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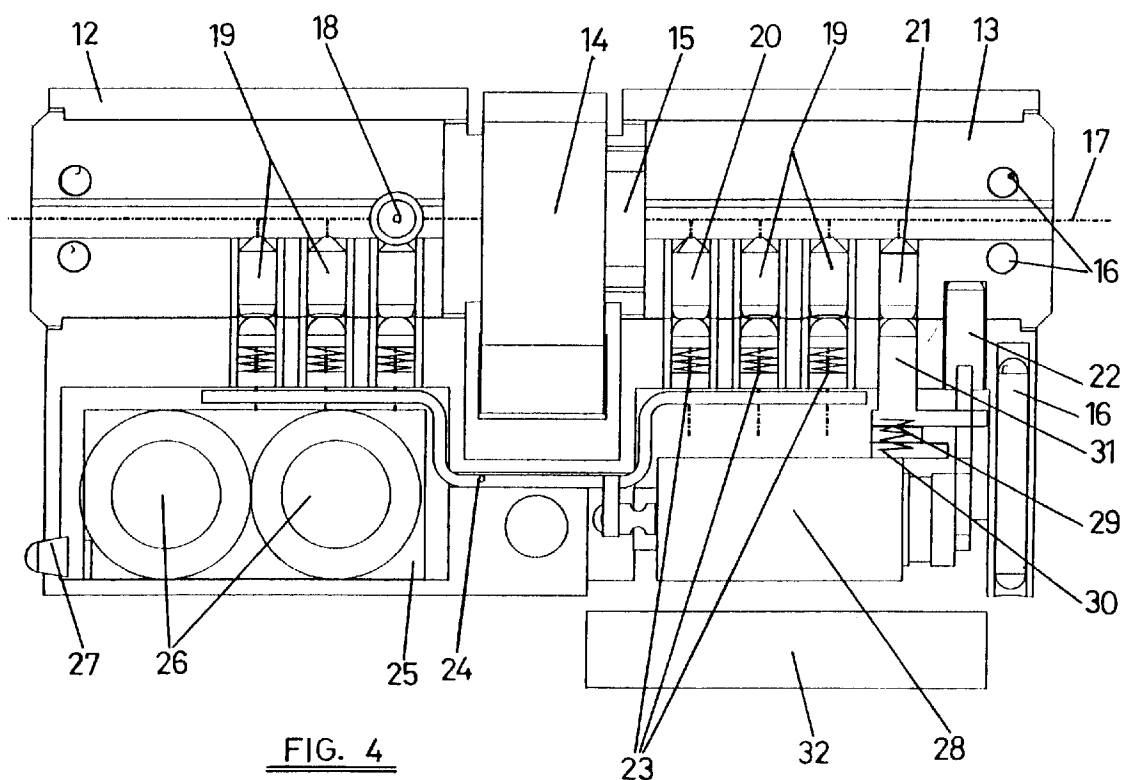
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28760 Tres Cantos (Madrid) (ES)**(54) **Single key system**

(57) Single key system comprising a lock, keys and a codifier. The lock includes an electronic circuit (25) which stores an access code and identification codes for the keys with specific restrictions. Besides the lock, there is also a mechanism (22), to enable or prevent the

cylinder (13) from turning, which is controlled by the electronic circuit (25). The keys include electronic circuits that store the access codes for one or several keys. The codifier enables the codes for the keys to be introduced, annulled or modified, with the possibility of one key including authorization to open several locks.

**EP 0 816 600 A2**

Description

This invention concerns an electronic locking system comprising an electronic lock and key incorporating codes that permit different locks to be opened with a single key, and a codifier which is the essential element for managing key authorizations.

Under this new system, the lock has an electronic circuit for identifying keys and a mechanism controlling movement of the lock bolts. The key is what triggers the action mechanism of the lock and includes an electronic circuit incorporating an access code.

DE-36128 describes a locking device of the type outlined above, in which the different components include fixed identification codes.

ES-2073403 describes an electronic security lock designed so that the security code can be changed by means of a "code copy" control device installed in the door and which is operated by the user. In both cases, however, the design of the lock, codifier and system in general is entirely different from the system described above.

The purpose of the present invention is to provide a locking system of the type described, but where the key incorporates a number of codes corresponding to an identical number of locks. Under this system, only one key is needed to open all the locks for which it is authorized.

Another aim of the invention is to provide a locking system in which the lock can incorporate time and date restrictions limiting the access of particular keys.

A further aim of the invention is to achieve an electronic lock whose access codes can be easily modified by the user by means of a device known as a codifier.

Another aim of the invention is to develop a system in which the lock is of the same shape and size as traditional locks, so that the new system can be easily and quickly installed in place of an old lock, with one cylinder as well as with two.

In this new invention, the locking system consists of a lock, two types of key (a personal and an original key), and a codifier.

The lock has an electronic circuit that stores an access code plus the identification codes of each personal key together with their restrictions. The lock also includes an action device that operates on the lock cylinder to enable or prevent turning. The device is controlled by the electronic circuit, which activates it when a key inserted in the lock possesses the lock code and has access permission for that date and time. Each key has an electronic circuit in which is stored the access code of one or more locks with time restrictions.

The codifier contains an electronic circuit that is used to give, withdraw or modify personal key authorizations, imposing time and/or date restrictions, which can be different for each key. The codifier also keeps track of authorized keys and communicates this information to the locks, as well as setting their time and date.

All the features described, together with others incorporated in the invention, as outlined in the features summary, are explained in further detail below with the help of the accompanying figures, which show one possible example of their use.

In the drawings:

Figures 1 and 2 show the top and bottom sides of a traditionally shaped key, on which has been drawn a possible configuration and layout of the electronic component of the key forming part of the locking system of this invention.

Figure 3 corresponds to the diagram of the electronic component of the key shown in figures 1 and 2.

Figure 4 shows a cross section of a lock forming part of the locking system concerned in the invention.

Figures 5 and 6 show a possible configuration of the electronic circuit of the lock.

Figure 7 gives a diagram of the circuit incorporated into the lock in figure 4.

Figure 8 shows a perspective drawing of a codifier used to manage the key codes.

Figure 9 corresponds to the electronic circuit of the codifier shown in figure 6.

Figure 10 shows the diagram of the codifier of figure 6.

Fig. 11 shows a lock as per the present invention in diametral section.

Fig. 12 is a similar section to Fig. 11, showing a slight variation in execution.

Figs. 13 and 14 correspond to a close-up of detail A of Fig. 11.

Figs. 15 and 16 are transversal sections of the lock, cut along A-A and B-B respectively, as per Figs. 13 and 14.

The electronic component of the keys involved in the locking system of the invention can adopt the configuration shown in figures 1 and 2. This electronic assembly consists of a microprocessor 1, which may be replaced by a specific application integrated circuit with equivalent features, an EEPROM 2, a printed double-sided circuit, indicated in general by reference number 3, which includes three contacts corresponding to the data signal 4, the synchronous clock 5 and the negative power supply 6. There is also an ample contact area 7 for the positive power supply, which comes in contact with the body of the lock on insertion of the key. The points of contact in the key area serve to allow communications with the lock or the codifier. The communication established through them is a two-wire cascade synchro: a synchro signal line generated by the lock or the codifier serving as masters and a two-way data line.

The key also includes a surface mounted push button 8 (switch with a single stable position) and a battery 9 (e.g. a 3-volt lithium battery) with a battery holder 10 on the weld side of the printed circuit. Finally, the circuit includes several passive discrete elements 11 constituting the RC circuit of the pulse generator, or pull-up resistances.

The layout shown here is modified for manufacturing purposes by introducing the integrated circuits without encapsulation and the discrete elements built using hybrid circuit techniques in the printed circuit.

All the above elements form a body that is mounted directly in the housing, whose holder is covered by pliable, water-proof insulating material that adapts to the position occupied by the push button 9, to allow it to move.

In the diagram shown in figure 3, the same reference numbers are used to designate the same components described with reference to figures 1 and 2.

Figure 4 shows, in cross section, a lock which can, in principle, be of the same size and shape as traditional locks to ensure their easy substitution without requiring changes in the other components of the door lock.

The example shown in figure 4 corresponds to a "Europerfil" lock, although it is applicable to locks of all shapes and types. A number of traditional elements are preserved, such as the housing 12 in which is mounted the cylinder 13, which produces the turning of the cam 14, which may or may not be of the monoblock variety. In the example shown in the drawings, there are two independent cylinders with a clutch or gear 15. The housing 12 incorporates protection devices, such as the hard metal drilling-proof pins 16. The key insertion groove 17 has a lateral key guide 18 making it impossible to remove the key once it has been turned.

The cylinder 13 has five perforations, two of them corresponding to contacts 4 and 5 of the key, figure 1. Another of the perforations, referenced with number 20, is a zero volt contact and corresponds to contact 6 of the key, figure 1, are data input/output perforations. The fourth perforation, referenced with number 21, corresponds to the mechanical recovery device for blockade pin 22, which is the fifth perforation. The first three are simple electric contact pieces which must be insulated from the cylinder and are therefore introduced into the perforations with a covering sleeve which also, due to the narrowing in the part of the key insertion groove, keeps it from emerging more than 1 mm, the amount necessary to exert pressure on the key and establish communication with it. These contacts do not keep the cylinder from turning. When the cylinder is in the non-turning position, the contacts 19 and 20 are in contact with contacts 23 which carry their signals to the data transmission wire 24 leading to the electronic circuit 25. The entire assembly is monitored by this electronic circuit.

The power used by the assembly is provided by batteries 26 in non-electrified doors, or by a small uninterrupted power supply unit in the case of electrified doors, connected to the main supply. The power needed to turn the cylinder 13 is provided by the user's hand as it turns the key in the lock. Electrified doors can be opened by a traditional system consisting of a solenoid or electric motor. In case a battery is used, as shown in the drawing there is a low-charge indicator 27 that lights up when

the battery charge falls below, e.g. 20%. Both the battery and the low-charge indicator are on the inside of the lock, aimed towards the inside of the dwelling, and the battery is changed through the side of the lock facing the inside of the dwelling as well. The batteries do not necessarily have to be located inside the lock, but may be on the indoor side of the door, thus allowing for larger batteries with higher capacity and longer duration.

In resting position, the cylinder 13 cannot turn because of the blockade pin 22 which is introduced into the cylinder. In the example shown in figure 4, the cylinder blockade pin is activated by a solenoid or motor on receiving the necessary signal from the electronic circuit 25. If the system has a motor 28, it only does a half turn, due to the presence of a mechanical stop, causing the pin 22 to rise or fall. The motor axis and the pin are connected to each other by means of a traditional shaft and hand wheel system. If the lock battery is too low to work, the necessary energy is supplied by the key, once inserted into the lock and the switch 8, figure 1, turned on, yielding three volts through the metal part of the key. If no provision had been made for power to be supplied, on withdrawing the key, the blockade pin 22 would not return to its blockade position, since the solenoid or motor could not be actuated, and consequently the door would be left unlocked. To avoid this situation, a mechanical system has been provided for the partial recovery of the blockade pin. This works by means of a pivot 21 which in its resting position lies against the top of the key insertion groove 17 and which is pushed down to the bottom surface of the groove when the key is inserted. When it has been pushed down some 2.5 mm, the pivot is positioned so that it no longer keeps the cylinder from turning and presses on an L-shaped piece 29, whose end runs along the axis of the blockade pin shaft and presses a spring 30, so that when the key is withdrawn, the L-shaped piece 29 tends to rise, and so, therefore, does the blockade pin, which is inserted into the cylinder 13, thus blocking it.

The assembly comprising contact 23, the mechanical recovery of the pin 31, the electric motor 28, the blockade pin and shaft system 22, and the transmission wire 24 leading to the electronic circuit, should be mounted as a package and fitted up into the lock through the lid 32 located on the underside. The contacts 19, 20 and the pivot 21 should be mounted with the cylinder removed.

The electronic circuit of the lock may be configured as shown in figures 5 and 6, following the diagram in figure 7. The circuit includes a microprocessor 33 or a specific application integrated circuit, in addition to an EPROM. The circuit also includes one or two 3-volt (e.g. lithium) batteries 34, with a holder 35 placed on the weld side of the printed circuit 36. There are various passive discrete elements 37 forming the RC circuit of a pulse generator. It also includes a double-sided surface mounted printed circuit (components side 38 and weld side 36), with five contacts corresponding to the syn-

chronous clock 39, the data signal 40, the positive power supply 41 from the switch located in the lock, the negative power supply 42 and the motor control signal 43. There is also an ample contact zone for the positive power supply 44 which comes into contact with the body of the lock and is closed by contact 42 when the key is inserted. The points of contact provided for contact with the key establish two-wire cascade synchro communication with the key: a synchro signal line generated by the lock 39 acting as master and a two-way data line 40.

The layout presented here can be changed for manufacturing purposes by introducing the integrated circuits without encapsulation and the discrete elements built using hybrid circuit techniques in the printed circuit.

All the above elements form a body that is mounted directly in the housing.

Also, the lock may optionally be connected to a computer. In this case, a connection to the serial port of the computer must be added to the electronic circuit. When connected to a computer, the program can be developed so that authorized key and restrictions data are stored in the computer, and information is relayed in real time on openings and attempted openings for data validation and presence control. The lock can also transmit messages and/or trigger alarms according to the instructions it receives.

Figure 8 shows a possible configuration of a codifier fitted with two inputs 45 and 46 for the original and personal keys, respectively, each with its corresponding reading devices. The codifier also has a display 47, a connection to the computer serial port 48 and four buttons 49 for authorizations, deauthorizations, modifications and confirmation. With this configuration, the codifier adapts to the simplest operation of the assembly, which only involves processing the code and not the restrictions or personalized control of the personal keys authorized. To develop these latter functions, the codifier must be connected to a computer so that they can be performed through it. Another option is for the codifier to be provided with an electronic circuit and a keyboard so that it can be operated directly.

In an even simpler development of the codifier, it is possible to use a computer keyboard and its larger screen capacity to perform the codifier's functions, in which case the physical configuration of the codifier is reduced to the inputs for the two keys and to the serial port connection with the computer.

In cases where a codifier is strictly dedicated to a lock, its programming could include the lock code, so that the presence of the original key will not be necessary to perform the functions of authorizing or deauthorizing personal keys.

The electronic circuit of the codifier can have the configuration shown in figure 9 with the diagram shown in figura 10. The electronic components comprising this circuit are: a microcontroller-type microprocessor 50, a liquid crystal screen module 51, keys for function selection using the keyboard 52, power supply from a power

outlet using a system based on an external AC/DC converter and an internal voltage regulator and connector for DC input 53, a driver and transceiver for adapting to voltages and line negative logic 54, a connector 55 for the serial line to the computer, a double-sided printed circuit with two areas of three contacts in gold corresponding to the synchronous clock 56, the data signal 57, and the negative power supply 58, each of whose areas is used for the contact of one of the keys (the original and the personal key), and various passive discrete components 59 for pulse generation and pull up.

The features of the invention make it possible to have a single key system for opening numerous locks with a single key containing the electronic access code of each of the locks for which access permission has been granted.

The locking assembly of the invention consists of the electronic keys, the electronic locks and a codifier. The operation of each of these elements and its relation to the other elements is explained below.

a) Original key functions

The original key is where a single code is stored corresponding to the lock to which it belongs and for which it provides backup, written in the EPROM by means of the codifier. It can also store five more codes corresponding to codes that are obsolete but that serve to update the codes in personal keys. Another octet is reserved for generating the lock initialization code. A final octet of the EPROM is reserved for different pointers indicating the update status of the data. This key opens the lock to which it belongs. When it is inserted in the lock, the key points 4 and 5 come into electric contact with the points 19 of the lock.

The communication used in this case between the key and the lock is an SPI-type cascade synchro reduced to two wires.

The communication is defined as follows:

- Physical level: the paths of the printed circuit of the key, the stubs or contacts between the key and the lock and the printed circuit of the lock. The total length amounts to a few centimetres.
- Electric level: 0 to 3 volt signals in positive logic.
- The logic level is the one defined by the SPI standard modified to reduce the number of data wires from two to a single two-way wire.
- The basic protocol is the transmission of 8 bit fields together with a synchronous clock.
- The higher protocol consists of the following main functions: lock opening process consisting of a complex algorithm that includes random logic and data encoding by random logic and a lock code change process in two versions: using a new original key or modifying a code.

Opening process: following a given communication

protocol based on the above communications, if the current code of the key coincides with that of the lock, the electronic circuit of the lock sends a series of electrical pulses to the motor 38 which acts by sliding the blockade pin 22, freeing the cylinder 12. When the hand turns the key in the lock, the cylinder 12 moves the cam 14, as in traditional locks, thus activating the lock opening mechanism.

When the key is turned back to its normal position and withdrawn, the contacts are broken between 4, 5 and 19, causing the circuit to transmit an inverse signal to the motor to return it to initial position, the blockade pin slides back and the cylinder is blocked.

Insertion of the key moves the pivot 21, which in resting position lies against the top surface of the key insertion groove 17, pushing it down to the bottom of the groove. When the pivot has been pushed down some 2.5 mm, it is positioned so that it does not keep the cylinder from turning, but pushes the L-shaped piece 29, whose end runs along the axis of the blockade pin shaft and presses a spring 30, so that when the key is withdrawn, the L-shaped piece 29 rises, thus allowing the blockade pin to rise and enter the cylinder, blocking it. So recovery of the blockade pin is achieved by both an electronic and mechanical system.

Code change process: the original key is also used to change the code of the lock. This is an electronic operation, based on another specific electronic protocol. When the key is inserted and contact is made between the points 4, 5 and 19, if the key has a lock code electronically identified as an old code, the lock asks the key for the new code and changes it in its EPROM. The key also notes that the code has been changed and permits its use from that moment on for opening or for copying the code to other personal keys.

In addition to these functions, the battery inside the key has been provided to take over when the battery inside the lock fails to supply it with power. That is, normally the key battery is not in operation. Only when the lock fails to open, due apparently to lack of electric power supply, does the user press the switch on the grip of the key to provide the lock with power from the key battery.

Communication with the codifier is based on the same standard and type of communication. What varies is the higher communication protocol which must perform the following operations: reading the key's own individual code, reading the current key code and generating a new code for the key. All these operations are described in the codifier section.

b) Functions of the original key for locks with restrictions.

Optionally, a lock can restrict the time, days of the week and days of the year in which a given key can have access to it. This means using a restricted lock and an original key for locks with restrictions. Original keys for restricted locks contain all the elements and possibilities

of ordinary original keys plus the following characteristics:

They have an EPROM which is used to transmit access restrictions from the codifier to the lock.

Each key is identified by its code and can contain restrictions of three types: a time-of-day access window, a day-of-week access window and a day-of-year access window.

Using the pointers, these windows can be interrelated to impose restrictions.

When it comes into contact with the lock, the key, in addition to performing the functions described above, transfers all the information stored in its serial EPROM to the serial EPROM of the restricted lock.

By communicating with the codifier, the key enables the codifier to write in its EPROM all data concerning restrictions in the format indicated (see codifier section).

c) Functions of the personal key

The personal key stores the codes to which access has been allowed. Each code consists of 64 bits organized into 8 bytes. When being stored, the first byte is saved without encoding while the seven remaining bytes are encoded with a specific algorithm based on the individual code of each key, introduced during the manufacture of the microcontroller.

To facilitate data searches, an indexed list is stored in the internal EPROM of the microcontroller.

Whenever a search is going to be made for a given code, the first place scanned is the immediately inferior position in the internal EPROM, followed by a search in the external EPROM.

Communication with the external EPROM is as defined for serial EPROMs with standard 12C. More specifically:

- Physical level: the very short paths of the printed circuit, which measure less than a centimetre in length.
- Electrical level: 0 to 3 volt signals in positive logic.

The logical level is defined by the original Philips 12C standard: two wires, one for data and the other for the controller clock for the microcontroller. The data signal has a pull-up resistance to permit recognition logic, etc.

The basic protocol is as defined for the serial EPROM adopted by most manufacturers, including Philips, Xicor, Atmel, Microchip, etc.

The higher protocol comprises: writing of 8 byte pages for recording new codes; random readings of 1 to 4 bytes, or of 1 to 8 bytes, in the process of searching for a code for its identification on opening, or its inclusion in the recording, respectively; the sequential reading of 4 bytes in the process of identification.

The key makes it possible to unlock the doors for which it is authorized (hundreds of doors). The personal

key can carry numerous authorizations. Each authorization is given by the owner of the lock in question or by its supervisor, and can be given with time and/or date restrictions. In addition, the owner of the lock can deauthorize a given personal key (see codifier section).

When the key is inserted in the lock, the key points 4 and 5 make contact with the points 19 of the lock, so establishing communication between the key and lock. The communication used in this case is a cascade synchro type SPI but reduced to two wires.

The communication is defined as follows:

- Physical level: the paths on the printed circuit of the key, the stubs or contacts between the key and the lock and the printed circuit of the lock. The total length amounts to a few centimetres.
- Electric level: 0 to 3 volt signals in positive logic.
- The logic level is the one defined by the original Motorola SPI standard modified to reduce the number of data wires from two to a single two-way wire.
- The basic protocol is the transmission of 8 bit fields together with a synchronous clock.
- The higher protocol consists of the following main functions: initialization of EPROM only available during manufacturing, reading of the individual code of the key and opening protocol of the lock formed by a complex algorithm that includes random logic and data encoding by random logic. In this data transfer, communication begins with transmission from the lock, which asks for identification from that type of key. If the identification is correct, it sends part of the enciphered code together with various control words. On receiving this communication, the key must search among its codes for one that matches the characteristics of the part of the code received and then send the remainder of the code, which is likewise enciphered. In case various codes match the first part of the code sent by the lock, the operation is repeated until all the codes have been run through or the correct one is found.

If the correct code is not found, the lock will not open. If one of the codes is correct, it activates the motor and eliminates the obstacle keeping the key from turning in the lock, as described in the lock description above.

Communication with the codifier is based on the same standard and type of communication, varying only in the higher communication protocol, which must perform the following operations: the reading of the individual code of the key, the erasure of one code and the writing of another new one (see codifier functions).

Personal keys are identified with an individual code for each personal key. During the manufacturing process, each key is given a code that identifies it with a sufficient number of bits to distinguish it from the rest. As this code exists merely for identification or distinction purposes, a small number of bits suffices. For example, with 24 bits 16,777,216 different keys can be made. This

code is electronically recorded and can never be changed or altered.

The battery has been provided for times when the lock is left without power supply due to failure of the battery located inside the lock. That is, the key battery is ordinarily not working. Only when the lock fails to open and it is suspected that this must be due to lack of electric power, is the switch pressed on the grip of the key, thus providing electric power to the lock from the key battery.

d) Personal key functions for restricted authorizations.

The restrictions system can be designed in two ways. The first, described above, concerns authorization restrictions given by the codifier and controlled and stored in the lock. In these cases, when the locks are not connected to a computer, the restrictions are conveyed to the lock through the original key, as outlined above. An alternative procedure is described below in which the authorizations, together with their restrictions, are stored in the personal key. In these cases, once the code has been checked and okayed, the lock checks the time and/or date restrictions to see whether the current time and date, which is known by the lock, are within the authorized range. If they are, the lock proceeds to activate the motor or solenoid, unblocking the cylinder to permit opening. In this case, which is the one we shall describe now, the system is as follows:

Optionally an authorization may introduce restrictions on the times of day for which each personal key has access, the days of the week for which access is authorized, or the days of the year for which entry is permitted. This entails programming the lock to check the restrictions contained in the personal key. The personal key for restricted locks contains all the elements and possibilities of the personal key plus the following features:

It has an EPROM which serves to store the access restrictions introduced through the codifier.

Each personal key is identified by its code and contains restrictions of the three types defined above: time-of-day access window, day-of-week access window and day-of-year access window. These windows can be related to impose restrictions using the pointers.

Therefore, when the personal key interacts with the lock, in addition to the functions described above, it also checks time restrictions so that if the current date and hour are within the permitted range, the lock will give the order to open.

When the personal key interacts with the codifier, the key allows the latter to write in its EPROM all the data concerning restrictions in the format described above (see codifier section).

e) Lock functions

The lock carries stored inside a unique code com-

posed of 8 bytes in the EPROM of the microcontroller.

The basic operation consists of checking the code of a key, whether original or personal, and enabling access if the key is correct.

When a key is inserted in the lock, the key points 4 and 5 make contact with the points 19 of the lock, and an access protocol is initiated through the cascade synchro communication line between the two, which has the following characteristics:

- The physical level consists of the paths on the printed circuit of the key, the stubs or contacts between the key and the lock and the printed circuit of the lock. The total length amounts to a few centimetres.
- Electric level: 0 to 3 volt signals in positive logic.
- The logic level is the one defined by the original Motorola SPI standard modified to reduce the number of data wires from two to a single two-way wire.
- The basic protocol is the transmission of 8 bit fields together with a synchronous clock.
- The higher protocol consists of the following main functions: reading of the individual code of the key and opening protocol of the lock formed by a complex algorithm that includes random logic and data encoding by random logic.

With either type of key, communication commences with transmission from the lock, which asks for identification of the type of key. If the identification is correct, it sends part of the enciphered code together with various control words. On receiving this communication, the key must search among its codes for one that matches the characteristics of the part of the code received and then send the remainder of the code, which is likewise enciphered. In case various codes match the first part of the code sent by the lock, the operation is repeated until all the codes have been run through or the correct one is found.

If the correct code is not found, the microcontroller of the lock goes into sleep phase and does not enable opening of the lock. If one of the codes is correct, it activates the motor and eliminates the obstacle keeping the key from turning in the lock. Following a given communication protocol based on the communication described above, if the current code of the key coincides with that of the lock, the electronic circuit of the lock sends a series of electric impulses to the motor 28, which acts by sliding the blockade pin 22, thus freeing the cylinder 13. When the hand turns the key in the lock, this turns the cylinder 13, which moves the cam 14 as in traditional locks, thus activating the opening mechanisms of the door.

On insertion of the key, the pivot 21 which in its resting position against the top of the key insertion groove 17 and is pushed down to the bottom of the groove by insertion of the key is moved. After being pushed down some 2.5 mm, the pivot is positioned so that it no longer keeps the cylinder from turning, but presses an L-

shaped piece 29 whose end runs along the axis of the shaft of the blockade pin and presses a spring 30 so that when the key is withdrawn, the L-shaped piece 29 tends to rise, thus allowing the blockade pin to rise and enter the cylinder, blocking it. In this way recovery of the blockade pin is achieved by both an electric and mechanical system.

When the key is turned back to its original position and withdrawn, contact is lost between points 4, 5 and 19, causing the circuit to transmit an inverse signal to the motor to return it to its initial position. The blockade pin is slid back and the cylinder is blocked.

If the key inserted is an original key, it can also modify the code stored in the lock and introduce a new one. This is useful in cases of security risk due to a lost key or any other reason.

If the key inserted is identified as an original key, a check is made to see that its current code is correct. If it is, opening is enabled. In this case, on inserting the original key and making contact between the points 4, 5 and 19, if the key has a lock code electronically identified as an old code, the lock asks the key for the new code and changes it in its EPROM.

In the event of lock battery failure, none of this process can be performed. When the user finds that the lock doesn't open, s/he can press the switch on the key and supply electric power for identification and opening purposes.

The lock may incorporate three optional elements: electricity from the main power supply, restricted access and real time communication with a computer.

When electricity from the main power supply is desired, a small uninterrupted supply circuit is provided, consisting of:

- Rectifier bridge
- Rechargeable 3-volt battery
- Integrated control circuit for the battery charger
- Rectifier
- Connectors
- Printed circuit

These elements are located on the printed circuit and introduced in a metal box with two connectors: the 220 volt input from the main power supply and the 3-volt output. As long as there is electrical power, the rectifier elements supply power to the lock. In the absence of power supply, the battery takes over supplying electricity.

As an option, a lock can introduce restrictions on the time of day when each key can open the lock, on the days of the week on which a key has access or on the days of year on which access is authorized. This entails using a restricted lock and an original key for locks with restrictions. Restricted locks contain all the elements and possibilities of normal locks, plus the following features:

An EPROM that serves to store the access restric-

tions.

Each personal key is identified by its code and can contain restrictions of three types: a time-of-day access window, a day-of-the-week access window, and a day-of-the-year access window. These windows can be related with the pointers to impose restrictions similar to the following examples:

Code: 2A 56 F3 20 AB C6 E9 16

Access permitted from 8:30 to 17:45, Monday to Friday from September 1 to July 31.

Code: 67 34 8D 9F 35 B7 12 8C

Access permitted from 17:00 to 20:00, Monday, Wednesday, Friday, all year long.

It also has an integrated circuit for the real time clock that keeps permanent track of the minute, hour, day of the week, day of the month, month and year. It is operated by means of a software-controlled 12C line from the microcontroller.

When the lock operates with this option, in addition to the functions described above, on insertion of the key following the above procedure, and after checking that the key possesses the lock's code, it checks the restrictions database to see if opening is permitted at the present time. To do this, it asks for the key code and searches in the corresponding register to see if opening is authorized for the present moment. The time and date are obtained from the real time clock. To keep the real time clock in operation, it is necessary for this option to include electrification of the lock from the main power supply.

If the key inserted in the lock is an original key, in addition to the functions described above, it checks to see if there are restriction data to be transferred. If there are data to be transferred, it permits the data to be copied from the original key to the lock, for which purpose it uses the SPI communication between the original key and the lock, and the 12C communication between the microcontroller and the serial EPROM of the lock, both of which have been described in the corresponding sections.

With the option of a lock having real time communication with a computer, it is necessary to add to the electronic circuit of the lock a driver for the RS-232 serial line and a serial line connector.

In the microcontroller program there are serial line control algorithms for the following functions: to transmit a code by serial line and receive clearance confirmation. When a key is inserted in the lock, in addition to making the checks described above, the code of the key requesting access is sent to the computer, which says whether the key has access or not.

The computer can perform a range of operations: it can simply check whether the key has access, check whether at the current moment (time and date) it has access permission, perform presence control functions, perform security functions triggering alarms or other similar functions based on the information supplied through the key and the lock.

f) Codifier functions

When the codifier receives electric power, the microcontroller 50 initializes all the elements and enters a loop for random number generation. This loop can only be exited by interruption generated by pressing one of the keys 49 or by reception of data through the serial line 48.

If interruption is performed from the keyboard, the available functions and their mode of operation are as follows:

COPY key

Pressing this key accesses a subprogram that performs the following operations: it checks to see that an original key 45 and a personal key 46 have been introduced in the slots. If either is missing or incorrect, an error occurs and is notified on screen 47. The key check is performed by sending a given code from the microcontroller 50 through the contacts 56 and 57 which connect with the key contacts 4 and 5. If the keys are correct it reads the old codes of the original key and asks the personal key if it possesses any of them, i.e. if at a previous time it has had access to the lock and whether it is now trying to update that access. If the personal key has any of the codes, they are erased. The space of the freed memory is eliminated and a new access index to the external EPROM is generated. If none of the old codes exists, it means that access to this lock is going to be permitted for the first time. Next, the current code of the original key is read and written in the personal key. To perform this last operation, the personal key looks for the right location for the new code, opens up space in the memory, writes the new data and generates a new access index to the EPROM. This entire process occurs at the program or electronic level and is not reflected in the physical elements.

ERASE key

The operation is similar to the previous one but only in the first part. Pressing the erase key accesses a subprogram that reads the current code of the original key, searches for it and erases it from the personal key. The purpose of this operation is to deny the key's access to a given lock.

During this operation and the previous one, if the corresponding key is pressed again, the operation is repeated, yielding an incorrect result which serves as a check. If the user wishes to erase for a second time, a message is displayed on screen indicating that the code does not exist in the personal key. If the user wishes to copy for a second time, the message says that the code already exists and that it cannot be recopied.

NEW CODE key

In case a new lock code is desired, this key must be pressed with the original key inserted into the lock in question. As use of this key entails modification of the previous code and the need to assign this new code to all personal keys with access authorization, a device has been introduced to keep this key from being pressed by mistake. The interruption produced by pressing this key causes the microcontroller to leave the random number generation program writing an 8 byte random number in the SRAM of the microcontroller. This number is written in the original key, replacing the previously current one, which thereby becomes an old code. If an error occurs, as for example when the original key is not in the right position, a message is displayed on screen giving the corresponding explanation.

If this key is pressed twice with the same original key in the codifier, an error occurs and the corresponding message is displayed on screen. This is because it is not possible to write a new code over another unless the original key with the new code has been used in the lock. This prevents the loss of old codes that serve to update the personal keys that still do not have the new code.

OK key

The purpose of this key is to request confirmation that a message has been received. Every time an error message or message saying that an operation has been performed appears on screen, the user must press this key to regain access to the main menu.

Interruptions by serial line

Interruption by serial line 48 leads to 8 different functions.

The first three lead to the same functions and in the same operating mode as described for the keyboard functions. The only difference is that the orders are given by serial line, and error messages or performed operation messages are also received by serial line.

If the user does not wish to make habitual use of the original key, the following three functions may be used: read the current code of the original key, copy the code onto a personal key, or erase the code of a personal key. In this case, the procedure is similar to the previous one, although it is not necessary to have two keys in use simultaneously.

The next function is to read the individual code of the personal key. This function, together with the previous ones, makes it possible to have in a computer a database of the locks and of the personal keys belonging to the system (office, company, plant), and to relate these two databases to know what keys have access to a lock, to what locks a given key has access, etc. This will ensure that the access supervisor can keep total

track of access permits.

The last function is reserved for locks having the restrictions option. When this function is enabled, the computer transfers to the original key the restrictions that it must transfer to the lock in the format indicated in the key description. Also transferred from the computer are time and date information so that, if the user does not delay in inserting the key in the lock, the real time clock of the lock can be updated.

Thus, depending on the case, the original key is inserted in the slot 45 and its points 4 come into contact with the reading devices. The personal key is inserted and its points 4 come into contact with the reading devices. In this way, the circuits of the two keys and the electronic circuit make contact.

If the "Authorize" key is pressed, the code contained in the original key will be available for passing to the personal key by giving the command to do so. The user must then use the menu to answer whether s/he wishes to include restrictions. If not, the "Confirm" command is given and only the code is recorded in the EPROM of the personal key. If "s" were pressed instead, using the codifier's, the computer's, or its own keyboard, the next step would be to type in the restrictions (see Codifier logic). Once finished, the user types "Confirm" to record (i) in the memory of the personal key the code and its restrictions, and (ii) in the codifier memory the authorized key code, the name of the person to whom it belongs and the restrictions imposed. This information is recorded in both EPROMs.

If the Deauthorize key is pressed followed by the entire routine outlined above, by pressing Confirm (i) the code is removed from the memory of the personal key and (ii) the code of the personal key is removed from the memory of the codifier. This is recorded in both memories by the same procedure as above.

If Modification is pressed with only the original key present (or ignoring the presence of any personal key that may be in the corresponding slot), followed by Confirm, the code contained in the original key will be displaced so that the old one is copied in another field and replaced by the new one. This information is recorded in the memory of the original key by the same procedures outlined above.

In another embodiment of the present invention the lock, shown in Fig. 11, has, in principle, the same dimensions and shape as a traditional lock, making replacement simple and easy, and avoiding modifications to the rest of the door's lock components.

Said embodiment shown in Fig. 11 corresponds also to a Europrofile lock with knob, (60), where the lock's electronic components, (25), are located. This development is applicable to any type of lock. A number of traditional features are retained, such as the case (12) where the cylinder (13) of the exterior part of the lock is mounted and which makes the cam (14) rotate once it engages blockade mechanism (22). The case (12) retains the protection features, such as the hard metal

drilling proof pin (16). The key's entry groove (17) retains a lateral key positioner (18) that prevents the key from exiting while rotated and a vertical one (64) which positions the key to ensure that key contacts make contact correctly with the lock contacts and which also works as a switch.

The lock cylinder is conceived as a single cylinder which goes from one end of the lock to the other or a two-part cylinder, one corresponding to the outer part of the lock, (13) and the other to the interior part (66) which is shown here by way of example.

Choosing a single cylinder, or a cylinder in two parts, one exterior and the other interior, is purely a question of internal part assembly procedure and is therefore irrelevant from the point of view of this patent.

The cam (14) is joined to the knob structure (60) so that from the knob the cam is worked to open or close just by turning. The cylinder (13) and (66) rotates wild in the case (12) and the knob (60) structure unless an authorised key is inserted into the groove (17) which, as per patent no. 9601474, would activate the interlocking system described below and which meshes the cylinder with the knob structure, thereby transmitting the rotation force to the cam.

Five pins perforate the cylinder (13), two of which (19) are information entry/exit pins and correspond to two key contacts.

Another pin (20) is a zero volts contact pin and corresponds to a key contact. The fourth pin (64) corresponds to a vertical key positioner which is also a switch; so that the system is activated when the key is inserted in the groove (17) and pressures the pin set in the positioner.

The first three drills are simple electrical contact parts and must therefore be isolated from the cylinder, which means they have to be covered with a sheath before being inserted in the pins. Owing to the narrowing in the part of the key entry groove, this sheathing also prevents it from coming out more than 1 mm-just enough to place pressure on the key and establish contact with it. Such contact does not hinder cylinder rotation. Contacts (19 and 20) send their signals to data transmission cable (24) to electronic circuit (25). The entire unit is monitored by this electronic circuit.

Interior cylinder (66) contains a number of features such as a key reader module (70) identical to the one described in Spanish patent no. 9601474, located in external cylinder (13) and which works to obtain a presence control system if desired, which means its application is optional. An electric motor (28) works the interlocking action described below. The example where the interior key reader is missing is given in Fig. 12 which otherwise is the same as the example in Fig. 11.

In non-electrified doors, the unit is supplied with energy by batteries (26). If the lock battery is too low to provide the charge required for operation, energy is provided by the key itself, once inserted in the groove, by pressing the switch which sends, say, three volts

through the metal part of the key, as explained in the principal patent. The lock may also receive energy from a small continuous power supply unit. In electrified doors, a traditional system using an electric motor or solenoid may be used to open the lock. If a battery is included, as shown in the drawing, a low-charge warning indicator (27) (Fig. 11) is added, which lights up when the battery charge is lower than, say, 20%. Both battery and low-charge indicator are in the knob and so oriented preferentially towards the interior of the dwelling, batteries being changed through the side giving onto the house or flat. The batteries do not necessarily have to be located in the knob (60), but may be in the interior part of the door, thereby enabling the installation of a larger, longer-lasting battery.

If an unauthorised key is inserted in groove (17) of external cylinder (13), the cylinder (13), together with interior cylinder (66) and electronic unit (25) located inside the knob, rotates freely without engaging any mechanism and therefore without moving the cam (14). However, the lock can always be opened or turn-locked from the interior via knob (60) by hand only, so that the turn of the knob engages cam (14). When an authorised key is inserted into the external part, motor (28) would activate interlocking system (61) and both external cylinder (13) and internal cylinder (66) would be engaged, enabling them to move cam (14) and turn to open or close the lock.

The interlocking system detailed in Figs. 13 to 16 is activated by motor (28) in the lock axis in the interior cylinder (66) and which gives a quarter of a turn only on engaging the interlocking system as described below. The shaft has a rectangular strip (65) with a spindle (62) partially inserted in the 90°-wide arched groove (63) in the cylinder (13), acting as a mechanical stop to the angular movement of the spindle (62) and, therefore, to the rotation of the motor. At the same time, as the spindle (62) moves into the position shown in Figs. 13 and 15, it acts as a stop to pin (22) which, prevented from moving, leaves the casing of knob (60) (which forms a single piece with the cam) joined by blockade with cylinders (13) and (66).

The motor (28) is activated only when an authorised key is inserted in groove (17), in one direction as the key is inserted and in the opposite direction when the key is taken out.

Claims

1. Single Key System comprising a lock, two types of keys and a codifier, including the lock an electronic circuit where an access code and identification codes for each personal key with its restrictions are stored, and an action mechanism on the lock cylinder, controlled by the electronic circuit, which enables or prevents turning and is activated when the key introduced possesses the lock code and has

access permission at that moment; including the lock key an electronic circuit which stores the access code for one or several locks with their hourly and daily restrictions; and a codifier with an electronic circuit gives, removes or modifies personal key authorizations, imposes hourly and/or daily restrictions that may be different for each key, controls authorized keys and communicates such information to the lock as well as setting hour and date.

2. Single Key System as in claim 1, characterized because it includes one or several personal keys each containing its own code identifying each personal key and multiple access codes for a series of different locks.

3. Single Key System as in claim 1, characterized because it includes an original key that stores the code of a single lock, wherein the presence of said key is necessary for the operation of the codifier.

4. Single Key System as in claim 1, characterized because it includes the device here named as the codifier which is the essential element for managing authorizations (lock code incorporations on personal keys), deauthorizations (code removals from personal keys), lock code modifications and for the introduction and/or modification of hourly and/or daily restrictions.

5. Single Key System as in claim 1, characterized because it includes a lock of the same shape and size as any of the available mechanical ones making replacement very simple, and which consists of a cylinder with an insertion pathway for the key drilled by 5 corresponding points to 3 electronic contacts and two pivots, being one of them the cylinder blockade pin and the other working the cylinder blockade pin mechanically; and an electronic circuit plus one or several batteries if the door is not electrified.

6. Single Key System as in claims 1 and 4, characterized because the lock and/or personal key include access restrictions, such as limitations on hours and days, being said restrictions introduced by the codifier into the memory of the original key's electronic circuit, whereby said restrictions are transferred to the lock circuit memory or are introduced by the codifier to the memory of the personal key, respectively.

7. Single Key System as in claims 1 and 5, characterized in that the key has four contacts for connecting with the lock, one of which works through the metallic casing, through which positive power is supplied, and the other three arranged on the printed circuit in the key insertion section of the lock which

facilitates: negative power supply, synchronous clock signal of a synchronous series communication and two-way data communication signal, having the lock also the same four contacts as the key, and in that both circuits receive power supply and a synchronous series communication is established between the two, when the key is inserted, and in that the electronic circuit also has other contacts for controlling the lock cylinder blockade mechanisms.

8. Single Key System as in claim 1, characterized in that the lock cylinder blockade means consist of a pin axially slidable between two extreme positions: a blocking position, wherein it passes through the cylinder or the rotating element of the lock preventing its rotation, and a retraction position, wherein it retracts outside of said rotation element of the lock, allowing it to rotate, being the pin worked by a motor or an electromagnet activated by the lock's electronic circuit or by a back spring capable of displacing the pin from retraction portion to the blocking position.

9. Single Key System as in claims 5 and 7, characterized in that the lock contacts corresponding to the synchronous clock, the data signal and the negative power supply are established by a further number of pivots set in perforations in the lock and partially projecting through the insertion pathway for the key, whose pivots enable the lock cylinder to revolve and which rest on the corresponding contacts of the key, when it is inserted in the lock.

10. Single Key System as in claims 1 and 5, characterized in that the lock's own code can be modified via its original key, which is given a new code by the codifier and which is then transferable to the lock via insertion of the original key into it and which accepts the new code on recognising the old code, which is stored as well in the original key's memory.

11. Single Key System as in claims 1 and 5, characterized in that the lock includes an automatic, mechanical operation system that works the cylinder blockade system to correct power failures either in the lock or in the key battery.

12. Single Key System as in claims 1 and 5, characterized because the lock may be connected to a computer to facilitate data transmission in real time of access and presence control regulation, as well as modification from the computer of the list of authorized personal keys and their restrictions.

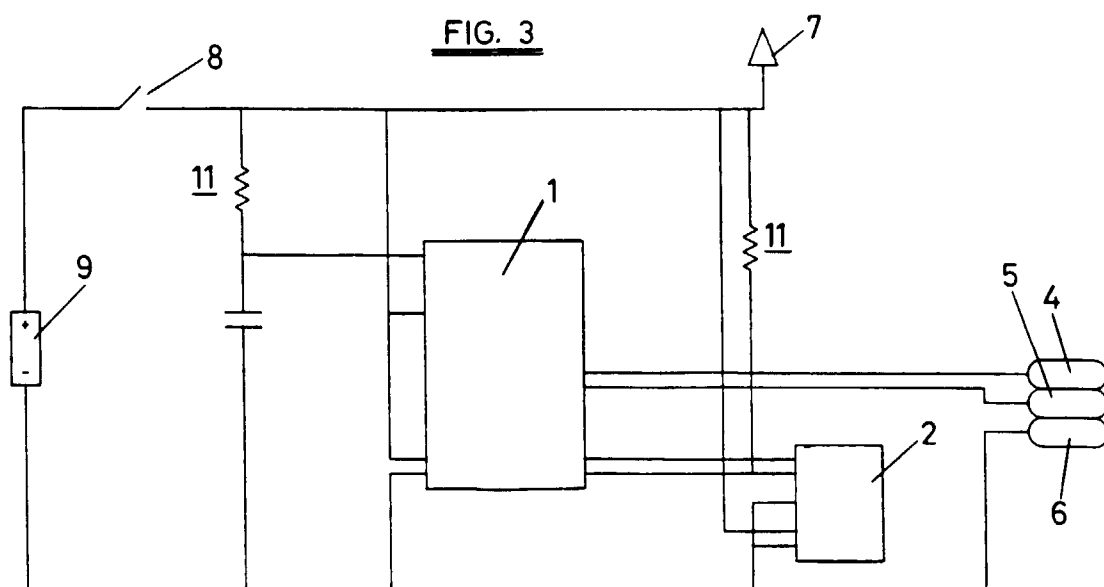
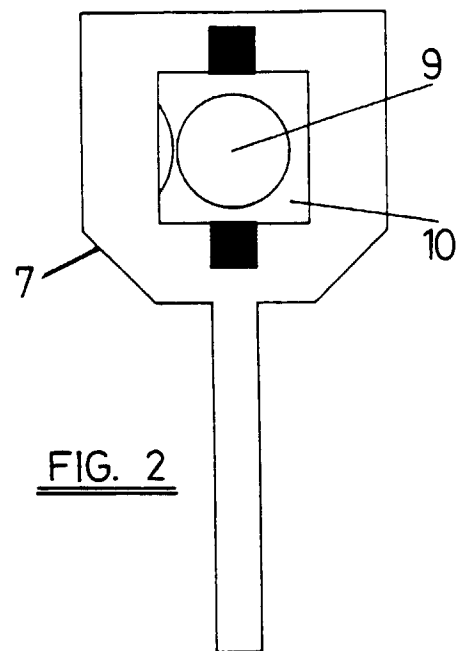
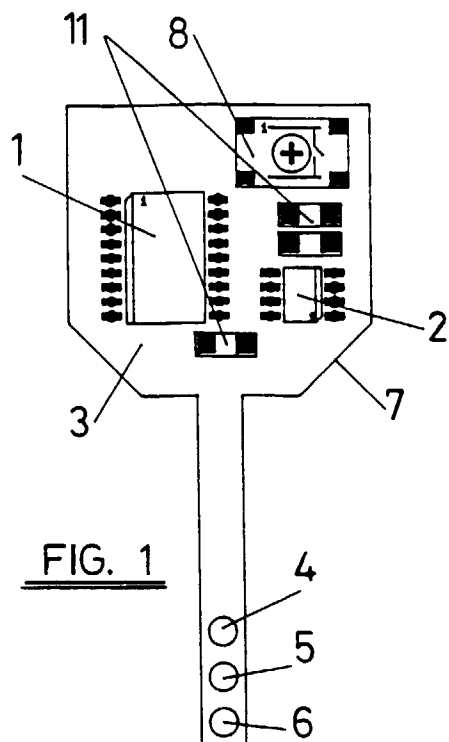
13. Single Key System as in claims 1 and 4, characterized because the codifier may be connected to a computer so that authorizations and hourly restrictions can be introduced in the original and/or per-

sonal key from the codifier control panel or from the computer.

14. Single Key System as in claims 1 and 4, characterized because the codifier may invalidate a specific key and modify the restrictions placed on that personal key and communicate the removal or the changes in restriction to the lock, all without the presence of the personal key. 5
15. Single Key System as in claims 4, characterized because the codifier stores information on which keys are authorized and their restrictions make it possible that said information is communicated to the lock by the original key. 10
16. Single Key System as in claims 1 and 4, characterized because the mode of generation of the codes is random and hidden, and the access code comprises a sufficient combination of bits giving a large number of combinations (8 bytes give 18 trillion possible codes), and code transfer between personal key and lock is coded according to a specific algorithm, so that the lock cannot "know" the other codes of the personal key, the key cannot "know" the lock's own code and no "observer" with the right tools can generate a key with the correct code. 15
17. Single Key System as in claims 1, 5 and 14, characterized because the lock can detect the code of a specific personal key and not enable access even if the personal key in question contains the lock access code, thereby creating a security measure if the key is stolen thus not only refusing access when the robbery of a specific personal key is communicated to the lock, this stolen key is inserted but setting off alarm mechanisms, telephone calls, sound devices etc. 30
18. Single Key System as claim 3, characterized in that the original key, in case the lock is not connected to a computer, becomes the basic element for communicating changes in the lock code to the lock itself, for setting hour and date and providing the list of authorized personal keys and their restrictions. 35
19. Single Key System as in claims 2 and 3, characterized in that the key's electronic circuit is powered by the lock via batteries or lock electrification and because the key itself has a battery. If the lock power supply fails, this battery can be used to provide energy for the lock by pressing a small switch on the key handle. 40
20. Single Key System as in claims 5 and 11, characterized in that the lock may or may not be electrified, in which case the lock is fitted with batteries which must be changed regularly as shown on the charge 45

indicator although, should the battery run down completely, the lock will receive power from the key and will operate the cylinder blockade pin mechanically on removing the key, thus ensuring that the door closes properly.

21. Single Key System as in claims 1, 2, 5, 7 and 16, characterized because, via the communication protocol between lock and personal key, the lock recognises if a key is authorized by identifying the lock code in the key, in which case it examines the access restrictions for the key, including hourly and daily limitations, and compares them with the real hour and date at that moment so that these values fall within the range of unrestricted hours and days, the lock's electronic circuit emits the order to unblock the lock cylinder, thus giving access to that particular key. 50
22. Single Key System as in claim 1, characterized in that a single personal key may open all doors with electronic lock to which the key holder has authorized access. 55
23. Single Key System as in claim 1, characterized in that the motor (28) is located coaxially in the interior of the cylinder or cylinders of the lock and works an eccentric axial spindle (62), linked to the motor (28) axis, which is housed partially in a 90°-wide arched groove (63) in the cylinder and which acts as a mechanical stop to the motor, limiting its rotation to a quarter of a turn in either direction, as well as a blockade pin (22) for the case (60) of the knob with cylinder or cylinders (13, 66). 60
24. Single Key System as in claim 23, characterized in that a lateral positioner (18) and a vertical positioner (64) are set in groove (17) in corresponding drills and which position the key in the groove, and where positioner (64) also works as a switch activating the system when a key is inserted in groove (17) and pressures a pin set in the positioner. 65
25. Single Key System as in claims 23 and 24, characterized in that the key reader module (70) is only fitted in the exterior part of the lock. 70



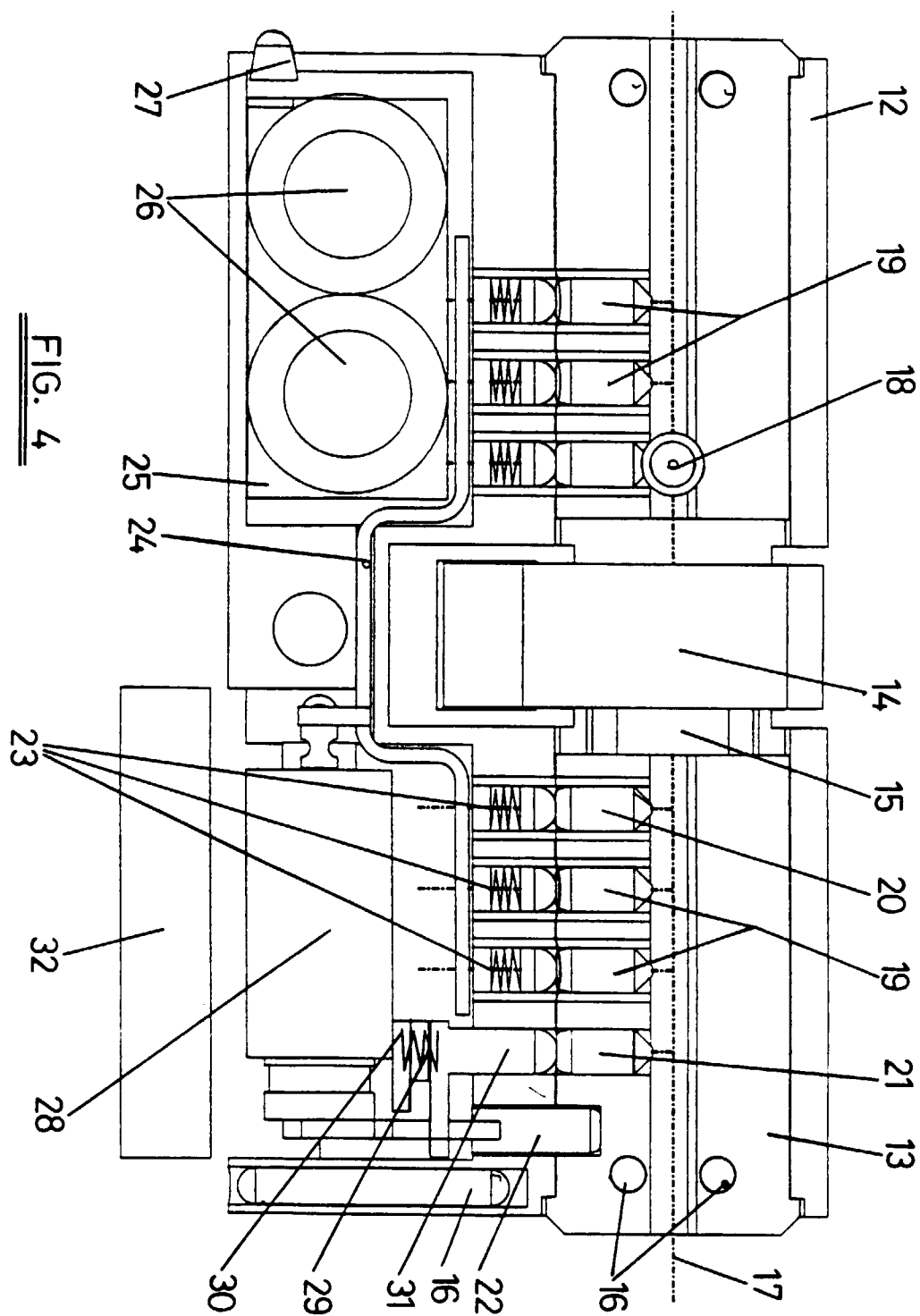


FIG. 4

FIG. 5

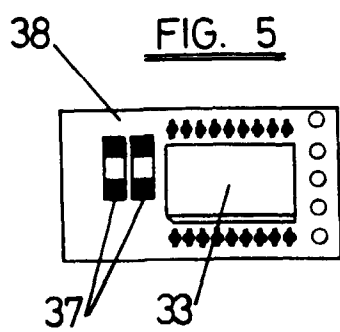


FIG. 6

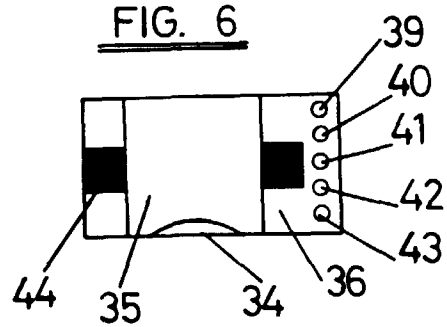
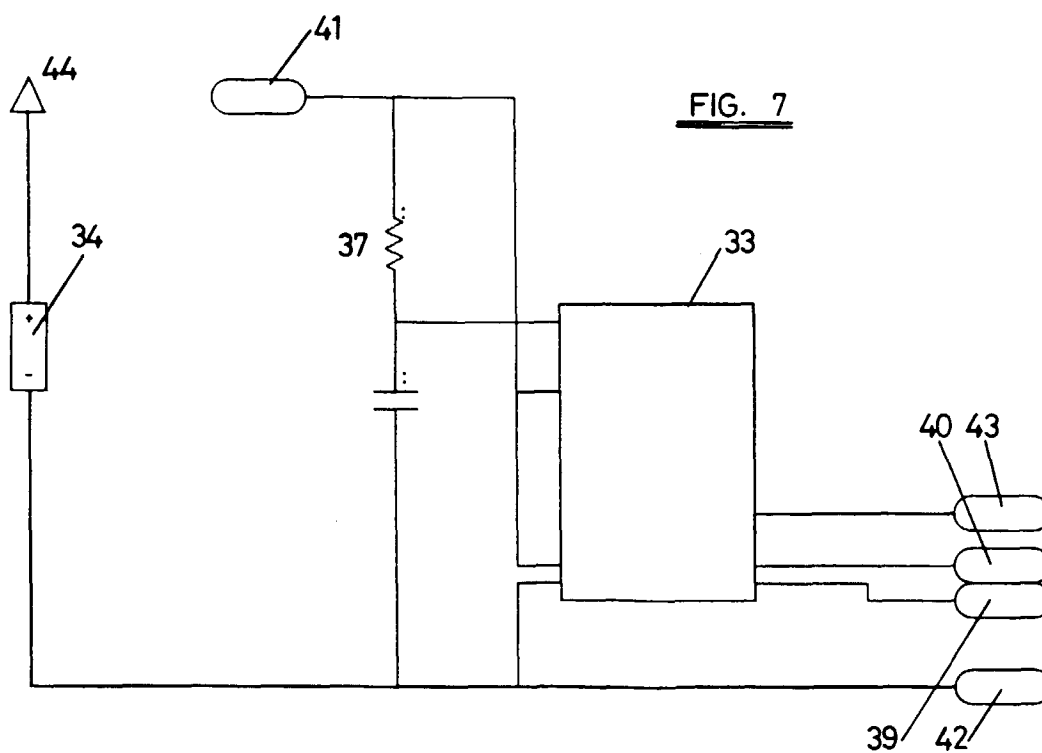
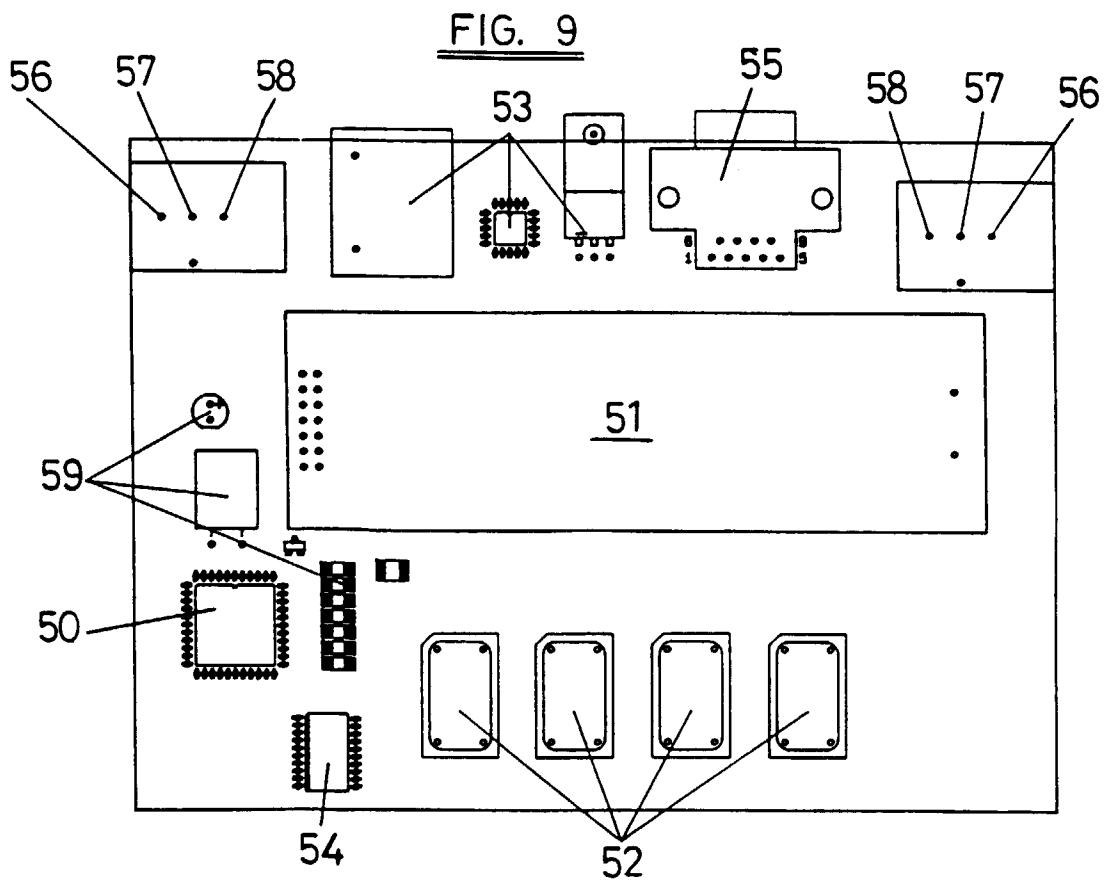
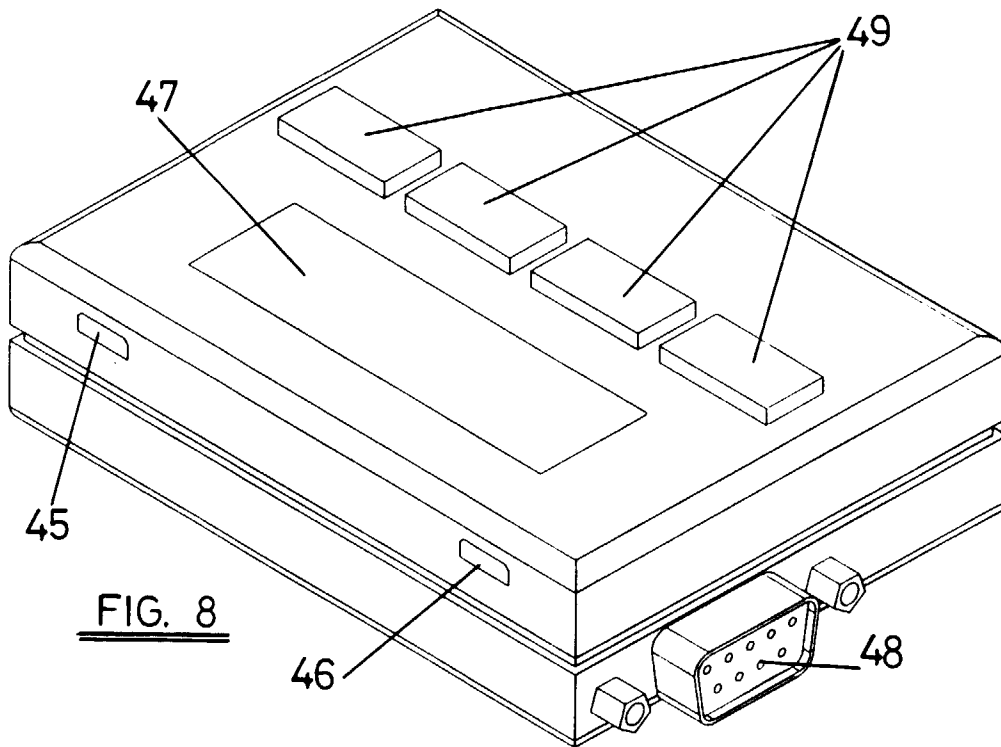


FIG. 7





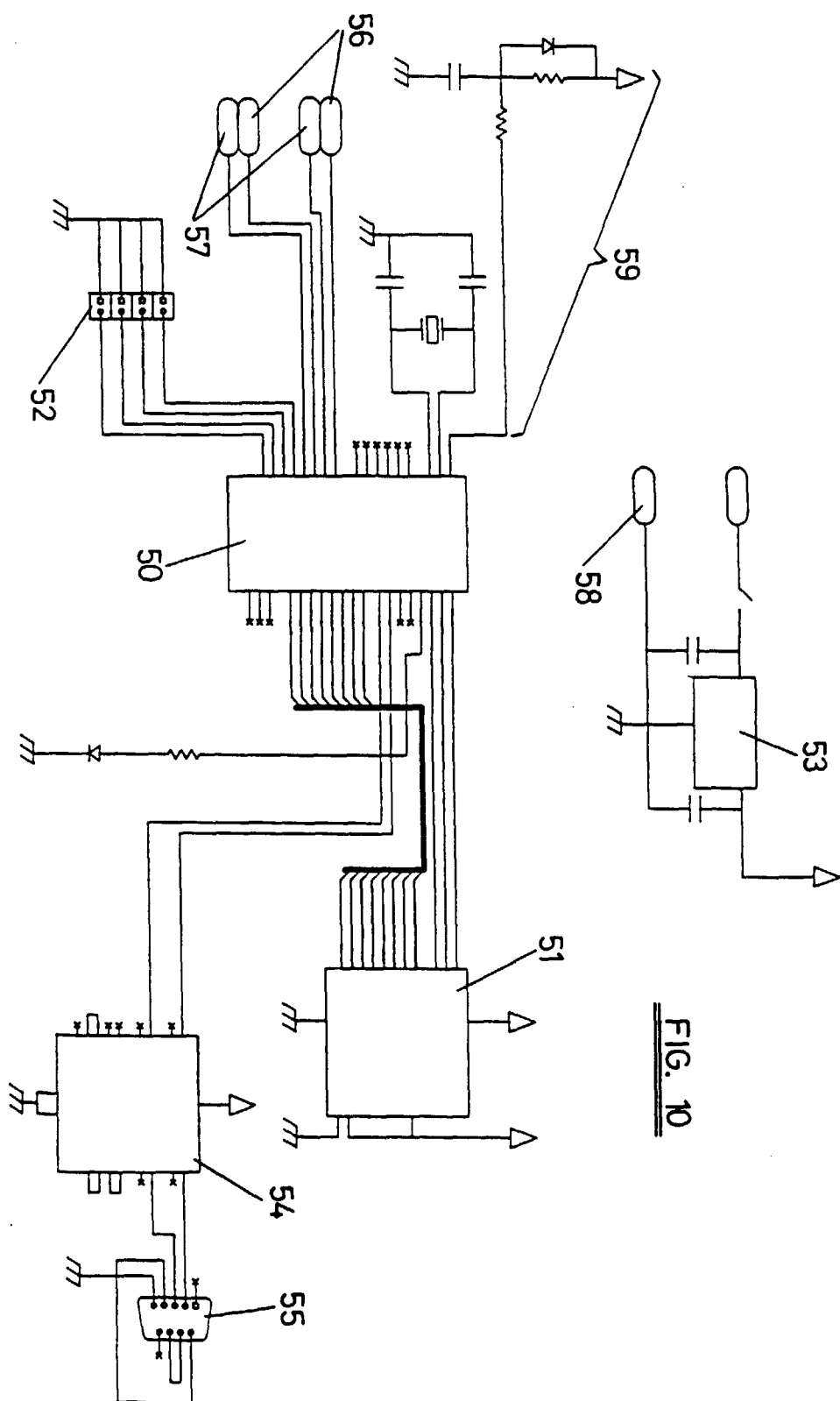


FIG. 10

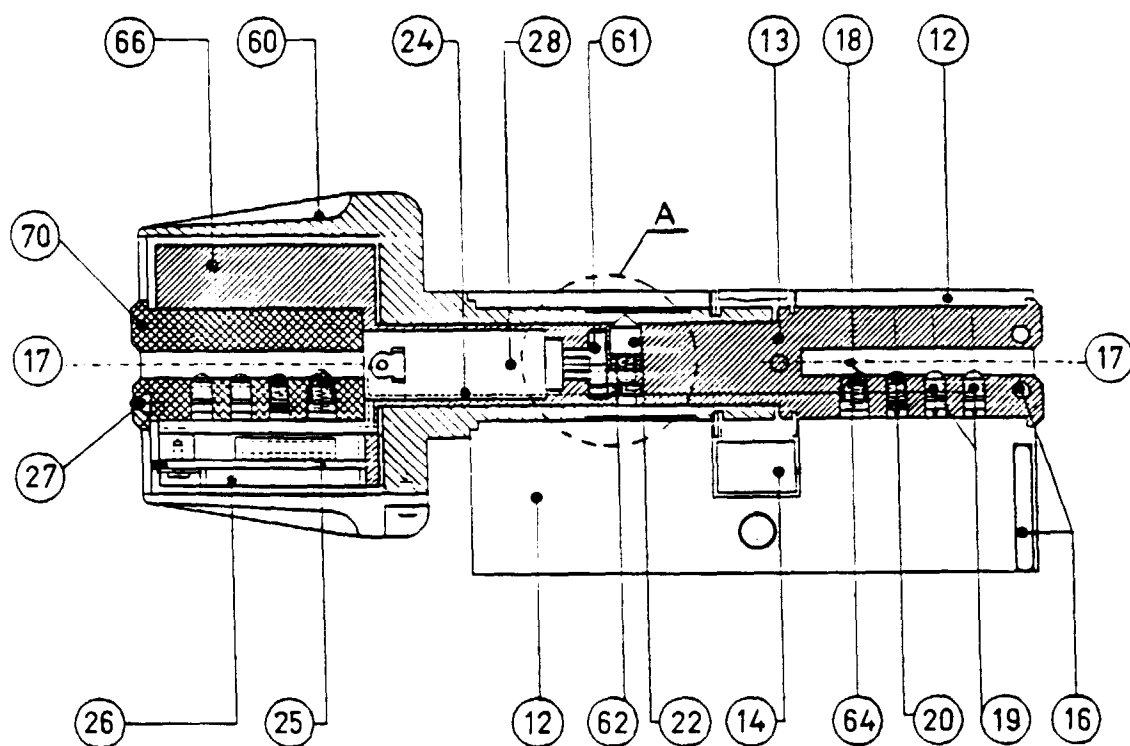


FIG. 11

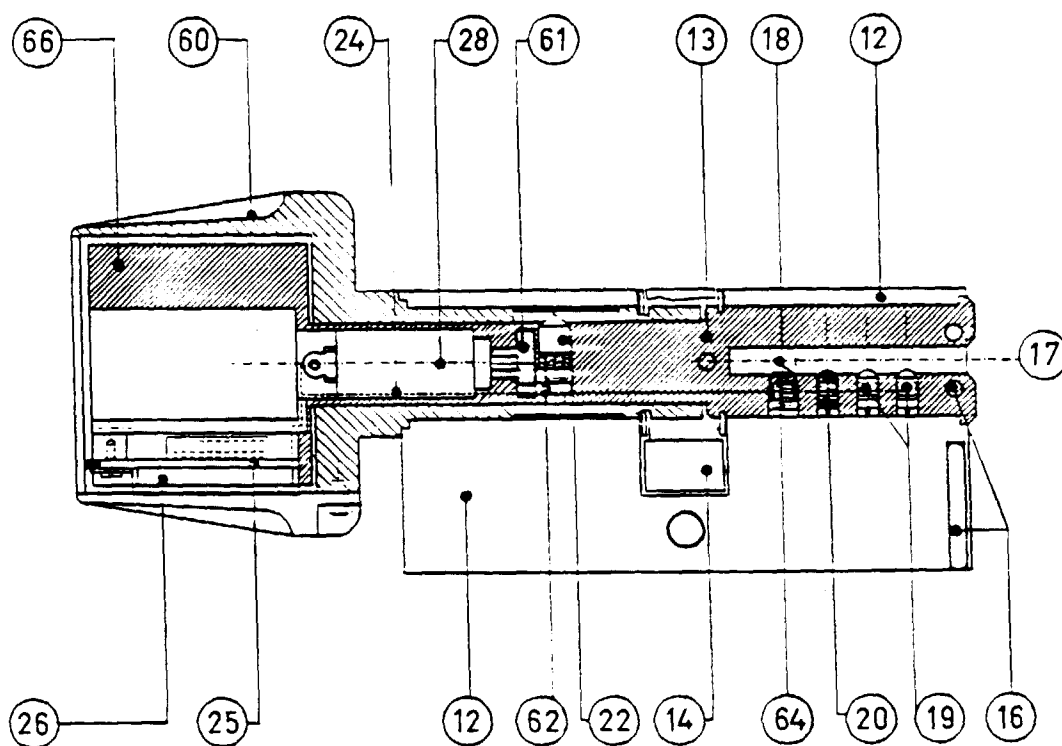


FIG. 12

