July 16, 1940.

G. W. BAUGHMAN

2,208,446

REMOTE CONTROL APPARATUS

Filed Feb. 17, 1939

2 Sheets-Sheet 1

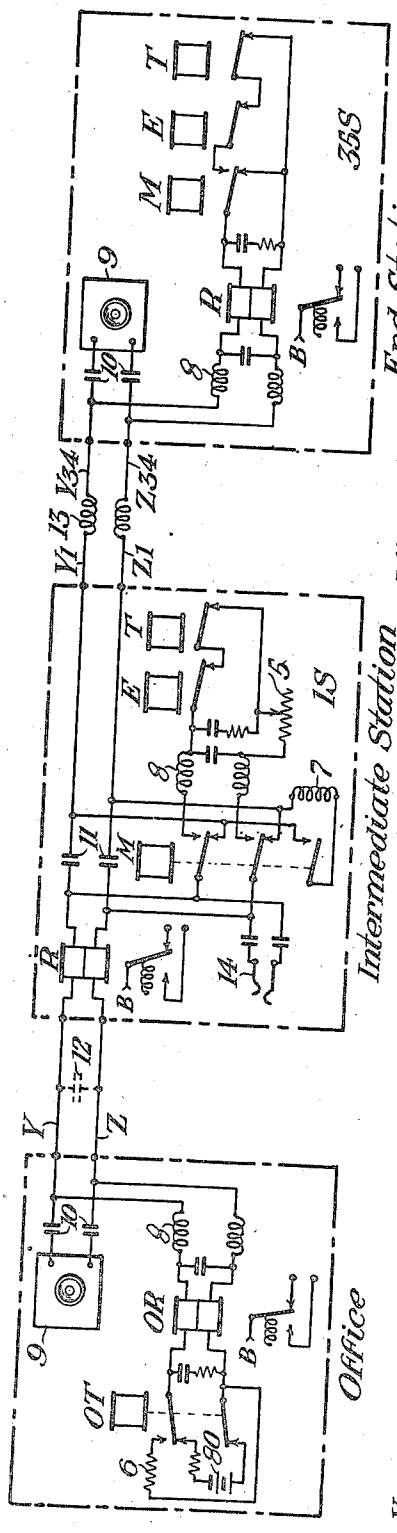

Fig. 1.

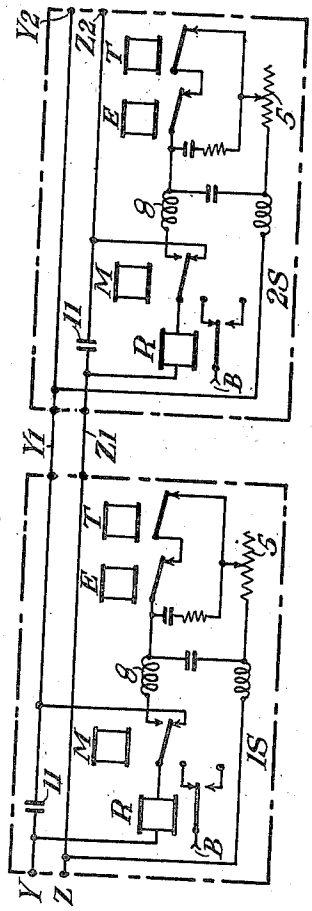

Fig. 3.

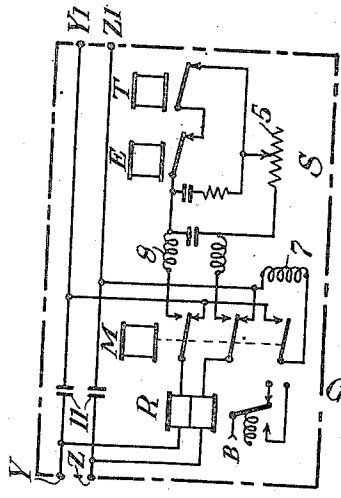

Fig. 2.

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July 16, 1940. G. W. BAUGHMAN 2,208,446

REMOTE CONTROL APPARATUS

Filed Feb. 17, 1939 2 Sheets-Sheet 2

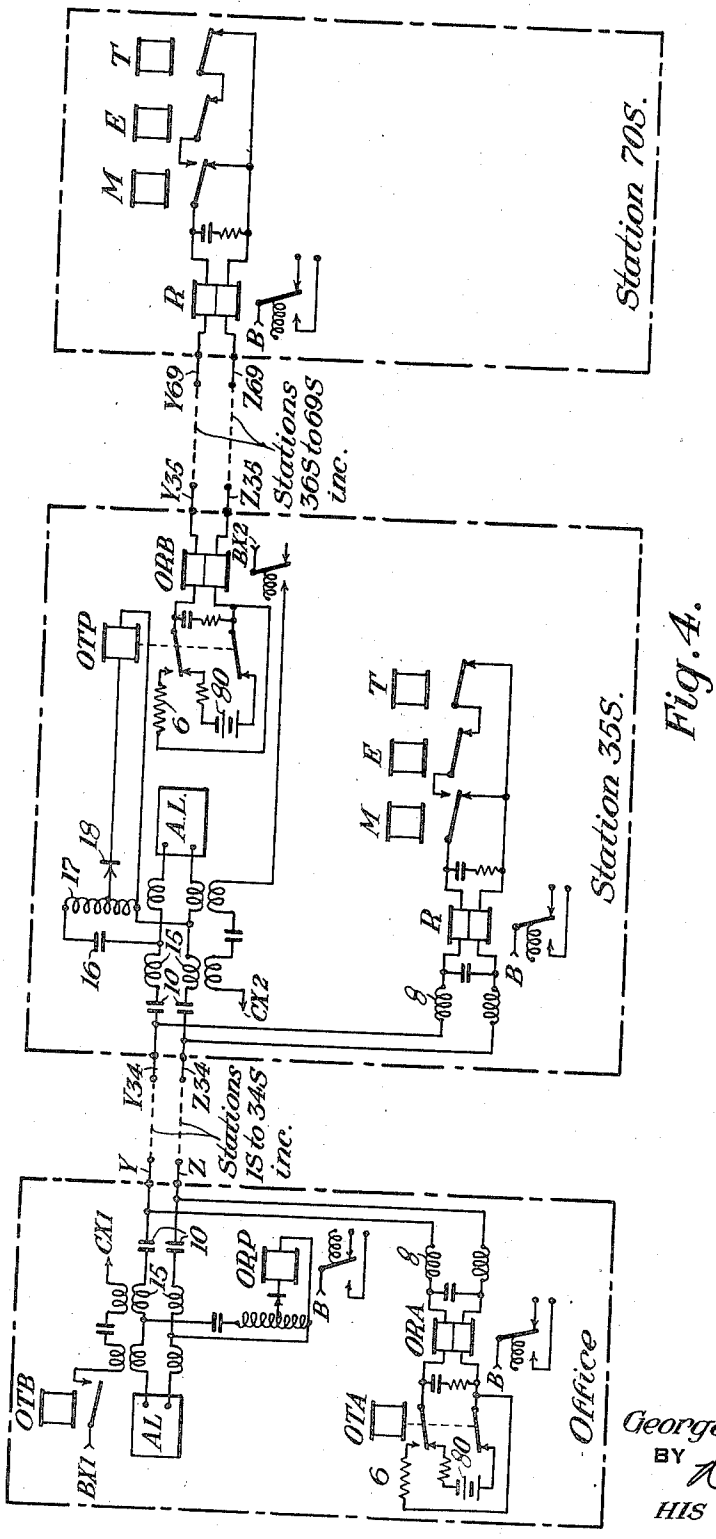

Fig. 4.

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Patented July 16, 1940 2,208,446

UNITED STATES PATENT OFFICE

2,208,446

REMOTE CONTROL APPARATUS

George W. Baughman, Pittsburgh, Pa., assignor to The Union Switch & Signal Company, Swissvale, Pa., a corporation of Pennsylvania

Application February 17, 1939, Serial No. 256,976

16 Claims. (Cl. 179—2)

My invention relates generally to remote control systems, and more particularly to the communication or line circuits for such systems.

My invention is particularly adapted for though in no manner limited to centralized traffic controlling systems for railroads in which a train dispatcher's office or other suitable point of control is connected with a plurality of field stations by line wires, over which code signals are transmitted at times for controlling selected devices at the stations, and at other times for indicating the condition of station devices at the office. The code signals may be of any suitable character, but in the illustrative embodiments which I have chosen, the code signals are formed by interrupting the current from a battery located at the office end of the line circuit.

My invention may advantageously be applied, for example, to a centralized traffic control system such as the one disclosed in the pending United States application, Serial No. 600, 786, filed March 23, 1932 by Lloyd V. Lewis, for Remote control system, which corresponds with British Patent No. 415,787, issued September 3, 1934.

One object of my invention is to provide additional communication channels over the line wires of the centralized traffic control system, the additional channels being suitable, for example, either for telephone communication or for code signaling, or for both purposes. A specific object of my invention is to provide telephone communication of unimpaired quality over a line circuit which is also used for code signaling and which includes line relays at a large number of way stations.

A further object of my invention is to extend the length of territory and the number of stations which may be controlled by a centralized traffic control system. In accordance with this feature of my invention the line circuit is sectionalized, each section providing a physical circuit for the control of a large number of way stations, and the code signals transmitted between the office and the more remote sections are relayed over the intervening sections by the employment of additional channels such as those above referred to.

Other objects, purposes and features of my invention will be pointed out as the description proceeds.

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

Referring to the accompanying drawings, Fig. 1 illustrates the line circuit for a centralized traffic control system such as the one disclosed in the patent hereinbefore referred to, which has been modified in accordance with one form of my invention to provide superimposed alternating current communication channels. It is to be understood that this view may be expanded to include additional intermediate stations, the maximum capacity of the system in the form illustrated in the patent being thirty-five stations. Fig. 2 shows a modified form of the apparatus at an intermediate station, which is suitable for use in the system of Fig. 1. Fig. 3 illustrates a second modification of the intermediate station apparatus which may be used in the system of Fig. 1 when single wound line relays, as illustrated in the patent, are used. Fig. 4 illustrates one manner in which certain of the superimposed communication channels of the system of Fig. 1 may be used for code signaling to provide for the control and indication of devices at a large number of additional stations located at a considerable distance from the control office. It is to be understood that in Fig. 4 the first section of the line circuit extending from the office to the end station 35S may include apparatus at a large number of intermediate stations such as that at station 1S in Fig. 1, or such as is shown in Fig. 2 or in Fig. 3, and that the second section of the line circuit extending from station 35S in Fig. 4 to station 70S may be similarly arranged. For simplicity, only the physical circuit for the second section and only one superimposed channel for each direction for the first section is shown in Fig. 4, but it is to be understood that additional channels may be added as required by the provision of suitable well-known filtering arrangements, such, for example, as are described in section 11, page 17, of the "Electrical Engineer's Handbook," Vol. V, published by John Wiley & Sons, Inc., New York, 1936, or by other suitable means.

Similar reference characters refer to similar parts in each of the several views.

The designations for the various relays disclosed herein are the same as those for the corresponding relays of the British Patent No. 415,787, hereinbefore referred to. As more fully explained in the patent, the line circuit for code signaling is normally closed and energized by a line battery 80 at the control office. As shown herein in Fig. 1, the line circuit extends from battery 80 over back contacts of a transmitter relay OT and the winding of a line relay OR at the control office to line wires Y and Z, thence through the winding of a similar line relay R and back contacts of a master relay M at the first station 1S to the outgoing line wires Y1 and Z1, thence similarly through each intermediate station, the circuit being completed from the incoming wires Y34 and Z34 at station S35 at the end of the line through the winding of the relay R and the back contacts of the relay M at that station. Control codes each comprising a series of time spaced impulses and intervals are trans-

mitted from the office by intermittently energizing the office transmitter OT, these codes being received by the office line relay OR, which relay controls relay OT to govern the transmission of the impulses, and also by the line relays R which control the selective apparatus at the stations, the apparatus at each station being responsive to a different code. Indication codes are transmitted from a station by energizing the corresponding relay M at the transmitting station for the duration of the code, to deenergize the portion of the line circuit extending to stations more remote from the office, the portion extending to the office being completed over a back contact of the relay T at the transmitting station and a compensating resistor 5 of a value approximately equal to the resistance of the disconnected line portion. Relay T is then operated intermittently to transmit a code characteristic of the station under the control of the associated relay R, this code being received by line relay OR to operate suitable selecting apparatus at the office. The apparatus is arranged so that a code may be initiated by the office or by any station when the line is free, and is further arranged so that no interference occurs in the event two or more transmitters are initiated simultaneously, the several codes being transmitted one at a time in a predetermined order under this condition as fully explained in the patent.

The line circuits shown herein differ from those of the patent by including certain provisions for better adapting the system for use over lines which are relatively long electrically, such, for example, as a long distance cable line having considerable cable capacity, as disclosed in a pending Lewis application for United States Patent, Serial No. 137,500, filed April 17, 1937, for Remote control system. These provisions include the use of sensitive line relays of the biased polar type in place of ordinary neutral relays, and the provisions of means for discharging the energy stored in the distributed capacity of the cable when the battery 80 is disconnected from the line, comprising a shunt including a resistor 6 which connects line Y to line Z each time the office relay OT picks up, and a choke coil 7 at each station for similarly discharging the remote portion of the line when that station is transmitting. The line circuits are further modified in accordance with the present invention by providing the line relays with two equal windings one of which is in series with each line wire, and by interposing a low pass filter 8 such as is used in the telegraph branch of the usual composite circuit, in the line circuit between the line wires Y, Z and the contacts of relay OT at the office and relay T at each station. Such filters are highly satisfactory for this purpose, since the frequency of the code signals as usually employed is lower than that of the usual telegraph code signals. With these arrangements, the line wires are rendered available for non-interfering voice frequency communication, and a telephone circuit may be superimposed upon the code signaling line. As illustrated in Fig. 1, the voice frequency circuit normally extends from the telephone apparatus 9 at the office through a high-pass filter indicated conventionally by the condensers 10 to line wires Y, Z thence through the windings of relay R and back contacts of relay M at each intermediate station, through a similar filter 10 to the telephone apparatus 9 at the end station. When an intermediate station is transmitting the relay M at that station sectionalizes the line for the code signaling channel, but the voice frequency channel is maintained intact under this condititon by the provision of by-pass condensers 11 at each station connected across the contacts of the corresponding relay M. Since the code signaling channel includes usually a large number of relays in series these relays are preferably wound to have a low resistance and inductance, which is also desirable because the voice frequency currents pass through these relays.

It is also desirable to select the inductance of these relays so that they will act in the same manner as the loading coils used on long distance telephone lines. A satisfactory value of loading for telephone lines is 0.175 henry per 8 miles for open wire line, and the same value per 9000 ft. for cable. The usual value of the inductance of the line relays in the system described as heretofore used is around 0.1 henry, and the stations are usually located at intervals of three or four miles, and it is apparent that but a minor change, if any, in the relay constants is required to adapt the relays to the purposes of the present invention. In order to eliminate reflection losses it is necessary that the loading coils be uniformly spaced. If the stations are irregularly spaced, as is usually the case, the electrical equivalent of uniform loading may be obtained by connecting a fixed condenser as indicated at 12 across the line to increase the capacity to correspond with that of a normal loading section, when the distance between stations is insufficient, or by inserting a loading coil as indicated at 13 in series with the line when this distance is excessive, the values of the condensers 12 and coils 13 being so chosen as to maintain a fixed ratio between the line inductance and capacity per unit of distance.

It will be seen from the foregoing that irrespective of the number of stations, the branch of the code signaling circuit which is in use at any time contains only two filters, namely, those at its two ends, and consequently the quality of the code transmission will not be impaired by the addition of the filters 8 and 10 and of the condensers 12 and coils 13 to even the slight extent as in the usual composite circuit in which the code signaling apparatus is located at the ends only. Further, the voice communication channel may be arranged to provide high quality transmission and may be extended from either end to a more remote point if desired.

In centralized traffic control systems it is often desirable to provide facilities to enable the operator at the control office to communicate by telephone with the maintainer in charge of the station apparatus or with the crew of a train held at a remotely controlled signal. In such cases the operator may call the maintainer to the nearest station by the transmission of a special code assigned to that purpose, and the maintainer or a train crew may communicate with the operator by connecting suitable telephone apparatus, not shown, to the line by means of a jack 14 provided at each intermediate station. A loud speaker is in such cases usually connected continuously to the line at the office, rendering it unnecessary to provide any call signal to establish telephone communication with the station desiring to communicate with the office.

The voice frequency channel may also be employed in a well-known manner to provide a plurality of code signaling channels each employing a different frequency as hereinbefore mentioned, or higher frequencies may be used to provide carrier-current transmission channels.

In such cases it may be preferable to omit the loading of the line by the series line relays as hereinbefore described. When this is the case, the apparatus at each intermediate station may be arranged in accordance with Fig. 2, which differs from the corresponding portion of Fig. 1 in that a high-pass filter shown as the condensers 11 bridges the winding of the relay R as well as the contacts of relay M. This permits higher values of alternating current to be used without causing vibration or chattering of the direct current relays at the intermediate stations.

My invention may also be applied to installations of the system of the patent hereinbefore mentioned which employ line relays of the ordinary neutral type. One manner in which this is accomplished is shown in Fig. 3, which shows apparatus for two successive stations which may be included in the line circuit of Fig. 1. This arrangement differs from Fig. 2 in that the line relays at alternate stations are included in line Y while the remaining line relays are included in line Z, so as to balance the characteristics of the two line wires as closely as is practicable. Since the operation of the system when the modifications of Fig. 2 or Fig. 3 are employed is generally similar to that already described, it is believed that it will be readily understood without further description.

In some installations the number of stations or the density of traffic is too great to permit the control of the apparatus at all the stations over a single line circuit. In such cases it has been the practice to employ two wires extending over a portion of the territory for the control of the apparatus at the nearby stations, and two other wires extending over the entire length of the territory for the control of the remainder.

In Fig. 4 is shown an arrangement whereby the necessity for the additional line wires is obviated. In this view a single pair of line wires provides two circuits in end to end relation, including a first circuit extending from the office to an end station 35S, and the second from that station to a more remote end station 70S. Each physical circuit provides a code signaling channel as hereinbefore described, that is, stations 1S to 35S may be controlled over the first circuit, and the additional stations 36S to 70S over the second. The first circuit is arranged to provide superimposed alternating current channels as in Fig. 1 and the intermediate stations, not shown, may be arranged as already described in connection with Figs. 2 and 3. The second circuit may be similarly arranged, but, as shown, the superimposed circuits are omitted since they are not required when the line has but two sections as shown. The intermediate stations which are controlled over the second line circuit are not shown, since these may be arranged as shown in the patent. The office is provided with two coding units, the one for the first line circuit having a transmitter OTA and a line relay ORA arranged as shown in the British patent hereinbefore referred to and described in connection with Fig. 1. The transmitter OTB for the second unit has a normally open front contact which is employed to deliver control code signals from a source of alternating current indicated by the terminals BX1 and CX1 through a tuned circuit to a hybrid coil 15, the secondary windings of which deliver the code respectively through condensers 10 to lines Y and Z, and to a balancing network comprising the artificial line AL. The alternating current signals passing over the line to sections Y34 and Z34 at the end station 35S pass through the condensers 10 and one-half of the hybrid coil 15 at that station to the tuned circuit comprising the condenser 16 and the coil 17 and are rectified by the rectifier unit 18 to operate the transmitter repeating relay OTP, which relay delivers the code to the second line circuit in the usual manner. It is to be understood that a vacuum tube amplifier may be included in this circuit when required.

Code signals in the second line circuit due to the operation of relay OTP or to that of a relay T at any one of the stations 36S to 70S operate the line relay ORB, which relay in a manner similar to that already described for relay OTB transmits an alternating current code over the first line circuit from an alternating current source of a frequency preferably different from that transmitted by relay OTB, the terminals of this alternating current source being designated BX2 and CX2. Codes of this second frequency operate the relay ORP at the office which replaces the usual relay OR in the control of the second office coding unit. It will be noted that the alternating current channels are normally open so that the codes are reversed, and the absence of alternating current corresponds to the line-closed condition, and the alternating current impulses correspond to the line-open condition of the battery code line. Consequently the connections to the contacts of relays OTB and ORP are reversed with respect to the corresponding connections of other similar relays.

In the system of the patent each relay OT or T is made somewhat slow acting to time the impulses, and its repeated operation is governed by the associated line relay OR or R. In transmitting control codes over the second line circuit the control of relay OTB by relay ORP is dependent upon the operation of two additional relays OTP and ORB, consequently relay OTB is made quicker acting than the other transmitting relays in order to secure approximately the same timing, so that the codes transmitted over the two line circuits will have similar characteristics and permit the use of interchangeable station apparatus.

It will be apparent that the method of control illustrated in Fig. 4 may be further extended to include a third section, in which case two pairs of alternating current channels with selective filtering arrangements are provided over the first section, one for the control of the second section, and the other extending also over the second section for the control of the third section. Since the number of channels rendered available by the use of filters is more than any installation is likely to require, it is evident that only two line wires will be required even in the case of extremely large installations involving heavy traffic.

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

Having thus described by invention, what I claim is:

1. In a remote control system, an office and a plurality of stations connected by two line wires, a code signaling circuit including said line wires, a source of direct current, and a line relay at the office and at each station, in series; means for repeatedly interrupting said signaling circuit to operate said line relays in accordance with different codes, a voice frequency communication

circuit including said line wires, means for signaling over said voice frequency circuit, and means for preventing interference between the two circuits comprising low-pass filters in the code signaling circuit at its two ends only and condensers in the voice frequency circuit at its two ends only.

2. In a remote control system, an office and a plurality of stations connected by two line wires, a normally energized code signaling circuit including said line wires, a source of direct current, and a line relay at the office and at each station, in series; means for repeatedly interrupting said signaling circuit to operate said line relays in accordance with different codes, a voice frequency communication circuit including said line wires and the windings of the line relays at intermediate stations, means for transmitting periodic currents over said voice frequency circuit, and means comprising said line relays for loading said superimposed circuit to more efficiently pass periodic currents of selected frequencies, the windings for said relays being proportioned to have a particular inductance with reference to the distributed inductance and capacity of said line wires.

3. nI a remote control system, an office and a plurality of stations connected by two line wires, a code signaling circuit including said line wires, a source of direct current, and a line relay at the office and at each station, in series; means for repeatedly interrupting said signaling circuit to operate said line relays in accordance with different codes, a voice frequency communication circuit including said line wires and the windings of the line relays at intermediate stations, the windings of such relays being chosen to have an inductance of a particular value with respect to the distributed inductance and capacity of said line wires to so load the line as to more efficiently pass a desired band of frequencies, means comprising series inductances and shunt condensers in said line circuits for rendering the loading due to said relays more uniform per unit of length when said intermediate stations are irregularly spaced, and means for transmitting periodic currents over said voice frequency circuit.

4. In a remote control system, an office and a plurality of stations connected by two line wires, a code signaling circuit including said line wires, a source of direct current, and a line relay at the office and at each station, in series, said circuit also including a low-pass filter at each end only; means for repeatedly interrupting said signaling circuit to operate said line relays in accordance with different codes, a voice frequency communication circuit connected through condensers to said line wires at the office and at a distant station, and means for transmitting periodic currents over said voice frequency circuit.

5. In a remote control system, an office and a plurality of stations connected by two line wires, a code signaling circuit including said line wires, a source of direct current and a line relay at the office and at each station, in series, code transmitting means at the office effective at times to repeatedly interrupt said signaling circuit to operate the station line relays in accordance with different codes, code transmitting means at each station effective at times to open the portion of said signaling circuit extending to stations more remote from the office and to then repeatedly interrupt the remaining portion to operate the office line relay, a voice frequency communication circuit including the same line wires and arranged to provide communication between the office and any station, and means for maintaining the continuity of said voice frequency circuit when a code is being transmitted from the office or from any station.

6. In a remote control system, an office and a plurality of stations connected by two line wires, a code signaling circuit including said line wires, a source of direct current and a line relay at the office and at each station, in series, code transmitting means at the office effective at times to repeatedly interrupt said signaling circuit to operate the station line relays in accordance with different codes, code transmitting means at each station effective at times to open the portion of said signaling circuit extending to stations more remote from the office and to then repeatedly interrupt the remaining portion to operate the office line relay, a voice frequency communication circuit including the same line wires and arranged to provide communication between the office and any station, a low-pass filter associated with each code transmitter for preventing the delivery of transient currents in the voice frequency range to the line wires by such transmitter when operating, and means for maintaining the continuity of said voice frequency circuit when a code is being transmitted from an intermediate station.

7. In a remote control system, an office and a plurality of stations connected by two line wires, a code signaling circuit including said line wires, a source of direct current and a line relay at the office and at each station, in series, code transmitting means at the office effective at times to repeatedly interrupt said signaling circuit to operate the station line relays in accordance with different codes, code transmitting means at each station effective at times to open the portion of said signaling circuit extending to stations more remote from the office and to then repeatedly interrupt the remaining portion to operate the office line relay, a voice frequency communication circuit including the same line wires and arranged to provide communication between the office and any station, a low-pass filter associated with each code transmitter for preventing the delivery of transient currents in the voice frequency range to the line wires by such transmitter when operating, and means for excluding the low-pass filter at each intermediate station from the code signaling circuit except when the transmitter at that station is operating.

8. In a remote control system, a single line circuit extending from a control office serially through a first group of stations and arranged to provide two non-interfering two-way communication channels, a second line circuit extending from the station of the first group most remote from the office serially through a second group of stations and arranged to provide a single two-way communication channel, two code transmitters and receivers at the office and one code transmitter and receiver at each station, means including one of said two channels for delivering codes from one office transmitter to the receiver at each station of the first group and from the transmitter at each such station to one receiver at the office, and means including the other of said two channels and said single channel for delivering codes from the other office transmitter to the receiver at each station of the second group and from the transmitter at each station of the second group to the other receiver at the office.

9. In a remote control system, a first line circuit extending from a control office through a first group of stations, a second line circuit extending from one of said stations through a second group of stations, two code transmitters and receivers at the office and one code transmitter and receiver at each station, means including said first line circuit for delivering codes from one office transmitter to the receiver at each station of the first group and from each such station to one receiver at the office, and means including both line circuits and the transmitter and receiver at said one station for delivering codes from the other office transmitter and receiver to each station of the second group and from the transmitter at each station of the second group to the other receiver at the office.

10. In a remote control system, a line circuit extending from a first station through a plurality of remote stations, a control office at a point remote from said first station, a code transmitter and a line relay for governing the operation of said transmitter at the control office, a repeating relay at said first station remotely controlled by said office transmitter for delivering codes to said line circuit, a line relay at each station responsive to said codes, and means for remotely controlling the line relay at the office in accordance with the operation of the line relay at said first station.

11. In a remote control system, a code signaling circuit including line wires extending from a control office through a plurality of remote stations, automatic sectionalizing means at an intermediate station effective at times to interrupt said circuit to disconnect the control office from more remote stations, an alternating current signaling circuit including the same line wires and extending from the office through said intermediate station, and means effective when said sectionalizing means is operated to include condensers in said alternating current circuit at said intermediate station to maintain its continuity.

12. In a remote control system, a single line circuit extending from a control office through a plurality of remote stations, means for establishing two communication channels over said line circuit comprising high-pass and low-pass filters connected thereto at the office and at a remote station, automatic sectionalizing means for interrupting said line circuit at times at an intermediate station, and means effective when said sectionalizing means is operated for connecting high-pass and low-pass filters to said line circuit at said intermediate station to establish one communication channel between the office and said intermediate station and another between the office and a more remote station.

13. In a remote control system, a single line circuit extending from a control office serially through a first group of stations and arranged to provide a physical circuit for two-way communication and two superimposed non-interfering one-way channels for communication in cppposite directions, a second line circuit extending from one station of the first group serially through a second group of stations and arranged to provide a second two-way communication circuit, two code transmitters and receivers at the office and one code transmitter and receiver at each station, means incuding said physical circuit for delivering codes from one office transmitter to the receiver at each station of the first group and from the transmitter at each such station to one receiver at the office, means including said one-way channels and said second two-way circuit for delivering codes from the other office transmitter to the receiver at each station of the second group and from the transmitter at each station of the second group to the other receiver at the office.

14. In a remote control system, a single line circuit extending from a control office to a remote station and arranged to provide two non-interfering one-way communication channels one for each direction, a second line circuit extending from said remote station serially through a plurality of stations and arranged to provide a single two-way communication channel, a code transmitter and receiver at the office and at each station, means including one of said two channels for delivering codes from the office transmitter to said two-way channel to control the receiver at each station, means including said two-way channel and the other of said two one-way channels for delivering codes from the transmitter at each station to the receiver at the office, and means effective when said office transmitter delivers a code over the one of said two channels to said two-way channel to repeat said code back to the office over the other of said two channels to govern the operation of said transmitter.

15. In a remote control system, a first line circuit extending from a control office serially through a first group of stations and arranged to provide a physical circuit for the transmission of codes of direct current impulses from said office to said stations, and to also provide non-interfering superimposed channels for the transmission of other codes from the office to one station and from said one station to the office, a second line circuit extending serially through a second group of stations including said one station and arranged to provide a circuit for the transmission of impulse codes from said one station to the remaining stations of the second group, a transmitter relay at the office effective to deliver said direct current impulse codes over said physical circuit to the stations of the first group, a second transmitter at the office effective to deliver impulse codes over one of said superimposed channels to said one station, a repeating relay at said one station responsive to the codes delivered by said second transmitter for repeating such codes over said second line circuit to the stations of said second group, and means for repeating the codes delivered to said second line circuit back to the office over the other superimposed channel to govern the operation of said second transmitter.

16. In a remote control system, a line circuit extending from a first station through a plurality of remote stations, a source of current at said first station, a repeating relay at said first station for delivering current impulses from said source to said line circuit, said impulses being arranged in accordance with different codes, a transmitter relay at a point remote from said first station for controlling said repeating relay, a line relay at each station responsive to the codes delivered to said line circuit, means including the line relay at one station for governing the operation of said transmitter relay, and means including the line relays at the other stations for receiving said codes of impulses.

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