March 7, 1933. P. N. BOSSART 1,900,405

ELECTRIC TRAIN SIGNALING SYSTEM

Filed April 2, 1931 2 Sheets-Sheet 1

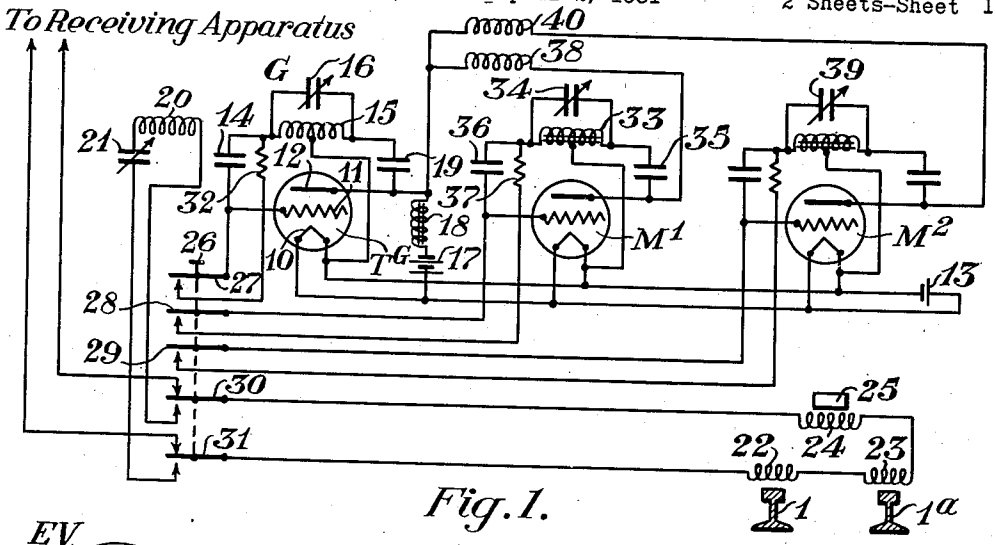


Fig. 1.

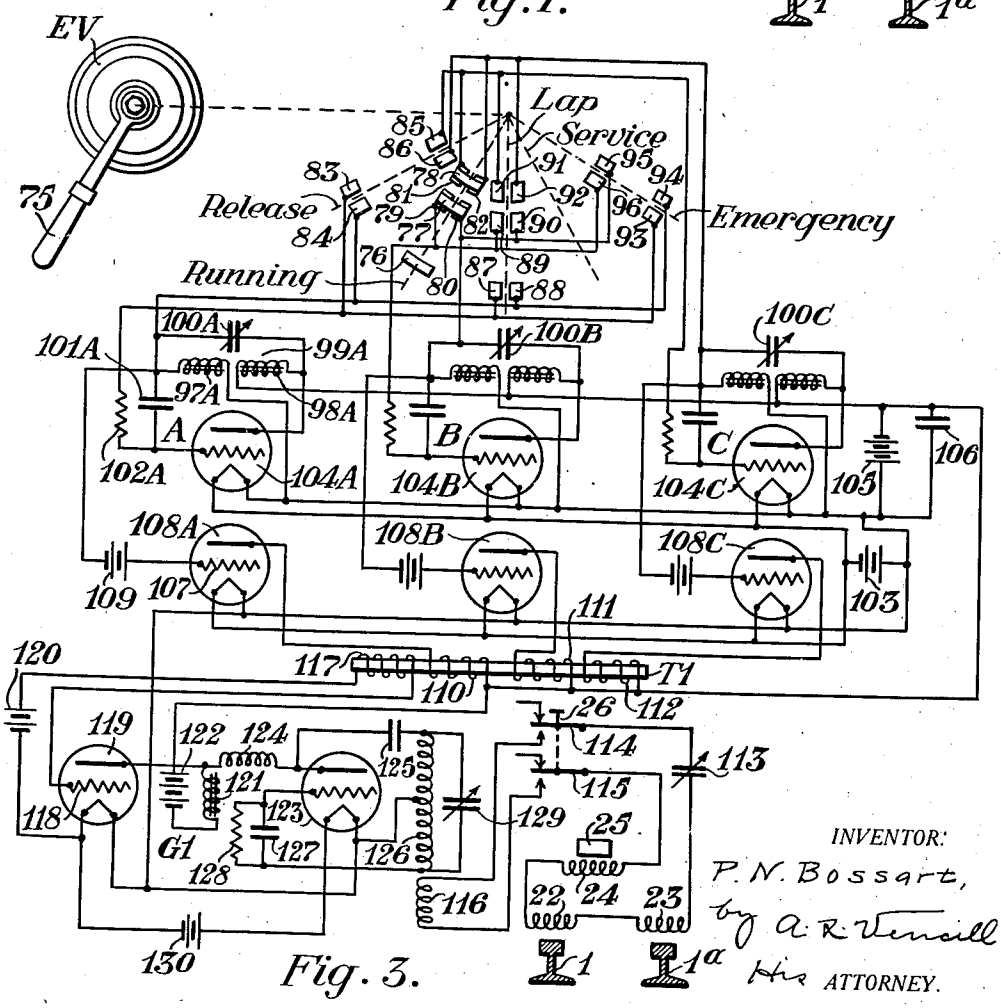


Fig. 3.

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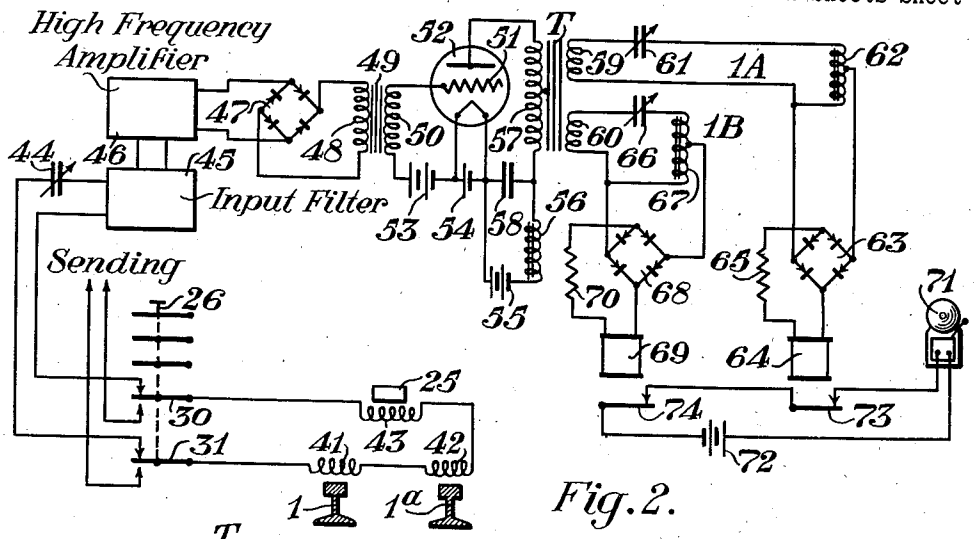


Fig. 2.

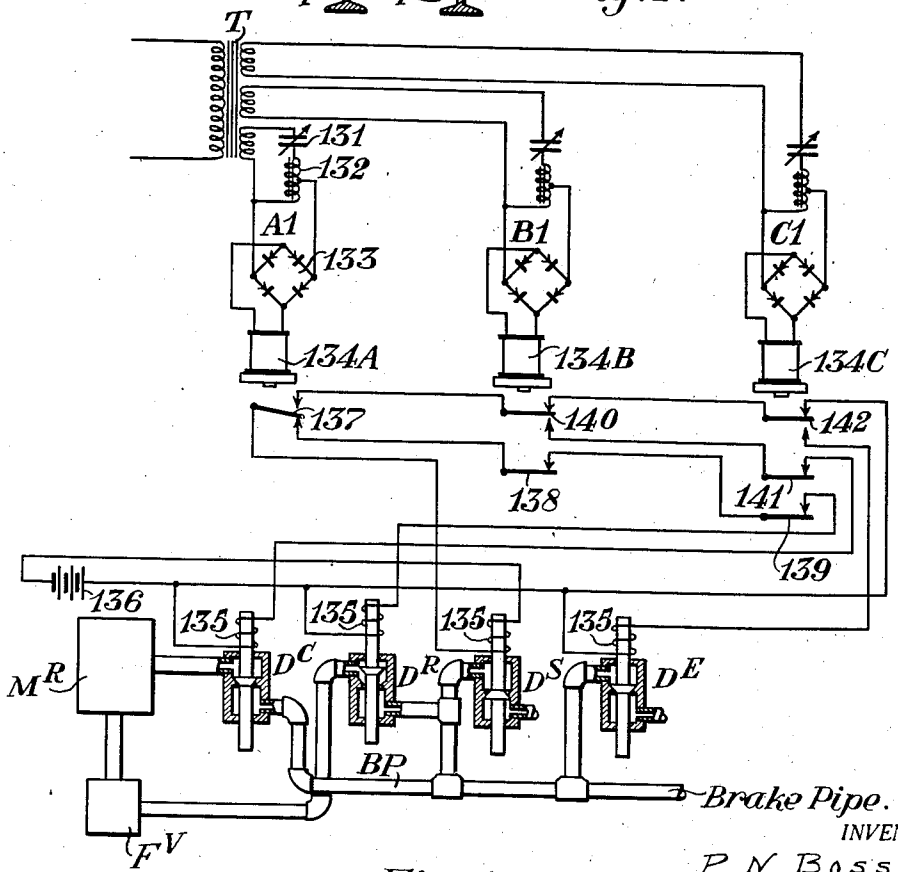


Fig. 4.

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Patented Mar. 7, 1933

1,900,405

UNITED STATES PATENT OFFICE

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ELECTRIC TRAIN SIGNALING SYSTEM

Application filed April 2, 1931. Serial No. 527,124.

My invention relates to communication systems for railway trains, and particularly to that class of systems for causing an auxiliary brake controlling mechanism located at some point on the train outside of the locomotive to register with the position of the usual engineer's brake valve on the locomotive.

I will describe certain forms of apparatus embodying my invention, and will then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a diagrammatic view of one form of the sending equipment of a signaling system embodying my invention. Fig. 2 is a diagrammatic vew of a preferred form of the receiving equipment that may be used to receive the signals sent out by the apparatus of Fig. 1. Fig. 3 is a diagrammatic view of the sending equipment for a train brake control system embodying my invention. Fig. 4 is a diagrammatic view of a preferred form of apparatus to be added to the receiving equipment of Fig. 2 when it is used with the equipment of Fig. 3 for the control of the train brakes. In each of the several views, like reference characters designate like parts.

In electric train signaling systems, it is proposed to confine the signaling current to frequencies ranging from two thousand to five thousand cycles per second, with a channel every three hundred cycles. This range will thus give eleven carrier frequency channels. Furthermore, it has been proposed to provide a definite signal by modulating the carrier current by a predetermined low frequency, for example, a modulating frequency of ten to ninety cycles per second.

In signal systems for controlling the train brakes, it is necessary to insure that the apparatus on one train will not be influenced by the signaling currents being generated on some nearby train. To this end, it becomes necessary to have available a large number of non-interfering communicating channels. Where the carrier frequency range is set as extending from two thousand to five thousand cycles per second and where the modulated frequency range is limited from say ten to ninety cycles per second, and as reliability requires at least a three hundred cycle separation of the carrier frequencies and at least a twenty percent separation between modulating frequencies, the maximum possible number of communication channels is found to be eleven carrier frequency channels and thirteen modulating frequency channels or one hundred forty-three communication channels.

As there are five independent brake functions, namely: "release", "running", "lap", "service" and "emergency", there are required at least four separate signal currents for each train, it being possible to obtain one function in response to no current. It is evident therefore that the possible one hundred forty-three channels mentioned above will likely not be sufficient to provide all the trains that will approach each other from time to time as they travel over the road with a separate channel for each brake function.

If two modulation frequencies are used in combination in place of a separate modulation frequency for each signal then the thirteen possible modulation channels will provide seventy-eight different modulation groups. These groups combined with the eleven carrier frequency channels make possible eight hundred fifty-eight communicating channels for signaling. Applying this idea of a combination of plurality of modulation frequencies for each individual signal to the case where multiple functions are desired for a system, it is evident that a large number of non-interfering systems can be provided. Take for illustration, the control of the train brakes of a given train where five separate functions are required by a group of three modulation frequencies. The five functions may be obtained by using the following combination: (first function) modulation 1 and 2; (second function) modulation 1 and 3; (third function) modulation 2 and 3; (fourth function) modulation 1, 2 and 3; (fifth function) none. It will be noted that in such a combination, no modulation frequency is used singularly. If, for instance, two of the functions, such as service and emergency might be combined, then the

1—2—3 combination would not be required.

By arranging that no two groups of three modulation frequencies have two frequencies in common, there will be no interference between two trains using these groups for a brake control system. It can be shown that with thirteen modulation frequencies twenty-one groups of three in which no pair of frequencies is repeated can be obtained. When these groups are combined with the eleven carrier frequencies available, two hundred and thirty-one communication systems of five functions each can be provided.

With the above arrangement, it would be possible for a nearby train on the same carrier frequency to supply the third modulation frequency to effect a false change of functions from a pair of frequencies to the 1—2—3 combination. This would of course be a very rare occurrence. By making the 1—2—3 combination correspond to a lap condition of the brake system, no undesirable active function could be initiated on a train by some nearby train. If this objection is considered serious, four modulation frequencies can be used in groups of three with no combination of three repeating and since for each group of four modulations, four separate groups of three can be obtained, and if the fifth function can be obtained with no current, then there would be no need of using a 1—2—3—4 combination. In such a scheme there is no possibility of a nearby train setting up a false function of the brake system. Furthermore, a still larger number of communicating systems can be obtained when four modulation frequencies are used in combination.

Referring to Fig. 1, there is shown the sending equipment for a carrier frequency current modulated simultaneously with two lower frequencies. In this instance, the equipment is arranged after the well-known Heising's modulation scheme. The tube T^G with its associated circuits supply the carrier frequency current while the tubes M^1 and M^2 supply the two lower modulation frequencies. Each of the three tubes contains a filament 10, grid 11 and plate 12. The grid 11 of the tube T^G is provided with a circuit including a condenser 14 and a portion of the oscillating coil 15. The current to heat each filament 10 is supplied by the battery 13, the filaments of the three tubes being connected in parallel. The plate potential for all three tubes is supplied by the battery 17 through the ordinary Heising iron core reactance coil 18 of relatively high impedance to all three frequencies generated. The oscillating circuit which includes coil 15 and the condenser 16 is connected to the plate circuit of the tube T^G through the plate blocking condenser 19 while a portion of the coil 15 is included in the grid circuit as mentioned above. The characteristics of the condenser 16 determine the frequency of the carrier current generated. The grid circuit for the tube T^G is provided with a grid leak circuit which includes a resistance 32 and an armature 27 of a sending key 26 to be shortly described.

The sending key 26 is mechanically connected to the armatures 27, 28, 29, 30 and 31 as indicated by a dotted line. With the key 26 depressed then each of these armatures engages a respective back contact as will be apparent from an inspection of the Fig. 1. Whenever key 26 is not depressed, it returns to its position as shown in the figure where each armature breaks contact with its back contact and the armatures 30 and 31 engage respective front contacts.

The control of the electron tubes here shown as effected by opening the grid leak circuit may be in some cases better accomplished by opening the direct current supply to the plate; or by removing a short circuit from a resistor, which then carries the plate current of the tube and which is so connected in the circuit that the voltage drop across it is used to apply a sufficiently large negative bias to the grid to stop any oscillations of the electron tube. These methods are all well known in the art and the form shown will serve to illustrate the different ways by which the electron tubes may be controlled.

The output coil 20 is inductively coupled with the oscillating coil 15. The coil 20 is connected to the output circuit which includes a condenser 21, back contact of armature 31 when key 26 is depressed, coils 22 and 23 located in inductive relation with the rails 1 and 1^a, respectively, coil 24 located in inductive relation with the train coupler 25 at the sending location, and a back contact of the armature 30. The characteristics of the condenser 21 are such as to tune the output circuit to resonance at the carrier frequency generated by the tube T^G.

The circuits associated with the tube M^1 are similar to the circuits associated with the tube T^G. The oscillating coil 33 is provided with an iron core and the characteristics of the condenser 34 determine the modulation frequency generated. 35 is the plate blocking condenser, 36 the grid circuit condenser and 38 is a high frequency choke coil which prevents the carrier frequency from being by-passed to ground through the low frequency oscillator M^1. The grid circuit for M^1 is provided with a grid leak circuit that includes the resistance 37 and the back contact of armature 28 of the sending key 26. The circuits associated with the tube M^2 are just the same as those for tube M^1 with the exception that the condenser 39 has different characteristics to insure that the modulation frequency generated by the oscillator M^2 is different than that generated by M^1. It is here pointed out that by providing the high frequency choke coils 38 and 40 for the tubes M^1 and M^2 respectively and by plac-

ing them in the separate plate circuits, the impedance of both high frequency choke coils add to oppose any by-passing of one modulation frequency through the tube and circuits supplying the other modulation frequency.

Normally the inductors 22, 23 and 24 are connected to the receiving apparatus through the front contacts of the armatures 30 and 31 of the key 26. Also normally the grid leak circuit for each of the tubes is open with the result that normally none of the tube circuits will oscillate and no signaling current is generated.

When key 26 is depressed, all three grid leak circuits will be completed, all three oscillators will start oscillating simultaneously and the coils 22, 23 and 24 will be connected to the output coil 20. It follows then that normally the sending equipment of Fig. 1 is inactive and that by depressing the key 26, a carrier frequency current modulated simultaneously at two frequencies will be supplied to the track rails 1 and 1^a and to the coupler 25 of the train.

Fig. 2 shows the receiving equipment necessary to receive at some other point on the train, the signals supplied to the traffic rails and train coupler by the equipment of Fig. 1. In Fig. 2, the parts 41, 42 and 43 are similar in every respect to the coils 22, 23 and 24 respectively of Fig. 1. Likewise the sending key 26 of Fig. 2 is similar to the sending key 26 of Fig. 1 and normally the coils 41, 42 and 43 are connected through the front contacts of the armatures 30 and 31 of key 26 to the input filter through a condenser 44 which tunes the input circuit to resonance at the carrier frequency of the generator T^G of Fig. 1. The signaling current received by the coils 41, 42 and 43 is applied through the input filter 45 and a high frequency amplifier 46 to the rectifier 47 where it is demodulated and the two modulation frequencies supplied to the primary 48 of a transformer 49. While this input filter and high frequency amplifier may take many forms, a preferred device is that disclosed and claimed in my copending application for Letters Patent, Serial No. 431085, filed February 25, 1930. As the input filter and amplifier form no part of this invention, it is deemed sufficient to indicate such apparatus in the Fig. 2 by a symbol in order to not unduly complicate the drawings.

The secondary 50 of the transformer 49 supplies the circuit for the grid 51 of a tube 52 through a biasing battery 53. The filament of the tube 52 is constantly heated by a battery 54 and its plate circuit is supplied from a battery 55 through a relatively high impedance coil 56 in series with the primary 57 of a transformer T. A large by-pass condenser 58 is connected between the filament and the junction point of the coil 56 and primary 57. The coil 56 and condenser 58 are used as a filter so that the battery 55 may be used to supply current to the high frequency amplifier 46 if it seems desirable to do so.

The operation of the apparatus of Fig. 2 can be summed up thus far as follows: When the modulated carrier current supplied to the track by the equipment of Fig. 1 is picked up by the inductors 41, 42 and 43 and applied to the filter 45 and amplifier 46, current is supplied through the full-wave rectifier 47 to the primary 48 of a transformer 49. Due, however, to the rectifier 47, this current is a pulsating direct current which has a varying component for each of the two modulation frequencies of the carrier current. This pulsating direct current in the primary 48 of transformer 49 induces an alternating electromotive force in the secondary 50 which has a component corresponding to each of the modulation frequencies and this alternating electromotive force is impressed across the grid 51 and filament of the tube 52. As a result, the plate current of tube 52 is periodically varied in accordance with the components corresponding to the two modulation frequencies.

The transformer T has two secondaries 59 and 60 which supply sharply tuned resonant circuits 1A and 1B, respectively. The circuit 1A in detail includes the secondary 59 and a condenser 61 in series with a low power factor reactor 62. A full-wave rectifier 63 is connected across a part of the reactor 62 and the output of this rectifier 63 energizes the relay 64. The characteristics of the elements of this 1A circuit are such that the circuit is sharply tuned to resonance at one of the modulation frequencies of the carrier current. Let us say that this circuit 1A responds to the frequency generated by the tube M^1 of Fig. 1. It follows then that the presence of this modulation frequency in the carrier current effects the energization of the relay 64.

The 1B circuit includes the secondary 60 and a condenser 66 in series with a low power factor reactor 67. A full-wave rectifier 68 is connected across a portion of the reactor 67 while the output circuit of the rectifier 68 includes the relay 69. The characteristics of the elements of the 1B circuit are such that it is sharply tuned to resonance at the second modulation frequency of the signaling current. That is to say, it responds to the presence of the modulation frequency supplied by the tube M^2 of Fig. 1 and that the relay 69 is energized as the result. In case the relays 64 and 69 are too slow in operation due to being normally short-circuited by their respective rectifier, the resistances 65 and 70 may be inserted in series with the coils of the relays 64 and 69, respectively,

as shown in the Fig. 2, although such resistances are not essential.

Thus to adjust the receiving apparatus of Fig. 2 to any given channel, condenser 44 and the input filter 45, are adjusted to the carrier frequency, secondary circuit 1A is adjusted to one modulation frequency and the secondary circuit 1B to the other modulation frequency.

It is apparent from the foregoing that as long as the track rails are supplied with a signaling current of a carrier frequency and two modulation frequencies corresponding to that at which the receiving apparatus of Fig. 2 is adjusted, the two relays 64 and 69 are both energized. When the supply of this signaling current is discontinued or when the carrier current is not modulated then the relays 64 and 69 become deenergized. When both relays are energized a signal here shown as a vibrating bell 71 is produced by means of the circuit which includes battery 72, front contacts 73 and 74 of relays 64 and 69, respectively, and the bell 71. Thus with one location on a train equipped with the signaling apparatus of Fig. 1 and a second location on the train equipped with the receiving apparatus of Fig. 2, a signal can be transmitted from the first location to the second location. Furthermore, if each location on the train is provided with the equipment of Figs. 1 and 2, communication can be established between the two locations by the alternate opening and closing of the sending keys. As a matter of fact, one set of sending and receiving equipment may be located along the trackway with inductor coils placed in inductive relation to the track rails and communication established between this wayside station and a train traveling on said track. Such a signal system disclosed in Figs. 1 and 2 possesses a high degree of sensitivity and selectivity and is substantially immune to shock excitation.

Fig. 3 shows my invention applied to a system for the control of train brakes by controlling an auxiliary mechanism capable of reproducing the functions of the usual engineer's brake valve on the locomotive and which mechanism is located at another point on the train. While this second point may be at any location on the train, it will be considered in this description as being in the caboose. In this instance, three low frequency generators which I shall designate A, B and C are provided. The choice of any pair or of three or of none is effected by the position of the handle 75 of the engineer's brake valve EV.

As here shown, the low frequency generators are of the electron tube type and their associated circuits are of the well-known Hartley direct or series fed type where the plate voltage is supplied between the plate and the grid coils. For example, coils 97A and 98A of the iron core oscillator coil 99A are respectively the grid and plate coils of generator A and are closely coupled to each other. 100A is the oscillating circuit condenser the characteristics of which determine the frequency delivered by the generator A. 101A is the grid condenser and 102A is the grid leak resistance. The battery 103 supplies current to the filaments of each of the tubes 104A, 104B and 104C in parallel while the plate voltage for all three of the tubes is supplied by the battery 105 by-passed by a large condenser 106. Oscillation of these three low frequency generators is controlled by opening and closing the grid leak circuit the same as previously described in Fig. 1. The selection of the grid leak circuits will now be taken up.

As shown schematically, the contact members 76, 77 and 78 are operatively connected to and actuated by the handle 75 of the engineer's valve EV. Each contact member is adapted to engage a series of stationary contacts as the handle 75 is moved to the several operating positions of the brake valve EV. For example, with the handle 75 in running position, the contact member 76 engages no stationary contacts, the contact member 77 engages the stationary contacts 79 and 80 and the contact member 78 engages the stationary contacts 81 and 82. With the handle 75 at release position, then contact 76 engages the stationary contacts 83 and 84, and 78 engages the contacts 85 and 86. When the brake valve handle 75 is placed in the lap position, the contact member 76 engages 87 and 88, 77 engages 89 and 90 and 78 engages 91 and 92. When the handle is at the service position, the contact members engage no stationary contacts but when the handle is in the emergency position 76 engages contacts 93 and 94 and 77 engages 95 and 96.

Each of the pairs of stationary contacts 83—84, 87—88 and 93—94 when bridged by the associated contact member 76 completes the grid leak circuit for the low frequency generator A. Each of the pair of contacts 79—80, 89—90 and 95—96 when bridged by the associated contact member 77 completes the grid leak circuit for the generator B. Likewise each of the pair of contacts 85—86, 81—82, and 91—92 when bridged by the contact member 78 completes the grid leak circuit for the generator C.

It follows then that with the handle 75 at release position, generators A and C are active; when handle 75 is at running position, generators B and C are active; at lap position, all three generators A, B and C are active; at service position none are active; while in the emergency position A and B are active. Thus A and C are used for release, B and C for running, A, B and C for lap, none for service, and A and B for emergency.

In Fig. 3, there is provided an intermedi-

ate amplifier tube for each of the low frequency generators. Referring to generator A, its output is applied to the grid 107 of the amplifier tube 108A in series with a grid biasing battery 109. The output or plate circuit of the tube 108A is supplied with current from the battery 105 through a primary winding 110 of a transformer T1. It follows then that the current generated by A will be reproduced in the plate circuit of the tube 108A with enlarged amplitudes and that this plate current flows in the primary 110 of transformer T1. In like manner the amplifier 108B whose plate circuit includes the primary 111 of transformer T1 is associated with the generator B. The primary 112 of transformer T1 is included in the plate circuit of the amplifier 108C which is associated with the generator C. A function of these intermediate amplifiers is to completely prevent any by-passing or interference by the energization of one modulation frequency with the circuits of another modulation frequency.

The transformer T1 has a secondary winding 117 connected, through a biasing battery 120, to the grid 118 of the modulating tube 119 of the modulator oscillator designated in Fig. 3 as a whole by the reference character G1. In the secondary 117 all three frequencies A, B and C will be induced. That is to say, which ever frequencies are active will be induced depending upon the selection made by the position of the engineer's valve EV. It follows that whichever frequency is selected by the valve EV, there will be a corresponding component in the voltage applied to the grid 118 of the modulator tube 119. 121 is the iron core plate reactance for the modulator oscillator G1. 122 is an additional plate battery for the tubes 119 and 123 in series with the plate battery 105. Battery 122 can of course be a separate battery independent of the battery 105. 124 is the usual high frequency choke to keep the carrier current out of the modulator tube 119. The carrier current oscillator 123 and its associated circuits are the same as previously described for the tube TG of Fig. 1, 125 being the plate blocking condenser, 126 the oscillating coil, 127 the grid condenser, 128 the grid leak resistance and 129 the oscillating circuit condenser. The filaments of the two tubes 119 and 123 are supplied with current from the battery 130 in series.

The output coil 116 is connected to the sending inductors 22, 23 and 24 through back contacts of the armatures 114 and 115 of the key 26 and the tuning condenser 113. The coils 22, 23 and 24 of Fig. 3 are similar to the same elements of Fig. 1 and are similarly located. To sum up the operation of the sending equipment of Fig. 3, the low frequency voltages generated by A, B and C are selected by the position of the engineer's valve handle 75, amplified and applied to the grid of the modulator tube 119 through the transformer T1. The carrier frequency current generated by the oscillator tube 123 is modulated in accordance with the frequencies impressed on tube 119 and this modulated carrier current is supplied to the track through the inductors 22, 23 and 24, assuming, of course, that the key 26 is depressed to close the output circuit. The modulation frequencies are determined by the condensers 100A, 100B and 100C and the carrier frequency determined by the condenser 129. The output circuit is also tuned to the carrier frequency by the condenser 113.

Fig. 4 shows a preferred form of the receiving apparatus for a train brake system to cooperate with the sending apparatus of Fig. 3 in so far as the receiving apparatus differs from the receiving apparatus of Fig. 2. In Fig. 4, the receiving apparatus preceding the transformer T is to be understood as being the same as that disclosed in the Fig. 2. The transformer T of Fig. 4 is provided with three secondary circuits instead of two as shown in the Fig. 2. The secondary circuits A1, B1 and C1 of Fig. 4 are sharply tuned to the low frequency of the currents generated by A, B and C of Fig. 3 respectively. The circuit A1 consists of a condenser 131 and a low power factor reactor 132 tuned to respond to the low frequency generated by generator A. A portion of the reactor 132 is connected to the input of the rectifier 133 while the output of rectifier 133 is connected to the slow-releasing relay 134A. It follows that when the carrier current is modulated by the low frequency current generated by A the relay 134A is energized. In a similar manner, the secondary circuit B1, adjusted to the low frequency current generated by B, will energize the relay 134B in response to the presence of this modulation frequency in the carrier current. Also circuit C1, adjusted to the low frequency current generated by C, will energize the relay 134C in response to the presence of this modulation frequency in the carrier current.

From the foregoing description, it is apparent that relays 134A, 134B and 134C are energized or deenergized in accordance to the selection of the generators A, B and C by the position of the engineer's brake valve. The relays 134A, 134B and 134C may therefore be utilized to control an auxiliary brake controlling mechanism located at some point on the train outside of the locomotive which, as stated above, we shall consider as being in the caboose.

The caboose is provided with a main reservoir M^R, a feed valve F^V and electropneumatic valves D adapted to reproduce the functions of the engineer's valve on the loco-

motive. It will be understood, of course, that the caboose is further provided with a compressor, etc., to insure a proper supply of air pressure in the reservoir M^R. The valves D^C, D^R and D^E are each biased to the closed position and are opened when its associated magnet 135 is energized. The valve D^S is biased to its open position and is closed when its associated magnet 135 is energized. When valve D^C is opened, that is, when its magnet 135 is energized, main reservoir M^R is connected with the brake pipe BP so that the auxiliary apparatus will then reproduce the condition that exists on the locomotive when the engineer's valve is in the release position. When the valve D^R is opened, the brake pipe is connected to the feed valve F^V thereby reproducing the condition existing on the locomotive when the engineer's valve is in the running position. When the valve D^S is opened, that is, when its magnet 135 is deenergized, the brake pipe is connected to the atmosphere through a vent of such characteristics as to produce a reduction in the brake pipe pressure at substantially the service rate of the usual brake valve to effect a service application of the brakes. When the valve D^E is opened by its magnet 135 being energized, the brake pipe is connected to the atmosphere through a vent of such characteristics as to cause an emergency rate of reduction of brake pipe pressure and an emergency application of the brakes. When the valves D^C, D^R and D^E are all deenergized and valve D^S energized, the condition reproduced by the auxiliary apparatus corresponds to the lap position of the engineer's brake valve.

The magnets 135 of the several valves are controlled by the slow-releasing relays 134A, 134B and 134C. Assuming the relays to be in the position as shown in the Fig. 4, that is, relay 134A deenergized and both 134B and 134C energized, current is supplied from the battery 136 through magnet 135 of D^S, back contact of armature 137 of relay 134A, front contact of armature 138 of relay 134B, front contact of armature 139 of relay 134C, magnet 135 of D^R and back to the battery 136. In the event relays 134A and 134C are energized and 134 B deenergized, then the circuit extends from the battery 136 through magnet 135 of D^S, front contact of armature 137, back contact of armature 140 of relay 134B, front contact of armature 141 of relay 134C, magnet 135 of D^C and to battery 136. Again should all three of the relays be energized, then current is supplied to the magnet 135 of D^S, front contacts of armatures 137, 140 and 142, respectively, and to the battery 136. Or, in the event relays 134A and 134B are energized and relay 134C deenergized, then current is supplied to the magnet 135 of D^S and the magnet 135 of D^E through the front contact of armatures 137, 140, and back contact of armature 142. The magnet 135 of the service valve D^S is adapted to be energized in series with each of the remaining magnets and energized alone when all three of the relays are energized. This arrangement of service valve D^S insures the auxiliary apparatus to operate on the closed circuit principle as any failure of the apparatus in the caboose will result in the service valve D^S being deenergized to effect a service application of the brakes.

In describing the operation of the apparatus of Figs. 3 and 4, let us first assume that the engineer's brake valve EV is in its normal running position as shown in Fig. 3, and that the key 26 of Fig. 3 is depressed to its sending condition. The B and C generators are rendered active by the closing of their respective grid leak circuits and the carrier frequency current is modulated by the B and C low frequencies. This modulated carrier current is applied to the rails by the sending apparatus and is picked up by the inductors of the receiving apparatus at the caboose and the relays 134B and 134C energized. With relays 134B and 134C picked up, then the valves D^S and D^R are energized to effect a running condition of the auxiliary brake mechanism. Let us next assume that the engineer's valve is placed at release position, the key 26 still being depressed to its sending position. With handle 75 at release position, generators A and C are selected and the carrier current supplied to the traffic rails will be modulated by the frequencies of A and C. With a carrier current of A and C frequency modulation picked up by the receiving apparatus at the caboose, the relays 134A and 134C are energized. With this set-up of the relays in the caboose, the valves D^S and D^C are energized to effect a release condition of the auxiliary mechanism. Again in the event the handle 75 is at lap position and all three generators A, B and C rendered active, all three relays 134A, 134B and 134C in the caboose are selected and the valve D^S only energized, effecting thereby a lap condition of the auxiliary brake mechanism. Once again let us assume that the engineer's valve is placed in its service position and none of the generators A, B and C made active. In the caboose, all of the relays will be deenergized and the auxiliary mechanism set to effect a service application of the brakes. In the case the engineer's valve is placed at emergency position where generators A and B are selected, the relays 134A and 134B in the caboose are selected to energize the valves D^S and D^E to render thereby an emergency application of the brakes by the auxiliary mechanism.

It is apparent from the foregoing description that the auxiliary brake mechanism in the caboose is adapted to reproduce the several operating functions of the engineer's brake valve and that by means of the sending

apparatus of Fig. 3 and the receiving apparatus of Figs. 2 and 4, the auxiliary mechanism is made to register with the position of the engineer's brake valve.

It has been proposed for systems that provide for the control of train brakes by an auxiliary mechanism located in the caboose as well as by the usual engineer's brake valve that a return indication be sent by the auxiliary mechanism in the caboose to the locomotive, so that the locomotive driver may know whether or not the condition that he has set up on the locomotive is being duplicated in the caboose. This requirement necessitates the providing of a transmitting apparatus in the caboose and a receiving apparatus on the locomotive. Furthermore, it has been proposed for systems of this kind, that there be alternate periods for sending the control and for the return of the indication. The relays 134A, 134B and 134C of Fig. 4 are made slow-releasing, so that when supplied with an energizing impulse during each control period, they will retain their armatures in the energized position during the indication period. By an alternate movement of a key 26 between its sending and receiving positions, then the inductor coils will be alternately connected to the sending and receiving apparatus. Thus by equipping both the locomotive and the caboose with both the sending and receiving apparatus of my system, a control of the auxiliary brake mechanism and a return indication to a locomotive can be obtained.

While in this description, definite ranges of frequencies for the carrier current and for the modulation current have been established, it is to be understood that my invention is not limited to any definite range of frequencies and that this range of frequencies is given by way of illustration. A system of brake control such as here disclosed provides a large number of non-interfering channels assuring thereby no interference between neighboring trains and it provides a system that is highly sensitive and reliable for each individual train.

Although I have herein shown and described only certain forms of apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, a railway train, a brake controlling mechanism having a plurality of operating functions, a transmitting means capable of supplying a carrier frequency current simultaneously modulated by different groups of low frequency currents, means for establishing the frequency of the carrier current and the frequencies of each of the modulating currents of the transmitting means of the train, a manually operated device adapted to select a different group of the modulating currents for each of the different operating functions of the brake mechanism, a receiving means responsive to the modulated carrier current supplied by the transmitting means for causing the operating function of the brake mechanism to register with that selected by the manually operated means, and selecting means to adjust said receiving means to respond to the current supplied by the transmitting means of that train and none other.

2. In combination, a signaling mechanism having a plurality of operating conditions, a transmitting means capable of supplying a carrier frequency current simultaneously modulated by different groups of low frequency currents, means for establishing the frequency of the carrier current and the frequencies of each of the modulating currents of the transmitting means, a manually operated device adapted to select a different group of modulating currents for each of the different operating conditions of the signaling mechanism, a receiving means responsive to the modulated carrier current supplied by the transmitting means for causing the operating condition of the signaling mechanism to register with that selected by the manually operated device, and selecting means to adjust said receiving means to respond to the current supplied by said transmitting means and none other.

3. In combination, a railway train, a brake controlling mechanism having a plurality of operating functions, a transmitting means capable of supplying a carrier frequency current simultaneously modulated by different groups of low frequency currents, a manually operated means adapted to select a different group of the modulating currents for each of the different operating functions of the brake mechanism, a receiving means responsive to the modulated carrier current supplied by the transmitting means for causing the operating function of the brake mechanism to register with that selected by the manually operated means.

4. Apparatus for the control of the several operating functions of train brakes comprising in combination, a source of carrier current on the locomotive, means for simultaneously modulating said carrier current with different groups of alternating current of different frequencies, a manually operated device on the locomotive for selecting a different group of modulating currents for each operating function of the train brakes, a brake controlling mechanism located on the train at a point outside the locomotive capable of producing the several operating functions of the brakes, and a receiving and demodulating means associated with the brake

controlling mechanism selectively responsive to the several groups of modulating frequencies of the carrier current for causing the condition of the said brake controlling mechanism to register with the manually controlled device on the locomotive.

5. Apparatus for the control of train brakes comprising in combination with the usual engineer's brake valve on the locomotive, a source of carrier current, means for simultaneously modulating said carrier current with different groups of alternating currents of different frequencies, means for selecting a different group of modulating currents for each position of the engineer's valve, auxiliary brake controlling mechanism at another point on the train capable of reproducing the functions of the engineer's valve, and a receiving and demodulating means associated with said auxiliary mechanism selectively responsive to the several groups of modulating frequencies of the carrier current for causing the condition of the auxiliary mechanism to register with the position of the engineer's valve.

6. Apparatus for the control of train brakes comprising in combination with the usual engineer's brake valve on the locomotive, a source of carrier frequency current, means for simultaneously modulating said carrier current with different groups of alternating currents, means for selecting a different group of modulating alternating currents for each position of the engineer's valve, auxiliary brake controlling mechanism at another point on the train capable of reproducing the functions of the engineer's valve, and receiving and demodulating means associated with said auxiliary mechanism selectively responsive to the several groups of modulating currents of the carrier current for causing the condition of the auxiliary mechanism to register with the position of the engineer's valve.

7. Apparatus for the control of train brakes comprising in combination with the usual engineer's brake valve on the locomotive, a transmitting means capable of supplying a carrier frequency current simultaneously modulated by different groups of low frequency currents, means for determining the frequency of the carrier current and the frequencies of the modulating currents, means operated by the engineer's brake valve to select a different group of modulating currents for each of the operating positions of the engineer's valve, auxiliary brake controlling mechanism at another point on the train capable of reproducing the functions of the engineer's valve, receiving means associated with said auxiliary mechanism responsive to the current supplied by said transmitting means for causing the condition of the auxiliary mechanism to register with the position of the engineer's valve, and selecting means to adjust said receiving means to respond to the current supplied by the said transmitting means and to none other.

8. In combination, a railway having a plurality of railway trains, a brake controlling mechanism for each train having a plurality of operating functions; a non-interfering control system for the control of the brake controlling mechanism of each train including, a generating means to supply a carrier frequency current simultaneously modulated by a group of different low frequency currents for each operating function of the brake mechanism, and a selecting means adapted to establish the frequencies of the currents supplied and capable of providing for different frequencies for the different trains; a manually operated means to select the different groups of modulating frequencies for the different operating functions of the brake controlling mechanism of a train, and a receiving means on the train influenced by the modulated carrier current for causing the brake mechanism to establish the operating function corresponding to that selected by the manually operated means.

9. In combination, a railway having a plurality of railway trains, a signaling mechanism for each train having a plurality of conditions; a non-interfering control system for the control of the signaling mechanism of each train including, a generating means to supply a carrier current simultaneously modulated by a different group of currents for each condition of the signaling mechanism, and a selecting means adapted to establish the frequency of the carrier current and of each of the modulating currents, and capable of arrangement for different frequencies for each train; means to select the different groups of modulating currents for the different conditions of the signaling mechanism of a train, and a receiving means on the train influenced by the modulated carrier current for causing the condition of the signaling mechanism to register with that selected by said last mentioned means.

10. In combination, a railway having a plurality of railway trains, a signaling mechanism for each train having a plurality of conditions; a non-interfering control system for the control of the signaling mechanism of each train including, a generating means to supply a carrier current simultaneously impressed by a different group of modulators for each condition of the signaling mechanism, and a selecting means adapted to establish the characteristics of the carrier current and of each of the modulators, and capable of arrangement for different characteristics for each train; means to select the different groups of modulators for the different conditions of the signaling mechanism of a train, and a receiving means on the train influenced

by the modulated carrier current for causing the condition of the signaling mechanism to register with that selected by said last mentioned means.

11. In combination, a railway having a plurality of railway trains, a signaling mechanism for each train having four conditions; a non-interfering control system for the control of the signaling mechanism of each train including, a generating means to supply a carrier current simultaneously modulated by the three different pairs of frequencies obtainable from a group of three modulating frequencies for three conditions and modulated by no frequency for the fourth condition of the signaling mechanism, and a selecting means to establish the frequency of the carrier current and of each of the modulating currents and capab'e of arrangement for different frequencies of the carrier current and that the said group of three modulation frequencies being chosen for different trains so that no two frequencies of any group are common to two or more trains having the same frequency of carrier current; means to select the different pairs of the modulating currents for the different conditions of the signaling mechanism of a train, and a receiving means on a train influenced by the modulated carrier current for causing the condition of the signaling mechanism to register with that selected by the last mentioned means.

12. In combination, an output circuit, an electron tube generator of carrier frequency current normally inactive, a plurality of electron tube generators of modulation current each normally inactive, a normally open grid leak circuit for each of said generators, means to simultaneously close said grid leak circuits to render said generators active to supply the output circuit with a carrier current simultaneously modulated by a plurality of modulating currents, and a signaling device controlled by said output circuit.

13. Apparatus for the control of train brakes comprising in combination with the usual engineer's brake valve on the locomotive, an auxiliary brake controlling mechanism located at another point on the train adapted to reproduce the operating functions of the engineer's valve, an electron tube generator of carrier frequency current, a plurality of electron tube generators of modulating currents, a transmitting circuit, a normally open grid leak circuit for each of the generators of modulating current, means for closing a different group of grid leak circuits for each position of the engineer's valve to supply the transmitting circuit with a carrier current simultaneously modulated by a different group of modulating currents for each position of the engineer's valve, and a receiving and demodulating means responsive to the current supplied by the transmitting circuit for causing the auxiliary mechanism to register with the position of the engineer's valve.

14. A control system including, a transmitting circuit, a generator of carrier frequency current, a plurality of generators of modulating frequency currents of different frequencies, a first control means to selectively control the modulating currents to determine the modulating frequencies of the carrier current, a second control means to control the output of the generator of carrier current to determine the period when said transmitting circuit is supplied with modulated carrier current, and signaling circuits influenced by said modulated carrier current selectively responsive to the different modulating frequencies.

15. A control system including, means located at one point for generating a carrier frequency current, a plurality of generators of modulating frequency current each having a distinctive frequency, means for rendering different groups of the generators of modulating current active to simultaneously modulate the carrier current, receiving and demodulating apparatus located at another point adaptable to receive said modulated carrier current, a plurality of controlling devices governed by said receiving and demodulating apparatus each responsive to a distinctive one of the modulating frequencies, and a plurality of signaling devices controlled by the controlling devices and selectively responsive to the different groups of said modulating currents.

16. A control system including, a source of carrier frequency current, a plurality of modulators each having a distinctive frequency, means for rendering different groups of said modulators active to modulate the carrier current simultaneously to form different control currents, receiving and demodulating apparatus adaptable to be influenced by the modulated carrier current, a plurality of controlling devices governed by said receiving and demodulating apparatus each responsive to the frequency of a specific modulator, and signaling devices controlled by the controlling devices and selectively responsive to the different groups of modulating frequencies for establishing a distinctive signal for each control current.

17. A control system including, a source of carrier frequency current at one location, a plurality of modulators each having a distinctive frequency, control means having different positions for rendering different groups of said modulators active to modulate the carrier current simultaneously to form different control currents, an operating mechanism having different operating conditions located at another location, receiving apparatus at said other location and adaptable to receive the control currents formed at the first mentioned location, a

plurality of controlling relays governed by said receiving apparatus each responsive to the frequency of a specific modulator, and operating circuits selectively controlled by the controlling relays in accordance with the different groups of modulating frequencies of the control currents for establishing the condition of the operating mechanism corresponding to the position of the control means.

18. Apparatus for the control of train brakes comprising in combination with the usual engineer's brake valve on the locomotive, a source of carrier frequency current, means rendered effective for a given brake condition of the engineer's brake valve to simultaneously modulate the carrier current by a group of different modulating frequencies, an auxiliary brake controlling mechanism at another point on the train capable of reproducing said given condition of the engineer's brake valve, receiving and demodulating means at said other point adapted to receive the modulated carrier current, and means governed by the receiving and demodulating means selectively responsive to said group of modulating frequencies for causing the auxiliary mechanism to establish said given brake condition.

In testimony whereof I affix my signature.

PAUL N. BOSSART.