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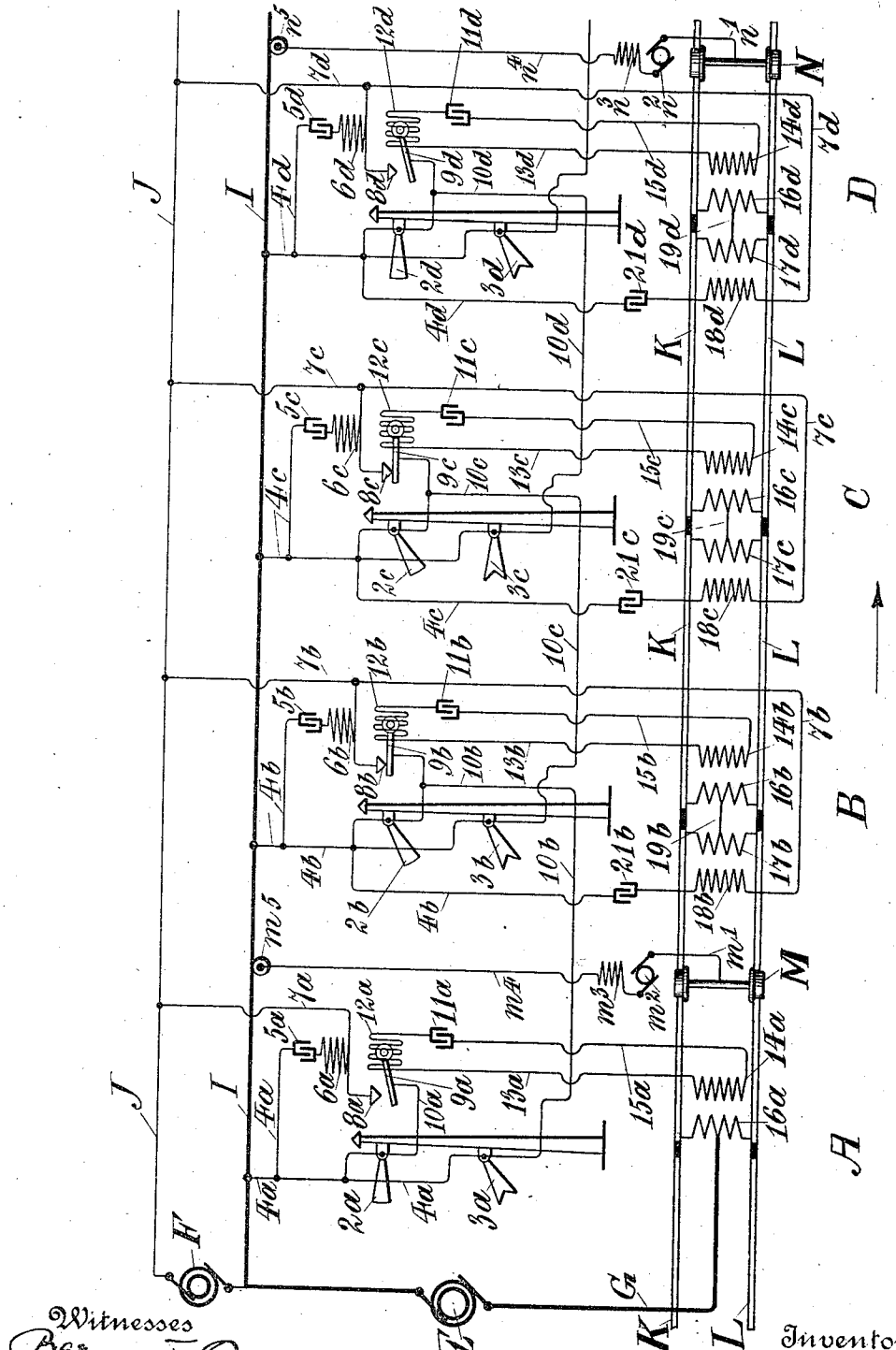
A. V. T. DAY.

RAILWAY SIGNALING SYSTEM.

APPLICATION FILED JULY 24, 1906.

1,081,925.

Patented Dec. 16, 1913.



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UNITED STATES PATENT OFFICE.

ALBERT V. T. DAY, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE HALL SWITCH & SIGNAL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF MAINE.

RAILWAY SIGNALING SYSTEM.

1,081,925. Specification of Letters Patent. Patented Dec. 16, 1913.

Application filed July 24, 1906. Serial No. 327,560.

To all whom it may concern:

Be it known that I, ALBERT V. T. DAY, a citizen of the United States, residing in the borough of Brooklyn, city of New York, in the county of Kings and State of New York, have invented certain new and useful Improvements in Railway Signaling Systems, of which the following is a specification, reference being had therein to the accompanying drawing, forming a part thereof.

My invention relates broadly to railway traffic-controlling apparatus, such as railway signaling apparatus, and certain features of my invention relate particularly to combined railway electric traction and electric traffic-controlling systems such as exemplified in the illustrated embodiment of my invention.

That particular embodiment of my present invention which I am about to describe includes various features already disclosed and broadly claimed in my application for United States patent filed July 24, 1906, Serial No. 327,559.

Broadly designated, the objects of my invention are reliability and economy of operation, and economy and simplicity of construction.

I will now describe that particular embodiment of my broad invention which I have illustrated in the accompanying drawing. This embodiment is a combined railway electric traction and home-and-distant electric block signaling system. I have illustrated four successive home-and-distant block signaling apparatuses, A, B, C and D, located substantially at the termini of three successive signaling blocks or sections A B, B C, and C D of a single railway track.

The signaling blocks or sections of the track are demarcated by suitable insulations interposed in a well known manner in both the track rails K and L. The opposite rails of the various blocks are cross-connected or cross-bonded at the advance ends of such blocks by the secondary coils 17^b, 17^c and 17^d of step-down supply transformers, the primary coils 18^b, 18^c and 18^d of such supply transformers being fed with alternating current in a manner described hereinafter. The opposite rails of the various blocks are also cross-connected or cross-bonded at the rear ends of the blocks by the primary coils 16^a, 16^b, 16^c and 16^d of step-up receiving transformers, the secondary coils 14^a, 14^b, 14^c and 14^d of such receiving transformers being arranged in control of their respective local home signals in a manner described hereinafter. The primary and secondary coils of the receiving and supply transformers, thus cross-bonding respectively the rear and the advance termini of the rails of adjacent blocks, have their neutral points connected by conductors such as 19^b, 19^c and 19^d, forming block-bonding connections between the adjacent track sections.

The traction current generator, which, in the present instance, is an alternating current generator, has one terminal connected to a neutral point of one of the rail-bonding transformer coils near the generator, the generator, in the present instance, being thus connected by a track feeder G to the primary coil 16^a of the receiving transformer of the signaling station A. The opposite terminal of the traction current generator is connected with a line conductor I common both to the traction current transmission line and the signaling current supply transmission line and in the diagram represented as an ordinary trolley wire feeding traction current to the trolley wheels m^5 and n^5 of two trains or railway vehicles M and N located respectively in the signaling block A B and the block in advance of the signaling station D. The traction circuit for the train M is as follows: from one terminal of the traction generator E through the trolley wire I, trolley wheel m^5, conductor m^4, motor fields m^3, motor armature m^2 and conductor m' to the axles and wheels of the train M, and thence in parallel through both the track rails K and L rearward through the block A B and in parallel through the two halves of the rail-bonding primary coil 16^a of the receiving transformer at the rear end of the block, such parallel branches through the rail-bonding coil 16^a being united at the neutral point in the coil, from whence the circuit continues through the conductor G back to the opposite terminal of the traction generator E. Similarly the traction circuit of the train N is traceable as follows: from one terminal of the traction generator E, through the trolley wire I, trolley wheel n^5 of the train N, conductor n^4, motor fields n^3, motor armature n^2, conductor n', axles and wheels of the train N, and thence rearward in parallel through the opposite rails K and L of the track section in advance of the signaling apparatus D and in parallel through the two

sections of the primary coil 16^d of the receiving transformer at the signaling station D, and from the neutral point of such coil 16^d through the block-bonding conductor 19^d to the neutral point in the rail-bonding secondary coil 17^d of the supply transformer of the signaling station D, and from such neutral point of the coil 17^d through the two sections thereof in parallel, and thence rearward in parallel through the opposite rails K and L of the block C D, and so on through the rail-bonding transformer coils at the signaling stations C, B and A, and, of course, through the track rails K and L extending between such stations, and from the neutral point of the rearmost rail-bonding transformer coil 16^a through the conductor G back to the opposite terminal of the traction generator E. From a consideration of the foregoing traction circuits of the trains M and N, it will be apparent how both rails K and L are included in parallel in the return circuit of the traction current and how the primary and secondary coils of the receiving and supply transformers act both as cross-bonding conductors to bond the opposite rails of the blocks and also as block-bonding conductors to connect the rails of the adjacent signaling blocks together for the return transmission of the traction current.

The signaling current supply generator which, in the present instance, is an alternating current generator F, has one terminal connected to the trolley wire I and has its other terminal connected with an additional signaling current transmission line wire or conductor J, the trolley wire I and the line conductor J thus constituting the signaling current supply transmission line. The primary coil of the supply transformer at the advance end of each block is bridged across this signaling current supply transmission line in connection with an inductance-compensating and current-limiting condenser, the special functions of which will be described hereinafter and which is connected in series with such primary coil. For example the circuit of the primary coil 18^d of the supply transformer at the signaling station D is traceable as follows: from the trolley wire I through the conductor 4^d, condenser 21^d, primary coil 18^d of the supply transformer and conductor 7^d to the signaling current transmission line conductor J. The alternating currents in such primary coils of the supply transformers induce alternating currents of lower potential in their respective secondary coils, such as 17^d, bridged across the rails of respective signaling blocks at the advance ends of the blocks. Thereby the secondary coils of the supply transformers deliver alternating currents from the advance ends of the various blocks to and through the rails of the blocks and rearward to and through the primary coils of the receiving transformers bridged across the rails at the rear ends of such blocks respectively; and such currents in the primary coils of the receiving transformers, for example in the primary coil 16^c, induce currents of higher potential in their respective secondary coils, such as the coil 14^c. The secondary coil of each receiving transformer is connected with the movable coil of the home-clearing relay at its respective signaling station and is connected with an inductance-compensating condenser, such secondary coil, movable relay coil and inductance-compensating condenser being, in the present instance, all in series with one another, and such local relay circuit, being traceable, for example at the station C, as follows: from one terminal of the secondary coil 14^c of the receiving transformer, through the conductor 13^c, movable relay coil 12^c, inductance-compensating condenser 11^c, and conductor 15^c back to the opposite terminal of the secondary coil 14^c.

The movable coil of each relay, such as the coil 12^c, is pivotally mounted in connection with a contact finger such as the contact finger 9^c constantly subjected to gravity or any other suitable retractile force tending to withdraw the contact finger from position of contact with its coöperating contact stop such as 8^c. Each movable relay coil, such as the coil 12^c co-acts with a stationary relay coil, such as 6^c, disposed with its magnetic axis substantially in the plane of the movable coil, or otherwise conveniently disposed so as to effect a substantially non-inductive relationship of movable and stationary coils, that is to say, a relationship or relative disposition whereby an alternating current in either coil cannot induce any considerable secondary E. M. F. in the other coil. This coörganization of movable and stationary coils without mutual induction, is, however, but one special form of relay adaptable to the system which constitutes my broad invention, such special relay being in no wise essential to the invention broadly.

The stationary coil of each relay is connected with an inductance-compensating condenser, which, in the present instance, is in series with the coil, and such coil is supplied with current from the signaling current supply transmission line, the local supply branch including such a stationary coil being traceable, for example at the station C, as follows: from the signaling current supply transmission conductor J, through the conductor 7^c, stationary relay coil 6^c inductance-compensating condenser 5^c and conductor 4^c to the trolley wire I.

Each home-signal semaphore is actuated by a local semaphore actuative branch also bridged across the signaling current supply transmission line and traceable, for example at the station C, as follows: from the line

conductor J, through the conductor 7^c, stationary contact 8^c, relay contact finger 9^c, and thence through a connecting wire to the actuative apparatus of the home-signal semaphore 2^c and conductor 4^c to the trolley wire I. Each distant-signal semaphore is actuated by a semaphore actuative branch also bridged across the signaling current supply transmission line, for example such actuative circuit for the distant-signal semaphore 3^b of the signaling station B, being traceable as follows: from the transmission line conductor J through the branch conductor 7^c at the signaling station C, relay-controlled contacts 8^c, 9^c at such station, and thence by conductor 10^c rearward through the block B C and through the actuative apparatus of the distant-signal semaphore 3^b, and thence by the branch wire 4^b to the trolley wire I.

From a consideration of the two foregoing home and distant semaphore actuative branch circuits, it will be apparent that both the home-signal and the distant-signal semaphores of the system are actuated by alternating current from the signaling current generator F, and that the actuative apparatus for each distant-signal semaphore is controlled in parallel with the actuative apparatus for the home-signal semaphore of the signaling apparatus next ahead and by the relay-controlled contacts of such apparatus next in advance. By virtue of this arrangement, closure of the relay contacts of any signaling apparatus will effect simultaneous clearance of the home signal of such apparatus and of the distant signal of the apparatus next in rear, and whether the home signal of such apparatus next in rear be in its clear or its danger position. This condition is exemplified in the diagram in the signaling apparatuses A and B, the block in advance of the signaling apparatus B being clear so that the home signal 2^b of such apparatus and the distant signal 3^a of the apparatus next in rear are both in their clear positions, although the occupancy of the block A B by the train M maintains the home-signal semaphore 2^a at the rear end of such block in its danger position.

I am aware that it is customary to control each distant-signal semaphore blade by the home-signal semaphore blade of the same signaling apparatus, and generally also by the home-signal semaphore blade of the signaling apparatus next in advance, so that the distant-signal semaphore blade of a given apparatus can only be cleared when its collateral home-signal semaphore blade is in clear position, or when such home-signal semaphore blade and the home signal next in advance are both in their clear positions. Obviously the distant-signal semaphores of my system can be thus controlled by the home-signal semaphores by the employment of the well known means generally applied to this purpose. But I believe such practice is not the most advantageous since, under such régime, an engineer approaching an occupied block will find both the home and distant signals at the rear end of such block standing in their danger positions, even if the second block in advance is clear of traffic. I believe it is most desirable that the engineer should be accurately advised of the condition of the block second in advance, since, under some conditions, such as greatly congested traffic, it might be necessary and proper for an engineer to pull his train slowly under control into an occupied block, if he were assured of the clear condition of the block second in advance and thus assured that the train ahead of him would receive a clear signal permitting it to enter such second block in advance.

I will now describe the functions of the inductance-compensating and current-limiting condensers, such as 21^d at the station D, which condensers, in order to discharge both the foregoing functions, are preferably connected in series with the primary coils of their respective supply transformers as in the specific embodiment of my invention which is illustrated. This coörganization of condensers and transformer coils, which I am about to describe, is broadly covered in my application filed July 24, 1906, Serial No. 327,559, for which reason the following description will be comparatively brief. The capacity of each condenser, such as 21^d, may be adjusted relative to the re-actance or co-efficient of self-induction in the primary coil such as 18^a of its coöperating supply transformer and relative to the frequency of the alternating current delivered by the signaling current supply generator F, so that the counter electromotive force of the condenser will effectually oppose, balance or neutralize the counter electro-motive force of self-induction in the primary transformer coil, so as to greatly augment the electro-motive force which may be developed in the secondary coil of such transformer. For instance, assume for the moment that the circuit of the secondary coil 17^d is completely open so that no current can flow in such secondary coil to modify the magnetic flux or induction produced in the transformer core by the current of the primary coil, and assume that with the secondary circuit thus open the capacity of the condenser 21^d is adjusted relative to the re-actance of the primary coil 18^d in exact resonance with the alternating current delivered to the supply transformer by the signaling current supply transmission line. Under these conditions, if the current wave be sinusoidal or approximately so, the

effects of re-actance in the primary coil 18^d and capacity in the condenser 21^d will substantially counterbalance or neutralize each other so that the current in the primary coil will have substantially its full ohmic value greatly exceeding the intensity of current which would flow through such primary coil if the re-actance-compensating condenser 21^d were omitted. Therefore such condenser greatly augments the flux density in the transformer core, which may also be of large cross-section so that the total magnetic induction through the secondary coil will have an extraordinarily high value. Wherefore such secondary coil may consist of a comparatively short and large conductor so as to introduce small rail-bonding resistance while yet delivering sufficient electromotiveforce to operate the rail circuit.

I have above considered the current and electro-motive force values in the transformer when its secondary circuit is open. Now assume for a moment that a train is present in the block C D, as shown in the block A B, so as to completely short-circuit the secondary coils 17^d. This will have the effect of removing substantially all the reactance or self-induction of the primary coil 18^d so that such primary coil will no longer develop counter electro-motive force to oppose or substantially neutralize the counter electro-motive force of the condenser 21^d, under which condition the current through the primary coil will be greatly reduced by the unbalanced opposition of the current-limiting condenser. Thus, when my current-limiting condenser is employed, the primary transformer current is subjected to a marked diminution by short-circuiting the rails of its secondardy circuit, in lieu of being subjected to an increase by such short-circuiting of the rails when a train is present in the block. Of course, the diminution of the primary transformer current when the track rails are short-circuited prevents an excessive current in the secondary transformer circuit under such condition.

It will be understood that the normal condition of the rail circuit or secondary transformer circuit under which condition the supply transformer delivers current through such rail circuit to the receiving transformer at the opposite end thereof, is a mean or intermediate condition between the two extreme conditions above considered, to wit, completely open condition of the secondary transformer circuit, and completely short-circuited condition of such secondary transformer circuit. The block C D may be assumed to represent this intermediate normal condition of the rail circuit. Here the secondary transformer coil 17^d delivered alternating signal-controlling current to the rails K, L, which, in return, deliver such current to the primary coil 16^c of the receiving transformer at the rear end of the block. When the primary coil 16^c of the transformer is thus excited, its secondary coil 14^c delivers alternating signal-controlling current to the movable coil 12^c of the signal-controlling relay of the signaling apparatus C. Since the magnetic circuits of the relay coils 12^c and 6^c are preferably filled with soft laminated iron, these coils will generally possess very considerable re-actance and the re-actance-compensating condenser 11^c in series with the movable coil 12^c is adjusted in opposition to the re-actance of such movable relay coil so as to augment the alternating current which flows through the movable coil from the secondardy coil 14^c of the receiving transformer. For instance, the capacity of the condenser 11^c may be adjusted so that the condenser and relay coil 12^c are substantially in resonance with the alternating signal-controlling current, in which case, the current through the relay coil 12^c will be opposed only by the ohmic resistance of the coil and will hence be far stronger than if the inductance-compensating condenser were omitted. The inductance-compensating condenser 5^c, connected in series with the stationary relay coil 6^c, is also adjusted to oppose the re-actance of such stationary coil so as to augment the alternating current flowing through the coil from the signaling current supply transmission line, and such inductance-compensating condenser 5^c and stationary relay coil 6^c may be adjusted relative to each other in resonance with such alternating current so that such current will attain its full ohmic value in the relay coil. Thus the movable and stationary relay coils 12^c and 6^c are subjected to alternating currents which may be augmented by the influence of the inductance-compensating condensers, and which currents are of common frequency since they are derived ultimately from a common generator.

The plane of the movable coil is disposed substantially in the magnetic axis of the stationary coil, or otherwise suitably disposed relative to the stationary coil so as to be subjected to a torque or turning moment by co-action of the two coils or re-action of such coils on each other, such torque or moment being, of course, a function of the phase relation of currents in the two coils, and, with a given phase relation, being proportionate to the product of such currents. The torque or turning movement developed on the movable coil is substantially *nil* when the currents in the respective coils are substantially in quadrature, that is to say, when the two currents have a phase difference of ninety degrees; and when such two currents correspond exactly in phase, that is to say, when the two currents rise and fall and reverse exactly together, the torque or turning mo-

ment will have its maximum value with given values of such currents. The coörganization of the three re-actance-compensating condensers 21^d, 11^c and 5^c, all co-acting to determine the values of the alternating currents in the two relay coils and to determine their phase relationship, produce a most flexible arrangement for adjusting the values and phase relation of such currents to attain the greatest turning moment in the movable coil 12^c, since such adjustment may be effected by varying or adjusting the capacity of one or more of these condensers.

It will be noted that the traction current passing through each rail-bonding transformer coil flows in parallel differentially through the two sections of such rail-bonding coil demarcated by its neutral point; that is to say, the components of the traction current which flow in parallel through the two sections of a given rail-bonding transformer coil, are opposed to each other in their electro-magnetic or inductive relation to the common transformer core on which they are wound and are hence opposed to each other in their electro-inductive influences on their complementary transformer coil. Therefore, if such two sections of a given rail-bonding transformer coil are closely superposed upon their common core, the traction current will flow through such two sections of the rail-bonding coil non-inductively, that is to say, without self-inductive re-actance or impedance to the traction current, wherefore the foregoing arrangement is advantageous in avoiding the introduction of considerable impedance in the return circuit of the alternating traction current. Also the flow of traction current in parallel equally through the two sections of a given rail-bonding transformer coil and in neutral differentiation or opposed relationship to its complementary transformer coil, makes it impossible to operate the signal-controlling relay by such traction current. For instance, the two equal components of traction current passing in parallel through the two sections of the primary coil 16^c of the receiving transformer above considered, cannot induce any electro-motive force in the secondary coil 14^c of such transformer, and hence cannot excite the movable coil 12^c of the relay. The signaling apparatus will be thus non-responsive to the return traction currents, even though such traction currents have the same frequency as the signaling current employed in the rail circuits of the various blocks. But if one of the rails of a given block should be accidentally broken, for instance, if the rail L of the block C D were broken in rear of a train standing in the block, substantially all of the return traction current would then pass through the rail K and from such rail through one-half of the primary coil 16^c to the neutral point thereof, and thence onward through the return track circuit, and such traction current flowing in but one section of the primary coil 16^c would of course, not be balanced by a neutralizing differential component of traction current in the opposite section of the primary coil, and would, therefore, excite the secondary coil 14^c and, under certain conditions of frequency phase and intensity, might operate to clear the relay of the signaling apparatus C even with a train present in the block C D, as above noted, at a point in advance of the rail break. Such an accident, however, can be absolutely prevented by either or both of two expedients, both of which are present in the preferred embodiment of my invention as illustrated, and which I will now describe. The traction generator E delivers an alternating current different in frequency from the alternating current delivered by the generator F, and since, in order to produce an effectual co-action of the two coils, the frequency of current in the movable coil 12^c of the relay must correspond with the frequency of current delivered to its coöperating stationary coil 6^c, it is impossible for any traction current flowing in the return track circuit and not having the frequency of the traction generator to effect response of the relay by exciting its movable coil. Also, the movable coil 12^c and its re-actance-compensating condenser 11^c may be adjusted in resonance with the particular frequency of the signaling current generator F so that such coil will be particularly susceptible or selectively responsive to current of such frequency by receiving or conducting such current much more readily than a current of any other frequency which must needs be opposed by the re-actance of the coil or the counter electro-motive force of the condenser according as such other frequency is higher or lower than the given frequency. Therefore the relay will respond in resonance to signaling current but will not respond to traction current of different frequency. This selective receptivity or responsiveness by resonance is available without the co-action of a complementary relay coil, for instance when the coil 12^c is employed to excite an ordinary or laminated relay magnet to actuate the contact finger 9^c by ordinary magnetic attraction.

To those versed in the art it will be apparent that the rudiments of my invention may be utilized in various embodiments differing in specific or particular form and arrangement, all such other embodiments coming, however, fully within the broad principles, scope and purpose of my broad invention.

What I claim and desire to secure by Letters Patent is:—

1. A combined railway electric traction and traffic-controlling system comprising one transmission line including the rail-

way track and a line conductor extending along the railway, a second transmission line including a second line conductor extending along the railway and including the line conductor already mentioned in common with the first transmission line, a traction current source connected in one transmission line, a traffic-controlling current source connected in the other transmission line, and electrically controllable traffic-controlling apparatus disposed along the railway in control of traffic thereon and arranged to receive energy from the transmission line in which the traffic-controlling current source is connected.

2. A combined railway electric traction and traffic-controlling system comprising two line conductors extending along the railway, a source of traction current connected with the railway track and with one of the line conductors as a traction current transmission line, a source of traffic-controlling current connected with both the line conductors as a traffic-controlling currrent transmission line having one line conductor in common with the traction current transmission line, and electrically controllable traffic-controlling apparatus disposed along the railway and arranged in control of traffic thereon and connected with both line conductors to receive traffic-controlling current therefrom.

3. A combined railway electric traction and traffic-controlling system comprising two line conductors extending along the railway, a source of traction current of given characteristics connected with the railway track and with one of the line conductors, a source of traffic-controlling current of different characteristics connected with both line conductors, and electrically controllable traffic-controlling apparatus disposed along the railway line in control of traffic thereon and connected with both the line conductors to receive energizing current therefrom and including the track rails in traffic-controlling circuits local to given sections of the railway.

4. A combined railway electric traction and traffic-controlling system comprising a source of alternating traction current of given frequency connected with the railway track as a return path, a line conductor connected with such source of traction current and extending along the railway, a source of alternating traffic-controlling current of different frequency connected with the line conductor already mentioned, a second line conductor connected with such source of traffic-controlling current and extending along the railway, and traffic-controlling apparatus disposed along the railway in control of traffic thereon and connected with both line conductors to receive energizing current therefrom and including sections of the track rails in traffic-controlling circuits local to sections of the railway.

5. A railway traction and traffic-controlling system comprising a traction-current transmission line including two conductors extending along the line of the railway, a second or traffic-controlling current supply transmission line including one conductor of the traction-current transmission line and including another conductor extending along the railway, a generator of traffic-controlling current connected with the second transmission line, traffic-controlling circuit branches each leading from a given point of connection to one conductor of the second transmission line and thence along the railway to a distant point of connection with the other conductor of the second transmission line, traffic-controlling apparatuses controlled by the respective circuit branches, and circuit-controlling means in control of the circuit branches to govern the traffic-controlling apparatuses controllable by such branches respectively.

6. A combined railway traction and signaling system comprising a traction-current transmission line including two conductors extending along the line of the railway, a second or signaling current supply transmission line including one of the conductors of the traction-current transmission line and also including an independent conductor extending along the railway, a number of home-and-distant block signaling apparatuses disposed in succession along the railway, signal-controlling rail circuits in control of the various home signals and each including the rails of a block or section of the railway track, distant-signal-controlling circuit branches in control of the various distant signals and each leading from a point of connection with one conductor of the second transmission line and thence through the distant signal and thence forward along the railway to a given point of control by that rail circuit which controls the home signal next in advance and thence to the opposite conductor of the second transmission line, and means for controlling each distant-signal-controlling circuit branch at the given point of control and subject to that said signal-controlling rail circuit which controls the next advance home signal.

In testimony whereof I have affixed my signature in presence of two witnesses.

ALBERT V. T. DAY.

Witnesses:

HENRY D. WILLIAMS,

BERNARD COWEN.