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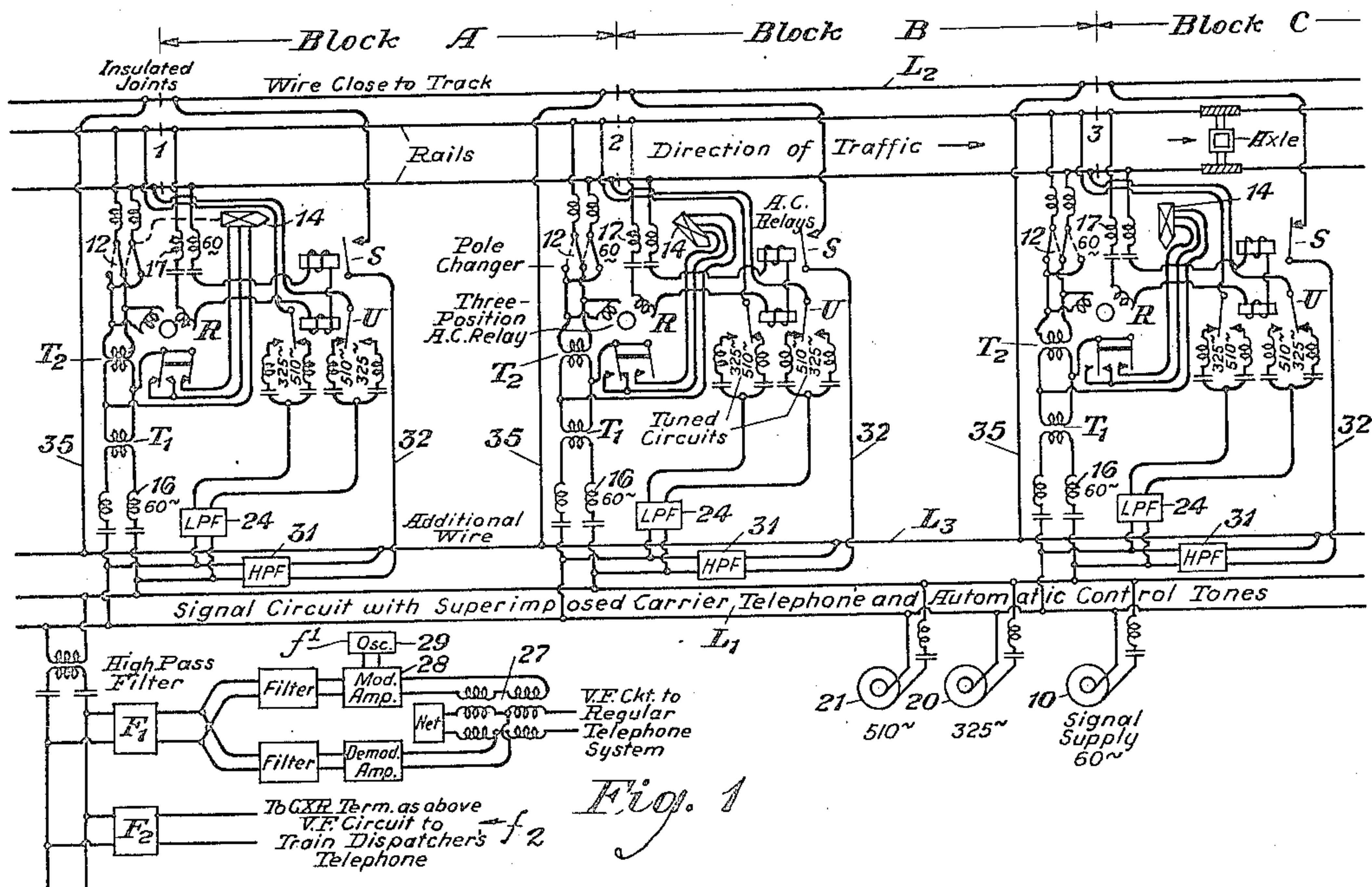
L. ESPENSCHIED ET AL

2,061,027

COMMUNICATION WITH MOVING TRAINS

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Track and Wire Circuits



Circuits in Locomotive and Passenger Car

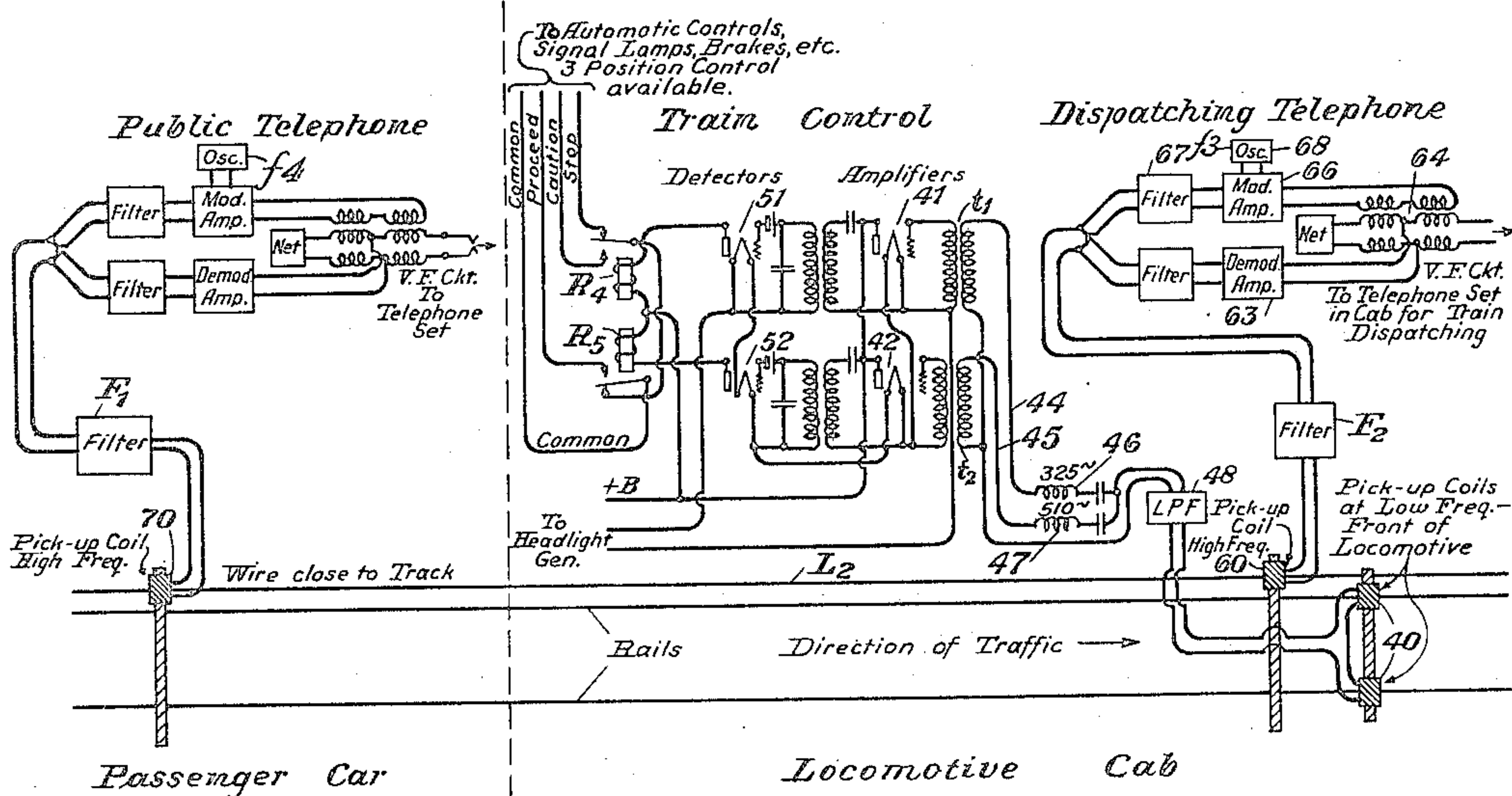


Fig. 2

INVENTORS
L. Espenschied & N. Monk
BY *GEORGE*
ATTORNEY

UNITED STATES PATENT OFFICE

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COMMUNICATION WITH MOVING TRAINS

Lloyd Espenschied, Kew Gardens, and Newton Monk, New York, N. Y., assignors to American Telephone and Telegraph Company, a corporation of New York

Application September 10, 1931, Serial No. 562,180

17 Claims. (Cl. 246—8)

This invention relates to systems for communication with moving vehicles and more particularly to a system in which there are associated various types of signaling for and with moving trains. The invention is an extension of signaling arrangements described in our application Serial No. 562,179, filed September 10, 1931, now Patent No. 1,933,795 granted November 7, 1933.

In that application we have shown a signaling arrangement in which telephony to and from moving trains is associated with and controlled in certain ways by a block signaling system. In this invention, we have disclosed a composite arrangement for block signaling, automatic train control, hereinafter called automatic control, train dispatching, hereinafter called dispatching, and public telephone service, hereinafter called telephony.

These are all coordinated in a system to render each service reliable and positive with a simplicity of operation and with an economy of apparatus not possible when the services are provided independently of each other.

Expressed in brief terms, the system of our invention consists of a railroad line equipped with a block signaling system, according to which the track is divided into blocks of comparatively short length, say a mile, each block being connected to appropriate signaling apparatus to operate block signals. In such systems, it is usual to have reasonably near this track a conductor or pair of conductors for supplying power for the block signaling system and this conductor or pair of conductors may be on a paralleling pole line or may be placed near the track supported on suitable arms or may be buried in the roadbed. In our invention we superimpose on this, or an adjacent pair of wires, currents for automatic train control, for train dispatching and public telephone service, these last two preferably being on a carrier frequency. The automatic control signal currents, preferably of at least two frequencies and of the order of a few hundred cycles, are connected to the rails of the various blocks through switching mechanism controlled by the block signaling system, the frequency supplied to any one block being such as to perform the necessary operations in sequence as the train proceeds from block to block and in accordance with train conditions on the adjacent blocks. As near to the track as feasible, we provide a special conductor well-insulated and of low resistance, this conductor being divided into sections at the block junction. By suitable

switching means, also controlled by the block signaling system, circuit is established for the carrier frequency to the section or sections of the conductor corresponding to a block or blocks occupied by the train and only to such sections. Various methods may be used to separate or distinguish between the dispatching signals and the telephone service, the one shown by us consisting in using separate carrier frequencies for the two types of service. Carried by the moving train at favorable positions are collecting devices such as coils for picking up by induction from the rails the signals for automatic control and from the special conductor the carrier frequencies for dispatching and telephone service. While much latitude is present as to the frequencies at which the various types of signaling are carried on, in this specification we have shown the block signaling carried on with low frequency current such as 60 cycles, the automatic control is carried on at two audio-frequencies such as 325 and 510 in non-harmonic relationship and the dispatching and telephone services at carrier frequencies which might be in the neighborhood of 10,000 to 30,000 cycles. High frequencies for these services are particularly desirable because of more efficient coupling across the necessary air-gap, which, in our invention, is reduced to a minimum. It will be seen that both train dispatching and public telephone service are similar and involve the same type of equipment, it being necessary solely to distinguish between these two by methods well known in the art.

By this system, various advantages appear, among which are economy in apparatus, simplicity of operation and reduction of variations in attenuation characteristic of telephony to moving trains, as well as reduction of the absolute attenuation across the air-gap to reasonably low values thus reducing materially the power necessary for bridging the gap. The use of the special conductor along the track also makes it possible to go to higher carrier frequency and so increases the number of available channels and decreases the loss across the inductive gap.

The invention will be better understood by reference to the following specification and accompanying drawing, in which Figure 1 is a circuit diagram for the fixed portion of the composite system and Fig. 2 is a diagram of the circuits on the train and that portion of the track with which they cooperate.

Referring more particularly to Fig. 1, there is shown a portion of a railroad track comprising

the block sections A, B, and C, these blocks being connected by insulated joints at the points 1, 2, and 3. The block signaling system is of a well-known form consisting of equipment and operating in a manner now to be described. Paralleling the track and supported, as on an adjacent pole line, is a transmission line L_1 to which is connected a source of power for block signaling purposes such as the generator 10, here shown as supplying power at 60 cycles. Connected to this line at or near each junction point are T_1 transformers which supply 60 cycle current to the rails of the various blocks through T_2 transformers and pole changing switches 12. There is thus supplied 60 cycle power entering the rails, as on the B side of junction 3, flowing through the rails and one winding of the R relays, as on the B side of junction 2. These R relays are three-position A. C. relays which may be of a type having two windings, one connected permanently to receive current from transformer T_2 and the other of which receives current from the rails, the phase being determined by the position of the corresponding pole changer. These relays go through a sequence of operations to be hereinafter described. In series with the R relays are S and U relays, the U relays being used in connection with the automatic control system and the S relays being used in connection with the telephone services, all in a manner hereinafter described. The operation of this block signaling system is as follows: If traffic is proceeding from left to right in the figure and the train is in block C, then the rails in that block are short-circuited by the axles of the train so that the 60 cycle current no longer passes through the R relay of that block. Thereupon, the signal 14 of that block is moved to stop position and by its motion transfers its pole changer 12, at junction 3, from the position which it occupied, as in block A, to the position here shown, bringing about a reversal of phase of the current in the rails of block B. Just before the train passed entirely into block C, the signal 14 in block B had been in the stop position and the armatures of the R relay in block B had been in the neutral position. Upon reversal of the current through the rails of block B, however, as the train moves entirely into block C, the signal 14 at the entrance to block B is moved to caution position and the armature of R in block B is moved to the right to supply power to the proper circuits to the moving mechanism of the signal 14 of block B. This motion of the signal of block B shifts the pole changer 12 adjacent to the junction 2 to the right, thus establishing 60 cycle current in the rails of block A in the normal phase; whereas, just previously it had been in the reversed phase. This re-poling of the current in the rails of block A operates through relay R of block A to move its armature to the left, whereupon power is supplied to the signal of block A to move it into the proceed position, leaving the associated pole changer in the right-hand position and thus maintaining the proceed position in the succeeding blocks to the rear. All of this equipment and mode of operation is old in the art. Inasmuch, however, as our composite system involves the use of signaling currents at other frequencies, we make provision to keep such other signaling frequencies out of the block signaling system by suitable devices such as circuits 16 and 17 which consist of series inductances and capacities tuned to the block signaling frequency of 60 cycles. While this block signaling has been described as carried on with

A. C. we wish it to be understood that it could be equally well done with D. C.

For the purpose of automatic train control, we connect to the transmission line L_1 two generators 20 and 21, preferably in the voice frequency range and here shown as 325 cycles and 510 cycles, these generators as well as the generator 10 being located at any remote power station. These voltages superimposed on the line L_1 are supplied to the rails of each block in the route through the armatures of the U relays and through low-pass filters 24 which are designed to pass, in this case, frequencies over the band from about 300 cycles to 550 cycles, thus excluding the 60 cycle power and carrier frequency power to be mentioned later. When the train is in block C and the tracks are short-circuited, the relay U in that block is released, giving connection through tuned circuits for the 325 cycle voltage which is then supplied through the rails of block B. Since, however, there is no train in the block B to bridge the rails, no 325 cycle current flows. As regards the circuits at the junction 2, it will be noted that 60 cycle current flows through the relay U activating it and thus connecting 510 cycle voltage to the rails of block A, and the same condition exists as to all blocks to the rear thereof, so long as no train is present in such blocks. If a train should enter block A, 510 cycle current will immediately flow in the rails of that block and will be picked up by a collector on the train at the front of the first axle to perform certain operations on the train which will be shown and described in connection with Fig. 2. Also, if a train should enter block B while a train is still in block C, 310 cycle current will flow through the rails of block B to be picked up and perform the appropriate operation on the train. It will be noted that normally there is impressed across the rails of each block voltage of 510 cycles but that in a block immediately to the rear of a train there will be voltage impressed of 325 cycles.

Turning now to the train dispatching and the telephone services, there is shown in the figure a station which supplies to the line L_1 two carrier frequencies f_1 and f_2 , this being done at any convenient point along the railroad route. One of these, such as f_1 , intended for the telephone service, is modulated with an appropriate speech signal, this being accomplished by methods and means well known in the art. For example, a voice frequency signal from some remote subscriber's station is connected through the hybrid coil 27 and is impressed on the modulator-amplifier 28 to which the frequency f_1 is also supplied from the oscillator 29. The modulated high frequency output of 28 is passed through appropriate filters and transformers to the line L_1 . A similar equipment is supplied to modulate a carrier frequency f_2 with a speech signal from a dispatcher's station and this modulated carrier frequency is also impressed on the line L_1 . For the best operation of this type of service, we find it important to make attenuation losses over the inductive coupling path to the train as small as possible and of as nearly constant value as possible. To this end and as an important feature of our invention, we place a special conductor L_2 as near to the passing train as feasible and at the same time make this conductor one which is well-insulated and of low resistance. This conductor may be buried in the roadbed close to the rails or may be mounted above the roadbed, preferably as close to one of

the rails as feasible. The conductor is divided into sections at the junction points of the blocks, each section being well-insulated to reduce leakage loss to a minimum.

5 Consider again the case of a train in block C. In that event, the rails are short-circuited and the relay S of junction 3 is released, whereupon, circuit for the carrier frequency is established from one side of the line L₁ through the high-
10 pass filter 31, conductor 32, armature of relay S to the conductor L₂ of block C at the junction 3. Circuit continues through this section of L₂ and returns by a conductor at the remote end of this block analogous to the conductor 35, which
15 is connected to an additional wire L₃ carried on the pole line or similarly located, and back through the high-pass filter to the opposite side of the transmission line L₁. The collecting device, such as a coil carried by the train in block
20 C and adjacent to the section of L₂, picks up the carrier frequency and is disposed of in a manner to be described in connection with Fig. 2. It will be observed that when 60 cycle current is passing through one winding of the R relays, the
25 S relays are activated thus breaking the circuit connection from the high-pass filter to a corresponding section of L₂ and it will be evident, therefore, that the only sections of L₂ which carry carrier frequency are the sections in those
30 blocks occupied by a train. As a result, carrier current is supplied to a minimum of sections giving a minimum of loss.

Among the considerations for installing the special line L₂, rather than using the rails, is the
35 fact that, in general, there is considerable leakage from rail to rail or from rail to ground and this leakage will vary markedly with weather conditions. The conductor is well-insulated, thus rendering it independent of weather con-
40 ditions and at the same time can be made of low resistance so that attenuation losses are low and are practically constant as the train proceeds from one end to the other of the block.

Referring now to Fig. 2, there are shown the
45 circuits on the train which are to cooperate with the circuits of Fig. 1 to pick up the automatic control signals and the carrier frequency signals. In Fig. 2, there is shown a short section of rails such as may be necessary for containing
50 the train. Referring, first, to the automatic control system, we have located at the front of the locomotive a coil or coils 40 adjacent to the rails, adapted to pick up the currents of 325 and 510 cycles. One terminal of these coils is connected
55 to the filaments of two amplifier tubes 41 and 42 and the other terminal divides, one branch 44 going to the grid of 41 and the other branch 45 going to the grid of 42. Across the input circuit of each of these tubes are step up trans-
60 formers t₁ and t₂ and in the branch 44 is included a tuned circuit 46, tuned to frequency 325 to exclude the frequency 510 and in the branch 45 a similar tuned circuit 47 to exclude the 325 cycle frequency. Also, in this circuit, we include
65 a low-pass filter 48 to exclude 60 cycle and carrier frequency currents. The output of the amplifier 41 is connected through suitable tuned circuits to the rectifier 51. The output of this rectifier or detector includes the winding of re-
70 lay R₄. Similarly, the output of amplifier 42 is supplied through suitable tuned circuits to the rectifier 52, the output of which contains the relay R₅. The filaments of these tubes may be heated from any suitable source and in this case
75 we have shown them as heated from the gen-

erator for the head-light of the locomotive. Also a B battery supplies voltage to the plates of these tubes in a manner well understood in the art. The relays R₄ and R₅ control any suitable train
5 of relays to light signaling lamps, apply brakes or perform any other desired operations for the automatic control of the trains. If, for instance, the train is in the block C and there are no trains in the block ahead, 510 cycle current passes
10 through the rails of this block C across the axles of the locomotive and the relay R₅ is activated, whereas the relay R₄ is released. In this event, current can flow from the wire marked "com-
15 mon" through the wire marked "proceed", thus lighting the corresponding signal lamp in the locomotive cab or performing other operations. If, on the other hand, there is a train in the block ahead, then 325 cycle current passes
20 through the rails of block C, as described in connection with Fig. 1 and the relay R₄ is activated, whereupon current from "common" passes through the released armature of R₅ and the activated armature of R₄ to the "caution"
25 wire, whereupon the appropriate signal is lighted in the cab and such other mechanism as is desired may be activated to control the speed of the train. If, as a third condition, the train has entered the block C, before a preceding train has moved out, then the rails of block C will be short circuited by the first train and neither 325
30 nor 510 cycle current is available at the rear train. Consequently, both relays R₄ and R₅ are in released position and current is established through "common" to the "stop" wire, whereupon, again, the appropriate signal lamp is light-
35 ed and, in general, mechanism would be activated to apply the brakes to the train. Thus, it is seen that the circuit described provides a three position control which is as much as is ordinarily desired. In the event that more ex-
40 tensive control is important, it is apparent that additional voice frequencies may be supplied to the transmission line L₁ in order to make possible the operation of additional controls.

For the carrier frequency signaling, we have
45 shown two channels, one for the dispatching system and one for the public telephone service. The first of these would ordinarily be supplied to the cab of the locomotive. To this end, there is shown a high frequency pick-up coil 60 sup-
50 ported in any suitable manner on the locomotive to bring the coil as near as feasible to the conductor L₂. A filter F₂ excludes the frequency f₁ and passes the modulated frequency f₂; and the circuit from the coil 60 then continues to a two-
55 way signaling set of such form as is now well known in the art. In this case, the incoming carrier frequency passes through a filter and a demodulator-amplifier 63, through a hybrid coil 64 to the voice frequency telephone set in the
60 cab and, for conversation in the opposite direction, voice frequency signaling from the cab passes through the hybrid coil 64 to the modulator-amplifier 66 and filter 67 back to the conductor L₂. The modulator-amplifier 66 is sup-
65 plied with carrier frequency from the oscillator 68, this being of a suitably spaced frequency f₃. Thus, there is established a two-way telephone channel between the engineer in the cab and the dispatcher at a remote station.
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Similarly, a high frequency pick-up coil 70 is supported as close as feasible to the conductor L₂ for two-way telephone communication to a telephone set on a passenger car, the circuit therefor being identical with that shown in con-
75

nection with the dispatching telephone. A carrier frequency f_4 would be used for transmission in the opposite direction. It will be evident that the filters F_1 should be of such a character as to transmit both carrier frequencies f_1 and f_4 with their modulation side bands. In general, it would be expected that while f_1 and f_4 are spaced sufficiently to avoid interference they still will be fairly close to each other, and the transmission band of the filters F might therefore be one which has a single transmission band of sufficient width to pass both carriers, or may be a filter with two transmission bands located as desired in the frequency spectrum. The same remarks hold for the filters F with the understanding that the transmission bands of the two sets of filters should preferably not overlap. It will be noted that since the inductive coupling for these two services are with an insulated section of L_2 , the pick-up coils 60 and 70 may be placed at any point along the train without regard to short circuiting effects of the axles of the train. Also, it will be apparent that if additional telephone channels are desired, they may be supplied at other carrier frequencies. Since the front and rear of this train may be in different blocks it will be desirable to make the relays S slow acting on release so that the connection for a given section will not be removed till the rear telephone equipment has passed, or the action of the relays may be otherwise modified.

Numerous modifications are possible in the system as we have described it. Thus, if so desired, communication to any one telephone set may be on a single carrier frequency instead of a pair of carrier frequencies this being used for transmission in both directions. Also, while we have shown the return from the conductor L_2 as being connected to an additional wire L_3 , presumably mounted on the pole line, it would be possible to eliminate this wire L_3 and connect the conductor 35 to ground, in which event, one side of the high-pass filter should also be grounded. Inasmuch, however, as the pole line paralleling the track usually carries a considerable number of conductors, some one or more of these may be selected to constitute the additional wire, the carrier frequency current being superposed on such other signals as that wire or wires may be carrying, it being necessary only to introduce appropriate blocking or tuned circuits to keep the various channels properly separated. Then, again, the equivalent of the additional wire L_3 may be obtained by a simplex arrangement on the circuit L_1 . Still other variations are possible, such as impressing the carrier frequency on the two conductors in parallel at the fixed stations and employing ground return from the L_2 sections.

Still further it should be noted that since the train is supplied with transmitter signaling equipment it becomes possible to generate the automatic control currents on the train and supply the track sections therefrom, thus removing the necessity of supplying them from a remote point. Also since there is two-way telephone apparatus at two points on the train, such as the front and the rear, it becomes immediately possible to establish head-end rear-end communication such as is frequently desired on long freight trains. Cognizance should be taken, as noted above, of the fact that the front and rear ends of the train may be in different blocks.

It may occur also that with reliable automatic control of trains it will be deemed desirable to

eliminate the semaphore signals, still retaining the sectionalized track. In this event the mechanical operation of the switches could be carried on by equivalent but much smaller moving elements.

What is claimed is:

1. In a composite system of block signaling, automatic train-control, and communication, the combination with a block-signaling circuit having a source of current connected thereto, of a train dispatching circuit also having a source of current connected thereto, the frequency of one source differing from that of the other, a track forming part of the block signaling circuit, a sectionalized conductor parallel and in close juxtaposition to said track but insulated therefrom forming part of said dispatching circuit, each section of said conductor being co-extensive with a block signal section, the said dispatching circuit being normally open, and means controlled normally by the block-signaling current adapted, whenever a train enters a given block to close said dispatching circuit through the section of said conductor corresponding to the signal block into which the train has just entered.

2. In a system of signaling to trains, the combination with a block signaling circuit having a source of current connected thereto, of a telephone circuit having means for establishing a two-way channel of communication with trains in any block, a sectionalized conductor adjacent to the rails but insulated therefrom, each section of said conductor being coextensive with a block signal section and designed to form part of the said telephone circuit but being normally disconnected therefrom, and means controlled by the block signal current for establishing the connection of the said telephone circuit to those sections of the conductor corresponding to those blocks occupied by trains.

3. In a system of signaling to and control of trains upon a given track, the combination with a block-signaling circuit having a source of current connected thereto, of an automatic train-control circuit having sources of current connected thereto, the frequencies of which differ from that of said signaling current, and a telephone circuit transmitting frequencies differing from those of the other circuits, a transmission line along the route of the said track for carrying the currents of the several circuits, an insulated conductor adjacent to the rails and sectionalized at the block junction points, designed to form part of the telephone circuit but normally disconnected therefrom, and means controlled by the block-signaling currents for applying the automatic train control currents to the rail blocks in definite frequency sequence, and for connecting into the telephone circuit only that section of the conductor corresponding to a block occupied by a train.

4. In a system of signaling to and control of trains upon a given track, the combination with a block-signaling circuit having a source of current connected thereto, of an automatic train control circuit having sources of current the frequencies of which differ from that of the signaling current, and a telephone circuit transmitting the frequencies of which differ from that of the currents of the other circuits, a transmission line along the route of the said track for carrying the currents of the several circuits, an insulated conductor adjacent to the rails and sectionalized at the block junction points, means controlled by the block-signaling currents for

applying the automatic control currents to the rail blocks in definite frequency sequence depending upon the presence of a train in a given block and for connecting into the telephone circuit only that section of the conductor corresponding to a block occupied by a train, and devices on the train for inductively picking up the automatic train control signals from the rails and the telephone signals from the said section of the conductor.

5. In a composite system of signaling to and communication with a train upon a given track sectionalized to form a plurality of signal blocks, the combination with a block signaling circuit operated on low frequency current, of an automatic train control circuit operated on current of voice frequencies, a telephone circuit operated on carrier frequency current, a transmission line along the train route on which all currents are superposed, a sectionalized conductor very close to the track but insulated therefrom, each section being coextensive with a block section, a tap from the transmission line at each block to apply block-signaling current thereto, and means controlled by the block-signaling currents to apply the telephone currents to that section of the said conductor coextensive with the block in which the said train is located, and to apply the automatic control currents to the preceding blocks in accordance with a predetermined code.

6. In a system of signaling to and control of trains upon a given track sectionalized to form a plurality of signal blocks, the combination with a block signaling circuit, of an automatic train control circuit, and a telephone circuit, a transmission line along the route carrying the currents of the said circuits, an insulated conductor adjacent the track rails intended to form part of the telephone circuit but being normally disconnected therefrom, and means controlled by the block-signaling current for effecting a connection for the telephone circuit between the transmission line and that portion of the said conductor adjacent to a train, and means also controlled by the block-signaling current for applying in definite sequence the automatic train control current to that block preceding that in which a train may be present.

7. In a system of signaling to and control of trains, the combination with a block-signaling circuit, of an automatic train control circuit and at least two telephone circuits, each of said circuits having a source of current connected thereto, the frequency of each source differing from that of the other sources, means controlled by the block signaling current in a given block to control the selection of the frequency transmitted over the said automatic train-control circuit of a preceding block and to effectively establish telephone circuits in each block in which a train may be present.

8. In a system of signaling to and control of trains, the combination with a block-signaling circuit, of an automatic train control circuit, and at least two telephone circuits, said telephone circuits having parts of their transmission paths in common and each of said circuits having a source of current connected thereto, the frequency of each source differing from that of the other sources, and means connected to the train control circuit and the telephone circuits responsive to the block-signaling current to control the selection of the frequency of the train control current applied in a given block and to

effectively establish telephone communication in those blocks in which a train is present.

9. In a system of signaling to and control of trains, the combination with a block-signaling circuit, of an automatic train control circuit to which one of a plurality of frequencies may be selectively applied, and at least two telephone circuits, each of said telephone circuits being in part fixed and in part mobile, the fixed part of said circuits being normally open in each block, the said parts being inductively related, and the said mobile part of one circuit being terminated at a different point upon a train than the said mobile part of the other circuit, the selection of the frequency to be applied to the said train control circuit, and the effective closing of the said telephone circuit being controlled by changes in the block-signaling current.

10. In a composite system of block-signaling, automatic train-control, and communication, the combination with a block-signaling circuit having a source of low frequency current connected thereto, the said signaling current including a section of track, of an automatic train-control circuit having a source of voice frequency currents connected thereto, a speech transmission circuit having a source of carrier frequency currents connected thereto, the said transmission circuit including a section of conductor insulated from but coterminous with the said signaling section of track, and means connected to said train-control circuit and said speech transmission circuit and responsive to the block signaling current to effectively close the speech transmission circuit through that section of conductor corresponding to a signal section into which a train has just entered, and also to change the connection of the automatic train-control circuit in the signal section preceding that into which the said train has entered.

11. In a system of signaling to and communication with trains upon a given track, the combination with a block-signaling circuit having a source of current connected thereto, of a telephone circuit also having a source of current the frequency of which differs from that of the signaling frequency, a transmission line along the train route common to both of said circuits, a conductor adjacent to and insulated from rails and sectionalized at the block junction point, branch circuits extending from said transmission line to each section of said conductor, the said branch circuits including filters to select the telephone frequencies, the said branch circuits being normally open, and switching means controlled by the block-signaling current to close the said branch circuits extending to those blocks occupied by trains.

12. The combination with a track divided into a plurality of block-signaling sections of a conductor in a close proximity to said track and divided into sections substantially coterminous with said block-signaling sections, a block signaling circuit including the rails of each section of said track, a communication circuit including the sections of said conductor, the said circuit being normally ineffective in those sections corresponding to a track section having no train therein, and switching means responsive to a change in the block signaling current whenever a train enters a given signal section to effectively establish the communication circuit in the block-section in which a train is located.

13. The combination with a track divided into a plurality of block-signaling sections of a con-

ductor in close proximity to said track and divided into sections substantially coterminous with said block-signaling sections, block-signaling apparatus connected to the rails of each block-section and a source of low frequency current also connected to each section of said rails to operate said apparatus, sources of train-control current, each of a frequency differing from that of said block-signaling current, one or the other of which train control frequencies may be effectively connected to said rails of each section, means controlled by a change of said block-signaling current whenever a train enters a given block to apply a train control current of a different frequency to the block preceding that in which the said train is located, communication apparatus normally disconnected from the said sections of said conductor, and means also controlled by the change in the block signaling current upon the entrance of a train into a given block to effectively connect said communication apparatus to the section of conductor corresponding to the track section in which the train is located.

14. In a composite system of block-signaling, automatic train control, and train dispatching, the combination with a track sectionalized to form block-signal sections, a conductor likewise sectionalized and coterminous with the block-signal sections, a vehicle adapted to operate upon said track and containing control apparatus responsive to current transmitted over said track or an independent circuit, a source of block-signaling current, a source of train-control current of a plurality of frequencies, each of which frequencies differs from that of the block-signaling current, both of said sources being effectively connected to said track and means responsive to a change in said signaling current upon the entrance of said vehicle into a given block-signal section to effectively change the frequency of the train-control current being supplied to the track of the block-signaling section preceding that into which the said vehicle has just entered to effect the proper regulation of the train-control apparatus upon any vehicle that is in or may come into the said preceding signal section, and means also controlled by the block-signaling current to effectively close the train-dispatching circuit through the section of said conductor adjacent to a block section in which the said vehicle is present.

15. In a system of signaling to and control of trains, the combination with a sectionalized track having block-signaling apparatus connected thereto operated by signaling current, of an automatic train-control circuit having sources of current of a plurality of frequencies adapted to be

effectively connected to said control circuit, a train-dispatching circuit to establish communication with trains upon said track, the said dispatching circuit normally being open in a block-section in which a train is not present, means controlled by the block-signaling current to selectively apply current of one of said train-control frequencies to said control circuit, and means also controlled by said signaling current to effectively close said dispatching circuit in a block wherein a train may be present thereby rendering possible communication over the said dispatching circuit.

16. In a combined block-signaling, automatic train control and train communication system, the combination with a block-signaling system having a source of low frequency current connected thereto to operate the block-signaling apparatus connected to the block-sections of the track, an automatic train control circuit having sources of current of a plurality of voice frequencies adapted to be selectively connected to said control circuit, and a sectionalized telephone circuit operated by carrier frequency currents, the said telephone circuit being normally open in block-sections in which a train is not present, means controlled by current conditions in said block-signaling circuit to selectively apply one or the other of the train-control frequencies to said circuit, and means also controlled by the block-signaling current to close each section of the telephone circuit corresponding to those block-signaling sections in which trains may be present.

17. In a system of block-signaling, automatic train-control and train-communication, the combination with a block-signaling circuit including a source of current, a track relay and the rails in each block-section of a track to the opposite ends of which said source and said relay are connected, a train-control circuit including sources of current of at least two frequencies, the rails in each block section to which the frequencies of said sources are to be applied and a relay controlled by the block-signaling current in a given block to apply one or the other of said train-control frequencies to the next preceding block, and a train-communication circuit including a carrier frequency terminal circuit, a loop circuit individual to and co-terminous with each block section, the said loop circuits being normally open, and means controlled by the block-signaling current to close each loop circuit corresponding to a block-signaling section in which a railway vehicle may be present.

LLOYD ESPENSCHIED.
NEWTON MONK.