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(71) Applicant (for all designated States except US): **LUTRON ELECTRONICS CO., INC.** [US/US]; 7200 Suter Road, Coopersburg, Pennsylvania 18036-1299 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **MOSEBROOK, Donald** [US/US]; 3276 Bingen Road, Bethlehem, Pennsylvania 18015 (US). **ALTONEN, Gregory** [US/US]; 85 Connard Drive, Easton, Pennsylvania 18042 (US). **BOLLINGER, Robert, Jr.** [US/US]; 8530 Claussville Road, Fogelsville, Pennsylvania 18051 (US).

(74) Agents: **WEINER, Samuel H.** et al.; Ostrolenk, Faber, Gerb & Soffen, LLP, 1180 Avenue of The Americas, New York, New York 10036 (US).

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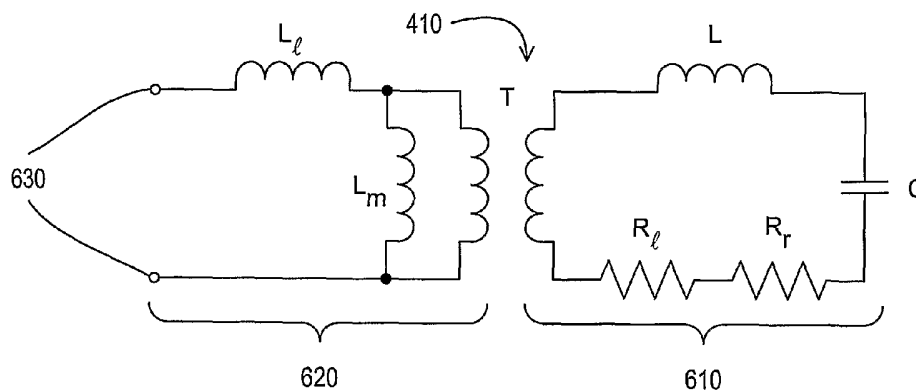
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(54) Title: LOAD CONTROL DEVICE HAVING A COMPACT ANTENNA



(57) Abstract: A compact antenna for use in a load control device for controlling the power delivered to an electric load and operable to transmit or receive radio frequency signals at a specified frequency is presented. The antenna comprises a first main radiating loop of conductive material having an inductance and a capacitor forming a circuit being resonant at the specified frequency, and a second feed loop of conductive material having two ends adapted to be electrically coupled to an electronic circuit. The second feed loop is substantially only magnetically coupled to the first main radiating loop. The antenna is disposed in an actuator button, which is provided in an opening of a traditional-style faceplate. The antenna extends beyond the faceplate of the load control device.

LOAD CONTROL DEVICE HAVING A COMPACT ANTENNA

BACKGROUND OF THE INVENTION

Related Applications

[0001] This application claims priority from commonly-assigned U.S. Provisional Application Serial No. 60/687,894, filed June 6, 2005, entitled REMOTE CONTROL LIGHTING CONTROL SYSTEM, the entire disclosure of which is hereby incorporated by reference.

Field of the invention

[0002] The present invention relates to antennas and in particular, to radio frequency antennas for transmitting and receiving radio frequency (RF) signals. Even more particularly, the present invention relates to a compact antenna, which is provided for use in connection with a radio frequency controlled lighting control system.

Description of the Related Art

[0003] Systems for controlling an electrical device by remote control are known. For example, prior art systems and methods control the status of electrical devices such as electric lamps, from a remote location via communication links, including radio frequency links, power line carrier links or infrared links. Status information regarding the electrical devices (e.g., on, off and intensity level) is typically transmitted between specially adapted lighting control devices and at least one master control unit. At least one repeater device may also be provided to help ensure reliable communications between the master control unit and the control devices for the respective electrical devices. The repeater may be required when a control device is unable to receive control signals transmitted directly from the master control unit, and, typically, employs a repeater sequence for helping to ensure that each receiver receives those signals intended for it.

[0004] Referring now to the drawing figures, in which like reference numerals refer to like elements, there is shown in Fig. 1A a prior art arrangement of a system 100 for remote

control of electrical devices. The example prior art system 100 illustrated in Fig. 1A includes configurable devices that are manufactured by the assignee of the present patent application and commercially known as the RadioRA® lighting control system. The RadioRA® lighting control system is described in greater detail in commonly-assigned U.S. Patent No. 5,905,442, issued May 18, 1999, entitled METHOD AND APPARATUS FOR CONTROLLING AND DETERMINING THE STATUS OF ELECTRICAL DEVICES FROM REMOTE LOCATIONS, the entire disclosure of which is hereby incorporated by reference.

[0005] As shown in Fig. 1A, the hardware devices include a master control unit 102, two control devices 104, a repeater 106, a car visor control 108 that may be mounted on an automobile's sun visor, and two electrical devices 110, e.g., lamps. The devices 102, 104, 106 and 108 transmit radio frequency signals 112, which can include control information and instructions regarding the respective electrical devices 110.

[0006] In the prior art system 100 illustrated in Fig. 1A, the control devices 104 are coupled to electrical devices 110 by wire connections, such as, for example, building wiring for providing power to electrical devices. Each control device 104 includes a communications and control circuit 114 that comprises a radio frequency transmitter/receiver 116 and an antenna 118 for transmitting/receiving the radio frequency signals 112. The antenna 118 is described in greater detail in U.S. Patent No. 5,736,965, issued April 7, 1998, and U.S. Patent No. 5,982,103, issued November 9, 1999, both entitled COMPACT RADIO FREQUENCY TRANSMITTING AND RECEIVING ANTENNA AND CONTROL DEVICE EMPLOYING SAME. The entire disclosures of both patents are hereby incorporated by reference.

[0007] The communications and control circuit 114 further includes a controller 120 for adjusting the status of the attached electrical device 110. The transmitter/receiver 116 receives the radio frequency signals via the antenna 118 and transmits a status radio frequency signal with information regarding the status of the controller 120 (which indirectly reflects the status of the connected electrical device 110). The controller 120 adjusts the status of the electrical device in response to the control information. Each control device 104 further includes button(s) 122 and dimmer control(s) 124, which are further operable to allow manual adjustment of the connected electrical device 110.

[0008] The master control unit 102 includes at least one actuator 126, at least one status indicator 128, a transmitter/receiver 116, and an antenna 118. The actuators 126 enable a user to

control the electrical devices 110 remotely. The status indicators 128 indicate the status of the electrical devices 110. The transmitter/receiver 116 and the antenna 118 are operable for transmitting a radio frequency signal 112 having the control information therein to control the status of the electrical devices 110, as well as for receiving status information from the control devices 104.

[0009] The master control unit 102 can take several forms. For example, the master control unit 102 can be formed as a tabletop master, which plugs into an electrical outlet and includes a conventional antenna for transmitting and receiving signals. In another form, the master control unit 102 mounts on a wall, and is sized such that the master control unit 102 fits within the confines of a standard electrical wall box. In either form, the master control unit 102 includes a plurality of controls, each associated with a particular control device or a plurality of control devices. In the prior art, the user must program the association of the electrical control devices to a particular actuator 126 on the master control unit. Further, prior art master control units 102 must be programmed in order to provide functions allowing all control devices 104 to turn on or off substantially simultaneously.

[0010] The repeater 106 may receive radio frequency signals 112 (including status information and instructions) from the master control unit 102 and, thereafter, transmit radio frequency signals 112 to the control devices 104. Further, the repeater 106 may receive radio frequency signals 112 from the control devices 104 and, thereafter, transmit them to the master control unit 102.

[0011] The car visor control 108 provides a convenient and remotely usable interface to transmit radio frequency signals 112 to the master control unit 102, and may be disposed in a vehicle, for example, on a vehicle's interior sun visor. The buttons 130 are provided for remotely activating the master control unit 102. For example, the car visor control 108 can be used to cause a lighting scene to turn on/off, or may be operated to turn the electrical devices 110 on/off, via the master control unit 102.

[0012] Thus, the master control unit 102 is operable to generate radio frequency signals, which are transmitted to and received by the control devices 104, such as light dimmers, and/or the repeater 106. The control devices 104 use the information received in the radio frequency signals 112 to control the connected electrical devices 110 to a desired intensity. The control devices 104 preferably transmit radio frequency signals 112 via antennas 118 to the master

control unit 102 (or to the master control unit 102 via the repeater 106) in order to indicate the status of the control devices 104 (and thus, the connected electrical devices 110). Using the respective devices, a combination of lighting controls in different or the same rooms of a structure, for example, can be instructed to turn on/off, thereby creating a lighting "scene" according to a user's desire.

[0013] Figure 1B shows a front view of a prior art lighting control device 104 of the lighting control system 100 of Figure 1A. Lighting control devices 104 preferably fit into standard electrical wall boxes. The antenna 118, which comprises a part of each control device 104, is sized so as to fit within the standard electrical wall box and is preferably disposed directly behind an actuator button 150 that is provided in the opening of a designer-style faceplate 160 as shown in Fig. 1B. An example of such an antenna is described in greater detail in co-pending commonly-assigned U.S. Patent Application Serial No. 10/873,033, filed June 21, 2004, entitled COMPACT RADIO FREQUENCY TRANSMITTING AND RECEIVING ANTENNA AND CONTROL DEVICE EMPLOYING SAME, the entire disclosure of which is hereby incorporated by reference.

[0014] However, it is desirable to provide an RF load control device that has an actuator button that is provided in the opening of a traditional-style faceplate. It is also desirable to provide an RF load control device that will work with a metal faceplate. Therefore, there is a need for an antenna that is disposed behind the actuator button that is provided in the opening of a traditional-style faceplate.

SUMMARY OF THE INVENTION

[0015] According to the present invention, an antenna operable to transmit or receive radio frequency signals at a specified frequency comprises a first loop and a second loop of conductive material. The first loop has an inductance, and a capacitor, the capacitor and the inductance forming a circuit resonant at the specified frequency. The second loop has two ends adapted to be electrically coupled to an electronic circuit. The second loop is substantially only magnetically coupled to the first loop and electrically insulated from the first loop. The antenna is for use with an electrical control device for controlling the power delivered to an electrical load. The first loop of conductive material is adapted to extend beyond a faceplate of the device.

[0016] According to another embodiment of the present invention, an antenna for an electrical load control device for controlling the power delivered to an electrical load is operable to transmit or receive radio frequency signals at a specified frequency. The antenna comprises a printed circuit board, a first loop of conductive material, and a second loop of conductive material. The printed circuit board has first and second sides. The first loop of conductive material has an inductance, and a capacitor, the capacitor and the inductance forming a circuit resonant at the specified frequency. The first loop is formed on the first side of the printed circuit board. The second loop of conductive material has two ends adapted to be electrically coupled to an electronic circuit. The second loop is formed on a side of the printed circuit board and is substantially only magnetically coupled to the first loop. The first loop extends beyond a faceplate of the electrical control device.

[0017] In addition, the present invention provides a load control device for controlling the power delivered to an electrical load. The load control device comprises a controllably conductive device, a controller, an actuator button, a faceplate, a transmitter and/or receiver, and an antenna. The controllably conductive device has a control input and is operable to control the power delivered to the electrical load. The controller is coupled to the control input of the controllably conductive device for control of the controllably conductive device. The actuator button is provided in an opening of the faceplate and is operable to provide an input to the controller. The transmitter and/or a receiver are in communication with the controller. The antenna is coupled to the transmitter and/or the receiver. The antenna is adapted to receive a first signal at a specified frequency from a remote control device and/or transmit a second signal at a specified frequency to a remote control device. The receiver is operable to couple the first signal from the antenna to the controller for remotely controlling the controllably conductive device. The receiver is operable to couple the second signal from the controller to the antenna for providing a status of the electrical load. The antenna extends through the opening of the faceplate beyond the front surface of the faceplate.

[0018] Other features and advantages of the present invention will become apparent from the following description of the invention, which refers to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The invention will now be described in greater detail in the following detailed description with reference to the drawings in which:

[0020] Fig. 1A illustrates a prior art radio frequency lighting control system for remote control of electrical devices;

[0021] Fig. 1B is a front view of a prior art lighting control device of the lighting control system of Fig. 1A;

[0022] Fig. 2 shows an exemplary hardware arrangement of components and devices of an RF lighting control system according to a preferred embodiment of the present invention;

[0023] Fig. 3 shows a master control unit of the lighting control system of Fig. 2;

[0024] Fig. 4 is a perspective view of a load control device of the lighting control system of Fig. 2;

[0025] Fig. 5 is a simplified block diagram of the load control device of Fig. 4;

[0026] Fig. 6 shows an equivalent circuit of an antenna of the load control device of Fig. 4;

[0027] Fig. 7A shows a front view of the load control device of Fig. 4 without a faceplate;

[0028] Fig. 7B shows a right side cross-sectional view of the load control device of Fig. 4 without a faceplate;

[0029] Figs. 8A and 8B show the first and second sides, respectively, of a first embodiment of an antenna of the load control device of Fig. 4; and

[0030] Figs. 9A and 9B show the first and second sides, respectively, of a second embodiment of an antenna of the load control device of Fig. 4.

DETAILED DESCRIPTION OF THE INVENTION

[0031] The foregoing summary, as well as the following detailed description of the preferred embodiments, is better understood when read in conjunction with the appended drawings. For the purposes of illustrating the invention, there is shown in the drawings an embodiment that is presently preferred, in which like numerals represent similar parts throughout the several views of the drawings, it being understood, however, that the invention is not limited to the specific methods and instrumentalities disclosed.

[0032] Referring to Fig. 2, an example hardware arrangement of components and devices in a building installation in accordance with a preferred embodiment of the present invention is displayed, and referred to herein generally as remote control system 200. As shown in Fig. 2, the system comprises, for example, one master control unit 202, five control devices 204A – 204E, one repeater 206, and two car visor controls 208A, 208B, which represent a preferred combination of devices packaged and distributed for the retail market. In accordance with the teachings herein, each of the control devices 204A – 204E is installed to replace a traditional mechanical switch. The control devices 204A – 204E are coupled to electrical devices 210A – 210E, respectively, for control of power delivered to the electrical devices. In the system 200 shown in Figure 2, the electrical devices 210A – 210E are electric lamps.

[0033] In a preferred embodiment of the present invention, the control devices 204A – 204E and the master control unit 202 are preferably pre-programmed to support the functionality described herein without requiring configuration and programming by the user. Preferably, the master control unit 202 includes a plurality of device control buttons 302A – 302E. Each of the device control buttons 302A – 302E is operable to control one, and only one, of the control devices 204A – 204E. For example, a first device button 302A on master control unit 202 is operable to cause unit 202 to transmit commands to which only the first control device 204A responds. The second device button 302B commands the second control device 204B; the third device button 302C commands the third control device 204C; and so forth.

[0034] Figure 3 illustrates an example master control unit 202 in accordance with the present invention. The example master control unit 202 shown in Fig. 3 is of the table top variety, plugs into a standard electric outlet, and can be placed anywhere in a home, such as, for example, on a bedside table. As noted above, the master control unit 202 can be provided in other various forms, including as a wall mounted device. The master control unit 202 includes

the device buttons 302A – 302E, which, when pressed, operate to cause the master control unit 202 to transmit a radio frequency signal and instruct the control device 204A to turn the electrical device 210A on or off. The master control unit 202 comprises an “all-on” button 304 (described in greater detail below), which operates to turn on a combination of the control devices 204A – 204E to various levels, thereby providing a lighting preset (or “scene”). The master control unit 202 further comprises an “all-off” button 305, which operates to turn off all of the control devices 204A – 204E when pressed. The master control unit 202 further comprises a plurality of status indicators 306A – 306E for providing visual feedback about the status of the control devices 204A – 204E to a user of system 200.

[0035] Figure 4 is a perspective view of the load control device 204A according to the present invention. The load control device 204A is equipped with a slider control 402 and an actuator, e.g., a button 404. Actuation of the button 404 causes the load control device 204A to toggle an associated lighting load. Adjusting the slider control 402 changes the intensity of the lighting load. An antenna 410 (shown in Figures 5 and 7B) is preferably provided inside or behind the button 404 and is used for transmitting/receiving radio frequency signals to/from the master control unit 202, either directly or indirectly via the repeater 206. The control device 204A is preferably arranged with a faceplate 406. The faceplate preferably has a traditional-style opening, such that the faceplate can be used for the control devices 204A – 204E as well as a standard mechanical wall switch. According to NEMA Standards Publication ANSI/NEMA, page 7, WD 6-2002, published by the National Electrical Manufacturers Association, Rosslyn, Virginia, the entire disclosure of which is hereby incorporated by reference, a traditional style opening is a rectangular opening having a minimum width of 0.401 +/- 0.005 inch, and a minimum length of 0.925 +/- 0.005 inch. A bezel 407 extends through the opening of the faceplate 406. The front surface of the bezel is substantially flush with the front surface of the faceplate 406.

[0036] Figure 5 is a simplified block diagram of the load control device 204A. The load control device 204A is coupled between an AC voltage source 506 and the lighting load 210A. The load control device 204A includes a controllably conductive device 510, such as a bidirectional semiconductor switch, for example, a triac. The controllably conductive device 510 may also be implemented as a relay or another type of semiconductor switch, such as two field effect transistors (FETs) in anti-series connection, a FET in a rectifier bridge, or one or more insulated gate bipolar junction transistors (IGBT). The controllably conductive device 510 has a

control input (or gate), which is connected to a gate drive circuit 512. The input to the gate renders the controllably conductive device 510 selectively conductive or non-conductive, which in turn controls the power supplied to the lighting load 210A.

[0037] The gate drive circuit 512 provides control inputs to the controllably conductive device 510 in response to command signals from a controller 514. The controller 514 is preferably implemented as a microcontroller, but may be any suitable processing device, such as a programmable logic device (PLD), a microprocessor, or an application specific integrated circuit (ASIC). A power supply 516 is coupled across the controllably conductive device 510 and generates a DC voltage VCC to power the controller 514. The power supply 516 is only able to charge when the controllably conductive device 510 is non-conductive and there is a voltage potential developed across the load control device 204A.

[0038] A zero-crossing detector 518 determines the zero-crossing points of the AC voltage source 506 and provides this information to the controller 514. A zero-crossing is defined as the time at which the AC supply voltage transitions from positive to negative polarity, or from negative to positive polarity, at the beginning of each line voltage half-cycle. The controller 514 determines when to turn on (or turn off) the controllably conductive device 510 each half-cycle by timing from each zero-crossing of the AC supply voltage.

[0039] A user interface 520 is coupled to the controller 514 and provides a means for receiving inputs from a user and for providing feedback to the user. The user interface 520 preferably includes the button 404 and the slider control 402 as shown in Fig. 4. The controller 514 will toggle the state of the lighting load 210A (i.e., from on to off and vice versa) in response to an actuation of the button 404. The slider control 402 is operable to provide dimming of the lighting load 210A. In response to inputs from the slider control 402, the controller 514 controls the conductive state of the controllably conductive device 510 thereby to affect the dimming level of the lighting load 210A.

[0040] The load control device 204A further includes an RF transceiver 522 for transmitting and receiving RF communication signals from the other devices of the system 200 via an antenna 410. Once the controller 514 receives inputs from the user interface 520, the controller 514 then controls the lighting load 210A to the desired level set by the slider control 402, or to off, and then transmits a radio frequency signal to the master control unit 202

to identify the status of the lighting load 210A, which may be the intensity of the lighting load, or whether the lighting load is on or off, as determined by the controller 514.

[0041] Figure 6 shows an equivalent circuit of the antenna 410 according to the present invention. The antenna 410 is comprised of two parts: a main loop 610 and a feed loop 620. The main loop 610 is the primary radiating element of the antenna 410 and includes an inductance L and a capacitance C in series. When energized, the main loop 610 resonates at a frequency determined by the values of L and C and enables the transmitting and receiving of RF signals via a radiation resistance, R_r , which is a representation of the energy delivered to radiation. A loss resistance, R_ℓ , represents the losses in the main loop 610. The main loop 610 is primarily magnetically coupled to the feed loop 620. This coupling is shown schematically in Fig. 6 by an ideal transformer T . The feed loop 620 includes a magnetizing inductance L_m , a leakage inductance L_ℓ , and two ends 630 that connect to the RF transceiver 522. The feed loop 620 allows for the conduction of signals between the RF transceiver 522 and the main loop 610.

[0042] In this way, the antenna 410 is adapted to receive RF signals via the main loop 610, with those radio frequency signals being electromagnetically coupled to the feed loop 620 for input to the RF transceiver 522. Conversely, the feed loop 620 receives signals to be transmitted from the RF transceiver 522, electromagnetically couples these signals to the main loop 610 for transmission of RF signals to a master or repeater device.

[0043] Figure 7A shows a front view of the load control device 204A, without the faceplate 406 installed, including a yoke 408. Fig 7B shows a right side cross-sectional view of the load control device 204A of Fig. 7A. An antenna 410 is provided on a printed circuit board inside and behind the button 404 in the plane of the drawing paper. The antenna 410 extends beyond the front surface of the bezel 407 (which is substantially flush with the front surface of the faceplate 406 as shown in Fig. 4). Accordingly, the antenna 410 protrudes through the opening of the faceplate 406 and extends beyond the faceplate. The positioning of the antenna 410 increases the transmission range of the antenna, particularly when the faceplate comprises a metal faceplate. The antenna 410 connects to a dimmer printed circuit board (PCB) 412 that includes the controllably conductive device 510, the gate drive circuit 512, the controller 514, the

power supply 516, the zero-crossing detector 518, the user interface 520, and the RF transceiver 522. The yoke 408 and a back cover 414 enclose the PCB 412.

[0044] A first side 810A and a second side 810B of an antenna 810 for the load control device 204A according to a first embodiment of the present invention is shown in Figs. 8A and 8B, respectively. The antenna 810 includes a main loop trace 820 and a feed loop trace 822 that intersects with the main loop trace. Thus, the main loop of the antenna 810 is not electrically isolated from the feed loop. A capacitor 824 is provided across a break 825 in the main loop trace 820. The antenna 810 is formed on a printed circuit board and includes three terminals 826, 828, 830 for connection to the dimmer PCB 412. The main loop terminates at the two outer terminals 826, 828, while the feed loop is connected to the inner terminal 830. A main loop trace 820' is provided on the second side 810B of the antenna 810 and is connected to the main loop trace 820 on the first side 810A through a plurality of vias 832.

[0045] The main loop terminals 826, 828 are connected to circuit common on the dimmer PCB 412. The feed loop terminal 830 is connected to the RF transceiver 522 on the dimmer PCB 412. When a signal is conducted from the transceiver to the feed loop terminal 830, current flows through the feed loop trace 822, the main loop traces 820, 820', and the main loop terminals 826, 828 to circuit common on the dimmer PCB 412. The main loop is substantially only magnetically coupled to the feed loop, and thus, a current having a larger magnitude is induced in the main loop trace 820 when current flows through the feed loop trace 822. This current flows through the main loop terminals 826, the main loop traces 820, 820', the capacitor 824, and the main loop terminal 828. The main radiating loop 820, 820' is positioned in relation to the feed loop 822 such that substantially all of the magnetic flux generated by the current flowing through the feed loop 822 passes through both the area circumscribed by the feed loop 822, and the area circumscribed by the main loop 820, 820'.

[0046] An antenna 910 for the load control device 204A according to a second embodiment of the present invention is shown in Figs. 9A and 9B. As shown in Fig. 9A, a first side 910A of the antenna 910 includes a feed loop trace 922 that terminates at two terminals 926, 930. A main loop trace 920 is provided on a second side 910B of the antenna 910 as shown in Fig. 9B and is electrically isolated from the feed loop trace 922. The main loop trace 920 includes a break 925 with a capacitor 924 disposed across the break. A third tab 928 is provided on the PCB of the antenna 910 to aid in connection of the antenna to the dimmer PCB 412.

[0047] The terminal 926 is connected to circuit common on the dimmer PCB 412, while the terminal 930 is coupled to an RF transceiver. When a signal is conducted from the transceiver to the feed loop terminal 930, current flows through the feed loop trace 922 and the terminal 926. Accordingly, a current is induced in the main loop trace 920 due to the magnetic coupling of the main loop and the feed loop and an RF signal is transmitted from the load control device 204A.

[0048] Although the words “device” and “unit” have been used to describe the elements of the lighting control systems of the present invention, it should be noted that each “device” and “unit” described herein need not be fully contained in a single enclosure or structure. For example, the master control unit 202 of Fig. 2 may comprise a plurality of buttons in a wall-mounted device and a processor that is included in a separate location.

[0049] Although the present invention has been described in relation to particular embodiments thereof, many other variations and modifications and other uses will become apparent to those skilled in the art. Therefore, the present invention should be limited not by the specific disclosure herein, but only by the appended claims.

What is claimed is:

CLAIMS

1. An antenna operable to transmit or receive radio frequency signals at a specified frequency, the antenna comprising:
 - a first loop of conductive material having an inductance, and a capacitor, the capacitor and the inductance forming a circuit resonant at the specified frequency; and
 - a second loop of conductive material having two ends adapted to be electrically coupled to an electronic circuit, the second loop being substantially only magnetically coupled to the first loop and electrically insulated from the first loop;the antenna for use with an electrical control device for controlling the power delivered to an electrical load, the first loop of conductive material is adapted to extend beyond a faceplate of the device.
2. The antenna of claim 1, wherein the first loop is formed on a first side of a printed circuit board, and wherein the printed circuit board is adapted to be disposed in a plane perpendicular to a mounting yoke of the electrical control device, the yoke adapted to mount the electrical control device in an electrical wallbox.
3. The antenna of claim 2, wherein the second loop is formed on a second side of the printed circuit board.
4. The antenna of claim 2, wherein the first and second loops each have a loop axis, and the loop axis of the first loop is adapted to be substantially parallel to the plane in which the yoke is disposed.
5. The antenna of claim 1, wherein the first loop of conductive material is adapted to be enclosed by a button of the electrical control device.
6. An antenna for an electrical load control device for controlling the power delivered to an electrical load, the antenna operable to transmit or receive radio frequency signals

at a specified frequency, the antenna comprising:

- a printed circuit board having first and second sides;
 - a first loop of conductive material having an inductance, and a capacitor, the capacitor and the inductance forming a circuit resonant at the specified frequency, the first loop formed on the first side of the printed circuit board; and
 - a second loop of conductive material having two ends adapted to be electrically coupled to an electronic circuit, the second loop formed on a side of the printed circuit board and substantially only magnetically coupled to the first loop;
- wherein the first loop extends beyond a faceplate of the electrical control device.

7. The antenna of claim 6, wherein the second loop is only magnetically coupled to the first loop and electrically insulated from the first loop.

8. The antenna of claim 6, wherein the first loop is provided on both sides of the printed circuit board and electrically coupled to the second loop.

9. The antenna of claim 6, wherein the first loop is enclosed by a button of the electrical control device.

10. The antenna of claim 6, wherein the first and second printed circuit board sides are disposed in a plane substantially perpendicular to the faceplate.

11. A load control device for controlling the power delivered to an electrical load, the load control device comprising:

- a controllably conductive device for controlling the power delivered to the electrical load, the controllably conductive device having a control input;
- a controller coupled to the control input of the controllably conductive device for control of the controllably conductive device;
- an actuator button for providing an input to the controller;
- a faceplate having an opening, the actuator button provided in the opening;
- a transmitter and/or a receiver in communication with the controller; and
- an antenna coupled to the transmitter and/or receiver; the antenna adapted to receive a first signal at a specified frequency from a remote control device and/or transmit a

second signal at a specified frequency to a remote control device, the receiver operable to couple the first signal from the antenna to the controller for remotely controlling the controllably conductive device, and/or the transmitter operable to couple the second signal from the controller to the antenna for providing a status of the electrical load, the antenna extending through the opening of the faceplate beyond the front surface of the faceplate.

12. The load control device of claim 11, wherein the antenna comprises:
a first loop of conductive material having an inductance, and a capacitor, the capacitor and the inductance forming a circuit being resonant at the specified frequency; and
a second loop of conductive material having two ends adapted to be electrically coupled to an electronic circuit, the second loop being substantially only magnetically coupled to the first loop and electrically insulated from the first loop;
wherein the first loop extends beyond the faceplate of the load control device.

AMENDED CLAIMS

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1. An antenna operable to transmit or receive radio frequency signals at a specified frequency, the antenna comprising:

a first loop of conductive material having an inductance, and a capacitor, the capacitor and the inductance forming a circuit resonant at the specified frequency; and

a second loop of conductive material having two ends adapted to be electrically coupled to an electronic circuit, the second loop being substantially only magnetically coupled to the first loop and electrically insulated from the first loop;

the antenna for use with an electrical control device for controlling the power delivered to an electrical load,

wherein the first loop of conductive material is adapted to extend beyond a faceplate of the device and is formed on a first side of a printed circuit board, and wherein the printed circuit board is adapted to be disposed in a plane perpendicular to a mounting yoke of the electrical control device, the yoke adapted to mount the electrical control device in an electrical wallbox.

2. (canceled)

3. The antenna of claim 1, wherein the second loop is formed on a second side of the printed circuit board.

4. The antenna of claim 1, wherein the first and second loops each have a loop axis, and the loop axis of the first loop is adapted to be substantially parallel to the plane in which the yoke is disposed.

5. The antenna of claim 1, wherein the first loop of conductive material is adapted to be received within a button of the electrical control device.

6. (currently amended) An antenna for an electrical load control device for controlling the power delivered to an electrical load, the antenna operable to transmit or receive radio frequency signals at a specified frequency, the antenna comprising:

a first loop of conductive material having an inductance, and a capacitor, the capacitor and the inductance forming a circuit resonant at the specified frequency, and

a second loop of conductive material having two ends adapted to be electrically coupled to an electronic circuit, the second loop being electrically insulated from the first loop and being substantially only magnetically coupled to the first loop;

wherein the first loop extends beyond a faceplate of the electrical control device and is received within an actuator button of the electrical control device.

7. (canceled)

8. The antenna of claim 6, further comprising a printed circuit board having first and second sides and wherein the first loop is provided on both sides of the printed circuit board and electrically coupled to the second loop.

9. The antenna of claim 6, further comprising a printed circuit board having first and second sides and the first loop is formed on the first side of the printed circuit board and the second loop is disposed on one of said sides of the printed circuit board.

10. The antenna of claim 9, wherein the first and second printed circuit board sides are disposed in a plane substantially perpendicular to the faceplate.

11. The antenna of claim 6, further wherein the electrical load control device comprises:

a controllably conductive device for controlling the power delivered to the electrical load, the controllably conductive device having a control input;

a controller coupled to the control input of the controllably conductive device for control of the controllably conductive device;

the actuator button providing an input to the controller;

a faceplate having an opening, the actuator button provided in the opening;

a transmitter and/or a receiver in communication with the controller;

and

an antenna coupled to the transmitter and/or receiver; the antenna adapted to receive a first signal at a specified frequency from a remote control device and/or transmit a second signal at a specified frequency to a remote control device, the receiver operable to couple the first signal from the antenna to the controller for remotely controlling the controllably conductive device, and/or the transmitter operable to couple the second signal from the controller to the antenna for providing a status of the electrical load, the antenna extending through the opening of the faceplate beyond the front surface of the faceplate.

12. (canceled).

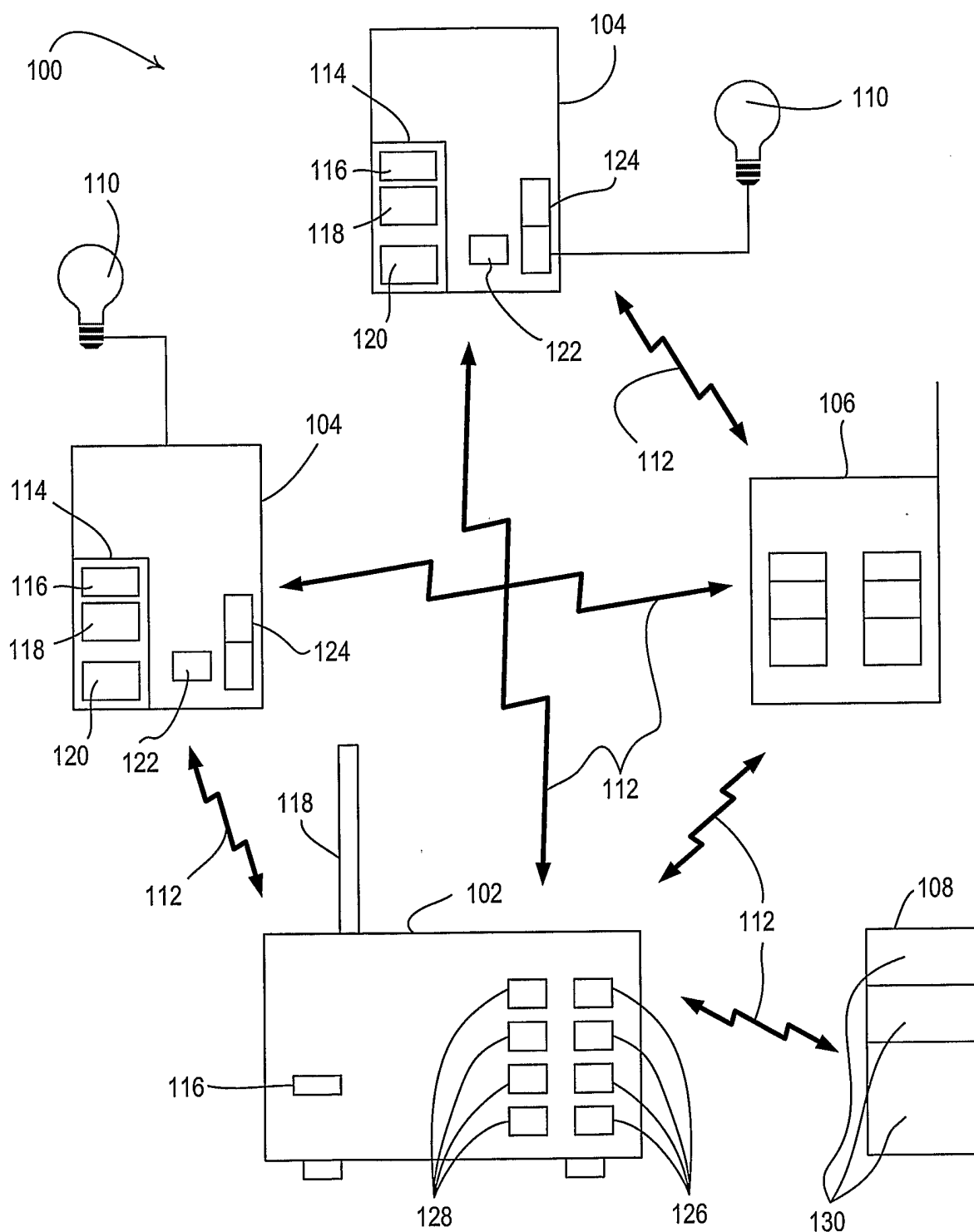


FIG. 1A
PRIOR ART

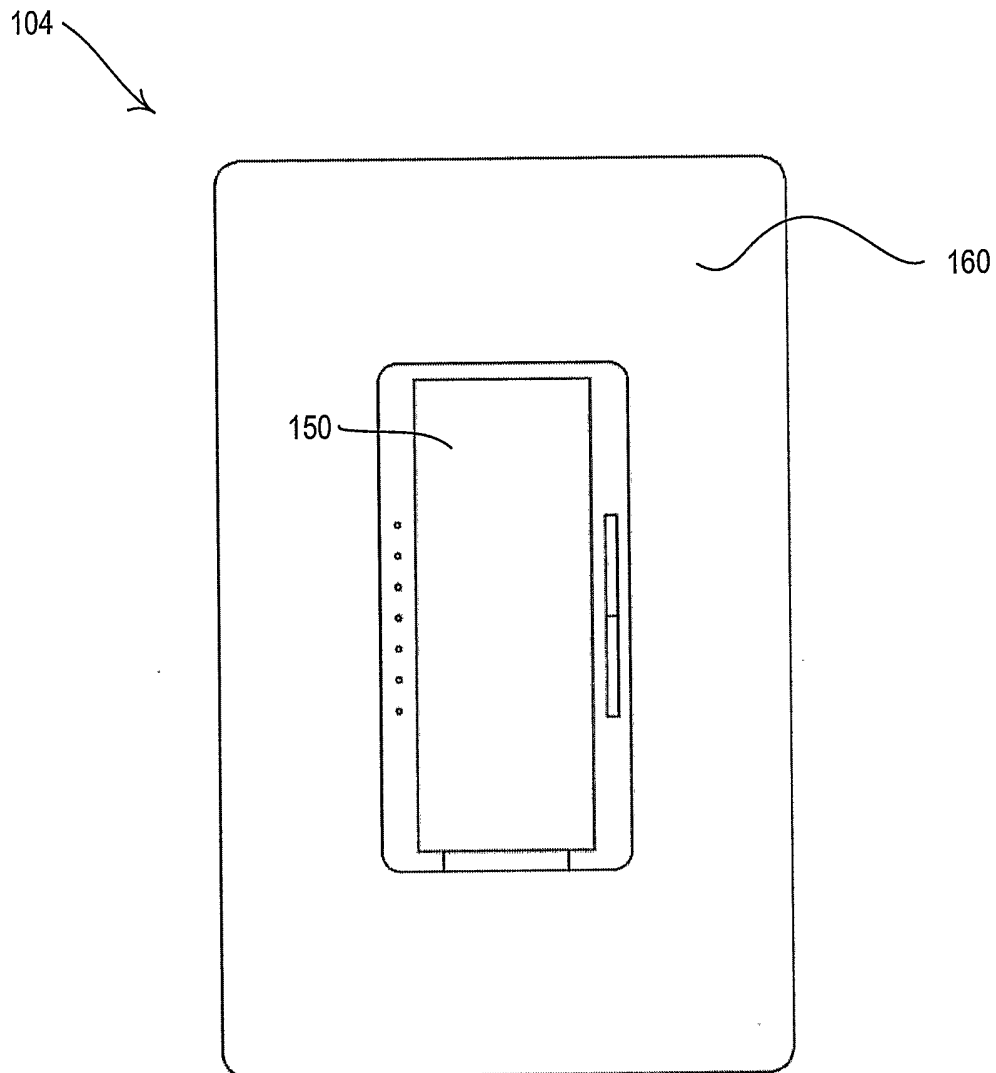


FIG. 1B
PRIOR ART

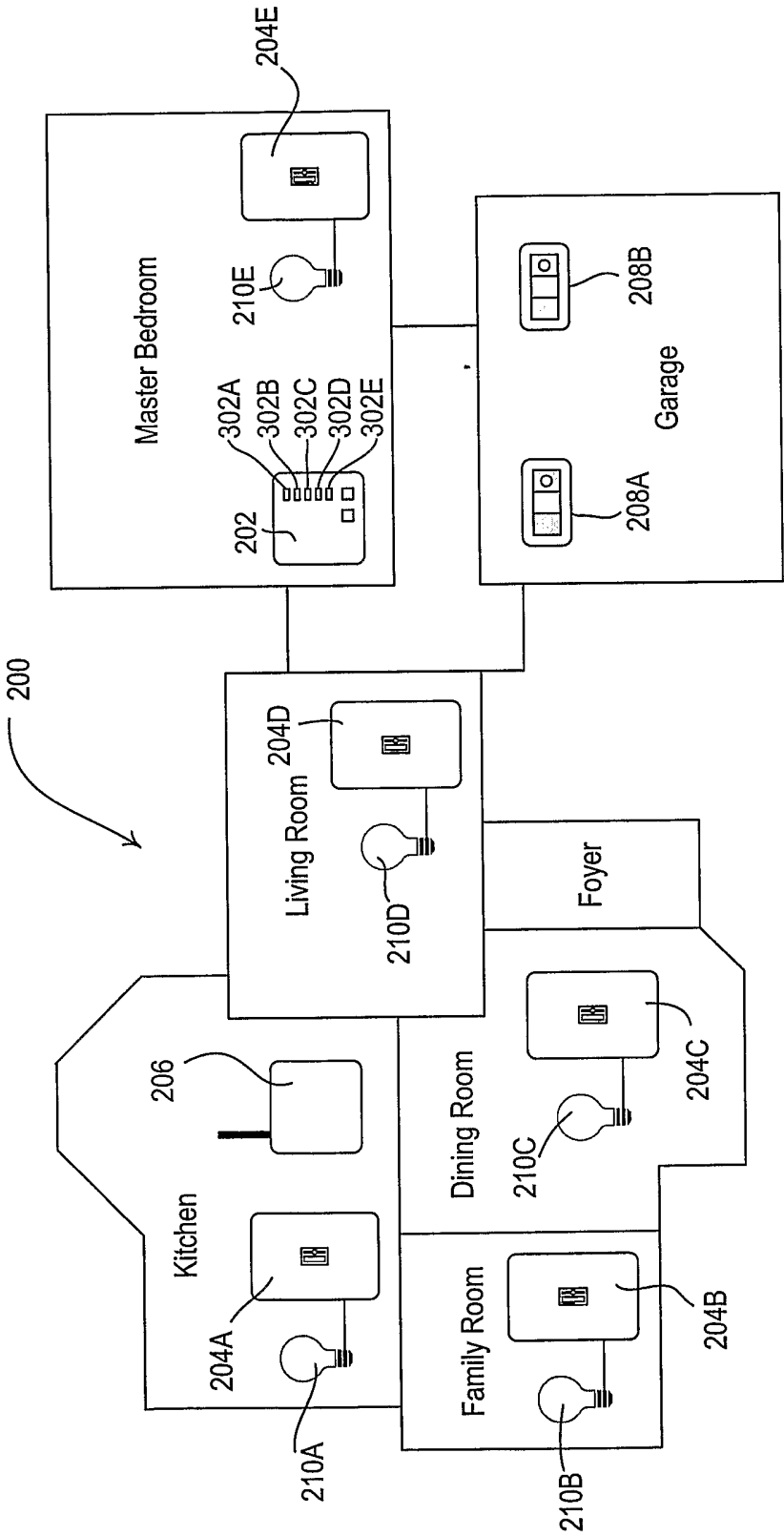


FIG. 2

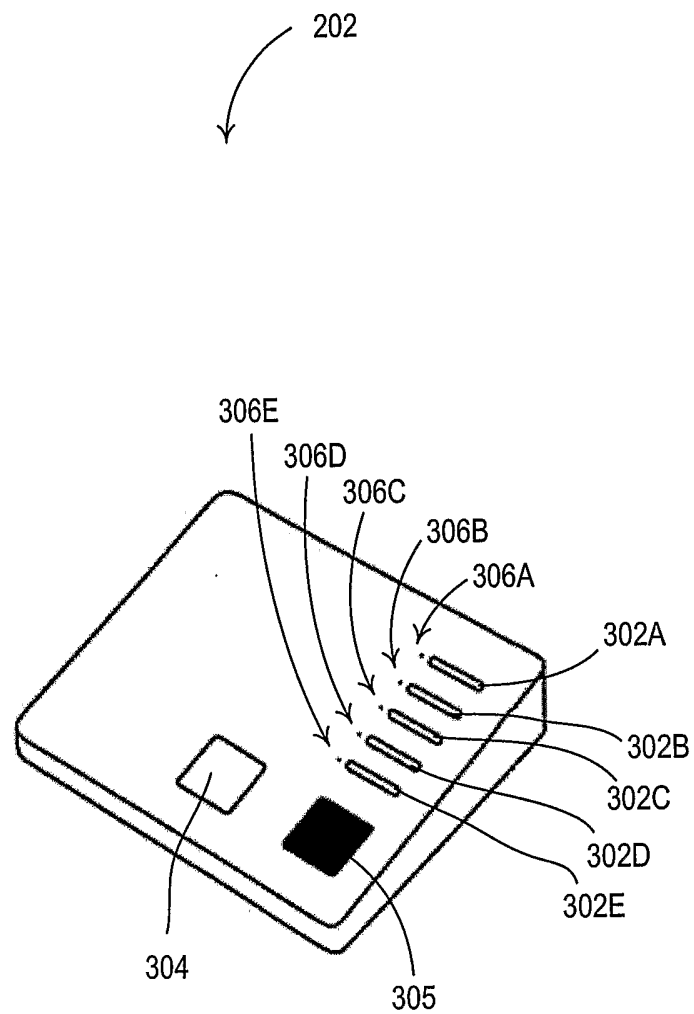


FIG. 3

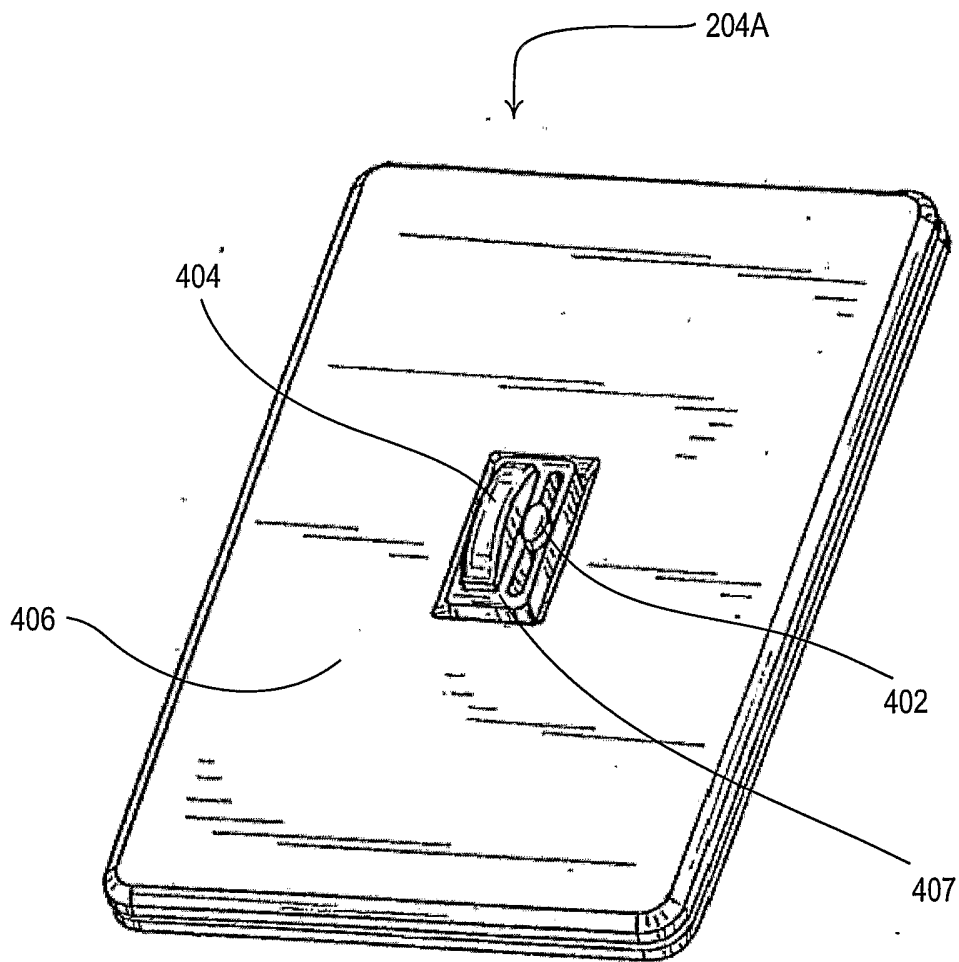


FIG. 4

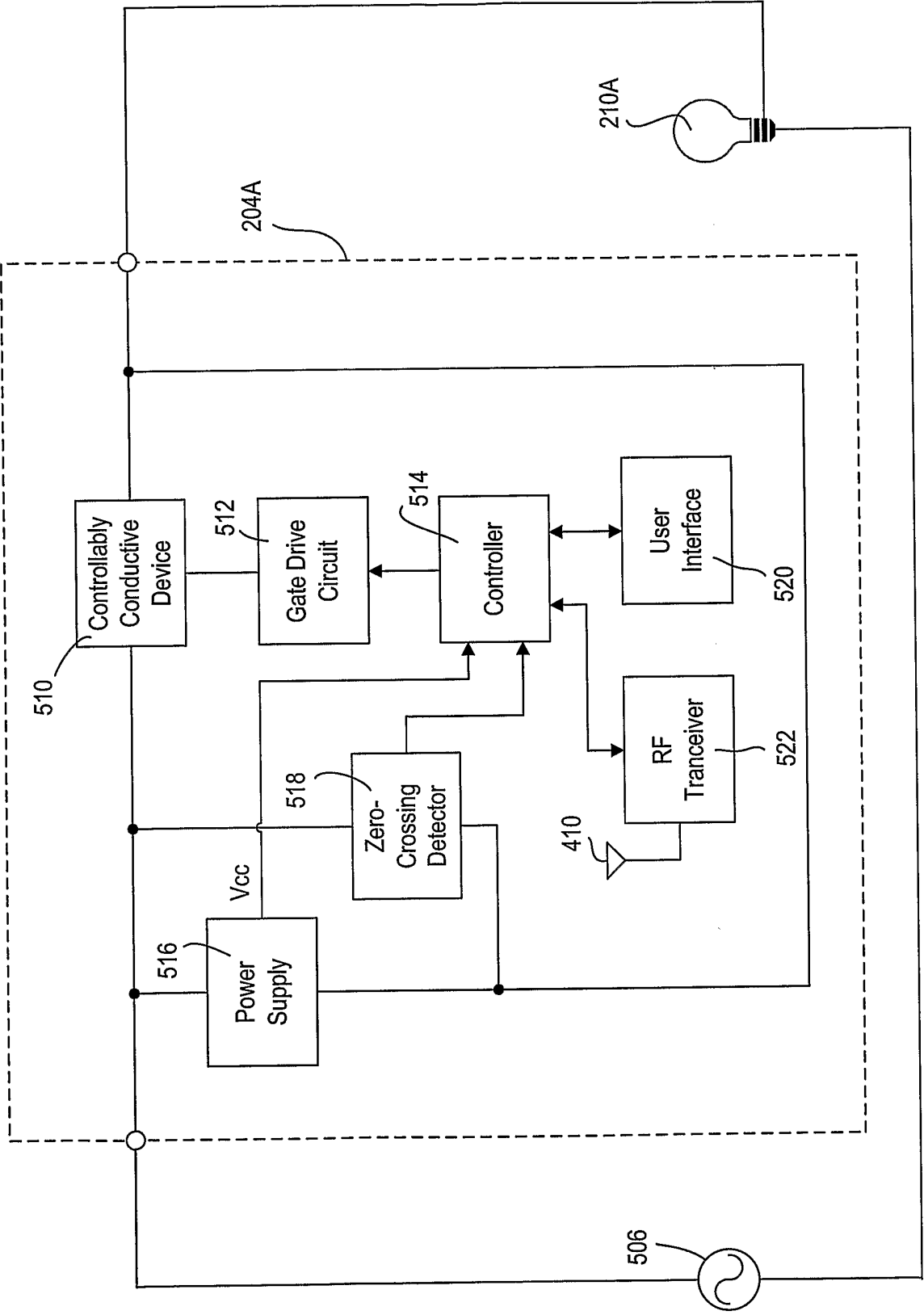


FIG. 5

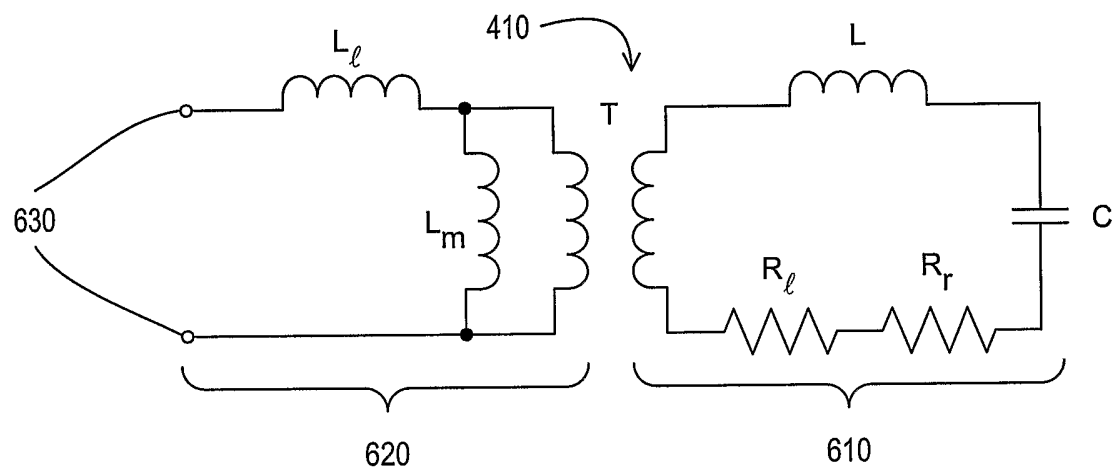


Fig. 6

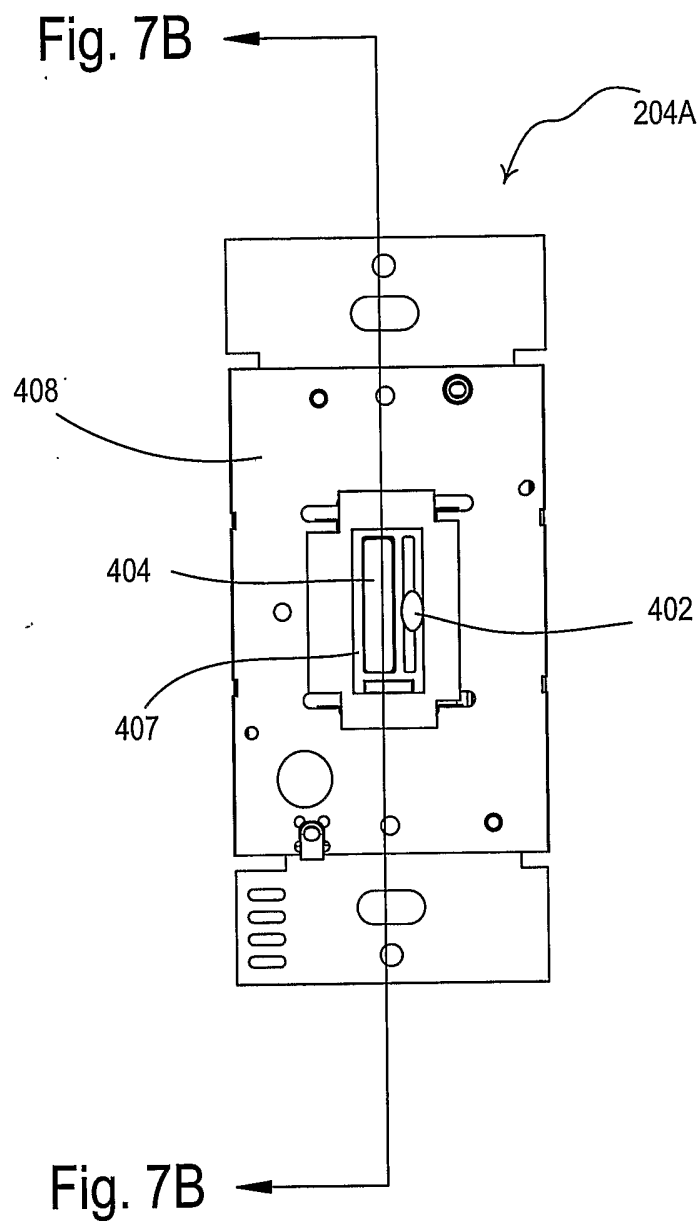


FIG. 7A

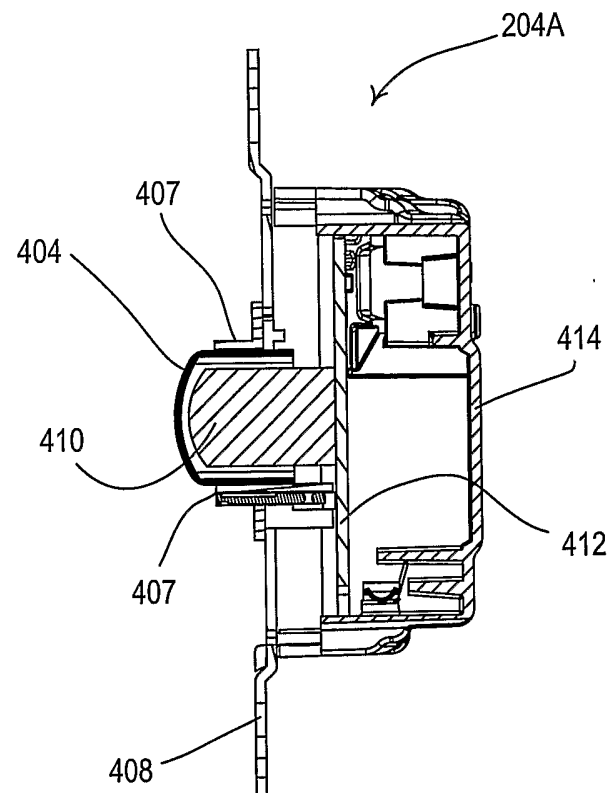
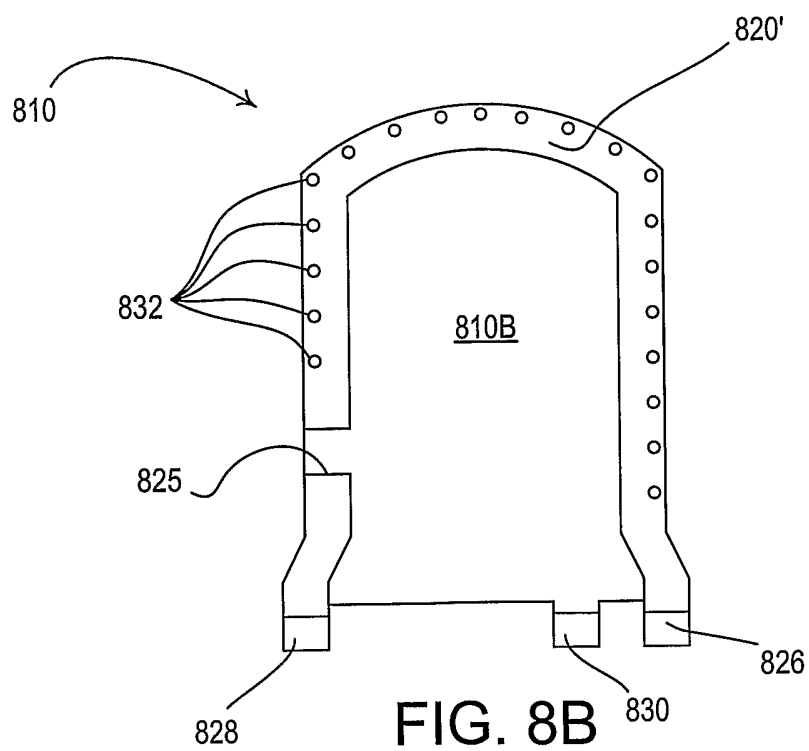
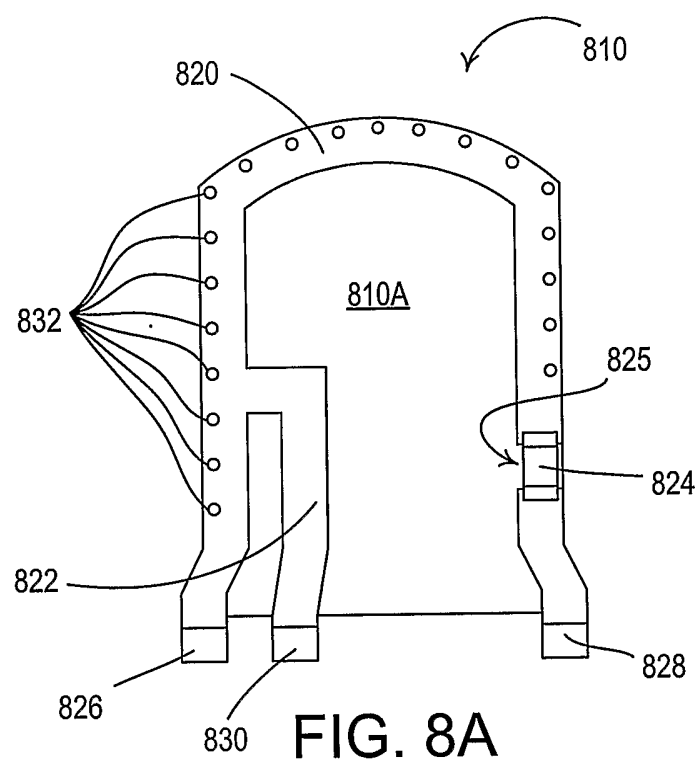
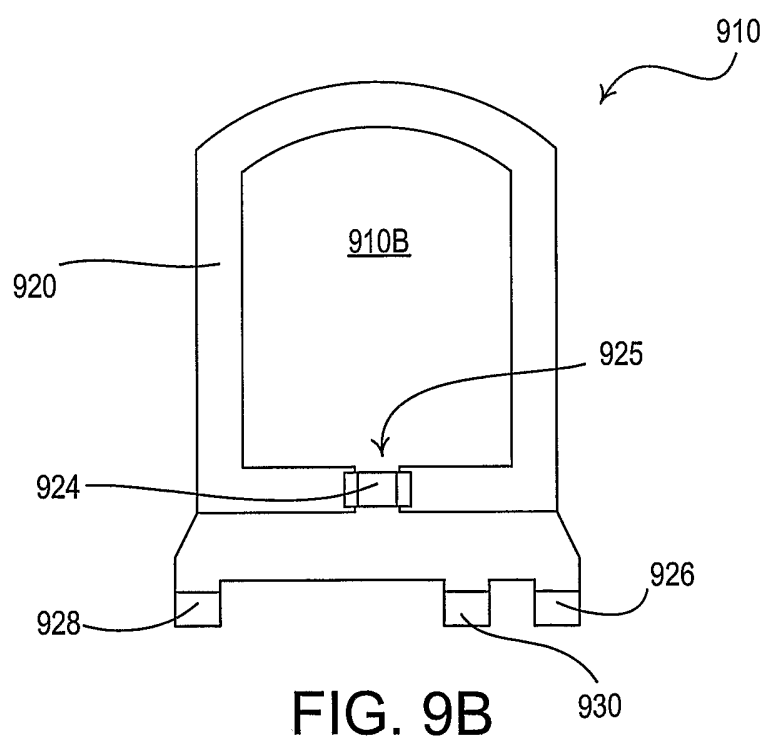
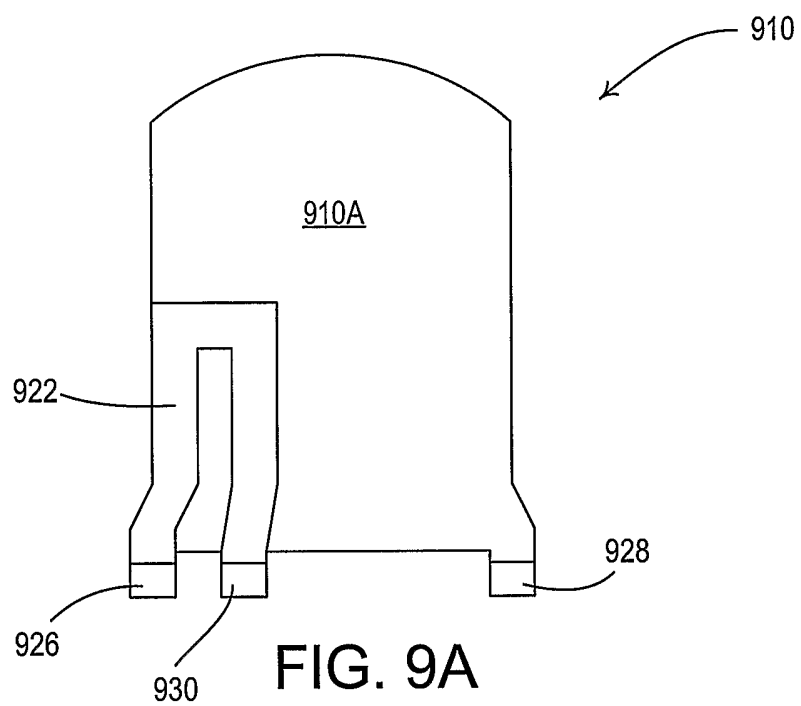


FIG. 7B





INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/021862

A. CLASSIFICATION OF SUBJECT MATTER

INV. H01Q7/00
ADD. H01Q1/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 144 346 A (BOY ET AL) 7 November 2000 (2000-11-07) column 2, line 66 - column 3, line 38; figure 1	1,6,7, 11,12
X	US 3 550 137 A (JOHN A. KUECKEN) 22 December 1970 (1970-12-22) abstract; figure 2	1
X	US 6 104 354 A (HILL ET AL) 15 August 2000 (2000-08-15) abstract; figure 4	1
A	EP 0 646 984 A (N.V. NEDERLANDSCHE APPARATENFABRIEK NEDAP) 5 April 1995 (1995-04-05) the whole document	1-12
-/-		



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

7 September 2006

Date of mailing of the international search report

18/09/2006

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

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MAROT-LASSAUZAIE, J

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/021862

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No

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US 6104354	A	15-08-2000	CN 1262795 A DE 69928732 T2 EP 0985246 A1 ES 2255241 T3 WO 9950931 A1 JP 2002500852 T TW 410488 B	09-08-2000 10-08-2006 15-03-2000 16-06-2006 07-10-1999 08-01-2002 01-11-2000
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US 5225847	A	06-07-1993	NONE	