

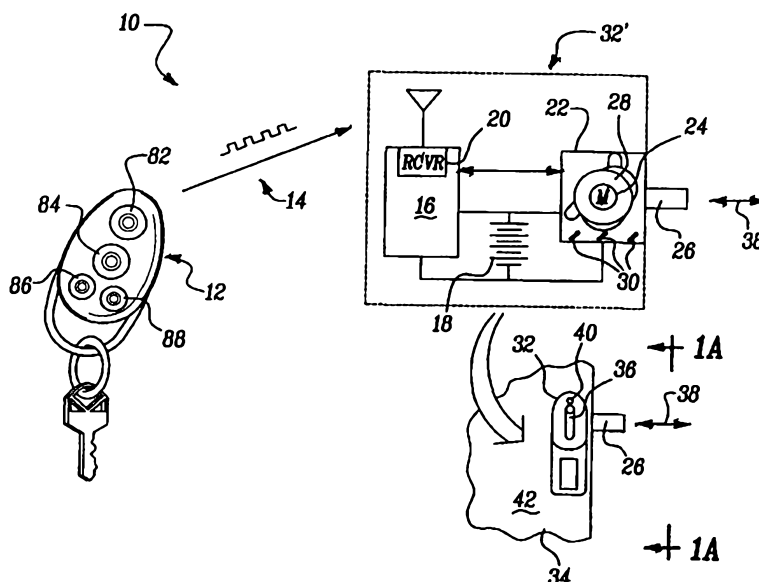


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<p>(21) International Application Number: PCT/US99/08360 (22) International Filing Date: 16 April 1999 (16.04.99) (30) Priority Data: 09/062,156 16 April 1998 (16.04.98) US (71) Applicant: EMHART INC. [US/US]; Drummond Plaza Office Park, 1423 Kirkwood Highway, Newark, DE 19771 (US). (72) Inventors: SCHAFER, David, C.; 277B Willow Road, Menlo Park, CA 94025 (US). BURNETT, William, R.; 1295 Woodland Avenue, Menlo Park, CA 94025 (US). KALAYJIAN, Nicholas, R.; 411 Lombard Street, San Francisco, CA 94133 (US). (74) Agents: BROCK, Christopher, M. et al.; Harness, Dickey &amp; Pierce, P.L.C., P.O. Box 828, Bloomfield Hills, MI 48303 (US).</p>	<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b> <i>With international search report.</i></p>
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(54) Title: REMOTELY CONTROLLED DOOR LOCK SYSTEM AND METHOD



(57) Abstract

A remote door lock system (10) including a radio frequency transmitter (12) for transmitting a coded sequence (14), a battery-powered controller (16) including a radio frequency receiver (20) receptive to the coded sequence, and a lock mechanism (22) including actuator (24) and a bolt (26) coupled to the actuator. The controller decodes the coded sequence during an awake mode and develops an actuator signal if the coded sequence is proper. The controller has a sleep mode that alternates with the wake mode to reduce the overall power consumption. The actuator of the lock (10) mechanism is responsive to the actuator signal, and is operative to assert a force on the bolt to lock or unlock the door (34). The controller preferably includes a low power LED driver circuit (112) including a pulse generator powering a flyback converter to control the output of the LED.

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**REMOTELY CONTROLLED DOOR LOCK SYSTEM AND METHOD****Background of the Invention**

This invention relates generally to door lock systems, and more particularly to radio remote controlled door lock systems.

5 Radio remote controlled (or "remotely controlled" or "remote control") door locks for automobiles are well known. A small transmitter is carried by the vehicle owner, typically as part of the door key, or in the form of a small "fob" attached to a key chain. A button is pressed on the transmitter to cause various doors of the automobile to lock and unlock. This is typically effectuated within the automobile  
10 by a number of small solenoids coupled to the mechanical lock system of the doors and controlled by a radio receiver responsive to the remote control transmitter.

There are also other types of radio remote controlled door operating systems. For example, there is the remote control-type garage door opener. These systems include a radio receiver coupled to a door opening motor. A remote  
15 control unit (typically hand held) sends out a coded radio frequency (r.f.) signal to cause the garage door to open and close.

While these prior art systems are convenient and effective, they are not well suited for use within conventional doors found in residential and commercial buildings. This is because a typical door does not include a power source, and only  
20 provides a very small area in which a receiver, actuator and control circuitry can be located. Typically, from a practical point view, the entire remote control locking system must be contained within the lock assembly housing.

The aforementioned radio remote controlled car lock systems and radio remote controlled garage door systems are typically unconcerned with both power and size constraints. In the case of the automobile lock system, the remote control  
25 radio transmitter can be located in any number of places in the non-passenger areas of the automobile. Furthermore, automobile lock systems are powered by large lead-acid batteries, from which relatively little power is drawn. With radio remote controlled garage door openers, the power source is typically a.c. household  
30 current, and the receiver can be placed in any convenient location, e.g., along a wall or near the ceiling of the garage. Therefore, radio remote control systems in the automotive door and garage door arts tend not to address the problems of low power consumption and compact space.

There have been a number of attempts to create a remote door lock system in the prior art. For example, U.S. Patent No. 4,907,429 of Kenneth et al. teaches a remote controlled door lock apparatus including a solenoid for remotely locking and unlocking the door. Likewise, in U.S. Patent No. 5,678,436 of Alexander, a remote controlled door lock system is provided for remotely unlocking or locking a dead bolt. In the Alexander device, an electric motor is used to move the dead bolt between the open and closed positions.

While there are a number of disclosures of remote controlled door lock systems in the prior art, none of them adequately address the problem of energy consumption. Since the overall lock mechanism size must be relatively small, a practical design requires relatively small batteries, such as AA size batteries. However, a reasonable number, e.g., four AA size batteries do not provide enough power to operate these prior art systems for a sufficient period of time.

It would be a highly desirable feature for a remotely controlled door lock system to have one or more light emitting diode (LED) displays to indicate the status of the lock. However, LEDs are big consumers of electrical power. For example, a single LED that is continuously illuminated can consume the majority of the total power budget for a remote controlled door lock system. This is, of course, unacceptable since the lock actuator (i.e., a solenoid, motor, etc.) and the electronics of the controller also require considerable power.

U.S. Patent No. 4,866,430 of Chek teaches a low voltage LED driver circuit that uses a small magnitude inductor in combination with an astable multivibrator to supply sufficient voltage to illuminate an LED from a supply voltage source that is less than the LED's typical operating voltage. By use of the high pulse rate of the multivibrator in conjunction with the small magnitude inductor, the LED is turned on and off at a rate at which it appears to be continuously illuminated to the human eye.

While the Chek circuit is useful in that it illuminates a LED with reduced magnitude of current, it is a relatively complex circuit, primarily due to the circuit elements required for the astable multivibrator. That is, the astable multivibrator requires, as a minimum, two transistors and a number of passive support elements. This high component count adds to the cost of the circuit and reduces its efficiency in that each of the circuit elements, being less than ideal, consume some of the energy available to the system.

### Summary of the Invention

The present invention provides a remote controlled door lock system and method that is very power-efficient. In addition, the present invention includes an energy-efficient method for receiving encoded data, and an uncomplicated, yet very efficient, low-power LED power circuit.

More particularly, a remote control door lock system in accordance with the present invention includes a radio frequency transmitter for transmitting a coded sequence; a battery-power controller including a radio frequency receiver receptive to the coded sequence, and a lock mechanism including an actuator and a bolt coupled to the actuator. The controller decodes the coded sequence during an "awake" mode and develops an actuator signal if the coded sequence is proper. The controller also has a "sleep" mode which alternates with the awake mode to reduce the overall power consumption.

A remote controlled system of the present invention includes a radio frequency transmitter for transmitting a coded sequence, a battery-power controller including a radio frequency receiver receptive to the coded signal, and an LED indicator. The LED indicator is energized only during an awake mode of the controller, although stored energy may cause it to be illuminated during the sleep mode. In addition, during the awake mode the controller may decode the code sequence and develop an actuator signal if the coded sequence is proper. A sleep mode of the controller alternates with the awake mode, where reduced current is drawn from the battery during the sleep mode.

A method for receiving encoded data in accordance with the present invention includes generating an interrupt to enter into an awake mode from a sleep mode, retrieving an interrupt count, turning on a radio receiver when the count reaches a power-on value, monitoring with the radio receiver for encoded data, decrypting the encoded data, comparing the decrypted encoded data with manufacturer key data, providing an output signal if the decrypted encoded data is a correct key, and reentering the sleep mode. Preferably, before reentering the sleep mode, the radio receiver is turned off to reduce power consumption.

A slow power LED driver circuit of the present invention includes a pulse generator creating a series of pulses and a flyback circuit including a transistor having a first node, a second node and a control node. The control node of the transistor is coupled to the pulse generator to receive the series of pulses, and the

first node is coupled to a first potential by the parallel connection of an inductor and the LED. The second node is coupled to a second potential. The combination of the pulse generator and the flyback circuit provide the illusion that the LED is continuously lit, while drawing relatively little power from the battery.

5           These and other advantages of the present invention will become apparent upon reading the following detailed descriptions and studying the various figures of the drawings.

### **Brief Description of the Drawings**

10           Figure 1 illustrates a remote controlled door lock system in accordance with the present invention;

            Figure 1A is a view taken along line 1A-1A of Fig. 1;

            Figure 1B is a view taken along line 1B-1B of Fig. 1A;

            Figure 2 is a schematic diagram of a radio frequency transmitter in accordance with the present invention;

15           Figure 3 is a block diagram of a battery-powered controller including a radio frequency (r.f.) receiver;

            Figure 4 is a flow diagram illustrating a method for receiving encoded data in accordance with the present invention;

20           Figure 5 is a timing diagram illustrating a coded sequence used with the present invention;

            Figure 5A is an illustration of the data portion of the coded sequence of Fig. 5;

            Figure 6 is a timing diagram illustrating certain logical states during the operation of the controller of Fig. 3;

25           Figure 7 is a low power LED driver circuit in accordance with the present invention; and

            Figure 8 is a timing diagram illustrating several voltage and current signals created during the operation of the driver circuit of Fig. 7.

### **Detailed Description of the Preferred Embodiments**

30           In Fig. 1, a remote controlled door lock system 10 in accordance with the present invention includes a radio frequency (r.f.) transmitter 12 for transmitting a coded sequence 14 to a controller 16. The controller 16 is powered by a battery

18, and includes an r.f. receiver 20. The remote controlled door lock system 10 also includes a lock mechanism 22 having an actuator (e.g., a small electric motor) 24 and a bolt 26 coupled to the actuator 24 by a drive mechanism 28. The lock mechanism also preferably includes a number of switches 30, and is preferably  
5 powered by the same battery 18 that is used to power the controller 16. A suitable lock mechanism 22 is disclosed in copending U.S. Patent Application No. 09/002,821, filed January 5, 1998, on behalf of Armstrong, the disclosure of which is incorporated herein by reference.

The controller 16, battery 18, and lock mechanism 22 are preferably mostly  
10 enclosed within a common enclosure 32 as suggested by the broken lines 32'. The enclosure 32 is attached to one side of the door 34. A rotatable knob 36 can be used to manually extend and retract the bolt 26 as suggested by the arrow 38. In addition, the remote control system of the present invention can be used to remotely extend and retract the bolt 26 by use of the r.f. transmitter 12. Preferably,  
15 an interior LED 40 is provided in the enclosure 32, for purposes to be discussed subsequently.

Fig. 1A is a view taken along line 1A-1A of Fig. 1. In this view, the enclosure 32 is shown to be attached to the inside portion 42 of the door 34. The bolt 36 is extendable through a bolt plate 44 attached to an edge 46 of the door 34.  
20 An external lock enclosure 48 is attached to an outside portion 50 of the door 34. As will be appreciated by those skilled in the art, the entire door lock assembly 52 is assembled by placing the bolt 26 within a bolt hole 54 formed into the edge 46 of the door 34, and then assembling the enclosures 32 and 48 from opposing sides. Screws (not shown) are provided through enclosure 32 to engage with the  
25 enclosure 48 to hold the door lock assembly 52 together.

Fig. 1B is a view taken along line 1B-1B of Fig. 1A. The external lock enclosure 48 includes a cylinder 56 with a keyway 58. The external lock enclosure 48 is also preferably provided with a pair of LEDs 60 and 62. The lock assembly within the external lock enclosure 48 is a standard, mechanical lock mechanism, as  
30 will be appreciated by those skilled in the art.

Fig. 2 is a schematic diagram of an r.f. transmitter 12 in accordance with the present invention. The r.f. transmitter 12 includes a small battery 64, a number of switches 66, 68, 70, and 72, a pair of encoders 74 and 76, an OR gate 78, and a Colpitts oscillator 80.

The battery 64 is preferably a small, six-volt battery of the type used in hearing aids and electronic watches. The switches 66 - 72 are simple SPST normally open switches that can be activated by the buttons 82 - 88, respectively, of Fig. 1. The encoders 74 and 76 are preferably controllers available from  
5 Microchip Technology, Inc. of Chandler, Arizona, under the KeeLoq™ trademark. More particularly, controller 74 is preferably a Microchip Technology, Inc. model HCS360, and controller 76 is preferably a model 331920.

The reason why two encoders 74 are used in the present design is that manufacturers closely guard their manufacturer's code (which is part of the key  
10 system) for security reasons. Therefore, if the transmitter 12 is to control devices from multiple manufacturers, each of which has its own secret manufacturer's code, a separate encoder can be provided for each manufacturer. In this instance, it is assumed that the unlock switch 66, light switch 68, and lock switch 72 operate under a first manufacturer's code, and are therefore coupled to various inputs of the  
15 encoder 74, while the garage switch 70 operates under a different manufacturer's code, and is therefore coupled to encoder 76. The output of the encoders 74 and 76 are input to an OR gate 78 to provide an ORed input to Colpitts oscillator 80.

The Colpitts oscillator 80 is an amplitude (i.e., on/off) modulated by the output of the OR gate 78. That is, one or the other of encoders 74 and 76 will be  
20 developing a coded sequence of 1's and 0's which will turn on and off the oscillator 80. The frequency of the oscillator is preferably set to about 390 MHz by a combination of the inductance of a loop antenna 90 and the series connections of two capacitors 92 and 94. A resistor 96 provides biasing for a transistor 98 through the loop antenna 90.

The controller 16 of the present invention is illustrated in block diagram form in Fig. 16. The controller 16 is based upon a microcontroller 100, which is  
25 preferably a PIC™ family microcontroller available from Microchip Technology, Inc. of Chandler, Arizona. A preferred PIC microcontroller can be purchased from Microchip Technology, Inc. by product number 16LC62A-04.

The power input from battery 18 is shown at 102 and powers the microcontroller 100 through a series connection of a Schottky diode 104 and a  
30 voltage regulator 106. Switches 30A, 30B, and 30C (collectively, "switches 30") of the lock mechanism 22 are also coupled to the microcontroller 100. The outside LEDs 60 and 62 and the inside LED 40 can also be seen in this figure. A serial



EPROM 108 is coupled to the microcontroller 100 to store the encryption keys, counters, etc. Likewise, an audible transducer 110 is coupled to the microcontroller 100 to provide audible feedback in the form of beeps, for example, to indicate an error condition, or the completion of a lock or unlock procedure.

5           The inside LED 40 is coupled to the microcontroller 100 by a LED driver 112 which will be discussed in greater detail subsequently. It should be noted that the diode 40 can be illuminated for extended periods of time, making it very important that its illumination be as low in power drain as possible. For example, the inside light is illuminated the entire time that the lock mechanism is in a locked mode. In contrast, the outside LEDs 60 and 62 are only briefly illuminated to indicate momentary status and/or functional errors, and therefore special precautions to reduce their power consumption is not required.

10           The controller 16 also includes a motor driver 114 which can be coupled to the motor 24. It should be noted at this point, that the presently described embodiment of the invention uses a motor to impart a force on the bolt, other forms of actuators (such as electrical solenoids) can also be used. Therefore, as used herein, the term "actuator" will refer to an electrically powered transducer which can exert sufficient force upon the bolt, either directly or indirectly, to cause it to extend and retract.

15           The controller 16 also includes an r.f. receiver 116. A preferred receiver is the well-known superregenerative receiver due to its low cost, low power consumption, and fast turn-on time. The receiver is coupled to the microcontroller 100 by a data line 118, which can carry coded sequences, and a power line 120, which can be used to turn on and off the receiver.

20           Also coupled to the microcontroller 100 is a low battery detector 122 and a voltage monitor 124. In the present embodiment, an output 126 of the low battery detector 122 goes from high to low when the voltage at  $V_{prot}$  drops below 4.5 volts. This allows software within the microcontroller 100 to detect a low battery condition and to act accordingly. The voltage monitor 124 has an output 128 which goes from high to low when the voltage  $V_{dd}$  drops 2.7 volts. This creates a complete and immediate shutdown of the microcontroller 100 to prevent false data from being written into the EEPROM 108.

25           The controller 16 also includes a RC circuit 130 coupled to an oscillator input of the microcontroller 100. The resistance and capacitances are chosen, in

the present embodiment, to provide a microcontroller 100 clock frequency at a maximum of about 4 MHz. Preferably, a frequency of 3 MHz (plus or minus about 20%) is chosen.

5 A low power 200 Hz oscillator 132 is provided at an interrupt of the microcontroller 100. As will be discussed in greater detail subsequently, the 200 Hz oscillator performs a number of useful functions. For one, the oscillator 132 is used to control when the microcontroller 100 is awoken from a "sleep" state or mode to an "awake" state or mode. That is, most of the time the microcontroller 100 (and therefore most of the controller 16) is in a low-power or "sleep" state, and  
10 it is occasionally "awakened" into an operational state to perform the necessary detection, decryption, housekeeping, and other functions.

It should be noted that the microcontroller 100 often includes its own oscillator for interrupt purposes. However, it is important for the present invention to have a stable, repeatable oscillator since it is used for certain timing functions  
15 that require fairly good tolerances. Therefore, a more accurate external oscillator 132 is used in this case.

In Fig. 4, a process 134 for receiving encoded data is illustrated in flow diagram form. It should be noted that the process 134 is preferably a computer-implemented process with program instructions stored internally to the  
20 microcontroller 100. That is, the microcontroller 100 includes some write-once memory (such as a EPROM) and some random access memory (RAM) for the computer-implemented process 134.

The process 134 is usually in an idle or "sleep" mode as indicated at 136. However, this sleep mode is interrupted every 5 milliseconds by the oscillator 132.  
25 An operation 138 determines whether the LED 40 should be turned on. The LED is typically turned on when the locked assembly is in the locked position so that a person within the dwelling can tell at a glance whether the door is in an unlocked or locked state. This status can be learned by the microcontroller 100 from switch 30C (see Fig. 3). If it is determined that the LED should be turned on, an operation  
30 140 sends a 12-microsecond pulse to the LED driver 112. After the pulse has been sent, or if it is determined the LED should not be turned on, an operation 140 determines whether a variable COUNT is equal to 80. COUNT is a variable, stored by microcontroller 100, to indicate the number of times that the microcontroller has been interrupted ("awakened") since the last time that the COUNT was set to zero.

If operation 142 determines that the COUNT is equal to 80, the radio (i.e., the r.f. receiver) 116 is turned on. In an operation 144, COUNT is incremented by one in an operation 146. The process 134 then returns to the sleep mode 136.

5 If operation 142 determines that the COUNT is not equal to 80, an operation 148 determines whether the COUNT is equal to 94. If it is, it is determined whether the r.f. receiver 116 is receiving data in an operation 150. If no data is being received, the COUNT is then incremented by one in operation 146 and the process 134 returns to sleep mode 136.

10 If operation 148 determines that COUNT is not equal to 94, an operation 152 determines whether COUNT is equal in 99. If not, COUNT is incremented by one in operation 146 and the process returns to the sleep mode 136.

If, however, operation 152 determines that COUNT is equal to 99, an operation 154 determines whether any data is being detected by the r.f. receiver 116. If not, the operation 154 concludes that no data is being currently transmitted, and reads the switches 30A-30C and the low battery detector 122 and acts accordingly. In operation 158 then resets COUNT to zero and turns off the r.f. receiver 116 to save power.

15 If data is detected by either operation 150 or 154, the data is read in an operation 160. The data is then decrypted in operation 162 and is determined in an operation 164 whether a correct key has been used. The decryption process is, in the present embodiment, set by the KeeLoq standards. If a correct key has not been used, operational control is turned over to operation 156. However, if a correct key has been received, the motor (or other actuator) is powered with an output or actuator signal to run the motor. After the motor has run its course, as determined by switch 30B, various housekeeping functions are performed by an operation 168 and operation control is returned to operation 156.

20 Some of the operations of process 134 will be found into all embodiments of the present invention. Certain other operations are, however, dependent upon the particular code sequence format chosen for this system. In the present embodiment, the microchip data format of Microchip Technology, Inc. of Chandler, Arizona, has been chosen. This format is illustrated in Fig. 5.

30 In Fig. 5, a transmission 170 in Microchip data format includes a preamble 172 and data 174. There is an approximately 2 millisecond delay 176 after the preamble 172, and an approximately 64 millisecond delay 178 after the data 174.

In Fig. 5A, the structure of the data 174 is illustrated. The data 174 is a 67-bit transmission and includes a 32-bit rolling code field 180, a 28-bit serial number or "ID" field 181, a 4-bit function code field 182 (for the switches), a one-bit status field 183, and a 2-bit CRC checksum field 184. This data structure is, again, in accordance with standards set by Microchip Technology, Inc. with their KeeLoq technology.

The reason why data is detected at two points in the process 134 of Fig. 4 is because of the delays 176 and 178 in the Microchip Technology, Inc. data format. It is possible that the radio is turned on and data is monitored during one of these delay periods, giving the false indication that no data is being currently transmitted. This actually occurs about 10% of the time. Therefore, the test for data is repeated a few milliseconds after the first test for data to ensure that there really is no data being transmitted, rather than a first data test with the delay 176 or 178.

The timing of the process 134 is illustrated in Fig. 6. As noted, the microcontroller 100 is awoken every 5 milliseconds. One of the design features of the present invention is that the signal from the transmitter (i.e., decoded sequence) be recognized within one half second of when a button is first pushed on the transmitter. As noted by waveform 186, the microcontroller 100 is active every 5 milliseconds for less than about 20 microseconds. If data is detected, it remains active until the coded sequence has been verified and the output or actuating signal is provided to the actuator.

As noted, there is a relatively low "duty cycle" on the waveform 186 indicating substantial power savings.

Still referring to Fig. 6, at 400 milliseconds (i.e., a COUNT of 80) the radio is turned on as indicated by waveform 188. The radio is allowed to settle until 470 milliseconds (i.e., a COUNT of 94). At that time, the data is considered to be valid as indicated by waveform 190. Data is then checked and processed as indicated by waveform 192, and after the data has been processed the switches are read as indicated by waveform 194.

In Fig. 7, the LED driver 112 includes the LED 40 that is provided on the inside portion of the lock. The LED driver 112 includes a resistor 196, a transistor 198, an inductor 200, and the LED 40. Preferably, the transistor 198 is a bipolar transistor having its emitter coupled to ground and having its collector coupled to

the  $V_{BAT}$  by the parallel connection of the inductor 200 and the diode 40. The inductor 200 is typically in the range of 1000 microhenries, and the resistor 196 is about 470 ohms. The Gilway E233 Ultrabright red LED is suitable for the LED 40 of the present invention.

5           The circuit 112 is essentially a flyback or boost converter which provides about one third the current three times as long to the diode 40 then it would have if it was simply connected across the battery. This greatly increases efficiency. In addition, the flyback circuit is coupled with a pulse drive to provide even greater efficiency from the LED. That is, a pulse drive at high current for a short period of  
10 time is used to illuminate the LED much more efficiently than a d.c. current of the same average value.

          The pulse drive  $V_{CTRL}$  is provided by the microcontroller 100. That is, a new pulse begins every 5 milliseconds (due to the oscillator 132) and lasts for approximately 12 microseconds.

15           The operation of the combination pulse drive/flyback LED driver is shown in Fig. 8. The waveform 202 is of  $V_{CTRL}$  which, as explained above, is developed by the microcontroller 100. Waveform 204 illustrates the  $V_L$  at the collector of transistor 198. Waveform 206 illustrates the current  $I_L$  through the inductor 200, and waveform 208 illustrates the current  $I_{LED}$  through the LED 40. Waveform 209  
20 is the current  $I_B$  drawn from the battery.

          As mentioned previously,  $V_{CTRL}$  produces a pulse 210 of a duration of 12 microseconds every 5 milliseconds. This causes the transistor 198 to turn on permitting a current  $I_L$  to start flowing through the inductor 200 as seen in waveform 206. Initially,  $V_L$  is pulled to ground due to the conductance of the transistor 198  
25 until  $V_{CTRL}$  goes low. At this point, the current  $I_L$  starts to flow through the LED 40 at a discharge rate that is approximately one third of its charging rate.  $V_L$  rises above  $V_{BAT}$  while the current is flowing through the LED from the inductor. After the current  $I_L$  through the LED 40 drops to zero,  $V_L$  assumes a state of about  $V_{BAT}$  until the next pulse 210 Of  $V_{CTRL}$  occurs.

30           Therefore, the circuitry 112, when combined with the pulse generator implemented with the microcontroller 100 and the oscillator 132, reduces the power consumption of the LED in two ways. For one, the power is only drawn from the battery for 12 microseconds every 5 milliseconds. Secondly, the flyback converter takes the current that would have been dissipated within the 12 microsecond period

and stretches it out threefold, i.e., to about 36 microseconds. The flyback converter can be thought of as taking the higher battery voltage and reducing it to a lower voltage to drive the LED, and spreading the current over a longer time than the original pulse. The combination of these two synergistic energy saving mechanisms results in a LED 40 which consumes no more than about 25% of the power budget. If it is assumed that the lock is opened and closed an average of 10 times a day, the motor or actuator 24 typically consumes another 50% of the power budget with the remaining 25% being allocated to the controller 16.

While this invention has been described in terms of several preferred embodiments, there are alterations, permutations, and equivalents which fall within the scope of this invention. It should also be noted that there are many alternative ways of implementing both the process and apparatus of the present invention. For example, while this invention has been described in terms of r.f. transmitters and receivers, other types of transmitters and receivers (such as I/R transmitters and receivers) can be used to practice the present invention. It is therefore intended that the following appended claims be interpreted as including all such alterations, permutations, and equivalents as fall within the true spirit and scope of the present invention.

**What is claimed is:****CLAIMS**

1. A remotely controlled door lock system comprising:  
a radio frequency transmitter for transmitting a coded sequence;  
5 a controller powered by a battery and including a radio frequency receiver receptive to said coded sequence, said controller decoding said coded sequence during an awake mode and developing an actuator signal if said coded sequence is proper, said controller having a sleep mode that alternates with said awake mode, wherein reduced current is drawn from said battery during said sleep  
10 mode; and  
a lock mechanism including an actuator and a bolt coupled to said actuator, said actuator being responsive to said actuator signal and operative to exert a force on said bolt.
2. A remote door lock system as recited in claim 1 wherein said coded  
15 sequence is first coded sequence encoded with a first manufacturer's key, and said controller is a first controller utilizing said first manufacturer's key, said radio frequency transmitter further being capable of transmitting a second coded sequence encoded with a second manufacturer's key that can be received by a second controller utilizing said second manufacturer's key, said second controller  
20 developing an output signal upon receiving a correct second coded sequence.
3. A remote door lock system as recited in claim 1 wherein said controller further includes an LED indicator which can be energized during an awake mode of said controller.
4. A remote door lock system as recited in claim 1 wherein said LED  
25 indicator is energized by a pulsed flyback converter.
5. A remote door lock system as recited in claim 4 wherein pulses are provided to said flyback converter by a microcontroller.

6. A remotely controlled system comprising:  
transmitter for transmitting a coded sequence; and  
controller powered by a battery and including a receiver receptive to  
said coded sequence, said controller further having an LED indicator which can be  
energized during an awake mode of said controller, said controller decoding said  
coded sequence during said awake mode and developing an actuator signal if said  
coded sequence is proper, said controller having a sleep mode that alternates with  
said awake mode, wherein reduced current is drawn from said battery during said  
sleep mode.
7. A remotely controlled system as recited in claim 6 wherein said  
controller is put into said sleep mode after said receiver has been turned on, but  
before said receiver has settled into a steady state.
8. A remotely controlled system as recited in claim 7 wherein said LED  
indicator is part of a flyback circuit.
9. A remotely controlled system as recited in claim 6 wherein said  
controller checks for data a plurality of times within the duration of a coded  
sequence.
10. A method for receiving encoded data comprising:  
generating an interrupt to enter an awake mode from a sleep mode;  
retrieving an interrupt count;  
turning on a radio receiver when said count reaches a power-on  
value;  
monitoring with said radio receiver for encoded data;  
decrypting said encoded data;  
comparing said decrypted encoded data with key codes, and  
providing an output signal if said decrypted encoded data is a correct key; and  
entering said sleep mode.

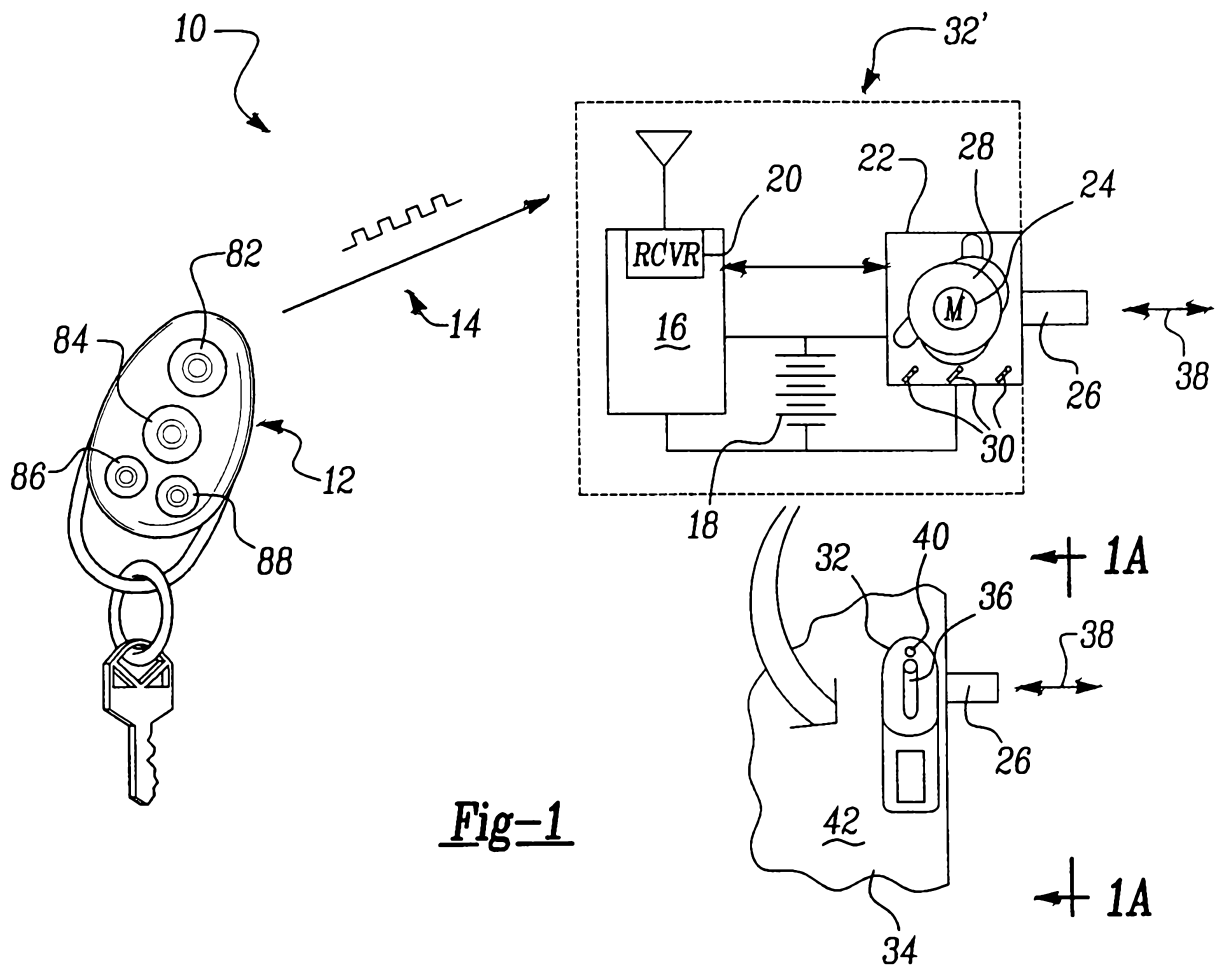


11. A method for receiving encoded data as recited in claim 10 further comprising:  
determining whether an LED should be turned on; and  
providing a pulse to an LED driver circuit if it is determined that an  
5 LED should be turned on.
12. A method for receiving encoded data as recited in claim 10 further comprising:  
checking for data multiple times within the duration of a coded  
sequence.
- 10 13. A low power LED driver circuit comprising:  
a pulse generator outputting a series of pulses; and  
a flyback circuit including a transistor having a first node, a second  
node, and a control node, said control node being coupled to said pulse generator  
to receive said series of pulses, said first node being coupled to a first potential by  
15 an inductor and a LED that are coupled in parallel, said second node being coupled  
to a second potential.
14. A low power LED driver circuit as recited in claim 13 wherein said  
pulse generator includes a microcontroller.
15. A low power LED driver circuit as recited in claim 13 wherein said  
20 transistor is a bipolar transistor.
16. A low power LED driver circuit as recited in claim 14 wherein said  
first node is a collector of said transistor, said second node is an emitter of said  
transistor, and said control node is a base of said transistor.
17. A low power LED driver circuit as recited in claim 16 wherein said  
25 first potential is a positive potential, and wherein said second potential is a ground  
potential.

18. A low power LED driver circuit as recited in claim 17 wherein said base is coupled to said pulse generator by a resistive member.

19. A low power LED driver circuit as recited in claim 17 wherein said series of pulses have a pulse duration that is at least two orders of magnitude less than a period for said pulses.

5



**Fig-1**

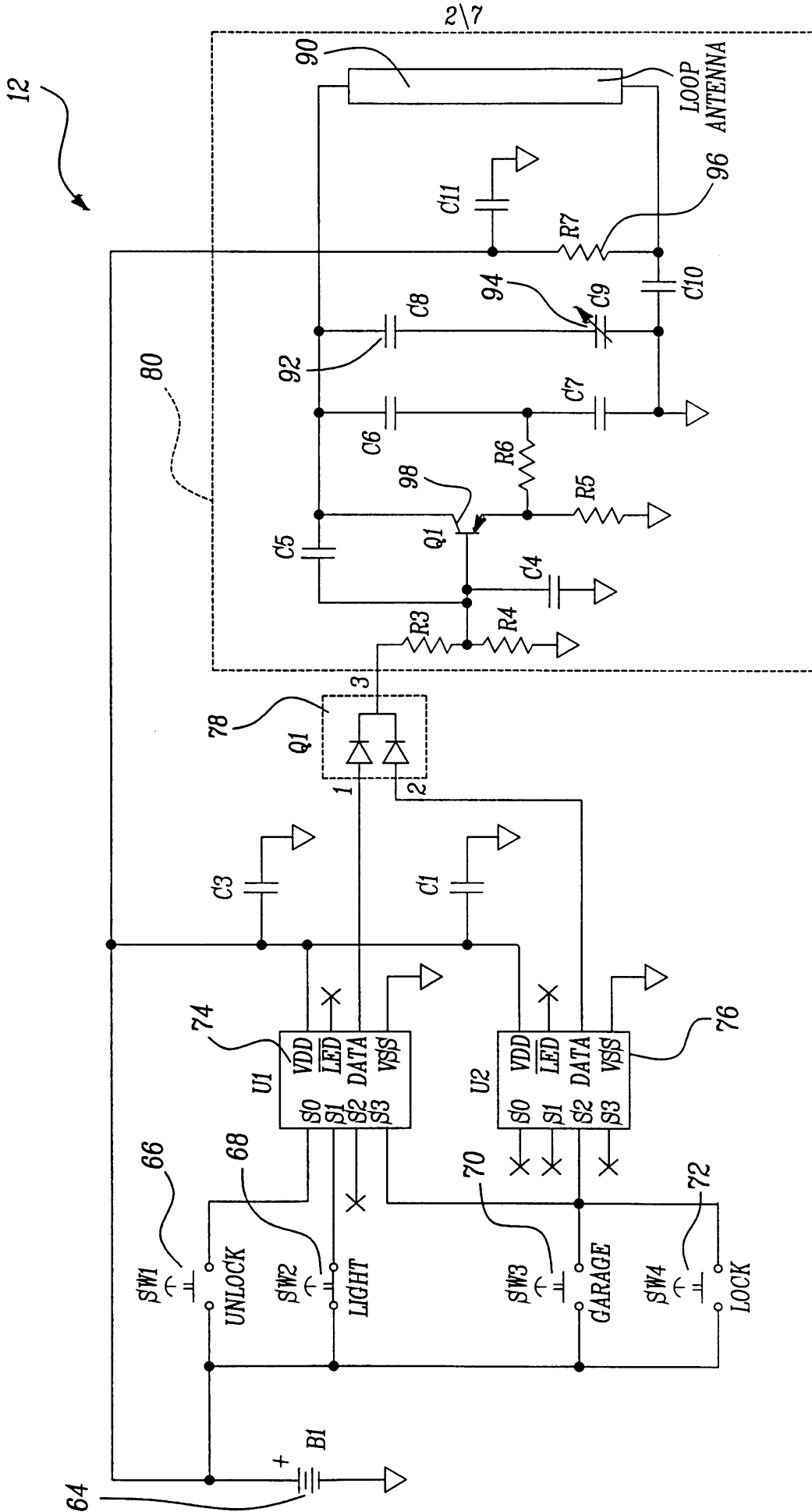


Fig-2

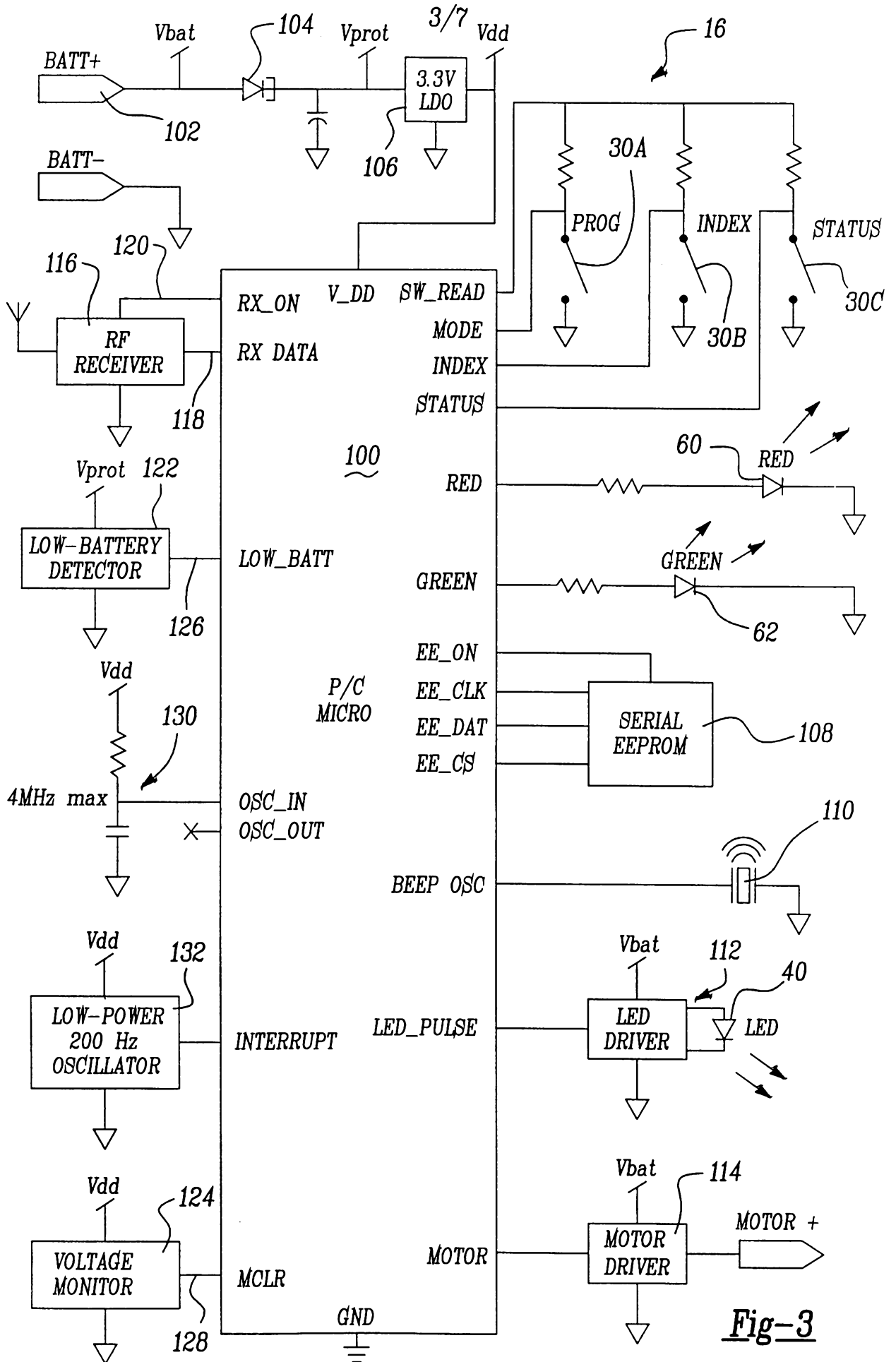
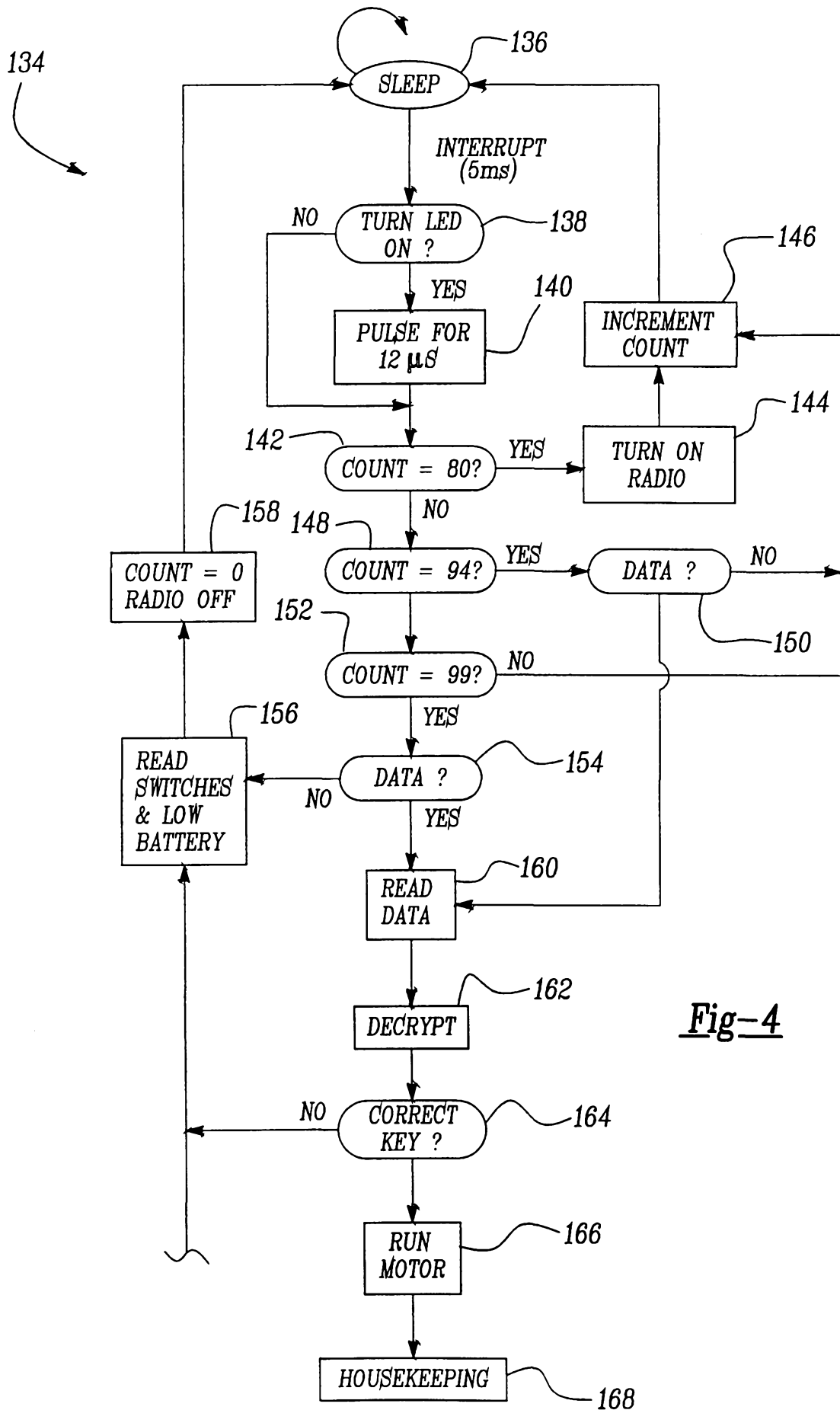
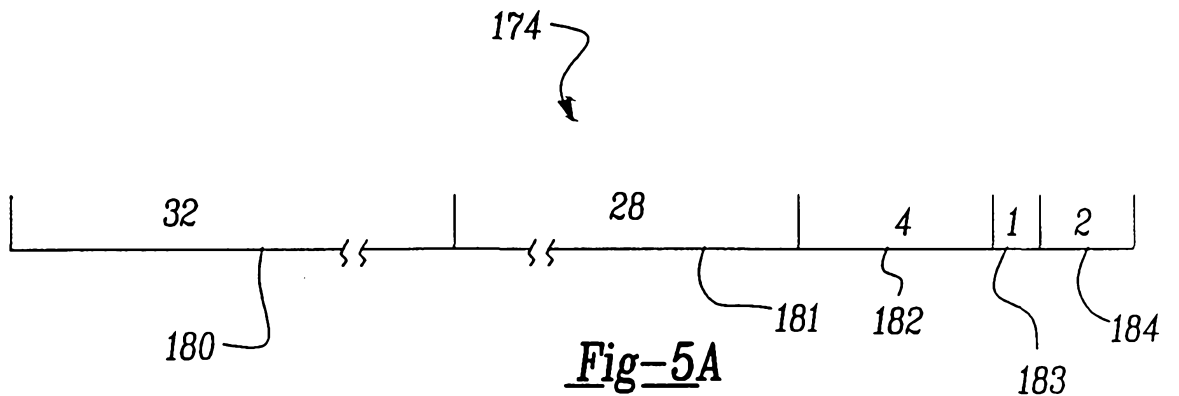
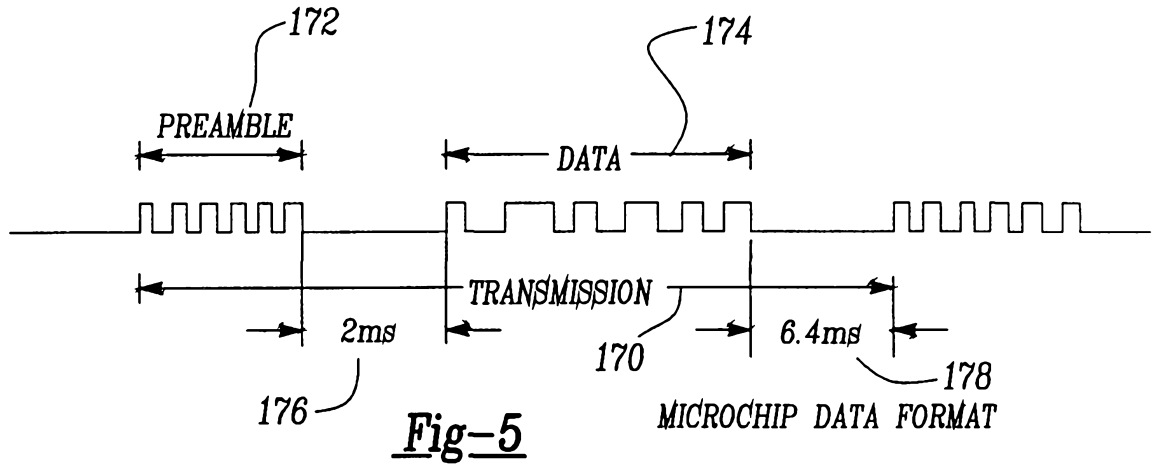
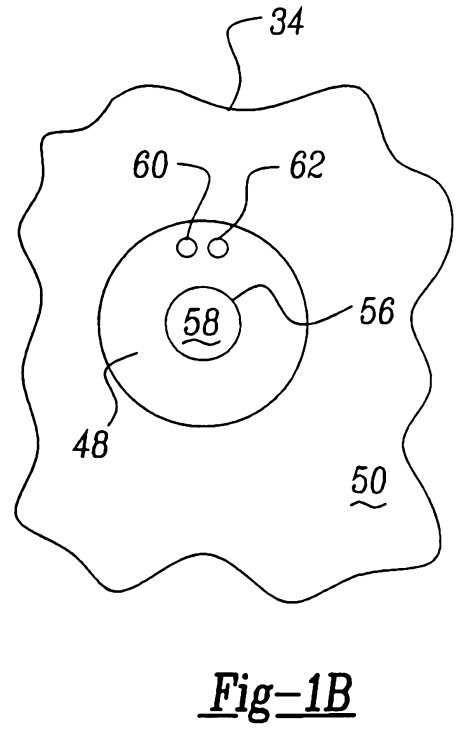
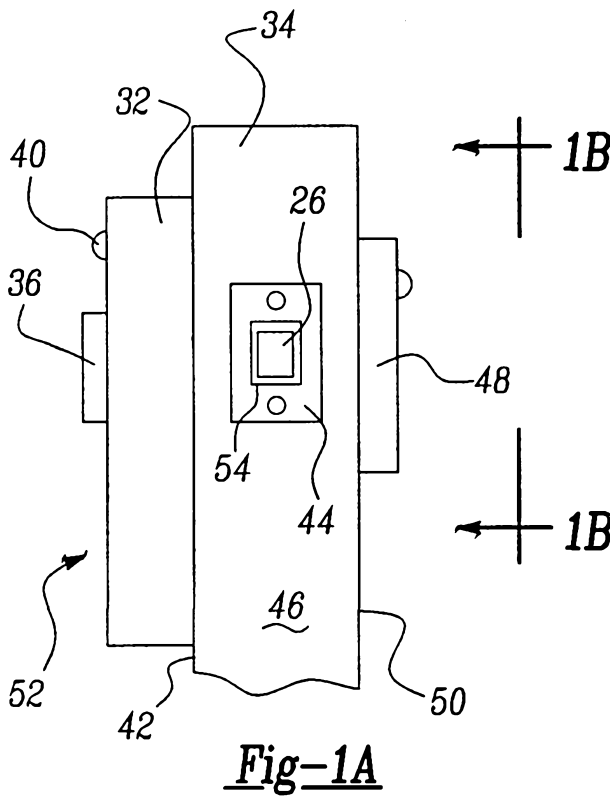


Fig-3

4/7



**Fig-4**



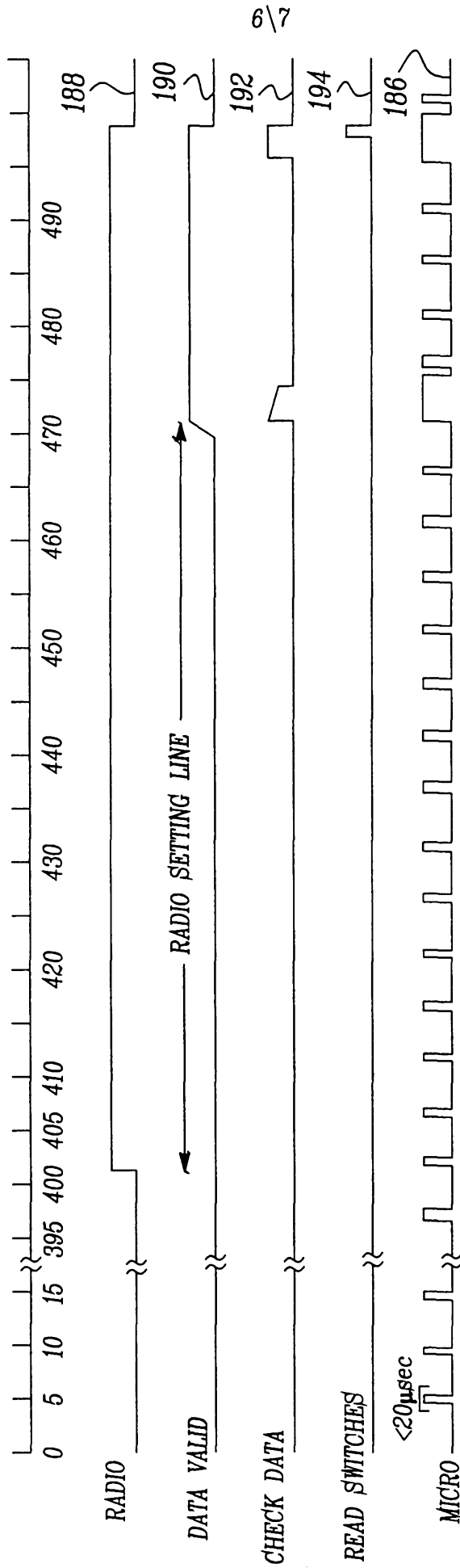
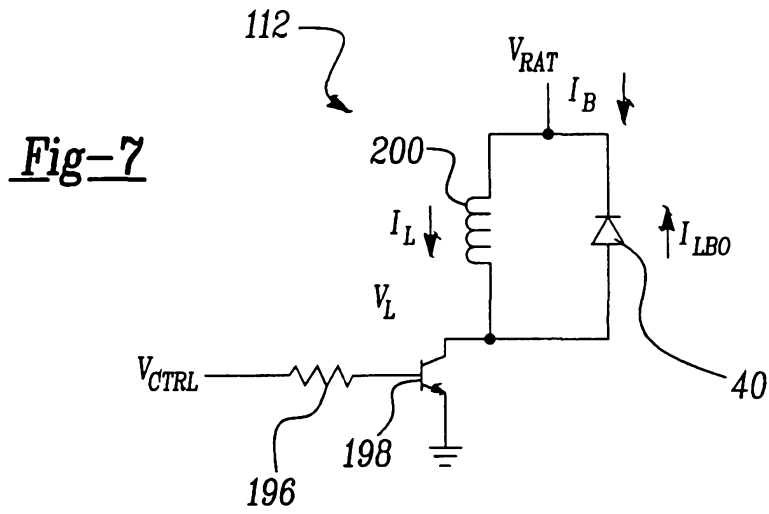


Fig-6





**Fig-8**

