

[54] D-C MONITORING SYSTEM USING TWO-WIRE TRANSMISSION LINES

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[51] Int. Cl. G08b 1/08

[58] Field of Search..... 340/409, 266, 309.1, 340/309.4, 326, 328, 416, 216; 179/5 R

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Primary Examiner—David L. Trafton

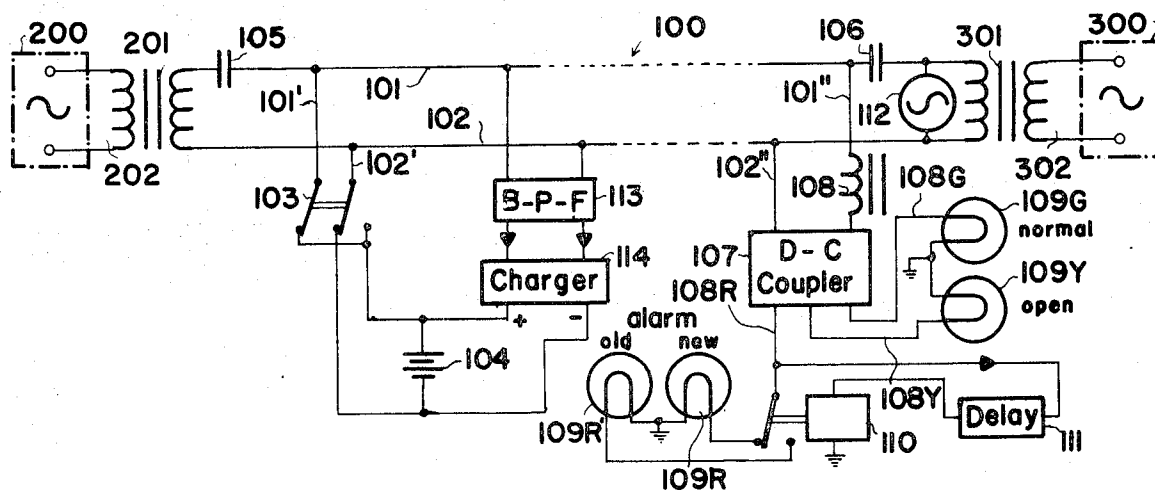
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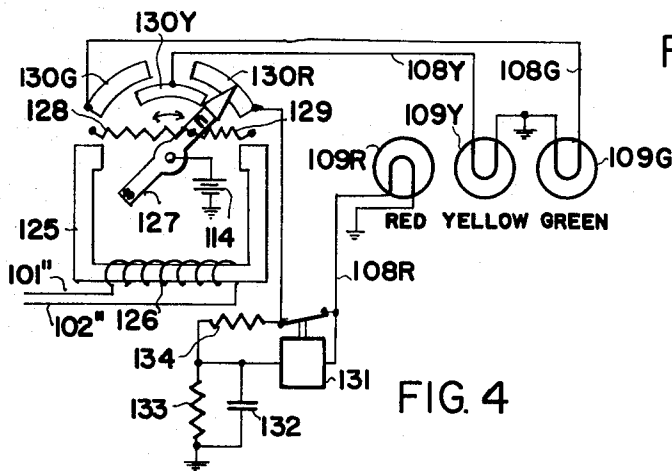
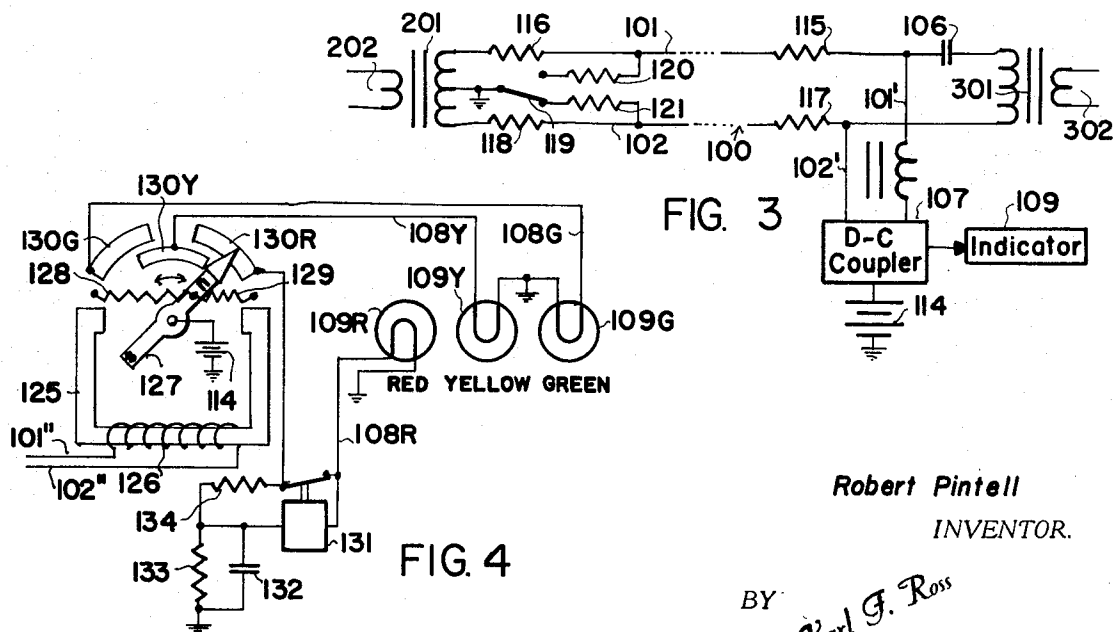
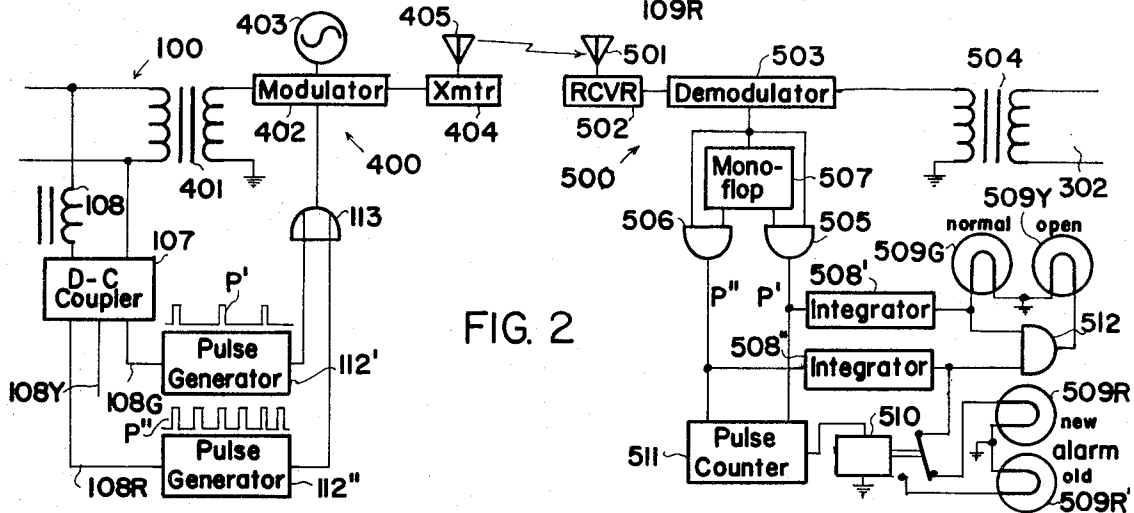
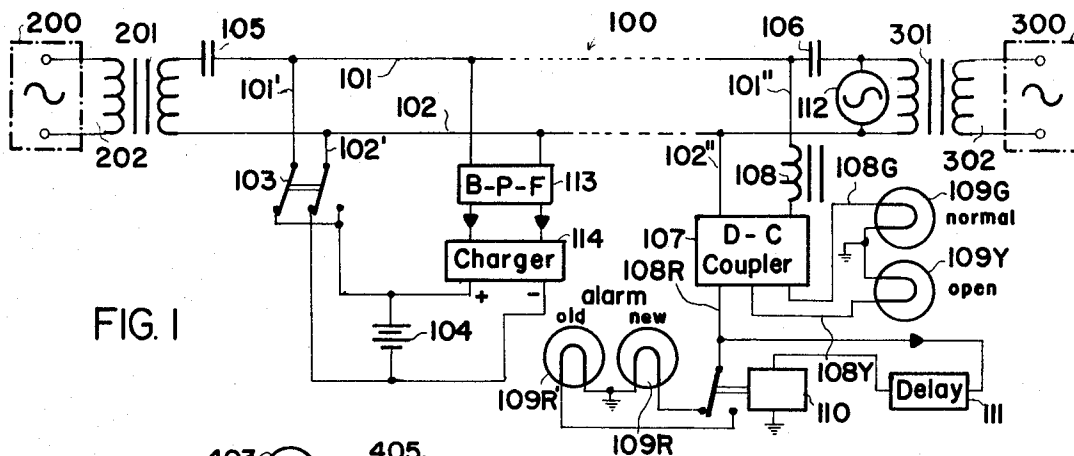
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ABSTRACT

A reversible d-c voltage impressed upon the conductors of a two-wire line at a supervised location is detected at a central station and transmitted via a d-c coupler to a load circuit with indicating lamps for normal operation (green), open circuit (yellow) and alarm condition (red). A recent alarm condition is indicated at a display panel by a flashing red light which subsequently changes to a steady glow, thereby facilitating the detection of new emergencies. The coupler may include a transformer with a primary-side oscillator, a dual magnetic amplifier, a differential amplifier, an electromagnetic sensor or a photoelectric transducer.

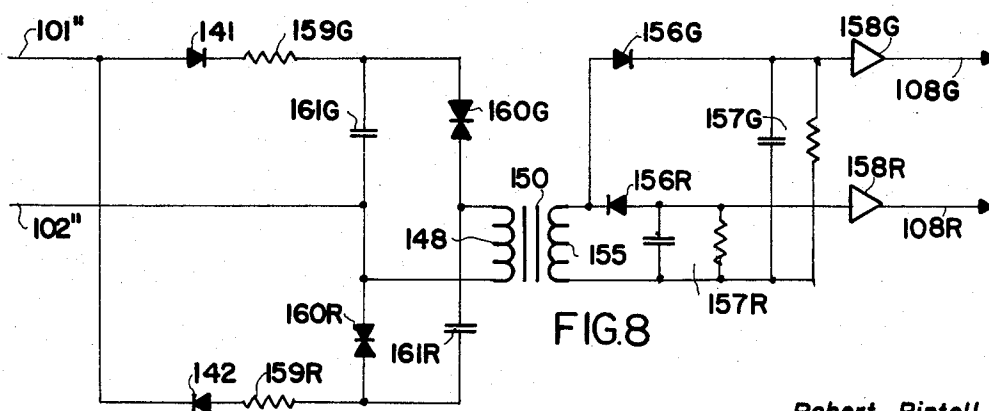
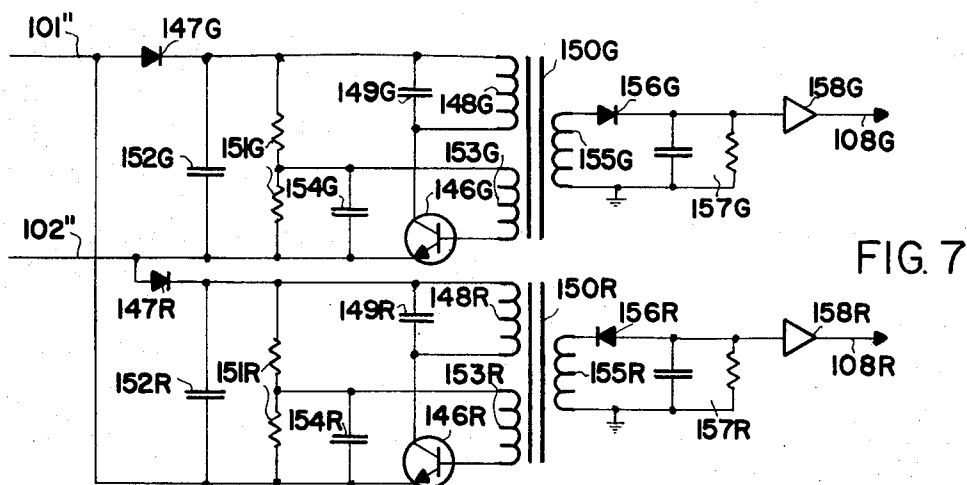
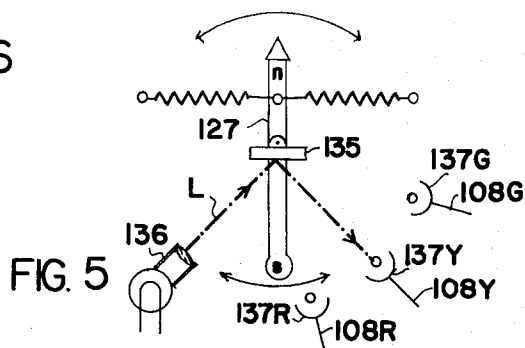
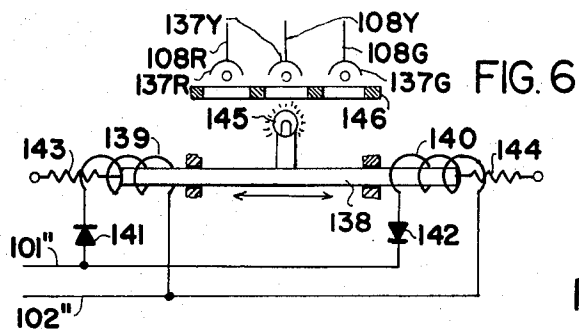
7 Claims, 12 Drawing Figures





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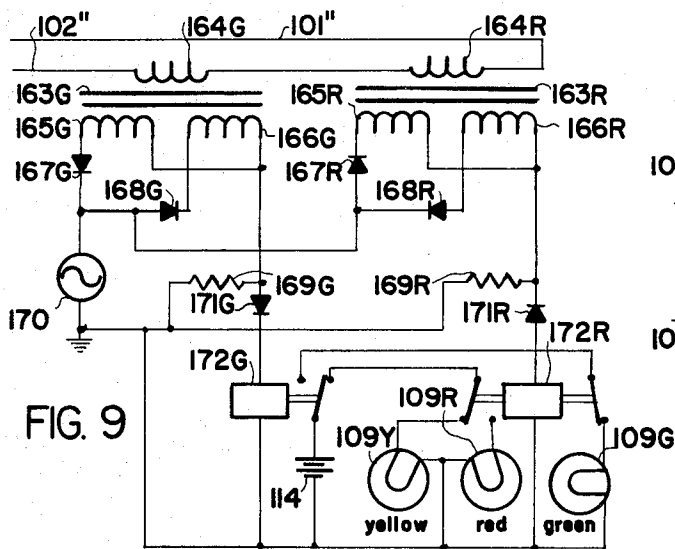


FIG. 9

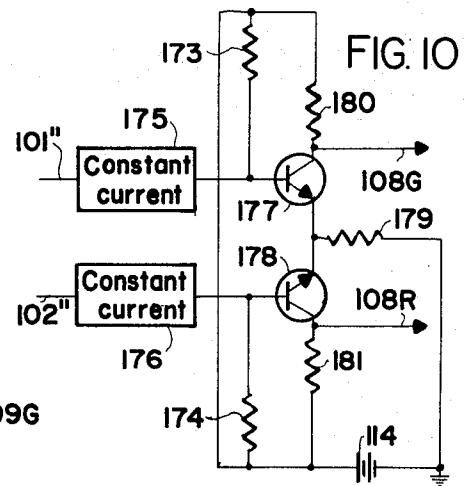


FIG. 10

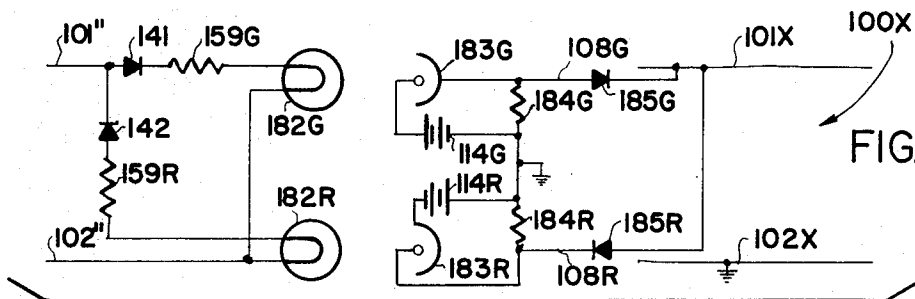


FIG. 11

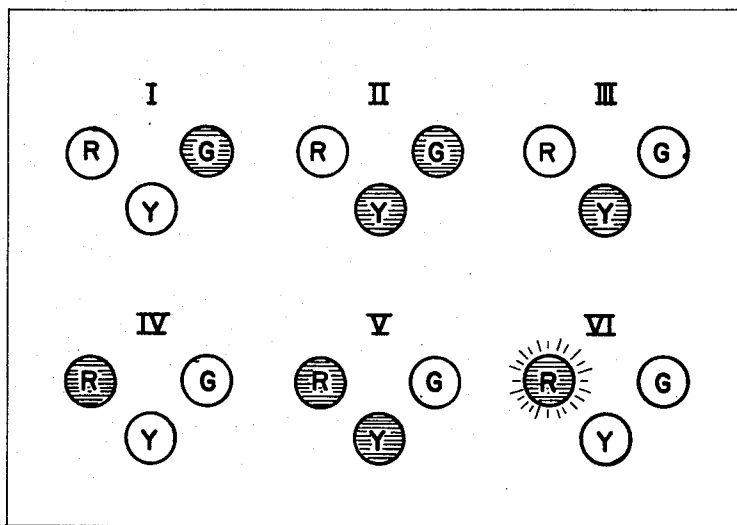


FIG. 12

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D-C MONITORING SYSTEM USING TWO-WIRE TRANSMISSION LINES

My present invention relates to a system for the continuous transmission of supervisory signals over a two-wire line, specifically (though not exclusively) for the signaling of signaling to a control station the occurrence of an abnormal condition at a remote location, such as the tripping of a burglar alarm or the response of a detector to heat or radiation.

A two-wire line suitable for use in such a system may be a subscriber circuit of a telephone or other telecommunication network and may therefore be designed to carry voice frequencies or other alternating currents in addition to a direct-current monitoring signal controlling the supervisory or alarm equipment. This equipment may include polarized relays or equivalent means for ascertaining not only the presence but also the polarity and/or the magnitude of the supervisory current in order to discriminate between (a) a normal line condition, (b) an alarm condition at the monitored location, and (c) an interruption in the continuity of the line not necessarily due to such alarm condition.

At the control station, which may be a police precinct, a firehouse, a private detective bureau or the like, a multiplicity of such lines may converge for the selective actuation of visual indicators such as signal lamps arrayed on a monitoring panel. These lamps may have different colors, e.g. green for normal operation, yellow for line failure and red for alarm. The green or "normal" lamp could be omitted to simplify the display. The lighting of the red lamp generally requires the immediate dispatch of assistance to the location concerned where, after the trouble has been checked, the circuits are reset to restore the normal operating condition (green light), yet considerable time may elapse until the red lamp is extinguished on the control panel. In a large monitoring installation of this type, many red lamps may be simultaneously lit so that the supervisor may not become readily aware of a new red light on the panel. Since such lack of awareness may unduly delay the dispatch of a policeman, a fire engine or a repair crew to the location involved, the general object of my invention is to provide an improved system of this character in which every new alarm condition is indicated at the by a distinctive signal drawing the attention of the operator at the control station.

Frequently, the monitoring current is supplied by a local battery at the remote location whose service life is determined by the current drain. Thus, another object of my invention is to provide means at the control station for minimizing the current drain and for energizing the signal indicators and associated elements from a central power supply at that station.

A related object is to provide means for energizing the several transmission lines from the central power supply, either directly or through a periodic or continuous recharging of the local batteries, to maintain the system operative for an indefinite period.

The transmission of direct current over a two-wire line terminated at each end by a coupling transformer requires the interposition of blocking condensers to prevent short-circuiting of the d-c path by the transformer windings. Thus, the line cannot be effectively balanced with reference to ground so that the absolute potential of its conductors is subject to considerable variation and may result in an untimely actuation of the

corresponding indicator unless effective means are provided for isolating the line circuit from the indicator circuit. Another important object of my invention, therefore, is to provide means for insuring such isolation.

More specifically, my invention aims at providing a coupling circuit for the transfer of d-c voltages from a supply circuit to an associated load circuit with effective galvanic separation of the two circuits.

Such a coupling circuit includes, according to an important feature of my invention, an electromagnetic current sensor with a primary or monitoring side connected across the supply circuit and transmission line and with a secondary or signaling side having two outputs for positive and negative voltage, respectively, derived from a source of electric energy in the load circuit. The electromagnetic sensor may be a transformer or a magnetic amplifier but could also comprise one or more coils controlling the displacement of an armature to energize one or the other output with the aid of mechanical contacts, photoelectric transducers or the like; such photoelectric devices may also be used directly for contactless energy transfer.

In some instances, as where the lines are energized from a powerful central battery or equivalent current supply, sufficient isolation between these lines and their load circuits can be achieved with the aid of high-ohmic resistors so as to eliminate the need for electromagnetic coupling. Since a line energized from the control station does not require blocking condensers at its remote end to prevent short-circuiting, such a line can be effectively balanced with reference to ground so that its coupling circuit may comprise a differential amplifier with inputs respectively connected to the two line conductors. The use of constant-current devices is advantageous in such a case to make the response of the differential amplifier substantially independent of the absolute line resistance varying with the length of its conductors.

According to a further feature of my invention, the load circuit at the control station includes a timer measuring a predetermined delay interval upon detection of an alarm condition on a monitored line to cause a switchover from one type of alarm signal, e.g. a flashing red light, to another type of alarm signal, e.g. a steady light of similar color, at the end of the delay interval if the alarm condition persists.

Certain features of my invention, as more fully described hereinafter, are also applicable to communication systems wherein part of the signal path is constituted by a radio link rather than a metallic circuit.

The above and other features of my invention will be described in detail hereinafter which reference to the accompanying drawing in which:

FIG. 1 is a diagrammatic overall view of a supervisory system for monitoring the flow of direct current over a two-wire transmission line in accordance with the invention;

FIG. 2 is a view similar to FIG. 1 but showing a system wherein part of the transmission line has been replaced by a radio link;

FIG. 3 is another view similar to FIG. 1, illustrating a further modification;

FIG. 4 shows an electromechanical circuit adapted to be used in the system of FIG. 1, 2 or 3;

FIG. 5 shows a partial modification of the coupling circuit of FIG. 4;

FIG. 6 is a view similar to FIG. 4, illustrating another type of electromechanical coupler;

FIGS. 7-9 show various purely electronic coupling circuits for the system of FIG. 1;

FIG. 10 shows an electronic coupler for the system of FIG. 3;

FIG. 11 shows a photoelectric coupler; and

FIG. 12 shows part of a display panel with an array of signal lamps for the monitoring of a multiplicity of transmission lines with the aid of equipment as shown in the preceding Figures.

In FIG. 1 I have shown a transmission line 100 which may form part of a commercial telecommunication network and which includes two conductors 101, 102, extending between a subscriber station 200 and a central station 300. Station 200 may include telephone or other telecommunication equipment, not shown, for the transmission of alternating-current signals over the line 100 to similar equipment at station 300, and vice versa, via a pair of transformers 201, 301 coupling this line to a pair of talking circuits 202, 302; station 300 may also represent another subscriber at the opposite end of the line.

A double-pole switch 103 at or near station 200 connects branch leads 101', 102' of line wires 101, 102 across a local battery 104 with reversible polarity; a condenser 105 prevents short-circuiting of the battery by the line winding of transformer 201 whereas a condenser 106 at the opposite end has a similar function with reference to transformer 301.

In the illustrated position of reversing switch 103, wire 101 is positive while wire 102 is negative. These two wires are connected, in the vicinity of station 300 (or possibly at some intermediate point of the line), across a d-c coupler 107 through the intermediary of a monitoring circuit which comprises branch leads 101'', 102'' and a choke 108 serving to block the flow of alternating current to the coupler and to suppress transient pulses. Coupler 107 has three outputs 108G, 108Y and 108R which form part of a signaling circuit and are alternately energized to light a lamp 109G (green) if conditions are normal, to light a lamp 109Y (yellow) if the line 100 is interrupted at any point between branches 101', 12' and 101'', 102'', and to light a lamp 109R or 109R' (red) if switch 103 is manually or automatically reversed to indicate a state of alarm.

In accordance with an advantageous feature of my invention, output lead 108R is extended to lamp 109R through an armature and back contact of a relay 110 whose winding is connected to the same lead by way of a delay network 111, the armature of that relay also having a front contact leading to lamp 109R' so as to light the latter when the relay is operated. Thus, any energization of lead 108R first lights the lamp 109R to indicate a new alarm condition; after an interval of perhaps one or several minutes, determined by the delay period of network 111 (which may include a mechanical timer), relay 110 goes into action to switch over from emergency lamp 109R to lamp 109R', thereby indicating a longer-lasting alarm condition. Lamp 109R may be brighter, or more prominently positioned, or of the flashing type to draw the immediate attention of an operator.

FIG. 1 also shows an oscillator 112, advantageously operating on a frequency outside the signal band transmitted over line 100, whose output is picked up at station 200 by a bandpass filter 113 and delivered to a bat-

tery charger 114 connected across the local supply 104. Charger 104 may include the usual rectifying, smoothing and threshold (e.g. Zener) circuits to maintain the terminal voltage of battery 104 substantially at a predetermined level.

FIG. 2 shows part of a modified communication system wherein the receiving end of transmission line 100, i.e., the end remote from subscriber station 200 of FIG. 1, is coupled via a transformer 401 to a sending station 400 including a modulator or mixer 402, a carrier oscillator 403, a radio transmitter 404 receiving the modulated carrier from mixer 402, and an antenna 405 for radiating this carrier to a distant receiving station 500. Modulator 402 has an additional input receiving either of two pulse trains P', P'' from a pair of pulse generators 112', 112'' which are respectively triggered upon the energization of output lead 108G or 108R of coupler 107; pulse train P'' has a cadence several times (e.g. twice) as high as that of pulse train P'. An OR gate 113 supplies the output of the active pulse generator to modulator 402 so as to superimpose the pulses P' or P'', if present, upon the low-frequency signal (if any) from transmitter 401. At station 500 the modulated carrier is picked up by an antenna 501 of a receiver 502 feeding a demodulator 503 whose low-frequency output is delivered to line 302 via a coupling transformer 504. Demodulator 503 also includes a circuit, such as a high-pass filter, selecting the sharp pulses P' or P'' for transmission to a pair of AND gates 505, 506 and, in parallel therewith, to a monoflop 507 delivering its normal output to AND gate 505 and its off-normal output to AND gate 506. With the off-period of the monoflop 507 selected to exceed slightly the time separating successive pulses P'', AND gate 505 conducts in the presence of pulses P' whereas AND gate 506 passes the pulses P''.

An integrator 508' in the output of AND gate 505 energizes the "normal" lamp 509G, corresponding to lamp 109G of FIG. 1, whereas an integrator 508'' in the output of AND gate 506 lights either of two lamps 509R, 509R' respectively corresponding to lamps 109R and 109R'. The switchover between lamps 509R and 509R' is again performed by a relay 510 which in the present instance is actuated by a pulse counter 511 receiving the pulses P'' from AND gate 506; upon complete loading of counter 511, relay 510 responds to reverse its armature and to indicate the prolonged state of alarm. Upon a resetting of the alarm switch at the monitored station, the first pulse P' appearing in the output of AND gate 505 resets the counter 511.

An AND gate 512 responds to the absence of an output from either integrator 508', 508'' to energize a lamp 509Y indicating a break in the subscriber line 100 or a malfunction in the radio link between stations 400 and 500.

If desired, integrators 508' and 508'' could also control a reversing switch, similar to switch 103, to energize the conductors of line 302 with one or the other relative polarity for the actuation of equipment further along the line 302 similar to the circuit elements 107-111 of FIG. 1.

FIG. 3 shows a modification of the system of FIG. 1 wherein the line 100 is energized from a central battery 114 at the control station, with omission of the local battery 104. Battery 114 works through or forms part of coupler 107 and is connected across the two line conductors 101, 102 in a circuit including resistors

115, 116 and 117, 118 in series with the secondary winding of input transformer 201. This secondary winding has a grounded center tap also connected to a single-pole reversing switch 119, replacing switch 103 of FIG. 1, which alternately grounds the two line conductors through respective resistors 120, 121. Resistors 115 and 117 may be considered part of the line resistance and may therefore be omitted in practice.

In the illustrated position of switch 119, resistor 121 is effectively connected in parallel with resistor 118 so that the potential of wire 102 is substantially lower than that of wire 101, the latter being therefore more positive than the former if the negative terminal of battery 114 is grounded, as shown. When the switch 119 is thrown, the relative polarity of the wire potentials will be reversed, as before. Thus, an indicator 109 controlled by coupler 107 may again register the normal, open-line and alarm conditions discussed above, e.g. with the aid of distinctively colored lamps such as those shown in FIGS. 1 and 2.

In FIG. 4 I have shown a detector, such as the one designated 107 in FIGS. 1 - 3, comprising a magnetic yoke 125 which carries a winding 126 connected across branch leads 101'' and 102'' of line 100. A magnetic needle 127 in the field of yoke 125 is biased by a pair of springs 128, 129 into a central position and is urged in a counterclockwise sense upon normal energization of the line, i.e., with switch 103 of FIG. 1 in its illustrated position, a reversal of that switch causing a clockwise deflection of the needle, as shown. In the embodiment illustrated in FIG. 4, needle 127 serves as a mobile electric contact connected to the central battery 114; three arcuate bank contacts 130G, 130Y, 130R are engaged by the needle in its left-hand, central and right-hand positions, respectively, to energize one of the conductors 108G, 108Y, 108R leading to lamps 109G (green), 109Y (yellow) and 109R (red). Contact 130Y partly overlaps the contacts 130G and 130R so that lamp 109Y lights simultaneously with lamp 109G or 109R if the battery 104 (FIG. 1) at the remote station is weak; if that battery is fully charged, green lamp 109G alone is normally lit whereas red lamp 109R alone lights up to indicate an alarm condition. If only the yellow lamp 109Y is energized, the operator at the central station knows that there is a break in line 100 or that the battery 104 is dead.

As further shown in FIG. 4, a relay 131 similar to relay 110 of FIG. 1 has its armature and back contact in series with lead 108R and with its own energizing circuit which is returned to ground through an integrating network including a condenser 132 and a resistor 133, the latter forming part of a voltage divider also comprising a resistor 134 connected to the same lead. Thus, the appearance of positive voltage on lead 108R actuates the relay 131 in a self-interrupting manner so that lamp 109R flashes, this condition continuing until the pulsating relay current has charged to condenser 132 to an extent reducing the flow of this current to a magnitude insufficient to attract its armature. Thereafter, lamp 109R remains permanently energized until voltage is removed from bank contact 130R.

As illustrated in FIG. 5, needle 127 need not be included in the energizing circuit of the indicator lamps but may carry a reflector 135 for a beam of light L emitted by a source 136, this beam being individually trained in different needle positions upon any of three photocells 137G, 137Y, 137R feeding the output leads

108G, 108Y and 108R, respectively. Again, a weak battery at the remote station may be indicated by additional photocells disposed between those shown in FIG. 5 or in overlapping relationship therewith. Needle 127 could also carry its own light source, e.g. a luminescent crystal.

FIG. 6 shows a generally similar arrangement with a slidable solenoid core 138 controlled by two electromagnetic windings 139, 140 which are connected across branch leads 101'' and 102'' in series with oppositely poled diodes 141 and 142, respectively, a pair of springs 143, 144 tending to maintain the core 138 in a centered position. A light source 145 carried on that core individually confronts, through a stationary mask 146, any of three photocells 137G, 137Y, 137R with output leads 108G, 108Y, 108R.

The electromagnetic switches of FIGS. 4 - 6 could also be used in the system of FIGS. 2 for a characteristic energization of the conductors of an extension 100X (FIG. 11) of line 100; thus, for example, needle 127 could be ganged with a second switch arm connected across line 100X in essentially the same way as shown for switch 103 and line 100 in FIG. 1.

FIG. 7 shows another type of coupling circuit to be used in the system of FIG. 1. This circuit comprises a pair of transistors 146G and 146R, here shown to be of the NPN type, having their collector-emitter circuits connected in parallel across conductors 101'' and 102'' in series with respective diodes 147G, 147R and primary windings 148G, 148R of respective transformers 150G and 150R, these primary windings being tuned by associated capacitors 149G, 149R. Voltage dividers 151G, 151R, connected across conductors 101'' and 102'' in parallel with filter condensers 152G and 152R, supply base current to the transistors by way of feedback windings 153G, 153R of these transformers, a part of each voltage divider being further bridged by a respective condenser 154G, 154R. Transformer 150G has a secondary winding 155G working via a diode 156G and an integrating circuit 157G into an amplifier 158G with output lead 108G; a corresponding secondary winding 155R of transformer 150R controls an amplifier 158R via a diode 156R and an integrating circuit 157R to energize lead 108R in alarm state, diode 156R being oppositely poled with reference to diode 155G. With leads 108G and 108R again terminating at a green and a red lamp, for example, a yellow lamp could likewise be operated by a circuit similar to that shown at 512 in FIG. 2 to indicate failure of line current; the same applies to the embodiments of FIGS. 8-11 described hereinafter. The current source or sources for amplifiers 158G and 158R have not been separately illustrated.

Transistors 146G and 146R form part of respective oscillators whose operating frequencies are determined by the reactances 148G, 149G and 148R, 149R and which are alternatively turned on whenever the corresponding diode 147G or 147R conducts, e.g., when conductor 101'' is more positive or more negative than conductor 102''.

The oscillators thus generated, if of different frequencies, could also be transmitted via a radio link (such as that shown in FIG. 2) to a remote receiver for selective detection by respective narrow-band filters and reconversion into two distinct d-c signals.

FIG. 8 shows a coupling circuit utilizing a single transformer 150 to energize either of two amplifiers

158G and 158R, having output leads 108G and 108R, by way of respective diodes 156G, 156R and intergrating networks 157G, 157R from a secondary winding 155. Transformer 150 has a primary winding 148 with one terminal connected to conductor 102'' and with another terminal energizable, with positive or negative polarity, from conductor 101'' by way of rectifying diode 141, a resistor 159G and an electronic breakdown device in the form of a four-layer diode or diac 160G, or by way of rectifying diode 142, a resistor 159R and a four-layer diode or diac 160R. The junction of resistor 159G and diac 160G is returned to conductor 102'' through a condenser 161G whereas the junction of resistor 159R and diac 160R is coupled via a similar condensers 161R to the junction of winding 148 and diac 160G.

Normally, i.e., with lead 101'' more positive than lead 102'', diode 141 conducts and charges the condenser 161G to a level sufficient to break down the diac 160G, thereby sending a positive pulse through transformer 150 with consequent loading of integrating circuit 157G, the diac and the condenser acting as a relaxation oscillator transmitting a succession of such positive pulses to circuit 157G so as to turn on the amplifier 158G and to energize the lead 108G. Upon a reversal of the polarity of conductors 101'' and 102'', diac 160R and condenser 161R operate in an analogous manner to load the integrating circuit 157R with eventual energization of lead 108R through amplifier 158R.

FIG. 9 shows a coupling circuit comprising a pair of magnetic amplifiers 163G, 163R with biasing windings 164G, 164R serially connected between conductors 101'' and 102''. Magnetic amplifier 163G has two operating windings 165G and 166G connected in series with respective diodes 167G, 168G, of opposite polarity, across an alternating-current source 170 in series with a load resistor 169G; magnetic amplifier 163R comprises similar windings 165R and 166R, oppositely poled diodes 167R, 168R, and a load resistor 169R also connected across source 170R. A further diode 171G, tied to the ungrounded terminal of resistor 169G, conducts whenever current flows through winding 164G from conductor 101'' to conductor 102'', i.e., in the normal line condition; a relay 172G then attracts its armature to energize the green lamp 109G from battery 114 by way of an armature and back contact of an unoperated companion relay 172R whose energizing circuit includes a diode 171R tied to the ungrounded terminal of resistor 169R. Relay 172R operates upon a reversal of line current to light the red lamp 109R in a circuit which includes battery 114 along with another armature and front contact of relay 172R as well as the armature and back contact of relay 172G, it being evident that the two relays cannot be energized simultaneously. If both relays are de-energized, yellow lamp 109Y lights via armatures and back contacts of two relays.

FIG. 10 shows a coupling circuit particularly adapted for use in the embodiment of FIG. 3 and comprising a pair of resistors 173, 174 for the energization of conductors 101'', 102'' by way of respective constant-current devices 175, 176 (e.g. pentodes) from the positive terminal of battery 114. A pair of NPN transistors 177, 178, with interconnected emitters returned to ground via a common resistor 179, constitute a differential amplifier connected across the line, the collectors of these transistors being connected to positive

battery through respective resistors 180 and 181 while their bases are connected to the same battery terminal through the resistors 173 and 174, respectively. With the switch 119 of FIG. 3 in its illustrated normal position, the base potential of transistor 117 is relatively positive so that this transistor conducts and cuts off the transistor 178, thereby energizing the output lead 108G. If switch 119 is reversed, the differential amplifier is flipped and output lead 108R is energized in lieu of lead 108G.

In FIG. 11 I have a photoelectric transducer replacing the electromagnetic coupler of FIGS. 4 - 9. As in FIG. 8, conductor 101'' is connected to a pair of oppositely poled diodes 141, 142 in series with respective resistors 159G, 159R, each diode and resistor being included in an energizing circuit for a respective light source 182G, 182R shown as a lamp but also realizable as a solid-state emitter of luminous radiation. Each light source 182G, 182R confronts a respective photocell 183G, 183R whose operating circuit includes a battery 114G, 114R in series with an output resistor 184G, 184R. Output lead 108G originates at the junction of resistor 184G with the cathode of photocell 183G so as to go positive whenever that photocell is illuminated; output lead 108R is tied to the junction of resistor 184R with the anode of photocell 183R and is therefore driven negative upon illumination of the latter cell. Thus, positive or negative potential on conductor 101'' (with reference to conductor 102'') is again translated into a positive potential on lead 108G or a negative potential on lead 108R.

In this and preceding embodiments, the polarity of the operating voltage developed on output lead 108G or 108R is immaterial as long as these leads are connected directly or through further amplifying stages to lamps or similar indicating devices. The polarity becomes significant, however, if these voltages are connected by way of respective diodes 185G, 185R to a conductor 101X of a transmission line 100X whose other conductor 102X is grounded as likewise shown in FIG. 11. Such a two-wire extension of the original transmission line 100 may serve as a further link in the signal path between the controlled stage 200 and the control stage 300 shown in FIG. 1.

FIG. 12 shows part of a panel 190 with several clusters of lamps R (red), G (green) and Y (yellow) which constitute three-mode indicators assigned to different monitored stations I - VI. In the specific example illustrated, station I is normal as indicated by the lighting of its green lamp. Station II is also normal but its battery is weak, as denoted by the simultaneous lighting of its lamps G and Y. Lamp Y of station III is energized to show trouble in the corresponding transmission circuit. Red lamp R of station IV is lit to indicate an alarm condition which has persisted for some time. Lamps R and Y of station V are on, showing a similar alarm condition coupled with a weak battery. Station VI has a flashing red light, calling attention to a new emergency.

A flashing circuit, such as those shown in FIGS. 1, 2 and 4, may of course be used with any of the other embodiments herein disclosed.

The system according to my invention is capable of realization by means of miniaturized components of the integrated-circuit type, it being understood that the various electromagnetic relays shown in the drawing are also representative of electronic relays or equivalent logic circuitry.

I claim:

1. A supervisory system comprising:

a controlled station;
a control station remote from said controlled station;
a transmission path including a two-wire line linking said controlled station with said control station;
a source of direct current at one of said stations connected across said line;

switch means at said controlled station for reversing the polarity of a flow of direct current from said source over said line to discriminate between a normal condition and an off-normal condition thereat;
a direct-current monitoring circuit bridged across said line;

a signaling circuit inductively coupled to said monitoring circuit and provided with a first output energized in the presence of line current of one polarity and with a second output energized in the presence of line current of the opposite polarity in said monitoring circuit, the inductive coupling between said monitoring and signaling circuits including a pair of magnetic amplifiers each provided with a biasing winding forming part of said monitoring circuit, said magnetic amplifiers further having operating windings in said signaling circuit respectively connected to said outputs, said monitoring circuit including diode means for alternately enabling said magnetic amplifiers in the presence of a current flow of a respective polarity across said line; and
three-mode indicator means at said control station connected to said outputs for identifying said normal condition at said controlled station in response to energization of said first output identifying said off-normal condition at said controlled station in response to energization of said second output and identifying an abnormal line condition in response to simultaneous de-energization of both outputs.

2. A system as defined in claim 1 wherein said indicator means comprises timer means responsive to energization of said second output for generating one kind of signal during a predetermined period and changing to another kind of signal at the end of said period upon continuing energization of said second output.

3. A system as defined in claim 2 wherein said indicator means includes a signaling device controlled by said timer means to generate a flashing light signal during said period and a steady light signal thereafter.

4. A system as defined in claim 1 wherein said source of direct current is a rechargeable battery at said controlled station, further comprising a supply of electric energy at said control station and circuitry including said line for recharging said battery from said supply.

5. A supervisory system comprising:

a control station remote from said controlled station;
a transmission path including a two-wire line linking said controlled station with said control station;
a rechargeable battery at said controlled stations connected across said line;

switch means at said controlled station for reversing the polarity of a flow of direct current from said battery over said line to discriminate between a normal condition and an off-normal condition thereat;

a direct-current monitoring circuit bridged across said line;

a signaling circuit coupled to said monitoring circuit and provided with a first output energized in the presence of line current of one polarity and with a second output energized in the presence of line current of the opposite polarity in said monitoring circuit;

three-mode indicator means at said control station connected to said outputs for identifying said normal condition at said controlled station in response to energization of said first output, identifying said off-normal condition at said controlled station in response to energization of said second output and identifying an abnormal line condition in response to simultaneous de-energization of both outputs;

a source of alternating current connected across said line at said control station; and

rectifying circuitry at said controlled station connected across said line for maintaining said battery charged from the alternating current supplied by said source.

6. A system as defined in claim 5 wherein said line is part of a communication channel for the transmission of a band of signal frequencies, said source having an operating frequency outside said band.

7. A system as defined in claim 5 wherein said monitoring circuit and said signaling circuits are galvanically separated from each other.

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