

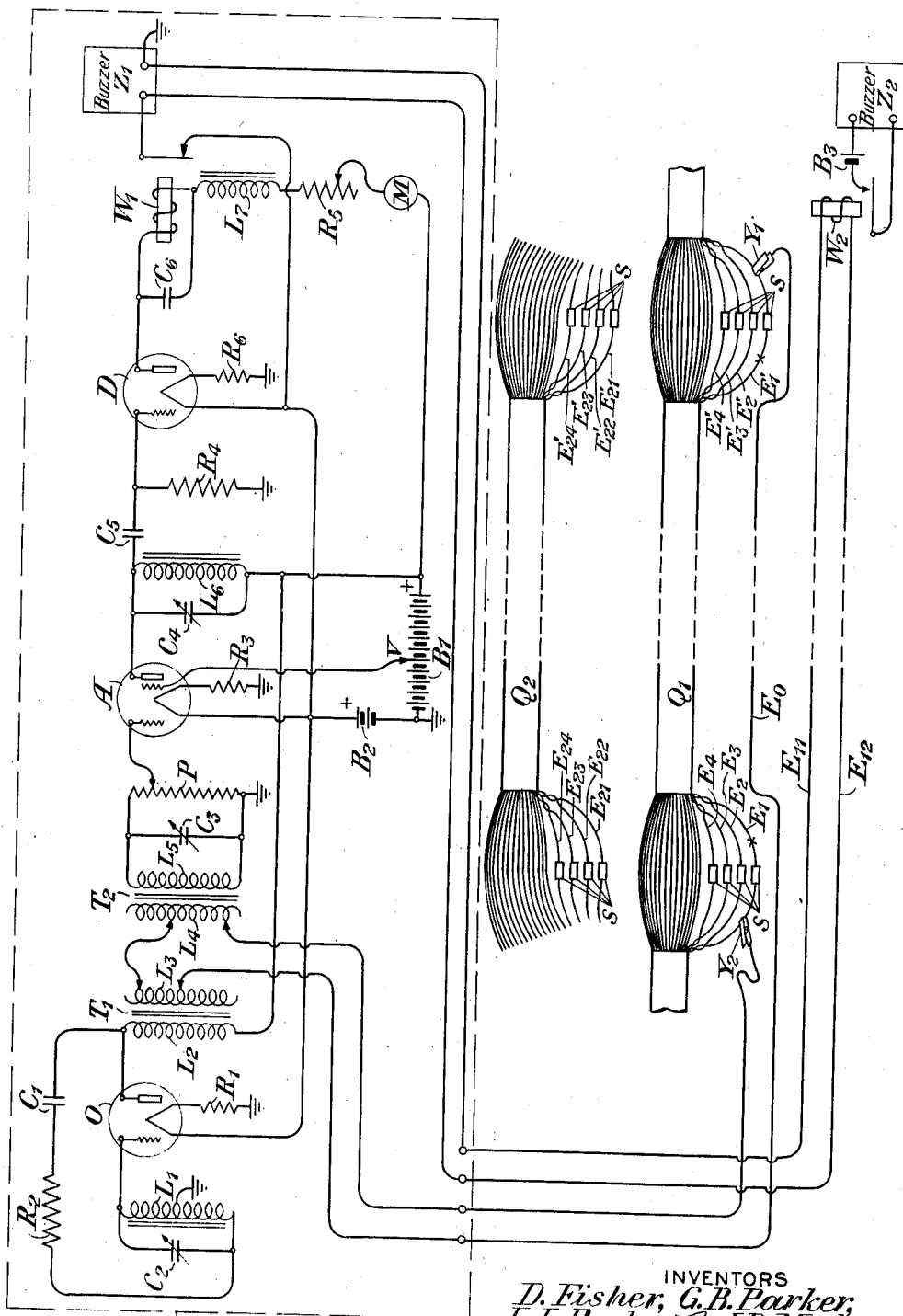
Aug. 20, 1940.

D. FISHER ET AL

2,212,290

APPARATUS FOR TRANSFERRING CABLE CIRCUITS

Filed Oct. 25, 1939



INVENTORS
*D. Fisher, G.B. Parker,
 L.L. Parker and J.P. Meehan*
 BY *William F. Simons*
 ATTORNEY

UNITED STATES PATENT OFFICE

2,212,290

APPARATUS FOR TRANSFERRING CABLE
CIRCUITS

Donald Fisher, Elizabeth, George Blaine Parker,
East Orange, Lloyd L. Parker, Ridgewood, and
John Phillip Meehan, Harrington Park, N. J.,
assigners to American Telephone and Tele-
graph Company, a corporation of New York

Application October 25, 1939, Serial No. 301,284

7 Claims. (Cl. 175—183)

This invention relates to electrical circuits and systems. This invention also relates to testing circuits and systems as well as to arrangements for identifying the various conductors of a cable.

More particularly, this invention relates to methods and means for transferring the circuits of one cable to those of another cable without interfering with transmission over the various circuits.

In cable systems it is frequently important to identify many of the conductors of a cable at two or more points along the cable without interfering with transmission over those conductors being identified or over any other conductors of the cable. In order to accomplish this, it has been heretofore proposed that a high frequency signal be applied to each conductor to be identified at one point along the cable and that at one or more identifying points along the cable the signal be picked up by a probing device placed in proximity to the conductor carrying the signal. A signal particularly suitable for this purpose, especially in cables carrying currents of a broad range of frequencies, including high frequencies, may be a current of a frequency higher than that used for transmission over any of the conductors of the cable.

It is often necessary, in practice, to substitute a new cable or a section of a new cable for an old cable or a section of old cable. As a first step in this process, the individual conductors of the old and new cables are properly identified and then a selected conductor of the old cable is bridged across the replacing conductor in the new cable at two transfer points along the cable. Then the splicers at the two transfer points check the connections with each other over a telephone circuit established between them and they then cut the conductor in the old cable at the two points. Thus the circuit through the new cable is established.

Experience has proven, however, that this transfer operation was frequently made erroneously, especially because of misunderstandings between the workmen in their telephone instructions to each other. Any error of this kind necessarily interrupts service over some of the circuits extending through the cable. The interruption of service frequently lays up the various circuits for some considerable time and this is therefore highly undesirable and at the same time costly.

One of the objects of this invention is therefore to provide arrangements for the transference of the circuits from the conductors of one cable

to the conductors of another cable without error, and hence without any interruption whatever of service through the cable.

Another of the objects of this invention is to insure that each circuit provided through a conductor of the new cable is complete over a temporary path before the corresponding conductor of the old cable is severed. It is also important to see that the circuit provided through the conductor of the new cable is complete over the new path before the temporary path is removed.

Briefly, it is an object of this invention to replace one section of cable by another section of cable, maintaining the continuity of each circuit through the cable throughout the process of replacement and establishing the accuracy of each replacement by signals which are readable at both ends of the cable section.

This invention and its further objects and features will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing showing one embodiment of the invention merely for the purpose of illustration.

Referring to the drawing, the reference character O designates a vacuum tube which may form part of an oscillation generator. The grid circuit of the tube O includes the upper portion of a coil L₁ as well as a resistor R₁, the midpoint of the coil L₁ being grounded. The output circuit of the tube O includes a coil L₂ which may be the primary winding of a transformer T₁, a battery B₁, one terminal of which is grounded and the resistor R₁. Some of the current flowing in the output circuit of the tube O is electromagnetically fed back to the input circuit through a path including a condenser C₁, a resistor R₂, the lower portion of the coil L₁ and ground. The two portions of coil L₁ which are divided by the point at which the coil is grounded are, of course, coupled electromagnetically to each other and hence produce an effect in the input circuit of the tube O for the purpose of generating oscillations, as is well understood in the art. The coil L₁ is shunted by a condenser C₂ which may be variable, as illustrated, for the purpose of controlling the frequency of the oscillations generated by the oscillation generator. The oscillation generator just described may be of any other type well known in the art but is preferably one which is capable of generating a low frequency current as, for example, a current of 85 cycles.

The coil L₃ is the secondary winding of the transformer T₁. This coil is connected near its upper terminal to the primary winding L₄ of

another transformer T₂. The lower terminal of coil L₃ may be adjustably connected to a conductor E₀ which may be one of the conductors of a cable Q₁ extending between two points which are widely spaced from each other. At the distant end of the cable, a clip Y₁ may be used to establish a connection between the conductor E₀ and one of the other conductors such as E'₁ of the cable Q₁. This same conductor of the cable which is designated E₁ at the near end, may be connected by means of a circuit including a clip Y₂ to any desired point along the coil L₄ of transformer T₂. The adjustability of the connections to coils L₃ and L₄ are useful in initially setting up the circuit, but they need not be adjustable in practice.

The secondary winding L₅ of the transformer T₂ is bridged by a condenser C₃ which may also be adjustable, as illustrated, so as to tune the circuit to the particular current generated by the circuits attached to the tube O. The tuned circuit just referred to is also bridged by a potentiometer P which is used as a gain-control device for controlling the level of the current transmitted to an amplifier tube designated A. The control grid of the amplifier tube A is connected to the adjustable terminal of the potentiometer P. The screen grid of the tube A is supplied with a suitable potential obtained at point V along the battery B₁. The output circuit of the tube A includes a coil L₆, battery B₁ and resistor R₃. The output circuit of the tube A may also be tuned by means of a condenser such as that designated C₄ which may be adjustable if so desired.

The current amplified by the amplifier tube A may be fed through a condenser C₅ to the grid of a detector tube D. The detector tube D may be of any well-known type but is preferably a gas-filled tube of the Thyratron type. One form of such a tube is sold under the trade name of Raytheon RK-62. Such a tube will yield a larger plate current change for a given change in grid voltage than is available with the usual vacuum tube. The detector D is operated as a grid leak detector, the leak resistor R₄ being connected between the grid of the tube D and ground. The condenser C₅ blocks the flow of direct current from the battery B₁ to the grid of tube D.

The detected current will flow through the output circuit of the tube D, this circuit including the winding of a relay W₁, a coil L₇, a variable resistor R₅, a meter M, the battery B₁ and resistor R₆. The resistor R₅ may be adjusted so that when none of the current of the oscillation generator O is supplied to the detector tube D, a substantial current will flow through the plate circuit of the tube D and hence operate the relay W₁. When the locally generated current is impressed upon the grid circuit of the detector tube D, however, a high negative bias will be built up on the grid of the detector tube D which will thereupon reduce the current through the winding of relay W₁ of the output circuit of the tube D. Under such circumstances, the reduced current will be so small as to release the armature of the relay W₁.

A condenser C₆ is bridged across the winding of relay W₁. The latter condenser is also part of a filter circuit which includes the winding L₇. The capacitance and inductance of the filter circuit are such that they will act to prevent the transmission of current within a certain range of frequencies which might otherwise traverse the

selective circuits already described. The filter circuit may, for example, be employed to suppress currents corresponding to telegraph signals of large amplitude transmitted through the cable circuits and thereby prevent the operation of relay W₁ in response to such currents.

The relay W₁ may be used to control the operation of a buzzer Z₁ as well as of a relay W₂ which is located at the distant end of the cable section. The winding of relay W₂ may be connected, for example, in parallel with the buzzer Z₁. When the relay W₁ is released as, for example, when the oscillation generator O supplies current which is amplified by the amplifier A, the buzzer Z₁ will be operated, the circuit of the buzzer Z₁ including the armature and back contact of relay W₁, battery B₂ and ground. At the same time, the winding of relay W₂ which is connected in parallel with the buzzer Z₁ by means of conductors E₁₁ and E₁₂ will also be operated. The conductors E₁₁ and E₁₂ may be, and usually would be, a spare pair within the cable Q₁. The operation of the relay W₂, in turn, will cause the operation of the buzzer Z₂ which is also located at the distant end of the cable station. The circuit of buzzer Z₂ will include a battery B₃ and the armature and front contact of the relay W₂.

The current generated by the oscillator O is supplied through coils L₃ and L₄ of transformers T₁ and T₂ to two conductors, either or both of which may be within the cable Q₁ (or cable Q₂). One of these conductors may be the conductor E₀ and the other of the conductors may be that one to which the clips Y₁ and Y₂ are connected. If the circuit over the two conductors of cable just referred to is completed, then the current generated by the oscillator O will be fed to the amplifier tube A. Otherwise, the current generated by oscillator O will fail to reach the amplifier tube A. If the generated current reaches tube A and is amplified thereby, it will be detected by tube D and then cause the relay W₁ to release. The release of relay W₁ will thereafter cause the simultaneous operation of the buzzers Z₁ and Z₂ as already pointed out hereinabove. If, however, the circuit which includes the conductor E₀ and that conductor to which the clips Y₁ and Y₂ are both connected is incomplete, or if the circuit formed by the two conductors has a very substantial impedance—an impedance which is greater than a predetermined value—the current, if any, amplified by the amplifier and detected by the tube D will be insufficient to release the relay W₁. In that event, the relay W₁ will remain operated and its armature will be separated from its back contact. This will prevent the two buzzers Z₁ and Z₂ from operating.

Thus, one of the features of this invention consists in the provision of a circuit coupling the oscillator O with the amplifier-detector which is of low impedance and this low impedance coupling circuit must be completed before the amplifier-detector will operate. The completion of the coupling circuit is established through two of the conductors, either or both of which may form part of the cable circuit as already explained.

Let us assume that the cable section Q₁ is the old cable section which is to be replaced by a newer cable section Q₂. The various conductors E₁, E₂, E₃, E₄, etc., of the cable Q₁ may be identified and marked by tabs S with apparatus of the type shown and described in a copending application of George B. Parker et al., Serial No. 75

265,574, filed April 1, 1939, entitled "Systems and methods for identification of conductors * * *." The conductors E_1, E_2, E_3, E_4 are designated at the distant end of the cable by the reference characters

$E'_1, E'_2, E'_3, \text{ and } E'_4, \text{ etc.}$

at which point they will also be marked or tabbed. Similarly, the conductors $E_{21}, E_{22}, E_{23}, E_{24}, \text{ etc.}$, of the new section of cable Q_2 may be similarly identified and marked at the distant point at which these conductors are designated

$E_{21}, E_{22}, E_{23}, E_{24}, \text{ etc.}$

in the drawing.

After the conductors of the two cable sections are properly identified, the clips Y_1 and Y_2 are then connected to opposite terminals of any one of the various conductors, such as

$E_1 - E'_1$

of the old cable such as Q_1 . This will complete the coupling circuit extending to the windings L_3 and L_4 of the transformers T_1 and T_2 . If this circuit is completed, both buzzers Z_1 and Z_2 will be sounded. The splicers may then simultaneously cut the conductor

$E_1 - E'_1$

of the old cable at the two terminals as, for example, at the points X adjacent the tabs S . When the conductor

$E_1 - E'_1$

is cut, the coupling circuit including coils L_3 and L_4 will be opened and the relay W_1 will then be operated. This, in turn, will remove the battery B_2 from the buzzer Z_1 as well as from the winding of relay W_2 . Hence both buzzers Z_1 and Z_2 will release.

The conductor

$E_{21} - E'_{21}$

of the new cable may then be connected at points X in place of the conductor

$E_1 - E'_1$

This will again close the coupling circuit including coils L_3 and L_4 and the buzzers Z_1 and Z_2 will again operate. When proper buzzer signals have indicated to the workmen that the transfer operations are correct and complete, the clips Y_1 and Y_2 will then be removed and the buzzers will cease to operate. This same process will be repeated for each conductor to be transferred.

The use of the arrangement above described provides a continuity of operation and by means of the buzzers assures the splicers that no errors have been made in picking up previously identified conductors and connecting them into service. The arrangement provides the splicers with automatic supervision over the transfer operations, the signals indicating the status of the various steps in the operation.

The transformer T_1 may be arranged so that the impedance ratio may be, for example, about forty or fifty thousand to one. The transformer T_2 will, however, be reversed so that the impedance ratio is, for example, one to about a thousand or fifteen hundred. These impedance ratios are, of course, given merely for the purpose of illustration and are utilized to provide a very low impedance coupling circuit.

It has been pointed out hereinabove that the frequency of the current generated by the circuits connected to the tube O may be, for example, 85 cycles. This frequency has been suc-

cessfully used in certain installations of the apparatus of this invention. Of course, any other frequency may be used with the apparatus. The 85-cycle current, however, lies predominantly above the telegraph frequencies ordinarily assigned to cable circuits and below the ordinary voice frequencies. The level of the generated currents must be low enough so as not to introduce interference into the telegraph or telephone circuits.

The low impedance in the circuit coupling the oscillator O with the amplifier A prevents false operation of the transfer set. In the event that the connections through clips Y_1 and Y_2 are erroneously established to points other than those of the very same conductor, the buzzers will fail to operate. This latter provision insures a positive check on the identification of the various conductors of a cable.

An arrangement set up in accordance with this invention may have an impedance between the clips Y_1 and Y_2 of, for example, 5 ohms or less, to all telephone or telegraph currents. This impedance may be measured at the lower terminals of coils L_3 and L_4 . The small unbalance to working circuits completed through clips Y_1 and Y_2 will be insufficient to appreciably interfere with transmission over these working circuits.

While the arrangement described hereinabove may be used to transfer the circuits extending through the conductors of one cable to those extending through the conductors of another cable, the same arrangement and process may be used to transfer the circuits from certain of the conductors within a cable sheath to other conductors within the same cable sheath.

While this invention has been shown and described in certain particular arrangements merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. Apparatus for transferring the circuits of the conductors of one cable to those of another cable without interfering with service over any of said circuits, comprising a source of alternating current, a detector, and means for coupling said source with said detector, said coupling means including a low impedance circuit to which the various cable conductors are connected one at a time, the alternating current emanated from said source flowing over the particular conductor connected into the coupling means.

2. Apparatus for substituting the conductors of one cable section for the conductors of another cable section without interfering with transmission of signals over the circuits of said conductors, comprising an oscillator, a detector, means for coupling the oscillator with the detector, said coupling means including a circuit of low impedance, said circuit including the various cable conductors connected thereto one at a time, and signal devices located at the two terminals of said cable sections, said signal devices being connected to said detector.

3. Apparatus for substituting the conductors of one cable section for those of another cable section without interruption of service over any of the circuits connected to said conductors, comprising a source of alternating current, a detector located together with said source at one terminal of the cable section, means for coupling said

source with said detector, said coupling means comprising a circuit which includes the various conductors of the cable section connected thereto one at a time, and signaling devices located at the two terminals of the cable section, said devices being responsive to the detected currents.

4. Apparatus for substituting the conductors of one group for those of another group without any interruption of service over any of the circuits connected to said conductors, comprising an oscillator, an amplifier, a circuit for coupling the amplifier to the oscillator, a detector for rectifying the amplified current, said coupling circuit including low impedance windings, said low impedance windings being connected in a series circuit including one of the cable conductors.

5. Apparatus for transferring the circuits of the conductors of one cable section to those of another cable section without interfering with the service over said circuits, comprising a signal device located at one of the terminals of the cable section, the apparatus at the other terminal of the cable section including an oscillator, an amplifier, a detector coupled to the amplifier, a low impedance circuit coupling the oscillator to the amplifier, said low impedance circuit including a conductor within the cable section which extends between the two terminals thereof, and a signal device controlled by the detector, both signal devices responding simultaneously to the opening or closing of the low impedance coupling circuit.

6. Apparatus for transferring the circuits of the conductors of one cable section to those of another cable section without interfering with the transmission of signals over said circuits,

comprising an oscillator, a detector including a selective circuit which transmits only currents emanating from said oscillator, the frequency of the current generated by the oscillator being so chosen as not to conflict with those frequencies transmitted over the circuits of the cable conductors, a low impedance circuit for coupling the oscillator with the detector, said low impedance circuit including one of the cable conductors connected thereto as a series element, two signal devices located at the two terminals of the cable section, both signal devices being coupled to the detector, and a filter circuit interposed between the detector and the signal devices for preventing the operation of the signal devices by currents which may traverse the selective circuit of the detector but do not emanate from the oscillator.

7. Apparatus for progressively transferring the various circuits of the conductors of one cable section to those of another cable section without interfering with the transmission of signals over the various circuits, comprising an oscillator, a detector, a low impedance circuit coupling the oscillator with the detector, said coupling circuit including the various conductors of the cable section which are progressively connected in series therewith, and signal devices responsive to the detected current, said signal devices being located at the two terminals of the cable section and responding to each opening and closing of said coupling circuit.

DONALD FISHER.
GEORGE BLAINE PARKER.
LLOYD L. PARKER.
JOHN PHILLIP MEEHAN.