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LINE CIRCUIT COMMUNICATION SYSTEM

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This invention relates to line-circuit communication systems, and it more particularly pertains to means for transferring a line circuit used for direct and for alternating current communication from one pair of line wires to the other.

In a line circuit communication system such as a centralized traffic control system for railroads, conveniently termed a CTC system, a central control office governs traffic through a particular assigned territory by line circuit communication of control and indication. It is often desirable to locate the control office in a downtown office building, or the like, remote from the CTC territory with which the control office is associated, in order to take advantage of central office facilities. Under such conditions, the connection of the office to communication line wires at the beginning of the CTC territory is often accomplished through aerial and/or under ground cable, or the like, which is necessarily somewhat subject to damage as the result of weather conditions or as a result of damage by workmen in the maintenance of communication wires which may be closely associated therewith. It is therefore desirable to provide spare line wires, preferably in different cables and differently routed, to which the CTC line circuit can be transferred in case of loss of continuity through one pair of line wires, or in case of other line circuit difficulties interfering with the communication of controls and indications between the control office and the CTC territory with which it is associated.

An object of the present invention is to provide means responsive to manual designation by an operator at the control office for transfer of a CTC line circuit from one pair of line wires to another in a manner so as to isolate one pair of line wires at both ends from the other pair.

Another object of the present invention is to render the shifting from one line circuit to the other effective through a carrier repeater station so as to effect the transfer of the circuit extending beyond the repeater station in response to manual designation of the transfer at the control office.

Another object of the present invention is to effect the transfer from one pair of line wires to the other in response to manual designation at the control office by means of normally deenergized transfer relays which are controlled over the idle line wires in combination with a locally energized transfer stick relay.

Another object of the present invention is to use the line circuit transfer means at the repeater station to shift to standby repeater apparatus in

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response to manual designation at the control office.

Other objects, purposes and characteristic features of the present invention will be in part obvious from the accompanying drawings, and in part pointed out as the description of the invention progresses.

In describing the invention in detail, reference is made to the accompanying drawing which illustrates schematically, with some parts shown in block form, an organization for the transfer of a CTC line circuit from one pair of line wires to another pair. The symbols (+) and (-) are used in the drawing as representing connections to respective positive and negative terminals of suitable batteries or other sources of direct current.

Inasmuch as the specific character of the CTC transmitting and receiving apparatus for communication of controls and indications over the line circuit has little bearing on the present invention, for the purpose of simplification of this embodiment of the present invention, such apparatus has been indicated on the drawings in block form, and it is to be understood that this apparatus which is well known to those familiar with the art is provided according to the requirements of practice. If desired, the D. C. CTC transmitting and receiving apparatus can be disclosed, for example in the patent to W. D. Hall et al. No. 2,399,734, dated May 7, 1946.

For this embodiment of the present invention, it is assumed that both direct current CTC pulses and alternating current carrier pulses are transmitted over the line wires illustrated in the drawings. The direct current pulses are used for the communication of controls and indications to a first section of the CTC territory for which the CTC control machine is provided, and the carrier apparatus is used for the communication of controls and indications over the line wires and through the first section of the CTC territory to a suitable converter station where the carrier pulses for the communication of controls are converted into direct current pulses, and the direct current indication pulses received by such converter station from the second section of the CTC territory are converted into carrier pulses for communication through the first section of the CTC territory and the line wires illustrated in the drawings to the control office. It is of course a matter of choice as to the frequencies used for carrier communication of controls and indications, and it has been found that carrier frequency currents in the band from 10 to 20 kc.

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are satisfactory, distinctive frequencies being generally employed for the communication of controls and indications.

Because of attenuation of the carrier pulses, carrier repeater stations are required at intervals for amplification of the carrier pulses, and thus the carrier repeater units Nos. 1 and 2 are provided at the carrier station illustrated in the accompanying drawing for repeating the carrier pulses received from the control office into the line wires $L1^3$ and $L2^3$ extending in the direction of the CTC territory.

Each of the carrier repeaters illustrated in block form in the accompanying drawings is to be understood as including electronic amplification means for amplifying the respective control and indication frequency currents, the wires 10 and 11 being the in-put wires for the communication of controls and the out-put wires for the communication of indications for the carrier repeater No. 1. The wires 12 and 13 are the out-put wires of the carrier repeater No. 1 for the communication of controls and the in-put wires for the communication of indications. The carrier repeater No. 1 is illustrated as being associated with the line wire $1L1^1$ and $1L2^1$ as selected by the position of the carrier repeater transfer switch CTS, such switch being effective in a manner to be hereinafter considered to select between carrier repeater No. 1 and carrier repeater No. 2. It is thus provided that only one of the carrier repeaters is used at a time, two identical carrier repeaters being provided so as to cause a minimum interruption of service in case of failure of the electronic control apparatus associated with any one carrier repeater unit. In other words the carrier repeater No. 2 can be considered as a standby carrier repeater although means is provided as hereinafter considered for manually selecting as to which repeater is to be the standby repeater.

The wires $1L1^1$ and $1L2^1$ constitute one pair of line wires, which may or may not be in aerial or underground cable, for connection of the portion of the CTC line circuit connecting the control office and the repeater station, and the wires $2L1^1$ and $2L2^1$ constitute a second pair of line wires, conveniently called standby wires extending between the control office and the repeater station to which the line circuit can be shifted as required. It is of course desirable that the respective pairs of wires be routed separately as much as possible so as to reduce the possibility of failure of both pairs of wires at the same time. In a similar manner the wires $1L1^2$ and $1L2^2$ constitute one pair of line wires connecting the repeater location and the beginning of CTC territory, and the wires $2L1^2$ and $2L2^2$ constitute the second or standby pair of wires extending between these points.

At the control office the line transfer switch LTS is located convenient to the operator of the control machine, preferably on the panel of the control machine, and it is provided as a means for manual designation of the particular pairs of wires and the particular carrier repeaters that are to be used in the line circuit of the CTC communication system. Associated with the line transfer switch at the control office is a line transfer relay LT, the contacts of which directly select as to which of the pairs of line wires extending from the control office is to be connected to the CTC carrier transmitter and receiver at the control office. It is to be understood that the relay LT is used in combination with the

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line transfer switch LTS particularly for the purpose of facilitating the wiring of the system, and that the contact 14 and 15 of the relay LT could as well be controlled directly by the line transfer switch LTS if such is the requirements of practice.

Line transfer relays LT^1 and LT^2 are associated with the respective pairs of line wires extending between the control office and the repeater station so as to be responsive to direct current communicated from the control office over the particular pair of line wires that has been idle in a manner to be more clearly understood when considering the mode of operation of the organization. In a similar manner, at the beginning of the CTC territory, the relays LT^1 and LT^2 are provided for transfer purposes, such relays being associated with the respective pairs of line wires extending between the repeater station and the beginning of the CTC territory.

Stick relays LTP and LTP^1 are provided respectively at the repeater station and at the beginning of the CTC territory for transfer purposes, such relays being controlled by the associated relays LT^1 and LT^2 at such locations. A relay CTR at the repeater station is used to transfer from one repeater unit to the other at the repeater station in response to the actuation of switch LTS at the control office. It also is used to select the application of power to the particular carrier repeater unit that is to be rendered active.

Having thus considered the general organization of the system according to the embodiment of the present invention illustrated in the accompanying drawing, the organization will hereinafter be more specifically considered upon considering typical conditions of operation to be encountered in practice.

Operation

It has been illustrated in the drawings that the line wires $1L1^1$ and $1L2^1$ are connected so as to be in use in the CTC line circuit under conditions that may, for the purpose of facilitating the description of the present invention, be assumed to be the normal conditions of the system. Similarly the carrier repeater No. 1 and the line wires $1L1^2$ and $1L2^2$ are in use during the normal conditions of the system.

In accordance with the general principles of operation of the above mentioned CTC system as disclosed in the patent to W. D. Hailes et al. No. 2,399,734, the line circuit is normally energized during a period of rest when no controls or indications are being communicated and such energization can be traced to connect the positive terminal of the line battery CB to the line wire $L2^3$ at the beginning of the first section of CTC territory, through selections of the CTC apparatus at the control offices, wire $L2$, back contact 15 of relay LT, wire $1L2^1$, back contact 18 of relay LTP, choke 17, back contact 19 of relay LTP, wire $1L2^2$, back contact 20 of relay LTP, and winding 21 of the impedance matching transformer 28. The negative terminal of the control battery CB is connected to the line wire $L1^3$ at the beginning of the first section of CTC territory through selections of the D. C.-CTC transmitter and receiver at the control office, wire $L1$, back contact 14 of relay LT, wire $1L1^1$, back contact 22 of relay LTP, choke 16, back contact 23 of relay LTP, wire $1L1^2$, back contact 24 of relay LTP^1 and winding 25 of the impedance matching transformer 28.

It will be noted from the selection that has just been traced for the connection of the control battery CB to the line wires L1³ and L2³ that there are no line transfer relays LTT¹ or LT2² energized by the line circuit at this time as such relays are energized only momentarily upon shifting to the alternate pair of line wires as will be hereinafter considered. In addition to the direct current CTC circuit connections as has been just described, where there is an A. C. carrier superimposed upon the line circuit for a second section of the CTC territory, carrier pulses are also transmitted through the circuit selections just described in that the A. C.-CTC carrier transmitter and receiver illustrated in block form in the drawings is connected in multiple with the D. C.-CTC transmitter and receiver to the wires L1 and L2.

The transmission of the carrier currents, however, is blocked in the repeater station by the choke coils 16 and 17, and thus rather than being directly connected through the repeater station, the control carrier frequency currents are fed as in-pu to the carrier repeater No. 1 in which they are amplified and applied as out-put to the line wires extending to the CTC territory. Indication carrier current pulses are fed back from the CTC territory to the control office at a distinctive frequency over the same circuit.

It is therefore provided that the carrier current pulses for the communication of controls are transmitted from the control office and applied across the wires 10 and 11 of the carrier repeater No. 1. The wire L2 of the CTC transmitter at the control office is connected to the wire 13 of carrier repeater No. 1 through back contact 15 of relay LT, wire 1L2¹, back contact 18 of relay LTP and back contact 26 of relay CTR. The wire L1 of the CTC transmitters at the control office is connected to the wire 11 of the carrier repeater No. 1 at the repeater station through back contact 14 of relay LT, wire 1L1¹, back contact 22 of relay LTP and back contact 21 of relay CTR.

The carrier repeater No. 1 is connected to the impedance matching transformer 28 by a circuit including wire 12 of carrier repeater No. 1, back contact 29 of relay CTR, back contact 19 of relay LTP, wire 1L2², back contact 20 of relay LTP¹, winding 30 of the impedance matching transformer 28, coupling condenser C1, winding 31 of the impedance matching transformer 28, back contact 24 of relay LTP¹, wire 1L1², back contact 23 of relay LTP¹, and back contact 32 of relay CTR to the wire 13 of the carrier repeater No. 1. The line wires L1³ and L2³ are connected through the windings 25, 31, 30 and 21, respectively, and the condenser C1, all connected in series. The connections of the impedance matching transformer 28 as illustrated assume that the wires 1L1² and 1L2² extending from the repeater a relatively high impedance as compared to the wires 1L1² and 1L2² extending from the repeater station to the impedance matching transformer 28 being assumed to be in a cable having relatively lower impedance. It is to be understood that if no impedance matching is required under these conditions, the impedance matching transformer 28 is not required and the wires L1³ and L2³ are energized directly from the contacts of the relay LTP¹. The condenser C1 is included in the transformer circuit as a blocking condenser for direct current energization of the line wires.

It will be seen from the organization as it has been described up to this point that there are

several possibilities of failure in the integrity of the line circuit between the control office and the CTC territory which can cause failure of the CTC system to operate properly. One of these conditions is in the line wires 1L1¹ and 1L2¹ either of which may become open circuited, or these wires may become short circuited because of damage to the cable. Similarly the wires 1L1² and 1L2² extending from the repeater station to the first section of CTC territory may become open circuited or short circuited to cause failure of proper operation of the CTC system. Because of the carrier repeater No. 1 at the repeater station being dependent upon electronic tubes, a failure of the electronic apparatus can interrupt the service between the control office and the CTC territory, thus making it desirable to be able to transfer to the stand-by carrier repeater apparatus No. 2.

If failure occurs under any one of more of the three above described conditions, the operator at the control office upon becoming aware of the failure, may, by actuation of the line transfer switch LTS on the control panel of the control machine, cause the transfer of the D. C. and A. C. communication line circuits from the normal line wires 1L1¹ and 1L2¹ to the standby line wires 2L1¹ and 2L2¹. In response to the transfer being rendered effective at the repeater station, energy is applied to the standby wires 2L1² and 2L2² so as to complete the transfer to these wires at the location of the beginning of CTC territory. Also a transfer is effective to shift from the carrier repeater station No. 1 to the standby carrier repeater No. 2.

To consider more specifically the manner in which the above described transfer operation is effective, the actuation of the switch LTS at the control office is effective to pick up the relay LT and open the connection of the wires L1 and L2 to the wires 1L1¹ and 1L2¹ at back contacts 14 and 15, respectively. The shifting of contacts 14 and 15 of relay LT, upon the picking up of that relay, connects the wires 2L1¹ and 2L2¹ to the wires L1 and L2, respectively. Because of direct current energy being applied by the D. C.-CTC transmitter at the control office to the wires 2L1¹ and 2L2¹ through the front contacts 14 and 15 of relay LT, the relay LT2 at the repeater station becomes energized by a circuit extending from the wire L1 at the control office, including front contact 14 of relay LT, wire 2L1¹, back contact 33 of relay LTP, winding of relay LT2, back contact 34 of relay LTP, wire 2L2¹ and front contact 15 of relay LT, to the wire L2.

Upon the picking up of relay LT2, the stick relay LTP is picked up by the closure of front contact 35, and the picking up of that relay establishes a stick circuit extending from (+), including back contact 36 of relay LT¹, front contact 37 of relay LTP, and winding of relay LTP, to (-). By this stick circuit, pick up contact 35 is shunted out, and it is provided that the restoration of relay LTP can be accomplished only by the subsequent picking up of the relay LT¹ at a time when an operator at the control office designates the restoration to the former line circuit by the restoration of the switch LTS to its normally open position. The picking up of the relay LTP, by the opening of back contacts 33 and 34 deenergizes the relay LT2 and thus provides that the relay LT2 is disconnected from the line circuit and dropped away immediately subsequent to the picking up of relay LTP.

The closure of front contact 34, of relay LTP

provides that direct current energy is applied from wire 2L2¹ to the wire 2L2² through the choke 17 and front contact 19 of relay LTP. Similarly the wire 2L1¹ is connected to the wire 2L1² through front contact 33 of relay LTP, choke 16, and front contact 23 of relay LTP. It is thus provided that direct current energy is fed from the control battery CB at the control office through the back contacts 38 and 39 of relay LTP¹ to the winding of relay LT2¹ at the location of the beginning of the first section of CTC territory.

The picking up of relay LT2¹ by the closure of front contact 49 causes the picking up of the relay LTP¹ which is maintained picked up by its stick circuit extending from (+), including back contact 41 of relay LT1¹, front contact 42 of relay LTP¹, and winding of relay LTP¹, to (-). The relay LTP¹ when picked up connects the wire 2L1² through front contact 38 to the impedance matching transformer 28, and the closure of front contact 39 of relay LTP¹ connects the wire 2L2² to the impedance matching transformer 28. It is thus provided by the mode of operation as above described that the D. C.-CTC line circuit is shifted to the standby circuits extending from the control office to the repeater station and from the repeater station to the beginning of the first section of CTC territory.

The carrier current line circuit is necessarily similarly shifted in that it involves the use of the same line wires, and in addition, there is an automatic shift from the carrier repeater unit No. 1 to the carrier repeater unit No. 2. This is accomplished by the picking up of the relay CTR at the repeater station in response to the picking up of relay LTP. Relay CTR is picked up by a circuit extending from (+), including the front contact 49 of relay LTP, contact of the carrier transfer switch CTS in its left hand position, and winding of the relay CTR, to (-). The picking up of relay CTR, by the shifting of contacts 26 and 27 opens the connections to the wires 10 and 11 of carrier repeater No. 1 and closes connections to corresponding wires 43 and 44 of carrier repeater No. 2. Similarly the shifting of contact 32 opens the connection of the wire 13 of the carrier repeater No. 1 and closes a connection for the corresponding wire 45 of the carrier repeater No. 2. The shifting of the contact 29 opens the connection of the wire 12 associated with the carrier repeater No. 1 and closes a connection for the corresponding wire 46 associated with the carrier repeater No. 2. Inasmuch as the contacts 23 and 19 have shifted upon the picking up of relay LTP the wires 45 and 46 are connected through these contacts respectively to the wires 2L1² and 2L2². It is therefore provided that the transfer in response to the actuation of the switch LTS at the control office is effective not only for the shifting from one pair of line wires to the other for both the line portion extending between the control office and the repeater station and the line portion extending between the repeater station and the first section of CTC territory, but it is also effective to transfer from one carrier repeater unit to the other.

It will be noted that the local direct current power for operation of the respective carrier repeaters is selected by the relay CTR so as to apply power only to the particular carrier repeater that is used in the carrier line circuit. Thus the closure of back contacts 47 and 48 of relay CTR applies direct current power to the carrier re-

peater unit No. 1, and front contacts 47 and 48 applies direct current power to the carrier repeater unit No. 2.

If for some reason it is desired to reverse the order of the association of the respective carrier repeater units with the normal and standby line wires so as to have the carrier repeater No. 2 normally active when the line wires 1L1¹, 1L2¹, 1L1², and 1L2² are in use, the carrier repeater transfer switch CTS at the repeater station can be actuated to its right hand position to thus select that the relay CTR is picked up in response to the closure of back contact 49 of relay LTP as compared to the picking up of this relay through front contact 49 of relay LTP as has been described.

Assuming that the particular difficulty has been remedied in the line circuits and/or carrier repeater unit that is normally used, transfer can be effected back to these wires which have been described as being used under normal conditions.

In order to accomplish this transfer back to the normal channels of line circuit communication, the operator actuates the line transfer switch LTS back to its normally open position and thus allows the dropping away of the relay LT. By the opening of front contacts 14 and 15, the wires 2L1¹ and 2L2¹ are disconnected from the wires L1 and L2 at the control office, and the closure of back contacts 14 and 15 connects the wires 1L1¹ and 1L2¹ at the control office in a manner which has been described when considering the normal conditions of the system. It is thus provided that direct current energy is applied from the battery CB to the wires 1L1¹ and 1L2¹ at the control office at a time when the relay LTP is picked up at the repeater station, and thus a circuit is closed to energize the relay LT1 extending from the wire L1 at the control office including back contact 14 of relay LT, wire 1L1¹, front contact 22 of relay LTP, winding of relay LT1, front contact 18 of relay LTP, wire 1L2¹, and back contact 15 of relay LT, to wire L2.

Upon the picking up of relay LT1, the opening of back contact 36 in the stick circuit for the relay LTP causes relay LTP to be dropped away, and the dropping away of that relay opens the connection through the repeater station that has been established through front contacts 33 and 34 of relay LTP, and closes circuit connections to the wires 1L1² and 1L2² through back contacts 22, 18, 19 and 23 to establish circuit connections which have been described when considering the normal conditions of the system.

Upon the dropping away of relay LTP, the circuit for relay LT1 is opened at front contacts 22 and 18, and thus that relay is dropped away to close back contact 36 and condition the stick circuit for the relay LTP so that it can be established upon subsequent transfer to the standby line wires.

Assuming the carrier repeater transfer switch CTS to be in the left-hand position as illustrated, the relay transfer relay CTR is dropped away upon the opening of its circuit at front contact 49 of relay LTP, and by the shifting of contacts 32, 27, 26 and 29 of relay CTR, the carrier repeater unit No. 1 is again rendered active and the carrier repeater unit No. 2 inactive. The shifting of contacts 47 and 48 of relay CTR disconnects the local source of power from the carrier repeater unit No. 2 and connects such source to the carrier repeater unit No. 1.

Having established continuity from the control office including wires L1 and L2, through the re-

peater station and the normal line wires 1L1² and 1L2², with the relay LTP¹ picked up, the relay LT1¹ becomes energized through front contacts 20 and 24, and the picking up of that relay by the opening of back contact 41, provides for the dropping away of the relay LTP¹. Upon the dropping away of relay LTP¹, the connections from wires 2L1² and 2L2² to the impedance matching transformer 28 through front contacts 38 and 39 of relay LTP¹ are opened, and the closure of back contacts 20 and 24 connects the wires 1L1² and 1L2² to the impedance matching transformer in a manner which has been more specifically described when considering the normal conditions of the system. The opening of front contacts 24 and 20 disconnects the relay LT1¹ and causes that relay to be dropped away so as to close back contact 41 to condition the stick circuit for the relay LTP¹ so that such stick circuit can be established upon subsequent transfer to the standby wires 2L1² and 2L2². This completes the restoration from the use of the standby line wires and standby carrier repeater unit No. 2 to the normal line wires and carrier repeater unit No. 1 which are considered to be normally used for communication purposes.

Although only a single repeater station has been illustrated in this embodiment of the present invention, it is to be understood that as many repeater stations may be provided as are required in practice, the station illustrated being typical of other stations which can be added. It is believed that it should be readily apparent that the mode of operation where a plurality of repeater stations is involved is comparable to that which has been described in that the standby line circuit is put together in steps from the control office, and restoration to the line wires normally employed is accomplished in a similar manner.

It is also to be understood that if the line circuit is short enough so as not to require a repeater station for the communication of carrier current pulses that the repeater station can be eliminated, and under such conditions the respective normal and standby pairs of line wires are unbroken between the control office and the beginning of the CTC territory. Under such conditions the line transfer relays LT1¹ and LT2¹ will be energized directly from the control office through the respective normal and standby pairs of line wires with which they are associated.

Although this embodiment of the present invention is illustrated as being applied to the use of a combination of direct current and carrier current communication line circuits, it is to be understood that the system of line transfer that is herein disclosed is equally applicable to conditions where only direct current or only carrier current communication line circuits are involved. If only direct current line circuits are involved, no repeater station is required, and the normal and standby pairs of line wires are directly connected from the control office to the location at the beginning of CTC territory. If only carrier current communication line circuits are involved, the line transfer organization is provided as illustrated in the drawing except that a source of direct current is necessarily connected to the wires L1 and L2 at the control office as a means for energization of the line transfer relays LT1¹ and LT2¹. It is to be understood that such direct current energization would not necessarily have to be steady, but could be selected through a suitable transfer push-button or other momentarily actuated means whereby the direct current would

be applied to the line wires only at times when transfer is to be effected.

Having thus described one specific embodiment of the present invention relating to means for transferring a line circuit of a centralized traffic control system from one pair of line wires to the other, it is desired to be understood that this form is selected to facilitate the disclosure of the invention rather than to limit the number of forms which the invention may assume, and it is to be further understood that various adaptations, alterations and modifications may be applied to the specific form shown to meet the requirements of practice without in any manner departing from the spirit or scope of the present invention except as limited by the appending claims.

What we claim is:

1. In a line circuit communication system for applying communication energy to a pair of control wires at a location remote from a control office, a normal and a standby pair of line wires extending from the office to the location, manually operable means at the office for selectively applying energy to either said normal or said standby pair of line wires, normally deenergized transfer and stick relays at said location normally effective to connect said normal pair of line wires to said control wires, circuit means for connecting said transfer relay across said standby pair of line wires whereby said transfer relay is picked up upon the application of energy to said standby pair of line wires at the office by said manually operable means, circuit means for energizing said stick relay in response to the picking up of said transfer relay, and means responsive to the picking up of said stick relay for disconnecting said transfer relay and for transferring the connection of said pair of control wires from said normal pair of line wires to said standby pair of line wires.

2. In a line circuit communication system of the character described for applying energy to a pair of control wires at a location remote from a control office, a normal and a standby pair of line wires extending from the office to the location, manually operable means at the office for selectively applying energy to either said normal or said standby pair of line wires, a normally deenergized line transfer relay at said location associated with each pair of line wires, a normally deenergized transfer stick relay at said location, circuit means for connecting one of said transfer relays to said standby line wires through a back contact of said stick relay, circuit means for connecting the other of said transfer relays to said normal line wires through a front contact of said stick relay, circuit means for energizing said stick relay in response to the picking up of said one transfer relay and for deenergizing said stick relay in response to the picking up of said other transfer relay, and means selected by said stick relay for selectively connecting said control wires to said normal or said standby pair of wires.

3. In a line circuit communication system for maintaining communication between a control office and a pair of communication wires at a remote location, the combination with normal and standby pairs of line wires extending between the control office and the location and means for selectively applying direct current energy at the control office to one pair of line wires or the other, of line transfer means at the location comprising a normally deenergized line

transfer relay for each of the pairs of line wires, a transfer stick relay at said location, circuit means for connecting one of said transfer relays across said standby line wires through a back contact of said stick relay, circuit means for connecting the other of said transfer relays across said normal line wires through a front contact of said stick relay, pick-up circuit means for said transfer stick relay responsive to the picking up of said one transfer relay, and stick circuit means for said transfer stick relay effective to maintain that relay picked up only so long as said other transfer relay is maintained dropped away.

4. In a line circuit communication system of the character described for maintaining communication between a control office and a pair of communication wires at a remote location, normal and standby pairs of line wires extending between said office and said location, a repeater station between said control office and said location at an intermediate point in said line wires, said repeater station having normal and standby repeater units respectively associated with said normal and standby pairs of line wires, line transfer means including a stick relay at the repeater station selectively governed in accordance with the application of direct current to said normal or said standby pairs of line wires at the control office, local energization means at the repeater station for each of said repeater units said means being effective to energize either said normal or said standby repeater unit as selected by said stick relay, and transfer means at said location effective in response to a shift in direct current energization at the office from one pair of line wires to the other to transfer the connection of said pair of communication wires at that location from one of said pairs of line wires to the other.

5. In a line circuit communication system for communication by direct current and alternating current energy simultaneously over the same pair of line wires from a control office to a pair of control wires at a remote location, a repeater station between said control office and said location, said repeater station having normal and standby repeater units, normal and standby pairs of line wires extending between the office and the location through said repeater station, manually operable means at the control office for selectively energizing either said normal or said standby pair of line wires, a transfer stick relay at the repeater station effective to selectively connect said normal or said standby wires through said repeater station, said stick relay also being effective to selectively connect said normal repeater unit or said standby repeater unit in the line circuit,

electro-responsive means at the repeater station normally connected through a back contact of said stick relay to said standby wires, said electro-responsive means being effective to energize said stick relay in response to the energization of said standby wires by said manually operable means, and means at said location responsive to the energization of said standby wires for transferring the connection of said pair of control wires at that location from said normal pair of line wires to said standby pair of line wires.

6. In a line circuit communication system for maintaining alternating current communication between a control office and a pair of communication wires at a remote location, normal and standby pairs of line wires extending between the control office and the location, a repeater station at an intermediate point in said line wires having normal and standby repeater units, manually operable means at the control office for selectively energizing either said normal or said standby pairs of line wires with direct current, means at said repeater station for connecting said normal pair of line wires through said normal repeater unit for alternating current communication, normally deenergized line transfer means at said repeater station responsive to the energization of said standby wires at the control office and effective to connect said standby wires through said standby repeater unit for alternating current communication, means at said repeater station for bypassing said repeater units for direct current communication whereby the direct current applied to said normal or said standby pair of wires at the control office is applied effectively to the corresponding pair of line wires extending between said repeater station and said location, and normally deenergized line transfer means at said location energized in response to the direct current energization of said standby line wires, said line transfer means being effective when deenergized to connect said normal line wires to said pair of communication wires and effective when energized to connect said standby line wires to said pair of communication wires.

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