ELECTRONIC RECOGNITION DOOR LOCK

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ABSTRACT

An electronic, door lock controlled by a passive transponder used as a key by the person desiring to open the door. A hand-operated electric generator is coupled by a gearing system to the door handle, and generates power to operate a door lock transceiver which receives coded signals from the personal transponder to open the lock. Upon the reception of properly coded signals, a solenoid is activated to withdraw an abutment member from the path of a laterally slidable door bolt mechanism so that the door may be opened. The personal transponder may be disposed within a watch case, or have the size and shape of a conventional writing pen. The system may be radio frequency or ultrasonic.

16 Claims, 7 Drawing Figures
ELECTRONIC RECOGNITION DOOR LOCK

The present invention relates to electronic locks, and in particular, to an electronic recognition lock which automatically releases an electronically controlled door bolt in response to the reception of a coded sequence of signals transmitted by a transponder unit carried by a person desiring to open the lock.

Conventional key lock systems are undesirable for a variety of reasons. For example, in the dark, a person must first find his key, and then insert it in the lock, in order to gain entrance to his home or apartment. If the person is carrying a number of packages or other items, or a keychain with many keys, opening the lock is made more difficult. Inclement weather conditions further complicate the process. Furthermore, keys may be lost, stolen or copied by unauthorized persons in order to gain entrance to a house or apartment.

Accordingly, the applicant provides an electronic recognition lock which electronically controls a door bolt in response to the reception of a plurality of coded signals which the lock mechanism is programmed to decode and identify to determine if the lock is to be opened. The door handle is coupled by a gearing system to an electric generator, which generates power in response to rotational movement of the handle to power the electronic controls of the door lock. A rack and pinion is coupled to the door handle, and controls the movement of the door bolt. A pivotable stop member is slidably adjacent the rack and pinion, and abuts a corresponding abutment member on the rack to limit movement of the door handle. The stop member is coupled to a solenoid, which is electrically coupled to the electronic controls of the door lock, and mechanically coupled to the stop member. The solenoid is activated and pivots the stop member from its limiting position when a signal of the proper code is received by the door lock control mechanism. The rack and pinion then bypasses the stop member and the handle is fully rotated to release the door bolt and admit the person to the house or apartment.

In one embodiment of the invention, the door lock is controlled by a wrist watch including a radio frequency signal transmitter, which transmits the coded sequence of signals to the door lock. The watch is biased in a "passive" or deactivated state, and is activated by a magnet disposed in the handle which vibrates a pair of reed switches in the watch when it is placed in proximity to the magnet. The switches connect the power source to the transmitter to start transmission of the signals. An antenna is disposed in the door adjacent the handle for receiving the signals transmitted from the watch.

In another embodiment of the invention, a radio frequency signal transmission unit, having three external buttons projecting from its case, is used to control the lock instead of the watch. The three buttons are coupled to three separate transmitter circuits which transmit signals separately at three different frequencies. The door lock control system has a three frequency receiver and a shift register coupled to the receiver, for receiving the transmitted signals and processing them to determine if they were transmitted in the proper sequence. The door lock is released by the electronic apparatus when signals of the predetermined frequencies are received in the proper coded sequence.

In other embodiments of the invention, a single push button switch, projecting from the casing of the radio frequency transmitter, is used to switch the transmitter from a normally passive to an active state, in which the transmission of the coded signals is automatically carried out by the electronic circuitry of the transponder. The personal transmitter may also be completely automatic, transmitting the coded signals in response to a signal generated by the electronic door apparatus.

In still other embodiments of the invention, the system may be ultrasonic, using ultrasonic transducers to transmit the signals required to open the lock. It is therefore an object of the present invention to provide an electronic recognition lock which is opened by a remote transponder which identifies the person carrying the unit.

It is another object of the present invention to provide an electronic recognition lock which is completely automatic, and which requires no conscious effort on the part of the user to open the lock.

It is a further object of the present invention to provide an electronic recognition lock which is simple in design, easy to manufacture, and efficient and reliable in operation.

Other objects and features of the present invention will become apparent from the following detailed description taken in connection with the accompanying drawings which disclose several embodiments of the invention. It is to be understood, however, that the drawings are designed for the purpose of illustration only, and are not intended as a definition of the limits and scope of the invention.

Referring to the drawings, wherein similar reference characters denote similar elements throughout the several views:

FIG. 1 is a perspective view of an electronic door lock constructed in accordance with the present invention;

FIG. 2 is a schematic diagram of a wrist watch sized transponder for controlling the door lock of FIG. 1, constructed in accordance with the present invention;

FIG. 3 is a schematic diagram of the electrical and mechanical elements of the door lock and personal transponder;

FIG. 4 is a schematic diagram of a personal transponder and the electronic components of the receiver of an ultrasonic door lock constructed in accordance with the present invention;

FIG. 5 is a cross-sectional view of one embodiment of a personal transponder for controlling view door lock of the present invention; and

FIG. 5A is a schematic diagram of the electronic components of the personal transponder of FIG. 5.

FIG. 5B is an end view, in phantom, of the piezoelectric transducer section of the personal transponder of FIG. 5.

FIG. 6 is a schematic diagram of another embodiment of personal transponder and of the electronic components of the receiver of a radio frequency electronic door lock constructed in accordance with the present invention.

Referring to the drawings, in particular FIG. 1, there is shown an L-shaped, rotatable door handle 10, disposed through an annular door plate 11, having gear teeth 12 provided on the end of the handle disposed through the door. Gear teeth 12 are slidably disposed within a cylinder 13 mounted on the end of a shaft 14,
and mesh with gear teeth 15 provided on the inside surface of cylinder 13. A coarse pitch spur gear 16 is also mounted on shaft 14, and meshes with a gear rack 17 of the same pitch provided on a slidable control bar 18, which moves laterally in the direction of arrow 19. A stepup gearing system, consisting of gears 20, 21 and 22, and drive gear 23 attached to extension 24 of shaft 14, couple the door handle with the rotor shaft of a permanent magnet, AC generator 25.

A door bolt 26 is slidably disposed beneath control bar 18, and has a coarse pitch rack 27 provided on the bottom surface thereof, which meshes with the spur gear 28 mounted on a rotatable shaft 29 to which an inside door knob 30 is attached. Door bolt 26 moves laterally in the direction of arrow 27 when door knob 30 is rotated to open the door. Both control bar 18 and door bolt 26 have abutment members 31, integrally formed at their ends perpendicular to the longitudinal axis of the bar and door bolt, for engaging each other when handle 10 is turned, and causing control bar 18 to pull door bolt 26 from the door latch. Compression springs 32 engage the ends of the control bar and door bolt, for returning them to their illustrated positions after the door is opened. The springs are secured in place engaging the ends of the door bolt and control bar by L-shaped retaining members 33.

A pivotable stop member 34, movable upwardly in the direction of arrow 35, is mounted on a stationary shaft 36, and is biased so as to normally engage the top surface of control bar 18. As control bar 18 is moved laterally in the direction of arrow 19, an abutment member 37 provided at the end of rack 17 engages the end of stop member 34 and prohibits further movement of the control bar to displace door bolt 26 and open the door. When member 34 engages abutment member 37, members 31 on control bar 18 and bolt 26 are positioned almost in engagement with one another. Stop member 34 thus prevents lateral disposal of bolt 26 to open the door, unless it is pivoted upwardly, in the direction of arrow 35, to allow the control bar to slide laterally past it and pull the door bolt from the door latch.

Member 34 is coupled to an electrical solenoid switch 38 by a vertically movable cylindrical rod 39 disposed through aperture 40. Rod 39 has an annular disc affixed to its end perpendicular to its longitudinal axis to lift the stop member. Electrical wires 41 couple the solenoid to electrical control unit 42, which is coupled to generator 25 by wires 43. Control unit 42 has a transmitting and receiving antenna 44 disposed about the periphery of annular door plate 11. Permanent magnet 45 is disposed in the end of handle 10 for controlling the remote transponder, which is described below.

The mechanical and electrical components of the door lock are mounted within a rectangular casing 46 which abuts the interior surface of the door. Annular door plate 11 is disposed on the exterior surfaces of the door, and is coupled by bolts 47, which are threadably engaged in cylinders 48 attached to plate 11, to the rectangular casing. When bolts 47 are tightened, the plate and casing engage the inside and outside surfaces of the door and secure the door lock in its mounted position. Shaft 29 for door knob 30 is disposed through circular aperture 48, and a rectangular-shaped notch 49 is provided in the side of the casing adjacent the door latch 40, through which bolt 26 extends.

The electrical control system of the door lock and transponder is shown in detail in FIG. 3. In general, the personal transmitters 50 are activated by a person using the lock include a reed switch 51 responsive to the presence of a magnetic field coupled to a battery 52 to power the transponder, and an electronic transmitter 53 which transmits coded radio frequency signals through antenna 54. The electronic door lock includes generator 25, which is mechanically coupled to door handle 10, coupled to a rectifier and filter 55 and UHF receiver 56. A silicon controlled rectifier 57 couples rectifier-filter 55 and receiver 56 to solenoid 38. The solenoid is mechanically coupled to stop member 34 which is moved out of the path of control bar 18 when the solenoid is activated.

FIG. 2 illustrates, in schematic form, one embodiment of a personal transponder for controlling the electronic door lock. The electrical components of the pocket transponder are disposed in a watch case 58 and include an annular-shaped battery 59, an integrated circuit transmitter 60, and a pair of reed switches 61 and 62 for coupling the battery to the transmitter when watch case 58 is placed near magnet 45. The switches are positioned perpendicular to one another to ensure that at least one will be activated by the magnetic field of magnet 45 regardless of the position of the user's hand or wrist when he grips handle 10 to open the door. Antenna 63 is coupled to the transmitter to radiate the rf signals from the transponder.

The personal transponder is normally set in a "passive" state, that is, the power source is not coupled to the transmitter continuously, but only activates the transmitter when the person approaches handle 10 and magnet 45 causes the reed switches in the personal transponder to close and couple the battery power source to the transmitter and other electrical components of the transponder unit. A modulated signal is then transmitted from the personal transponder and is received by antenna 44 of the door lock control unit. Simultaneously, as the person turns handle 10, the gear system coupled to generator 25 rotates the generator shaft to a sufficiently high angular speed so that the generator rotor produces sufficient electrical power to operate receiver 56, rectifier-filter 55, and solenoid 38. When a signal of the proper code is received by the door unit, silicon rectifier 57 is switched on to activate solenoid 38. Rod 39 then pulls member 34 upwardly so that abutment member 37 may slide past and control bar 18 may pull door bolt 26 from the door latch. When the handle is released, compression springs 32 force the control bar and door bolt back to their original positions, thereby locking the door.

The door is opened from the inside by means of door knob 30, which is coupled directly to door bolt 26. When this knob is rotated, only the door bolt moves, and the remaining portion of the door lock remains stationary. Compression spring 32 returns the door bolt to its original position as soon as knob 30 is released. If a person not having a transponder unit attempts to open the door, stop member 34 prevents control bar 18 from moving past it and consequently, handle 10 cannot be
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from the door unit is received. This embodiment of the invention differs from the previously described embodiment only in that the transponder is not "passive." It is switched on continuously, in order to receive transmitted signals from the door lock unit.

With a transponder of this type, constant recharging of the battery is necessary. If the system is used within a business office, hospital, etc., the employees could leave their transponders on a charging rack each day at quitting time to recharge the batteries. In order to remind employees who forget, the charging rack may be equipped with a transmitter, which continuously sends out a coded signal into the immediate area of the employee exit to activate an audible transducer in the transponder and remind the employee to put his transponder on the rack when the audible tone is produced. Otherwise, the operation of this embodiment is the same as the system described previously. In both of the above-described systems, the personal transponder may be made passive by providing a manual pushbutton switch on the outside of the transponder unit casing. With this switch, the person using the lock activates the transponder before turning door handle 10 to gain entrance. The coded signal is then transmitted to the door unit to activate the solenoid and release the door bolt.

In systems which require more security, a personal transponder and door lock unit may be modified so that the door can be opened only in response to the transmission of a finite number of radio frequency signals of different frequency in a selected sequence. In the embodiment illustrated in FIG. 6, personal unit 50 is modified so that its transmitter transmits radio frequency signals at three different frequencies, and receiver 56 is modified so that it receives the three frequencies transmitted from the personal transponder and responds only to a particular sequence of these signals. The transponder has three pushbutton switches 65 projecting from its casing, each of which is connected to a battery power source for the transponder and one of three different capacitors having different capacitance values. Thus, the depression of each of the pushbutton switches couples the battery of the transponder and each capacitor separately to the transmitter of the transponder. Three different radio frequency signals are thus transmitted to the door unit, and are received by antennas 66. The antennas are coupled to receivers 67 so as to form a triple receiver which is sensitive to each of the three frequencies transmitted by the transponder. The receivers produce a DC pulse output signal which is transmitted to shift registers 68, and the shift register delivers a pulse to rectifier 57 to activate solenoid 38 only if the signals transmitted from the transponder are received in the required, predetermined sequence. A reset timer 69 is provided in the receiver to periodically reset the shift registers to their quiescent state to avoid interference from random, spurious signals or improperly sequenced signals. When the pushbuttons are not depressed, the personal transponder remains in a "passive" state.

It should be noted that although three pushbutton switches were used for generating three different frequencies in the above-described embodiment, any number of switches and frequencies may be used, depending on the security required for the particular system. The above embodiment is intended merely as an illustration.
An alternate method of transmitting three different frequencies is to use a single frequency transmitter having three different tone modulators which are actuated by the three separate pushbuttons. The receiver is modified so that only a single receiver, having three different tone sensitive relays or solid state switches feeding the shift registers 68, is required. The transmission of the three frequencies may also be accomplished automatically by using a time delay system which causes the pocket transponders to transmit at the three different frequencies, such as, for example, a system which goes from one frequency to the next after depressing a single pushbutton switch.

To provide even greater security, the system may be modified so that the signal transmitted from the lock to the transponder is transmitted a selected number of times over different time intervals, and the signal transmitted in response to those signals is transmitted back to the lock within the same time intervals, including time for decoding, to open the door lock. A system of this type can be constructed by providing the lock and pen transmitters with R-C circuits for transmitting the coded signals with a slowly rising amplitude. When the signals are transmitted by the lock with a slowly rising amplitude of a specified time interval, the signals received by the lock must be transmitted by the transponder with a slowly rising amplitude of the same time duration for the lock to open. This system can be combined with the above-described shift register system so that the signals are transmitted and received at a specified frequency, in a selected sequence, over different time intervals.

Each of the above-described embodiments of the invention may transmit ultrasonic, instead of radio frequency signals. Antenna 44 is replaced by a piezoelectric crystal transducer 70, disposed in a circular aperture in plate 11, and coupled to electronic control 42 of the door lock. The personal transponder is modified so that a piezoelectric crystal is coupled to receiver 33 instead of antenna 54. A personal transponder using reed switches to activate the transponder would include a battery, coupled to an oscillator-transmitter and a gate circuit by the reed switch, and a piezoelectric transducer, coupled to the gate switch, for transmitting the desired frequency and pulse modulated signals to the door unit. These signals would be received by transducer 70 of the electronic lock, and transmitted to a receiver-decoder whose output activates solenoid 38 when the proper signal is received. The reed switch may also be a pushbutton switch, coupled to the oscillator-transmitter of the transponder, for switching the "passive" transponder unit on.

An ultrasonic "non-passive" system, which is fully automatic, may be constructed by providing both the electric door lock and the transponder with a receiver-decoder and transmitter-oscillator for transmitting and receiving signals in the same manner as described with respect to the corresponding RF system described above. One embodiment of a personal transponder which may be used with an ultrasonic door control lock is shown in FIG. 5. Transponder 71 has the dimensions and shape of a conventional writing pen, so that it may be easily carried by the user of the door lock. A battery 72 is disposed in the lower end of its cylindrical casing, and supplies power to an electronic circuit module 73 disposed in the upper portion of the pen. The circuit module comprises a gate or switch 74 coupled to a receiver 75 and a decoder 76. An oscillator-transmitter 77, coupled to the decoder, is coupled by gate 74 to a piezoelectric transducer 78 disposed at the top end of the pen through pin 79. Pin 80 is the ground for the circuit module.

The transponder has a detachable threaded cap 81 including a three-pin coupling element on its bottom surface having pins 79, 80 and spare pin 82. The cap has a plurality of apertures 83 in its front surface above clip 84 from which the ultrasonic signals are transmitted to the door unit. Apertures 83 are directed towards the front of the pen so that the signals will be transmitted directly at the door lock. Circuit module 73 is cylindrically shaped, and has three corresponding sockets 85, 86 and 87 which receive pins 79, 82 and 80, respectively. The module is coupled to the cap by the pins, and the assembled structure threaded into the tubular casing of transponder 71. Battery 72 engages a contact terminal 88 coupled to the module, and held in place against the terminal by means of a spring 89 disposed between the negative terminal of the battery and the end of the tubular casing. A plurality of rotating switches 90 may be coupled to the circuit module to allow manual adjustment of the frequency to which the transponder will respond. This additional feature produces, in effect, a key and door lock with "tumblers" which may be changed as desired.

It should be noted that the transponder unit just described may also be modified to include a manual pushbutton switch which may be depressed to activate the transponder. With such a unit, only an oscillator-transmitter, battery, and gate would be required to open the door lock, since the remaining electronic components of the control system are no longer needed.

One of the most desirable features of the ultrasonic transponder unit described in FIG. 5 is that it may be used simultaneously with both an electronic door locking system, and an electronic personnel locating system, such as those described in applicant's co-pending patent application, Ser. No. 160,851, filed July 8, 1971, now U.S. Pat. No. 3,696,384, issued Oct. 3, 1972 entitled "Ultrasonic Tracking and Locating System".

An ultrasonic transponder, which is both automatic and passive, may be provided by using a transducer and receiver in the door control unit which transmits a high power DB ultrasonic signal, at, for example, 30,000 cycles, in response to the rotation of the door handle, which causes a reed or transducer provided in the transponder to vibrate when the signal is received. The reception of the signal couples the battery of the transponder to the transmitter and activates the transponder. The transponder then transmits a range of ultrasonic signals of varying frequencies, which equal a code sequentially both in time length and frequency. The signals are preferably broadbanded to allow for temperature variations when the units are used outdoors, and should be kept approximately 3 to 5 thousand cycles apart. Both transducers in the door lock and the transponder should be omnidirectional.

FIG. 4 illustrates an ultrasonic transponder and door lock similar to the embodiment described with respect to FIG. 6. Transponder 91 has an exposed ultrasonic transducer 92, which transmits ultrasonic signals to transducer 93 of receiver 56. The transponder includes a pushbutton switch 94, coupled to an automatic shift register, which transmits ultrasonic signals of three dif-
ferent frequencies in the required sequence. The trans-
mittcd signals are received by transducer 93, and fre-
cquency selective receivers 95, and DC pulses from the
receivers are transmitted to a shift register 96, shift reg-
ister 96 activates the lock control circuits only after sig-
nals are received in the proper sequence. A reset timer
87 is provided for the same purpose as in the corre-
spounding radio frequency system. It should be noted
that substantially the same circuitry may be used in
transponder unit 91 to cause automatic transmission of
the three frequencies necessary to open the lock. In
such a transponder, the shift register controls three
transmitters which generate the desired signals through
transducer 92.

If manual operation is desired, transponder 91 may
be provided with three pushbuttons, each controlling
the transmission of one selected frequency, as de-
scribed previously with respect to the radio frequency
systems.

It should be noted that generator 25 may be elimi-
nated by electrically wiring the door so that power is
supplied to the lock when the handle is turned.

While only several embodiments of the present in-
vention have been shown and described, it will be obvi-
ous to those persons skilled in the art that many
changes and modifications may be made thereunto
without departing from the spirit and scope of the in-
vention.

What is claimed is:

1. An electronic lock, for a door having movable in-
terior and exterior door handles, and a laterally-
sliding door bolt coupled to said handles, comprising:
means, coupled to the exterior door handle and the
door bolt, for laterally displacing the door bolt in
response to movement of the exterior door handle;
means, moveable in and out of engagement with said
door bolt displacement means, for limiting the lat-
eral movement of said door bolt displacement
means;
means, remotely positioned from said door lock, and
carried by each individual using the door lock, for
transmitting a coded signal having a form unique
with respect to the door lock;
means, coupled to said exterior door handle, for gen-
erating electrical power in response to movement
of the exterior door handle;
means, coupled to and responsive to the activation of
said electric power generating means, for receiving
said signals transmitted by said remote signal trans-
mittting means; and
means, responsive to the reception of said coded sig-
 signals, for positioning said limiting means in and out
of engagement with said door bolt displacement
means.

2. The door lock as recited in claim 1, further com-
prising means for actuating said signal transmitting means to initiate transmission of said coded signals to
said door lock receiver means.

3. The electronic door lock as recited in claim 2,
wherein said door bolt displacement means comprises
an elongated, rectangular-shaped bar, slidably disposed
and laterally moveable in said door, and coupled to said
exterior door handle by a gear rack, provided on the
top surface thereof, and a spur gear engaging said gear
rack, coupled to said exterior handle, said bar also in-
cluding a downwardly extending end portion disposed
perpendicular to the longitudinal axis thereof, for en-
gaging said door bolt and displacing said bolt in re-
ponse to rotational movement of said door handle.

4. The lock as recited in claim 3, wherein said control
bolt further comprises an abutment member, disposed
on the top surface thereof adjacent one end of said gear
rack, and wherein said limiting means comprises an
elongated, substantially rectangular-shaped member,
pivoted and biased so as to engage the sur-
faced of said control bar and said abutment member,
and thereby limit the lateral displacement of said con-
trol bar, and prevent displacement of the door bolt
when said coded signals are not received.

5. The lock as recited in claim 4, wherein said elec-
tric generating means comprises an electric generator,
coupled to said handle by a plurality of gear-wheels, for
imparting high angular speed to the rotor shaft of said
generator in response to rotational movement of said
handle.

6. The lock as recited in claim 5, wherein said signal
transmitting means comprises:
a transmitter, for transmitting said coded signals,
a battery, coupled to said transmitter, and
means, responsive to said transmitter actuating
means, for coupling said battery to said transmitter
and thereby causing transmission of said coded sig-
als for opening the lock.

7. The door lock as recited in claim 6, wherein said
signal receiving means comprises a receiver, for receiv-
ing said transmitted signals, coupled to and responsive
thereby causing transmission of said coded sig-
als.

8. The door lock as recited in claim 7, wherein said
stop member positioning means comprises a solenoid,
mechanically coupled to said stop member and electri-
cally coupled to said receiver, for moving said stop
member out of engagement with said control bar, so
that said bar displaces said door bolt in response to
movement of said handle.

9. The door lock as recited in claim 8, wherein said
transponder actuating means comprises a permanent
magnet, disposed in the end of said door handle, and
wherein said transponder means for coupling said
transmitter to said battery comprises at least one reed
switch, responsive to the presence of a magnetic field,
for coupling said battery to said transmitter when said
transponder is placed in proximity to said magnet.

10. The door lock as recited in claim 8, wherein said
means for actuating said transponder comprises a push-
button switch, coupled to said battery and said trans-
mitter, for coupling said battery to said transmitter and
thereby causing transmission of said coded signals.

11. The door lock as recited in claim 8, wherein said
transponder comprises a three-frequency transmitt-
er, including three pushbutton switches, each coupled to
separate frequency generation circuits in said transmitt-
er, for generating a plurality of differently coded sig-
als in a predetermined sequence by pressing said
pushbuttons in said sequence, and wherein said door
lock receiver comprises a three-frequency sensitiv-
signal receiver, and a shift register coupled to said re-
ceiver, for receiving said three coded signals and gener-
ating an output signal for activating said solenoid when
said signals are received in said predetermined
sequence.

12. The door lock as recited in claim 8, wherein said
door lock further comprises a transmitter, for transmitt-
11. Coded signals from said door lock to said transponder, and wherein said transponder further comprises a receiver, for receiving said signals transmitted from said door lock and actuating said transponder to cause transmission of said coded signals to said door lock.

13. The door lock as recited in claim 8, wherein said transponder transmitter comprises a three-frequency transmitter, coupled and responsive to the depression of a single pushbutton switch provided on the external surface thereof, and a shift register coupled to said three-frequency transmitter, for transmitting, in a selected sequence, three coded signals for opening said lock, and wherein said receiver in said door lock comprises a three-frequency receiver, and a shift register coupled to said receiver, for generating an output pulse in response to the reception of said plurality of coded signals in said door lock for activating said solenoid and opening the door lock.

14. The door lock as recited in claim 8, wherein said signals transmitted and received are radio frequency signals, and wherein said transponder and said door lock further comprise antennas, coupled to said transmitters and receivers, for transmitting and receiving said radio frequency signals.

15. The door lock as recited in claim 8, wherein said signals transmitted and received are ultrasonic signals, and wherein said transponder and said door lock further comprise ultrasonic piezoelectric transducers, for transmitting and receiving said ultrasonic signals.

16. The door lock as recited in claim 15, wherein said transponder further comprises an elongated, tubular-shaped casing, having the dimensions and shape of a conventional writing pen, a cylindrically-shaped, electronic circuit module disposed within said casing and including said transmitter and receiver, a battery coupled to said module for supplying power to said transmitter and receiver, and an ultrasonic transducer, coupled to said electronic circuit module, for receiving and transmitting said coded signals.

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