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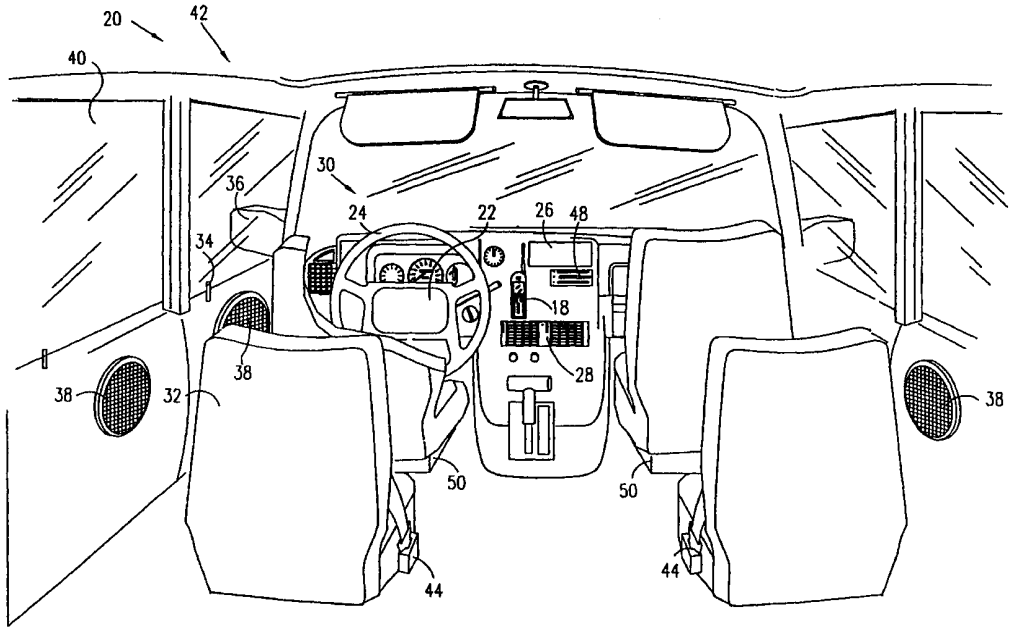
(54) Title: INFRARED VEHICLE CONTROL SYSTEM



(57) Abstract: Wireless communications apparatus (20) for use in a motor vehicle (42), the vehicle including one or more devices. The apparatus includes a control unit (22) and a communicating unit. The communicating unit is coupled to at least one of the devices, and is in wireless communication with the control unit by means of infrared radiation. Preferably, the infrared radiation is transmitted by one of the units in a manner generally insensitive to the position of the other unit.

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INFRARED VEHICLE CONTROL SYSTEM

FIELD OF THE INVENTION

The present invention relates generally to wireless communication of control messages and data, and specifically to the use of infrared radiation for communication of control messages and data in a vehicle, including both line-of-sight (LOS) and non-LOS, as well as direct and indirect transmission.

BACKGROUND OF THE INVENTION

The use of electromagnetic radiation in general, and infrared (IR) radiation in particular, for enabling the wireless transfer of analog and digital information is well known in the art. In the field of handheld personal desk assistants (PDAs), for example, it is known to use IR signaling to transfer data or data files between two different PDAs whose infrared data transfer ports are positioned such that the IR radiation emitted from the data sending unit is generally directed towards the IR port of the data receiving unit. In the context of the present patent application, the term "direct IR" refers to this sort of directed transmission, which requires that the transmission be aimed in the general direction of the receiver, and is therefore sensitive to the receiver's position. Handheld remote control devices often use direct IR to send signals to, for example, audio-visual equipment.

U.S. Patent 5,515,345 to Barreira et al., whose disclosure is incorporated herein by reference, describes a control unit for an automobile audio system, which includes a transmitting device mounted on the gear shift, in order to allow the driver to have easy access to the control unit. The transmitting device is coupled to the vehicle's audio system by wires or by direct IR.

U.S. Patent 4,940,964 to Dao, whose disclosure is incorporated herein by reference, describes a motor vehicle control system having a control unit located in the vehicle, and a handheld, portable unit which is in two-way communication with the control unit, in order to remotely activate one or more of the vehicle's systems.

It is also known to use "diffuse" infrared signaling to enable a transmitting IR unit that is not in a line of sight of a receiving unit to broadly "illuminate" an area, e.g., a room, with infrared radiation. A portion of the transmitted IR radiation reflects off surfaces in

the room, and these reflected signals are detected by a receiving unit. Spectrix Corporation (Deerfield, Illinois), for instance, produces handheld, portable, devices which allow a plurality of users in a room to transfer data to and from a base station using diffuse IR radiation.

SUMMARY OF THE INVENTION

It is an object of some aspects of the present invention to provide improved apparatus and methods for wireless control of electrical and/or mechanical/servo systems of a motor vehicle.

In preferred embodiments of the present invention, a control unit, operated by the driver of a vehicle, is used to communicate with at least one device in the vehicle by means of non-direct and/or non-line-of-sight infrared radiation. Preferably, the control unit is fixed to the vehicle's steering wheel and/or dashboard, and enables the driver to regulate and/or monitor the operation of a plurality of the vehicle's systems and devices (e.g., audio system, temperature control, door locks, gas tank lock, fuel gauge, etc.), by sending instructions thereto and/or by receiving data therefrom, substantially without using wires to transmit the instructions and data. The wiring required in the vehicle to communicate with these systems and devices is thus substantially reduced, and, moreover, the driver is able to control the systems and devices substantially without removing his/her hands from the area of the vehicle's steering wheel and/or dashboard.

Implementation of these embodiments typically substantially reduces the vehicle's cost and complexity. For example, special care is generally needed both in design and assembly of a prior art vehicle to assure that data and control wires are correctly and efficiently placed in the vehicle, so as to allow the driver to reliably communicate with the large number of devices located therein. Moreover, if the vehicle subsequently requires repairs, one or more of the data and control wires may be damaged by a mechanic who may not be fully apprised of the location and purpose of each of the many wires. It is accordingly a benefit of these embodiments of the present invention that many or all of these wires are replaced by wireless communication, and thus these embodiments reduce the cost, complexity, and likelihood of damage associated with wired communications typically used in vehicles known in the art.

Additionally, by practicing these embodiments of the present invention, changes to an existing vehicle can be made quicker and cheaper than as provided by present techniques. For example, a buyer of a new car in a showroom can specify modifications which can easily be performed on-the-spot by the dealer, and do not require complex rewiring and delayed delivery. In a preferred embodiment, new vehicles are shipped from the factory with a power bus, but substantially without any "options," or control or data wires installed. At the time of purchase, the buyer specifies a desired set of options which are quickly coupled to the power bus and which communicate via non-direct and/or non-line-of-sight IR with the control unit.

In some preferred embodiments of the present invention, the received data are output on a display, in order to inform the driver of the status of the device coupled to the transmitting communicating unit. For example, the display may indicate the radio station or CD track currently playing, the temperature measured by a sensor located within or without the vehicle, the use or non-use of a seatbelt by each passenger, the status of the vehicle's door-locks, whether a door is ajar, etc. The use of such a display reduces the need for the driver to take his/her eyes off the road in order to control the systems and devices in the vehicle.

Alternatively or additionally, data transmitted by one or more of the communicating units may be used directly by the control unit in order to modulate the function of a device coupled to another communicating unit. For example, if the control unit receives a signal indicating that a specified passenger is not wearing a seatbelt, the control unit may transmit a signal to a communicating unit coupled to an indicator, in order to tell the passenger to put on her seatbelt. Additionally, a "door ajar" signal may be used by the control unit in some operating modes to limit the vehicle's maximum attainable speed. In these examples, a first communicating unit transmits a data signal to the control unit, which transmits, responsive thereto, an instruction to a second communicating unit.

In some preferred embodiments of the present invention, one or more relay units are coupled to the interior of the vehicle, in order to detect weak signals transmitted by the control unit and/or the communicating units and to amplify and re-transmit the signals.

There is therefore provided, in accordance with a preferred embodiment of the present invention, wireless communications apparatus for use in a motor vehicle, the vehicle including one or more devices, the apparatus including:

a control unit; and

a communicating unit, coupled to at least one of the devices, which communicating unit is in wireless communication with the control unit by means of infrared radiation, the infrared radiation being transmitted by one of the units in a manner generally insensitive to the position of the other unit.

Preferably, the control unit receives an input from an operator of the vehicle, and the control unit includes an infrared transmitter which transmits the infrared radiation to the communicating unit to control the device responsive to the input.

In a preferred embodiment, at least one of the one or more devices is selected from the group consisting of: a cellular telephone, an audio-system controller, an air-conditioning/heating controller, electric door-locks, side-mirrors, loudspeakers, power-windows, external vehicle lights, a Global Positioning System unit, a device coupled to communicate via the Internet, seat-adjustment motors, canopy lights, a sun roof, a rear de-fog unit, a retractable antenna, a head-rest, a steering wheel position controller, a sun visor, and a gas tank lock.

Preferably, the at least one of the devices generates a signal, and the communicating unit includes an infrared transmitter which transmits the infrared radiation to the control unit responsive to the signal. Further preferably, the device which generates the signal is selected from the group consisting of: a cellular telephone, an audio-system controller, an air-conditioning/heating controller, electric door-locks, seatbelt mechanisms, external vehicle lights, a Global Positioning System unit, and fuel/oil/temperature gauges.

Alternatively or additionally, the control unit includes:

an infrared receiver, which receives the infrared radiation transmitted by the communicating unit coupled to the device; and

a display, which displays information responsive to the received infrared radiation.

In a preferred embodiment, the control unit and the communicating unit do not transfer data therebetween using wired communication.

Typically, the control unit is fixed to a steering wheel of the vehicle.

Preferably, the apparatus includes a relay unit, coupled to an interior aspect of the vehicle, which receives the infrared radiation and retransmits the radiation in order to boost a signal strength thereof.

In a preferred embodiment, the communicating unit includes:

a first communicating unit, coupled to one of the one or more devices; and

a second communicating unit, coupled to another one of the one or more devices,

wherein the first communicating unit transmits a first signal to the control unit, and wherein the control unit transmits a second signal to the second communicating unit responsive to the first signal, in order to actuate the second device responsive to the first signal.

In a preferred embodiment, at least one of the one or more devices includes an electronic device and/or a mechanical device.

There is also provided, in accordance with a preferred embodiment of the present invention, a method of wireless communication in a motor vehicle, including:

transmitting infrared radiation from a first site in the vehicle in a manner that is generally insensitive to a choice of a position at which the radiation is to be received;

receiving the infrared radiation at a second site in the vehicle; and

changing a state of an electrically-actuated unit located at the second site responsive to the received radiation.

Preferably, the first site is in a vicinity of an operator of the vehicle, and the radiation is transmitted responsive to an input from the operator. Alternatively, the second site is in a vicinity of an operator of the vehicle, and the radiation is transmitted responsive to a sensor reading at the first site. In a preferred embodiment, changing the state of the electrically-actuated unit includes displaying an indication of the reading.

Alternatively or additionally, the second site is in a vicinity of an operator of the vehicle, and the radiation is transmitted responsive to a query generated at the second site.

In a preferred embodiment, the method includes receiving the infrared radiation at a third site in the vehicle and retransmitting the received radiation from the third site, in order to boost a signal strength of the radiation.

In a preferred embodiment, the method includes transmitting additional infrared radiation from the second site to a third site in the vehicle, in order to change the state of

an electrically-actuated unit located at the third site responsive to the radiation transmitted from the first site.

Preferably, transmitting the radiation includes transmitting diffuse infrared radiation.

There is further provided, in accordance with a preferred embodiment of the present invention, wireless communications apparatus for use in a motor vehicle, the vehicle including one or more devices, the apparatus including:

a control unit; and

a communicating unit, coupled to at least one of the devices, which communicating unit is in wireless communication with the control unit by means of non-line-of-sight infrared radiation.

Preferably, the infrared radiation is transmitted by one of the units in a manner substantially insensitive to the position of the other unit.

There is still further provided, in accordance with a preferred embodiment of the present invention, a method of wireless communication in a motor vehicle, including:

transmitting infrared radiation from a first site in the vehicle;

receiving the infrared radiation at a second site in the vehicle not in line-of-sight of the first site; and

changing a state of an electrically-actuated unit located at the second site responsive to the received radiation.

Preferably, the infrared radiation is transmitted from the first site in a manner substantially insensitive to the position of the second site.

The present invention will be more fully understood from the following detailed description of the preferred embodiments thereof, taken together with the drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a simplified pictorial illustration showing a vehicle control system in the interior of a vehicle, in accordance with a preferred embodiment of the present invention;

Fig. 2 is a schematic sectional view of the vehicle of Fig. 1, in accordance with a preferred embodiment of the present invention;

Fig. 3 is a schematic illustration of a user interface, for use in the system of Fig. 1, in accordance with a preferred embodiment of the present invention; and

Figs. 4A-4C are block diagrams of components of the system of Fig. 1, in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is now made to Figs. 1 and 2, which schematically illustrate a vehicle control system 20 in a vehicle 42, in accordance with a preferred embodiment of the present invention. Fig. 1 is a simplified pictorial illustration showing a control unit 22 coupled to transmit instructions to and receive data from one or more devices associated with vehicle 42 by direct and/or indirect wireless infrared communications, either with or without a clear line-of-sight (LOS) between the control unit and the devices. Fig. 2 is a schematic sectional view of vehicle 42, showing further details of the vehicle control system.

Control unit 22 transmits infrared signals to communicate with or control the operation of a plurality of devices within or coupled to the outside of vehicle 42, such as those in the following exemplary list:

- a cellular telephone 18,
- an audio-system controller 26,
- an air-conditioning/heating controller 28,
- electric door-locks 34,
- side-mirrors 36,
- loudspeakers 38,
- power-windows 40,
- seatbelt mechanisms 44,
- external vehicle lights 46 (e.g., headlights, indicators, brake lights),
- a Global Positioning System (GPS) unit 48,
- seat-adjustment motors 50,
- canopy lights 64 and 66,

- a sun roof 68,
- a rear de-fog unit 70,
- a retractable antenna 72,
- a gas tank lock 76, and
- fuel/oil/temperature gauges 78.

These controllable devices are listed by way of example and not limitation. In some applications of the present invention, only one or several of the listed devices are enabled to receive instructions from or communicate with control unit 22. It will be understood by one skilled in the art that substantially any electrically-actuated device known in the art of motor vehicle design can be controlled by control unit 22.

Whereas some of the devices listed hereinabove may be enabled only to receive instructions from control unit 22, for some applications of the present invention, one or more electrical and/or mechanical/servo devices within vehicle 42 are enabled to transmit information to control unit 22, using direct and/or non-direct, infrared radiation, with or without a clear LOS. In a typical mode of operation, for example, a communicating unit coupled to audio-system controller 26 transmits status data, such as CD track number, current radio station, radio volume, etc., responsive to a query signal from control unit 22. Similarly, air-conditioning/heating controller 28 is preferably enabled to transmit on/off status and fan and temperature settings, responsive to a query from the control unit. Other devices, for example fuel/oil/temperature gauges 78, are preferably, but not necessarily, enabled only to transmit sensor readings to control unit 22, and generally do not receive instructions from the control unit.

Control unit 22 is typically coupled to the steering wheel 24 of vehicle 42, such that the driver is easily able to see the control unit and to enter commands into the unit. In another preferred embodiment of the present invention (not shown), control unit 22 is mounted on dashboard 30 of the vehicle.

Typically, some of the devices which are in communication with control unit 22 are in a line of sight of the unit, while some other of the devices are not in line of sight of the unit. Diffused and/or quasi-diffused infrared radiation (i.e., radiation which is transmitted from one or more sources substantially in all directions) is the preferred transmitting means by which substantially all of the devices communicate with the control unit. Most preferably, at the time of manufacture of vehicle 42, substantially no wires are

required to connect the control unit and the various devices controlled thereby. This is different from vehicle control systems known in the art, in which control wires are generally necessary to connect control mechanisms activated by the driver to devices activated thereby, especially devices which are located relatively far from the driver in the vehicle (e.g., rear de-fog). In this manner, use of this and similar embodiments of the present invention may provide significant savings of cost, design time, assembly time, and/or vehicle complexity.

It will be understood by one skilled in the art that for various reasons (including safety regulations and/or data transmission rate constraints) it may be desirable for some of the devices which communicate with control unit 22 to be additionally, or exclusively, in wired communication with the unit. Thus, in some applications of the present invention, control unit 22 is the primary means by which the driver enters commands into, and receives data from, most of the vehicle's electrically-actuated systems, including those which are controlled by wired communication.

Typically, the various devices enabled to communicate with control unit 22 are coupled to receive power from power lines 62, which are additionally coupled to a battery 60 within vehicle 42. Lines 62 are generally similar to power lines which are well known in the art for powering electrical and/or mechanical/servo devices of a motor vehicle.

Reference is now made to Figs. 3, 4A, 4B and 4C, which illustrate details of vehicle control system 20, in accordance with a preferred embodiment of the present invention. Fig. 3 is a schematic illustration of a user interface 94 of control unit 22, comprising a display 92 and an input unit 98. Figs. 4A-4C are block diagrams of elements of vehicle control system 20, including control unit 22 (Fig. 4A), a communicating unit 120 (Fig. 4B), which is coupled to air-conditioning/heating controller 28, and an optional relay unit 96 (Fig. 4C) coupled to canopy light 64.

Display 92 preferably comprises a back-lit liquid-crystal display or an array of light-emitting diodes, and is actuated by a processor 110 of control unit 22 to display the status of one or more of the devices in IR wireless or wired communication with the control unit. By way of example, outputs of display device 92 may include some of the messages shown in Table I hereinbelow. For some applications of the present invention, display 92 additionally has graphical output capabilities, for example, in order to display (a) a map generated by GPS unit 48, which is in IR wireless and/or wired communication

with control unit 22, or (b) a Web page or other information downloaded through cellular telephone 18 from the Internet or from another electronic network.

TABLE I

- "AIR CONDITIONER: ON, 20 DEG. C"
- "SELECT RADIO STATION"
- "96.6 FM SELECTED"
- "LOCK ALL DOORS?"
- "HI-BEAMS: ON"
- "4 LITERS OF GASOLINE REMAINING"
- "CHECK OIL"
- "50 MPH | 3500 RPM | 8:20 PM"
- "NOW DIALING: (914) 555-1212"
- "GPS UPDATE: ROUTE 95N, LEAVING NEW YORK CITY"
- "PRESS * TO SEND/RECEIVE E-MAIL MESSAGES"
- "FRONT RT. DOOR AJAR. MAX. SPEED 5 MPH. PRESS * TO OVERRIDE"

Input unit 98, comprising one or more input elements 90, preferably comprises an array of buttons, most preferably including a telephone-style keypad and at least two buttons with arrows impressed thereon, to enable operations such as menu selection, temperature control, radio station scanning, and/or navigating of an audio cassette or CD. During use of vehicle control system 20, the driver typically chooses menu options displayed on display device 92 in order to view the status of an electrically-actuated device (e.g., the radio or an electromechanical, servo-operated unit) or of a sensor (e.g., the oil gauge), and additionally to change one or more settings of a device whose status is being viewed. In this manner, the driver uses one interface, as provided by embodiments of the present invention, to monitor and exercise control over one or more systems and devices located throughout the vehicle.

As shown in Fig. 4A, processor 110 of control unit 22 is preferably coupled to a clock 106, a memory unit 108, user interface 94, and transmit and receive circuitry 112 and 114. Memory unit 108 typically comprises a volatile and/or non-volatile RAM, which stores all of the options, parameters, and settings selected by the driver. The RAM preferably receives power from battery 60 via lines 62 and/or from an optional rechargeable battery 116 located within unit 22, in order to enable efficient operation of

control unit 22, and to preserve the contents of the RAM when vehicle 42 is off. Preferably, memory unit 108 additionally comprises a ROM, which stores, for example, menu options and system software for operating processor 110.

Transmit and receive circuitry 112 and 114 are preferably coupled respectively to an infrared LED 118, most preferably a quasi-diffuse LED, and an IR-sensitive photodiode 119, in order to enable control unit 22 to communicate control messages and/or data to, and receive data from, the devices in vehicle 42. It will be understood that whereas for simplicity only one LED 118 and one photodiode 119 are shown in Fig. 4A, it is within the scope of the present invention for LED 118 to comprise a plurality of LEDs, and, for example, for photodiode 119 to comprise a photodiode array. Circuitry 112 and 114, LED 118, and photodiode 119 are preferably constructed and operate generally as described in U.S. patent application 08/992,934, which is assigned to the assignee of the present patent application and is incorporated herein by reference, with changes as will be clear to one skilled in the art. Most preferably, circuitry 112 and 114 are controlled by processor 110 to communicate with one or more communicating units coupled to the various devices in vehicle 42, for example communicating unit 120 coupled to air-conditioning/heating controller 28 (Fig. 4B).

Methods, circuitry, and optics disclosed in application 08/992,934 are preferably used in the present invention to enable control unit 22 to manage transmission and reception, as well as timing of the wireless transfer, of data and instructions to multiple communicating units 120. Any suitable choice or combination of directional and non-directional IR and of LOS and non-LOS transmission may be used. By contrast, U.S. Patent 5,515,345 to Barreira et al., as related above, uses IR signals directed from a single transmitter to a single receiver, in order to control the audio system of a car. The vehicle control system as provided by embodiments of the present invention, however, uses directional and non-directional, and LOS and non-LOS infrared transmission, as appropriate, in order to control and receive data from a large number of devices located throughout the vehicle. For example, an infrared signal which is initially transmitted in a relatively wide (non-directional) beam, may be intended to reach a non-LOS receiver after reflecting off of an interior surface of the vehicle. The system as provided by embodiments of the present invention thus achieves a substantially higher level of functionality than that available using directed IR, as is known in the art.

Fig. 4B shows communicating unit 120 having both transmit and receive circuitry 132 and 134, because controller 28 transmits status information to control unit 22, as described hereinabove, and additionally receives commands therefrom. Some communicating units, however, typically have only transmitting capabilities (e.g., the communicating unit for fuel/oil/temperature gauges 78), while others typically have only receiving capabilities (e.g., communicating units for canopy light 66 and side mirrors 36).

Communicating unit 120 preferably comprises a processor 130, coupled to a clock 126, a memory unit 128, D/A-A/D conversion circuitry 136, and transmit and receive circuitry 132 and 134. Circuitry 132 and 134 are preferably respectively coupled to an infrared LED 138 and an IR-sensitive photodiode 139, which are constructed and perform substantially the same functions as LED 118 and photodiode 119, as described hereinabove. D/A-A/D conversion circuitry 136 preferably enables control messages and/or data to be communicated between communicating unit 120 and air-conditioning/heating controller 28. Unit 120 preferably functions and is generally constructed in a manner similar to that described in U.S. patent application 08/992,934, as related above with reference to control unit 22. Some other communicating units in system 20, for example those coupled to GPS unit 48 and other devices with digital inputs and outputs, typically do not comprise D/A-A/D conversion circuitry.

Optional relay unit 96, shown in Fig. 4C, which is preferably coupled to canopy light 64, relays (i.e., receives, boosts, and re-transmits) infrared signals generated by control unit 22 or by one of the communicating units, in order to ensure that all IR receivers in system 20 receive signals having adequate strength and signal-to-noise ratio, even under bright ambient lighting conditions and in vehicles wherein obstacles block LOS signal transmission. Relay unit 96 therefore preferably comprises transmit and receive circuitry 154 and 152, coupled respectively to an infrared LED 158 and an IR-sensitive photodiode 156, generally similar to those described hereinabove. For clarity, LED 158 and photodiode 156 are shown in Fig. 4C as single elements. It will be appreciated, however, that for many applications one or both of the LED and photodiode may comprise a plurality of elements acting in parallel. For example, in some embodiments, photodiode 156 comprises a photodiode array. Alternatively or additionally, LED 158 comprises at least one LED whose output is directed at a particular IR receiver. Preferably, circuitry 154 is coupled to transmit a signal substantially identical to that received by circuitry 152. Such a relay unit is typically used in vehicles in which

some of the interior surfaces are not sufficiently reflective of the infrared radiation, and in vehicles in which one or more of the communicating units are positioned such that they do not receive a signal of adequate strength.

Although coupling relay unit 96 to canopy light 64 is one preferred means of enabling signal amplification, it will be understood by one skilled in the art that other locations, preferably but not necessarily on the inside roof of vehicle 42, are also appropriate for a relay unit. When LED 158 and photodiode 156 are disposed near the bulb of canopy light 64, a light baffle 160 is typically placed between the bulb and the IR components so that the light from the bulb does not interfere with the received IR signal. Preferably, analog and/or digital signal-processing techniques are used during a pre-processing stage to enhance the infrared signal when it is expected that natural or artificial lighting conditions may interfere with the interpretation of the infrared radiation.

In applications of the present invention wherein control unit 22 communicates with devices outside of the passenger compartment, such as external vehicle lights 46, retractable antenna 72, fuel/oil/temperature gauges 78, etc., it is preferable to place a relay unit in a location between the passenger compartment and the area where the remote device's communicating unit is positioned. For example, in order to transmit a signal to the vehicle's headlights, a relay unit is typically placed between the passenger compartment and the engine compartment. In some applications, particularly those wherein signals are transmitted inside the engine compartment, wired communications may be used instead of, or in addition to, LOS or non-LOS and directed or non-directed infrared transmission. In some of these applications, the relay unit is in wireless communication with control unit 22, and in wired communication with a communicating unit. Alternatively, the relay unit is in wired communication with the control unit and in wireless communication with the communicating unit.

Preferably, control unit 22 communicates with multiple communicating units, all of which are preferably active simultaneously. The control unit typically communicates with each of the communicating units in sequence, or over multiple, parallel channels. Preferably, each of the communicating units transmits during a predetermined time slot, in accordance with a time-division multiplexing (TDM) scheme, most preferably as described in the above-mentioned U.S. patent application 08/992,934. In this manner, a plurality of communicating units can simultaneously operate in vehicle 42, substantially without mutual interference. It will be understood, however, that analog communications

schemes, e.g., Frequency Division Multiplexing (FDM) and Space Division Multiplexing (SDM), and digital communications schemes, such as On-Off Keying (OOK), PPM, SGM, MSM, LPPM, AND DPPM, as are known in the art, may also be used.

Although preferred embodiments of the present invention are described hereinabove with respect to implementation in a car, it will be understood that the scope of the invention includes application in other motorized vehicles, such as airplanes, boats, buses, helicopters, and spacecraft. It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. Rather, the scope of the present invention includes both combinations and subcombinations of the various features described hereinabove, as well as variations and modifications thereof that are not in the prior art, which would occur to persons skilled in the art upon reading the foregoing description.

CLAIMS

1. Wireless communications apparatus for use in a motor vehicle, the vehicle including one or more devices, the apparatus comprising:

a control unit; and

a communicating unit, adapted to be coupled to at least one of the devices, which communicating unit is adapted to be in wireless communication with the control unit by means of infrared radiation, the infrared radiation being transmitted by one of the units in a manner generally insensitive to the position of the other unit.

2. Apparatus according to claim 1, wherein the control unit is adapted to receive an input from an operator of the vehicle, and wherein the control unit comprises an infrared transmitter which is adapted to transmit the infrared radiation to the communicating unit to control the device responsive to the input.

3. Apparatus according to claim 2, wherein at least one of the one or more devices is selected from the group consisting of: a cellular telephone, an audio-system controller, an air-conditioning/heating controller, electric door-locks, side-mirrors, loudspeakers, power-windows, external vehicle lights, a Global Positioning System unit, a device coupled to communicate via the Internet, seat-adjustment motors, canopy lights, a sun roof, a rear de-fog unit, a retractable antenna, a head-rest, a steering wheel position controller, a sun visor, and a gas tank lock.

4. Apparatus according to claim 1, wherein the at least one of the devices is adapted to generate a signal, and wherein the communicating unit comprises an infrared transmitter which is adapted to transmit the infrared radiation to the control unit responsive to the signal.

5. Apparatus according to claim 4, wherein the device which is adapted to generate the signal is selected from the group consisting of: a cellular telephone, an audio-system controller, an air-conditioning/heating controller, electric door-locks, seatbelt mechanisms, external vehicle lights, a Global Positioning System unit, and fuel/oil/temperature gauges.

6. Apparatus according to claim 4, wherein the control unit comprises:

an infrared receiver, which is adapted to receive the infrared radiation transmitted by the communicating unit coupled to the device; and

a display, which is adapted to display information responsive to the received infrared radiation.

7. Apparatus according to any one of claims 1-6, wherein the control unit and the communicating unit are not adapted to transfer data therebetween using wired communication.

8. Apparatus according to any one of claims 1-6, wherein the control unit is adapted to be fixed to a steering wheel of the vehicle.

9. Apparatus according to any one of claims 1-6, and comprising a relay unit, adapted to be coupled to an interior aspect of the vehicle, which relay unit is adapted to receive the infrared radiation and to retransmit the radiation in order to boost a signal strength thereof.

10. Apparatus according to any one of claims 1-6, wherein the communicating unit comprises:

a first communicating unit, adapted to be coupled to one of the one or more devices; and

a second communicating unit, adapted to be coupled to another one of the one or more devices,

wherein the first communicating unit is adapted to transmit a first signal to the control unit, and wherein the control unit is adapted to transmit a second signal to the second communicating unit responsive to the first signal, in order to actuate the second device responsive to the first signal.

11. Apparatus according to any one of claims 1-6, wherein at least one of the one or more devices comprises an electronic device.

12. Apparatus according to any one of claims 1-6, wherein at least one of the one or more devices comprises a mechanical device.

13. A method of wireless communication in a motor vehicle, comprising:

transmitting infrared radiation from a first site in the vehicle in a manner that is generally insensitive to a choice of a position at which the radiation is to be received;

receiving the infrared radiation at a second site in the vehicle; and

changing a state of an electrically-actuated unit located at the second site responsive to the received radiation.

14. A method according to claim 13, wherein the first site is in a vicinity of an operator of the vehicle, and wherein transmitting the radiation comprises transmitting the radiation responsive to an input from the operator.

15. A method according to claim 13, wherein the second site is in a vicinity of an operator of the vehicle, and wherein transmitting the radiation comprises transmitting the radiation responsive to a sensor reading at the first site.

16. A method according to claim 15, wherein changing the state of the electrically-actuated unit comprises displaying an indication of the reading.

17. A method according to claim 13, wherein the second site is in a vicinity of an operator of the vehicle, and wherein transmitting the radiation comprises transmitting the radiation responsive to a query generated at the second site.

18. A method according to claim 13, and comprising receiving the infrared radiation at a third site in the vehicle and retransmitting the received radiation from the third site, in order to boost a signal strength of the radiation.

19. A method according to any one of claims 13-18, and comprising transmitting additional infrared radiation from the second site to a third site in the vehicle, in order to change the state of an electrically-actuated unit located at the third site responsive to the radiation transmitted from the first site.

20. A method according to claim 19, wherein changing the state of the electrically-actuated unit comprises changing the state of an electronic unit.

21. A method according to claim 19, wherein changing the state of the electrically-actuated unit comprises changing the state of a mechanical unit.

22. A method according to any one of claims 13-18, wherein transmitting the radiation comprises transmitting diffuse infrared radiation.

23. Wireless communications apparatus for use in a motor vehicle, the vehicle including one or more devices, the apparatus comprising:

a control unit; and

a communicating unit, adapted to be coupled to at least one of the devices, and to be in wireless communication with the control unit by means of non-line-of-sight infrared radiation.

24. Apparatus according to claim 23, wherein the infrared radiation is transmitted by one of the units in a manner substantially insensitive to the position of the other unit.

25. Apparatus according to claim 23, wherein at least one of the one or more devices is selected from the group consisting of: a cellular telephone, an audio-system controller, an

air-conditioning/heating controller, electric door-locks, side-mirrors, loudspeakers, power-windows, external vehicle lights, a Global Positioning System unit, a device coupled to communicate via the Internet, seat-adjustment motors, canopy lights, a sun roof, a rear de-fog unit, a retractable antenna, and a gas tank lock.

26. Apparatus according to claim 23, wherein the at least one of the devices is adapted to generate a signal, and wherein the communicating unit comprises an infrared transmitter which is adapted to transmit the infrared radiation to the control unit responsive to the signal.

27. Apparatus according to any one of claims 23-26, wherein the control unit and the communicating unit are not adapted to transfer data therebetween using wired communication.

28. Apparatus according to any one of claims 23-26, and comprising a relay unit, adapted to be coupled to an interior aspect of the vehicle, which is adapted to receive the infrared radiation and retransmit the radiation in order to boost a signal strength thereof.

29. Apparatus according to any one of claims 23-26, wherein the communicating unit comprises:

a first communicating unit, adapted to be coupled to one of the one or more devices; and

a second communicating unit, adapted to be coupled to another one of the one or more devices,

wherein the first communicating unit is adapted to transmit a first signal to the control unit, and wherein the control unit is adapted to transmit a second signal to the second communicating unit responsive to the first signal, in order to actuate the second device responsive to the first signal.

30. A method of wireless communication in a motor vehicle, comprising:

transmitting infrared radiation from a first site in the vehicle;

receiving the infrared radiation at a second site in the vehicle not in line-of-sight of the first site; and

changing a state of an electrically-actuated unit located at the second site responsive to the received radiation.

31. A method according to claim 30, wherein transmitting the infrared radiation comprises transmitting the radiation from the first site in a manner substantially insensitive to the position of the second site.

32. A method according to claim 30, wherein the first site is in a vicinity of an operator of the vehicle, and wherein transmitting the radiation comprises transmitting the radiation responsive to an input from the operator.

33. A method according to claim 30, wherein the second site is in a vicinity of an operator of the vehicle, and wherein transmitting the radiation comprises transmitting the radiation responsive to a sensor reading at the first site.

34. A method according to any one of claims 30-33, and comprising receiving the infrared radiation at a third site in the vehicle and retransmitting the received radiation from the third site, in order to boost a signal strength of the radiation.

35. A method according to any one of claims 30-33, and comprising transmitting additional infrared radiation from the second site to a third site in the vehicle, in order to change the state of an electrically-actuated unit located at the third site responsive to the radiation transmitted from the first site.

FIG. 1

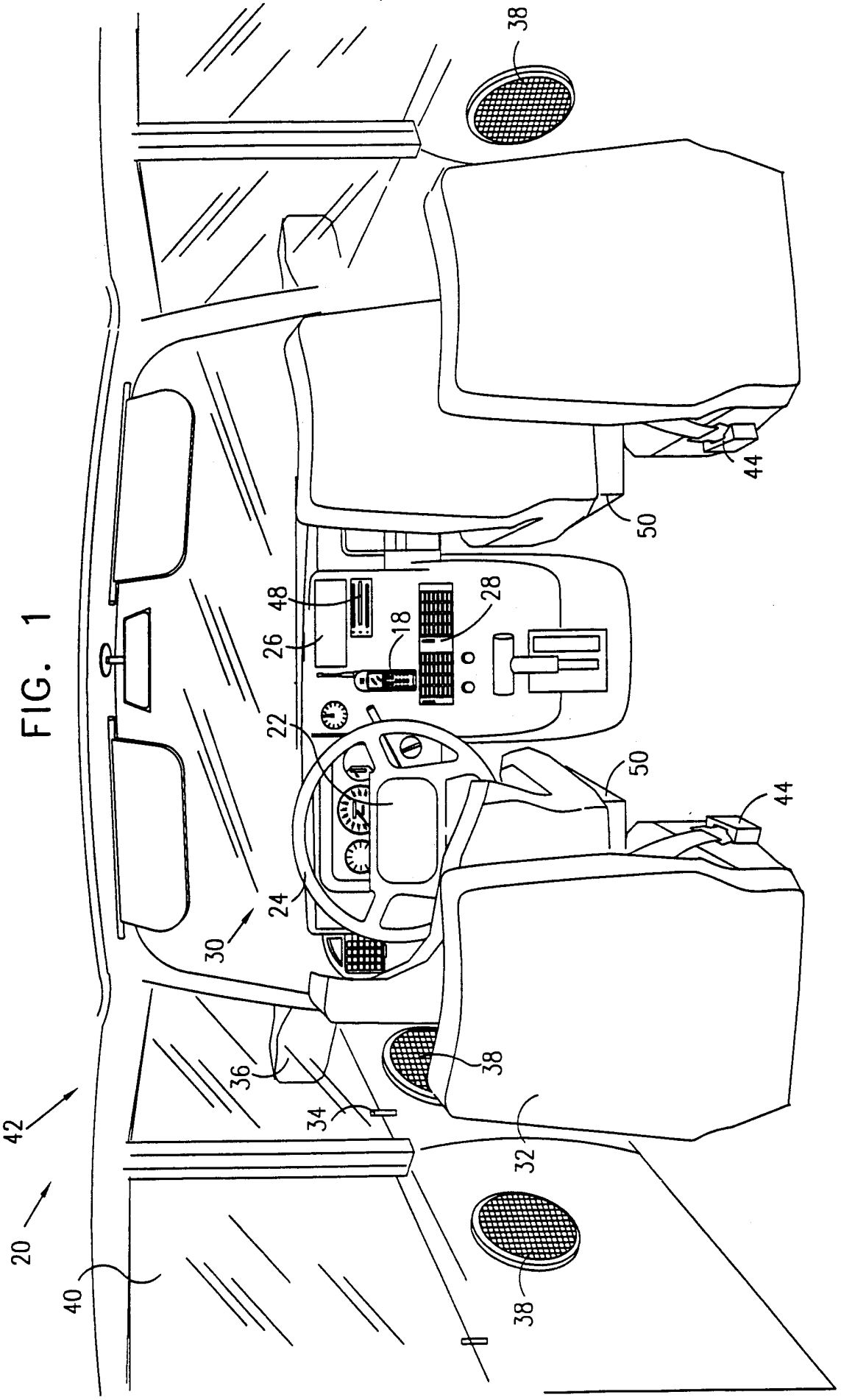

FIG. 2

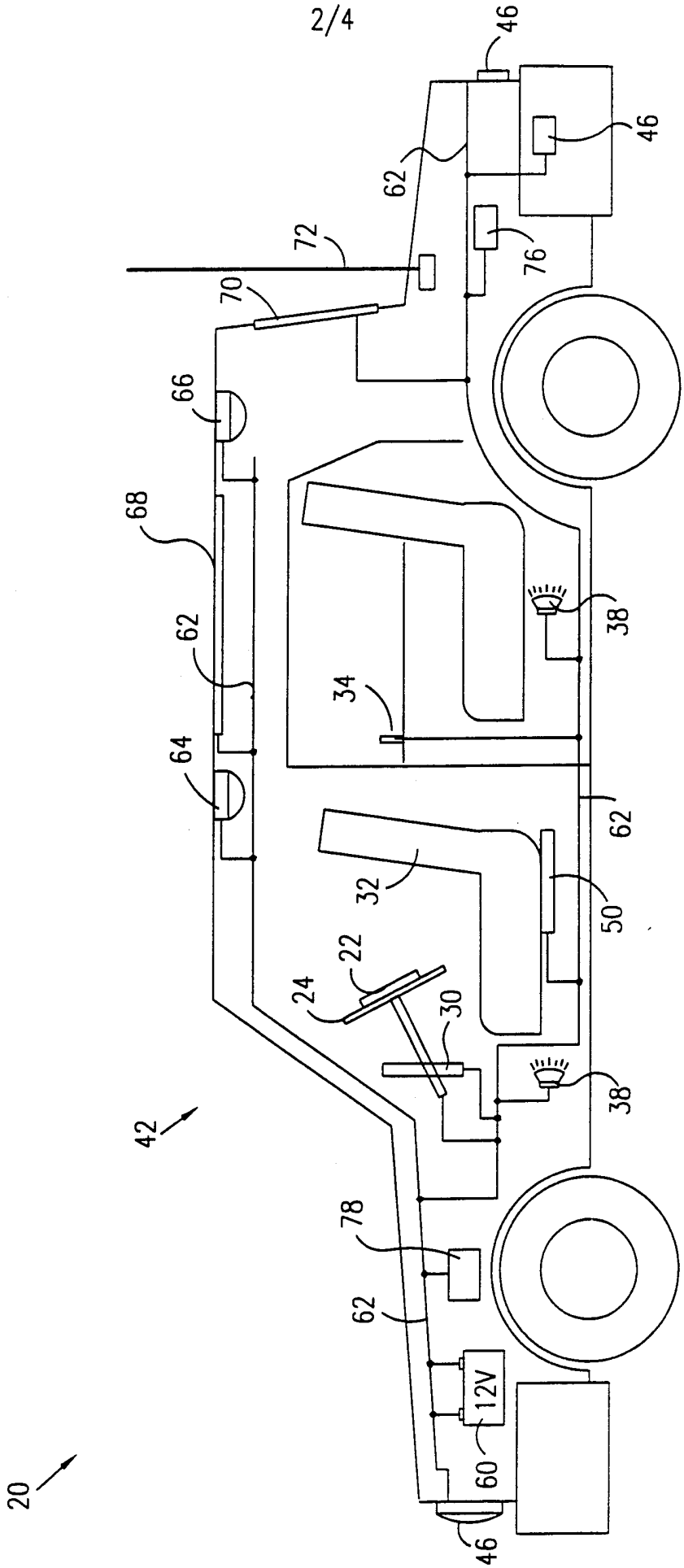
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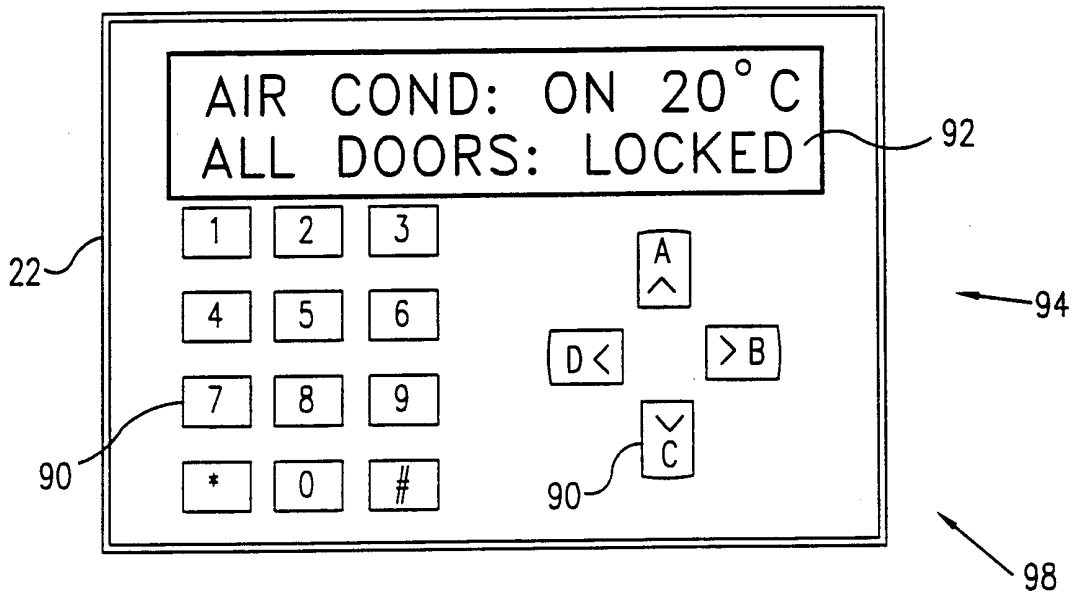
FIG. 3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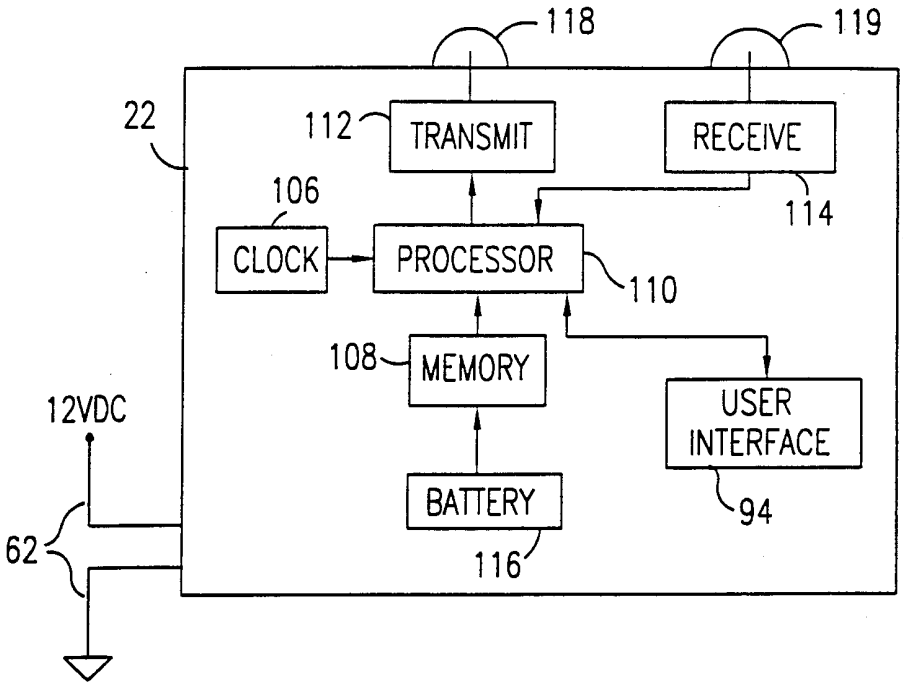

FIG. 4A

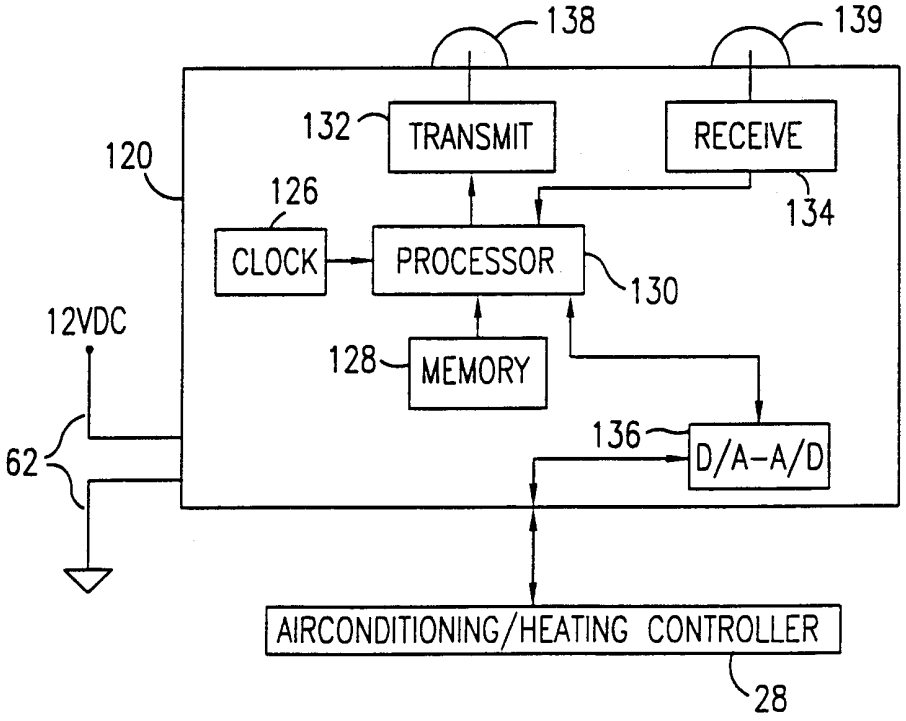

FIG. 4B

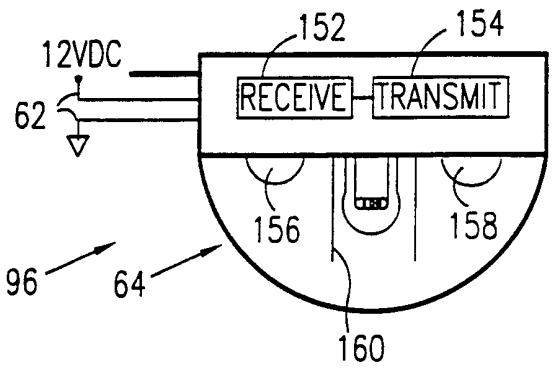

FIG. 4C

INTERNATIONAL SEARCH REPORT

Int. ..ational Application No
PCT/IL 00/00727

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60R16/02

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)
IPC 7 B60R B60K H01R

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)

PAJ, WPI Data, 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 Y	US 5 040 168 A (JACK ROBERT A ET AL) 13 August 1991 (1991-08-13) the whole document	1-5, 7-15, 17-35 6,16
Y	DE 195 20 063 A (SPIES MARTIN J DIPL ING FH) 12 December 1996 (1996-12-12) the whole document	6,16
A	WO 98 15428 A (BONN HELMUT ;PETRI AG (DE); ZAWIDZKI ULRICH (DE)) 16 April 1998 (1998-04-16) page 3, line 1 -page 4, line 20 page 5, line 1 - line 18 page 6, line 9 -page 8, line 12; figures 1-3	1-17

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
1 February 2001	08/02/2001

Name and mailing address of the ISA	Authorized officer
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	Geyer, J-L

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INTERNATIONAL SEARCH REPORT

In ational Application No
PCT/IL 00/00727

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	DE 41 01 163 C (DAIMLER - BENZ) 21 May 1992 (1992-05-21) the whole document -----	1-17

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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. tional Application No
PCT/IL 00/00727

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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WO 9815428 A	16-04-1998	DE 19643451 A	28-08-1997
DE 4101163 C	21-05-1992	NONE	