Oct. 26, 1943. W. W. FRITSCHI 2,332,907

SIGNALING SYSTEM

Filed April 23, 1942

FIG. 1

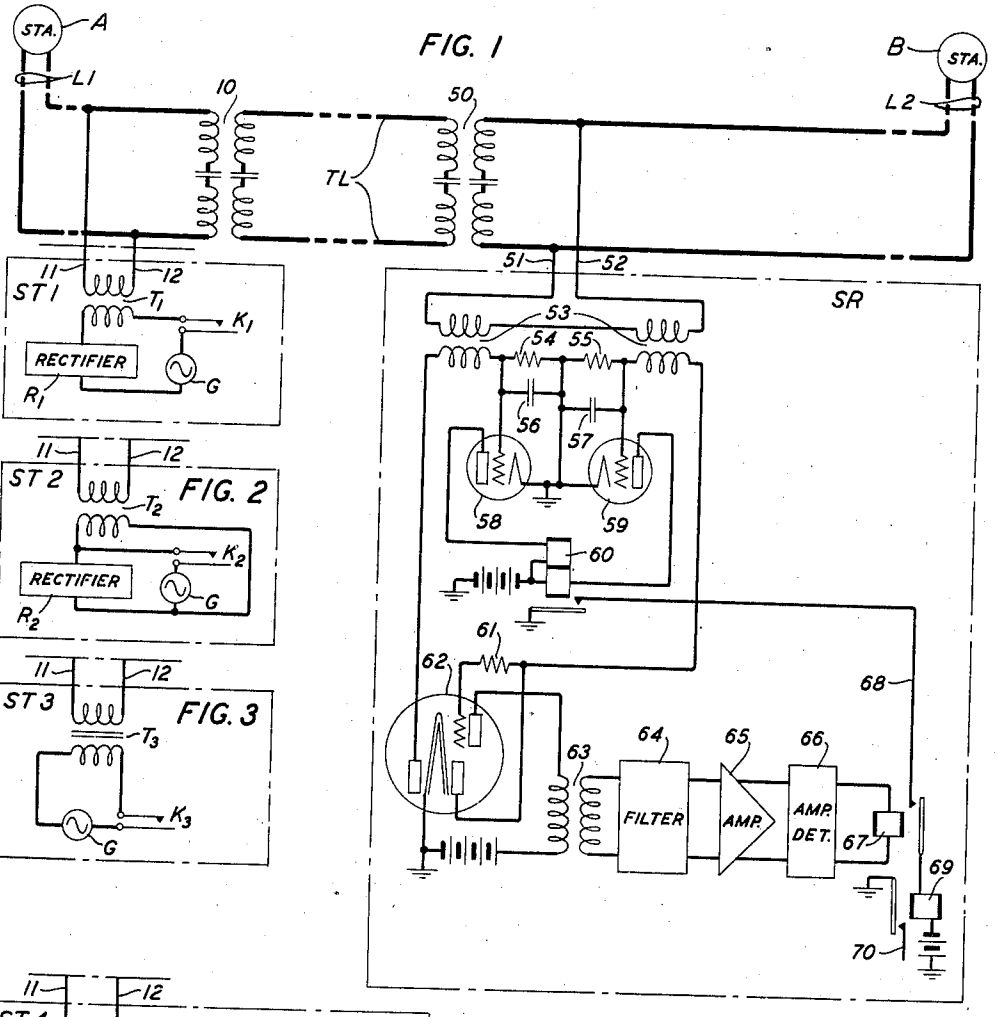
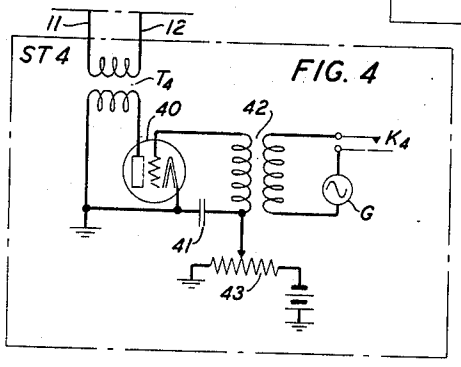


FIG. 2

FIG. 3

FIG. 4



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SIGNALING SYSTEM

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9 Claims. (Cl. 179—4)

This invention relates to signaling systems and particularly to systems in which alternating current of voice frequency is utilized to transmit signals over telephone lines.

Objects of the invention are an increase in the reliability of voice frequency signaling systems and the prevention of false signal operations due to voice currents occurring in telephone lines.

This invention is a signaling system in which the alternating current of voice frequency transmitted as a signal over a line to operate a signal receiver is an asymmetric current, that is, current in which the amplitude of the positive half cycles differ substantially from the amplitude of the negative half cycles thereby enabling a signal operation responsive to signaling current but not to voice current of the signaling frequency, voice currents being only slightly asymmetric as compared with the signaling current.

Features of the invention are the provision of signal current supply and transmitting means for transmitting signals consisting of current of a particular frequency characteristic and of a character wherein the amplitude of the positive half cycles of the current differs substantially from the amplitude of the negative half cycles, and the provision of a signal receiver adapted to effect a signal operation responsive to asymmetric signaling current without effecting a signal operation responsive to voice currents of the signaling frequency, the voice currents being considerably more symmetrical in wave form than signaling current.

Another feature of the invention is the use of a rectifier or detector in a signal transmitter to render the signaling current asymmetrical in its wave form to enable its detection as distinguished from voice or other currents of more symmetrical wave form.

The copending application of S. M. Babcock, A. W. Horton, Jr., and M. A. Logan, Serial No. 440,138, filed April 23, 1942, also covers a system in which the difference in wave form between signal currents and speech currents is utilized to prevent signal operation in response to speech currents.

Another feature is the insertion of a transformer with a polarized core in the signal transmission path of a voice frequency signaling circuit to render the signaling current transmitted therethrough sufficiently asymmetrical in its wave form to be distinguishable from voice or other currents of more symmetrical wave form.

A clear and complete understanding of the invention will be facilitated by considering a signaling system arranged in accordance with the various features of the invention, one such system being represented schematically in the drawing which forms a part of this specification.

Referring to the drawing which consists of four figures,

Fig. 1 represents a system comprising subscribers' telephone stations A and B and lines L1 and L2 and a toll line TL to which are connected a signal transmitter ST1 and a signal receiver SR; and

Figs. 2, 3 and 4 show signal transmitters ST2, ST3, and ST4 each of which may be substituted for transmitter ST1 for transmitting signals over line TL to the signal receiver SR.

The line TL is a telephone line over which voice currents and supervisory and selective signals are transmitted, alternating current within the voice frequency range being employed for the transmission of the various signals. One end of the line TL is connected through a repeating coil 10 to a signal transmitter ST1 and the other end through a repeating coil 50 to a signal receiver SR. If arranged for two-way signaling the line TL will also be connected through coil 10 to a signal receiver similar to SR and through coil 50 to a signal transmitter similar to ST1. A calling station A and line L1 may be connected to one end of line TL by manually operated or impulse controlled switching mechanism and the other end of line TL may then be connected under the control of selective impulses to a called line L2 and station B. Reference may be had to the patent to King et al. No. 2,209,777 granted July 30, 1940 for a description of a system comprising toll lines and impulse controlled switching mechanism for establishing connections.

The signal transmitter ST1 comprises a signal current generator G which generates alternating current of a desired frequency characteristic within the voice frequency range, a transformer T1 through which the signaling potentials are impressed across the repeating coil 10, a signal sending device K1, and a half-wave rectifier R1 or unidirectional impedance element for rendering the current, which is transmitted over line TL to the receiver SR upon closure of the contacts of device K1, asymmetrical in that the amplitude of the half cycles of one polarity will be substantially larger than the half cycles of the other polarity. A like polarization of the signaling current is effected in the alternative signal transmitters ST2, ST3 and ST4. In transmitter ST2, a half-wave rectifier is connected

in parallel with the generator G instead of in series with the generator as in the transmitter ST1. In transmitter ST3, the transformer T3 through which the signaling potentials are impressed across repeating coil 10 has a polarized core to render the signaling current asymmetric. The polarization of the core may be effected by energization of another winding (not shown) by direct current. And in transmitter ST4, the signaling potentials are applied through a transformer 42, vacuum tube detector 40 and transformer T4, the detector being biased to render the current transmitted through transformer T4 asymmetric in the desired degree.

The signal receiver SR comprises an input transformer 53, three-element vacuum tubes 58 and 59 acting as amplifiers, a differential relay 60, and a vacuum tube 62 having a cathode, a control grid and an anode which cooperate to form an amplifier and having two additional anodes which cooperate with the cathode to form two half-wave rectifiers for oppositely polarizing the potentials applied to the grids of tubes 58 and 59. The receiver SR further comprises a transformer 63, a band-pass filter 64, an amplifier 65, an amplifier detector 66, a relay 67 for operation in response to current of either symmetrical or asymmetrical wave form in the input circuit of transformer 53, and a single relay 69 controlled by relays 60 and 67.

Voice current transmitted over line L1 from station A and signaling current from transmitter ST1 are transmitted through repeating coil 10, toll line TL, repeating coil 50, conductors 51 and 52, and transformer 53 thereby impressing an alternating potential on the control grid of tube 62 and impressing potentials derived from the positive and negative half cycles of the current in the primary winding of transformer 53 on the grids of amplifier tubes 58 and 59, respectively. The current in the output circuit of amplifier tube 58 energizes the upper winding of relay 60 and the current in the output circuit of amplifier tube 59 energizes the lower winding of relay 60, these windings being thereby differentially energized. If the current in line TL is symmetrical in its wave form, relay 60 does not operate; but, if the current in line TL is sufficiently asymmetrical in wave form, relay 60 operates thereby connecting ground potential to conductor 68. Whether the current in line TL be symmetrical or asymmetrical in wave form, the alternating potential applied to the control grid of tube 62 causes the transmission of an amplified current through transformer 63 to the input side of band-pass filter 64. This filter is tuned to pass current of the signaling frequency, the current thus transmitted being amplified by amplifier 65, further amplified and rectified by amplifier detector 66 to energize the winding of relay 67. Thus relay 67 is operatively energized by current of the signaling frequency of either symmetrical or asymmetrical wave form. If this current is signaling current it is sufficiently asymmetrical in wave form to operate relay 69 in addition to operating relay 67, the operation of both of relays 67 and 60 being effective to operate signal relay 69 to effect any desired signaling operation. If, however, the current in line TL is voice current which is symmetrical or only slightly asymmetrical in wave form, the energization of the two windings of relay 60 will so closely balance each other that relay 60 does not operate; and the operation of relay 67 alone, in response to the voice current, will be ineffective to operate signal relay 69.

What is claimed is:

1. In a signaling system in which alternating current of voice frequency is utilized for the transmission of signals, the signaling current being asymmetrical in wave form, a signal receiver for responding to signaling current, said receiver comprising an input circuit, a first control relay, a detector responsive to the positive half cycles of current in said input circuit for energizing a winding of said first control relay, a detector responsive to the negative half cycles of current in said input circuit for energizing another winding of said first control relay, said windings being differentially energized to prevent the operation of said first control relay in response to current of substantially symmetrical wave form in said input circuit and to effect operation of said first control relay in response to signaling current in said input circuit, a second control relay, means comprising amplifier and detector means responsive to current in said input circuit for operatively energizing said second control relay, and a signal relay responsive only to the simultaneous operation of both of said control relays.

2. In a signaling system, a line, means for transmitting signals comprising alternating current of voice frequency over said line, means rendering said signaling current asymmetrical in wave form, and a signal receiver for responding to signals transmitted over said line, said receiver comprising a detector responsive to alternating current of both symmetrical and asymmetrical wave form transmitted over said line, an asymmetry detector operatively responsive only to current which is asymmetrical in wave form in larger degree than are voice currents, and a signal device under the joint control of said detectors, said device being operated in response to signaling current but not in response to voice current or other currents of substantially symmetrical wave form.

3. In a signaling system in which signals are transmitted by alternating current which are within the voice frequency range and asymmetrical in wave form to a substantially greater degree than are voice currents, a signal receiver comprising an input circuit, a detector for detecting the positive half cycles of current in said input circuit, a detector for detecting the negative half cycles of current in said input circuit, a first control relay, one winding of said relay connected in the output circuit of one of said detectors and another winding of said relay connected in the output circuit of the other of said detectors, said windings being differentially energized by the currents in the output circuits of said detectors thereby to enable operation of the relay responsive to asymmetrical signaling current in said input circuit but non-responsive to voice currents or other currents which are substantially symmetrical in wave form, a second control relay, means for operating said second control relay responsive to current in said input circuit of either symmetrical or asymmetrical wave form, and a signal relay under the joint control of said control relays.

4. In a signaling system in which signals are transmitted by alternating currents which are within the voice frequency range and asymmetrical in wave form to a substantially greater degree than are voice currents, a signal receiver comprising an input circuit, two detector tubes con-

nected to said input circuit, rectifier means in the grid circuit of one of said detector tubes rendering said tube responsive only to the positive half cycles of current in said input circuit, rectifier means in the grid circuit of the other of said detector tubes rendering said tube responsive only to the negative half cycles of current in said input circuit, a relay having two windings connected differentially in the output circuits of said two detectors thereby to effect operation of said relay only in response to current of asymmetric wave form in said input circuit, an amplifier connected to said input circuit, a relay operatively controlled by said amplifier responsive to current of symmetrical or asymmetrical wave form in said input circuit, and a signal circuit closed by the operations of both of said relays responsive to signaling current in said input circuit.

5. In a signaling system in which signals are transmitted by alternating current of a particular frequency within the voice frequency range and asymmetrical in wave form to a substantially greater degree than are voice currents, a signal receiver comprising an input circuit, a detector for detecting the positive half cycles of current in said input circuit, a detector for detecting the negative half cycles of current in said input circuit, a relay having two windings individually and differentially connected in the output circuits of said detectors to effect the operation of said relay in response to current of wave form which is asymmetrical in a larger degree than are voice currents, another relay, means comprising amplifying means, a band-pass filter and detector means connecting said other relay to said input circuit, said filter tuned to said particular frequency, whereby said other relay is operatively responsive only to current of said particular frequency, and signal means operated only by the operation of both of said relays responsive to signaling current in said input circuit.

6. In a signaling system, a line, means for transmitting signals comprising alternating current of voice frequency in said line, said means comprising a half-wave rectifier, a source of alternating current, and a signal sending device connected in series for transmitting signaling currents of wave form asymmetrical to a substantially greater degree than are voice currents, and a signal receiver connected to said line, said receiver comprising a detector responsive to alternating current of both symmetrical and asymmetrical wave form transmitted over said line, an asymmetry detector operatively responsive only to current which is asymmetrical in larger degree than are voice currents, and a signal device under the joint control of said detectors, said device being operated in response to signaling current but not in response to voice current or other currents of similar wave form.

7. In a signaling system, a line, means for transmitting signals comprising alternating current of voice frequency over said line, said means comprising a source of alternating current and a signal sending device connected in series and a half-wave rectifier connected in parallel with said source and device, the signaling current thus transmitted over said line being asymmetrical in wave form to a greater degree than voice currents, and a signal receiver connected to said line, said receiver comprising an input circuit, a detector for detecting the positive half cycles of current in said input circuit, a detector for detecting the negative half cycles of current in said output circuit, a relay having two windings individually and differentially connected in the output circuits of said detectors to effect the operation of said relay in response to current of wave form which is asymmetrical in larger degree than voice currents, another relay, means comprising amplifying and detecting means connected to said input circuit for operatively energizing said other relay responsive to current of symmetrical or asymmetrical wave form in said input circuit, and signal means operated only in response to the operation of both of said relays.

8. In a signaling system, a line, means for transmitting signals comprising alternating current of voice frequency over said line, said means comprising a source of alternating current and a transformer having a core of saturated magnetic material effective to polarize the current in the secondary winding of said transformer, the signaling current thus transmitted over said line being asymmetrical in wave form to a greater degree than voice currents, and a signal receiver connected to said line, said receiver comprising an input circuit, a detector for detecting the positive half cycles of current in said input circuit, a detector for detecting the negative half cycles of current in said output circuit, a relay having two windings individually and differentially connected in the output circuits of said detectors to effect the operation of said relay in response to current of wave form which is asymmetrical in larger degree than voice currents, another relay, means comprising amplifying and detecting means connected to said input circuit for operatively energizing said other relay responsive to current of symmetrical or asymmetrical wave form in said input circuit, and signal means operated only in response to the operation of both of said relays.

9. In a signaling system, a line, means for transmitting signals comprising alternating current of voice frequency over said line, said means comprising a source of alternating current and a signal sending device in series and comprising a vacuum tube detector for polarizing the current transmitted over said line, the signaling current thus transmitted over said line being asymmetrical in wave form to a greater degree than voice currents, and a signal receiver connected to said line, said receiver comprising an input circuit, a detector for detecting the positive half cycles of current in said input circuit, a detector for detecting the negative half cycles of current in said output circuit, a relay having two windings individually and differentially connected in the output circuits of said detectors to effect the operation of said relay in response to current of wave form which is asymmetrical in larger degree than voice currents, another relay, means comprising amplifying and detecting means connected to said input circuit for operatively energizing said other relay responsive to current of symmetrical or asymmetrical wave form in said input circuit, and signal means operated only in response to the operation of both of said relays.

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