(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 032 135**
**A2**

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 81300065.0

(22) Date of filing: 08.01.81

(51) Int. Cl.³: G 08 B 29/00

(30) Priority: 08.01.80 GB 8000544

(43) Date of publication of application: 15.07.81 Bulletin 81 28

(84) Designated Contracting States: AT CH DE FR IT LI NL SE

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(54) **Monitoring apparatus.**

(57) Where monitoring apparatus includes remote units intended to maintain surveillance of an area for an event such as unauthorised entry into the area, a remote unit fails to convey to a master unit any information if the remote unit ceases to function. A master transmitter (11) therefore transmits, over mains electricity supply lines, frequency-modulated bursts which stimulate the or each remote unit to reply with a characteristic frequency-modulated burst for each burst from the master transmitter (11). The master frequency-modulated burst resets a counter (38) in the remote unit. If a remote unit fails, or detects an alarm situation, the remote unit does not reply, the counter (38) being frozen. A master receiver and indicator (12) demodulates the characteristic bursts from the remote unit or units and prevents an alarm (65) from sounding provided that the characteristic bursts are received at the expected intervals. Failure of a characteristic burst to arrive results in the alarm (65) being sounded and a red LED (64, 76, 77 or 78) being energised to indicate which of four remote units has failed to reply.

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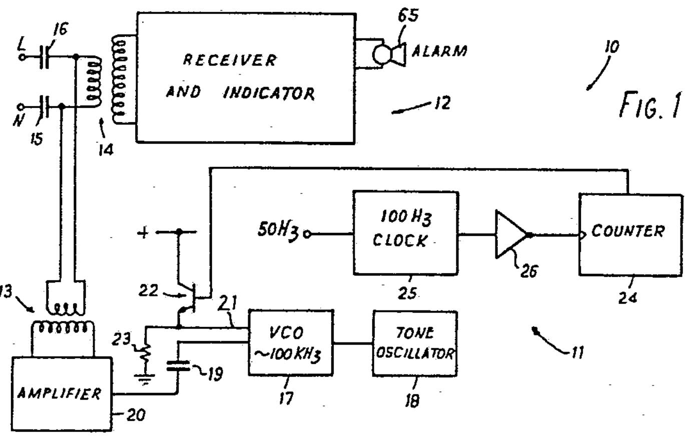
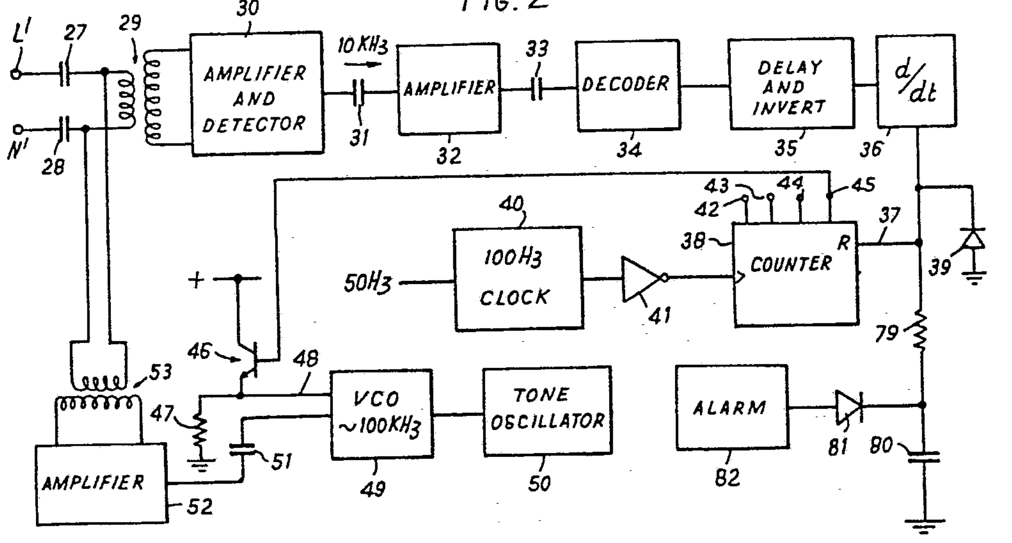


RECEIVER AND INDICATOR
ALARM
65
10
12
L
N
16
15
14
13
AMPLIFIER
20
+
22
23
21
19
VCO ~100KH3
17
TONE OSCILLATOR
18
50H3
100H3 CLOCK
25
26
COUNTER
24
11


FIG. 1

FIG. 2



L'
N'
27
28
29
30
AMPLIFIER AND DETECTOR
10KH3
31
AMPLIFIER
32
33
DECODER
34
DELAY AND INVERT
35
d/dt
36
43
44
42
45
37
38
COUNTER
R
39
40
100H3 CLOCK
50H3
41
+
46
48
VCO ~100KH3
49
TONE OSCILLATOR
50
ALARM
82
81
80
79
53
47
51
AMPLIFIER
52

# Monitoring Apparatus

The present invention relates to monitoring apparatus, and especially, but not exclusively, to monitoring apparatus adapted to monitor an area for the occurrence of such events as unauthorised entry and outbreaks of fire.

One problem which is always present in monitoring, and especially likely to be acute in monitoring for unauthorised entry into an area, is that of ensuring that the monitoring apparatus provides an indication of the disabling of a unit located in the area being monitored.

It is an object of the present invention to provide monitoring apparatus which can provide an indication in response to the disabling of such a unit.

According to the present invention, therefore, there is provided monitoring apparatus comprising a master transmitter producing, in operation, a regular train of bursts of a master frequency-modulated signal, at least one remote unit for producing a characteristic frequency-modulated signal differing from the master frequency-modulated signal, the remote unit including gating means for receiving and producing in response to a received burst of the master frequency-modulated signal a gating signal which so gates the characteristic frequency-modulated signal as to enable a burst of the respective characteristic frequency-modulated signal to be emitted by the remote unit and the gating means including a sensing circuit for sensing a respective condition and adapted to inhibit production of the gating signal of the remote unit in response to sensing by the sensing circuit of a change of a predetermined kind in the respective condition so that occurrence of the said change prevents the emission of one or more bursts of the respective characteristic frequency-modulated signal, a master receiver for recieving and demodulating bursts of the or each characteristic frequency-modulated signal so as to produce a respective demodulation output signal corresponding to each burst demodulated, and an indicating circuit capable of operating in a resultant one of a plurality of different states, the indicating circuit being so coupled to the master receiver as to receive therefrom each demodulation output signal produced thereby and including timing means such that the resultant state of the indicating circuit depends upon whether the length of the interval between successive ones of the demodulation output signals corresponding to the or a respective characteristic frequency-modulated signal departs from a predetermined duration.

When the remote unit, or any one of the remote units if there is more than one, is disabled, it fails to emit a burst of its characteristic frequency-modulated signal and consequently the resultant state of the indicating circuit is changed, thereby providing an indication in response to the disabling of the remote unit.

A preferred embodiment of the present invention is adapted to make use of the electric channels provided by a mains electricity supply system, the master transmitter, the master receiver and the remote unit or units being adapted to transmit and receive the frequency-modulated signals which they produce through the channels provided by live and neutral conductors of the mains system.

The master transmitter preferably includes means for generating a regular train of gating pulses and a gating circuit arranged to be controlled by the gating pulses and such as to allow the master transmitter to emit a burst of the master frequency-modulated signal only during a gating pulse. Where the apparatus makes use of a mains electricity supply system to couple the master transmitter to the or each remote unit and to couple each remote unit to the master receiver, and the mains electricity supply is alternating, the train of gating pulses may be locked to the alternating mains supply.

In one preferred embodiment which has a plurality of remote units, the indicating circuit includes a corresponding plurality of decoding circuits each of which produces in response to each demodulation output signal corresponding to a respective one of the characteristic frequency-modulated signals, which in this embodiment differ from one another, a decoding output signal having a first value, the decoding circuit producing a decoding output signal having a seond value whenever the respective decoding circuit is not receiving the demodulation output signal corresponding to the respective characteristic frequency-modulated signal. This indicating circuit further includes a corresponding plurality of stretching circuits each of which is so coupled to the respective decoding circuit as to receive therefrom the decoding output signal therefrom and is responsive to the said first value only so as to produce an output control signal including a stretched signal having a duration beginning substantially simultaneously with the respective occurrence of the said first value and continuing for a predetermined time after the end of the respective occurrence of the first value, a controllable switching circuit being so coupled to the stretching circuit as respond to absence of a stretching signal in the output control signal by changing the state of operation of the indicating circuit.

The gating means of the or each remote unit preferably has a receiving section which receives and demodulates each burst of the master frequency- modulated signal transmitted to the unit by the master transmitter and produces from each demodulation of a burst a triggering signal, the gating means further including a triggered gating circuit arranged to receive each triggering signal and such as to effect the said gating of the respective characteristic frequency-modulated signal only when triggered by a triggering signal, triggering of the triggered gating circuit occurring on receipt of a triggering signal by the triggered gating circuit only when the gating means is not inhibited by the sensing circuit. For example, the triggered gating circuit may include a counter supplied in operation with a continual train of clock pulses and adapted to be reset by the triggering signals and to be frozen by an inhibiting signal supplied to the counter by the sensing circuit in response to sensing of the said change.

In the preferred master transmitter the means for generating a regular train of gating pulses may comprise a counter supplied in operation with a continual train of clock pulses and adapted to reset automatically on reaching a predetermined count, so as to repeatedly execute a predetermined counting cycle, the counter being adapted to provide an output stream of pulses constituting the gating pulses of the said generating means and corresponding to division of the rate of the clock pulses by a factor determined by the counting cycle of the counter.

The sensing circuit of the or each remote unit may include a form of coupling circuit suitable for coupling a steady voltage of a particular polarity into the gating means where the respective condition is the voltage appearing at an output terminal of a sensing device.

The invention will now be described in more detail, solely by way of example, with reference to the accompanying drawings, in which:

Fig 1 is a block diagram of a master unit with a master transmitter, a master receiver and an indicating circuit of an embodiment of the present invention, Fig 2 is a block diagram of a remote unit of the embodiment which includes the master unit of Fig 1,

Fig 3 is a more detailed block diagram of the master receiver and indicating circuit of Fig 1,

Fig 4 is a circuit diagram of the master transmitter of Fig 1,

Fig 5 is a circuit diagram of part of the remote unit of Fig 2,

Fig 6 is a circuit diagram of another part of the remote unit of Fig 2, and

Fig 7 is a circuit diagram of the master receiver and indicating circuit of Fig 1.

In Fig 1 of the accompanying drawings there is shown a master unit 10 of monitoring apparatus which makes use of the live and neutral conductors of a 50 Hz mains electricity supply system as a channel for the passage of signals between the master unit and four remote units, one of which is shown schematically in Fig 2. The master unit 10 has a master transmitter 11 and a master receiver and indicator 12 coupled to a pair of input/output terminals L and N adapted to be electrically connected to the live and neutral conductors of the mains supply system at a suitable point by, for example, being provided in the form of the live and neutral pins of an electric plug which can be engaged with a conventional mains supply wall socket outlet point.

The transmitter 11 and the receiver and indicator 12 are coupled to the terminals L and N through respective isolating transformers 13 and 14 both of which are coupled to the terminals L and N by a pair of series capacitors 15 and 16.

To generate a master frequency-modulated signal, the master transmitter 11 includes a voltage controlled oscillator 17 providing, in operation, a nominal 100 kilohertz carrier frequency, and a tone oscillator 18 with a fixed frequency of 10 kilohertz connected to the control terminal of the voltage controlled oscillator 17 so as to frequency modulate the output of the oscillator 17. The output of the oscillator 17 is coupled through a capacitor 19 to an output amplifier 20 connected to the transformer 13.

The oscillator 17 has a gating signal input terminal 21 connected to an NPN transistor 22 and a resistor 23 arranged as an emitter follower circuit, the transistor 22, the resistor 23 and circuitry connected to the terminal 21 within the oscillator 17 forming a gating circuit which allows the oscillator 17 to supply its output to the amplifier 20 only when the transistor 22 is conducting. In operation the base of the transistor 22 is supplied with a regular train of positive-going pulses by a counter 24 so that the pulses thus supplied by the counter 24 serve as gating pulses, the transmitter 11 emitting a burst of the master frequency - modulated signal through the transformer 13 during each gating pulse.

A 100 hertz pulse generator 25 supplies its pulses to an inverter 26 coupled to the clock terminal of the counter 24 which is arranged to reset automatically to zero on reaching a count of nine. Thus the counter 24 repeatedly executes a counting cycle of zero to nine, and each such cycle occupies 100 milliseconds. The pulse generator 25 is supplied with a 50 hertz sinusoidal voltage from the mains supply system and this voltage used as a phase reference with which the pulses generated by the generator 25 are synchronised. One count of the counting cycle of the counter 25 is decoded and a 10 millisecond positive-going pulse is thereby generated once every 100 milliseconds and is supplied to the base of the transistor 22 as a gating pulse.

Thus, in operation, the master transmitter produces a train of bursts of frequency-modulated 100 kilohertz signal, each burst lasting for 10 milliseconds and occurring 100 milliseconds after the beginning of the previous burst.

The remote unit shown in Fig 2 has a pair of input/output terminals L' and N' which can be electrically connected respectively to the live and neutral conductors of the mains supply system, similarly to the terminals L and N of the master unit 10. A burst of the master frequency-modulated signal transmitted to the terminal L' and N' is coupled through series capacitors 27 and 28 and a receiving transformer 29 to an amplifier and detector 30 which amplifies the burst and demodulates the amplified burst to produce a corresponding burst of 10 kilohertz output signal which is coupled through a capacitor 31, an audio amplifier 32 and a further capacitor 33 to a decoder 34. The decoder 34, in response to the burst of amplified 10 kilohertz, produces a negative-going pulse having a duration corresponding to that of the 10 kilohertz burst, ie substantially 10 milliseconds. This pulse is delayed and inverted by a delay and invert circuit 35 to eliminate noise and provide a signal of suitable polarity for the subsequent stages of circuitry. The now positive-going pulse is differentiated at a differentiator 36 and the resultant positive spike from the leading edge of the positive-going pulse is supplied to a reset terminal 37 of a counter 38 and the resultant negative spike from the trailing edge of the positive-going pulse is suppressed by a diode 39 having its cathode connected to the output terminal of the differentiator 36 and its anode connected to ground.

A 100 hertz pulse generator 40 is coupled through an inverter 41 to the clock input of the counter 38 and is synchronised with the 50 hertz mains in the same way as the pulse generator 25 of the master transmitter 11 is synchronised. The counter 38 does not reset automatically but only on receiving a positive spike at its reset terminal 37. However, since these spikes each derive from a burst of the master frequency-modulated signal, and these bursts occur at the rate of one every 100 milliseconds, unless the positive spikes are blocked or rendered ineffective the counter 38 is reset once every 100 milliseconds and therefore has a repeating counting cycle of zero to nine, the reset being to zero. The synchronisation of the pulse generator 41 of the remote unit as well as of the pulse generator .5 of the master unit 10 to the mains frequency ensures that the resetting of the counter 38 occurs at a suitable time in relation to the arrival of clock pulses at the clock input of the counter 38.

Four counts of the counter 38 are decoded to provide four differently timed sources of trains of 10 millisecond pulses with a repetition rate of 10 hertz, the four trains appearing respectively at four output terminals 42, 43, 44 and 45 of the counter 38. One of these terminals, the terminal 45 for the remote unit of Fig 2, is connected to the base of an NPN transistor

46 which forms an emitter follower circuit with a resistor 47, the emitter of the transistor 46 being connected to a gating signal input terminal 48 of a voltage controlled oscillator 49. The voltage controlled oscillator 49 provides, in operation, a nominal 100 kilohertz carrier frequency, and a tone oscillator 50 with a fixed frequency of 8.1 kilohertz is connected to the control terminal of the oscillator 49 so as to frequency modulate the output of the oscillator 49. The output of the oscillator 49 is coupled through a capacitor 51 to an output amplifier 52 coupled through a transformer 53 and the capacitors 27 and 28 to the terminals L' and N'.

As in the voltage controlled oscillator 17 of the master transmitter 11, the gating signal input terminal 48 has connected thereto within the oscillator 49 circuitry which together with the transistor 46 and the resistor 47 forms a gating circuit which allows the socillator 49 to supply its output to the amplifier 52 only when the transistor 46 is conducting. Thus, as in the master transmitter 11, the remote unit produces a train of bursts of frequency-modulated 100 kilohertz signal, each burst lasting for 10 milliseconds and occurring 100 milliseconds after the beginning of the previous burst. Each such burst transmitted to the terminals L and N of the master unit 10 is coupled through the capacitors 15 and 16 and the transformer 14 to an amplifier and detector 54 shown in Fig 3. The amplifier and detector 54 amplifies this burst and demodulates the amplified burst to produce a corresponding burst of 8.1 kilohertz output signal which is coupled through a capacitor 55 to four decoders 56, 57, 58 and 59 in parallel. Each of these decoders 56, 57, 58 and 59 is tuned to respond to only one input frequency, namely, 8.1 kilohertz for the decoder 56, 6.6 kilohertz for the decoder 57, 5.4 kilohertz for the decoder 58, and 4.3 kilohertz for the decoder 59.

The decoder 56, in response to the burst of 8.1 kilohertz, produces a negative-going pulse having a duration corresponding to that of the 8.1 kilohertz burst, ie, substantially 10 milliseconds. This pulse causes a green light emitting diode 60 to emit light for about 10 milliseconds and is stretched to more than 100 milliseconds by a pulse stretcher circuit 61. The output of the pulse stretcher circuit 61 is supplied to a switching circuit 62. The output of the pulse stretcher circuit 61 in response to a negative-going pulse supplied thereto by the decoder 56 is a low level signal with a duration of slightly more than 100 milliseconds. If the stretcher circuit 61 does not receive a further negative-going input pulse before the end of its current low level signal, the output of the stretcher circuit 61 becomes a high level signal. The switching circuit 62 is such that while it is receiving the low level signal of the stretcher circuit 61, the switching circuit 62 does not energise the coil 63 of a relay RL-1 and does not energise a red light emitting diode 64 connected to the switching circuit 62 as shown. As soon as the switching circuit 62 ceases to receive a low level signal from the stretcher circuit 61 and receives instead a high level signal, the state of the switching circuit 62 changes to one in which the red light emitting diode 64 is energised and the coil 63 is energised. Energisation of the coil 63 causes closure of the normally open contacts RL1 of the relay RL-1 and this completes an alarm circuit including an audible alarm device 65 between a positive supply line and earth through a key-operated switch 66. The key-operated switch 66 is shown closed in Fig 3, closure of the key-operated switch 66 being a necessary action for bringing the indicating circuit of the master unit into operation. The indicating circuit includes, in addition to the decoder 56, the light emitting diodes 60 and 64, the stretcher and switching circuits 61 and 62, the relay RL-1, the alarm device 65 and the key switch 66, the three further decoders 57, 58 and 59, three green light emitting diodes 67, 68 and 69, three stretcher circuits 70, 71 and 72, three switching circuits 73, 74 and 75, and three red light emitting diodes 76, 77 and 78, connected as shown in Fig 3. Each of the three stretcher circuits 70, 71 and 72 operates in the same way as the circuit 61, and each of the three switching circuits 73, 74 and 75 operates in the same way as the circuit 62. Consequently, while trains of 10 millisecond bursts of 8.1, 6.6, 5.4 and 4.3 kilohertz are coupled to the decoders 56 to 59, each train having a repetition rate of 10 hertz, the green light emitting diodes 60, 67, 68 and 69 indicate the occurrence of these bursts, the red light emitting diodes 64, 76, 77 and 78 remain unenergised, and the coil 63 of the relay RL-1 remains unenergised and the audible alarm device 65 is silent. However, as soon as any of the four trains is interupted by the absence of the burst of the respective frequency after the expected time interval, the corresponding red light emitting diode 64, 76, 77 or 78 is energised and the alarm device 65 operates, the indicating circuit thereby indicating that one of four remote units has failed to transmit a burst of its characteristic frequency-modulated signal. The four remote units are the unit of Fig 2 and three further remote units each identical to the unit of Fig 2 except in the frequency of the respective tone oscillator corresponding to the tone oscillator 50, the three such tone oscillators generating respectively 6.6, 5.4 and 4.3 kilohertz. It will be understood from the description of Fig 3 given hereinbefore that the indicating circuit is capable of operating in any one of a plurality of different states, one of which indicates proper functioning of all four remote units and the others of which indicate non-reply functioning by one or more of the remote units, ie failure by one or more remote units to generate the expected burst or bursts of characteristic frequency-modulated signal.

Non-reply functioning of a remote unit can be brought about by the generation of an inhibiting signal in the remote unit as now described with reference to Fig 2. The remote unit of Fig 2 includes a sensing circuit consisting of series combination of a resistor 79 and a capacitor 80 coupling the reset terminal 37 of the counter 38 to ground as shown, a diode 81 for coupling a direct current signal of one polarity to the junction of the resistor 79 and capacitor 80, and inhibiting circuitry connected to the reset terminal within the counter 38. A sensor 82 is connected to the anode of the diode 81 and is such that in normal, unactuated operation the anode of the diode 81 receives a low voltage so that the diode 81 is non-conducting, and in normal actuated operation the anode receives a high voltage which biases the diode 81 into conduction and causes a voltage to appear at the reset terminal 37 which freezes the count in the counter 38. Thus actuation of the sensor 82 results in the

the application of an inhibiting signal in the counter 38 and halts the production of gating pulses by the counter 38 so that the remote unit ceases to produce bursts of its characteristic frequency-modulated signal.

Fig 4 shows the circuit of the master transmitter 11 in detail, corresponding elements having the same reference numerals in Figs 1 and 4. Figs 5 and 6 similarly show the circuit of the remote unit of Fig 2 in detail, and Fig 7 shows the circuit of the master receiver and indicator 12 of Fig 3 in detail.

As shown in Fig 4, the 100 hertz pulse generator 25 consists of two NOR gates 101 and 102 coupled by resistors 103, 104 and 105 and a capacitor 106 to form a multivibrator with one input terminal 107 of the gate 101 serving as a synchronising input terminal at which the generator 25 receives a 100 hertz ripple produced by a full wave rectifier 108 and limiting circuit 109 coupling the mains input/output terminals L and N to the terminal 107. The counter 24 is a cmos decade counter/divider SCL4017A by Solid State Scientific Inc. The active component of the tone oscillator 18 is a Signetics SE/NE567 tone decoder phase locked loop 110, and the active component of the voltage controlled oscillator 17 is a Signetics SE/NE 566 function generator 111. The manufacturers' pin numbers are shown on these items 110, 111 and 111.

The tone oscillator 18 is tuned to 10 kilohertz by adjustment of an adjustable resistor 112 connected in series with a fixed resistor 113 between the pins 5 and 6 of the component 110.

In the remote unit, the amplifier and detector 30 has as its active component is an LM 1351 detector, limiter and audio amplifier 114 having its pins 1 to 14 connected as shown in Fig 5. An adjustable inductor 115 connected between pins 3 and 13 is used in tuning this component 114 to a centre frequency of 100 kilohertz. The decoder 34 has as its active component a Signetics SE/NE 567 tone decoder phase locked loop 116 tuned by an adjustable resistor 117 connected as shown. The counter 38 is a cmos decade counter/divider SCL 4017A by Solid State Scientific Inc, the pin 15 of which serves as the reset terminal 37. The pulse generator 40 is formed in the same way as the pulse generator 25 of Figs 1 and 4 and is synchronised to the mains frequency in the same way. Stabilised d.c. supply lines 118 and 119 at 12 volts and 5 volts are provided by a power unit 120 coupled to the mains supply.

As shown in Fig 6, the tone oscillator 50 has an active component 121, which is another Signetics SE/NE 567 tuned to 8.1 kilohertz with the aid of an adjustable resistor 122, and the voltage controlled oscillator 49 has an active component 123, which is another Signetics SE/NE 566.

The circuit of the master receiver includes as shown in Fig 7, as the active component 124 of the amplifier and detector 54 another LM 1351 which in this case is equipped with a filter 125 connected between its pins 9 and 10 and serving to establish a bandwidth suitable for 100 kilohertz frequency modulated by 8.1, 6.6, 5.4 and 4.3 kilohertz. Each of the decoders 56 to 59, of which only 56 and 59 are shown in Fig 7, the other two being connected in the same way, includes a Signetics SE/NE 567 as active component tuned to the respective frequency of 8.1, 6.6, 5.4 or 4.3 kilohertz.

The stretcher 61 includes a parallel combination of a capacitor 126 and a resistor 127 connected between a positive supply line 128 and the anode of a diode 129 having its cathode connected to the anode of the green light emitting diode 60. Each negative-going, 10 millisecond pulse coupled through the diodes 60 and 129 from the pin 8 of the SE/NE 567 of the decoder 56 charges the capacitor 126 which then, during the subsequent 90 milliseconds before the next negative-going pulse, discharges through the resistor 127. This discharging continues further if the expected next negative-going pulse fails to arrive. Thus the voltage at the anode of the diode 129 is a low level signal unless the capacitor 126 has sufficient time to discharge almost completely whereby the voltage at the anode of the diode 129 becomes a high level signal. The switching circuit 62 includes a two input AND gate 130 having one input terminal coupled to the positive supply line 128 by a resistor 131 and the other input terminal coupled to the anode of the diode 129 by a resistor 132. The output terminal 133 of the AND gate 130 is connected to the base of an NPN transistor 134 connected as an emitter follower with the red light emitting diode 64 in series with an emitter resistor 135 and the relay coil 63 connected in a parallel emitter circuit when the key switch 66 is closed, this switch 66 being shown in its open position in Fig 7.

Feedback of high level signals from the output terminal 133 of the AND gate 130 to the input terminal end of the resistor 132 is provided by a diode 136. A resetting push button switch 137 connected in series between the resistor 131 and the key switch 66 allows the output level of the gate 130 to be set to the low level when the key switch 66 is open. The output level of the gate 130 can be set to the high level by closure of a switch 138 connected in series with a capacitor 139 between a positive supply line 140 and the input terminal end of the resistor 132. The transistor 134 is effectively off when the gate 130 supplies the low output level to the base of the transistor 134 and is on, ie conducting heavily, when the gate 130 supplies the high output level. Provided that a switch 141 is set as shown to connect the emitter of the transistor 134 through a diode 142 to the relay coil 63, the on state of the transistor 134 results in energisation of the coil 63 but the off state does not. The state of the transistor 134 is indicated by whether or not the red light emitting diode 64 is energised or not.

The output level of the gate 130 is low when the key switch 66 is closed, the switch 138 is open, as shown, and negative-going pulses of 10 milliseconds duration and occurring every 100 milliseconds arrive at the cathode of the diode 129. If the interval between one such pulse and the next increases by a relatively small amount, the capacitor 126 discharges, both input terminals of the gate 130 receive high level signals and the output level of the gate 130 switches to the high level, thereby switching on the transistor 134 which energises the red diode 64 and the coil 63 and consequently causes the audible alarm device 65 to emit a warning sound, a switch 143 being closed when the key switch 66 is closed and vice versa. The switches 141 and 138 are ganged together so that when the switch 138 is open, the switch 141 makes the connection shown, and when the switch 138 is closed, the switch 141 connects the coil 63 to a resistor 144 in parallel with a series combination of a resistor 145 and a capacitor 146 connected as shown.

The other stretcher circuits 70 to 72 and switching circuits 73 to 75 are the same as the circuits 61 and 62 and operate in the same way as these circuits.

CLAIMS

1. Monitoring apparatus comprising a master unit (10, 11) and at least one remote unit (Fig. 2), the remote unit being adapted to communicate monitoring information to the master unit, characterised in that the master unit includes a master transmitter (11), a master receiver (14, 54, 55) and an indicating circuit (56 to 78), the master transmitter producing, in operation, a regular train of bursts of a master frequency-modulated signal, the remote unit (Fig. 2) produces a characteristic frequency-modulated signal differing from the master frequency-modulated signal, the remote unit including gating means (29 to 40) for receiving and producing in response to a received burst of the master frequency-modulated signal a gating signal which so gates the characteristic frequency-modulated signal as to enable a burst of the respective characteristic frequency-modulated signal to be emitted by the remote unit and the gating means including a sensing circuit (79, 80, 81) for sensing a respective condition and adapted to inhibit production of the gating signal of the remote unit in response to sensing by the sensing circuit of a change of a predetermined kind in the respective condition so that occurrence of the said change prevents the emission of one or more bursts of the respective characteristic frequency-modulated signal, the master receiver (14, 54, 55) receiving and demodulating bursts of the or each characteristic frequency-modulated signal so as to produce a respective demodulation output signal corresponding to each burst demodulated, and the indicating circuit (56 to 78) being capable of operating in a resultant one of a plurality of different states and being so coupled to the master receiver (14, 54, 55) as to receive therefrom each demodulation output signal produced thereby and including timing means (61, 70, 71, 72) such that the resultant state of the indicating circuit depends upon whether the length of the interval between successive ones of the demodulation output signals corresponding to the or a respective characteristic frequency-modulated signal departs from a predetermined duration.

2. Monitoring apparatus according to claim 1 and adapted to make use of the electric channels provided by a mains electricity supply system, the master transmitter, the master receiver and the remote unit or units being adapted to transmit and receive the frequency-modulated signals which they produce through the channels provided by live and neutral conductors of the mains system.

3. Monitoring apparatus according to claim 1 or 2, wherein the master transmitter (11) includes means (24, 25, 26) for generating a regular train of gating pulses and a gating circuit (22, 23) arranged to be controlled by the gating pulses and such as to allow the master transmitter to emit a burst of the master frequency-modulated signal only during a gating pulse.

4. Monitoring apparatus according to claim 2 and 3, wherein the mains electricity supply is alternating and the train of gating pulses is locked to the alternating mains supply.

5. Monitoring apparatus according to claim 1, wherein there is a plurality of remote units, the indicating circuit (56 to 78) includes a corresponding plurality of decoding circuits (56 to 59) each of which produces in response to each demodulation output signal corresponding to a respective one of the characteristic frequency-modulated signals, which differ from one another, a decoding output signal having a first value, the decoding circuit producing a decoding output signal having a second value whenever the respective decoding circuit is not receiving the demodulation output signal corresponding to the respective characteristic frequency-modulated signal.

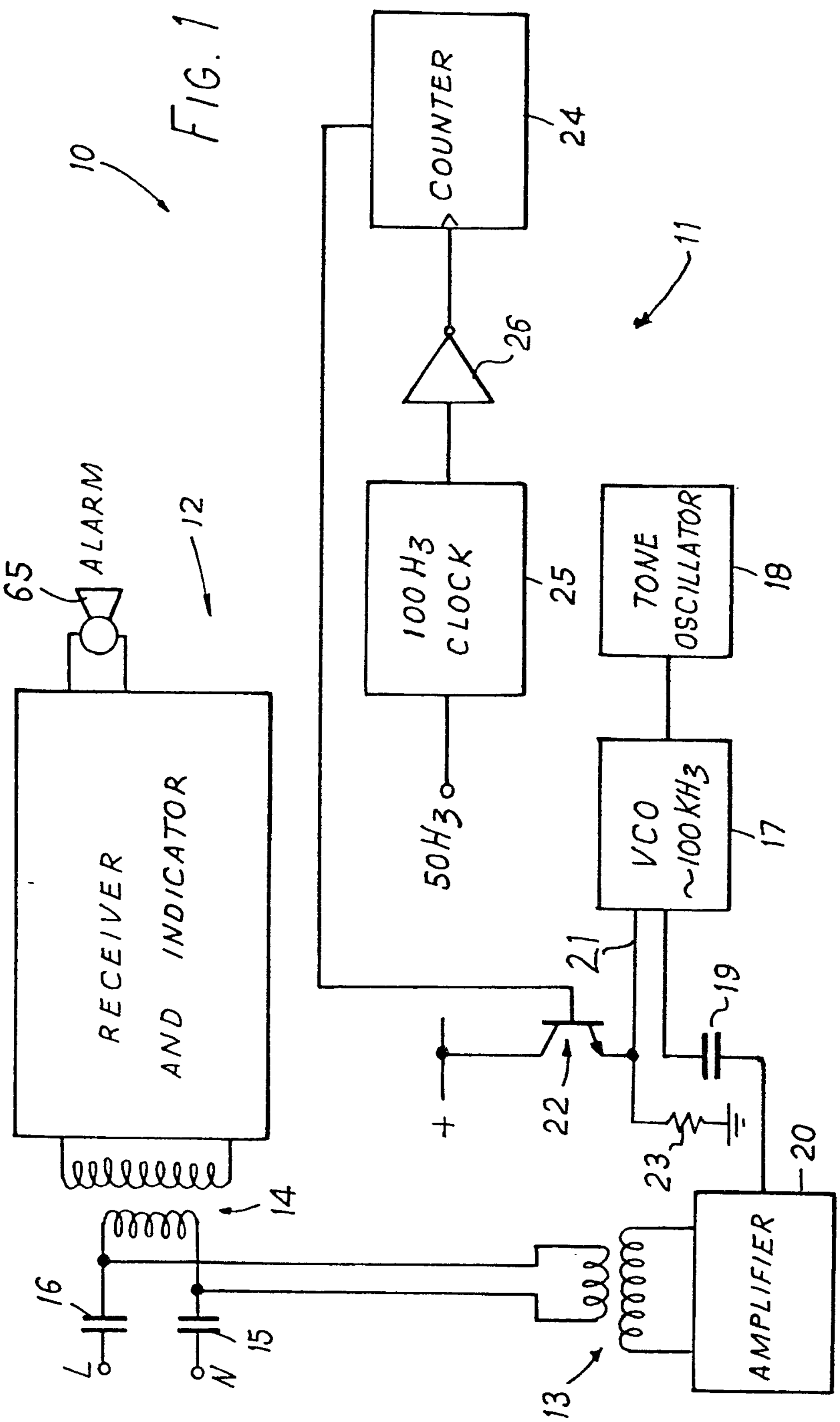
6. Monitoring apparatus according to claim 5, wherein the indicating circuit (56 to 78) includes a corresponding plurality of stretching circuits (61, 70, 71, 72) each of which is so coupled to the respective decoding circuit (56, 57, 58, 59) as to receive therefrom the decoding output signal therefrom and is responsive to the said first value only so as to produce an output control signal including a stretched signal having a duration beginning substantially simultaneously with the respective occurrence of the said first value and continuing for a predetermined time after the end of the respective occurrence of the first value, a controllable switching circuit (62, 73, 74, 75) being so coupled to the stretching circuit (61, 70, 71, 72) as respond to absence of a stretching signal in the output control signal by changing the state of operation of the indicating circuit.

7. Monitoring apparatus according to claim 1, wherein the gating means (29 to 40) of the or each remote unit has a receiving section (29 to 36) which receives and demodulates each burst of the master frequency-modulated signal transmitted to the unit by the master transmitter (11) and produces from each demodulation of a burst a triggering signal, the gating means further including a triggered gating circuit (38, 46, 47) arranged to receive each triggering signal and such as to effect the said gating of the respective characteristic frequency-modulated signal only when triggered by a triggering signal, triggering of the triggered gating circuit occurring on receipt of a triggering signal by the triggered gating circuit only when the gating means is not inhibited by the sensing circuit (79, 80, 81).

8. Monitoring apparatus according to claim 7 wherein the triggered gating circuit includes a counter (38) supplied in operation with a continual train of clock pulses and adapted to be reset by the triggering signals and to be frozen by an inhibiting signal supplied to the counter by the sensing circuit (79,80, 81) in response of the said change.

9. Monitoring apparatus according to claim 3, wherein the means (24, 25, 26) for generating a regular train of gating pulses comprises a counter (24) supplied in operation with a continual train of clock pulses and adapted to reset automatically on reaching a predetermined count, so as to repeatedly execute a predetermined counting cycle, the counter (24) being adapted to provide an output stream of pulses constituting the gating pulses of the said generating means and corresponding to division of the rate of the clock pulses by a factor determined by the counting cycle of the counter (24).

10. Monitoring apparatus according to any preceding claim, wherein sensing circuit of the or each remote unit includes a form of coupling circuit (79, 80, 81) suitable for coupling a steady voltage of a particular polarity into the gating means (29 to 40) where the respective condition is the voltage appearing at an output terminal of a sensing device (82).



10
COUNTER
24
11
26
100 Hz CLOCK
25
50 Hz
TONE OSCILLATOR
18
VCO ~100 KHz
17
21
19
22
+
23
20
AMPLIFIER
13
ALARM
65
12
RECEIVER AND INDICATOR
14
16
15
L
N


FIG. 1

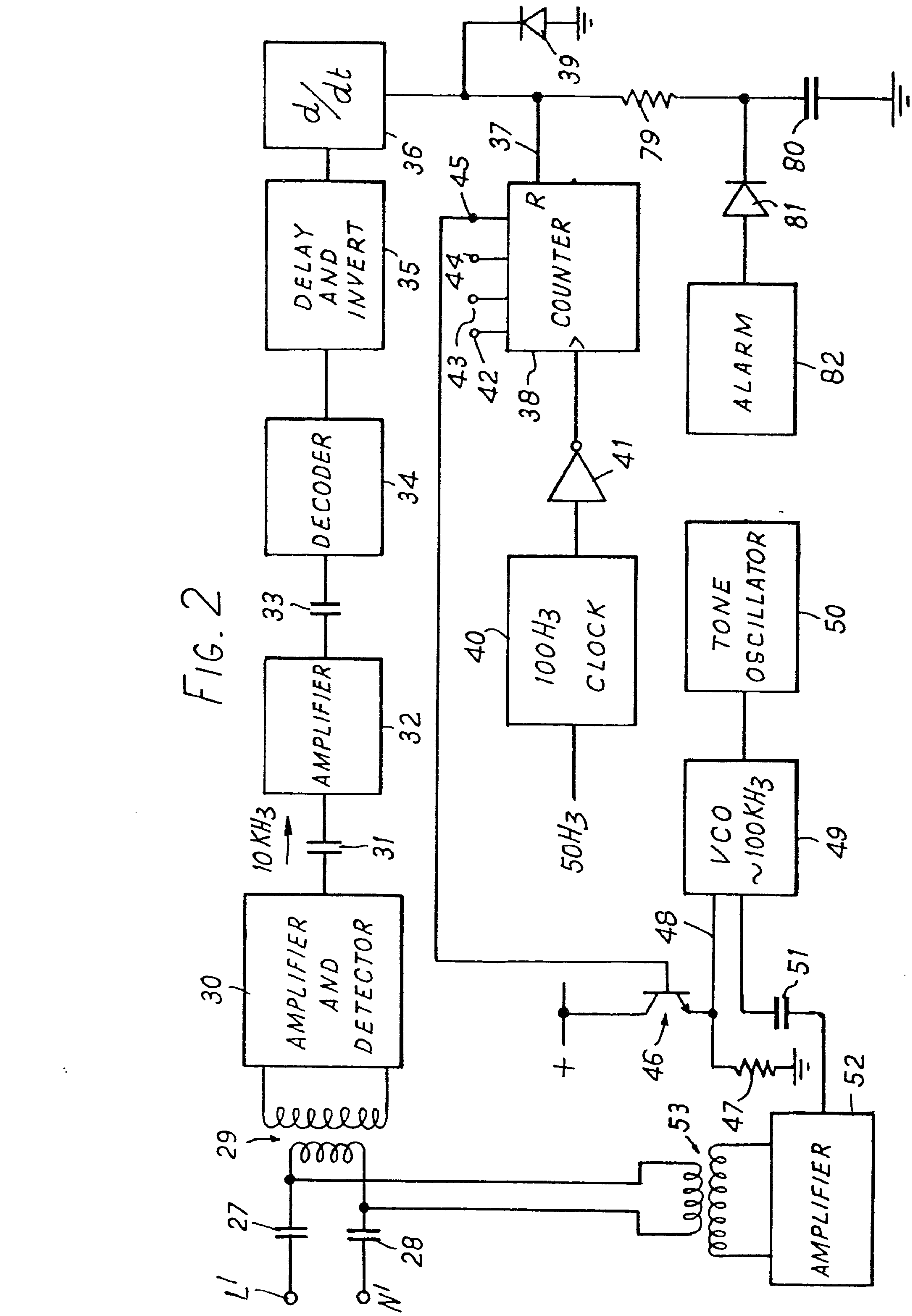
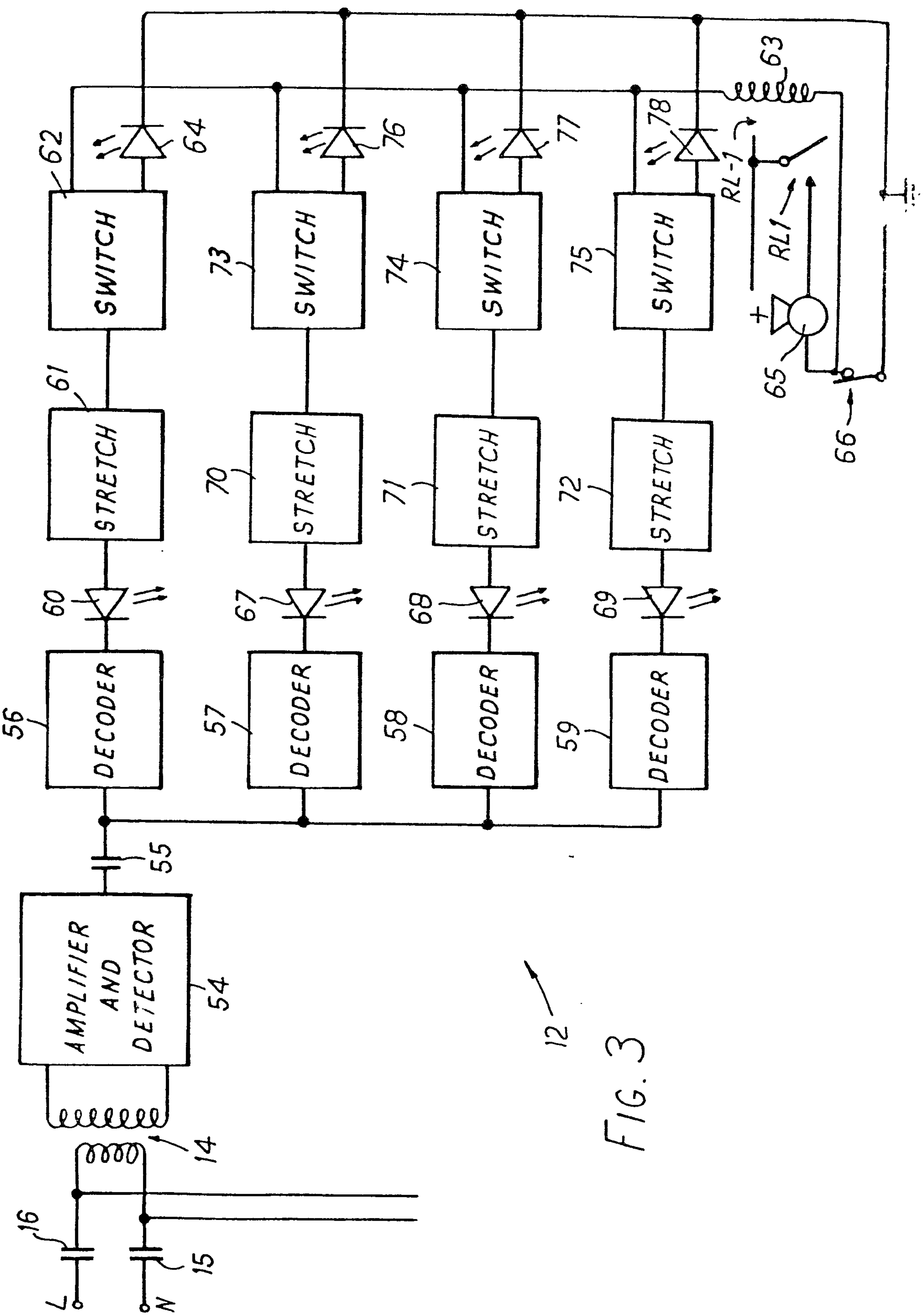

AMPLIFIER AND DETECTOR
30
10 KHz
31
AMPLIFIER
32
33
DECODER
34
DELAY AND INVERT
35
d/dt
36
37
39
79
80
81
R
COUNTER
45
44
43
42
38
41
100Hz CLOCK
40
50Hz
ALARM
82
TONE OSCILLATOR
50
VCO ~100KHz
49
48
46
+
51
47
52
AMPLIFIER
53
29
27
28
L'
N'

FIG. 2



SWITCH
SWITCH
SWITCH
SWITCH
STRETCH
STRETCH
STRETCH
STRETCH
DECODER
DECODER
DECODER
DECODER
AMPLIFIER AND DETECTOR
RL-1
RL1
L
N


FIG. 3

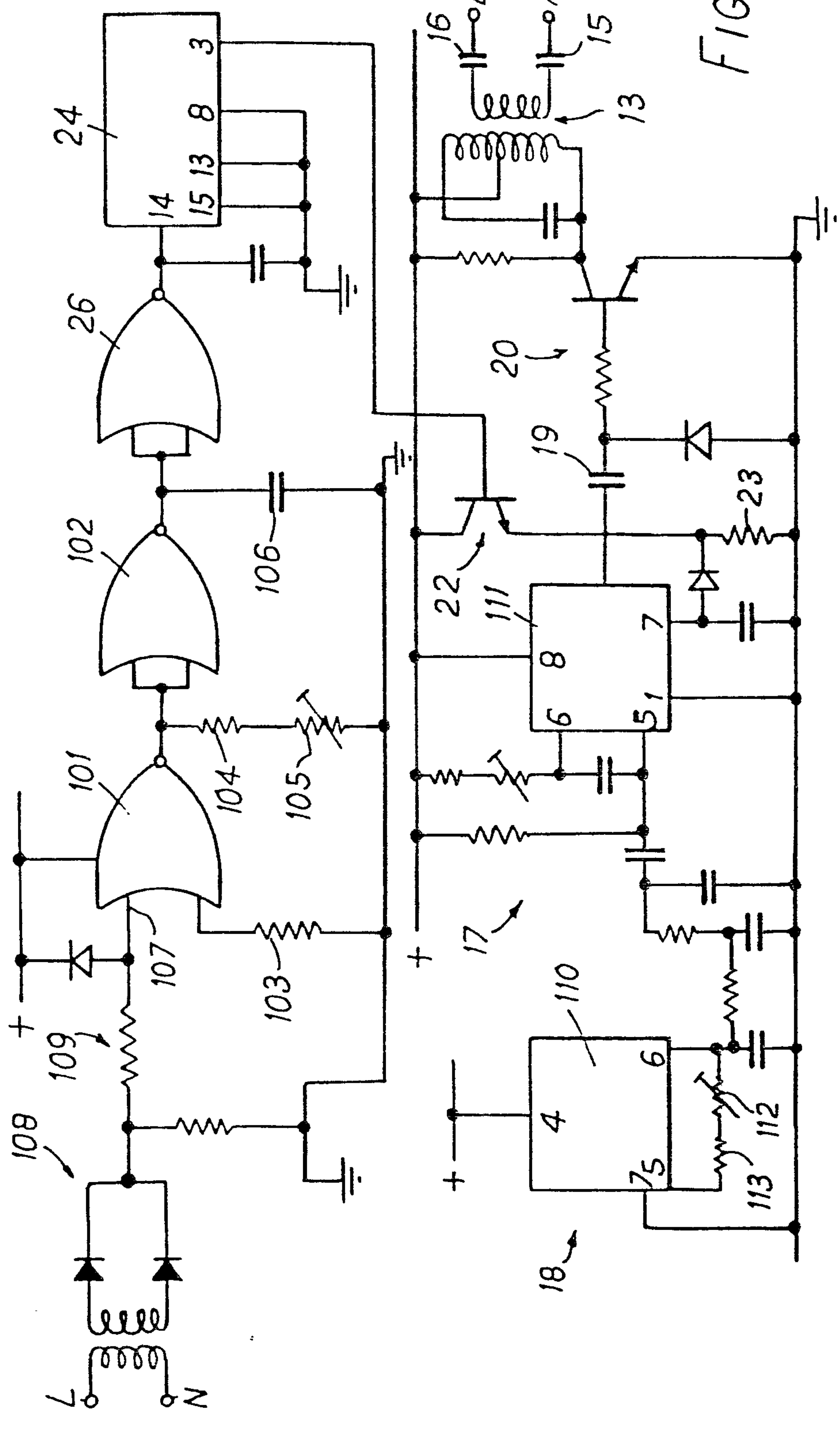

24
3
8
13
15
14
26
102
101
104
105
106
103
107
109
108
L
N
+
16
15
13
20
19
23
22
111
8
7
6
5
1
17
110
4
6
5
112
113
18

FIG. 4

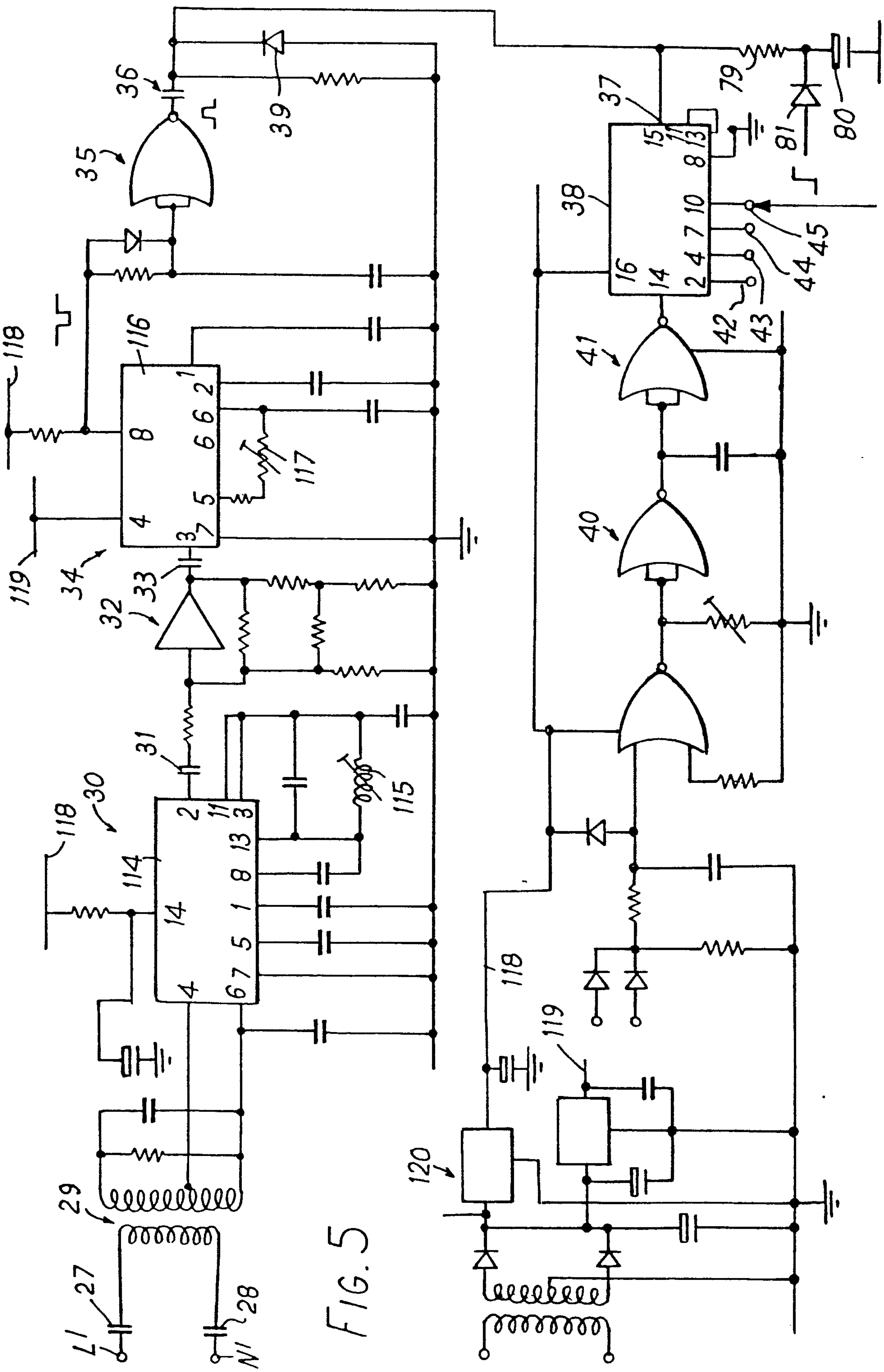

L1
27
N1
28
29
30
114
118
14
4
2
11
3
13
8
1
5
6
7
31
115
32
33
34
119
116
117
35
36
39
37
15
38
16
10
79
80
81
42
43
44
45
40
41
120

FIG. 5

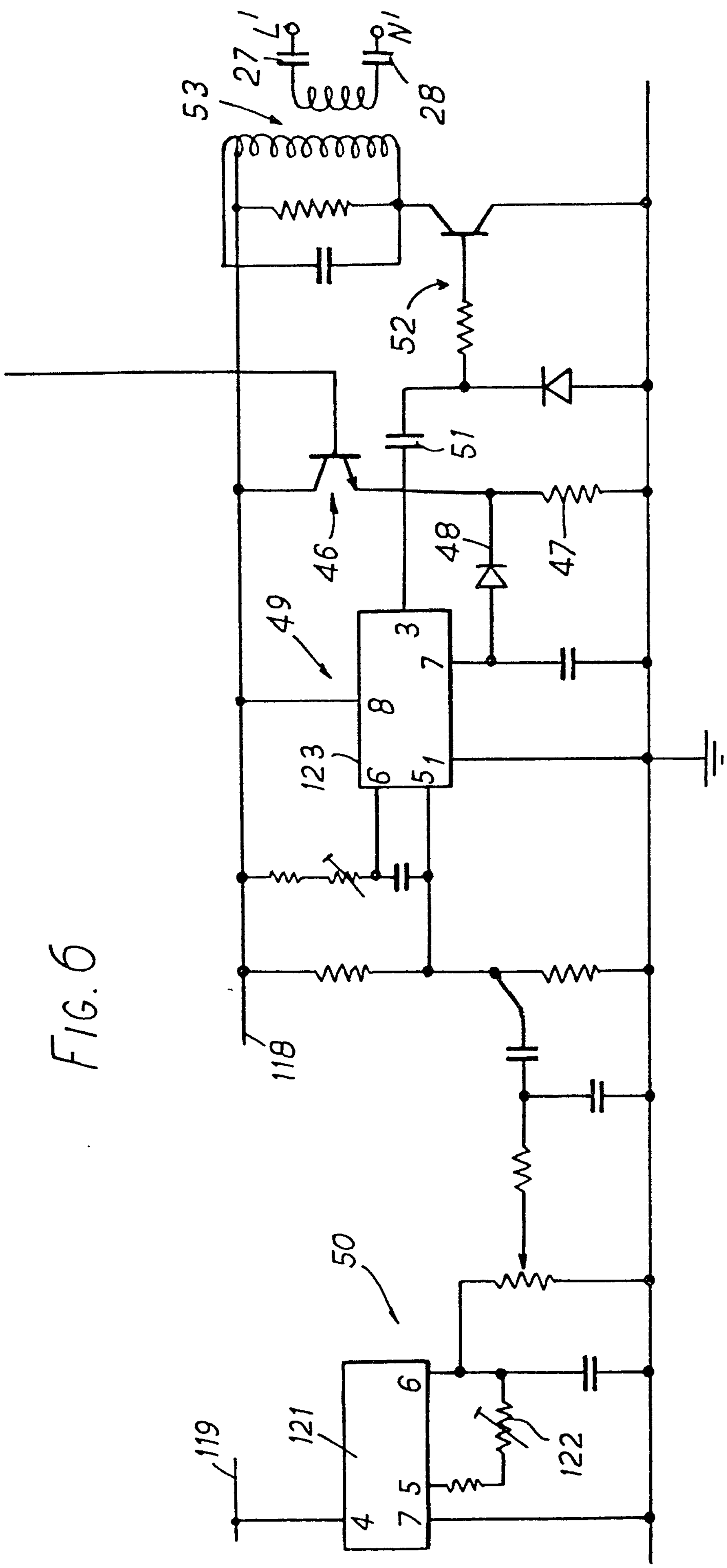



FIG. 6

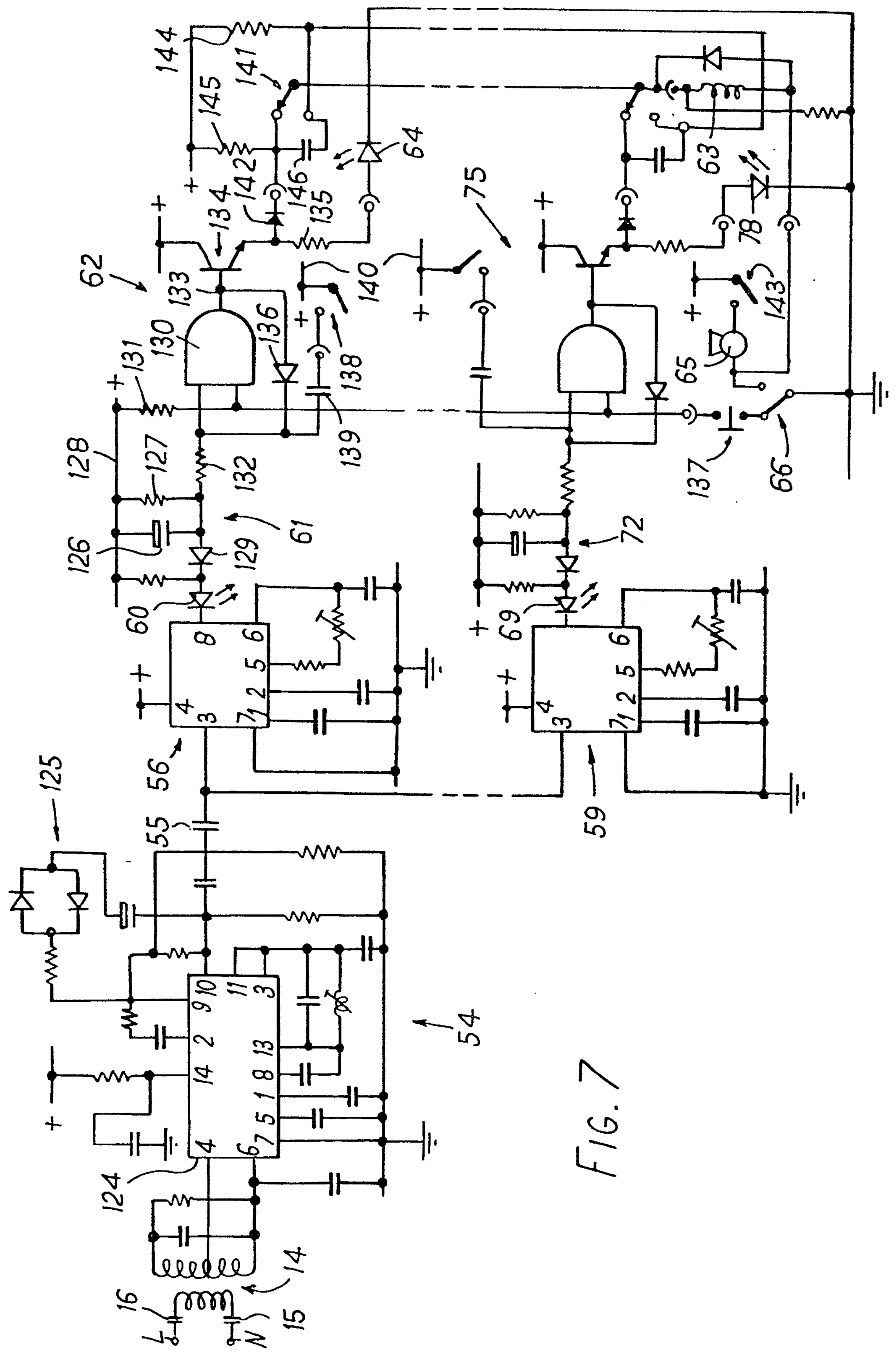

144
141
145
142
146
135
134
64
62
133
130
131
136
138
140
75
63
78
143
65
128
127
132
139
137
66
126
129
61
72
60
69
56
59
55
125
54
124
14
16
15
L
N

FIG. 7