May 12, 1942. E. M. STAPLES 2,282,434

SPEECH TRANSMISSION SYSTEM

Filed Feb. 25, 1941 2 Sheets-Sheet 1

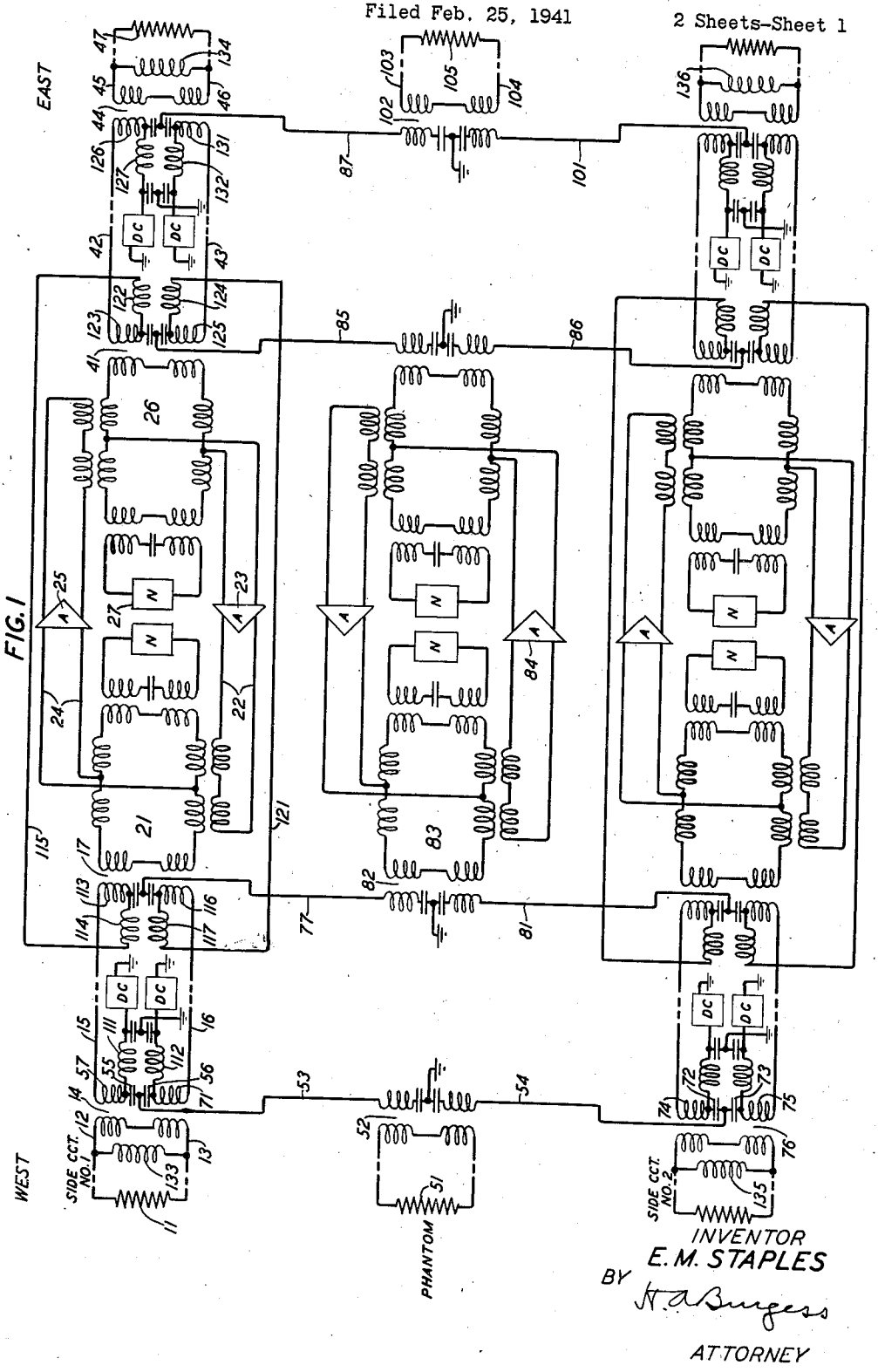

FIG. 1

INVENTOR
E. M. STAPLES
BY H. A. Burgess
ATTORNEY

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SPEECH TRANSMISSION SYSTEM

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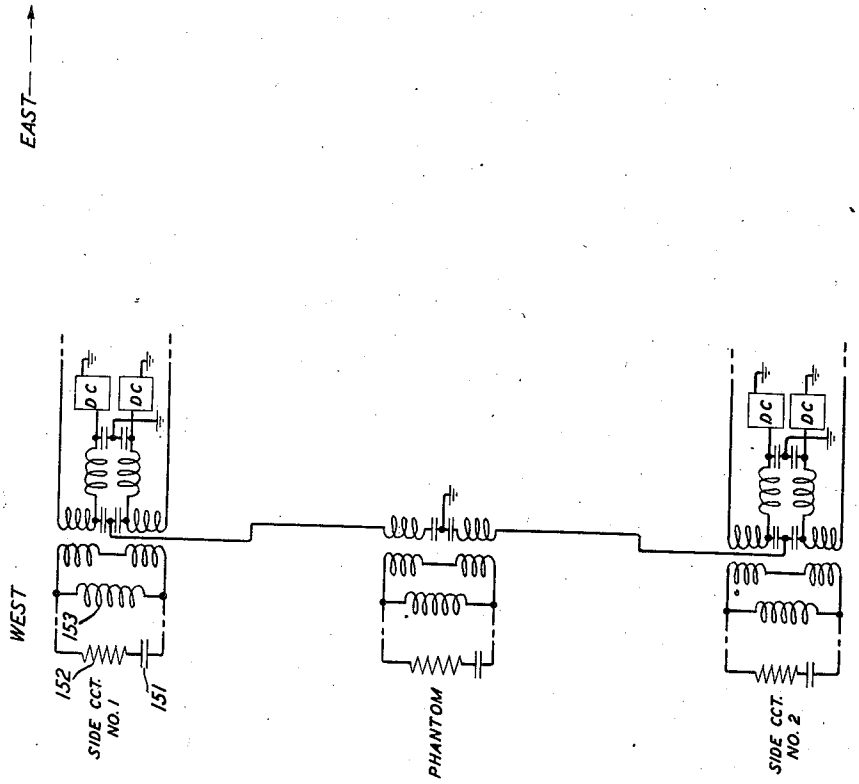

FIG. 2

INVENTOR
E. M. STAPLES
BY H. A. Burgess
ATTORNEY

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SPEECH TRANSMISSION SYSTEM

Elliot M. Staples, Hohokus, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application February 25, 1941, Serial No. 380,426

4 Claims. (Cl. 179—3)

This invention relates to a speech transmission system of the type which includes telephone repeaters spaced at intervals along the transmission line and more particularly to such a system adapted to transmit, in addition to the speech currents, direct current signaling currents.

An object of the invention is to increase the efficiency of speech transmission systems.

A more specific object of the invention is to prevent pulse distortion due to so-called "cross-fire" resulting from application of direct current signaling currents to the speech transmission lines. (Cross-fire is a term commonly used by communication engineers as referring to disturbing currents that are set up due to mutual admittance in one circuit when direct current signals are passed through a paralleling circuit.)

A copending application in the names of P. G. Edwards and E. R. Taylor, Serial No. 380,446, filed Feb. 25, 1941, entitled Speech transmission system, discloses, among other things, a novel way of applying direct current signaling currents to a speech transmission system. Briefly stated here, but described in detail in the copending application referred to, the telegraph (direct current) signaling currents are applied to the speech transmission lines in shunt with capacitances located between the line windings of the line repeating coil whereby the direct current composite sets are shunted by a low impedance at voice frequencies. The arrangement contemplated by the present invention is particularly applicable to the above arrangement as fully disclosed by the copending application referred to.

A feature of the present invention comprises means effective to materially reduce the coupling at low frequencies between the two sections of the secondary winding of the line repeating coil without materially reducing the efficiency of the coil at speech frequencies.

In accordance with a specific embodiment of the invention the drop side of the line repeating coil is shunted by an inductance. This in effect reduces the efficiency of the repeating coil at low frequencies and materially reduces low frequency cross-fire resulting from passage of direct current telegraph currents through either section of the line repeating coil secondary. The provision of the inductance results in no material reduction in the efficiency of the coil at voice frequencies, however.

A complete understanding of the novel arrangements contemplated by the present invention as well as appreciation of the various desirable features thereof will be gained by consideration of the following detailed description in connection with the annexed drawings in which:

Fig. 1 illustrates schematically a speech transmission system which embodies features of the present invention; and

Figure 2 illustrates schematically a modified form of terminal for use with the system of Fig. 1.

Referring now to Fig. 1, there is illustrated schematically a speech transmission system of the general type disclosed in the copending application of P. G. Edwards and E. R. Taylor referred to above. As illustrated, the system comprises a west terminal, an intermediate repeater section and an east terminal. It will be understood, however, that the system may, and in most cases will, include more than one intermediate repeater section between the terminals.

Speech currents produced by the voice frequency apparatus associated with the west terminal of side circuit No. 1, which apparatus would actually be a telephone set but is here represented by its nominal resistance, taken as 600 ohms, pass over lines 12 and 13 to repeating coil 14 and pass therethrough to lines 15 and 16 for transmission to the intermediate repeater section.

Upon reaching the intermediate repeater section the voice frequency currents pass through repeating coil 17 to line section 21. The voice frequency currents divide in line section 21, one half passing by induction into output path 22 of east-west amplifier 23 and being lost and the useful half passing into input path 24 of west-east amplifier 25. After amplification by west-east amplifier 25, the currents pass by induction into line section 26 where they again divide, one half being absorbed by balancing network 27 and the useful half passing through repeating coil 41 to lines 42 and 43 for transmission to the east terminal.

Upon reaching the east terminal, the voice frequency currents pass through repeating coil 44 to lines 45 and 46 over which they pass to the receiving equipment of the voice frequency apparatus associated with the east terminal of side circuit No. 1, which apparatus is represented by resistance 47 which may be of the order of 600 ohms.

It will be understood that transmission of voice frequency currents over side circuit No. 1 from east to west and over side circuit No. 2 in

both directions is accomplished in a manner similar to that described above.

Voice frequency currents produced by the voice frequency apparatus associated with the west phantom terminal, which apparatus is represented by resistance 51 which may be of the order of 600 ohms, pass through repeating coil 52 to a phantom circuit derived over lines 53 and 54. Line 53 terminates in side circuit No. 1 between capacitances 55 and 56 which are connected, in turn, between line windings 57 and 71 of repeating coil 14 while line 54 terminates in side circuit in No. 2 between capacitances 72 and 73 which are connected, in turn, between line windings 74 and 75 of repeating coil 76.

At the intermediate repeater section, the phantom voice frequency currents are picked off over lines 77 and 81 and applied through repeating coil 82 to line section 83. After amplification by phantom west-east amplifier 84 (in a manner similar to that described above) the phantom speech currents are reapplied to the phantom circuit, over lines 85 and 86, for transmission to the east terminal.

Upon reaching the east terminal the phantom voice frequency currents are picked off over lines 87 and 101 and applied through repeating coil 102 to lines 103 and 104 for transmission to the receiving equipment of the east terminal phantom voice frequency apparatus, which apparatus is represented by resistance 105 which may be of the order of 600 ohms.

It will be understood that transmission of voice frequency currents over the phantom circuit from east to west is accomplished in a manner similar to that described above.

Direct current signals, for example telegraph signals, produced by composite sets provided at the west terminal are applied to line 15 at the west terminal through composite set retardation coil 111 and line winding 57 of repeating coil 14 in series and are applied to line 16 through composite set retardation coil 112 and line winding 71 of repeating coil 14 in series.

Upon reaching the intermediate repeater section, the direct current signals present on line 15 pass through line winding 113 of repeating coil 17 and retardation coil 114 to line 115 and those present on line 16 pass through line winding 116 of repeating coil 17 and retardation coil 117 to line 121, lines 115 and 121 comprising a by-path over which the direct current signals are by-passed around the intermediate repeater section.

After by-passing the intermediate repeater section, the direct current signals are applied to line 42 through retardation coil 122 and line winding 123 of repeating coil 41 and are applied to line 43 through retardation coil 124 and line winding 125 of repeating coil 41, the direct current signals now being transmitted over lines 42 and 43 to the east terminal.

Upon reaching the east terminal, the direct current signals pass respectively through line winding 126 of repeating coil 44 and composite set retardation coil 127 and through line winding 131 of repeating coil 44 and composite set retardation coil 132 to the direct current receiving equipment of the composite sets associated with the east terminal.

It will be understood that transmission of direct current signals over side circuit No. 1 from east to west and over side circuit No. 2 in both directions is accomplished in a manner similar to that described above.

It has been observed that, in the absence of the corrective means which is the subject of the present invention, signal distortion due to so-called cross-fire has resulted from passage of the direct current signals through the line windings of the repeating coils. To illustrate, let us refer to the west terminal of side circuit No. 1 and assume, for the moment, the absence of the corrective means of the present invention. It has been observed that, when direct current signals are passed through line winding 57 from the composite set associated with line 15 through line winding 57 and retardation coil 111, direct current signals passing from, or to, the composite set associated with line 16 through line winding 71 and retardation coil 112 are distorted. This distortion is due to transient currents which are set up by induction in line winding 71 due to the passage of the direct current signals through line winding 57.

The corrective means which is provided in accordance with the present invention is effective in eliminating the distortion referred to. In accordance with this novel arrangement, inductance 133 is connected in shunt to the primary windings of repeating coil 14. This inductance offers a relatively low impedance to currents of low frequency and to direct current and, when connected as shown, results in a marked reduction of the coupling between windings 57 and 71 at low frequencies, or stated differently, the transformer efficiency at low frequencies is lowered substantially. As the net result of this reduced coupling the currents set up in line winding 71 by induction when direct current signals are passed through line winding 57 are of such a small value that their distorting effect on the signals passing from or to the composite set associated with line 16 is negligible.

It should be remembered that, while inductance 133 presents a low impedance to currents in the lower frequency range, the impedance offered to voice frequency currents is high from which it follows that provision of the corrective means has no appreciable effect on the efficiency of repeating coil 14 so far as the voice frequency currents are concerned.

It will be understood that inductance 133 also acts in the manner described to prevent the establishment of disturbing currents in line winding 57 when direct currents are passed through line winding 71 and it will be understood, further, that inductance 134 provided at the east terminal of side circuit No. 1, inductance 135 provided at the west terminal of side circuit No. 2 and inductance 136 provided at the east terminal of side circuit No. 2 all are effective in a manner similar to that described above in preventing signal distortion at the respective terminals with which they are associated.

Referring now to Fig. 2, there is illustrated the west terminal of a speech transmission system of the general type illustrated in Fig. 1. The general arrangement of the terminal is the same as that of the terminals of Fig. 1 and the arrangement and function of parts common to both figures will not be again described. In the instance of the terminal of Fig. 2, however, capacitance 151 has been provided, being connected in series with terminating resistance 152. Provision of this capacitance at the terminal may be desirable, for example to modify voice frequency characteristics, or to block direct current signals from a certain path. In event of provision of the capacitance, the value of inductance

153 should be slightly less than that of inductance 133 of Fig. 1 as the capacitance reduces the shunting effect at low frequencies of the terminating resistance.

The capacitances provided in the phantom terminal and in the terminal of side circuit No. 2 are similar to and act in a manner similar to that provided in the terminal of side circuit No. 1.

While specific embodiments of the invention have been selected for illustration and detailed description, the invention is not, of course, limited in its application to such embodiments. The embodiments specifically disclosed should be looked upon as illustrative of the invention and not as restrictive thereof.

What is claimed is:

1. In a speech transmission system, a terminal section, a two-wire line, a repeating coil for inductively coupling said terminal section and said line, said repeating coil including a primary winding section and a secondary winding section, a composite set for transmission of direct current signals, the secondary winding section of said repeating coil including two inductive portions of high impedance to voice frequencies and a portion of low impedance to voice frequencies but of high impedance to direct currents, means for connecting said composite set across said latter portion, and a path connected in shunt to the primary winding section of said repeating coil, said path being of low impedance with respect to low frequency currents, including direct currents, but of high impedance with respect to voice frequency currents.

2. In a speech transmission system, a terminal section, a two-wire line, a repeating coil for inductively coupling said terminal section and said line, said repeating coil including a primary winding section and a secondary winding section, a composite set for transmission of direct current signals, the secondary winding section of said repeating coil including two inductive portions of high impedance to voice frequencies and a portion of low impedance to voice frequencies but of high impedance to direct currents, means for connecting said composite set across said latter portion, and an inductance connected in shunt to the primary winding section of said repeating coil, said inductance presenting low impedance to low frequency currents or direct current signals but high impedance to voice frequency currents.

3. In a speech transmission system, a terminal section, an intermediate repeater section, a two-wire line for connecting said terminal section and said intermediate repeater section, means for inductively coupling said terminal section to the terminal end of said two-wire line, said coupling means including a first winding connected in shunt to said terminal section and conductive means connected in shunt to the terminal end of said two-wire line, said conductive means including a second winding, a capacitance and a third winding connected in series in the order named, said first winding and said conductive means being inductively coupled, said second and said third windings also being inductively coupled, a composite set for transmission of direct current signals, means for connecting said composite set across said capacitance, and means effective to materially reduce the coupling between said second winding and said third winding with respect to low frequency currents or direct currents, said last-mentioned means having substantially no effect on the coupling between said first and said second windings with respect to voice frequency currents.

4. In a speech transmission system, a terminal section, an intermediate repeater section, a two-wire line for connecting said terminal section and said intermediate repeater section, means for inductively coupling said terminal section to the terminal end of said two-wire line, said coupling means including a first winding connected in shunt to said terminal section and conductive means connected in shunt to the terminal end of said two-wire line, said conductive means including a second winding, a capacitance and a third winding connected in series in the order named, said first winding and said conductive means being inductively coupled, said second and said third windings also being inductively coupled, a composite set for transmission of direct current signals, means for connecting said composite set across said capacitance, and means effective to materially reduce the coupling between said second and said third windings with respect to low frequency currents or direct currents, said last-mentioned means comprising an inductance connected in shunt to said first winding and having substantially no effect on the coupling between said second and said third windings with currents.

ELLIOT M. STAPLES.