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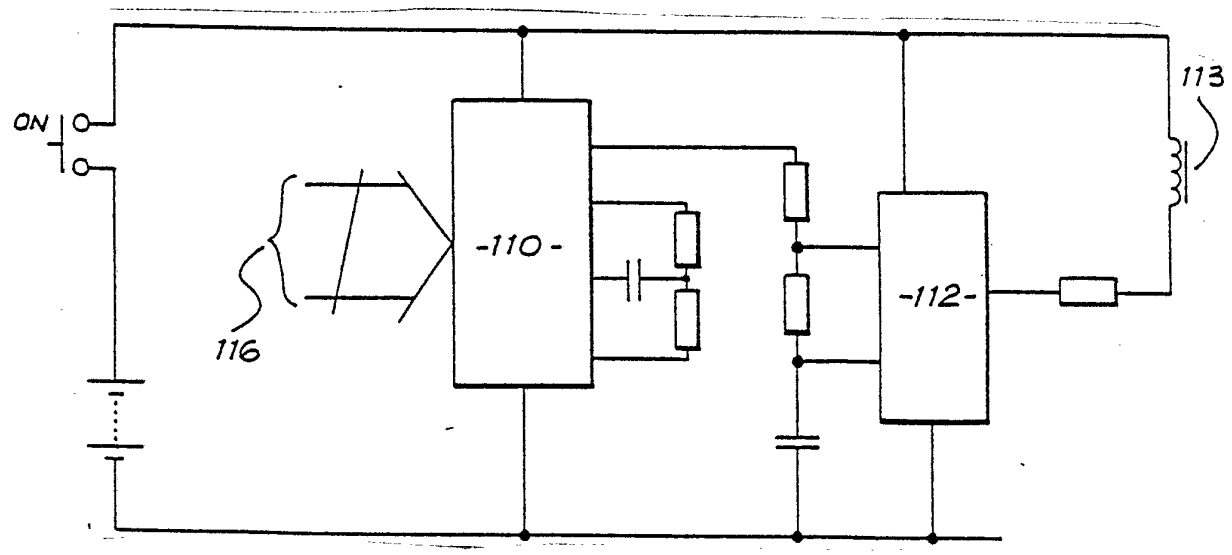
(54) Title: ELECTRO-MAGNETIC LOCK



(57) Abstract

An electro-magnetic locking system includes a digitally derived encoder transmitter or electronic key (110) and a decoder receiver or electronic lock. The electronic key (110) is coupled to a pulse oscillator unit (112) whilst in turn is connected to an inductive load circuit (113). A series of pulses are radiated by the load circuit (113) in accordance with the data rate and data code as set by the encoder. The decoder demodulates the received signal and if it is in accord with its preset input code an output signal will be generated which can be used to activate or deactivate a further locking system. The received code is used to determine whether or not an attempt is made to track the code, to initiate a time delay in the event that a wrong code is received and to identify the code as being valid.

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ELECTRO-MAGNETIC LOCK

FIELD OF INVENTION

This invention relates to locks and more particularly to an electro-magnetic lock.

For the sake of brevity, the invention will be described in relation to an electronic lock for setting and releasing vehicle burglar alarms, but, it is to be understood that the invention is not limited thereto so it may be employed in any situation where a lock is required.

BACKGROUND ART

Prior art electronic locks were developed to re-set car alarms without the driver first entering the vehicle and they embodied what may be termed a radio-frequency transmitter in the key.

Such radio frequency operated electronic locks suffer from a number of disadvantages not the least of which is that the code carried by the radio frequency signal could be recorded by an unauthorised third party, stationed some distance from the car, who could re-transmit the coded signal when the vehicle was unattended to de-activate the alarm. Furthermore, the receiver within the vehicle could be jammed by a signal from another transmitter operating at or near the same frequency.

Improved designs of such locks overcame the above disadvantages, but to date, no electronic lock has been devised which overcomes another disadvantage that the code (being digital in nature) carried by the radio frequency signal could be identified by use of a sequencer adapted to count through every permutation of the code to disable the alarm even at a considerable distance from the receiver.

There is, therefore, a need to detect whether or not some form of code breaking is taking place and the system devised to fulfil that need has to be free of any chance of being accidentally triggered to give a false alarm.

DISCLOSURE OF INVENTION

According to the invention there is provided an electromagnetic locking system having a digitally derived encoder transmitter and a decoder receiver, said encoder transmitter having circuit means adapted to generate a predetermined coded magnetic field and said decoder receiver having circuit means adapted to respond to the coded magnetic field radiated by the encoder receiver.

In one form of the invention the encoder transmitter (which constitutes an electronic key) includes a tuned circuit having an inductive portion adapted to radiate the alternating magnetic field, means for energising the tuned circuit and coder means adapted to trigger the energising means in accordance with pre-set data rates and codes.

The decoder receiver (which constitutes an electronic lock) preferably includes means for coupling to and receiving the alternating magnetic signal, means to identify the correctness of that signal and means for processing the correct magnetic signal.

In another form of the invention, the electronic key or transmitter includes a digitally derived code pulse modulated circuit to activate an inductive transducer which is adapted to radiate the magnetic field.

In this case, the electronic lock or receiver includes means for coupling to and receiving the pulse modulated magnetic signal, circuit means for demodulating the received signal and circuit means for identifying the correctness of the digitally derived code. Upon acknowledgement of the correct code, an electronic switch is activated to control power to an application lock, an application locking mechanism or an application circuit.

The decoder receiver may include time delay means adapted to render the signal processing means inoperative for a pre-determined time whilst the identified-as-correct signal is being recieved.

The electro-magnetic locking system of the invention may incorporate means for identifying valid key users so as to control access to authorised users and to restrict user operation. Furthermore, the decoder receiver may incorporate an additional time delay to permit input signal processing to be rendered inactive for a pre-determined time upon receipt

of an invalid input code or invalid user identification.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings in which:-

Fig 1 is a schematic diagram of an encoder transmitter of an electro-magnetic lock according to one embodiment of the invention,

Fig 2 is a schematic diagram of a decoder receiver for an electro-magnetic lock according to one embodiment of the invention,

Fig 3 is a schematic diagram of an encoder transmitter, the electronic key, of an electro-magnetic lock, according to a second embodiment of the invention, and,

Fig 4 is a schematic diagram of a decoder receiver, the electronic lock, for an electro-magnetic lock, according to a second embodiment of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

The encoder transmitter of the first embodiment includes a coder unit integrated circuit 10 to which is applied pre-determined data rates and codes 16. A light emitting diode

11 indicates that the encoder transmitter is ready for use.

The coder unit 10 is coupled to an oscillator unit 12 which in turn is connected to a tuned circuit 13 having capacitive component 14 and inductive component 15. When the output of the coder unit 10 is high, the oscillator unit 12 is triggered to energise the tuned circuit 13 so that the series of pulses radiated by the inductive component 15 is in accord with the data rate and code rate set by the coder unit 10.

The pulsing alternating magnetic field radiated by the encoder transmitter is coupled magnetically to a tuned circuit 20 of the decoder receiver set to resonate on the same frequency. The tuned circuit 20 has capacitive component 21 and inductive component 22 which form a tank circuit that responds to the narrow band of the alternating magnetic field signal.

If the frequency of the incoming signal is correct, it will be amplified by the integrated unit 23 and the original data code will be recovered through the network formed by diode 24, resistance 25 and capacitor 26.

The coded data is then fed to the decoder 27 which, if the code is correct and in accordance with its input 50, produces a signal at its output 28. When this occurs, a positive voltage is applied to an input of the integrated circuit 29 so rendering integrated circuit 29 inoperative.

If the code is incorrect, capacitor 30 changes to a pre-set voltage through diode 31. When this voltage has been

reached and no output has been received from the decoder 27, the utput 34 goes low to cause an alarm output signal to indicate that an attempted code break has occurred. Diode 32 is now forward biased and grounds the tuning circuit 20 stopping any further reception of codes until the capacitor 30 has discharged through resistor 33 to a pre-determined value.

The time constant of the network formed by resistor 25 and capacitor 26 sets the number of corrupt codes prior to lock out and the time constant of the resistance 35 capacitance 26 network sets the lock-out period. Capacitance 36 may be reduced or removed to reduce the period of valid transmission at output 37. In one form of the invention, the transmission time is set for 5 seconds and the lock-out time at 6 minutes.

It will be appreciated that the magnetically coupled alternating field does not require an aerial and as no radio frequency carrier wave is used, a user licence is not required. As a consequence of the use of magnetic coupling, the range of the system is small, say, of the order of 5 centimetres.

The coded signal will penetrate any non-ferrous solid such as the glass of a car window and the power requirements of the device are minimal.

The preferred frequency band is in the range of 1 to 15 kilohertz but higher frequencies may be used. Although an identical word code may be used in another similar device,

each of them will be immune from activation by the other. Furthermore, the invention discriminates against casual tampering to reduce the nuisance value of false alarms from other users.

The alarm section of the lock will only respond for a predetermined period and only when the precise frequency is received. If, during this period, the correct code is received the alarm section will not respond and the lock will open. Thus, three components are required to operate the lock, namely:-

a) precise frequency of the alternating magnetic field

b) data rate

c) code word

Figs 3 and 4 show a second embodiment of the invention.

The encoder transmitter includes a digital encoding unit integrated circuit 110, to which is applied a predetermined digital code 116.

The digital encoder unit 110, is coupled to a pulse oscillator unit 112, which in turn is connected to an inductive load circuit 113. When the output of the digital encoder unit 110 is logic "1", the pulse oscillator 112, is activated to energise the load circuit 113, so that the series of pulses radiated by the inductive component 113, is in accord with the data rate and data code as set by the digital coder unit 110.

The pulsing magnetic field radiated by the encoder

transmitter is coupled magnetically to the circuit component 114, of the decoder receiver. The incoming pulse modulated magnetic signal is amplified by the integrated circuit unit 115, and the original data code will be demodulated by the network formed by diode 117, and resistance/capacitance network 118.

The coded data is then fed to the decoder unit 120, which if the code is correct in accordance with its own preset input code 121, produces a signal at its output 122. When this occurs, a positive voltage is applied to an input of the integrated unit 125, enabling the output of unit 125 to cause transistor 126 to be activated dependent upon the application of the lock.

If the received pulse modulated digital code is received incorrect, i.e. not matching that which the lock has been pre-programmed, then the components 127 and 126 shall neglect the key operation and thereby trigger an audible alarm 128, as well as provide a visual indication that an invalid code has been received. This unauthorised attempt at using a key to electronically operate the lock, would cause the circuit of unit 128 and 130 to sound the audible alarm.

The time constant of the network formed by resistor 123 and capacitor 124, will determine the number of corrupt codes prior to raising the invalid operator alarm, whilst the time constant formed by resistor 130 and capacitor 129 will determine the time period that the invalid user alarm is activated.

It will be appreciated that the magnetically coupled pulsing magnetic field does not require an antenna as no radio frequency carrier wave is employed, a user licence thereby not being required. As a consequence of the use of electro-magnetic coupling, the range of operation of the system is in the order of ten to twenty centimetres in any non-magnetic and shielded environment.

The coded signal will penetrate any non-ferrous solid such as glass, brick, cement, acrylic, and aluminium, but with reduced sensitivity.

The pulse modulating frequency of the encoder transmitter is approximately 1.0 kHz, higher frequencies may be employed, but it is dependant upon the component values of output transducer 113 and input transducer 114. The high frequencies may be employed however at the sacrifice of sensitivity.

There are three components that are required to operate the electronic lock of the second embodiment namely:

a) the pulse modulating frequency,

b) the rate at which data is being sent and

c) the actual code itself.

As will be apparent from the above description, the invention is based on the premise that the receiver code performs three functions namely,

a) to determine whether there is any serious attempt to crack the code,

b) to initiate a time delay should the receiver

recognise any attempt to crack the code, this delay being programmable, dependant on the application. The delay ensures that code cracking by use of any form of sequencing would take an impractical time, together with the fact that this invention must be activated at close range, from ten to fifteen centimetres, in addition, an audible alarm should be triggered to acknowledge a violation has been attempted.

c) that the code be identified as valid and the application lock is made operational.

This electronic locking system may be applied to any system to which power may be applied either via mains operation or by battery power, where a key and a lock are required. Further, this electronic locking system may be applied to any application which requires operation by an identified and/or authorised user of another electronic or electrical circuit.

Various modifications may be made to design and construction without departing from the scope and ambit of the invention.

CLAIMS

1. An electro-magnetic locking system comprising a digitally derived encoder transmitter and a decoder receiver, said encoder transmitter having circuit means adapted to generate a predetermined coded magnetic field and said decoder receiver having circuit means adapted to respond to the coded magnetic field radiated by the encoder receiver.

2. A locking system according to claim 1 and including means operative upon the receipt by the decoder receiver of a correct coded magnetic field to activate or deactivate a further locking system.

3. A locking system according to either of the preceding claims wherein the encoder transmitter includes a tuned circuit having an inductive portion adapted to radiate an alternating magnetic field, means for energising the tuned circuit and coder means adapted to trigger the energising means in accordance with pre-set data rates and codes.

4. A locking system according to any one of the preceding claims wherein the decoder receiver includes means for coupling to and receiving an alternating magnetic signal, means to identify the correctness of that signal and means for processing the correct magnetic signal.

5. A locking system according to claim 1 wherein the encoder transmitter includes means for generating a digitally derived code, means for generating a pulse modulated magnetic signal and a transducer adapted to radiate the magnetic

field.

6. A locking system according to claim 5 wherein the decoder receiver includes means for coupling to and receiving the pulse modulated magnetic signal, circuit means for demodulating the received signal and circuit means for identifying the correctness of the received signal.

7. A locking system according to claim 6 wherein the decoder receiver includes means operative upon receipt of the correct received signal to activate or de-activate a further locking system.

8. A locking system according to any one of the preceding claims wherein the decoder receiver includes time delay means adapted to render the signal responding means inoperative for a pre-determined time.

9. A locking system according to any one of the preceding claims and further including means for identifying valid users of the encoder transmitter.

10. A locking system according to any one of the preceding claims and further including means providing a time delay operative to permit input signal processing to be rendered inactive for a pre-determined time upon receipt by the decoder of an invalid signal input code or invalid user identification.

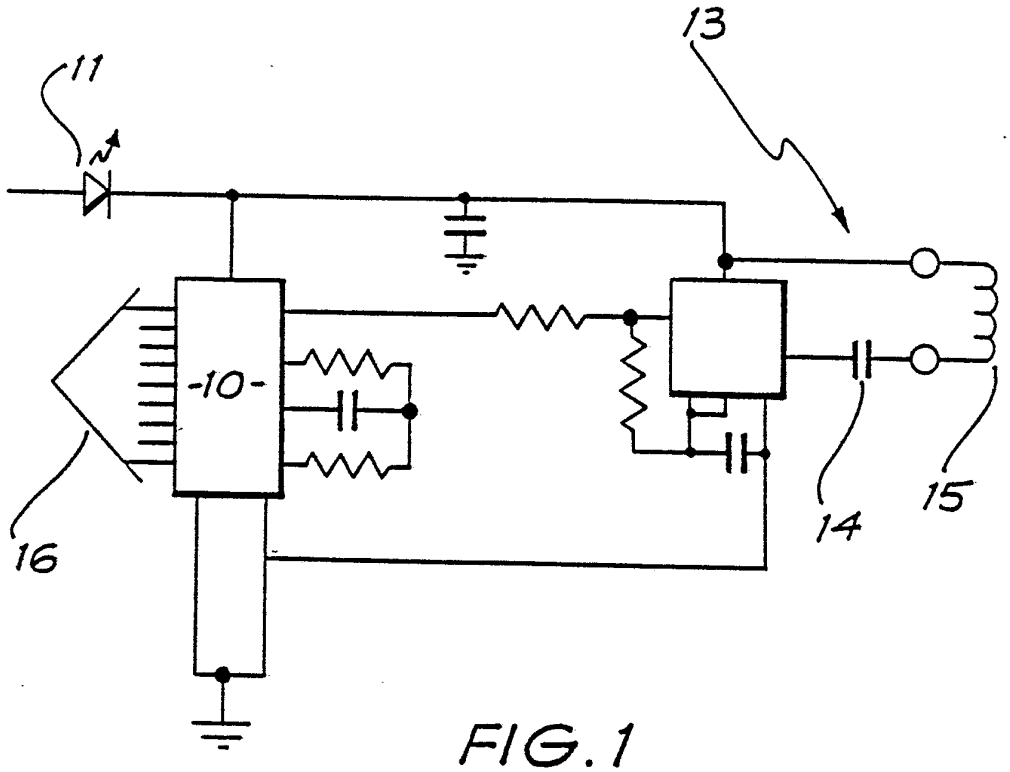

FIG. 1

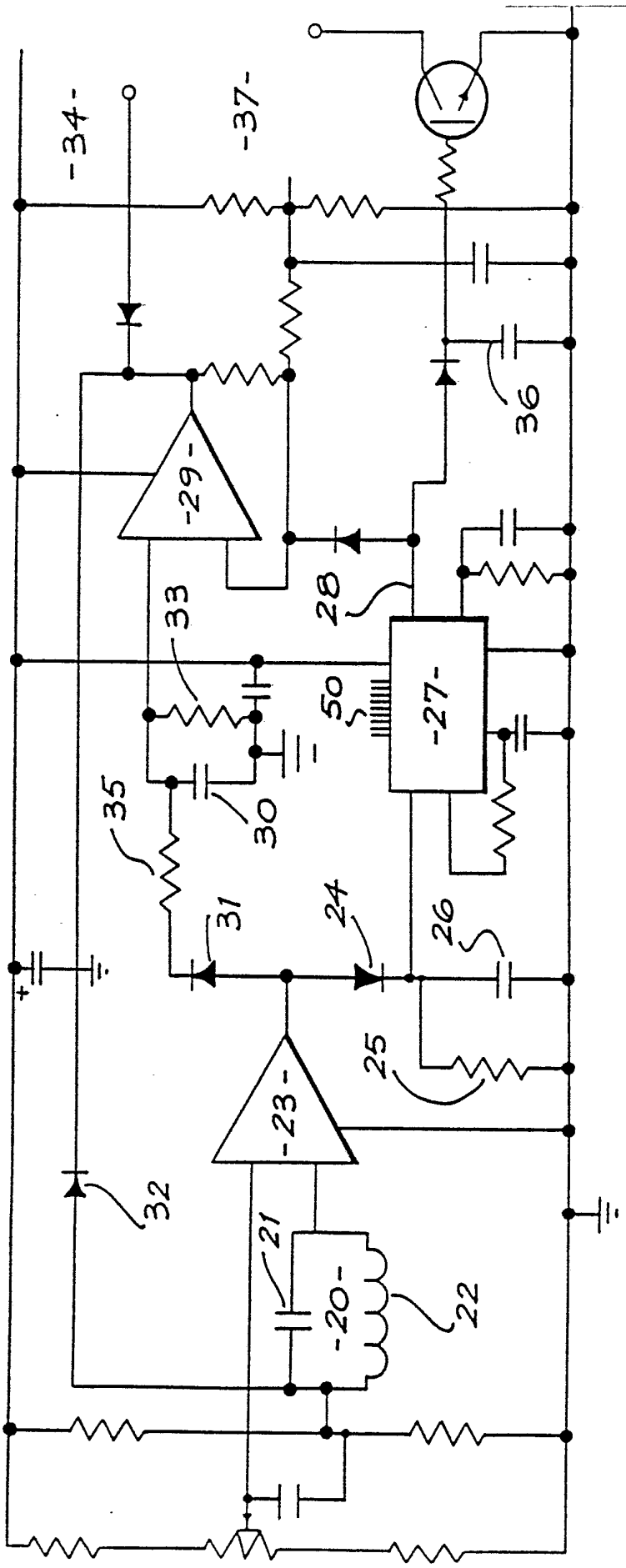

FIG. 2

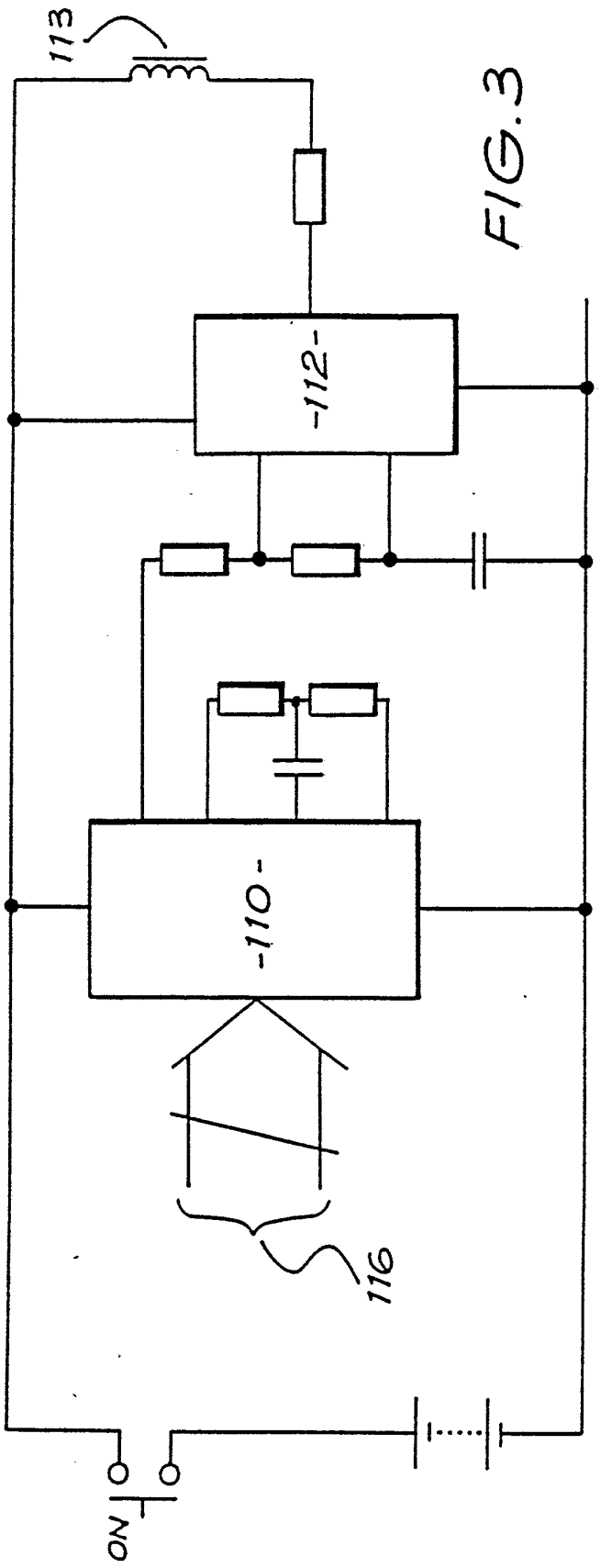

FIG. 3

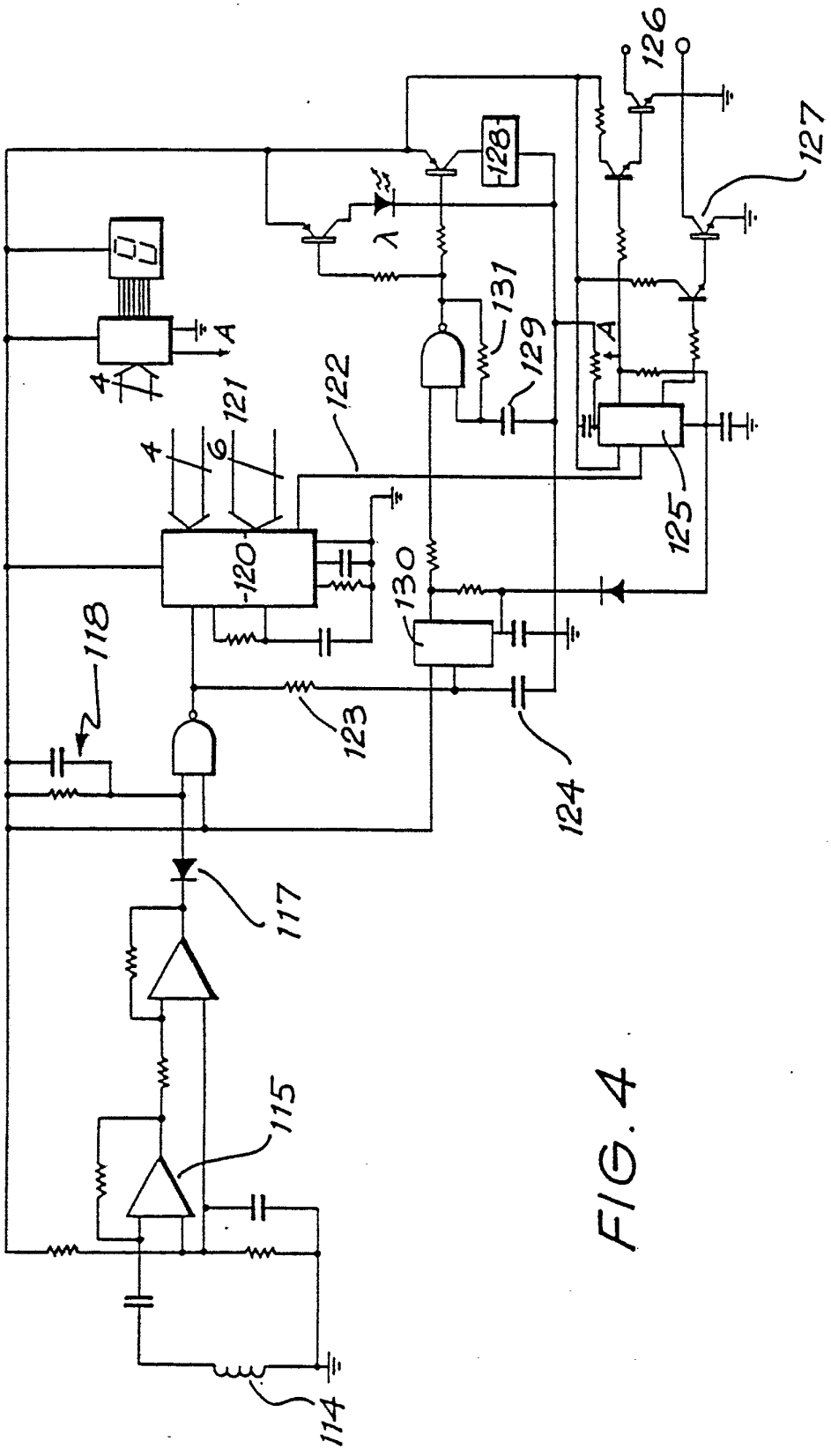

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 86/00358

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[4] G08B 13/22, E05B 47/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	G08B 13/22, E05B 47/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

AU : IPC as above , E05B 49/00

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
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X	FR,A, 2518285 (ANGEWANDTE DIGITAL ELECTRONIC GMBH) 17 June 1983 (17.06.83)	1-7
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Y	DE,A, 3244566 (ANGEWANDTE DIGITAL ELECTRONIC GMBH) 14 June 1984 (14.06.84)	1
A	GB,A, 2133073 (KIEKERT Gmbh & CO.) 18 July 1984 (18.07.84)	1
A	GB,A, 1531951 (EASTERN CO.) 15 November 1978 (15.11.78)	
A	US,A, 3,196,440 (WEINSTEIN) 20 July 1965 (20.07.65)	

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
19 February 1987 (19.02.87)	10·3·87 10 · MARCH 1987
International Searching Authority	**Signature of Authorized Officer**
Australian Patent Office	R.A. MURRAY

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/AU **86/00358**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members		
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	IT 1110783	JP 54131500	SE 7902336
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	SE 8207153		

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