Jan. 6, 1931. R. H. CLAPP 1,787,511

PATCHING ARRANGEMENT FOR CARRIER TELEGRAPH CIRCUITS

Filed March 3, 1930

INVENTOR
R. H. Clapp

BY

ATTORNEY

Patented Jan. 6, 1931 1,787,511

UNITED STATES PATENT OFFICE

ROBERT H. CLAPP, OF RAMSEY, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

PATCHING ARRANGEMENT FOR CARRIER TELEGRAPH CIRCUITS

Application filed March 3, 1930. Serial No. 432,848.

This invention relates to carrier telegraph circuits, and more particularly to four-wire carrier telegraph circuits in which signals are sent in one direction over one pair of wires and in the opposite direction over another pair of wires.

In such a four-wire arrangement the two-way circuit is dependent upon four wires, of course, as distinguished from the arrangement in which the two-way service is obtained by the use of different frequencies on a single pair of wires, and a subscriber sending on one of the two pairs of the four-wire circuit is not aware of trouble on that pair until he is advised of it from the receiving end. Accordingly, it becomes of particular importance in the case of four-wire operation that the hazard of interruption to the service be reduced.

The principal object of this invention is to provide for the automatic substitution of a one-way transmission path for that which has failed.

In general, the applicant accomplishes this object by providing a spare one-way path and means responsive to a failure of any one of a plurality of paths for substituting the spare path for the failed path by effecting the necessary disconnection and connection at the receiving and sending ends of the circuit.

The various features and advantages of the invention will be understood when the following detailed description of one desirable embodiment thereof is read with reference to the accompanying drawing, which shows in diagrammatic form that embodiment and the circuits affected by the operation thereof.

With reference to the details of the drawing, a station A at the left is shown connected to station B at the right by two four-wire circuits. The circuit shown in the upper part of the drawing comprises a two-wire line L_1 adapated for transmission from A to B, and a second two-wire line L_2 adapted for transmission from B to A. Likewise, the lower four-wire circuit includes line L_1' for transmission from A to B, and line L_2' for transmission from B to A. At each end of each four-wire circuit there are shown telegraph sending apparatus and receiving relays represented by *s* and *r*, respectively.

It is proposed to show and discuss in detail the apparatus and circuits which, in accordance with the invention, serve to patch in a spare line SL, adapted for transmission from B to A, upon the failure of either of the two-wire lines L_2 and L_2'. It will be understood, of course, that provision is made for substitution in the case of a failure of line L_1 or line L_1' by the duplication of the equipment shown in detail.

Since the spare path SL, for instance, will presumably be in use as a substitute for one of the lines L_2 and L_2' only a small part of the time, this spare path can be used during the greater part of the time for service messages or what may be termed order wire business, for instance. Accordingly, this spare line SL is shown normally connected to a service message sender at station B and a service message receiver at station A, this apparatus being indicated schematically.

The apparatus employed primarily for the substitution of the spare line SL for the line L_2 of the upper four-wire circuit, will first be considered. Connected between the armature and the spacing contact (not specifically shown) of each of the receiving relays of the upper circuit at station A, is a slow release relay R. Associated with these slow release relays are relay R_1, which may be termed the switching relay and has as its particular function the switching of the receiver connections from line L_2 to the spare line SL, relay R_2, which may be termed the lock-out relay, relay R_3, which may be termed the lock-up relay, and a relay RR, which functions directly in response to a failure of either line L_2 or line L_2' to disconnect the service message receiver from line SL and aid in the connection thereto of the telegraph receiving relays. In addition, there are provided at station A in particular association with the upper circuit an electro-magnet AR, which may control an alarm, a lamp S, an oscillator O and a jack J. The functions of these elements will be considered in detail hereinafter. It is to be noted that relay R_1

is arranged to operate two armatures controlling the connections to the two wires of line L_2. Likewise, it is to be noted that relay RR has two armatures controlling the connections to line SL, and that this relay has two windings, one associated with the upper four-wire circuit and the other associated with the lower four-wire circuit. It will also be noted that the various elements directly associated with the upper circuit have, with the exception of relay RR, corresponding elements similarly designated but primed, directly associated with the lower four-wire circuit.

If all the receiving relays *r* of the upper circuit at station A remain open long enough in response to a failure of line L_2 to permit the release of the slow release relays R, the armatures and back contacts of these relays R are connected in series to form a path from battery, as indicated, to ground through the back contact and right-hand armature of relay R_2' directly associated with the lower four-wire circuit, the back contact and armature of relay R_3, the left hand winding of relay RR, jack J, the winding of relay R_2 and the windings of relay R_1. Relay R_1, as indicated above, operates to throw its armatures out of contact with the wires of line L_2 and into contact with the leads l_1 and l_2. Relay R_2, by the operation of its right-hand armature, breaks a circuit which includes the switching relay R_1' associated with the lower four-wire circuit and accordingly prevents the substituting operations in connection with the lower circuit. The operation of the left-hand armature of relay R_2 removes ground normally connected through the back contact of the armature from the special oscillator O, and it will be noted that battery is connected to this oscillator and to the winding of relay AR through the armatures and back contacts of the slow release relays R. Through the closed contact of the left-hand armature of relay R_2 ground is connected to a circuit including a battery, the lamp S and the winding of relay R_3. The operation of relay R_3 disconnects the slow release relays R from the relays of the chain now under discussion and applies battery to replace that supplied through the contacts of relays R to hold the switching relay R_1 and the relay RR operated until a disconnection by manual operation of the jack J. It will be understood that it is desirable that relay R_2 should be somewhat sluggish in releasing in order that time may be allowed for the suitable function of relay R_3. Relay RR responds to the release of the slow release relays R to throw its armatures out of connection with the service message receiver and into connection with the leads l_1 and l_2, which form connections to the armatures of relay R_1 and the telegraph receiving relays *r*.

From the discussion given above it will be understood that the failure of the two-wire line L_2 results, if the spare line SL is not in substitute use, in the transfer of the connections of the line SL from the service message apparatus to the receiving relays *r* and the disconnection from said relays of the disabled line L_2. The electromagnet AR is operated to produce an alarm signal of the desired nature and the lamp S is lighted to show that the spare line SL is in use. The operation of the lock-out relay R_2 prevents the operation of relay R_1' and the attempted double use of the spare line SL should the failure of line L_2' follow immediately upon that of line L_2. In addition, relays R_1, R_2, R_3 and RR are locked up and can be released only by the manual operation of the jack J. The alarm control electromagnet AR, it will be noted, is designed to operate as long as all the receiving relays *r* are open. In response to the release of relays R and the removal of ground through the operation of relay R_2, current is sent out from the special oscillator O on the line L_1 to station B. Since this special switching current is transmitted infrequently and only for brief periods, it may be quite unusual in magnitude and frequency. At station B a filter functions to select the special switching current, which is amplified and rectified to operate the relay SR. This relay operation connects battery to a circuit including the windings of relays RR_1, RR_3 and RR', a lamp S_1 and a jack J_1. These elements, with the exception of relay RR', are particularly associated with the upper four-wire circuit and have corresponding elements, similarly designated but primed, in association with the lower four-wire circuit. The relay RR', it will be noted, has, like the relay RR at station A, a winding in connection with each of the four-wire circuits. Relay RR_1 corresponds to relay R_1 at the other station and functions to disconnect the telegraph sending apparatus of the upper circuit at B from the line L_2. Relay RR' disconnects the spare line SL from the service message sender at station B and aids in the connection of this spare line to the telegraph sending apparatus. Relay RR_3 corresponds to relay R_3 at station A and serves to lock up relays RR_1 and RR'. As soon as communication is established over line SL, the slow release relays R are pulled up; thus battery supply is removed from the alarm relay AR and the oscillator O. Since the special switching current is transmitted from A to B only when the lock-out relay R_2 at A is closed and the receiving circuits at A are open, no lock-out relay is necessary in connection with the telegraph sending apparatus at station B— because R_2 cannot be closed if the line SL is already in use.

Thus, in response to a failure of the two-wire channel L_2, we have the substitution of the spare two-wire line SL for line L_2 and the

incidental disconnection from the line SL of the service message apparatus at both station A and station B, together with suitable alarm indications. Furthermore, we have protection against the substitution of line SL for line L_2' while the former is in use as a substitute for line L_2. When the regular line L_2 has been repaired, the normal conditions of the system may be restored by the simple operation of opening the circuits at the jack J of station A and the jack J_1 of station B. This jack operation, which is preferably performed simultaneously at the two stations, removes battery from the windings of the relays and causes the relays to open.

It will be understood that if the line L_2' fails, slow release relays R' associated with the telegraph receiving relays *r* of the lower circuit at station A release and cause the operation of relay RR, R_1', R_2' and R_3'; in addition, the electromagnet AR', the lamp S' and the special oscillator O' are operated. Accordingly, the spare line, unless it is already in use as a substitute for line L_2, is substituted for line L_2', at the service message equipment is disconnected and special switching current is sent over line L_1' to station B to operate relays SR', RR', RR_1' and RR_3' to perform the necessary switching and lock-up operations at that station. If the spare line is already in use, R_2 will be operated already, thus preventing the operation of R_2' and the picking up of the spare line. If no spare line is available, the operation of relay AR' will sound an alarm.

It is to be understood that the spare line SL may be made to serve as substitute for a greater number of one-way channels than the two specificially shown by the simple modification of providing more lock-out relays.

It will be understood further that the four-wire system shown is equipped at stations B and A, respectively, with apparatus associated with the telegraph receiving relays at B and the telegraph sending relays at A to take care of the substitution of a spare line SL' adapted for transmission from A to B upon the failure of line L_1 or L_1'. The apparatus and the circuits involved are identical with those shown and described in detail in connection with the substitution of line SL for L_2 or L_2', and no further detailed description is deemed necessary herein.

While the invention has been disclosed in one specific embodiment which is deemed desirable, it will be understood that it is capable of embodiment in other and different forms within the scope of the appended claims.

What is claimed is:

1. In a carrier telegraph system, a plurality of regular one-way paths, receiving apparatus at one end of each of said paths and sending apparatus at the other end thereof, a spare one-way path, and means responsive to the failure of any one of said regular paths for disconnecting the receiving apparatus and the sending apparatus from the respective ends of the failed regular path and connecting the same to said spare path.

2. In a carrier telegraph system, a plurality of regular one-way paths, receiving apparatus at one end of each of said paths and sending apparatus at the other end thereof, a spare one-way path, service message transmission apparatus normally connected to said spare path, and means responsive to the failure of any one of said regular paths for disconnecting the receiving apparatus and the sending apparatus from the respective ends of the failed regular path, disconnecting said service message transmission apparatus from said spare path and connecting said receiving and sending apparatus to said spare path.

3. In a carrier telegraph system, a plurality of four-wire circuits each including two regular paths adapted for transmission in opposite directions, sending apparatus and receiving apparatus at each end of each of said four-wire circuits in appropriate connection with said paths, a spare path, and means responsive to the failure of any given one of said regular paths for disconnecting the sending and receiving apparatus from said path and connecting the same to said spare path.

4. In a carrier telegraph system, a plurality of four-wire circuits each including two regular paths adapted for transmission in opposite directions, sending apparatus and receiving apparatus at each end of each of said four-wire circuits in appropriate connection with said paths, a spare path, service message transmission apparatus normally connected to said spare path, and means responsive to the failure of any given one of said regular paths for disconnecting the sending apparatus and the receiving apparatus from said regular path, disconnecting said service message transmission apparatus from said spare path and connecting the sending apparatus and the receiving apparatus to said spare path.

5. In a carrier telegraph system, a plurality of four-wire circuits each including two regular paths adapted for transmission in opposite directions, sending apparatus and receiving apparatus at each end of each of said four-wire circuits in appropriate connection with said paths, a spare path, means associated with the receiving apparatus and responsive to the operative failure of the regular path connected therewith for disconnecting said apparatus from said regular path and connecting the same to said spare path, and means at the sending end of said regular path responsive to operations at the receiving end thereof for disconnecting the sending apparatus from said regular path and connecting the same to said spare path.

6. In a carrier telegraph system, a plural-

ity of four-wire circuits each including two regular paths adapted for transmission in opposite directions, sending apparatus and receiving apparatus at each end of each of said four-wire circuits in appropriate connection with said paths, and the following elements associated with each group of regular paths adapted for transmission in a common direction: a spare path, means at the receiving end responsive to the failure of any one of said regular paths for disconnecting the receiving apparatus from said regular path and connecting the same to said spare path, means at the receiving end responsive to said failure for sending special impulses to the sending end, means at the sending end responsive to said impulses for disconnecting the sending apparatus from said regular path and connecting the same to said spare path, and means for preventing the operation of said disconnecting and connecting means to substitute said spare path for more than one of said regular paths at a time.

7. In a carrier telegraph system, a plurality of four-wire circuits each including two regular paths adapted for transmission in opposite directions, sending apparatus and receiving apparatus at each end of each of said four-wire circuits in appropriate connection with said paths, and the following elements associated with each group of regular paths adapted for transmission in a common direction: a spare path, service message transmission apparatus normally connected to said spare path, means at the receiving end responsive to the failure of any one of said regular paths for disconnecting the receiving apparatus from said regular path, disconnecting the service message transmission apparatus at the receiving end from said spare path and connecting the receiving apparatus to said spare path, means at the receiving end responsive to said failure for sending special impulses to the sending end, means at the sending end responsive to said impulses for disconnecting the sending apparatus from said regular path, disconnecting the service message transmission apparatus at the sending end from said spare path and connecting the sending apparatus to said spare path, and means for preventing the operation of said disconnecting and connecting means to substitute said spare path for more than one of said regular paths at a time.

In testimony whereof, I have signed my name to this specification this 28th day of February, 1930.

ROBERT H. CLAPP.