My invention relates broadly to railway block systems and more particularly to a continuous train control and signal system adapted for modern high speed operation.

One of the objects of my invention is to provide a continuous train control and signal system of simplified form which is relatively inexpensive to install and maintain but which has a high factor of safety and reliability.

Another object of my invention is to provide a train control and signal system for high speed train operation wherein longer track sections may be employed and signals and control energy transmitted to the train continuously throughout the track sections.

Still another object of my invention is to provide a block signal and control system of uniform arrangement in each block section and without connection between the ends of a track section except through the track rails.

A further object of my invention is to provide a continuous train control and signal system wherein multi-frequency currents in the track rails are separately employed for signal and control purposes and wherein the presence of a train in a track section effects the application of the proper frequency current.

A still further object of my invention is to provide a train control and signal system having the track rails supplied normally with energizing current, with means operative upon the entrance of a train into the section to remove such current and substitute one or another of different currents indicative of track conditions in the forward section, the train being controlled accordingly.

Still another object of my invention is to provide an intermediate connection to a track section in a railway block signal and control system whereby a sufficient track length adjacent the exit of the section is provided for stopping a train in the event the forward section has not been cleared at the time the following train reaches the intermediate control connection.

A further object of my invention is to provide emergency brake control means operated automatically to stop a train under predetermined unsafe track conditions, and manually controlled means for releasing the brakes for restarting the train, the releasing means being operable only with the train at rest and having associated therewith a mechanical counter for registering the operation of the releasing means; also, in this connection, it is an object of my invention to provide speed governing means effective when the train is running by virtue of the manually operated brake releasing means.

Another object of my invention is to provide speed control means operative in lieu of positive braking means where the operation of the braking means is prevented or nullified in the discretion of the engineman, such as when it is desired to proceed under a caution signal, or when it is necessary to approach close to another train to render assistance or the like.

Other and further objects of my invention reside in the circuit arrangements and apparatus herein disclosed as will be understood from the description thereof hereinafter set forth with reference to the accompanying drawings in which:

Fig. 1 is a schematic diagram of the system of my invention, showing the track circuits associated with a representative track length and the cab circuits and apparatus aboard the train, in preferred arrangement; Fig. 2 is a schematic diagram of a modified form of track circuit showing two different frequency supply circuits instead of the three indicated in Fig. 1; Fig. 3 is a schematic diagram of a modified form of cab circuit with separate speed control provisions for conditions requiring caution; and Figs. 4 and 4A are diagrammatic illustrations of one form of speedometer dial and indicator vane cooperative with photoelectric devices in the speed control systems of my invention.

Developments in the structural and operational aspects of railway trains in recent years have created the need for more adequate and more positively operable signal and control systems. A primary consideration, due to the increased speeds of travel, is the lengthening of the track section in the usual block system while still maintaining reasonable voltage and current facilities for the signal system.

I have devised for the purposes of supplying the required current values and providing for the variation thereof in operation a new form of power supply circuit as shown and claimed in my copending application Serial No. 190,121, supra. This form of supply circuit is employed in the system herein disclosed.

Another consideration of vital importance is the provision of adequate signal and control devices aboard the train positively operable throughout the extended track sections. Cab signals hereinafter employed have required elabo-
rate and expensive equipment difficult to maintain and therefore of doubtful reliance. In the systems of my invention, by virtue of the incorporation of the novel power supply circuit and other characteristic features, the cab signals are continuously operated and the control circuits energized with a minimum of equipment, few moving parts and in a positive and reliable manner.

The simplicity and reliability of the system of my invention therefore contribute to a high safety factor, and this combined with the relative inexpensiveness and low maintenance costs involved constitute the practical features which characterize the system of my invention.

Referring to the drawings in detail, the lower portion of Fig. 1 represents the sideslack circuits whereas the upper portion, boxed by broken line I, shows the cab circuits and the apparatus carried by the train. The broken line 2 envelopes apparatus which is located at one position adjacent the junction of two track sections, at the wayside. Portions of three track sections are indicated in Fig. 1, with the train moving in the direction of arrow 3 through sections III, II and I, consecutively. The condition of the circuits shown is that wherein section I is unoccupied and forward of section II which is occupied by a train one set of wheels of which is indicated at 4.

Section II is supplied with current at one of three frequencies through transformer arrangements of the type disclosed in my copending application Serial No. 190,121, supra. A 60 cycle source is connected with a transformer system including transformers 5 and 6 both of the same ratio of turns, e.g. 12:1. Primary 5a is connected directly across the 60 cycle source whereas primary 6a is connected through the rails and across the source. The circuit of primary 6a is normally completed through relay winding 7 connected with the rails of section II at the far end thereof, but in the condition shown, the wheels 4 shunt the relay 7 so that primary 6a receives substantially the same voltage as primary 5a, and in the same phase, and substantially no power current flows in the shunted rails. Sectionary 5b and 6b are connected together with their voltages in phase opposition so that with the ratio of transformation equal, as prescribed, no current flows in the loop circuit including the secondaries 5b, 6b.

A similar loop circuit comprising separate secondaries 5c, 6c, is provided for energizing a relay 11 by a current produced in the loop circuit by virtue of phase shift in the voltage supplied to primary 6a when relay winding 7 is energized, which winding is inductive. The relay 11 is thus responsive, as is relay 7, to the presence of a train in the section. Relay 7, connected with section I is shown energized in accordance with the clear track condition assumed, whereas relay 1 connected with section II is deenergized. The purpose of the separate loop circuit 5c, 6c, is to supply adequate current to the relay 11 without disturbing the load conditions in the track supply circuit. Relay 11, which is normally energized but in the condition shown is not, is shunted by a condenser 10 which has a capacitance substantially equal to the inductance of relay 11. Relay contacts 11a complete a circuit through approach relay 12 and the 90 cycle source for controlling the supply of current to other frequencies to the rails of the occupied section II.

Relay contacts 12a upon closing complete a circuit to the transformer group 14, 18, of which transformer 14 has a higher ratio of turns than does transformer 15, e.g. a ratio of 60:1 in transformer 14 and a ratio of 12:1 in transformer 15. Primary 14a is connected across the source, which may be a 100 cycle frequency, whereas primary 15a is connected to the 100 cycle source through the rails of section II and contacts 1a of relay 1', which are closed under the condition shown. Secondaries 14b and 15b are connected together with their voltages in phase opposition, but as the ratio of transformation is unequal current flows in the loop circuit and voltage counter is produced in primary 15a which reduces the line voltage applicable to the rails. This counter voltage is functional upon the resistance of the rails in circuits such resistance will alter the phase relation of the voltages in secondaries 14b and 15b somewhat, resulting in decreased in-phase counter voltage. The voltage applied to the rails therefore automatically decreases as the resistance of the rails is shunted, by virtue of increased counter voltage in the transformer 15, making the current substantially uniform, independent of the length of the track section.

It will be seen that as the current of 100 cycle frequency is applied to the rails of section II with section I clear in the condition shown, this frequency is indicative of clear track conditions.

Relay contacts 12b and 12c upon closing complete a circuit to the transformer group 16, 17, similar in connection, constitution and operation to the group 14, 15; thus, transformer 16 has a ratio, for example, of 60:1 and transformer 17 a ratio of 12:1. Current from the group 16, 17, is applicable to the rails of section II through relay contacts 17b and 17c, shown open. These contacts are closed when relay 1' is deenergized—as by section I being occupied, by a broken rail in section I or any similar hindrance to clear running—and the current in this instance, which may be of 150 cycle frequency, is employed to indicate that caution is required.

This 150 cycle current is applied to the rails of section II at a predetermined distance from the exit end of the section, a distance of four hundred feet being suggested by way of example. This provision will be more fully considered in connection with the operation of the cab circuits at 1, but in general the distance represents the space required to bring the train to a stop from a governed low speed at which the train may be running, in the event a track clear signal is not produced before the point of connection of the 150 cycle current is reached. In this portion of the track section II, there is substantially no power current in the rails when section I is occupied, which is indicative of danger conditions and the train is brought to an emergency stop, as will be explained. Similarly, complete failure of the control system due to any cause, natural or accidental, resulting in the absence of any current in the rails, will produce the indication of danger with the train anywhere in the section, and the local cab circuits will operate to apply emergency brakes.

The purpose of relay contacts 12c is to open the shunt circuit that would otherwise stand across the rails of section II when section I is occupied but section II is not. That is, the primaries of transformers 16 and 17, are connected in series with contacts 12c with respect to the transformer bank 5, 6, through the rails, and contacts 12c are closed by relay 12 only when section II is occupied.
It will be understood that the frequencies 60, 100 and 150 cycles are merely suggestive and that any distinguishable frequency values may be employed. Also, means equivalent to the relay system 10—11, may be provided for control of relay 12 in accordance with the current in the main circuit 30, 39.

To adapt the system of my invention to control of trains in respect to conditions other than track conditions in a forward section, I introduce relay 18, energized in parallel with relay 12 from the 60 cycle source upon the entry of a train in section 11. Contacts 18a on relay 18 simulate the presence of a train in section 7 by shunting relay 7 and thus the 150 cycle current, indicating caution, is applied to the rails. This means of control is applicable where caution is required for various reasons such as roadbed repair, curves, crossings, townships, etc. The relay 18 is of a type which operates for a limited time period so that the control afforded thereby may be regulated to the particular portion of the track section considered; such a relay may be constructed in accordance with Albert B. Rypinski Patent 2,682,121, granted June 1, 1933, for Slow electro-magnetic relays.

The condition requiring caution is temporary, or is subsequently remedied, the relay 18 may be removed from the system, as in Fig. 2.

Referring now to the cab circuits shown at 1 in Fig. 1, coupling to the rails is effected by means of coils 19 and 20 which have voltages induced therein by the current in the rails. The coils 19 and 20 are connected to an amplifier 21, which may be of the electron tube type, and the output thereof is used to drive a motor 22 at speeds proportional to the frequency of the current in the rails. A single phase, four pole motor will have a speed of 3000 R. P. M. fed with 100 cycle current, and a speed of 4500 R. P. M. fed with a 150 cycle current. The motor 22 drives shaft 23 which has a centrifugal fan device such as the flyball arrangement shown at 24 connected therewith. Reciprocable rod 25 is actuated by the centrifugal fan device according to the position of the relays in the device as determined by the speed of rotation of shaft 23, controlled by the signal frequency. Rod 25 is provided with lug 25a which is disposed in operative relation to two tongue switches 26 and 27; switch 26 is closed by the action of lug 25a when the speed of the motor 22 is low, say 3000 R. P. M., which corresponds to the signal of clear track condition, as shown. At 4500 R. P. M. of motor 22, lug 25a acts to close the contacts of switch 27 pursuant to the application of 150 cycle current to the rails, indicating that caution is required. With motor 22 at rest, lug 25a moves beyond switch 26 and both switches 26 and 27 are left open, the cab circuits then indicating danger conditions.

An independent power source is provided at 28 for the cab apparatus with connector buses 29 and 30. A relay 21 is connected from the 30 through switch 25 to bus 29, and is shown energized in accordance with assumed conditions. Relay contacts 31a complete a circuit from bus 29 through lamp 32 to bus 30, lamp 32 giving a green signal indicative of clear track conditions. A relay 33 is connected from bus 30 to switch 25 and thereby to bus 29; relay 33 is thus operable when relay 31 is deenergized whereupon a circuit is completed from bus 29 through relay contacts 31a and lamp 32 to bus 30, lamp 32 being colored yellow to indicate caution. A relay 35 is connected with bus 30 and controlled by relay contacts 33a and 31b in connection to bus 28 so that relay 35 is energized when both relays 31 and 33 are deenergized. Relay contacts 35a complete a circuit from bus 29 to lamp 36 and bus 33, lamp 36 being colored red to indicate danger conditions; this circuit relation obtains normally in the cab circuits when motor 22 is at rest, caution and clear signals under which the train may be operated being derived only from positive indications afforded by current in the track rails. Relay 35 is deenergized in such case upon the operation of either relay 31 or 33.

Accompanying the operation of the signal devices above set forth are certain automatic control functions. Under clear track conditions and with the green lamp 32 illuminated, brake control valves 37 and 38 are both closed. These valves are electromagnetically controlled, as indicated, and valve 37 which controls the emergency application of the brakes is dependent upon a current to hold it closed, whereas valve 33 which controls the service application of the brakes is closed in the absence of a current through the actuating winding. Thus, under clear track conditions, valve 37 is maintained closed by current flowing through bus 29, valve coil 37a, normally closed relay contacts 33a and 33b to bus 29; and valve 38 is closed as the circuit thereto is incomplete at relay contacts 31c. Relay 39 which controls contacts 33a is operable pursuant to caution conditions as will now be considered.

When lug 25a leaves switch 26 and moves to actuate switch 27 under control of motor 22, relay 31 is deenergized and relay 33 is energized, the latter closing a circuit from bus 30 through relay contacts 33c, upper contacts 42a of a manual switch 40, and valve coil 33a to bus 29, thus opening valve 38 and making service application of the brakes to slow the train to a cautious speed, ultimately effective to stop the train should the caution signal not be removed. The application of the brakes by opening valve 33 may be precluded by operation of the manual switch 42 by the engineman, thus closing contacts 42b by which relay 35 is energized instead of valve coil 33a. By this operation, a speed governing system is brought into use under which the train may be run with caution at a predetermined safe speed without application of the brakes pending removal of the caution indication.

The speed governor is associated with a speedometer device having vane 41 operated thereby and adapted to control a photoelectric relay for operation above the predetermined safe speed. The relay includes light source 42 and photocell 43, with vane 41 movable therebetween and arranged to expose the cell 43 to the light source above a certain speed designation, say 30 M. P. H. The photocell 43 is in circuit from bus 30 with a relay 44 and relay contacts 33d—where the latter are closed when relay 33 is energized—and relay contacts 31c to bus 29. It will be remembered that relay 39 is energized through contacts 42b when it is desired to prevent service application of brakes through valve 32; relay contacts 33a thereby being opened, valve 37 would operate. Under emergency application of the brakes were it not for a shunt circuit through contacts 42b of a relay 45 from valve coil 37a to bus 29. This shunt circuit is dependent upon energization of relay 45 which in turn depends upon deenergization of relay 44, a condition obtaining with indication of vane 41

Exceeding the predetermined speed causes vane 41.
4. To expose cell 43 to light from the source 42, whereupon relay 44 is energized, opening the circuit to relay 45 which allows contacts 45b to open, resulting in application of emergency brake power by valve 37. Relay 45 is energized in the foregoing instance by circuit from bus 30 through controlling relay contacts 44a, relay contacts 39b to the relay 45, thence by relay contacts 39c and 31c to bus 29. Release of the caution signal and restoration of the clear track signal removes all restrictions by deenergizing relay 35 at switch 27, which opens the circuit to valve coil 38a at contacts 35c, and simultaneously releases relay 35, at contacts 35c, which restores the circuit for valve coil 37a at contacts 37a.

Considering now the danger conditions indicated by absence of current for motor 22 and opening of both switches 26 and 27, leaving relays 31 and 32 deenergized. A circuit is established to relay 35 from bus 29 through contacts 31b and 32b, returning to bus 30, as heretofore set forth. The closing of relay 35 immediately opens the circuit to valve coil 37a at contacts 37a, and the train is brought to an emergency stop; the engineer cannot prevent this occurrence by any means within his control while running the engine. However, as it is often necessary to approach close to a forward train despite the danger signal, means are provided whereby the brakes may be released and the train may proceed; in such case, record is made of the release of the brakes and the speed control hereinafter described is effective after restarting the train. In order to release the brakes, relay 45 is operated by push button switch 46 which completes a circuit from bus 30, through control contacts 44a, switch 46, relay 45, relay contacts 33a and 31c to bus 29; relay contacts 45a shunt the push button switch 46 and hold the circuit closed.

Switch 46 may be positioned exterior of the cab so that it is impossible to reach it while the train is running, making it necessary for the enginer to leave the cab and consciously operate the switch; a mechanical register of the number of times the switch is operated is provided at 47 in cooperation thereto in order that a check may be made on the enginer's actions in respect thereto.

Operation of relay 45 closes contacts 45b and restores current to valve coil 38a and releases the brakes. With relay 35 also energized, contacts 35c complete a circuit from bus 29 through relay 44 to photocell 45 and bus 30, rendering the photoelectric relay operative to control contacts 44a and thereby relay 45 and contacts 45b in circuit with the valve coil 37a, so that excessive speed results again in the emergency application of the brakes, upon the opening of contacts 45b.

In the modified forms of my invention shown in Figs. 2 and 3, the operation is generally similar to that of Fig. 1. Fig. 2 illustrates a form of track circuit in which two instead of three sources of different frequency currents may be employed in the track circuits with the same results as achieved and no modification of the cab circuits required. The 60 cycle current, it will be noted, is present in the rails in the system o' Fig. 1 only when the section is unoccupied, the same being reduced to substantially zero by the shunt on the rails provided by a train in the section. Any current of 60 cycle frequency that may be detected in the rails in such instance is without, of substantially zero power factor, and incapable of transmitting a signal to the coupling coils 19 and 20. This condition is attributable to the transformer connections in the 60 cycle power supply and especially the equal ratio of transformation in the two transformers 5 and 6.

Now, in Fig. 2, I provide connections from the 60 cycle source to another of the transformer systems, the former 100 cycle system, the output whereof under proper circuit conditions includes a 60 cycle power component which is fed as a signal current to the rails in place of the 100 cycle current provided in Fig. 1. There is no conflict of effect between the wattless current from the transformers 5, 6, and the signal current from transformers 14, 15, even though they are of the same frequency. Transformers 14 and 15 are of different ratings and the output therefrom through the rails and the train shunt 4 has a definite power factor, between zero and unity, and is thus capable of transmitting a signal to the cab circuits whereas the wattless output of the equal ratio transformers 5 and 6 is not. The absence of current both from transformers 16 and 17 and from transformers 14 and 15 in any portion of an occupied section is still indicative of danger conditions, and effective thus in the cab circuits, despite the presence of current of the frequency of one of the signal currents from transformers 5 and 6 as this current is essentially impotent as it draws substantially no power from the power source. The economical advantages of this modified form of track circuit should be evident.

In the modified cab circuits shown in Fig. 3, I provide an auxiliary speed control system operative with respect to the service brake control valve 33 for running under caution indications. This arrangement is adequate for maintaining the speed of the train below a predetermined rate without involving the operation of emergency brakes and without entailing the delays accompanying the operation of the emergency brakes where the speed may have but momentarily exceeded the limit. Another advantage of this form of circuit is that different speed limits may be invoked for operation under caution and under danger signals; the limit for the danger conditions may then be set very low and that for caution conditions reasonably greater.

The specific auxiliary speed control system is connected with contacts 49c on the manual switch 48 and comprises contacts 48a controlled by relay 48 in circuit with photoelectric regulating means similar to that at 41—43 connected with relay 44. The auxiliary photoelectric means comprises light source 49, speedometer vane 50, and photocell 51. The cell 51 is constantly energized by the circuit from bus 30 through the cell 51 an relay 48 to bus 29 and is thus conditioned for immediate operation.

Upon receiving the caution signal relay 33 is energized, as heretofore explained, and valve coil 38a is energized through circuit 33a to apply the service brakes. This action is forestalled by manual operation of switch 48 which puts contacts 48 on circuit with the valve coil 38a and the service brake is then under control of the speedometer vane 50 which allows the photocell 51 to be activated by light from lamp 49 whenever the train speed is above the limit. In such instances relay 48 is energized and contacts 48c closed to operate the valve 38, applying the service brakes and bringing the train down to proper speed, whereupon the brakes are released.
The speedometer vane 50 and that at 41 are constructed in the general form indicated in Fig. 4 at 52 which includes a radial portion 52a with a radial portion 52b movably along the scale 53a on dial 53. The radial portion 52b has a circumferential shutter arm 52c connected therewith which covers an opening 54 in the dial face 53 for a certain number of degrees of rotation of the vane 52, that is, up to the predetermined speed position, wherein the speedometer vane 50 is uncovered as indicated in Fig. 4A. A light beam for operation of the respective photocell 51 or 43 is projected through the opening 54 and is effective on the photocell when the opening is uncovered as shown in Fig. 4A. Thus, the photocells 51 and 43 may be operated when the train reaches any predetermined speed, by proper disposition of the opening 54 on the dial and cooperative design of the circumferential arm 52c, and the cells remain operated for all speeds above the selected limit.

Alternatively a separate shutter arm 52c is provided for each photocell system, and these may be radially or circumferentially displaced. Also, it will be understood, any equivalent form of speed responsive circuit control element may be employed in lieu of the photoelectric relay system shown; and modifications may be made as shown in Fig. 4, such as to cut off the light at a certain speed, with corresponding alterations in the immediate relay circuits.

In Fig. 3, the features of the system are applied by means of two rails 39 and associated circuits and used in accordance with the above described construction. The remainder of the cab circuits will be readily understood from the description herebefore given in respect to similar circuits in Fig. 1, with the exception that contacts 39a are replaced by direct connection from contacts 39b to valve coil 37a.

The system of my invention is applicable to track sections of 12,000 foot length for speeds approximating 125 miles per hour, and may be employed also with sections of approximately 20,000 foot length where speeds of about 140 miles per hour can be attained with reliance upon track conditions ahead. The operation of the train is within the complete control of the engineman only with clear track indicated as at all other times positive braking is applied or the train is proceeding under a speed control the violation of which results in application of brakes. Moreover, each time the train is restarted after an emergency stop, a record is made which cannot be circumvented or contradicted and for which the engineman will be held accountable.

While I have described my invention in certain preferred and modified forms, I am aware that various further modifications may be made in means and circuit connections within the scope of my invention, and I desire it understood that no limitations upon my invention are intended except as imposed by the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A continuous train control and signal system comprising a plurality of insulated rail track sections, means for selectively supplying electrical energy to a certain frequency to a limited portion of each track section extending from the entrance end thereof under advance traffic and track conditions requiring caution in the respective track section, energy of both said frequencies being absent under unsafe traffic and track conditions in advance of the respective track section, and signal means carried by a train operative over said track sections selectively responsive to the frequency of the energy in the rails of any track section, the last said means being responsive to the frequency indicating caution within said limited portion of the track section and operative for the remainder thereof in accordance with safe or unsafe conditions.

2. A continuous train control and signal system including a plurality of insulated rail track sections, a track relay connected to the rails of each track section, means for supplying electrical control energy to the rails in each track section to control the respective track relay, means for supplying electrical signal energy to the rails of each track section to control train carried apparatus, and means responsive to a change of current in the said control energy supplying means upon the entrance of a train in the respective section and connected with the said signal energy supplying means in the same section for energizing the said signal energy supplying means and supplying said energy to the rails of the respective section and operable for the remainder thereof in accordance with safe or unsafe conditions.

3. A continuous train control and signal system as set forth in claim 2 with each track relay connected to the rails at the entrance to the respective track section, the track relay connected to a first of said plurality of track sections being operative in accordance with the control energy supplied thereto, said track relay having control contacts connected with the means for supplying signal energy to a second of said plurality of track sections adjacent the entrance end of the said first track section for controlling the application of signal energy to the said second track section in accordance with track conditions in the said first track section.

4. A continuous train control and signal system including a plurality of insulated rail track sections, means for supplying electrical control energy for wayside apparatus to the rails in each track section, means for supplying electrical signal energy for train carried apparatus to the rails in each track section, and automatic switch means responsive to a change of current in the said control energy supplying means upon the entrance of a train in the respective track section and connected with the said signal energy supplying means for energizing the said signal energy supplying means and supplying said energy to the rails of the respective section.

5. A continuous train control and signal system as set forth in claim 4 and including a track relay connected with the rails at the entrance of an advance track section and having control contacts connected with the said signal energy supplying means connected with the next rearward track section for controlling the application of signal energy to the next rearward respective track section, in accordance with traffic conditions in the advance track section, and means operative in conjunction with the said switch means and connected with said track relay for determining the operation of said track relay independently of advance conditions.

6. A continuous train control and signal system including a plurality of insulated rail track sections, a track relay connected to the rails of each track section; means for supplying electrical...
control energy to the rails in each track section to control the respective track relay comprising a source of alternating current control energy, a pair of transformers of the same ratio of transformation having secondary windings with terminals of like polarity together and primary windings connected across said source with the rails of the respective track section and said track relay in series with one of said primary windings; means for supplying electrical signal energy to the rails in each track section to control train cab signals comprising a source of alternating current signal energy, a pair of transformers of transformation having secondary windings with terminals of like polarity connected together and primary windings connected across said source with the rails of the respective track section and said track relay in series with one of said primary windings; the power output from said control energy supplying means and from said signal energy supplying means to the rails of the respective track section being functional upon the phase of the currents in the primary windings in each of said means and upon the ratio of transformation in the interconnected transformers, the shunting of the rails of the respective track section and of the track relay connected with the rails by a train in said section producing substantially zero phase differences in the primary currents in each of said means wherein the power output of the said control energy supplying means is substantially zero and the power output of the said signal energy supplying means is dependent upon the difference in the ratios of transformation in the pair of transformers therein; and means responsive to a change of current in the said control energy supplying means upon the entrance of a train in the respective track section and connected with the signal energy supplying means for initiating the operation of the signal energy supplying means.

A continuous train control and signal system as set forth in claim 6 wherein said source of control energy and said source of signal energy are of the same frequency, and wherein said means for supplying control energy to the rails produces a continuous wavelet current at the common frequency while said means for supplying signal energy produces power current at the common frequency in the rails of an occupied track section; and including a common prime source of power of the said common frequency connected with both the aforesaid sources of energy for supplying power thereto.

A continuous train control and signal system as set forth in claim 6 and including separate prime sources of power at different frequencies connected respectively with said source of control energy and said source of signal energy for supplying power thereto.

A continuous train control and signal system including a plurality of insulated rail track sections, a track relay connected to the rails in each track section; means for supplying control energy to the rails in each track section to control the respective track relay, said means having a power output functional upon the phase of the current supplied to the rails in the respective track section, said power output being substantially zero in the rails of an occupied section to supplying electrical signal energy to the rails in each track section to control train cab signals; and means responsive to a change of current in the said control energy supplying means upon the entrance of a train in the respective track section and connected with the said signal energy supplying means for energizing the said signal energy supplying means.

A continuous railway block signal system including a source of alternating current signal energy, a pair of transformers each having primary and secondary windings and constituted with different ratios of transformation, connections from one of said primary windings directly to said source, connections from the other of said primary windings to said source through the rails of the railway block system, and connections between terminals of like polarity on said secondary windings, the voltage supplied to said rails being proportioned to the length of the track in circuit with the second said primary winding and dependent upon the difference in said ratios of transformation.

A continuous train control and signal system comprising a plurality of insulated rail track sections, means for supplying current of different signal frequencies to the rails of an occupied track section in accordance with track conditions in advance of said section, selective control means carried by a train in said track section responsive to the different signal frequencies of current in the rails, signal means actuated by said selective control means in response to the signal frequency for indicating clear track conditions, means for indicating clear track conditions, means for indicating advance track conditions requiring caution, brake control means cooperative with said caution means, said brake control means connected with said brake control means and operable to prevent the actuation of said brake control means in conjunction with said caution signal means, and speed control means including a train actuated speedometer system having contacts connected between said brake control means and said manual switch means and operated by said speedometer system for functioning upon the operation of said switch means to control the actuation of said brake control means, whereby operation of the train under a caution signal is governed by said speed control means.

A continuous train control and signal system as set forth in claim 11 and including danger signal means and separate emergency brake control means normally operative upon the appearance of current of signal frequency in the rails, manually operable releasing means connected with said emergency brake control means and speed control means including a train actuated speedometer system having contacts connected with said releasing means and operable by said speedometer system for functioning upon the operation of said releasing means to control the actuation of said emergency brake control means, whereby operation of the train under a danger signal is governed by said speed control means.

A continuous train control and signal system comprising a plurality of insulated rail track sections, means for supplying current of different signal frequencies to the rails of an occupied track section in accordance with track conditions in advance of said section, selective control means carried by a train in said track section responsive to the different signal frequencies of current in the rails, signal means actuated by said selective control means in response to one signal frequency for indicating clear track conditions, caution signal means actuated by said selective control
means in response to another signal frequency for indicating advance track conditions requiring caution, current actuated brake control means cooperative with said caution signal means, manual switch means connected with said brake control means and operable to prevent the actuation of said brake control means in conjunction with said caution signal means, danger signal means, and separate current-maintained emergency brake control means normally operative upon the absence of current of either signal frequency in the rails.

JOHN C. McDONALD.