to produce corresponding sets of detected waves differing from said first mentioned sets in frequency, frequency selective circuits for respectively selecting said sets of detected waves, and means responsive to said selected sets of detected waves for controlling the motion of said movable means.

6. An automatic train control system comprising a track, a train movable on said track, speed reducing means for said train, means responsive to the condition of said track for rendering said speed reducing means operative, and means for increasing automatically the intensity of application of said speed reducing means as the velocity of said train decreases.

7. An automatic train control system comprising a track, a train movable on said track, braking means for said train, and means responsive to different conditions of said track ahead of said train for decelerating said train along different time-speed curves corresponding to said different conditions, respectively, said decelerating means comprising means responsive to the speed of said train for adjusting the value of the maximum initial intensity of action of said decelerating means to the maximum safe value.

In witness whereof, I hereunto subscribe my name this 29th day of November, A. D. 1926.

LAURENCE E. MELHUISH.