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(71) Applicant *(for all designated States except US)*: **BEST ON-LINE SECURITY SYSTEMS, L.L.C.** [US/US]; P.O. Box 6, Waunakee, WI 53597 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **WENKMAN, Gregory, J.** [US/US]; P.O. Box 6, Waunakee, WI 53597 (US). **WENKMAN, William, S.** [US/US]; 5545 Clove Road, Waunakee, WI 53597 (US). **CAPPELLAZZO, Denis, C.** [—/IT]; Via le Della Liberta, 29, Silea, Treviso (IT). **DISCALA, Salvatore** [—/IT]; Via Gaetano Morgera, N4, Forio (IT).

(74) Agent: **BAXTER, Keith, M.**; Quarles & Brady LLP, 411 East Wisconsin Avenue, Milwaukee, WI 53202-4497 (US).

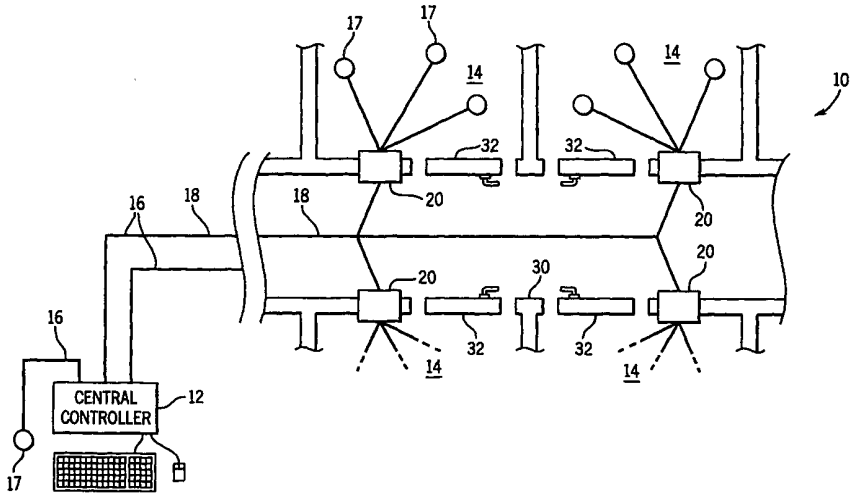
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(54) Title: ON-LINE, DOOR-MOUNTED ELECTRIC LOCK



(57) Abstract: A door-mounted on-line lock, suitable for controlling, monitoring and programming by a central station provides a power coupling between the door frame and the door on which the lock is mounted, producing a path for power and data transmission when the door is in the closed position. In this manner, relatively tamper-resistant and efficient power transmission may be provided by simple mechanisms including opposed inductive coils, or electrical contacts. The door mounted lock may thus be full integrated into an on-line system in which a central station communicates with various elements of the room control and monitoring system including the lock and other sensors and client service points.

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ON-LINE, DOOR-MOUNTED ELECTRIC LOCK

CROSS-REFERENCE TO RELATED APPLICATIONS

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STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

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BACKGROUND OF THE INVENTION

The present invention relates to electrically actuated locks ("electronic locks") for a variety of building doors including doors in hotels, motels, hospitals, nursing homes, businesses, apartments and houses, and in particular to an electronic lock having an actuation mechanism mounted in the door and which may be actuated or monitored from a remote source.

Many buildings have replaced the mechanical locks in the doors of their rooms with electronic locks. Such locks provide the ability to easily change the "keying" with each new occupant by a simple reprogramming process. Electronic locks also allow the use of sophisticated key cards such as those containing a magnetic stripe that may be programmed with a code or other data; or "inductive transponder" key cards that may actuate the lock without actual contact, or "smart cards" incorporating electronic memory to record occupant charges and facility usage during a occupant's stay.

Typically such door-mounted electronic locks employ a self-contained battery pack. The battery packs overcome the problem inherent in running secure and reliable wiring to and into the door while allowing it to swing freely between its open and closed position. The battery packs are normally accessible from the inside of the room so as to prevent tampering.

Such batteries, of course, need to be periodically replaced, an operation which requires access to the room. Failure of the batteries results in a considerable inconvenience to the occupants and the further problem of obtaining access to the room to change the batteries when the door lock cannot be operated. Some such door locks provide a means of activating a door lock from the outside by using an energized key, a

system which allows the door to be opened for replacement of the batteries, but necessarily compromises the security of the lock to some degree.

Another approach that avoids the problems of batteries, communicates electrical power through the door to a lock by means of a wire from the hinged side of the door, through the width of the door (via drilled a hole) to the opposite side to the lock. The wires from the doorframe to the door are connected to an electrified flex hinge. Such a hard-wired system is costly to install because it requires the time consuming task of drilling a hole from the hinged side of the door all the way through to the door lock door. Further the electrified flex hinge is subject to failure over time due to the repeated flexing each time the door is opened and closed.

Another such approach communicates power through an electrified mortise lock latch that provides for contacts that connect between the door and door frame when the door is closed. Power is supplied through these special contacts from a door frame mounted key card reader to activate the unlocking mechanism. A special split bolt latch of the mortise lock receives uncoded electrical power (i.e. power without an impressed code) that contacts a special contact mounted within the special strike plate which is connected to the door frame (wall) mounted key card reader. Because the electrical power signal is not coded it is simple to tamper with the wires going to the special strike plate and supply an external low voltage power from a battery to activate this lock and gain unauthorized access to the room. With this approach the entire lock mechanism must be replaced, an expensive undertaking.

A concurrent trend in building management is the on-line monitoring and control of the rooms including, for example, remote electronic sensing of room temperature, electrical usage, opening of the safe or minibar or door, and the like. Such on-line monitoring provides a communication path between each room and a central station at the front desk or other location, like housekeeping, security and room service allowing a more efficient building management and improved response to possible problems in a room.

Ideally, the trend towards on-line controlling and monitoring of the rooms would extend to monitoring and reprogramming of the door lock. Unfortunately, the same problem of door movement that leads manufactures to use battery packs to power the locks makes it difficult to connect the door locks to a building wide network for data communication and control.

One such approach for solving the problem of data communication to the door lock communicates with the moving door using an infrared beam transmitted between an optical assembly in inner lock escutcheon plate and transmitted to a receiver mounted in the ceiling. Such an infrared system allows direct communication between the lock and a central station over a range of door positions but significantly increases the cost of the lock. Further, such locks may experience reliability problems if the occupant blocks the infrared beam, and, since the infrared beam draws its energy from the battery source, a further drain on the battery is created.

BRIEF SUMMARY OF THE INVENTION

The present inventors have recognized that although it is difficult to provide a directly wired electrical connection to a door throughout its range of motion that most monitoring and control of a door can be done when the door is in the closed position. For example, unlocking the door is normally only required if the door is closed and reprogramming the lock may be forestalled until the door is closed.

By thus redefining the problem, the path of electrical communication may be greatly simplified to be a set of electrical contacts connecting only when the door is closed, or halves of a split transformer design brought into alignment when the door is closed. In some embodiments, such coupling can provide both power and data transmission eliminating the need for door-mounted batteries and auxiliary data communication channels. In other embodiments, such coupling can provide power transmission to the lock only while the transmission of data to and from the lock can be by separate means.

Specifically then, the present invention provides an improvement in a door unit having a door moving between an open and closed position with respect to a door frame, the door frame having a strike plate providing a strike plate opening, the door having a door-mounted bolt mechanism providing a bolt extensible from the door to engage the strike plate aperture when the door is in the closed position to retain the door in the closed position and further having an electronic bolt lock preventing retraction of the bolt out of the strike plate opening when in a locked mode. In one embodiment, the improvement includes a frame-mounted power coupling-half receiving electrical power, and a door mounted power coupling-half separate from the frame mounted power coupling-half but electrically engaging with the frame mounted power coupling-half when the door is in the closed position to receive the electrical power through inductive coupling or physical

contact coupling from the frame mounted power coupling-half and to communicate that electrical power to the electronic bolt lock when an approved key is presented.

Thus, it is one object of the invention to provide a simple means of communicating power to a door-mounted electronic lock. By recognizing that power need only be delivered when the door is in the closed position, an extremely simple power coupling mechanism may be used and the need for batteries may be reduced or eliminated.

It is another object of the invention to provide an extremely secure mechanism of power coupling into the door which because the power is transmitted inductively over a small air gap or by physical contact provides no visible wiring to tamper with or wires to break.

Door and frame mounted power couplings, that are not necessarily inductive, may provide a physical contact path not only of power but also of a coded lock signal impressed on the power signal from the frame to the door. In a similar way data, such as key codes from an on-door key reader may be communicated from the door to the frame. Thus, it is another object of the invention to provide a path of data communication allowing the key reader to be placed on the door to communicate with a central station. In a similar way, data may be communicated from the doorframe to the door for reprogramming the key lock or the like.

It is another object of the invention to provide a path of data communication to and from the lock possibly separate from the path of power transmission to the lock. This path of data communication may be done by modulation of the power over the power couplings or by separate optical or radio links to and from the door and frame or from the inside escutcheon lock cover to and from a local station.

It is another object of the invention to provide a system that may be used to retrofit existing battery powered door-mounted electronic locks with magnetic strip key readers and/or for on-line operation. Power and data needed for such retrofitting may be easily supplied by the power coupling halves.

The improvement may include a proximity sensing circuit communicating with the frame-mounted power coupling-half to sense when the door is in the closed position. Such sensing may, for example, detect power flow or a completing of a data communication path. Similarly detecting when the door is open is done by detecting an interruption in the power flow or data communication path.

Thus, it is another object of the invention to provide for the monitoring for the door state as opened or closed.

For new lock installations, the door-mounted power coupling and the frame-mounted power coupling may be attached to the faceplate and strike plate, respectively, or above or below the faceplate and strike plate or on a hinge side of the door. Likewise in this situation optical sensors may be placed adjacent to the door-mounted power coupling and the frame-mounted power coupling for the purpose of transmission of data communication.

Thus, it is another object of the invention to provide a means of power coupling and data communication that is either readily adaptable to new installations without the need for modification of the door through specialized strike and faceplates or that may be easily retrofitted at a convenient location elsewhere on the door.

The door lock may be part of an on-line control system communicating with room sensors such as temperature sensors, water sensors, room occupancy sensors, electrical usage sensors, light sensors, room-safe opening sensors, door opening sensors, key readers, emergency sensor, window position sensor, patio door position sensor, window drape position sensor, thermostat sensor, do-not-disturb sensor, make-up-room sensor, cigarette smoke sensors and the like.

It is another object of the invention, therefore, to provide a fully integrated on-line room monitoring system incorporating a door lock.

The foregoing and other objects and advantages of the invention will appear from the following description. In the description, reference is made to the accompanying drawings, which form a part hereof and in which there is shown by way of illustration a preferred embodiment of the invention. Such embodiment does not necessary represent the full scope of the invention, however, and reference must be made to the claims herein for interpreting the scope of the invention.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Fig. 1 is a simplified plan view in fragment of a building having a central station in communication with local stations at various rooms, the local stations collecting various information from sensors and communicating with door-mounted locks;

Fig. 2 is a schematic block diagram of a local station showing a power coupling to the door and an internal electronic bolt lock;

Fig. 3 is an elevational, fragmentary cross-sectional view through adjacent sections of a door and a doorframe showing the power coupling of Fig. 2 in an embodiment using a split transformer design of opposed coils and ferrite cores;

Fig. 4 is an exploded perspective view of one coil and ferrite core of Fig. 3;

Fig. 5 shows an alternative embodiment of the electronic bolt lock of Fig. 2;

Fig. 6 is a plan cross-sectional view of a door of a room of Fig. 1 showing a placement of the power coupling on the swinging-side of the door;

Fig. 7 is a reduced view similar to Fig. 3 showing opposed face plates and strike plates and a positioning of the ferrite cores of Figs. 3 and 6 at two positions in the plates for new construction and below the plates for retrofitting, and further showing the door mounted lock casing and a wall mounted escutcheon plate of a key card reader;

Fig. 8 is a detailed fragmentary view of the wall mounted escutcheon plate of Fig. 7 showing illuminated message panels that may be activated by the occupant of the room;

Fig. 9 is a figure similar to that of Fig. 6 showing an alternative placement of the power coupling in the hinge side of the door;

Fig. 10 is a perspective view of a key card caddie that may be placed in the room to communicate with the central station and to detect the presence of a contained key card;

Fig. 11 is a cross-sectional view taken along line 11--11 of Fig. 10 showing an associated internal interrogation coil and circuit card used with a transponder card, occupant activated membrane switches, and courtesy light;

Fig. 12 is a fragmentary front elevational view of the caddie of Fig. 10 showing labeling of two switches that may be activated by the occupant to communicate signals to the central station and to illuminate the message panels of Fig. 8;

Fig. 13 is a figure similar to that of Fig. 2 showing an embodiment of the invention in which the power coupling communicates both power and data along the same pathway;

Fig. 14 is a perspective representation of additional sensors and peripherals for the central station of Figs. 1 and 2 including an in-room container such as a mini-bar or room safe, a water sensor, and a temperature sensor;

Fig. 15 is a perspective view of an alternative power coupling employing spring-loaded contacts that engage when the door is shut;

Fig. 16 is a cross-sectional view of a power coupling of Fig. 15 when the door is in a closed position showing connection of the spring loaded contacts to the opposed spring contact plates;

Fig. 17 is a perspective view of a wall-mountable key card repository for receiving returned key cards at convenient locations throughout the building;

Fig. 18 is cross-sectional view taken along lines 18--18 of Fig. 17 showing the internal mechanism of the card repository such as may communicate to a central station of an on-line system.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to Fig. 1, a building 10 may include a central controller 12 being typically a computer having a processor and memory and executing a program providing for a centralized monitoring, control and management of a plurality of rooms 14 with electronic door locks.

In this capacity, the central controller 12 may have one or more input/output lines 16 connected to either local peripherals 17 such as key card programmers or the like, or to a building network 18 communicating with a number of local controllers 20 at each of the rooms 14. It is understood that in an effort to reduce costs the local controller 20 may be shared with more than one room, however, each room will have its own address for data communication. The local controllers 20 may, in turn, provide a hub connecting to remote peripherals 17 located in each room 14 including sensors for temperature or water, lock mechanisms and the like which will be described in greater detail below.

The building network 18 may be a high-speed serial network such is well known in the art and may be standard wiring including coaxial cable or the twisted wire CAN protocol, telephone wiring (such as may support Internet protocols), carrier current systems such X-10 systems in which data is sent over power lines ("power line communication)", radio or optical links providing for the transmission of data addressed to particular ones of the local controllers 20 and peripherals 17 from the central controller 12 and receiving data identified to particular local controllers 20 and peripherals 17 for transmission back to central controller 12. An operator of the central controller 12 may thus enter commands controlling and or monitoring the peripherals 17 for particular rooms 14 and data from those peripherals 17 may be displayed and recorded at the central controller 12 with an indication of peripheral 17 sending the data.

Referring now also to Fig. 2, the local controller 20 may be a micro-controller of a type well known in the art having an input/output line for communicating with the building network 18 and having other input/output lines 22 communicating with the various peripherals 17. One input/output line 22 is connected to an electronically controlled switch 23 such as a relay or thyrister to connect an AC power signal 24 to a primary winding 26.

The primary winding 26 is positioned in the doorframe 30 on one side of the interface 28 between the doorframe 30 and a door 32 of the room 14 with which the local controller 20 is associated.

A secondary winding 34 is positioned in the door 32, immediately opposite the primary winding 26 to receive AC power from the primary winding 26, inductively, in the manner of a transformer, when the AC power signal 24 is connected to the primary winding 26. The secondary winding provides the AC power to a full wave rectifier 36 to produce a DC signal, filtered by filter capacitor 38 according to methods well known in the art. The DC signal in turn is connected to solenoid or motor 40 of a lock mechanism 47 for actuating the same. The time constant of the solenoid internal resistance and the filter capacitor 38 are selected so that the solenoid or motor 40 is actuated only when switch 23 is closed. The effective unlock signal provided by the DC signal may be coded (for example, pulsed a certain number of times) and that coding "decoded" by a circuit card powered as described below, to prevent simple tampering with the door by use of an alternative source of power.

In one such method, the solenoid or motor 40, when energized, may retract a pin 42 from a ward plate 44 attached to a door lever 46 allowing rotation of the door lever 46 and the ward plate 44 to retract a bolt 48 from a strike plate opening 60 in a strike plate 58 attached to the door frame 30 allowing the door 32 to be opened. Prior to energizing solenoid or motor 40, the bolt 48 may not be retracted holding the door in a locked state. Pin 42 may be spring biased toward engagement with the ward plate 44 so that when solenoid or motor 40 is not activated, the bolt 48 will remain in the locked state meaning that the handle will rotate but not engage the lock. There are several methods by which power to a motor or solenoid may activate a mechanical mechanism which allows engagement of the outer door handle to actuate the unlocking mechanism. The lock mechanism 47 may include a conventional tumbler and cylinder lock that may override the solenoid or motor 40 to allow access to the room 14. Alternatively, the lock may employ in an electrical power outage a hand held electrical device used by building

personnel with a battery pack having a special connector to allow it to be plugged into the lock to actuate it.

Referring to Fig. 5, the present invention also contemplates an improved anti-tamper feature preventing possible manipulation of the solenoid or motor 40 by an external magnetic field that might move the pin 42. In the first embodiment, the solenoid coil is wound on a bobbin attached to the activating pin 42 reducing its magnetic susceptibility, the pin 42 itself being of a non-magnetic material. The coil then pulls the pin toward a stationary magnetic pole piece. In a second embodiment, a first and second opposed solenoids 40a and 40b are placed at opposed positions about the ward plate 44 so that manipulation of one pin 42a by an external magnet should only serve to further engage pin 42b and visa versa. Other systems for defeating the use of an external magnet to open the door, such as mechanical locking pins drawn by an external magnetic field into engagement with a ward plate 44 are also contemplated.

Referring now to Figs. 3 and 4, the primary and secondary winding 26 and 34 may be in the form of cylindrical coils of wire recessed into the doorframe 30 and door 32, (the coils axes aligned with one another when the door is closed). Each of primary and secondary winding 26 and 34 may be wound on a bobbin 50 and fit within a ferrite core 52 providing concentration of their magnetic flux for better energy transfer. The ferrite cores 52 provide a cylindrical chamber for receiving the bobbin 50 having an open face 53 through which the bobbin 50 may be fit and toward which the open face 53 of a corresponding ferrite core 52 may be brought to provide a inductive coupling between their contained bobbins 50.

Other core configurations may be provided for narrower European doors including well known C and E armature designs, which provide for an extremely narrow exposed face at the edge of the door and the frame.

The ferrite cores 52 may be held in a plastic grommet 54 to support them in an appropriately sized bore or (as shown in Fig. 3) in the edge of a hollow steel door 32. Movement of the ferrite core 52 within the grommet 54 may be eliminated by a spring 57 such as a compressible elastomeric material pressing the ferrite core 52 outward toward the interface 28. Alternatively, but not shown, the grommet 54 and spring 57 may allow extension of the ferrite core 52 beyond the edge of the door 32 or door frame 30 to retract slightly upon closing of the door 32 minimizing the gap between the open faces 53 of the ferrite cores 52 of the primary and secondary windings 26 and 34. In the preferred embodiment, the gap between the open faces 53 of the ferrite cores 52 is from 0.5 to 15

millimeters and may also be adjustable by a screw (not shown) mounted through the ferrite cores 52 connected to plastic grommet 54.

Referring now to Fig. 6, in one embodiment, the primary and secondary windings 26 and 34 are placed in facing edges of the door 32 and doorframe 30 on the swinging edge of the door 32 opposite the edge holding the hinges 56 supporting the door 32. In this way, the primary and secondary windings 26 and 34 are in close proximity when the door 32 is closed and inductively coupled with each other. By similar circumstance, when the door 32 is open (shown in phantom), primary winding 26 will be moved away from secondary winding 34 and coupling will not be provided.

Alternatively, as shown in Fig. 9, primary winding 26 and secondary winding 34 may be placed on facing edges of the door 32 and frame 30 at the edge of the door 32 supported by the hinges 56. In this case, opening of the door 32 does not provide as great a separation between primary winding 26 and secondary winding 32 but tips their axes to significantly reduce the coupling between these two windings 26 and 32.

Referring now to Fig. 7, in one embodiment for new construction, secondary winding 34 may be placed in the faceplate 35 of the lock mechanism 47 as mounted on the door 32 so as to require no additional mortising of the door 32. Correspondingly, primary winding 26 may be placed in the strike plate 58 attached to the doorframe 30 and having strike plate opening 60. Minimal modification of the door 32 and frame 30 are required in this situation.

In a retrofit situation, however, the primary and secondary windings 26 and 34 may be displaced to arbitrary locations on edges of the door 32 and frame 30 that will oppose each other when the door is in the closed state and will be separated when the door is in the open state.

While the ability to transfer power between two inductors over a long distance is relativity limited for compact inductor sizes such as would be required to fit within a door 32, the ability of the present invention to make significant power transfer relies on an observation that power transfer can be restricted to situations where the door is in the closed state.

Referring again to Fig. 2, the local controller 20 may include, as one of its peripherals, a card reader 62 being one of the commonly commercially available types including those having a magnetic stripe for reading by passing the magnetic stripe across or in a conventional magnetic read head; or a so called transponder card which receives an inductive energy signal from the card reader 62 to momentarily energize circuitry

within the key card 64 providing a responsive radio frequency signal, or a so-called smart card, having embedded solid state data storage capability that may be accessed either inductively, as provided before, or through direct contacts on the key card 64, contacting the card reader 62. The present invention should not be limited to a particular type of key mechanism but, as it will be understood from the following description, will work with a variety of electronically key readers currently available or available in the future, including biometric systems, for example, those reading a finger print or doing retinal scanning.

The card reader 62, by being placed on the frame 30 (as used herein including stationary walls) facing outside of the room 14 may simply communicate with a stationary source of power, such as the building wiring, a building generator or a shared battery back-up system such as is used for exit lighting. Further the card reader 62 may communicate with the central controller 12 through the local controller 20 by direct wiring or by radio frequency means and without the need for more complex mechanisms such as infrared links although such links may be used.

In one embodiment, the local controller 20 may have a prestored key code that it matches to the key code of a key card 64 read by the card reader 62. In this embodiment, the local controller 20 independently makes a judgment as to whether the lock should be opened and if so provides energy through input/output line 22 to switch AC power 24 to primary winding 26 or the door frame mounted physical contact coupler. In an alternative embodiment, however, the key code information read from key card 64 through card reader 62 is transferred along building network 18 to the central controller 12 where it is compared with a set of key codes stored for the particular rooms 14 in the central controller 12. In this way, the central controller 12 may effectively rekey any of the locks of the rooms 14 simply by changing the stored key codes at the central controller 12. Further, the codes on the key cards need not be changed, of particular value with inductive type systems.

Referring now to Figs. 7 and 8, the card reader 62 mounted on a wall forming part of the door frame 30 may have an escutcheon 66 defining a region 68 for the card reader mechanism, for example, an inductive coil for inductive-type systems or magnetic head and slot for magnetic-card systems beneath which may be illuminated message panels 70. In a preferred embodiment, the illuminated message panel 70 may include messages indicating that the occupant of the room is not to be disturbed, that the room needs to be made up, indicating possibly a change of linens and a making of the bed or a refreshing of

other room items, or that the room is in use. Each of these illuminated message panels 70 may be selectively illuminated by the local controller 20 by command, by the building network 18 or by the peripherals 17 attached to the local controller 20 notably an in-room switch, as will be described. Change in status of these illuminated panels may be reflected as data transmitted to the central controller 12.

Referring now to Figs. 10, 11, and 12, in a preferred embodiment, one peripheral 17 attached to the local controller 20 and hence to the central controller 12 via the building network 18 is a card caddie 72 preferably made of plastic. The card caddie 72 is fit on a wall inside of the room near the door 32 and has an upwardly opening pocket 74 into which key cards 64 may be placed. As shown, the card caddie 72 is intended for inductive type key cards 64, however, it will be apparent to those of ordinary skill in the art from the following description that the caddie may be simply modified to work with other types of key cards 64.

The pocket 74 may be supported by a wall plate 76 of plastic so as to allow an illuminated courtesy light 78 attached to a circuit card 80 positioned between the wall plate and the card caddie 72 is mounted against the wall to shine through the card caddie 72 allowing its location to be determined in a dark room. The card caddie 72 may also have an audio annunciate to serve as the rooms door bell. This annunciater and the courtesy light 78 may be programmed to flash after the door is opened to catch the attention of the occupant who must first insert the key card into the caddy 72 to turn on the lights. An inductive readout coil 82 positioned on the surface of the plate 76 may read inserted inductive transponder key cards 64 in the pocket 74 so as to detect those cards and their key code and to forward the key codes via network 18 to the central controller 12 or via conductors 22 to the local controller 20. The central controller 12 (or the local controller 20) may then provide another signal to another peripheral 17 (not shown) allowing activation of the room lights, television, room safe, mini-bar or similar conveniences. Because the key codes are forwarded to the central controller 12 which then returns an activation signal, different cards may be given different functions within the room, for example, a maid's card may not be enabled for television, room safe, or mini-bar access, but may simply turn on the room lights.

In an alternative embodiment, the readout coil 82 may be shared with the card reader 62 by having them placed on opposite sides of the same wall or door, or the circuitry of the circuit card 80 may be shared with that of the card reader 62.

The card caddie 72 may also include on the front surface of the pocket 74 a set of membrane switches 84 allowing the user to signal a desire not to be disturbed or to have the room made up. These membrane switches 84 may communicate via conductors 86 to the circuit card 80 and in turn relay information along building network 18 to the central controller or directly to local controller 20 to illuminate message panels 70 of the escutcheon 66 of the card reader 62. A reading of a key card 64 properly placed in the card caddie 72 will automatically illuminate the "room in use" message panel 70 either by direct transmission of information to the local controller 20 or via the central controller 12.

In an alternative embodiment, not shown, a single illuminated message panel 70 may be used with the message "Do not disturb". This message may be actuated in a conventional manner. Alternatively, when it is not activated, a key card issued to housekeeping, and read by the key card reader, may cause it to illuminate, indicating that the occupant is in the room. Only housekeeping or similar personnel can invoke this function to prevent this information from being available to other occupants. Additional functions for this single light may be provided by having it flash upon activation by housekeeping to indicate that the room needs to be made up. Similar functions may be invoked by personnel having charge of restocking the minibar and having their own key card so identifying their function. In this case the illumination means the occupant is in the room while the flashing means the bar needs restocking. No light, would mean no service of the bar is required. Other personnel may also be monitored by this means. The bellhop with a key can signal to the front desk and central controller the picking up or delivery of bags. Indication of the room having been made up may be provided by activation of the light panel upon reading of a supervisor's card.

In an alternative embodiment, the functions of membrane switches 84 may be realized without the pocket 74 by a plane wall escutcheon. Detecting the presence of the occupant within the room may be done by motion sensors such as those using passive infrared (PIR) detectors.

Referring now to Figs. 2 and 5, the present invention can be used with existing battery powered, door mounted electronic locks by simply bypassing the electronic card reading circuitry of the existing locks and connecting their bolt-locking solenoid or motor 40 directly through the full-wave rectifier 36 to a secondary winding 34 added to the door 32. Thus, much of the hardware used on current electric locks may be preserved. The

present invention can also be used with existing mechanical locks by adding a solenoid or motor for actuating the locking mechanism of these mechanical locks.

In a retrofit of a door lock having a motor actuator, special consideration must be given to resetting the motor after the unlocking has occurred. This resetting requires power to the motor and thus cannot occur, as it does with the spring -biased solenoid actuator, simply by removing power from the locking mechanism. Several ways may be used to provide for this resetting. In a first method, the power signal and the unlock signal may be sent separately from the card reader 62 to the lock as described below with respect to Fig. 13. When power and the unlock signal are received together, the lock may unlock. When the power signal is received without the unlock signal, the lock may reset.

For the purpose of providing power for resetting, the electronic circuitry card reader may detect when the door has closed again after an unlocking (as explained below) and may provide power to the lock at that time without the unlock signal or may simply leave the power on so that resetting is automatically undertaken.

Alternatively, the lock may store power sufficient for its resetting and may undertake a resetting at a predetermined time after unlocking. The power may be stored in a capacitor or rechargeable battery.

This separation of the power signal and the unlock (or lock) signal (henceforth both termed lock signals) the latter being a separate signal from the power signal, can be used to provide additional security in motor or solenoid type locks, by preventing simple application of power to the door from unlocking the door.

Referring now to Fig. 13, it may be also desirable to make use of pre-existing locks card readers 62 that are door mounted or to provide for new construction with door mounted card readers 62. In this case, card reader 62 may provide key code data via line 88 through a conventional high pass filter 90 to attach directly to the lead of secondary winding 34. The data comes from a modulator implemented by the local controller 20 or by dedicated circuitry (not shown).

In an example using inductive coupling, this high frequency data will inductively transfer to primary winding 26 and may be extracted by a second high pass filter 92 (serving as a demodulator) communicating via input/output lines 22 with the local controller 20 where upon it may be relayed over building network 18. Thus, power may be transferred in one direction from the frame 30 to the door 32 via the same inductive coupling mechanisms of primary and secondary windings 26 and 34 as that which allows data to pass in the opposite direction. Interference between the AC and the data is

prevented by an effective frequency division multiplexing of a single communication line. Alternatively, it will be understood that a separate data coupling of a type described herein may be used for the transfer of data or including radio, infrared or contact-type couplings. For example light emitting diode and phototransistor pairs may be opposed and mounted on opposite sides of the gap between the door and frame. The data may be communicated bi-directionally between door and frame.

Power for the door-mounted card reader 62 may be provided by a tap (not shown) off of capacitor 38. The ability to power circuitry on the door permits the unlock signal (in the case of an off-door card reader, shown in Fig. 2 or from the central controller 12 over the building network 18) to be coded so that the door may not be unlocked by mere imposition of a device to pass power into the power coupling device. An on-door circuit card decodes the coded lock signal to unlock the door lock.

It will be understood that data may also be transferred from the local controller 20 to card reader 62 by a similar mechanism so that card reader 62 may be electrically reprogrammable from the central controller 12.

The power connection formed by primary and secondary windings 26 and 34 may also be used to detect whether the door is in the open or closed state depending on a measurement of the coupling between primary and secondary windings 26 and 34. In the simplest embodiment, the primary winding 26 may be partially energized at a level below that necessary to activate solenoid or motor 40 and the amount of current flow through primary winding 26 may be measured by current detector 93. A predetermined magnitude of current flow indicates a coupling to secondary winding 34 whereas lesser current flow indicates a lack of coupling. By similar token, the high pass filter 92 may be used to inject a high frequency signal into primary winding 26 which may be dissipated when there is coupling between primary winding 26 and secondary winding 34 by a dissipation resistor 94 attached to the high pass filter 90 on the door side. A choke coil 96 may be required to prevent normal dissipation of the high frequency signal or attenuation of it when it is used as a data transmission means by the solenoid or motor 40 itself and the filter capacitor 38. Finally, the existence of data communication between the local controller 20 and circuitry on the door 32 such as the card reader 62 may indicate whether the door is open.

The state of the door as open or closed may be communicated via the local controller 20 and building network 18 to the central controller 12.

Referring now to Figs. 1 and 14, the existence of the local controller 20 allows for convenient attachment of a variety of different room sensors or service points to the building network 18 without requiring these peripherals 17 to have complex communication hardware. One such peripheral 17, may be a key pad 98 on a closed container within the room 14 such as that forming a "minibar" of alcoholic beverages and snacks items. The key pad 98 may relay a code entered by the user through the local controller 20 to the central controller 12 which may check for the correct code (so as to provide an implicit keying of the key pad 98) and may also check the code against the key code of the card carried in the card caddie 72 insuring that the proper billing party is present. Numerous alternative peripherals 17 may be provided including a water sensor for detecting overflow of water in the bathroom of the room 14 or general purpose temperature sensor 110 which may also provide for light sensing and other capabilities, or a smoke detector for detecting smoking in a non smoking room, or other sensors as listed herein or in general use in buildings such as fire alarms and the like.

Referring now to Figs. 15 and 16 in another embodiment of the invention, power coupling between the door 32 and the frame 30 when the door is closed, may be provided by a pair of mating electrical contacts 112 and 114. In this embodiment, the first electrical contacts 112 may provide for two conductive pads 115 held within a matrix of insulating material 116 which may be mounted against a door or frame in place of one of the ferrite cores 52 as described above with respect to Fig. 3. The opposing electrical contacts 114, mounted in the other of the door 32 or the frame 30, may include spring-loaded conductive fingers 118, in this case in the form of a captured conductive ball 120 held by means of a spring 122 in slight extension from a corresponding base plate 124. The spring-loaded ball 120 thus accommodates a variation in a gap 126 between the door 32 and frame 30 and allows a contact to be made when the pads 115 approach the ball obliquely to the axis of ball movement 128 such as would be the case in the mounting system of Fig. 6.

Alternative embodiments employing leaf spring-type designs and coaxial conductors may also be used. In these embodiments, where there is some risk of defeating the lock by insertion of conductors of an alternative power source in between the door and jamb, the unlock signal may be coded as described above.

This contact type coupling may also be used for data communication of the lock signal or the key code or the data communication may be done separate by optical or infra red means .

Referring now to Figs. 17 and 18, in the case where the key card 64 is a transponder-type card and should be returned to the building, card collection panels 130 may be placed at strategic locations throughout the building, for example, at the ends of the halls near or in elevators. The collection panels 130 present a slot 132 into which a key card 64 may be placed and a locked access door 134 from which collected cards may be recovered by building personnel. Within the wall on which the panel 130 is mounted, and behind the slot 132, a collection chute 135 is placed providing a guiding channel collecting the inserted key cards 64 and channeling them to position it adjacent to an inductive read coil 136. The inductive read coil 136 may read the key code on the key card 64 to provide an indication of return of the card and possible credit to clients account for such return via building network 18 to the central controller 12. A solenoid 138 may stop the card in its descent through the chute 135 for the reading process by inductive read coil 136 to take place, then upon signal from the central controller 12, release the card into a hopper 140 behind access door 134.

The above description has been that of a preferred embodiment of the present invention, and it will occur to those that practice the art that many modifications may be made without departing from the spirit and scope of the invention. In order to apprise the public of the various embodiments that may fall within the scope of the invention, the following claims are made.

CLAIMS

WE CLAIM:

1. In a building door unit having a door moving between an open and closed position with respect to a door frame, the door frame having a strike plate providing a strike plate opening, the door having a door-mounted bolt mechanism providing a bolt extensible from the door to engage the strike plate opening when the door is in the closed position to retain the door in the closed position, the door further having an electronic bolt lock preventing retraction of the bolt out of the strike plate opening when in a locked mode; the improvement comprising:

(a) a frame mounted power coupling-half receiving electrical power;

(b) a door mounted power coupling-half separate from the frame mounted power coupling-half but electrically communicating with the frame mounted power coupling-half when the door is in the closed position to receive the electrical power from the frame mounted power coupling-half and to communicate that electrical power to the electronic bolt lock;

(c) a frame mounted data coupling half receiving electronic data from a central source and transmitting it to the door; and

(d) a door mounted data coupling-half separate from the frame mounted data coupling-half but electrically communicating with the frame mounted data coupling-half to receive data transmitted from the frame mounted data coupling half;

whereby a door mounted lock assembly may be operated with external power and data communications

2. The improvement of claim 1 the wherein the frame mounted power coupling-half is a primary winding of a transformer and the door mounted power coupling half is a secondary winding of the transformer.

3. The improvement of claim 2 wherein the primary and secondary windings of the frame mounted power coupling-half and the door mounted power coupling-half are contained within high permeability armatures mating when the door is in the closed position.

4. The improvement of claim 3 wherein the armatures are ferrite cores.

5. The improvement of claim 4 wherein the ferrite cores are cylindrical and closed at one base and open at a base adjacent to the opposing core when the door is in the closed position.

6. The improvement of claim 1 wherein the frame mounted power coupling half and the door mounted power coupling half are halves of mating electrical contacts.

7. The improvement of claim 6 wherein one of the mating electrical contacts is spring loaded to compress when the door is moved to the closed position.

8. The improvement of claim 6 wherein one of the contacts is beveled so as to compress when the door is moved to the closed position with passage of the first and second power coupling halves in a direction generally perpendicular to a direction of compression of the electrical contact.

9. The improvement of claim 1 wherein door mounted data coupling half and the frame mounted data coupling half include first link circuitry selected from the group consisting of halves of visible light link circuits, infrared link circuits and radio frequency link circuits.

10. The improvement of claim 1 wherein frame mounted data coupling half and the door mounted data coupling half are a modulator and a demodulator respectively impressing the data on the power communicated by the frame mounted power coupling half to the door mounted power coupling half, respectively.

11. The improvement of claim 10 wherein the frame mounted data coupling half further receives electronic data transmitted from the door and relays the data to the central source; and wherein the door mounted data coupling-half further transmits data from the door to the frame.

12. The improvement of claim 11 wherein door mounted data coupling half and the frame mounted data coupling half include second link circuitry selected from the group consisting of halves of visible light link circuits, infrared link circuits and radio frequency link circuits.

13. The improvement of claim 1 including further:

(e) a key reader attached to the door receiving the electrical power from the door mounted power coupling-half to read a key code from a key used to unlock the door.

14. The improvement of claim 13 wherein the key reader controls the electrical power to the electronic bolt lock to move the electronic bolt lock from the locked state when a proper key is read.

15. The improvement of claim 12 wherein the key reader is selected from the group consisting of magnetic stripe keys, induction transponder keys, smart cards and biometric readers.

16. The improvement of claim 1 including further:

(c) a proximity sensing circuit communicating with the frame mounted power coupling-half to sense when the door is in the closed position and determined by whether power is being communicated to the door.

17. The improvement of claim 1 wherein the door mounted power coupling half and the frame mounted power coupling half are in the lock plate and strike plate, respectively.

18. The improvement of claim 1 wherein the door mounted power coupling half and the frame mounted power coupling half are in the edge of the door holding a lock strike plate and a portion of the door frame adjacent to the side of the door holding the strike plate, respectively.

19. The improvement of claim 1 wherein the door mounted power coupling half and the frame mounted power coupling half are in the hinge side of the door and the portion of the door frame adjacent to the hinge side of the door.

20. A centralized control and monitoring system for buildings having rooms with doors moving between open and closed positions with respect to door frames holding the doors, the door frames having strike plates providing strike plate openings, the doors having door-mounted bolt mechanisms providing bolts extensible from the doors to engage the strike plate apertures when the doors are in the closed position to retain the doors in the closed position, the door further having electronic bolt locks preventing

retraction of the bolts out of the strike plate openings when in a locked mode, the centralized control system comprising:

(a) a communications link connecting rooms of the building with a central station;

(b) at least one room control module connected for communication with the communication link to receive an unlock signal from the central monitoring station and to provide electrical power and a coded signal to the unlocking mechanism in response thereto;

(c) at least one frame mounted power coupling-half receiving electrical power and the coded signal from the room module; and

(d) at least one door mounted power coupling-half separate from the frame mounted power coupling-half but electrically engaging with the frame mounted power coupling-half when the door is in the closed position to receive the electrical power and the coded signal from the frame mounted power coupling-half and to communicate the electrical power to the electronic bolt lock only upon receipt of the coded signal.

21. The centralized control system of claim 20 wherein the communication link is selected from the group of links consisting of: dedicated electrical wiring, power line communication, telephone line communications, infrared communications, radio communications, and Internet protocol communications.

22. The centralized control system of claim 20 wherein the room control module further communicates with room sensors to provide room information from the sensors to the central monitoring station via the communications link.

23. The centralized control system of claim 22 wherein the room sensors are selected from the group consisting of: temperature sensors, water sensor, room occupancy sensor, electrical usage sensors, room safe opening sensor, door opening sensor, key reader sensor, and bar-door opening sensor, emergency sensor, window position sensor, patio door position sensor, window drape position sensor, thermostat sensor, do-not-disturb sensor, make-up-room sensor.

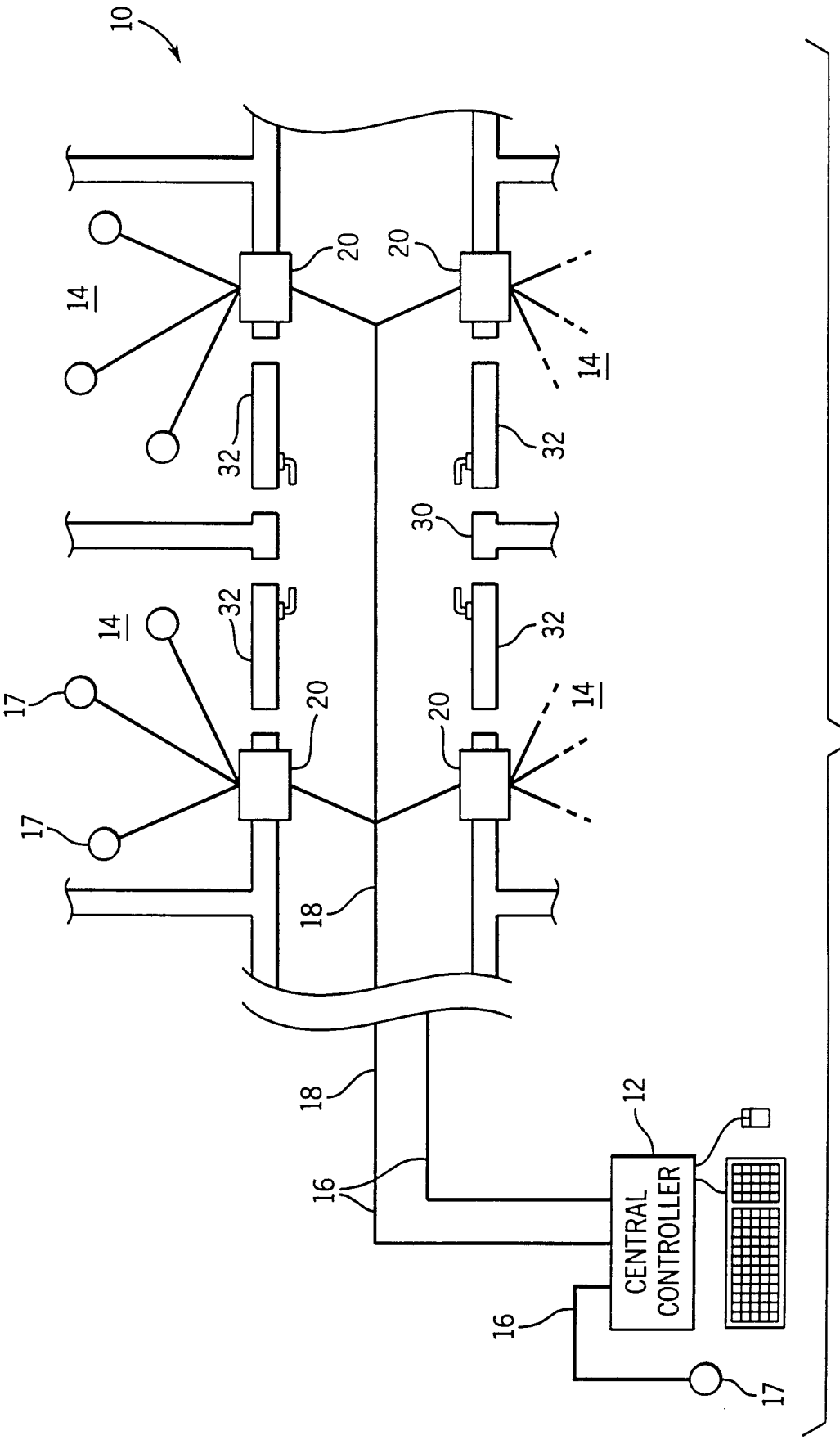

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CENTRAL CONTROLLER
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FIG. 1

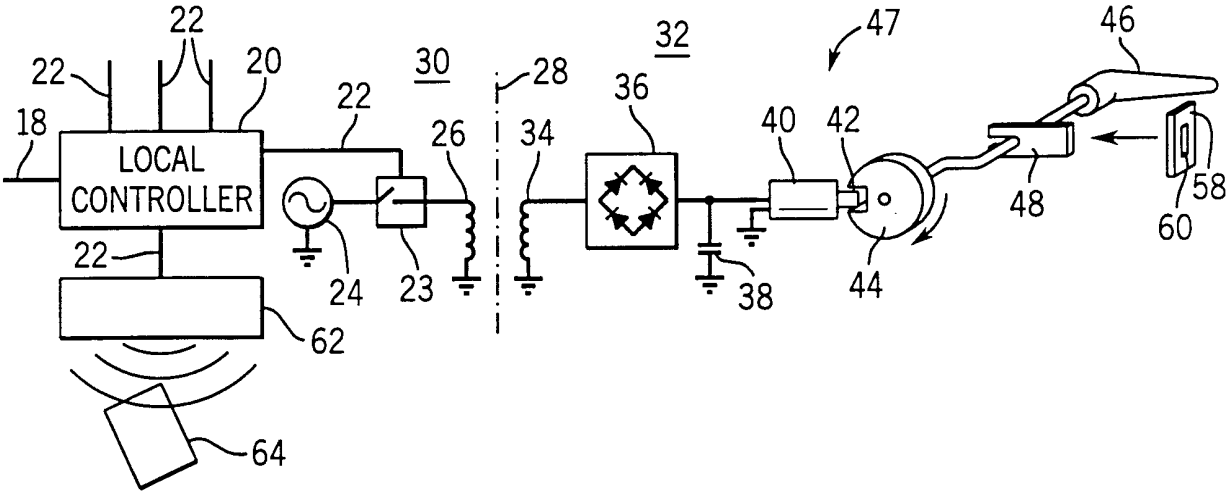


FIG. 2

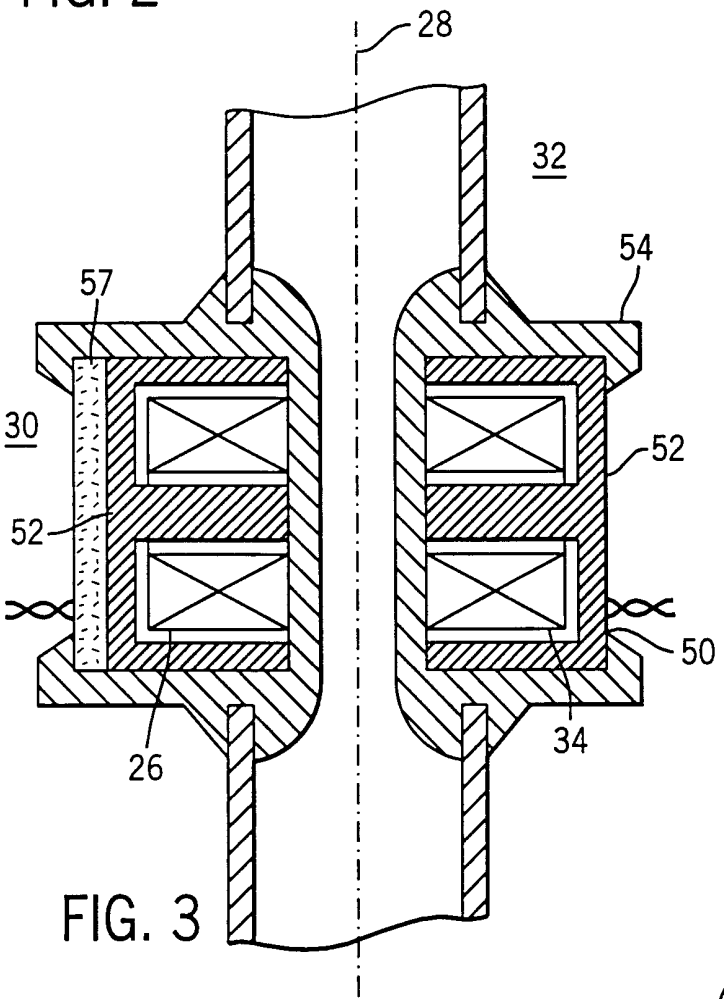


FIG. 3

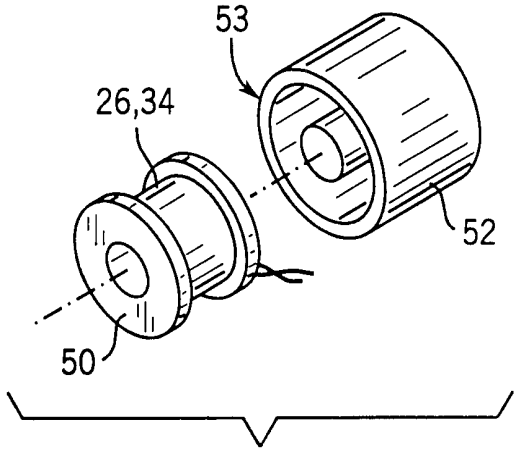


FIG. 4

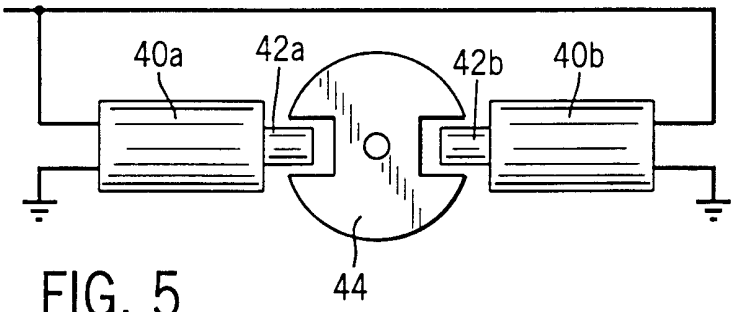


FIG. 5

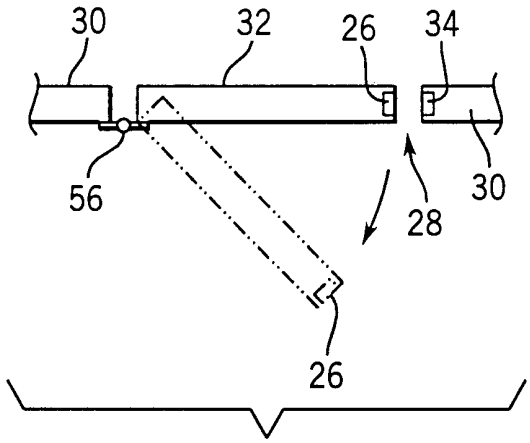


FIG. 6

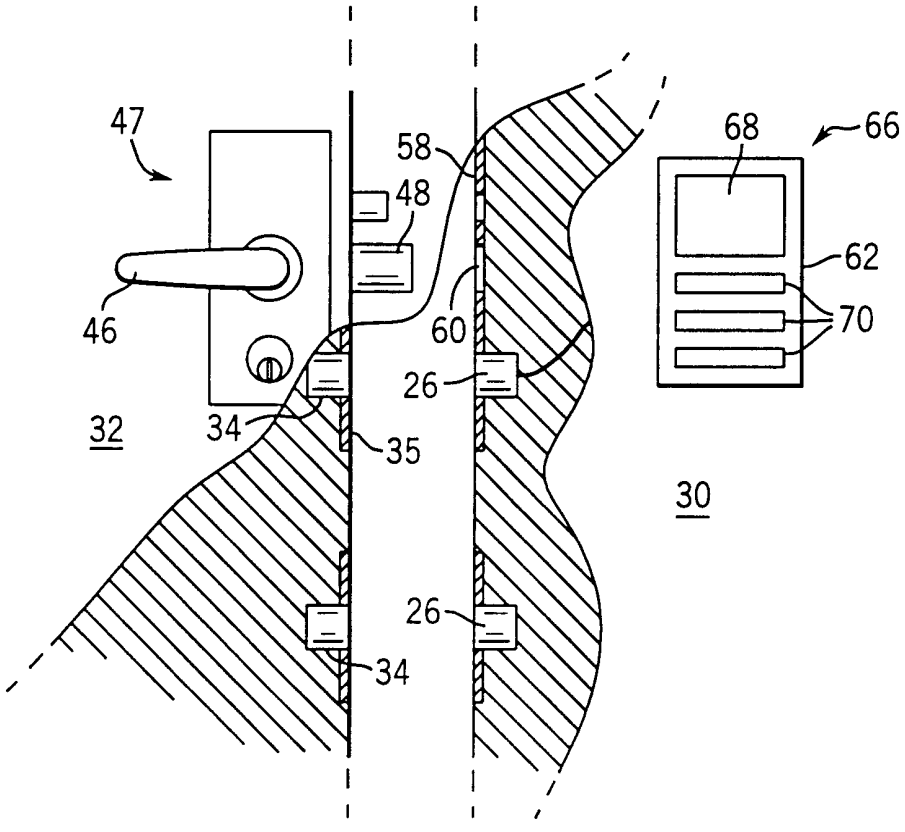


FIG. 7

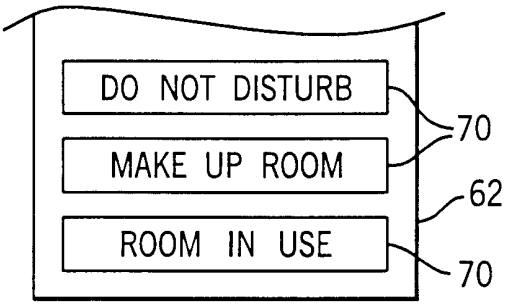


FIG. 8

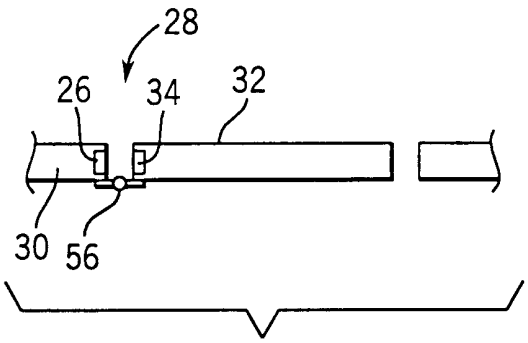


FIG. 9

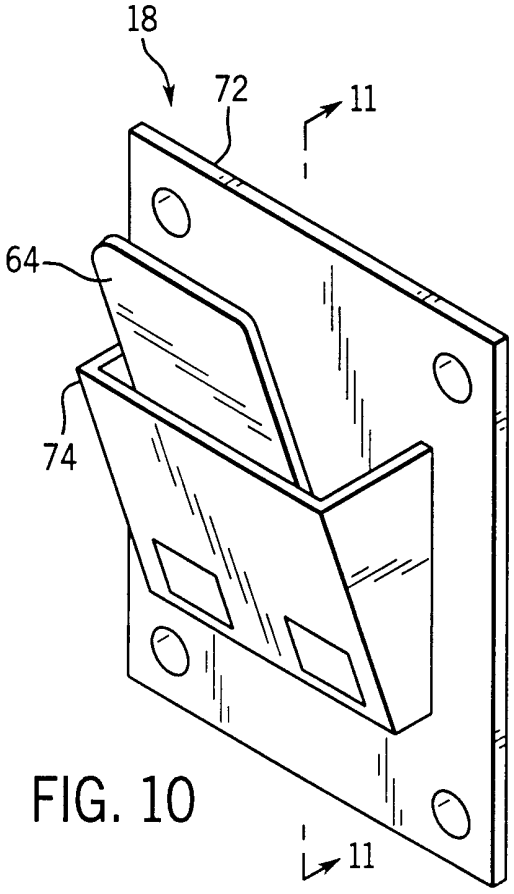


FIG. 10

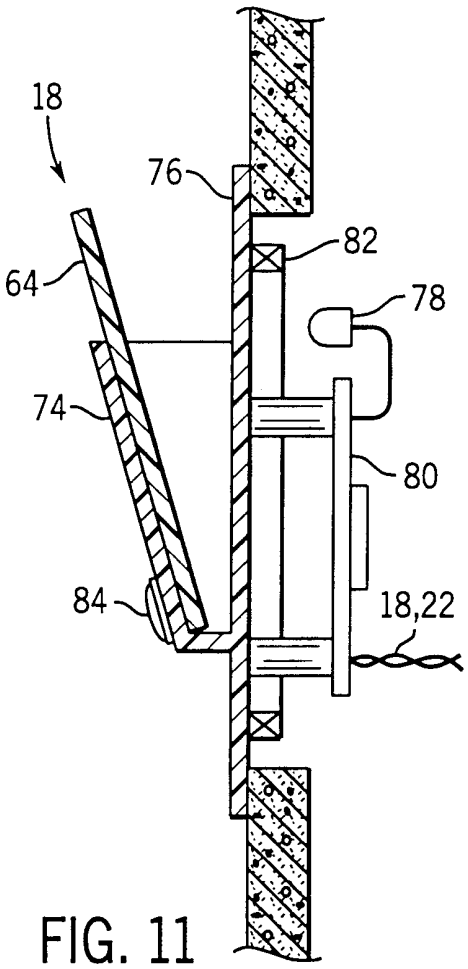


FIG. 11

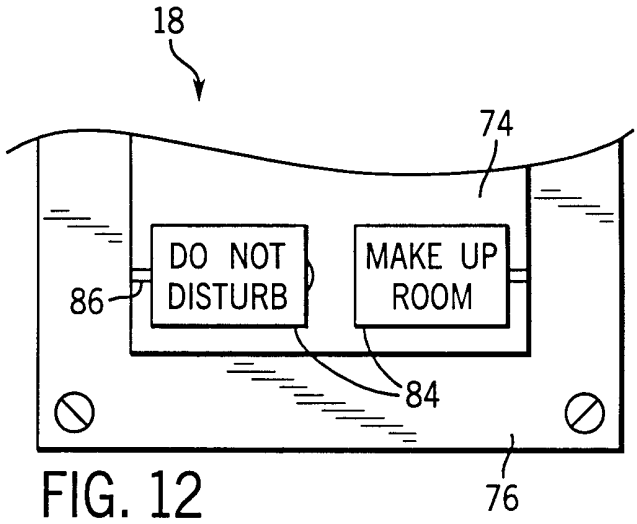


FIG. 12

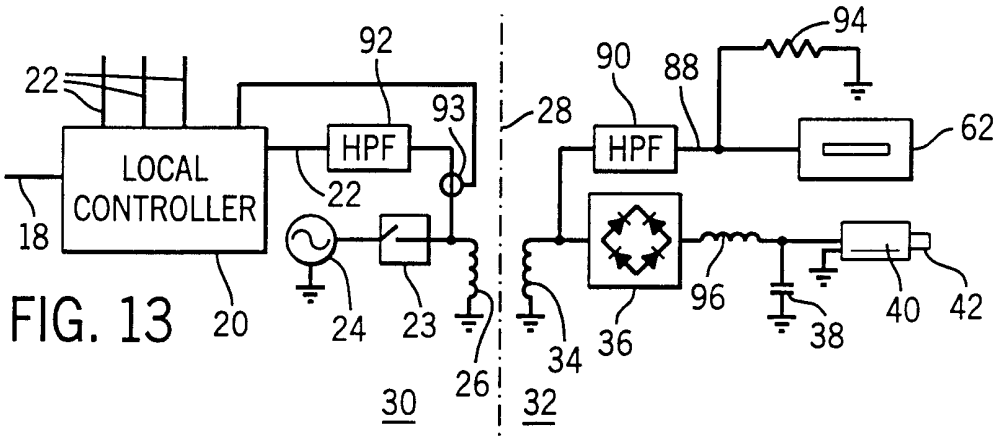


FIG. 13

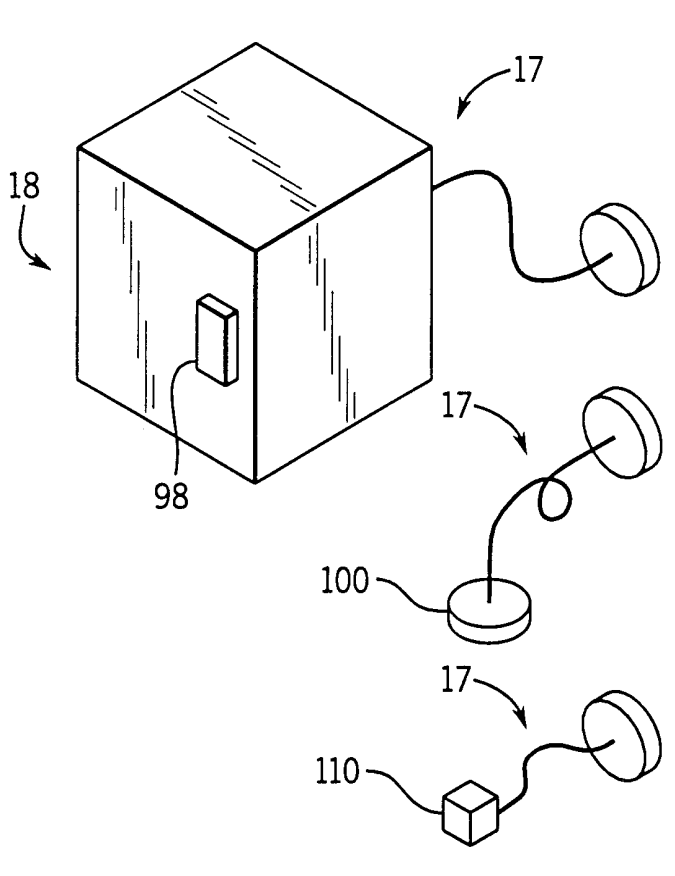


FIG. 14

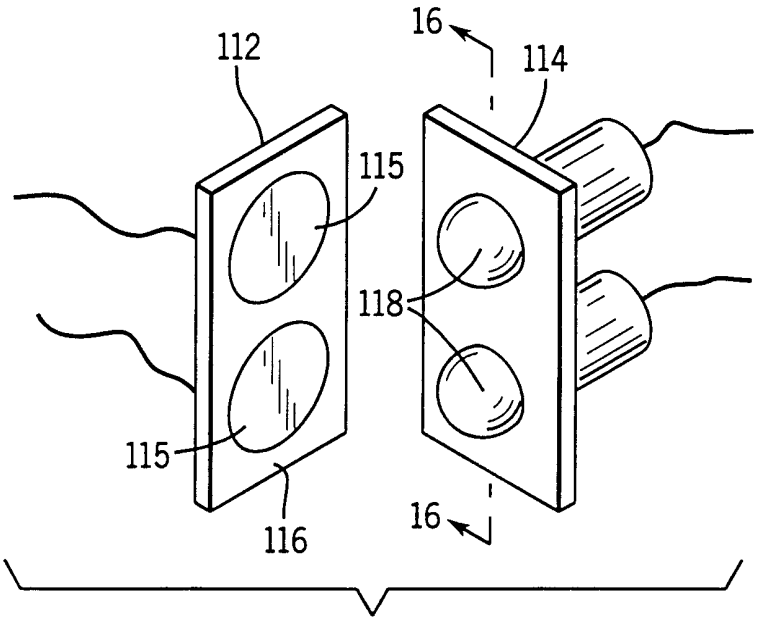


FIG. 15

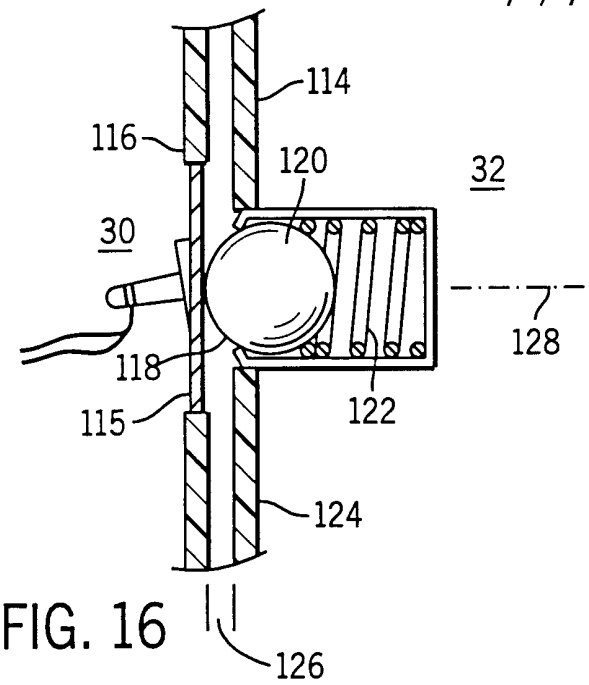


FIG. 16

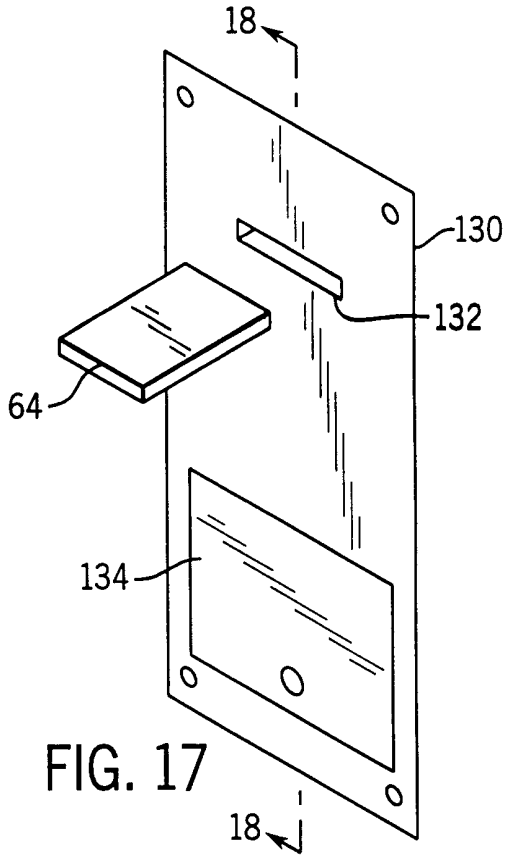


FIG. 17

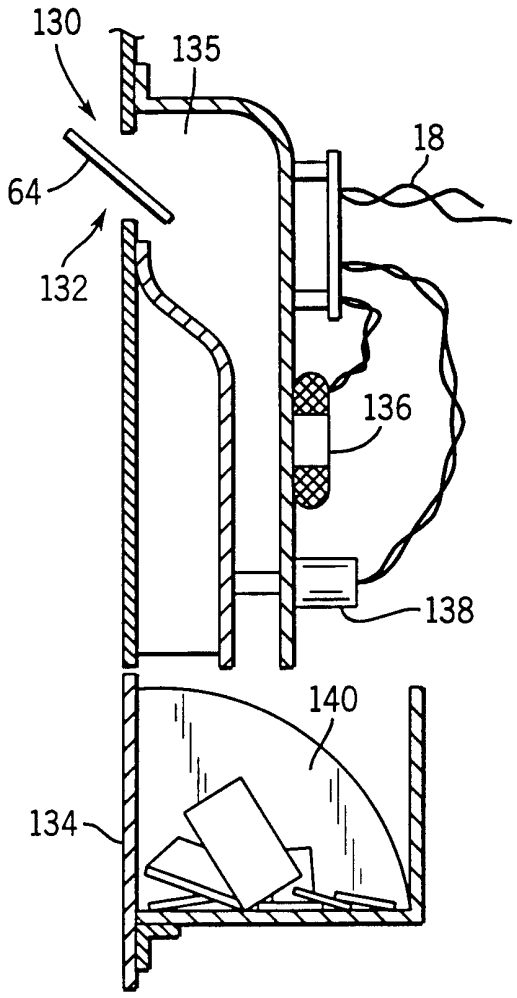


FIG. 18

INTERNATIONAL SEARCH REPORT

Int onal Application No
PCT/US 00/15919

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E05B47/00 E05B49/00 G07C9/00

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 E05B

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, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 677 396 A (FERCO INT. USINE DE FERRURES DE BATIMENT) 11 December 1992 (1992-12-11)	1-5, 9-11, 13-15, 17,18
Y	the whole document	6,7,19
Y	WO 95 27117 A (FORD MOTOR COMPANY LTD) 12 October 1995 (1995-10-12) abstract	6,7, 19-23
Y	WO 93 12495 A (HEMBERG) 24 June 1993 (1993-06-24) the whole document	20-23
A	FR 2 720 095 A (FONTAINE SA) 24 November 1995 (1995-11-24) the whole document	9-15, 20-23

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

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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
25 September 2000	04/10/2000

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	Van Beurden, J

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INTERNATIONAL SEARCH REPORT

Int. ɔnal Application No
PCT/US 00/15919

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 541 585 A (DUHAME DEAN C ET AL) 30 July 1996 (1996-07-30) the whole document -----	

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

INTERNATIONAL SEARCH REPORT

information on patent family members

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