CONTROL SYSTEM FOR AN ELECTRIFIED FENCE

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ABSTRACT

An automatic as well as manually operated switching system for selectively applying relatively high voltage pulses to an electrified fence from one of a pair of fence charger units commonly referred to as "fencers." In its automatic mode, an interface switching circuit under the control of a monitoring circuit senses the condition of the high voltage applied to a fence circuit from a first fencer unit and in the event of the occurrence of a predetermined abnormal operating condition, causes a switchover to a second fencer unit which, after a predetermined manually adjustable delay to allow for a varying number of shocks, is caused to turn on and apply its respective high voltage pulses to the fence circuit. The monitor circuit in one embodiment is also adapted to operate as a portable metering unit for trouble shooting the fence circuit.

15 Claims, 7 Drawing Figures
1 CONTROL SYSTEM FOR AN ELECTRIFIED FENCE

BACKGROUND OF THE INVENTION

This invention relates generally to high voltage electrified fence apparatus and more particularly to a system for switching the high voltage applied to an electrified fence from one fencer unit to another in the event of any departure from a predetermined set of operating conditions.

Fence chargers or fenceers as they are commonly referred to, are well known to those skilled in the art. Such apparatus generates a relatively high voltage, low current signal which is applied to an electrical conductor encircling a predetermined perimeter for repelling livestock, for example, coming in contact with the conductor and thus preventing breakout from an enclosed area. The fence circuit conductor is insulated from ground i.e. open circuited such that any subject having contact with the ground and coming in contact with the conductor completes the ground return for the fencer and in the process receives a shock. In general two major types of fencer output signals are utilized, a pulse type signal or a sine wave type signal. The pulse type signal is normally of a relatively higher voltage (typically 12,000 volts) while the sine wave type signal is of a larger duration and lower in voltage, being in the order of 500 volts. A repetition rate of one shocking cycle every 1.5 - 5.0 or more seconds for an unloaded fence moreover is obtainable depending on the make and/or model of the fencer utilized.

Typical examples of such apparatus are disclosed in the following U.S. Pat. Nos. 2,429,764; Moore; 2,801,350; Saunders; 3,115,610; Beguin; 3,182,211, Maratueh; 3,378,694, Griffiths; 3,384,788, Johnston; 3,655,994, Malme; and 3,655,995, Malme. Such apparatus is not necessarily limited to such a use, however, when desirable it may be utilized for the prevention of the intrusion into a predetermined area.

While electrical systems are also known which include back-up or stand-by power systems with automatic switching to prevent power outages in emergency, these systems are for more general utility and do not relate particularly to or are adapted for electric fence apparatus. Examples of these types of systems are disclosed in the following U.S. Pat. Nos. 3,041,465, Ayre; 3,596,106, Raddi; 3,201,592, Runert; and 3,646,355, Ireland.

SUMMARY

Briefly, the subject invention is directed to control circuitry for electric fence apparatus and comprises an interface controller under the influence and control of a voltage monitoring circuit which senses the high voltage signal applied to an electrified fence from a selective one of two fencer units. The high voltage is applied to the fence through the controller circuitry such that whenever a departure from normal operating conditions occurs, the monitoring circuit senses the condition and causes the controller to automatically switch to the other fencer unit which has remained until now in a deenergized standby state. In the event of a malfunction, the interface controller provides an indication that a malfunction has occurred and a switchover to the other fencer unit has been made. The monitoring circuit comprises two embodiments, one of which is adapted to operate as an ungrounded portable metering unit for remote operation whereby testing of the fence may be made for detecting shorts, open circuits and the like and when desirable, without actual contact with the fence thus permitting safe, relatively easy trouble shooting and repair, particularly during bad weather conditions. The second embodiment consists of a substitute circuit for the first embodiment when in remote operation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view physically illustrating the combination of the interface controller unit contemplated by the subject invention and two embodiments of voltage monitors associated therewith;

FIG. 2 is an electrical block diagram illustrative of the system contemplated by the subject invention;

FIG. 3 is an electrical schematic diagram of the preferred embodiment of the interface controller circuitry;

FIG. 4 is an electrical schematic diagram of the preferred embodiment of the first type of monitor circuit shown in FIG. 1;

FIG. 5 is an electrical schematic diagram illustrative of the second type of monitor circuit shown in FIG. 1;

FIG. 6 is a perspective view of fence disconnect means associated with the subject invention; and

FIG. 7 is a vertical cross sectional view of the disconnect means shown in FIG. 6.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the figures, and more particularly to FIG. 1, reference numeral 12 designates a housing or junction box which is adapted to contain interface controller circuitry for providing either manual or automatic switching from a primary high voltage fencer, not shown, to a second or back-up fencer, also not shown. The interface controller circuitry included in the housing 12 is shown by reference numeral 13 in the block diagram at FIG. 2 and the schematic appearing at FIG. 3. The housing 12 shown in FIG. 1 includes a pair of high voltage leads 14 and 16 which are respectively adapted to be coupled to the high voltage output from the pair of fencer units. The housing 12 includes a body cavity 18 having a multiple pin female connector 20 and a single pin female connector 21. Connector 20 makes connection both to the first embodiment of a monitor unit which is shown by reference numeral 22 as well as the second embodiment thereof which is shown by reference numeral 24. Female connector 21 on the other hand only makes connection to monitor circuit 24 for coupling the fencer high voltage thereto when utilized. A pair of output terminals 26 and 28 are located on one side wall portion 26 of the housing 12. Terminal 26 comprises the high voltage output terminal and is adapted to be connected to the fence perimeter wire conductor 29 shown in FIG. 2 while terminal 28 is connected to earth ground.

The front panel 27 of the housing 12 contains four fuse holders 30, 32, 34 and 36, which are adapted to contain respective fuse pairs for two separate AC line voltage circuits and respective returns therefor. Both AC line circuits are adapted to be coupled to a common AC power source through an AC line cord 38. A manual reset switch 40 comprising a double pole three position switch, to be referred to later, is also mounted on the front panel 27 of the housing 12 as well as three indicator lamps 42, 44 and 46. Also a sensitivity control
The indicator lamps are adapted to provide a visual indication of the system operation while the control 48 is adapted to provide a manual sensitivity setting for controlling the operating point at which system switchover from one high voltage fencer to another is to occur.

The first embodiment of the monitor circuit shown by reference numeral 22 in Fig. 1 as noted earlier is adapted to be utilized as a hand held test instrument for trouble shooting the fence circuit 29 (Fig. 2). This is accomplished by unplugging the monitor circuit 22 from the plug-in receptacle 20 in the housing 12 and coupling a high voltage probe including an insulating body member 50, a metal tip 51, and female connector member 20' identical to connector 20 coupled to the male connector 52. When the high voltage probe is connected to the test unit 22, the metal tip 51 is adapted to contact the fence circuit for normal metering operation; however, for quick checks and/or during bad weather it is adapted to act as a radio antenna to provide capacitative and inductive pick up from the high voltage fence 29, thus permitting operation and selected relative measurements to be made several feet from the fence. The distance will vary depending on the type of fencer unit used. When the testing unit 22 is being utilized as a remote test instrument, the second embodiment in the monitor circuit shown by reference numeral 24 is normally substituted in its place via the male plugs 53 and 55 being inserted into the female members 20 and 21, respectively. The latter unit while being of a different circuit configuration, is still adapted to provide a monitoring function of the high voltage output to the fence and signal a departure from a predetermined operating condition to the interface controller circuitry for switching from a primary high voltage fencer unit to a back-up unit.

The system block diagram of the subject invention is shown in Fig. 2. Referring now to Fig. 2, reference numeral 54 refers to a first or primary high voltage fencer unit while reference unit 56 refers to a second or back-up high voltage fencer unit. Such apparatus is well known and can be of any conventional design. A typical example particularly adapted for use in connection with the subject invention is the model Super 98 solid state fencer unit manufactured by the International Electric Company. The fencer units 54 and 56 receive selectively mounted from the interface controller circuitry 13 in the housing 12 which as noted above receives AC input line voltage by means of the line cord 38. When selectively energized through the interface controller circuitry 13, the fencer units 54 and 56 are adapted to supply an individual high voltage output in the form of periodically occurring pulse or sine wave modulated pulse signals varying in width, amplitude and frequency on respective high voltage conductors 14 and 16 which feed into the interface control circuitry. The output terminals 26 and 28 on the housing 12 are respectively adapted to be connected to the fence circuit 29 and earth ground 15. Both fencer units 54 and 56 additionally have ground connections to earth ground 15. The fence circuit 29 comprises a wire conductor mounted on insulators attached to supporting stakes or poles. The wire is thus above the ground and electrically isolated therefrom (open circuited). A plurality of disconnect switches 60 are adapted to be selectively connected in series along the wire conductor 29 for interrupting the line at predetermined location whereupon the remainder of the line is energized. By moving from one disconnect to another the absence of fence high voltage (or shorts) can be found quickly and easily.

Automatic switching from the primary fencer unit 54 to the back-up unit 56 is provided by the interface controller circuitry 13 in response to the monitoring of the high voltage signals applied to the conductor 29 by means of either the metering circuit 22 or the sensing module 24. The metering circuit 22 is adapted to receive a ±30 volt DC supply potential from the interface controller circuitry 13 on lead 63. This lead may for example go to the male connector plug 52 coupled to the female connector 20. The circuit operates in response to the high voltage applied to the conductor 29 which is sensed by means of a transformer 61 (Fig. 3) whose secondary winding is coupled across leads through connector elements 20 and 52. Each high voltage pulse or sine wave shock excites the secondary winding of transformer 61 which generates a damped oscillation signal which in turn is coupled back to the interface controller circuitry on circuit lead 66. This connection is also made through connector elements 20 and 52.

When the second or substitute module 24 is utilized in place of the removed metering circuit 22, it is adapted to be coupled to the high voltage output terminal 26 by means of circuit lead 67 which connects to the single pin connector elements 55 and 55. An earth ground and a ±30 volt DC supply potential is applied by means of circuit leads 68 and 69 which leads through connector elements 53 and 52. The sensing module 24 operates to couple a DC signal back to the interface controller circuitry on circuit lead 70. Additionally, a central malfunction warning device 72 is adapted to be powered from the interface controller circuitry 13 by means of an AC line pair 74 and 75.

Referring to the details of the interface controller circuitry 13 as schematically disclosed in Fig. 3, the input AC power applied by means of line cord 38 shown in Fig. 1 is coupled to pair of terminals 76 and 78 with terminal 76 defining the "hot" side of the line, while terminal 78 is adapted to represent the "return" side of the line. From terminal 76, a first and second AC line 80 and 82, respectively coupled to movable switch contact terminals 84 and 86 of the manually operable two-pole, three-position switch 40. This switch when desirable could be simply a two-pole, two-position switch since the middle position 2 of switch 40 is for convenience an open circuit position. The AC lines 80 and 82 are respectively fused by means of the fuses 90 and 92 which are adapted to be contained for example in fuse holders 30 and 34 shown in Fig. 1. In addition to being coupled to terminal 84, AC line 80 is also coupled to the movable relay contact 94 of the solenoid operated relay 96 which is adapted to act as the switching device coupling the high voltage output of either the first fencer unit 54 or the second fencer unit 56 to output terminal 26. More particularly, high voltage signal leads 14 and 16 from the fencer units 54 and 56 are coupled to respective fixed relay contacts 98 and 100 of the contact set including the movable contact 102. Contact 102 is directly connected to high voltage output terminal 26. Relay 96 additionally includes two other sets of relay contacts operable in response to the energization of the solenoid 104 which has one side coupled to the AC line 80 by the closure of switch contacts 84 and 106. The other side is connected to AC
line return 108 which is coupled back to line terminal 78 through a second fuse 110 contained for example in fuse holder 32. Relay 96 and the contacts associated therewith are shown in a position at the time the solenoid 104 is deenergized.

When switch contacts 84 and 106 of the manually operated switch 40 are closed, i.e. position 1, the solenoid 104 is energized by the application of AC line voltage thereacross, whereupon indicator light 42 on the front panel of the housing 12 goes on. AC line voltage is also applied to the primary fencer unit 54 by means of circuit leads 114 and 116 causing its high voltage fencer output to be provided on high voltage lead 14 which due to the closure of relay contacts 98 and 102 by energization of the solenoid 104 is coupled to fence conductor output terminal 26. The indicator lamp 44 on front panel of the housing 12 is also turned on to provide an indication that the fencer unit 54 is receiving AC power and is coupled to the fence conductor 29. As long as the manually operated switch 40 is in position 1, the primary fencer unit 54 will be the only unit capable of being applied to the fence conductor 29.

In order to provide a manual or automatic switchover to the back-up or secondary fencer unit 56, the second set of switch contacts including contacts 86, 120 and 122 of the manually operated switch 40 come into play. For manual operation only, it is to be noted that switch contacts 120 and 122 are commonly connected to the primary winding of a power transformer 124 as well as the movable relay contact 126 of relay 96. With switch 40 in position 1, switch contacts 86 and 120 are also closed. The solenoid 104 being energized opens the circuit between relay contacts 126 and 128. However, when switch 40 is moved to position 3, switch contacts 86 and 122 close, whereupon solenoid 104 is deenergized and the circuit relay contacts 126 and 128 now closes. This applies AC line voltage to the other fencer unit 56 by means of AC line 130 with an AC return line 132 being provided back to AC line return terminal 78 through fuse 134 which is contained in fuse holder 36. The fencer unit 56 now receiving AC line voltage generates its own high voltage output signal which appears on high voltage lead 16. Since lead 16 is coupled to relay contact 100 which due to the fact that solenoid 104 is unenergized, is now coupled to the high voltage output terminal 26 via the movable relay contact 102. When the fencer unit 56 receives line voltage indicator light 46 coupled across AC lines 130 and 132 also goes on noting that fencer unit 56 is now operating in place of fencer unit 54.

In order to provide automatic switching from the primary fencer unit 54 to the secondary or back-up fencer unit 56 in the event of for example a loss of output from the fencer unit 54, a holding relay 136 controlled by either the metering unit 22 or the module 24 is adapted to maintain relay solenoid 104 of relay 96 energized when the manually operated switch 40 is moved from the position 1 to position 3 wherein switch contacts 84 and 106 are open but where the other switch contacts 86 and 122 are closed. The relay coil 138 for the holding relay 136 is coupled into the output of voltage amplitude sensitive means such as a Schmitt trigger circuit 140 comprised of field effect transistor (FET) 142 and junction transistor 144. The holding relay 136 additionally includes a pair of normally open relay contact terminals 146 and 148. The holding relay is adapted to operate such that when the relay coil 138 is energized during normal operation, the relay contact terminals 146 and 148 are closed. It is to be noted further that relay contact terminal 148 is connected to relay contact 150 of the high voltage switching relay 96 by means of circuit lead 152. Relay terminal 150 is adapted to be closed with movable contact 94 when solenoid 104 is initially energized by movement of the switch 40 to position 1. It can be seen that if the holding relay 136 is also energized, the solenoid 104 will be held energized from AC line 80 back to line return 108 through the relay contacts terminals 94 and 150 and 148 and 146 and circuit lead 154.

The Schmitt trigger circuit 140 is adapted to receive a ±20 volt DC power supply potential. This power supply potential along with a + and −30 volt DC supply potential is provided by AC line 82 being connected to the primary winding 156 of the power transformer 124. Half wave rectifier devices and filter capacitors are coupled to the secondary winding 158 of transformer 124 in a well known manner to provide the required DC supply potentials.

Either of the monitor circuits, i.e. the metering unit 22 or the module 24, is adapted to sense an abnormal operating condition of the high voltage signal appearing at output terminal 26 as applied from the primary fencer unit 54 to cause the holding relay 136 to become deenergized in the event of a malfunction. In such an instance, an open circuit occurs between relay contacts 146 and 148 causing deenergization of the solenoid 104. Relay contacts 100 and 102 close while contacts 98 and 102 open. At the same time, a closed circuit occurs between relay contacts 126 and 128 supplying AC power now to the back-up fencer 56.

Considering now the circuitry for monitoring the high voltage fencer output signal applied to the fence conductor 29, consider first the use of the metering circuit 22. When positioned in the body cavity 18 of the housing 12 and connected to interface control circuitry 13 through connector elements 20 and 52, the transformer 61 whose primary winding is coupled in series between relay terminal 102 and output terminal 26 and has its secondary winding coupled to the input of the metering circuit by means of leads 64 and 65. In order for the system and more particularly the meter unit 22 to operate with all types and makes of fencer apparatus wherein either pulse or sinusoidal high voltage signals are provided, the transformer 61 is selected to exhibit a relatively high impedance across the primary as well as a relatively high (40 kv) breakdown voltage between the primary and secondary. Otherwise the high voltage will be shorted to ground potential because fencers as is well known to those skilled in the art are designed to have very low current capability for safety sake. A capacitor 62 is coupled across the secondary winding for providing a parallel resonant circuit which generates a damped oscillation in the order of 2KHz − 10KHz each time a high voltage pulse or a sine wave appears across the primary winding.

The metering circuit 22 is adapted to operate such that under normal operation, a relatively low frequency pulse output signal appears on circuit lead 66; however, upon sensing an abnormal condition, it is adapted to provide a relatively high frequency pulse output signal on circuit lead 66. A low pass RC filter circuit including resistor 164 and capacitors 166 and 168 shunt the high frequency pulses to ground while passing the low fre
frequency pulses under normal operation to the diodes 170 and 172. The diode 172 shunts the positive portion of the pulses to ground while diode 170 is poled to allow the negative portions of the pulses to charge capacitor 174 negatively to such a level that FET transistor 142 is held non-conductive while junction transistor 144 is rendered conductive. This acts to energize the relay coil 138 of holding relay 136. In the event of a malfunction, continuous negative pulses are unable to charge capacitor 174 and therefore the accumulated negative charge thereacross discharges through the series combination of variable resistor 180 and fixed resistor 182 until such time that transistor 142 is driven into conduction. This causes transistor 144 to become non-conductive, thereby opening relay contacts 146 and 148. The variable resistor 180 is adapted to provide a predetermined time constant for the discharge of the capacitor 174 and thus allow the operator to select a predetermined time delay before switching occurs from the relay to contactor 29.

The second embodiment of the monitor circuit, the module 24 on the other hand is also adapted to have its input coupled between the high voltage output terminal 26 and earth ground terminal 28 by means of circuit leads 67 and 68, male connector elements 53 and 55 and female connector elements 20 and 21. The circuit is operable such that in normal operating conditions, a relatively large negative voltage is coupled to circuit junction 190 to provide sufficient negative voltage across the capacitor 174 to maintain transistor 142 non-conductive; however, during an abnormal condition the negative DC output voltage from the circuit 24 becomes negative whereupon capacitor 174 discharges to a level where transistor 142 becomes conductive while transistor 144 becomes non-conductive.

Considering now the details of the metering circuit 22 above, the metering unit 22 is adapted for use not only as a monitor device for the interface control circuitry, but also as a portable meter for remote testing of the fence 29 as shown in FIG. 2. Accordingly in situ, a +30 volt DC power supply potential is coupled from the interface controller circuitry via circuit lead 63. This coupling may be made, as noted above, through the connector members 52 and 20 and connects to +30 volt supply buss 194.

For portable use, however, a 30 volt battery supply 196 is adapted to be coupled to a +30 volt supply buss 194 through a manually operated switch 198 and a blocking diode 200. The diode 200 is poled to prevent damage to the battery supply 194 in the event that switch 198 is accidentally closed while the metering unit 22 is coupled to the interface control circuitry 13. Also the high voltage probe is attached to connector 52 by means of female connector 20. A high voltage transformer 201 having characteristics substantially the same as transformer 61 is located in body 50 of the probe. Its primary winding has one end connected to the metal tip 51 while the other end is left floating i.e. not connected to anything. As is the case of transformer 61 the secondary winding of transformer 201 is parallely resonant with capacitor 204 such that relatively low voltage damped oscillations in the frequency range of 2KHz-10KHz are produced in response to the tip 51 sensing high voltage signals on the conductor 29 or disconnects 60 when brought in contact therewith. As noted for quick checks actual contact with the connector 29 becomes unnecessary since the tip 51 acts as an antenna pick up for the meter. The transformers 61 and 201 isolate the high voltage to be monitored or tested from the subsequent meter circuitry 22 shown in FIG. 4.

Referring now more particularly to FIG. 4, the potentiometer 206 acts as a manual gain control, the movable element of which is connected by means of a relatively high valued fixed resistor 208 to the input of a two stage DC amplifier comprised of FET transistor 210 and junction transistor 212. The output of the second stage transistor 212 is capacitively coupled to an emitter follower stage comprised of transistor 214 by means of coupling capacitor 216. The combination of transistors 210, 212 and 214 provide a high gain low frequency broadband amplifier having a high input impedance and low output impedance. The capacitors 217 and 218 respectively coupled from the input and output of the DC amplifier stages provide a high frequency by-pass to ground.

The amplitude of the voltage at the slider contact of potentiometer 206 together with gain provided by transistors 210 and 212 effectively causes the output of transistor 214 as sensed across the emitter resistor 220 to vary in width. Inasmuch as the signal appearing across the secondary winding of either input transformers 61 or 201 is a damped oscillation an input signal selectively varying in width is applied to the meter circuit 22. Thus the front end of the meter circuit serves a dual purpose, i.e. to amplify weak or low signals and to increase the signal width. When a pulse type fence is utilized a meter input signal will be received for each fence pulse; however, for a fence output of a sine wave type signal for a brief interval a meter input signal will be forthcoming each time the sinusoidal signal passes through zero potential.

The signal amplified and appearing across the emitter load resistor 220 is capacitively coupled to a pair of diode rectifiers 222 and 224 by means of a capacitor 225. The diode 222 clips the positive portion of the pulses by shunting them to ground while diode 224 conducts the negative portions of the pulses to one of three selectable filter capacitors 226, 228 or 230 which is adapted to charge negatively. Filtering of the signal is necessary to provide a substantially steady nonpulsating DC voltage at junction 234. Capacitor selection is provided by a manually operated selector switch 232. The selection of the capacitor is dependent upon the repetition rate of the fence high voltage signal intervals. The negative DC voltage level appearing across the selected capacitor at circuit junction 234 is therefore dependent upon the value of the capacitor for example capacitor 226 and the value of the resistor 236. The negative DC voltage level appearing at junction 234 is applied to FET transistor 238 which acts simply as a DC amplifier. A DC meter 242 and a series connected calibrating variable resistance 244 is coupled from the output circuit junction 240 of FET transistor 238 to ground, providing an indication of the signal level being monitored. The output circuit junction 240 is also connected to a voltage controlled oscillator (VCO) 241 by means of circuit lead 246.

The voltage controlled oscillator 241 comprises a free running multivibrator including cross-coupled transistors 248 and 250. The circuit lead 246 is connected to the junction of resistors 252 and 254 which are respectively coupled to the base of transistors 248.
and 250. To initiate operation of the multivibrator, the base of transistor 250 is momentarily grounded through the parallel combination of resistor 256 and capacitor 258 by closure of a push-button switch 260. The operating frequency of the multivibrator is dependent upon the voltage appearing at the output circuit junction 240 of the DC amplifier transistor 238. Accordingly, if the voltage at the drain of transistor 238 decreases, the VCO frequency will increase, while on the other hand if the voltage increases, the frequency will decrease. The operating frequency of the VCO 241 however is designed to be in the audio range such that an audio transducer 262 being coupled between the emitters of transistors 248 and 250 provides an output tone which can be indicative of system operation. A square wave output signal typical of a multivibrator is taken from the collector of transistor 250 across resistor 264 and capacitor 266 and is coupled to interface control circuitry 13 through connector elements 52 and 20 on lead 66. The capacitor 266 is adapted to operate in conjunction with resistor 164 and capacitors 168 and 166 shown in FIG. 3 to provide the low pass filter circuit referred to above.

Thus in operation if during a monitoring operation the high voltage AC signal applied to the fence circuit 29 from terminal 26 decreases by a predetermined amount for a predetermined length of time, the negative DC potential at circuit junction 234 will also decrease, causing the FET transistor 238 to increase in conductivity. This causes a decrease in the DC potential at the output circuit junction 240 which causes the operating frequency of the multivibrator to increase. As mentioned above with respect to FIG. 3, the low pass filter circuit will shunt the frequency signal to ground causing the DC voltage across capacitor 174 to become less negative and after a predetermined time delay will cause FET transistor 142 to become conductive while causing transistor 144 to become non-conductive. The holding relay 136 accordingly becomes energized and the relay contact terminals 146 and 148 will open, causing the high voltage relay 96 to become deenergized and switch the auxiliary fence unit 56 into operation and couple its respective high voltage output to the fence.

When the metering unit 22 is to be used as a portable device for trouble shooting and/or other operations, the gain control potentiometer 206 and selector switch 232 can be used to advantage to change the sensitivity of the meter 242 for responding more readily to the trouble being sought. Since variation of both the voltage pickoff from the potentiometer 206 and the negative DC voltage level at circuit junction 234 will affect the control voltage of the frequency of the multivibrator, the audio response tone and frequency output from the speaker changes. A typical meter calibration and setup procedure for portable use would be as follows: First the fence conductor 29 would be disconnected from the interface control circuitry 13. The female connector 20 of the high voltage probe would be connected to the male connector element 52 and the switch 198 be closed providing battery power to the circuitry shown in FIG. 4. The push-button switch 260 would be depressed, causing the VCO 241 comprised of transistors 248 and 250 to become operative. The system would be turned on and by manually moving switch 40 of the interface controller 13 to position 1, the high voltage fencer unit 54 would be energized. Fencer output high voltage now appears at terminals 26. The tip 51 of the high voltage probe is placed in direct contact with terminal 26, whereupon the gain potentiometer 206 is adjusted for a substantially steady reading from the meter 242 and a constant tone from the transducer 262. Subsequent adjustment of the calibration resistor 244 will establish a calibration point for the meter 242. Reconnecting the fence conductor 29 back to terminal 26, the unit 22 with the high voltage probe attached can be moved along the fence noting any variation from the calibrated setting previously made.

A very important feature of the meter 22 when used in the portable mode of operation is that it does not require a ground return wire to be connected to earth ground while metering. Also it is adapted to operate at low voltage levels and when desirable at a predetermined distance from the fence conductor wire. Thus all dangerous high voltage is confined to the fence and cannot come in contact with the operator.

While the system may be operated in a manual switching mode with the metering unit 22 removed, automatic switchover is preferable. Accordingly, the plug-in module 24 is substituted for the metering unit 22 by coupling it to the female receptacles 20 and 21 in the housing 12 by means of the male connector elements 53 and 55. The circuit included in the plug-in module 24 comprises the elements shown schematically in FIG. 5 and includes a relatively high resistance voltage divider circuit 288 which has circuit leads 67 and 68 adapted to be coupled across the high voltage AC output signal terminal 26 of the interface controller circuitry 13 and earth ground. The total resistance value of the voltage divider must be high enough so as not to affect the fencer output which as noted before is adapted to drop if a low resistance is applied between conductor 29 and earth ground 15. A light sensitive impedance element 290 has one end connected to the −30 volt DC supply potential by circuit lead 69, while the other side is suitably coupled to circuit lead 70. Both of these circuit leads couple to interface control circuitry through connector elements 53 and 20. The impedance element 290 is enclosed in a light tight housing or enclosure 292 along with a light emitting device 294 which is energized by connection to a predetermined voltage tap 295 of the voltage divider 288. Thus when full high voltage appears on terminals 26, sufficient voltage is present to cause the light emitting device 294 to operate. The device 294 transmits its light output to the impedance 290 which decreases in value, lessening the voltage drop thereacross such that the circuit junction 190 (FIG. 3) is sufficiently negative to maintain transistor 142 non-conductive and transistor 144 conductive. In the event that the high voltage output decreases to an abnormal value, the light energy emitted by the device 294 lowers, causing the impedance value of the light sensitive impedance 290 to increase, causing the voltage applied to circuit junction 190 to become lower. As before, the transistor 142 will become conductive, which in turn causes transistor 144 to become non-conductive. The holding relay 136 deenergizes causing the system to switch from fence unit 54 to the back-up fence unit 56.

While the circuitry in FIG. 5 is disclosed for purposes of explanation as a circuit which is coupled into the system as a monitoring circuit in place of the metering unit 22, it should be pointed out that when desirable, the
same circuitry could be permanently made part of the interface control circuitry such that it would be automatically connected to circuit junction when the metering unit is removed from the body cavity of the housing and then automatically disconnected when the metering unit is again connected to the interface control circuitry. Also, when desirable, the circuitry shown in FIG. 5 could be the sole monitoring circuit utilized in combination with the circuitry obviating the need for any direct connection of the metering unit to the circuit shown in FIG. 7. It being then used completely for remote portable use for testing the fence circuit and other select functions.

Completing the disclosure, the fence conductor shown in FIG. 2 also couples one or more fence disconnect means which is essentially a means for interrupting the high voltage fence conductor at a selected location along the fence perimeter. Each disconnect means is mounted on a respective wire supporting pole in place of the regular pole insulator. The disconnect means itself is relatively simple in construction, having a housing secured to a bracket which is mountable on the support pole. Projecting from the housing wall area is a pair of opposed connector means and attachment to the fence conductor. Internally of the housing is a dielieic disc type element having a conductor element running therethrough or partially therearound. The dielectric element is attached to a spring loaded spindle coupled to an external knob member which is adapted for manual rotation. Rotation of the knob turns the dielectric element to a position wherein the electrical conductor makes electrical contact with both connectors and. With the electrical fence conductor permanently connected to the connector means and a simple quarter turn of the knob will for example break the electrical circuit, while a subsequent rotation back to the initial position will reestablish circuit continuity. By moving from one disconnect means to another along the fence circuit, the absence of fence high voltage or shorts can be found very easily and quickly, utilizing the portable metering unit previously described. Fence disconnect switches are positioned at predetermined intervals along the fence circuit. The effectiveness of the present invention is evidenced by the fact that it is much easier to test the fence circuit and to determine the condition of the fence and its electrical parameters using the present invention than it is using the conventional method of testing.

While the present invention has been shown and described with what is at present considered to be a preferred embodiment of the subject invention, it should be pointed out that the present specification is not meant to be interpreted in a limiting sense, but it is to be considered by way of example only. Accordingly, other modifications and changes becoming obvious in view of the present disclosure are herein meant to be intended without departing from the spirit and scope of the invention as set forth in the following claims. Accordingly,

We claim as our invention:

1. An automatic monitoring and switching system including energizing means for transmitting an electrified fence from a first fencer unit to a second fencer unit, comprising in combination:

first circuit means including circuit transfer means coupled to and adapted to selectively receive a high voltage signal from each of said fencer units when respectively energized from said energizing means, said circuit transfer means having a first and second operating state and in said first operating state being operable to apply said high voltage signal from said first fencer unit;

switch means having a first and second operating state and in its first operating state initially energizing said first fencer unit and causing said circuit transfer means to assume its respective first operating state and couple said high voltage signal from said first fencer unit to said fence;

monitor circuit means coupled to and adapted to be responsive to the high voltage signal applied to the fence and being operable to provide a first type control signal during a predetermined normal operating state of the system and a second type control signal during a predetermined abnormal operating state of the system; and

second circuit means coupled to and being responsive to said control signals from said monitor circuit means and including circuit interruptor means coupled to said circuit transfer means, said circuit interruptor means being operable in response to said first type control signal from said monitor circuit means to maintain said circuit transfer means operable in said first operating state and said first fencer unit energized when said switch means is in its respective second operating state, said circuit interruptor means being further operable in response to said second type control signal to cause said circuit transfer means to assume its respective second operating state when said switch means is in its second operating state thereby energizing and coupling said second fencer unit to the fence while deenergizing and uncoupling said first fencer unit therefrom.

2. The system as defined by claim 1 wherein said circuit transfer means and said circuit interruptor means respectively comprise a first and second electrically operated relay, and wherein said switch means comprises a manually operated system reset switch having first and second positions for providing said first and second operating states.

3. The system as defined by claim 2 wherein said first and second type control signals from said monitor circuit means comprises first and second voltage amplitude signals, and wherein said second circuit means comprises voltage amplitude responsive circuit means coupled to said second relay for energizing said relay in response to said first voltage amplitude signal and deenergizing said relay during said second voltage amplitude signal.

4. The system as defined by claim 3 wherein said voltage amplitude responsive circuit means comprises a Schmitt trigger circuit.

5. The system as defined by claim 3 wherein said first and second voltage amplitude signals comprise DC signals, and wherein said second circuit means includes a charging capacitor having a selectable resistive discharge path, said capacitor being adapted to be charged by said first DC signal.

6. The system as defined by claim 5 and wherein said monitor circuit means comprises:

a voltage divider network coupled across said high voltage signal applied to said fence;
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13. A source of direct current voltage and a variable impedance element coupled between said DC source and said capacitor; and
means coupled to said voltage divider network and being responsive to a portion of the voltage thereacross for varying the impedance of said variable impedance element.

7. The monitor circuit means as defined by claim 6 wherein said last recited means comprises a light emitting device, the intensity of which is a function of said voltage portion, coupled to an intermediate voltage tap of said voltage divider network and wherein said variable impedance element comprises a light sensitive device optically coupled to said light emitting device and being adapted to vary its impedance in accordance with the intensity of the light generated by said light emitting device.

8. The system as defined by claim 5 and additionally including first transformer means coupled to said high voltage signal and providing an oscillatory signal therefrom and wherein said monitor circuit means comprises:
input circuit means disconnectably coupled to said first transformer means and being responsive to said oscillatory signal provided thereby;
circuit means developing a DC voltage, the amplitude of which is a function of the oscillatory signal coupled to said input circuit means; and
a voltage controlled oscillator coupled to said last recited circuit means generating an AC output signal whose frequency varies according to the DC voltage developed by said last recited circuit means, said output signal being coupled to said second circuit means; and
wherein said second circuit means additionally includes frequency filter circuit means adapted to pass selected output signal frequencies from said voltage controlled oscillator, and rectifier means coupled between said filter means and said charging capacitor for providing a DC voltage of a predetermined polarity from said output signal frequencies passed by said filter circuit means to control said amplitude responsive circuit means.

9. The monitor circuit means as defined by claim 8 and additionally including a voltage meter and calibrating means therefor coupled across said circuit means developing said DC voltage for providing an indication of the amplitude level of said high voltage signal coupled to said input means.

10. The monitor circuit means as defined by claim 9 wherein said monitor circuit means when disconnected from said first transformer means is utilized as a portable metering unit, and additionally including a high voltage probe connected to said monitor circuit means and coupled to said input circuit means, said probe including an insulated housing, second transformer means located in said housing and coupled to said input means and being adapted to provide an oscillatory signal in response to said high voltage signal, and a conductive probe tip attached to said housing and electrically coupled to said second transformer means, said tip being adapted to sense said high voltage signal and shock excite said second transformer means to generate said oscillatory signal.

11. The monitor circuit means as defined by claim 10 wherein said input circuit means additionally includes variable gain signal amplifier means coupled between said second transformer means and a rectifier means, and DC amplifier means coupled between said rectifier means and said voltage controlled oscillator.

12. The monitor circuit means as defined by claim 11 and additionally including at least one charging capacitor and a discharge path therefor of predetermined time constant coupled to said rectifier means, said capacitor being charged therefrom and the voltage appearing thereacross being applied to said DC amplifier means.

13. The monitor circuit means as defined by claim 12 wherein said variable gain amplifier means comprises transistor amplifier means including an emitter follower output circuit coupled to said rectifier means and potentiometer means coupling said second transformer means to the input of said transistor amplifier means.

14. The monitor circuit means as defined by claim 8 wherein said voltage controlled oscillator comprises a voltage controlled free running multivibrator.

15. The monitor circuit means as defined by claim 14 and additionally including an audio transducer coupled across said multivibrator providing an audio indication of the output frequency of said multivibrator.