United States Patent

Carlo et al.

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[54] SECURITY ALARM SYSTEM

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[52] **U.S. Cl.** **340/409**, 340/276, 340/420

[51] **Int. Cl.** **G08b 29/00**

[58] **Field of Search**.....340/409, 420, 416, 216, 310, 340/276

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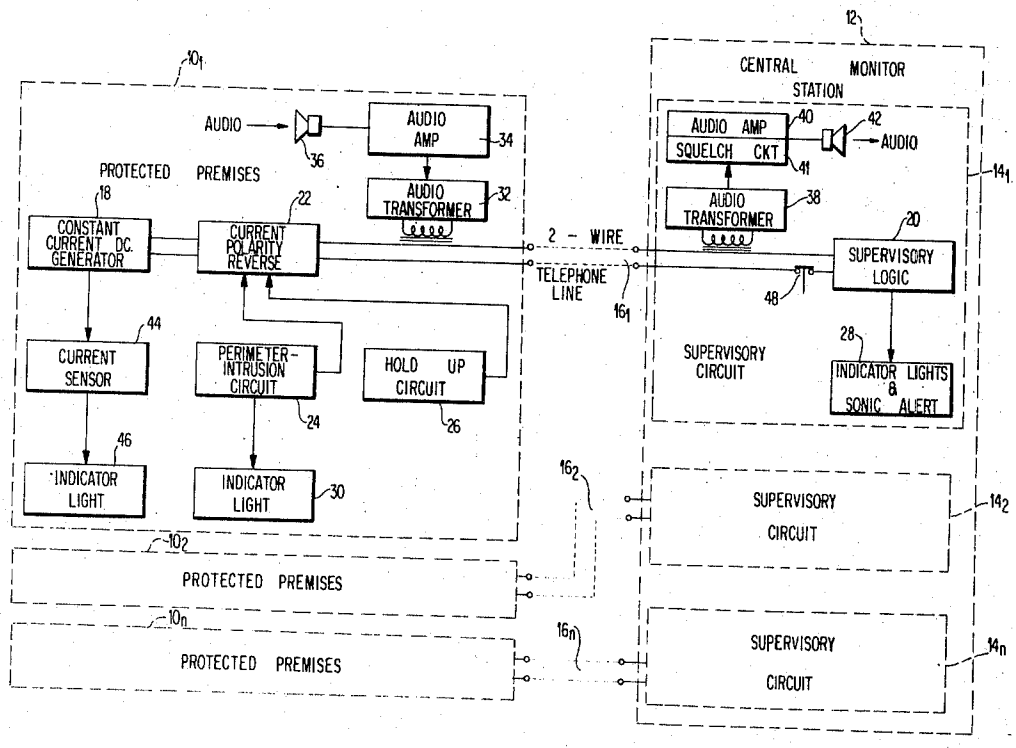
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[57] **ABSTRACT**

A constant DC current generator powers a communication link including a pair of telephone lines coupled between a protected premises and a central monitor station. The communications link includes means for reversing the DC polarity of the constant current from a predetermined polarity indicative of a normal condition to an opposite polarity in response to a detected alarm condition which occurs in response to a change in the operating parameters of a separate supervisory circuit located at the protected premises. The change in polarity is sensed at the central station and an indication of the alarm condition is presented. DC signalling of the alarm condition as well as the normal condition is thus provided by means of constant current control and DC polarity sensing. Signalling back to the protected premises from the central station is achievable by interrupting the continuity of the communication link and causing the constant current DC generator to sense the open circuit condition. Also when desirable an audio signal is adapted to be transmitted over the communication link from the protected premises to the central station.

30 Claims, 5 Drawing Figures



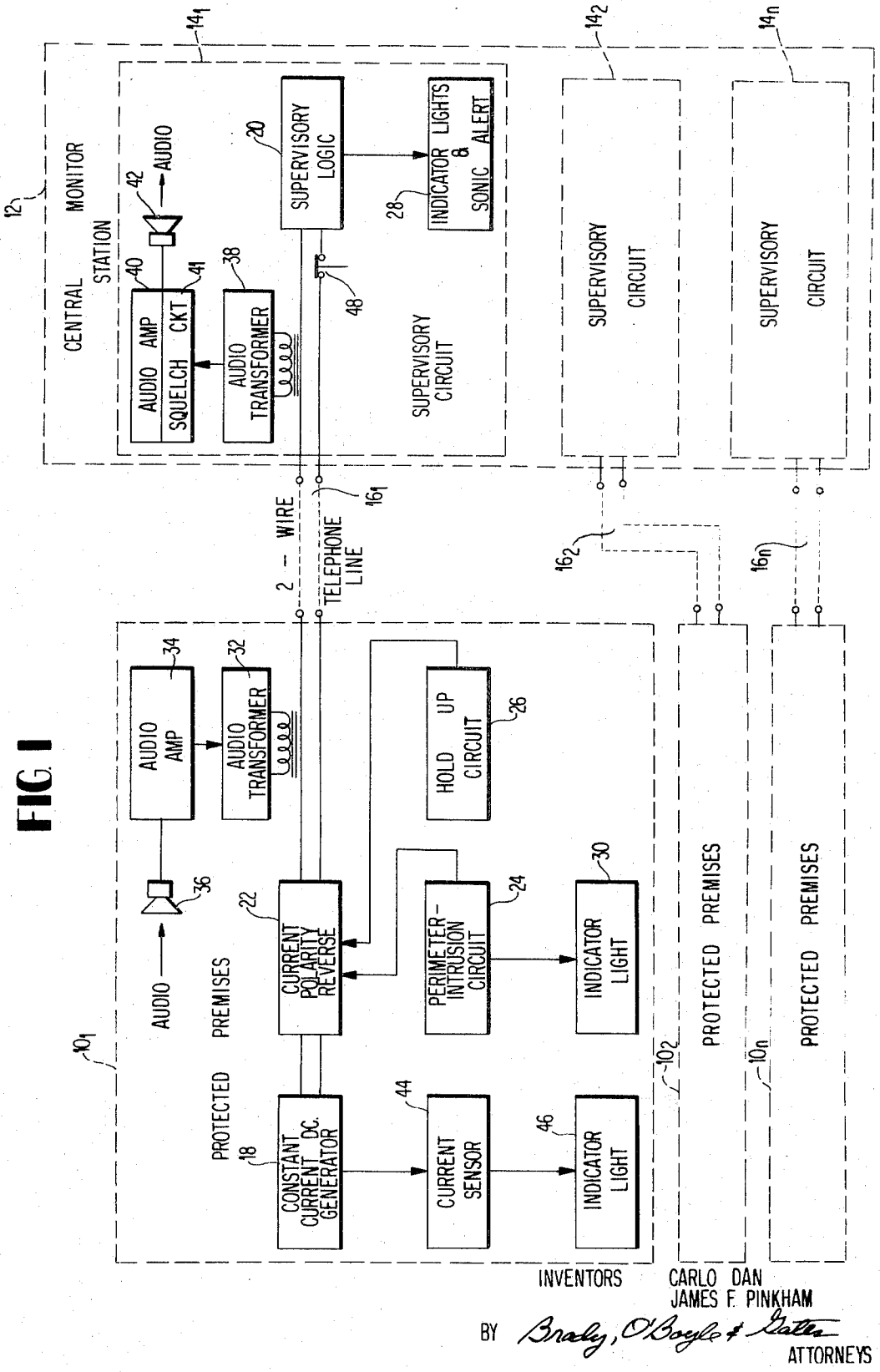


FIG. 1

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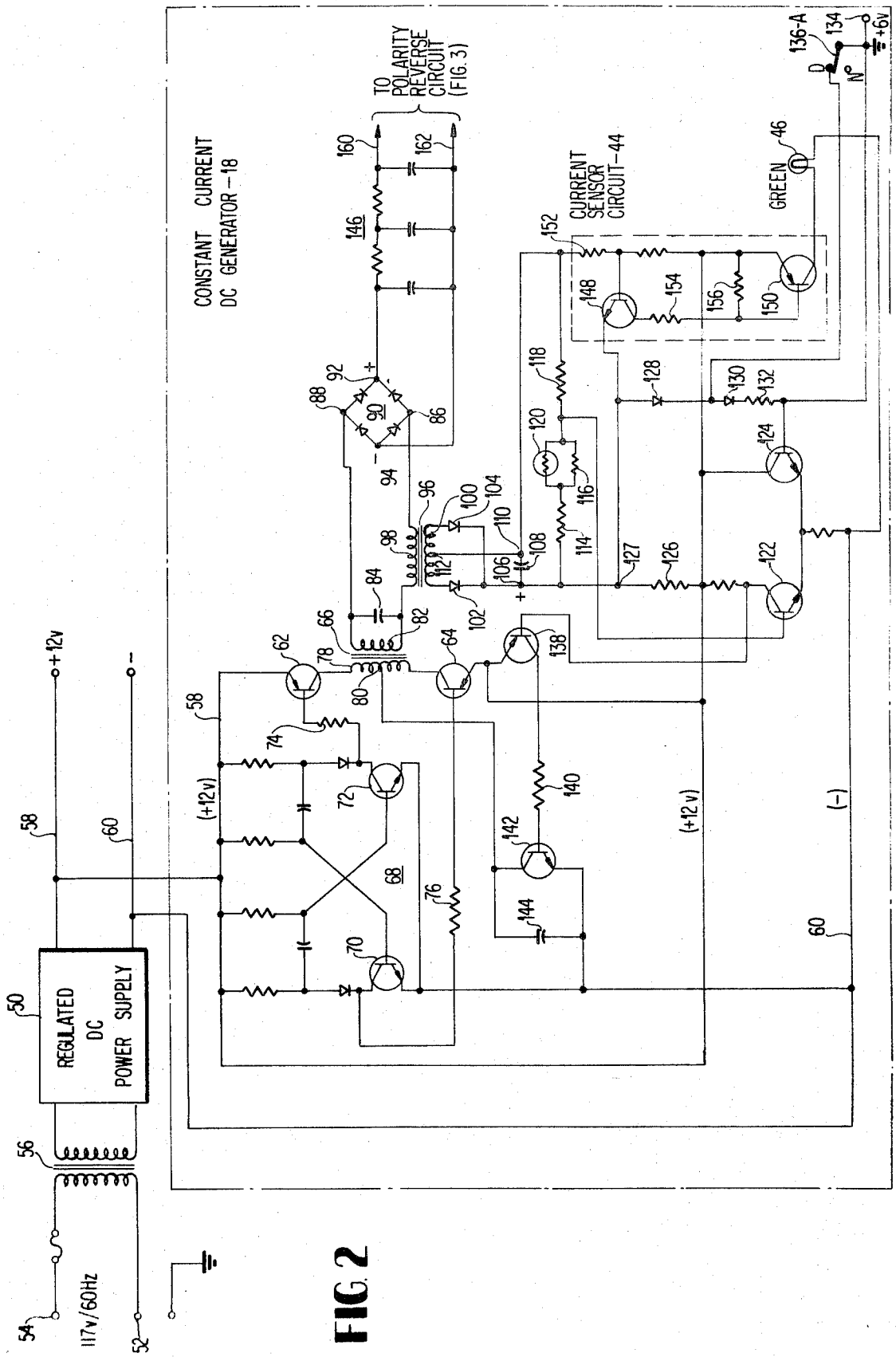

CONSTANT CURRENT DC GENERATOR—18
TO POLARITY REVERSE CIRCUIT (FIG. 3)
CURRENT SENSOR CIRCUIT—44
GREEN
136-A
134
+6V
46
152
160
162
146
148
154
156
150
118
128
130
132
120
124
116
114
127
126
122
92
88
90
86
94
96
100
104
110
98
112
108
106
102
84
82
66
62
78
64
138
80
58
74
72
140
142
68
76
144
70
(+12v)
(-)
60
+12v
-
REGULATED DC POWER SUPPLY
50
56
117v/60Hz
54
52

FIG 2

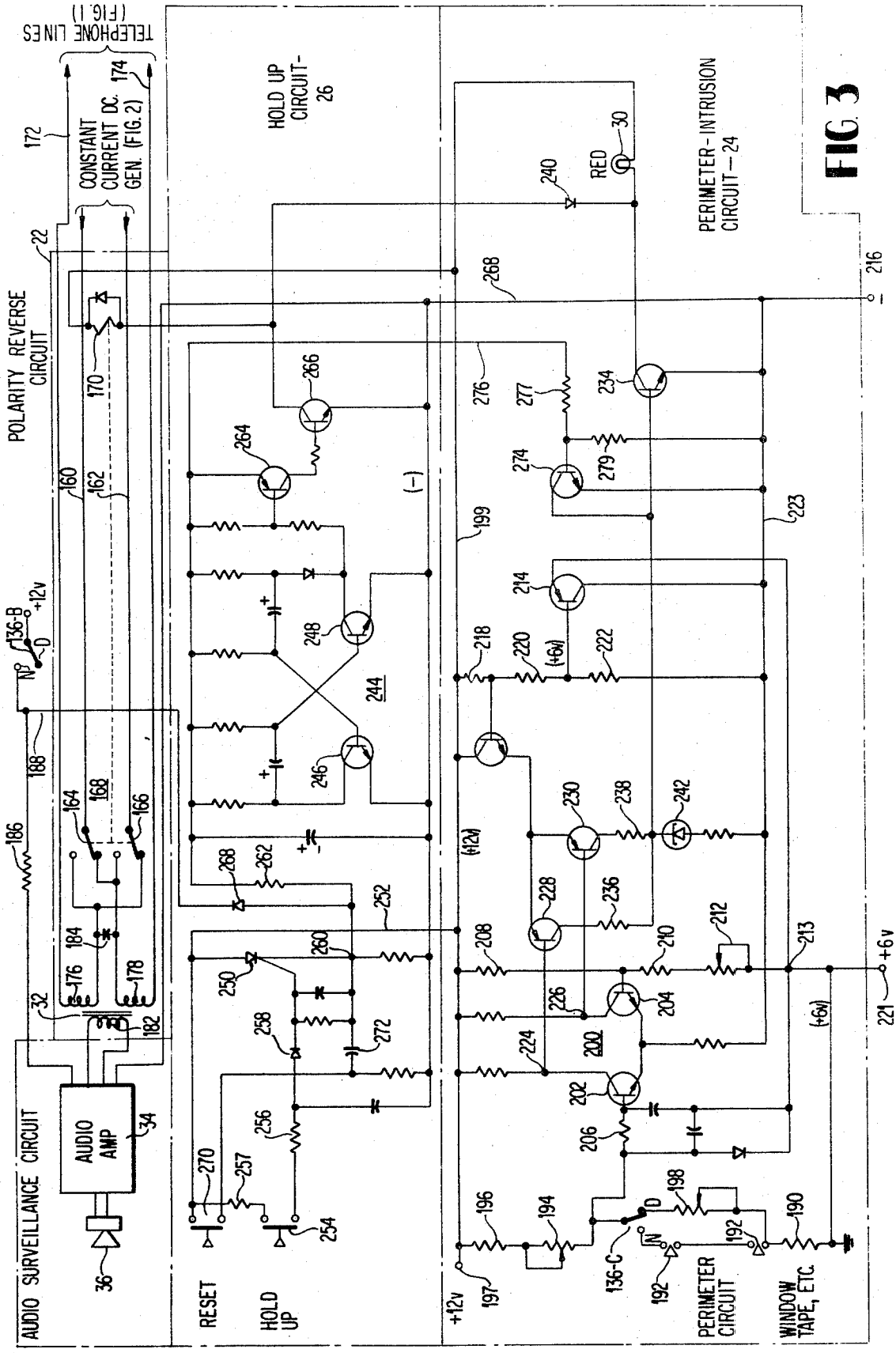

TELEPHONE LINES (FIG. 1)
CONSTANT CURRENT DC. GEN. (FIG. 2)
HOLD UP CIRCUIT-26
PERIMETER-INTRUSION CIRCUIT-24
POLARITY REVERSE CIRCUIT
AUDIO SURVEILLANCE CIRCUIT
AUDIO AMP
RESET
HOLD UP
PERIMETER CIRCUIT
WINDOW TAPE, ETC.
RED
+12v
+6v
(-)
(+6v)
(+12v)

FIG 3

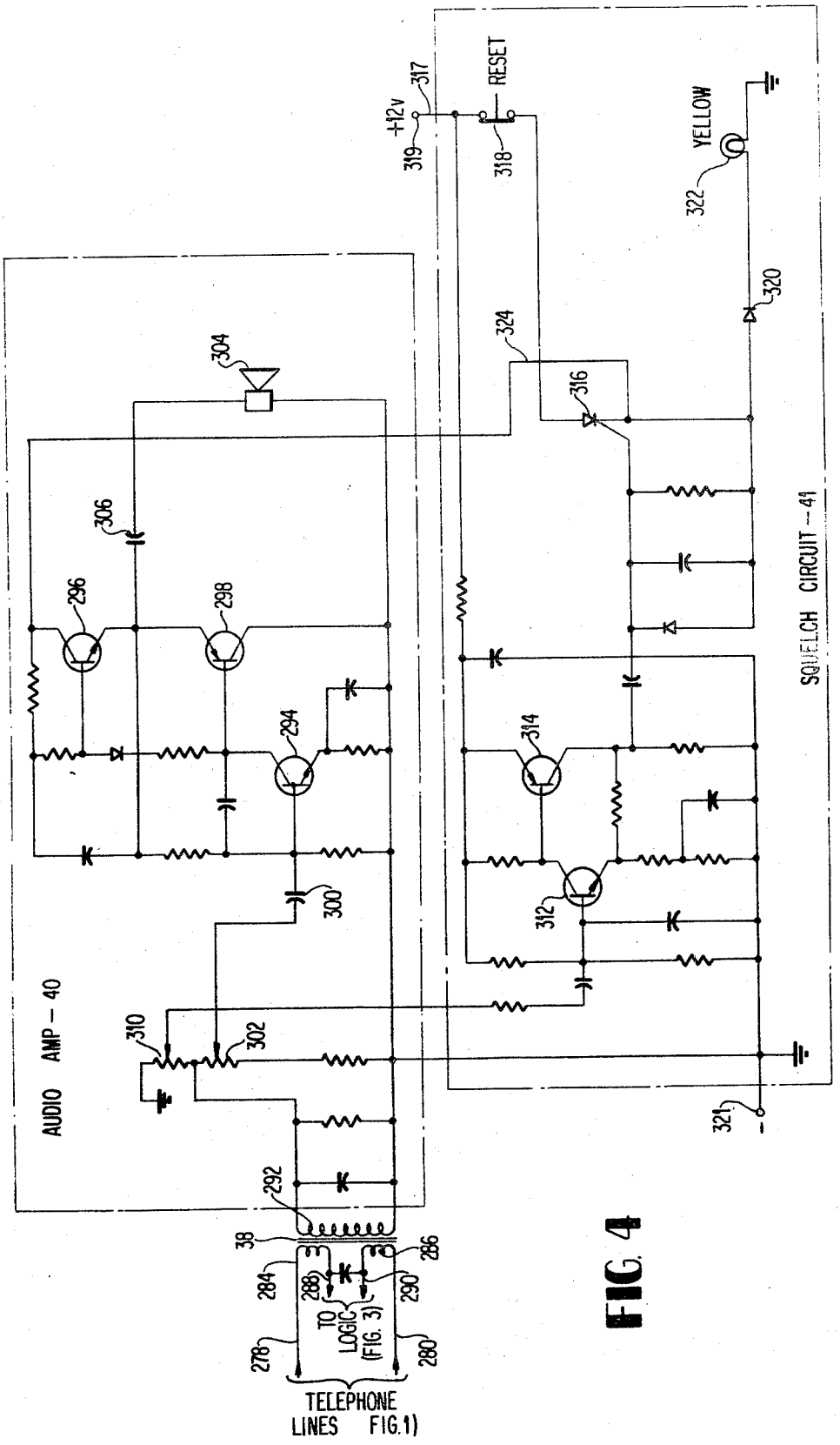

AUDIO AMP - 40
SQUELCH CIRCUIT - 41
+12v
317
319
RESET
318
YELLOW
322
320
324
316
304
306
296
298
294
314
312
310
302
300
292
38
286
284
288
290
TO LOGIC (FIG. 3)
278
280
TELEPHONE LINES FIG.1)
321

FIG. 4

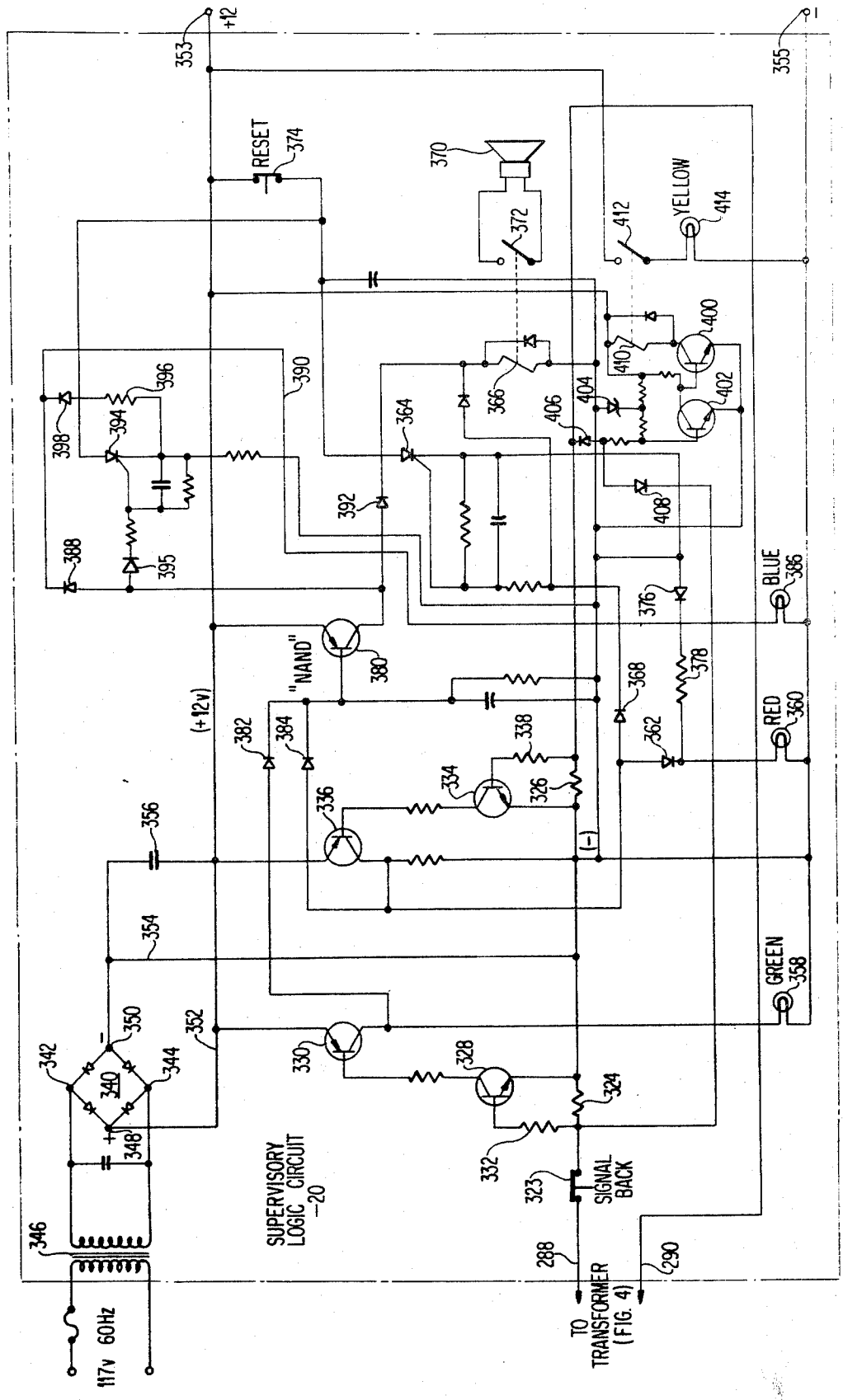

+12
353
355
RESET
374
370
372
412
YELLOW
414
400
402
410
404
406
366
364
390
396
398
394
392
408
388
395
BLUE
386
376
"NAND"
380
(+12v)
368
378
382
384
338
334
326
362
RED
360
336
356
(-)
354
GREEN
358
350
352
342
340
344
330
328
324
348
332
323
SIGNAL BACK
346
SUPERVISORY LOGIC CIRCUIT 20
288
290
TO TRANSFORMER (FIG. 4)
117v 60Hz

FIG. 5

SECURITY ALARM SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to supervised alarm systems and more particularly to a system wherein one or more remote stations under surveillance can respectively communicate with a central monitor station via a two wire telephone line to provide an emergency warning or other type signal to indicate at the central station the source and type of trouble. This invention is particularly adapted to be utilized as a burglary or unwanted intrusion alarm, a robbery or "hold-up" alarm, and even a fire alarm system.

2. Description of the Prior Art

Security alarm systems typical of the prior art presently in use are simple in construction and normally comprise a single closed series loop circuit, including a perimeter protection circuit, extending between the central monitoring station and the protected premises. The perimeter circuit is adapted to include frangible resistive tapes, trap wires, etc. A break in the perimeter circuit thus breaks the closed loop circuit to the central station and initiates an alarm.

The power supply for such systems consists of a battery or other constant voltage power supply located either in the central monitoring station or at the protected premises. With either arrangement, the system is easily compromised or defeated because the specifications for such systems, as dictated by the industry and consumer testing facilities such as the Underwriter's Laboratories, presently require that the systems merely give an indication if the resistance in the total circuit loop in the system varies ± 50 percent. Where telephone lines are utilized to interconnect the protected premises to the central station, the resistance of the lines themselves is in the range of 3,000 ohms. Where a 100 ohm perimeter circuit is connected in series to the 3,000 ohms of the telephone lines, an alarm will not be given until the resistance in the entire loop varies by approximately ± 1,500 ohms. It can be seen, therefore, that the resistance in the perimeter circuit can be tampered with over a considerably wide margin and in some cases entirely removed without interrupting the tolerance built into the system sufficient to sound an alarm.

In order to defeat such a series system where the battery or power supply providing energy for the system is located in the protected premises, it is merely necessary for one attempting to defeat the system to take a voltage measurement across the phone line entering the protected premises that constitutes the circuit to the central station. This will provide information on the size of the battery that must be substituted across the lines for the battery inside of the protected premises and by connecting the battery of the correct potential across the line and then cutting the line into the premises, the premises is removed from the circuit to the central station without interrupting the loop which then can be entered at will without an alarm being indicated at the central station.

Where the battery or power supply is located at the central station as opposed to being in the protected premises, one attempting to compromise the system must first determine the proper resistance to connect across the line going into the premises that connects the protected premises with the central station, but does not have to determine the supply potential. In the first example, one must also determine the substitute resistance for the protected premises and this is done in the same manner as will now be outlined.

A burglar or intruder, for example, must first place an ammeter in one of the lines entering the premises, then cut the line so that the circuit is completed through the ammeter and obtain information as to the current in the line. The line is then spliced together and then the ammeter removed. A voltage measurement is then taken across the two lines into the premises with a volt meter and with this information and using a simple Ohms law calculation, the resistance in the perimeter circuit of the premises can be determined knowing that a substantial portion of the resistance in the loop circuit is in the

phone line itself. A resistance of the value calculated is shunted across the two lines entering the premises and the two lines into the premises are then cut since it is removed from the surveillance loop to the central station without interferring with the loop or initiating an alarm at the central station.

The burglar or intruder does not have to be accurate in determining the store resistance and normally if a resistance in the amount of 200 ohms is shunted across the line, this will defeat the system without sounding an alarm because it is well within the tolerance range of the permissible resistance change in the entire loop before the alarm is sounded. In the system where the power supply is in the protected premises, the substitute resistance is placed in series with the substituted battery. In cases where the protected premises is extremely far from the supervising central station the lines into the premises can be jumpered together without any substitute resistance whatsoever without sounding an alarm because the resistance in the store is less than the resistance range tolerated by the system before initiating an alarm.

Realizing these deficiencies, prior art alarm system have attempted to overcome the problem. For example, U.S. Pat. No. 584,789 issued to H. M. Sutton et al. disclose a method for protecting the lines between a discloses station and a remote station in an alarm system by rapidly and continuously alternating the polarity of a signal current and alternately shifting this current from one set of line wires to another set of line wires, thereby leaving one set of wires momentarily dead at any given moment and causing an alarm signal to operate at the central station upon a variation in the predetermined current flow. Although this patent refers to a "current of constant strength," it is in reality a constant voltage system and any interference with the main line or the protected structure increases or decreases the current through a relay to close an alarm circuit.

U.S. Pat. No. 3,069,673 issued to E. J. Ward et al. discloses a security system having a separate perimeter protection loop and a separate supervisory loop coupled to a central station. A differential relay circuit operated by a control relay in the perimeter loop actuates the supervisory loop to send an alarm back to the central station.

U.S. Pat. No. 3,025,505 issued to A. B. Hube, discloses a two circuit system for protecting enclosed spaces wherein the failure of a blower motor circuit in an air pressure supported structure unbalances a relay to reverse the contacts of a three wire loop to the central station and thus communicate an alarm thereto.

The concept of DC current polarity reversal for an alarm condition of an alarm system is also broadly disclosed in U.S. Pat. No. 3,351,934 issued to N. J. Vietz.

While the above recited prior art presumably operates in the manner set forth in the above cited patents, the general use of electromechanical relay devices as sensing means provides inherent limitations in the system not only due to the fact that electromechanical devices vary in sensitivity from component to component but also in operating characteristics as a result of aging and changes in environmental conditions. Also conventional relay type signalling circuits require relatively high currents in the order of 30 and 40 milliamperes. Furthermore, the prior art systems operate with a substantially constant voltage power supply which by its very nature makes the system relatively easy to compromise by a sophisticated burglar or intruder.

SUMMARY

The subject invention is directed to an improved security protection system which utilizes a constant current generator powering a supervisory loop coupling a protected premises to a central monitor station by means of a pair of ungrounded or floating telephone communication lines. The supervisory loop additionally includes means for reversing the polarity of a relatively small (1.5 –3.0 ma.) DC constant current wherein said means is controlled by the output of a differential electronic

amplifier having one input thereof coupled to circuit means responsive to the change in resistance of a separate perimeter intrusion circuit to reverse the polarity of the DC current in the supervisory loop and thereby signal an alarm condition to the central station. The invention additionally includes means for causing the constant current DC generator to sense a current interruption in the supervisory loop for providing an indication at the protected premises of a system malfunction or as a means for signalling back to said protected premises from the central station. The constant current DC generator inherently makes the system more tamper proof due to the fact that it is capable of utilizing extremely low currents over relatively long line telephone circuits and is immediately responsive to the introduction of any foreign potential, loss of line continuity, and other detrimental circuit faults.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of the security alarm system contemplated by the subject invention;

FIG. **2** is an electrical schematic diagram of a constant current DC generator and current sensing circuit utilized by the system shown in FIG. **1**;

FIG. **3** is an electrical schematic diagram illustrating the current polarity reversing circuit, the perimeter-intrusion circuit, the "hold-up" circuit, and audio surveillance circuit located at the protected premises for the system shown in FIG. **1**;

FIG. **4** is a schematic diagram illustrating audio receiver amplifier and squelch circuit located at the central monitor station for the system shown in FIG. **1**; and

FIG. **5** is an electrical schematic diagram of the supervisory logic circuit located at the central station for providing supervisory indications of the condition of the protected premises for the system shown in FIG. **1**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and more particularly to FIG. **1**, there is disclosed in block diagrammatic form an overall system diagram wherein a plurality of protected premises $\mathbf{10}_1$, $_{102}$ and $\mathbf{10}_n$ are monitored at a remote central station **12** including a respective plurality of supervisory circuits $\mathbf{14}_1$, $\mathbf{14}_2$, and $\mathbf{14}_n$ which are coupled back to the protected premises by means of respective pairs of telephone lines $\mathbf{16}_1$, $\mathbf{16}_2$ and $\mathbf{16}_n$. Each protected premises, for example, is provided with signalling circuitry for providing an indication at the central station **12** of various alarm conditions such as burglary and/or unwanted intrusion, robbery or "hold-up" as well as audio surveillance of the premises under specified conditions, e.g. "night" operation or during a "hold-up" etc.

More particularly, each protected premises contains a constant current DC generator **18** which is adapted to transmit a relatively small DC current (1.5 ma. or 3.0 ma.) over an ungrounded or floating two wire telephone line **16** to a supervisory logic circuit **20** forming part of the supervisory circuit **14**. The DC current is made to pass through a current polarity reverse circuit **22** which is inserted in the current path to the telephone line **16** to provide a polarity reversal in the event of an attempt to compromise a perimeter-intrusion circuit **24** or a "hold-up" circuit **26** is manually actuated. The current polarity is sensed by the supervisory logic circuit **20** providing an indication thereof by indicating lights and sonic alarm means generally shown by reference numeral **28**. As will be described in greater detail in the subsequent description, the perimeter intrusion circuit **24** provides a steady state current reversal in the polarity reverse circuit **22** whereas the "hold-up" circuit **26** is adapted to provide a continuous alternating reversal whereupon the indicator lights **28** provide a coded indication of which condition is occurring. Additionally, the perimeter-intrusion circuit **24** when compromised, either intentionally or otherwise, activates an indicator light **30** at the protected premises **10**. Audio communication or surveillance is provided by an audio transformer **32** coupled into the DC current communication link including the two wire telephone line **16**. An audio amplifier **34** coupled to one or more microphones **36** located in the protected premises is connected to the audio transformer **32** so that audio signals picked up by the microphone **36** are transmitted to the respective supervisory circuit **14** which also includes a corresponding audio transformer **38** coupled to the telephone lines at that end. The output of the audio transformer **38** is then coupled into an audio amplifier **40** which also has a squelch circuit **41** coupled thereto so that an output to a loud speaker **42** will only be provided when the audio level back at the protected premises exceeds a predetermined value.

A current sensor circuit **44** is coupled to the constant current DC generator **18** to sense a current interruption to of the DC current flowing between the DC generator **18** of the protected premises **10** and the supervisory logic circuit **20** located at the central station **12**. An indicator light **46** is coupled to the current sensor circuit **44** to provide an indication of the DC current failure which may be caused for example by: (1) a break in the telephone line **16** accidentally, (2) in the event that one attempts to insert a device such as a dummy load into the system for defeating the alarm circuitry, (3) or an intentional momentary opening of the circuit to provide a signalling back to the protected premises from the central monitor station **12**. A push button switch **48** of the like contained in the supervisory circuit **14** can provide the third operating mode. Additionally, the supervisory circuit **20** also contains means, as will be subsequently illustrated, to also sense an open circuit condition or a failure of the constant current DC generator **18** and provide an indication of such a condition by means of the indicator lights **28**.

The use of the constant current DC generator **18** located at the protected premises **10** as disclosed in FIG. **1** is capable of employing currents at a relatively low value considering prior art relay type signalling circuits which necessarily employ currents as high as 30 or 40 milliamps. These higher currents produce circuit problems with extremely small gauge telephone line pairs presently available for leasing. As wire gauges get smaller, practical signalling distances become even shorter. As noted above, with a constant voltage variable current system a foreign potential of the right voltage and polarity can accidentally or intentionally be substituted for the signalling source without giving a false alarm. The latter condition occurs when a sophisticated or knowledgeable burglar for example defeats the system. The use of a constant current DC generator on the other hand makes it considerably more difficult to compromise the system because in order to do so a constant current generator must be substituted into the communication link externally of the protected premises while at the same time disconnecting the constant current generator **18** without interrupting the current flow in the telephone lines **16** of varying its predetermined magnitude either of which would be sensed by the supervisory logic circuit **20** whereupon an alarm condition would be indicated.

Considering now the subject invention in greater detail, reference now is made to FIG. **2** wherein reference numeral **50** designates a regulated DC power supply of conventional design for providing a +12 volt supply voltage. A 117 volt/60Hz AC line potential is applied to the terminals **52** and **54** which is then coupled to the power supply **50** by means of a power transformer **56**. The volt supply voltage appears across the positive (+) supply buss **58** and the negative (−) supply buss **60**. FIG. **2** additionally discloses a schematic representation of the preferred embodiments of the constant current DC generator **18** referred to in FIG. **1** as well as the current sensor circuit **44**. The constant current DC generator basically comprises a feedback controlled DC to DC voltage converter capable of providing two magnitudes (1.5 milliamps and 3.0 milliamps) of constant DC current. The DC to DC converter comprises a well known DC to AC chopper circuit including transistor switches **62** and **64** coupled to transformer **66** and driven by means of a free running multivibrator **68** including transistors **70** and **72**. The action of the multivibrator **68**

causes mutually opposite conductive states to alternately occur in transistors 70 and 72 for equal durations of time so that a square wave output signal appears at their respective collector electrodes. These square wave outputs are respectively coupled to the base electrodes of transistors 62 and 64 by means of resistors 74 and 76 so that transistors 62 and 64 are driven "on" and "off" accordingly. For example where transistors 62 is in an "on" state, transistor 64 is in an "off" state, and vice versa. Moreover when either of transistors 62 or 64 is "on," the +12 volt supply potential is applied to one end of the primary winding 78 of the transformer 66. Depending upon the magnitude of the voltage appearing at the center tap 80 of the primary winding 78, a corresponding AC voltage will appear across the secondary winding 82 for the combined switching of transistors 62 and 64. Where for example the frequency of operation of the multivibrator 68 is in the order of 2500 to 3000 cycles per second, a corresponding frequency AC output will appear across the secondary winding 82. A smoothing capacitor 84 is connected directly across the winding 82. The AC output voltage appearing across the secondary winding 82 is applied across opposite terminals 86 and 88 of a full wave rectifier bridge 90 so that a DC voltage appears across terminals 92 and 94.

A current sensing feedback control circuit for maintaining a predetermined constant current value at terminals 92 and 94 of the output of the rectifier bridge 90 is included which maintains the voltage at the center tap 80 at a predetermined voltage level so that either a 1.5 or 3.0 ma. output is constantly provided. This is effected by means of a current sensing transformer 96 the primary winding 98 of which is coupled in series between one end of the secondary winding 82 and the input terminal 86 of the rectifier bridge 90. The magnitude of the AC current flowing through the primary winding 98 is sensed across the secondary winding 100 which is then rectified by means of the semiconductor diodes 102 and 104 and applied across one side 106 of capacitor 108 which has its opposite side 110 coupled to the center tap 112 of the secondary winding 100. The magnitude of the voltage across capacitor 108 then is proportional to the AC current flowing in the output circuit of the transformer 66. A voltage divider circuit including fixed resistors 114, 116, 118 and thermistor 120 connected in parallel with resistor 116 is connected across capacitor 108. The voltage appearing at the junction between resistor 116 and 118 is applied as one input to a differential amplifier including transistors 122 and 124. It should also be noted that the + side 106 of capacitor 108 is also coupled to the +12 volt supply buss 58 through resistor 126 thereby providing a substantially constant voltage at circuit junction 127. The input signal applied to transistor 122 which is proportional to the DC to DC converter output current is compared against a fixed voltage reference provided by the diodes 128 and 130 as well as resistor 132 which is commonly connected to chassis ground in combination with the base of transistor 124.

Chassis ground is adapted to be at a +6 volt level provided by the perimeter-intrusion circuit 24 which will be subsequently considered. This +6 volt voltage is applied at terminal 134. One section A of a three pole two position "Day-Night" switch 136 is connected by means of its normally closed contacts between chassis ground and the common connection between diodes 128 and 130. The normally closed position of switch section 136-A referred to as the "day" position D, provides a fixed voltage reference to the other input of the differential amplifier including transistors 122 and 124 to produce a constant DC current of 1.5 ma. out of the rectifier bridge at terminals 92 and 94. The open position of switch section 136-A is referred to as the "night" position N and provides a voltage reference which is adapted to cause a constant DC current of 3.0 ma. from the rectifier bridge 90 output.

The differential amplifier output provided at the collector of transistor 122 is directly coupled to the base of transistor 138 which in turn is coupled by means of its collector electrode and resistor 140 to the base of transistor 142. Transistor 142 is shunted across capacitor 144 which is directly connected between the center tap 80 of primary winding 78 and the negative side of the 12 volt supply appearing at the supply buss 60. Transistors 138 and 142 are controlled by the differential output of transistors 122 and 124 to cause transistors 142 to act as a variable resistive impedance across capacitor 144 to control the electrical charge on capacitor 144. If for example transistor 142 is fully conductive, it acts as a virtual short circuit across capacitor 144 whereupon it fully discharges and the center tap 80 is directly connected to the − supply buss 60. When this condition occurs, a full 12 volt square wave is alternately impressed across each half of the primary winding 78. In the condition where transistor 142 is only partially conductive, capacitor 144 accumulates a charge whereupon the potential at the center tap 80 rises to a value so that the amplitude of the square wave impressed across the primary of the transformer 66 is decreased. Thus, the negative feedback provided by the current transformer 96, the differential amplifier including transistors 122 and 124 as well as the transistors 138 and 142 in combination with capacitor 144 will change the voltage at center tap 80 to effectively control the magnitude of the DC current flow of terminals 92 and 94 of the rectifier bridge and maintain it at a value as determined by the position of the day-night switch section 136-A.

Completing the consideration of the constant current generator 18 one or more stages of RC filter circuitry 146 is coupled across the output terminals 92 and 94 of the rectifier bridge 90 in order to remove any undesired ripple or other noise present from being transmitted to the current polarity reverse circuit shown in FIG. 3.

In the event that circuit interruption for current flow from the secondary winding 82 of the transformer 66 occurs, the current transformer 96 will sense the current interruption and the voltage appearing across capacitor 108 will fall whereupon transistors 148 and 150 in the current sensor circuit 44 will become conductive since junction 110 is coupled to the base of N-P-N transistor 148 by means of resistor 152. Since the emitter of transistor 148 is coupled to the +12 volt supply buss 58 by means of resistor 126, it will become conductive as the voltage at junction 110 falls. The conductive of transistor 148 causes transistor 150 to become conductive, due to the coupling of the resistors 154 and 156. When transistor 148 becomes conductive, a signal is coupled to the base of transistor 150 by means of resistor 154 which renders it conductive. The conductive transistor 150 acts like closed switch and applies the +12 volts appearing on supply buss 58 across the green indicator lamp 46 which is connected between the collector of transistor 150 and the − supply buss 60. Thus for any discontinuity of the predetermined DC constant current, the indicator light 46 will be turned "on" and an indication of this condition will be displayed at the protected premises 10.

Now referring to FIG. 3 attention is directed to the constant current polarity reverse circuit 22 which includes a pair of circuit leads 160 and 162 which are coupled to the filter circuit 146 connected across the output terminals 92 and 94 of the rectifier bridge 90 shown in FIG. 2. Leads 160 and 162 are respectively connected to sets of relay contacts 164 and 166 of a double pole electromagnetically actuated relay 168 which constitutes a current reversing relay energizable by means of the relay coil 170. The circuit leads 160 and 162 are selectively coupled to a pair of output circuit leads 172 and 174 by means of the current reversing relay 168 and the secondary windings 176 and 178 of the audio transformer 32 shown in FIG. 1 which has its primary winding coupled to the audio amplifier 34. The circuit lead 160 is connected to the output lead 174 through contacts 164 and the secondary winding 178 when relay 168 is in its normally deenergized position while circuit lead 162 is connected to the output lead 172 through contacts 166 and the secondary winding 176. When the current reversing relay 168 is energized, however, relay contacts 164 and 166 will operate to reverse the connections.

The purpose of the audio transformer 32 is to couple the microphone 36 and amplifier 34 when energized to the output

leads 172 and 174. The audio surveillance circuit shown in FIG. 3 can be eliminated when desirable which in turn removes the requirement for the transformer 32 whereupon relay contacts 164 and 166 would directly interconnect circuit leads 160 and 162 to the output leads 172 and 174. A capacitor 184 is coupled between opposite ends of the secondary windings 176 and 178 so that relay operation does not interfere with the operation of the audio amplifier 34 when energized. In this respect, the audio amplifier 34 is energized by the application of the +12 volt supply voltage thereto either by means of resistor 186 which is connected to the night terminal N of the second section B of the "day-night" operation switch 136 or circuit lead 188 coupled back to the "hold-up" circuit 26. In the present invention, therefore, the audio amplifier is energized when the switch 136-B is manually switched to "night" operation or whenever the "hold-up" circuit is energized.

The perimeter-intrusion circuit 24 and the hold-up circuit 26 operate to energize the relay coil 170 in the following manner. Considering first the perimeter-intrusion circuit 24, a frangible resistive tape circuit of well known construction is generally illustrated by the fixed resistance 190. The value of this resistance is in the order of 25 -100 ohms, depending upon the kind and length of tape and wiring utilized. It is applied to the perimeter of glass windows and doors etc. and is coupled in series between chassis ground and the +12 volt supply potential through a perimeter interlock switch 192, the third section C of the "day-night" operation switch 136, a variable resistor 194 and a fixed resistor 196. The +12 volts is coupled to the circuit by means of terminal 197 and supply buss 199 which is adapted to be connected to supply buss 58 shown in FIG. 2. The resistive tape 190 is coupled in series with perimeter interlock switches 192 to the "night" terminal N of the switch 136-C while a variable resistance 198 is connected between the "day" terminal D and resistive tape 190, to chassis ground so that during "day" operation a resistance may be substituted for the perimeter interlock switch circuit. The variable resistor 194 is adapted to adjust the value of the potential applied across both the perimeter or protection circuit resistance 190 and the substitute resistance 198.

The voltage divider potential appearing across resistance 190 and the rheostat 198 is coupled to one input of a differential amplifier circuit 200 comprised of transistors 202 and 204. This input is applied through resistor 206 to the base of transistor 202. The other input to the differential amplifier 200 consists of a reference voltage applied to the base of transistor 204 by means of the fixed resistors 208 and 210 in combination with the adjustable resistance 212 all coupled in series between circuit junction 213 and the +12 volt supply voltage appearing in supply buss 199. The variable resistor 212 provides a means of adjusting the value of the reference potential applied to the base of transistor 204 to a predetermined value. Junction 213 is connected to chassis ground which in the embodiment of all the circuitry included at the protected premises 10 is made to be at a value of +6 volts. This is provided by the action of P-N-D transistor 214 which has its emitter directly connected to junction 213. The base of transistor 214 is connected to a voltage divider consisting of fixed resistors 218, 220 and 222 which are connected in series across the 12 volt supply potential. The negative pole of the supply potential is provided by supply buss 223 which is connected to terminal 216 which in turn is adapted to be connected to the buss 60 shown in FIG. 2. The common connection between resistors 220 and 222 is made to have a value of +6 volts so that the connection of the collector of transistor 214 to the negative buss 223 causes transistor 214 to become conductive and apply the +6 volts directly to chassis ground through junction 213. This +6 volt potential is also connected to terminal 221 which is common to terminal 134 shown in FIG. 2. The reason for this condition to exist is in order to allow the output signal voltages of the differential amplifier 200 appearing at circuit junctions 224 and 226 respectively to swing both upwardly and downwardly from the preset operating point. This is established by making the value of the variable resistance 198 substantially identical to the perimeter wiring and interlock switch 192 resistance and then with the switch section 136-C in the "night" position N, the variable resistance 194 is adjusted to provide an input in the order of 60 millivolts to the base of transistor 202, at which value the differential amplifier 200 will respond to ± 30 percent change in the perimeter tape resistance 190. Any deviation of the resistance 190, e.g. by breaking the tape or attempting to defeat the system, from the ± 30 percent value as established by the variable resistance 194 will cause one or the other of transistors 228 or 230 to become conductive.

The collectors of both P-N-P transistors 228 and 230 are coupled to the base of N-P-N transistor switch 234 by means of respective collector load resistors 236 and 238 such that when either transistor becomes conductive transistor 234 receives a signal which will render it conductive also. Since the emitter of transistor 234 is directly connected to the negative side of the supply potential appearing on buss 223 and whereas the collector is coupled to one side of the relay coil 170 through diode 240 the conduction of transistor 234 causes the relay coil 176 through diode 240 the conduction of transistor 234 causes the relay coil 170 to energize because the other side of relay coil 170 is directly connected to the +12 volt supply buss 199. Relay contacts 164 and 166 switch upon energization of coil 170 and reverse the polarity of the current flow of the constant current in output leads 172 and 174.

A tunnel diode 242 is coupled across the base-emitter junction of transistor 234 in order to provide a more positive actuation of the relay coil 170 since the tunnel diode 242 will effect a much faster turn-on of the transistor 234 whenever either of the transistors 228 or 230 is rendered conductive. The turn-on of transistor 234 also energizes a red indicator lamp 30 which has one side connected to +12 volt supply providing an indication at the protected premises 10 of a compromise of the perimeter intrusion circuit 24.

Whereas prior art apparatus in some cases utilizes differential relay circuitry which is directly actuated by a change in either the perimeter circuit resistance alone or the combination of the perimeter circuit resistance plus the resistance in the transmission line, the present invention is adapted to provide a greater sensitivity in the protection circuit due to the fact that the current reverse relay 168 is not directly controlled by the perimeter resistive tape circuit resistance 190 but acts in response to a change only in the perimeter circuit resistance which is sensed by the differential amplifier 200. It is the highly sensitive differential amplifier 200 including the transistors 202 and 204 which control the relay coil 170 through the turn-on of transistor 234 which is in series with the relay coil across the +12 volt supply potential. In other words, most resistive sensing circuits employ sensitive relays. These relays necessarily have wide tolerance between pull-in and drop-out current. Furthermore, in "direct wire" alarm systems utilizing telephone lines, the line resistance is a part of the overall circuit and compromise protection is not what it should be over relatively long high resistance lines. Also most conventional circuits will not measure minute changes in current.

In the present embodiment, however, the alarm condition threshold of the perimeter-intrusion circuit 24 is adjusted by means of rheostat 194 until the current flow through the perimeter resistance 190 equals a voltage input to the differential amplifier 200 which will not trigger the turn-on of transistor 234. When the voltage drop across the perimeter resistance which is applied to the base of transistor 202 drops below or increases above the reference voltage appearing at transistor 204 by a predetermined percentage indicative of an alarm condition, the developed error signal operates to turn-on transistor 234 causing the current reverse relay 168 to operate and maintain its new state until the alarm condition is corrected and provide an alarm signal back to the central station. While not specifically shown, the perimeter resistance

190 may when desirable include a positive or a negative temperature coefficient thermistor to compensate for environmental resistance changes.

In addition to the perimeter intrusion circuit **24** being operable to operate the current reverse relay **168** for a sensed change in the perimeter resistance **190**, the "hold-up" circuit **26** is also adapted to activate the current reverse relay **168** but in a slightly different mode of operation. Whereas a detected change in the perimeter resistance **190** will cause a steady state actuation of the current reverse relay **168**, the "hold-up" circuit **26** will cause a continuous alternating reversal of the current relay **168** to constantly cause the current to reverse back and froth and provide a flashing type of visual indication at the central station **12**.

Considering now the "hold-up" circuit **26**, it is comprised of a normally deenergized free running multivibrator circuit **244** including transistors **246** and **248** which receive the +12 volt supply potential on supply buss **199** through a silicon controlled rectifier (SCR) **250** coupled to the +12 volt supply buss **199** over circuit lead **252**. The actuation of a normally open push-button switch **254** causes a positive trigger voltage to be coupled to the gate of SCR **250** by means of resistors **256** and **257** and the diode **258** to turn the SCR **250** "on." When SCR **250** is "on," i.e. in its conductive state, the +12 volt supply potential appears at circuit junction **260** which is at the cathode electrode of SCR **250**, and which then applies the +12 volt supply potential to the multivibrator **244** by means of resistor **262**. The application of the +12 volt supply potential to the multivibrator **244** causes a square wave voltage output signal to be applied to the base of transistor **264** which in turn is coupled to transistor **266**. Transistor **266** is alternately rendered conductive and non-conductive thereby which momentarily returns one side of the relay coil **170** to the negative supply buss **268**. In this manner the current reverse relay **168** is operated in a flip-flop fashion having a frequency of operation determined by the operating frequency of the multivibrator **244** which may be, for example, one pulse per second.

In addition to energizing the multivibrator **244**, the turn-on of SCR **250** by means of the hold-up switch **254** also couples the ++12 volt supply potential to the audio amplifier **34** in the audio surveillance circuit by means of the diode **268** and resistor **186** in order to provide a "listening-in" capability of the protected premises at the central station **12**. In this manner, this capability provides an advantage in that not only can the sounds and voices surrounding the hold-up situation be heard, but a description of the robbers can immediately be transmitted to the central station for relay to the police department, etc. providing greater speed in apprehension.

A silicon controlled rectifier characteristically operates such that when its gate electrode is selectively triggered to turn the device "on," it will remain in an "on" condition until it is deactivated. This is provided in the subject circuit by means of a normally open "reset" push-button switch **270** which is coupled across the device through capacitor **272** which charges up when the "reset" switch **270** is closed to render the SCR **250** non-conductive. When SCR **250** is turned "off" the hold-up circuit **26** again reverts to its normal "standby" state and the +12 volt supply voltage is removed both from the multivibrator **244** and the audio amplifier **34**.

Completing the description of the "hold-up" circuit **26**, the operation of the multivibrator **244** does not activate or turn-on the red indicator light **30** in the perimeter-intrusion circuit **24** due to the polarity coupling of diode **240** between the lamp **30** and one side of the relay coil **170** which is common to the collector of transistor **266**. The present embodiment of the circuitry thus described also has for its objective an override capability over the perimeter intrusion circuit **24** in the event of the "hold-up" circuit **26** is simultaneously activated. This priority is provided by transistor **274** coupled across the base and emitter of transistor **234** in the perimeter intrusion circuit **24**. When the +12 volt supply voltage is applied to the multivibrator circuit **244** the +12 volts supply potential is also applied to the base of the transistor **274** by means of circuit lead **276** and resistors **277** and **279** which will render transistor **274** conductive and apply a virtual short circuit across transistor **234** so that it cannot be activated and cause the red indicator lamp **30** to be energized notwithstanding the fact that the perimeter circuit resistance **190** has been compromised and a control signal indicative thereof has been coupled to either transistor **228** or **230** from the differential amplifier **200**.

What has been described thus far is the circuitry contained at the protected premises where in a normal "stand by" state the constant current DC generator **18** shown in FIG. **2** applies a relatively minute DC current (1.5 or 3.0 ma.) in a predetermined polarity direction over a two wire telephone line **16** which is preferably ungrounded, i.e. floating, to a supervisory logic circuit **20** at the central station **12**. In the event of the compromise of the perimeter circuit resistance **190** only, the current reversal relay **168** is actuated in response to a control signal provided by a highly sensitive electronic differential amplifier **200** to cause a steady state polarity reversal of the constant current DC current in the telephone line **16**. If a "hold-up" for example occurs, the "hold-up" circuit **26** is actuated whereupon the current reversal relay is caused to alternate continuously at a rapid rate causing the polarity of the DC current to switch back and forth as long as the "hold-up" circuit is initiated. Additionally, the "hold-up" circuit also causes the audio surveillance circuit including the microphone **36** and audio amplifier **34** to be actuated so that audio signals can additionally be transmitted from the protected premises **10** to the central station **12**. Under certain conditions the audio surveillance circuit can be actuated independently such as for "night" operation by switch **136-B** (FIG. **3**) whereupon a continuous audio surveillance can be provided over the two wire telephone lines.

Bearing the foregoing in mind, it becomes necessary that the supervisory circuitry **14** located at the central station **12** respond to the coded signalling respectively provided by the audio surveillance circuit, the "hold-up" circuit and the perimeter intrusion circuit. Referring now to FIGS. **4** and **5**, the other end of the two wire telephone line **16** at the central station **12** is coupled into a pair of input circuit leads **278** and **280** as shown in FIG. **4** which are connected to the audio transformer **38** shown in FIG. **1** which is identical to the transformer **32** located in the polarity reverse circuit **22** shown in FIG. **3**. Circuit leads **278** and **280** are connected to one end of the windings **284** and **286** respectively which at this end of the communication link act as primary windings. The opposite ends of windings **284** and **286** are directly connected to the supervisory logic circuit **20** shown in FIG. **5** by means of circuit leads **288** and **290**. In the event that an audio signal is sent over the two wire telephone line **16**, it will appear across winding **292** of transformer **282** which is then coupled to a conventional transistor audio amplifier including transistors **294**, **296**, and **298**. The audio signal is capacitively coupled from the transformer winding **292** by means of the capacitor **300** which is connected to a "volume" adjust potentiometer **302** which is adapted to couple only a selected amount of the signal amplitude appearing across transformer **292** to the amplifier. Ordinarily, any audio signal coupled to the transformer **282** from the protected premises **10** would be amplified and heard at the central station **12** by means of a loudspeaker **304** coupled to the common emitter connection between transistors **296** and **298** by means of the capacitor **306**.

In the preferred embodiment of the subject invention squelch circuit **41** shown in FIG. **4** is employed to normally render the audio amplifier **40** deenergized until a certain predetermined signal level appears across the winding **292**. The squelch circuit **41** is adapted to eliminate unwanted background noise from being constantly monitored. This circuit consists of a "sensitivity" potentiometer **310** coupled between one end of transformer winding **292** and chassis ground. The slider portion of the potentiometer **310** is capacitively coupled to a two stage transistor amplifier including transistors **312** and **314** which has for its objective the coupling of a triggering signal to the gate of SCR **316** which is

coupled across a +12 volt power supply potential appearing on supply buss **317** and chassis ground, across terminals **319** and **321**, by means of the series circuit combination of a normally closed push-button "reset" switch **318**, a semiconductor diode **320** and a yellow indicator lamp **322**. A normally unenergized supply buss **324** is coupled between the SCR **316** and the collector of transistor **296** in the audio amplifier **40**. When the audio signal amplitude exceeds the predetermined level as set by the potentiometer **310**, SCR **316** is rendered conductive at which time the +12 volt supply potential supplied through the "reset" switch **318** is applied simultaneously to the supply buss **324** and through the diode **320** to the yellow indicator lamp **22**. Once activated, the squelch circuit **41** will remain in continuous operation with the yellow indicator lamp **22** remaining "on" until such time that the "reset" switch **318** is manually opened at the central station **12** whereupon SCR **316** will be turned "off" and the entire audio amplifier **40** and squelch circuit **41** will revert back to a "stand by" state.

Referring now to the supervisory logic circuit **20** shown in FIG. **5**, it is adapted to sense: (1) the instantaneous polarity, both steady state and alternating, of the constant DC current transmitted from the constant current DC generator **18** shown in FIG. **2**, (2) the value of the constant DC current, and (3) the intermittent or continuous loss of constant DC current, as well as providing indications of these three conditions by means of indicator lights. Also an audible alarm is provided during alarm condition as well as for a loss of constant DC current. The constant current circuit loop between the constant current generator **18** in the protected premises **10** and the supervisory circuit **14** is provided by means of circuit leads **288** and **290** being coupled together in the logic circuit **20** through a series connection of a "signal back" push-button switch **323** and resistors **324** and **326**. DC current flow in one polarity direction produces a voltage across resistor **324** which is adapted to cause transistors **328** and **330** to become conductive or turn "on." A current in the opposite polarity direction, however, will not turn transistor **328** and **330** "on" due to the way in which the base and emitter electrodes of the transistor **328** is coupled across resistor **324** by means of resistor **332**. A current in the opposite direction, however, causes a voltage drop to occur across resistor **326** which is of a proper polarity to turn transistors **334** and **336** "on." It is seen then that the base and emitter electrodes of transistor **334** is coupled across resistor **326** by means of resistor **338** in an opposite sense to that shown with respect to transistor **328**.

These transistors are powered from a **12** volt power supply potential produced by the full wave DC rectifier bridge **340** which as 117 volt, 60Hz AC line potential applied across terminals **342** and **344** by means of the transformer **346**. Terminals **348** and **350** of the rectifier bridge constitute the +12 volt and −12 volt terminals respectively to which supply buss leads **352** and **354** are connected. A capacitor **356** is coupled across terminals **348** and **350** for providing a filter action of the +12 volt DC supply voltage.

Thus when a constant DC current of a first polarity direction flows through circuit leads **288** and **290**, transistor **328** and **330** will be rendered conductive. Transistor **330** acts substantially as a closed switch and the 12 volt DC power supply potential appearing across busses **352** and **354** is applied across a green indicator light **358** providing an indication of this first current polarity which by definition is made to indicate the "normal" steady state condition of the alarm system. Upon energization of the current reverse relay **168** (FIG. **3**) (FIG. described above, being indicative of an alarm condition, the DC constant current polarity will cause transistor **336** to act as a substantially closed switch and apply the 12 volt supply voltage across a red indicator lamp **360** through the diode **362** providing an indication of an alarm condition. The green indicator lamp **358** meanwhile is "off" due to the fact that transistor **330** has become non-conductive. If for example the perimeter-intrusion circuit **24** actuates the current reverse relay **168**, a continuous red indication will be provided. On the other hand, however, if the "hold-up" circuit **26** actuates the current reverse relay **168** in the alternately mode previously described both the green and red indicator lights **358** and **360** respectively will alternately turn "on" providing a flashing indication.

In addition to operating the red indicator lamp **360**, transistor **336** is coupled to SCR **364** and relay coil **366** through the diode **368**. The purpose of this circuit is to energize an audible alarm **370** through the relay contacts **372** which is actuated by the relay coil **366**. Thus both a visual and audio alarm is provided during an alarm condition. The purpose of the SCR **364** is to additionally provide a memory voltage signal to the red indicator lamp **360** after the alarm condition has subsided. As noted before, once a silicon controlled rectifier is triggered conductive, it will remain conductive until the circuit is interrupted. Accordingly, SCR **364** will provide a current path for the red indicator lamp **360** from the +12 volt supply buss **352** through a normally closed "reset" push button switch **374**, a diode **376** and a resistor **378**. The resistor **378** limits the voltage applied to the indicator lamp **360** so that it will light relatively dimly as compared to the brightness provided for the previously described alarm condition. The dim red indicator lamp thus designates that an alarm condition has occurred but which has subsided. Pressing the "reset" switch **374**, however, will turn SCR **364** "off" and extinguish the dim red light **360**. The circuitry surrounding SCR **364** then merely acts as a memory circuit.

In the event that the circuit loop completing the constant DC current flow between the protected premises **10** and the central station **12** is interrupted for any reason, transistor **380** in combination with diodes **382** and **384** act as a logic NAND circuit such that transistor **380** only becomes conductive when both transistors **330** and **336** are non-conductive. When this occurs a blue indicator lamp **386** is turned "on" by means of +12 volt being applied thereto through diode **388** and circuit lead **390** coupled thereto, since when transistor **380** is made conductive it acts as a closed switch. Additionally, the collector of transistor **380** is coupled to the relay coil **366** by means of the diode **392** so that when current interruption occurs, the audio alarm **370** is also actuated.

A second memory circuit including SCR **394** is coupled between the NAND circuit transistor **380** and the "reset" switch **374** to provide an indication of current interruption after this condition no longer exists. The blue indicator lamp **360** then is lighted whenever an open line condition occurs such as when a "signal back" is desired from the central station **12** to the protected premises merely by momentarily opening the push-button switch **323** which would then be sensed by the current relay **96** (FIG. **2**) in the constant current generator **20**. A loss of current such as would occur for a malfunction of the constant current generator **20** would also cause the blue indicator lamp **386** to light in the supervisory circuit **14**. A shorted telephone line **16** or open lines **172**, **174** and **288** and **290** for example would also be indicated by the blue lamp **386**. SCR **394**, however, is triggered "on" by the NAND circuit transistor **380** by means of the diode **394**. After the current interruption condition subsides, however, SCR **394** still conducts and provides a current path to the blue indicator lamp **386** through the resistor **396** and diode **398**. The resistor **396** limits the current through the blue indicator lamp **386** so that it shines dimly in the same manner as previously described with respect to the red indicator lamp **360**. A subsequent actuation of the normally closed "reset" switch **374**, however, will cause SCR **394** to become non-conductive whereupon the dimly lit blue indicator lamp is turned off.

Finally, a DC constant current level measuring circuit is provided which includes transistors **400**, **402** and zener diode **404** in combination with the diodes **406** and **408** which is operative to cause transistors **400** and **402** to become conductive whenever a predetermined level, for example, 2.5–3.0 ma. is being transmitted from the constant current DC generator **18** at protected premises **10**. When this condition occurs relay coil **410** becomes energized closing the relay contacts **412** whereupon the +12 volt supply potential on supply buss **354** is

applied across a yellow indicator lamp 414. Section A of the "day-night" switch 136 controls the DC current level so as to provide a 1.5 ma. current flow during "day" operation and 3.0 ma. during "night" operation as previously explained. Therefore, the yellow lamp 414 at the central station 12 provides indication at the supervisory circuit 14 when lit that the system is in the "night" operating mode.

The supervisory logic circuit 20 then provides a coded indication both visually and audibly of the condition of the respective perimeter intrusion circuit 24 and the hold-up circuit 26 located at the protected premises to which it is connected as well as the condition of the communication link between the protected premises and the central station. The protected premises on the other hand is adapted to provide a visual indication of the condition of the perimeter-intrusion circuit 24 as well as a loss or substantial reduction of the constant DC current flowing in the communication link including the telephone transmission lines.

What has been shown and described therefore is a reliable fully supervised bi-directional signalling system for use in alarm, telemetry, remote control and other applications which is operable in combination with relatively long wire circuits such as telephone lines while utilizing extremely low currents and which will at the same time indicate trouble and/or alarm indications at the introduction of foreign potential, loss of line continuity, or other detrimental circuit faults. DC signalling is achieved by means of constant current control and DC polarity sensing over a communication link which is completely independent of a protection circuit which senses predetermined operating conditions at a location remote from a central monitor station. Signalling back to the remote location is achieved by breaking the line continuity and causing the constant current generator located at the remote location to sense the open line.

Having thus described the present invention with what is at present considered to be the preferred embodiment thereof, claim as our invention:

1. A security alarm system for supervising a protected premises remotely located with respect to a central monitor station, comprising, in combination:

transmission line means interconnecting said protected premises to said central monitor station;

a constant current DC generator including current sensing feedback means for providing a substantially constant amplitude DC output current of a selected magnitude coupled to said transmission line means;

a supervisory circuit located at said central monitoring station coupled to said transmission line means, said supervisory circuit providing a normally closed current path for said DC output current from said constant current DC generator and including circuit means for providing an indication of the direction of flow of said DC output current and an absence thereof;

protection circuit means located at said protected premises including control circuit means coupled thereto for providing a control signal in response to the operating characteristics of said protection circuit; and

current polarity reversal means coupled to said transmission line means intermediate said constant current DC generator and said supervisory circuit, being additionally coupled to said control circuit means and responsive to said control signal to reverse the polarity of current flow of said DC output current from one current direction indicative of normal operation of said protection circuit to an opposite current direction indicative of an abnormal operations when a predetermined change in operation of said protection circuit means occurs.

2. The invention as defined by claim 1 wherein said transmission line means includes a two wire telephone transmission line.

3. The invention as defined in claim 2 wherein said two wire telephone transmission line comprises a floating pair of telephone lines.

4. The invention as defined in claim 2 wherein said constant current DC generator is coupled to one end of said two wire telephone transmission line and said supervisory circuit is coupled to the opposite end of said two wire telephone transmission line.

5. The invention as defined in claim 4 wherein said constant current DC generator is located at said protected premises.

6. The invention as defined by claim 5 where said two wire telephone transmission line comprises an ungrounded pair of telephone lines.

7. The invention as defined in claim 4 wherein said current polarity reversal means comprises a relay having relay contact means and a relay coil being electrically energizable for operating said relay contact means, and additionally including means coupling said relay contact means to said transmission line means and said relay coil to said control circuit means.

8. The invention as defined by claim 7 and wherein said protection circuit means comprises perimeter resistance means and a potential coupled thereto for providing a voltage drop thereacross, said resistance means being adapted to change in resistance value or become an open circuit when said protection circuit means is compromised and provide a change in voltage drop thereacross, said control circuit being responsive to said change in voltage drop to generate said control signal for energizing said relay coil.

9. The invention as defined by claim 8 wherein said perimeter resistance means includes a frangible resistive element strategically located at said protected premises.

10. The invention as defined by claim 9 and additionally including a variable resistance coupled in series with said frangible resistive element intermediate said potential and having a common circuit connection therebetween, said variable resistance providing a means for controlling the potential applied across said frangible resistive element.

11. The invention as defined by claim 10 and wherein said control circuit means comprises:

a differential electronic amplifier circuit having first and a second input means and at least one output means;

circuit means coupling said common circuit connection to said first input means; and

means for providing a predetermined reference voltage coupled to said second input means, said differential amplifier circuit being responsive to a predetermined change in the voltage across said frangible resistive element to provide an output signal at said one output means indicative of the signal difference between said voltage across said resistive element and said reference voltage, said output signal thereby constituting said control signal for operating said relay.

12. The invention as defined in claim 11 wherein said differential amplifier comprises a first and a second transistor each having an emitter, a base, and a collector and wherein said first and said second input means includes said base of said first and said second transistor, said at least one output means includes the collector of one transistor, and additionally including a common emitter-impedance coupled to the emitters of said first and second transistor.

13. The invention as defined in claim 11 and additionally including normally open electronic switch means coupled to said relay coil to energize said relay when closed, and additionally including circuit means coupling said switch means to said differential amplifier circuit being operated by said control signal to become closed and causing said relay to become energized whereby said contact means causes said constant DC current flow to reverse polarity.

14. The invention as defined in claim 13 and additionally including indicator means coupled to said electronic switch means, being adapted to be rendered operative by said switch means said switch means is closed to provide a visual indication of said predetermined change in operation of said protection circuit means at said protected premises.

15. The invention as defined in claim 13 wherein said normally open electronic switch means comprises a transistor

having a base, an emitter and a collector and wherein said circuit means coupled to said differential amplifier circuit includes the base of said transistor, and wherein said collector and emitter are coupled to one side of said relay coil.

16. The invention as defined by claim **7** and additionally including second protection circuit means located at said protected premises and including second control circuit means providing a control signal in response to the operating characteristics of said second protection circuit, said second control circuit being additionally coupled to said relay coil and including circuit means for preempting the operation of said relay by said first recited protection circuit means.

17. The invention as defined in claim **16** wherein said second protection circuit means includes a normally non-conductive controlled rectifier coupled across a supply potential and switch means coupled thereto for selectively causing said controlled rectifier to become conductive in the event of an alarm condition and wherein said control circuit means comprises an electronic multivibrator circuit coupled to said controlled rectifier and receiving a supply potential therefrom when said control rectifier is rendered conductive, said multivibrator circuit coupling a substantially square wave control signal to said relay coil for providing alternating operation of said relay, said operation being indicative of a second type of alarm condition.

18. The invention as defined by claim **17** and additionally including normally open electronic switch means coupled between said multivibrator circuit and said relay coil, said switch means being rendered operatively opened and closed by said substantially square wave control signal to control the energization of said relay coil.

19. The invention as defined in claim **1** wherein said constant current DC generator comprises a DC to DC converter having an output circuit and including feedback circuit means coupled to said output circuit and being responsive to the magnitude of output current therefrom for providing an error signal for controlling the operation of said converter to produce said substantially constant amplitude DC output current and current level circuit means coupled to said feedback means for additionally controlling said error signal to produce a predetermined magnitude of said DC output current.

20. The invention as defined by claim **19** wherein said feedback circuit means includes a transformer having a primary and a secondary winding and including means for coupling said primary winding in series with said output circuit;

a differential amplifier having first and second input means and at least one output means;

a reference voltage coupled to one input means; and

circuit means coupling a voltage signal from said secondary winding of said transformer which is a function of said output current to said second input means of said differential amplifier, said error signal being provided at said output means thereby.

21. The invention as defined in claim **20** and additionally including means for varying said reference voltage applied to said first input means of said differential amplifier for selectively providing a plurality of magnitudes of constant current DC output.

22. The invention as defined in claim **20** wherein said DC to DC converter comprises:

a DC to AC chopper circuit including a free running multivibrator, a first and a second electronic switch coupled to and driven by said multivibrator, a second transformer having a primary and secondary winding, means coupling said first and second electronic switch respectively to opposite ends of said primary winding of said second transformer, said primary winding of said second transformer having a center tap, means coupling said center tap to said output means of said differential amplifier; and

a full wave rectifier circuit coupled by means of its input circuit to the secondary winding of said second transformer, said constant current output DC being provided at the output circuit of said rectifier circuit.

23. The invention as defined by claim **22** and additionally including:

capacitor means coupled between said center tap and a point of reference potential; and

a transistor having a base, emitter and collector, said emitter and collector being coupled directly across said capacitor means providing a variable impedance thereacross which is a function of the conductive state of said transistor, circuit means coupling said base to said output means of said differential amplifier whereby conductive state of said transistor is controlled by said error signal and whereby a charge on said capacitor is varied in response to the amplitude of said output current.

24. The invention as defined in claim **20** including circuit means coupled to said secondary winding of said transformer for detecting a predetermined decrease and absence of said output current and providing an indication thereof at said protected premises.

25. The invention as defined by claim **2** wherein said supervisory circuit additionally includes logic circuit means coupled to said normally closed current path and including first circuit means for detecting said one current direction, second circuit means detecting said opposite current direction, and third circuit means for detecting an open circuit condition of said normally closed current path, and circuit means coupling said first, second and third circuit means to said circuit means for providing said indication.

26. The invention as defined in claim **25** and additionally including audible alarm circuit means coupled to said second and third circuit means for providing an audible alarm for current flow in said opposite direction and for said absence of said constant amplitude DC output current.

27. The invention as defined in claim **25** wherein said third circuit means comprises a logic NAND circuit.

28. The invention as defined in claim **27** and additionally including memory circuit means coupled to said NAND logic circuit and said second circuit means for providing a predetermined visual indication of said opposite current direction and absence of said constant amplitude DC output current after said last mentioned conditions cease.

29. The invention as defined in claim **26** and additionally including circuit means coupled to said normally closed current path for detecting the magnitude of said constant amplitude DC output current and providing an indication of a predetermined magnitude of said DC output current.

30. The invention as defined in claim **6** and additionally including:

transformer means respectively coupled to each end of said pair of telephone lines;

audio amplifier means coupled to each transformer means, an audio pick up device located at said protected premises coupled to one of said audio amplifier means for transmitting audio signals over said pair of telephone lines, and audio reproducer means coupled to the other audio amplifier means located at said central station for receiving said audio signals transmitted from the protected premises and rendering an audible indication at said central station.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,678,509 Dated July 18,1972

Inventor(s) CARLO DAN and JAMES F. PINKHAM

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the Title Page:

At the top of the page beneath "UNITED STATES PATENT" change CARLO ET AL. to --DAN ET AL. --.

In the designation of inventors, change "Dan Carlo" to -- Carlo Dan--, and change "Pinkman" to --Pinkham--.

In the Claims:

Claim 1, Col. 13, line 68, change "operations" to --operation--;

Claim 14, Col. 14, line 71, before "said" insert --when--;

Claim 23, Col. 16, line 17, after "whereby" insert --the--.

Signed and sealed this 6th day of February 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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