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Pazer et al.

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[45] **Oct. 22, 1974**

[54] **REMOTELY PROGRAMMABLE LOCK**

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[73] Assignee: **Instrument Systems Corporation**, Jericho, Long Island, N.Y.

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[52] **U.S. Cl.** ..... **70/264**, 70/276, 70/382, 317/134, 340/149 A

[51] **Int. Cl.** **E05b 47/04**

[58] **Field of Search** ..... 70/263, 264, 276, 277, 70/382, 413; 317/134; 340/149 A

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Primary Examiner—Albert G. Craig, Jr.

Attorney, Agent, or Firm—Blum Moscovitz Friedman & Kaplan

[57] **ABSTRACT**

A remotely programmable lock is provided for use with a key having one or more permanent magnets for producing a magnetic field of predetermined configuration. The lock is provided with a cylinder for receiving the key and capable of rotation independent of the latch. A device is provided for coupling the latch and cylinder upon detection of a magnetic field of a predetermined orientation produced by the key. The configuration of the magnetic field which will open the lock may be remotely set in coordination with the polarization of the permanent magnets of the key.

22 Claims, 16 Drawing Figures

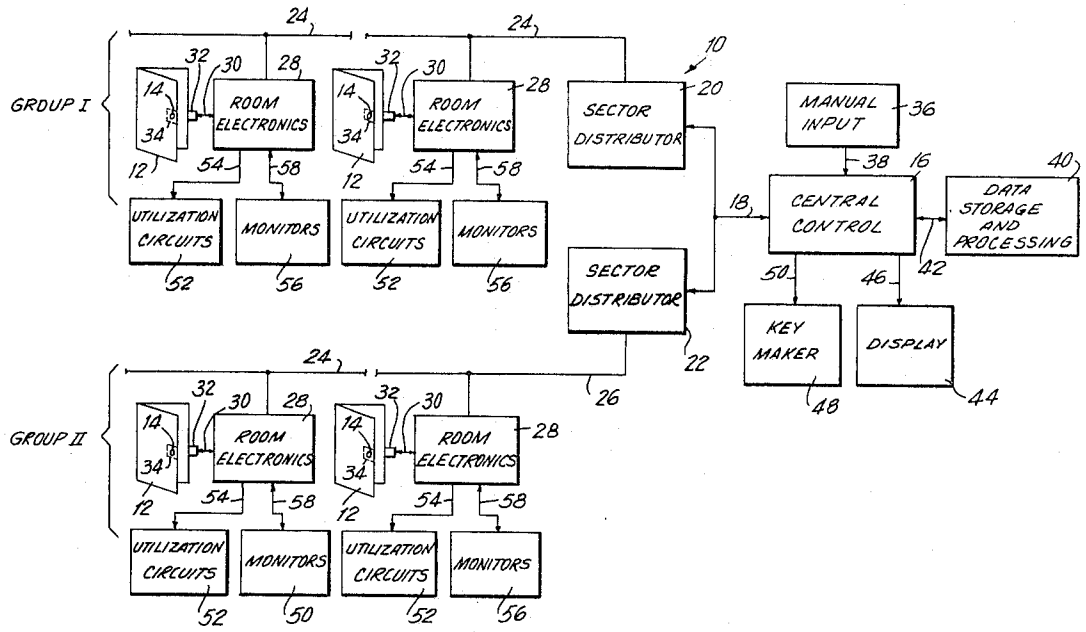
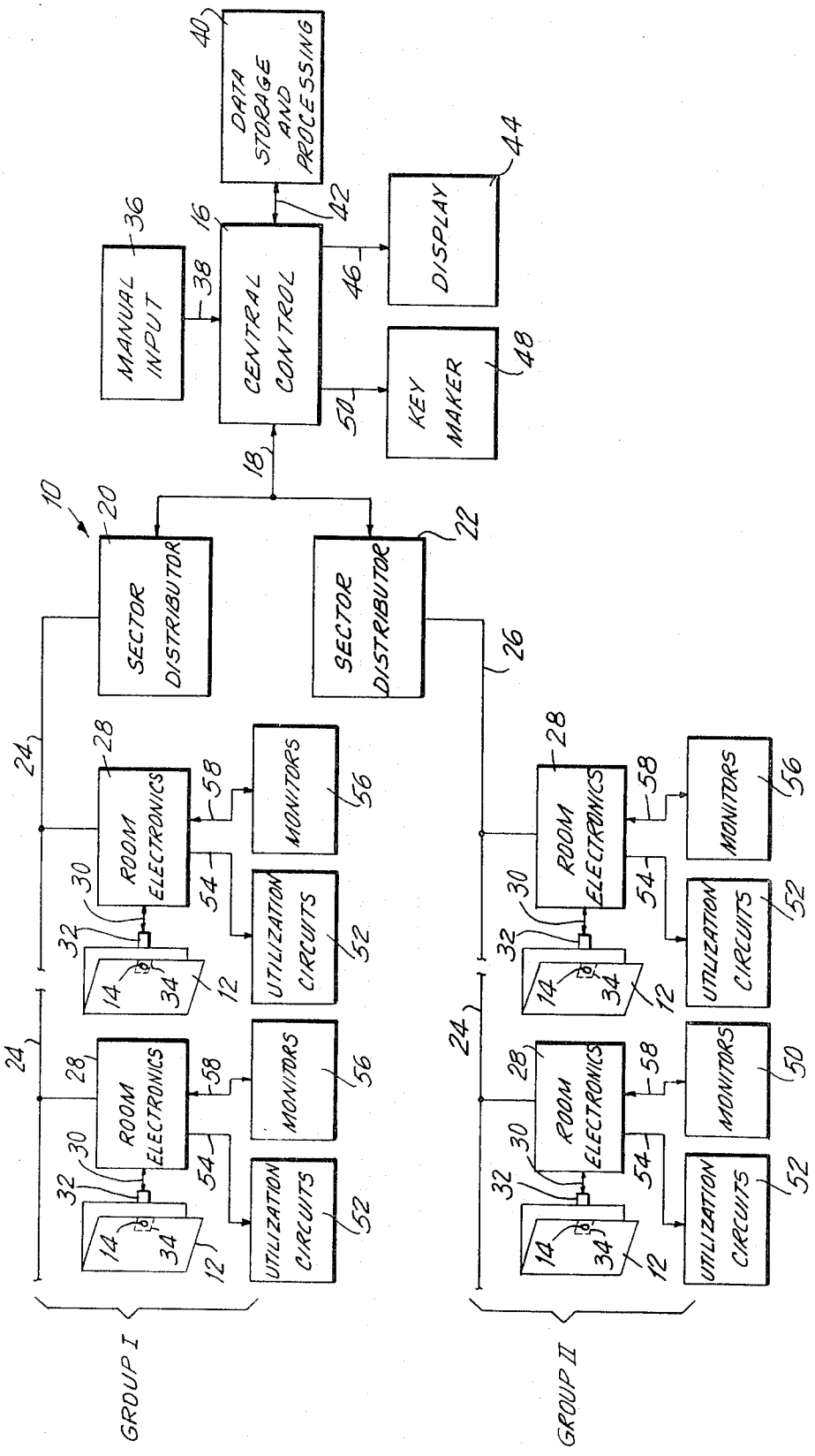


FIG. 1


DATA STORAGE AND PROCESSING
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CENTRAL CONTROL
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MANUAL INPUT
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DISPLAY
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KEY MAKER
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SECTOR DISTRIBUTOR
22
SECTOR DISTRIBUTOR
26
24
28
ROOM ELECTRONICS
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MONITORS
56
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UTILIZATION CIRCUITS
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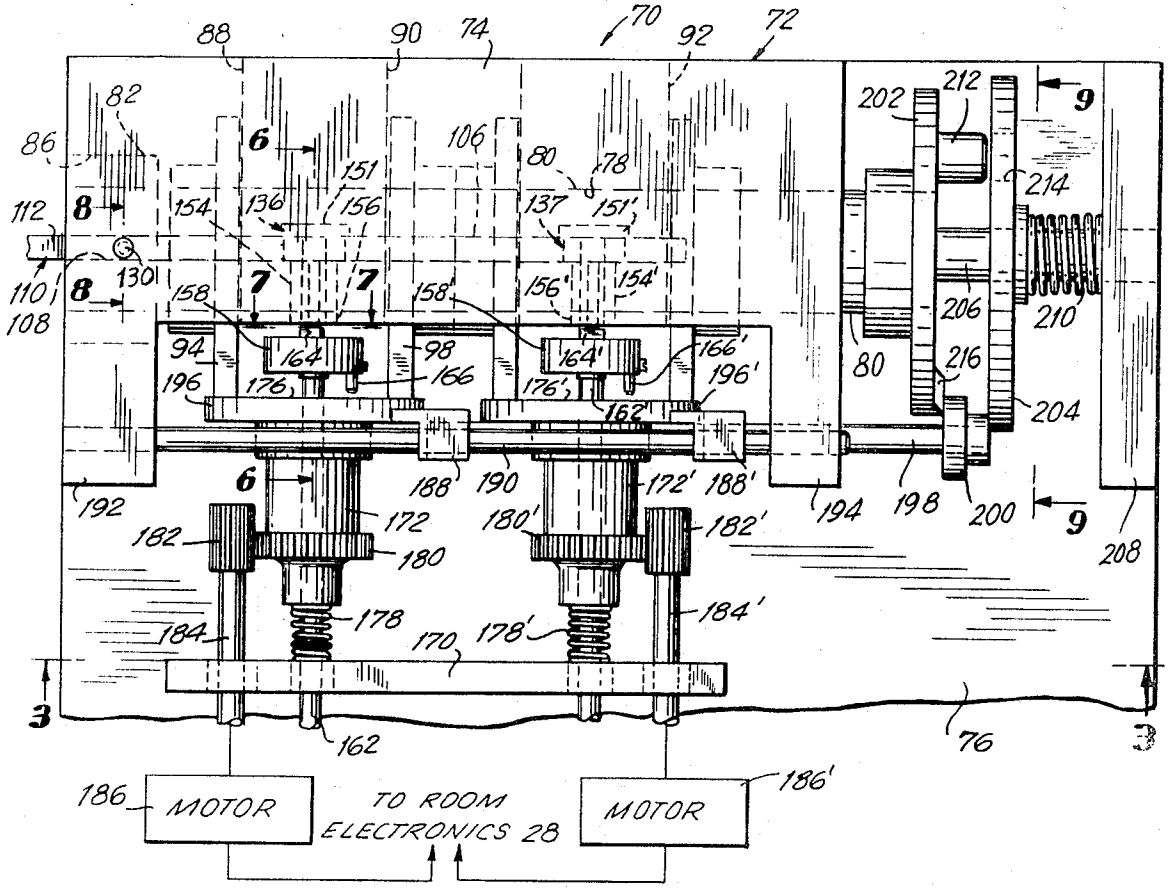
GROUP I
GROUP II

FIG. 2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MOTOR
TO ROOM ELECTRONICS 28
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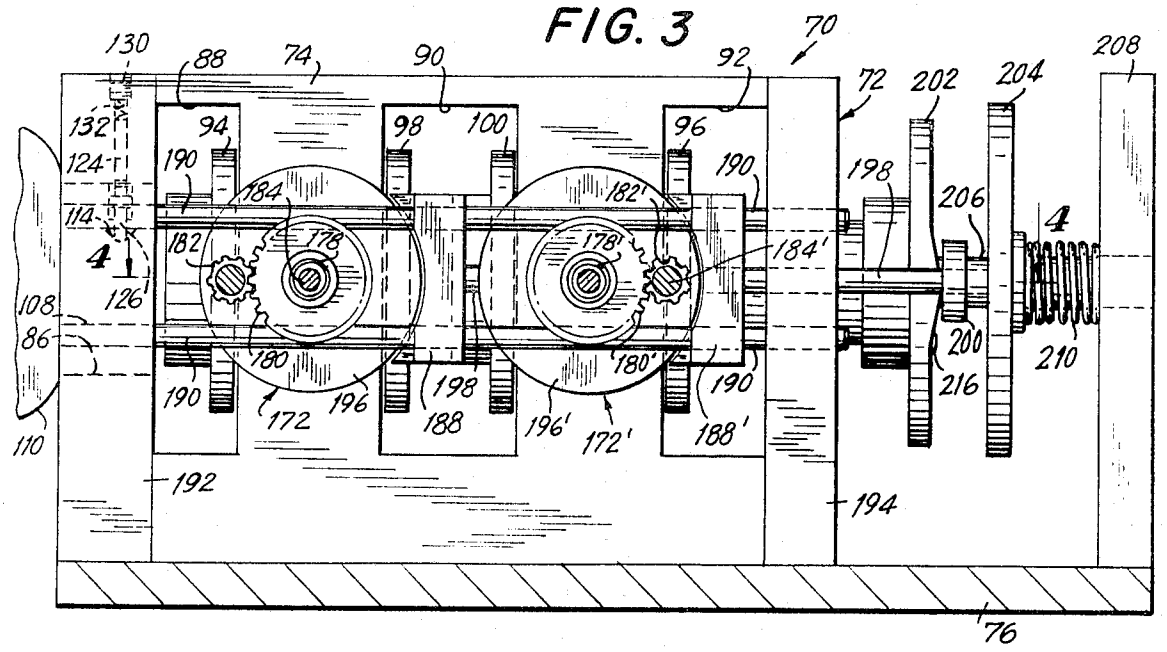
FIG. 3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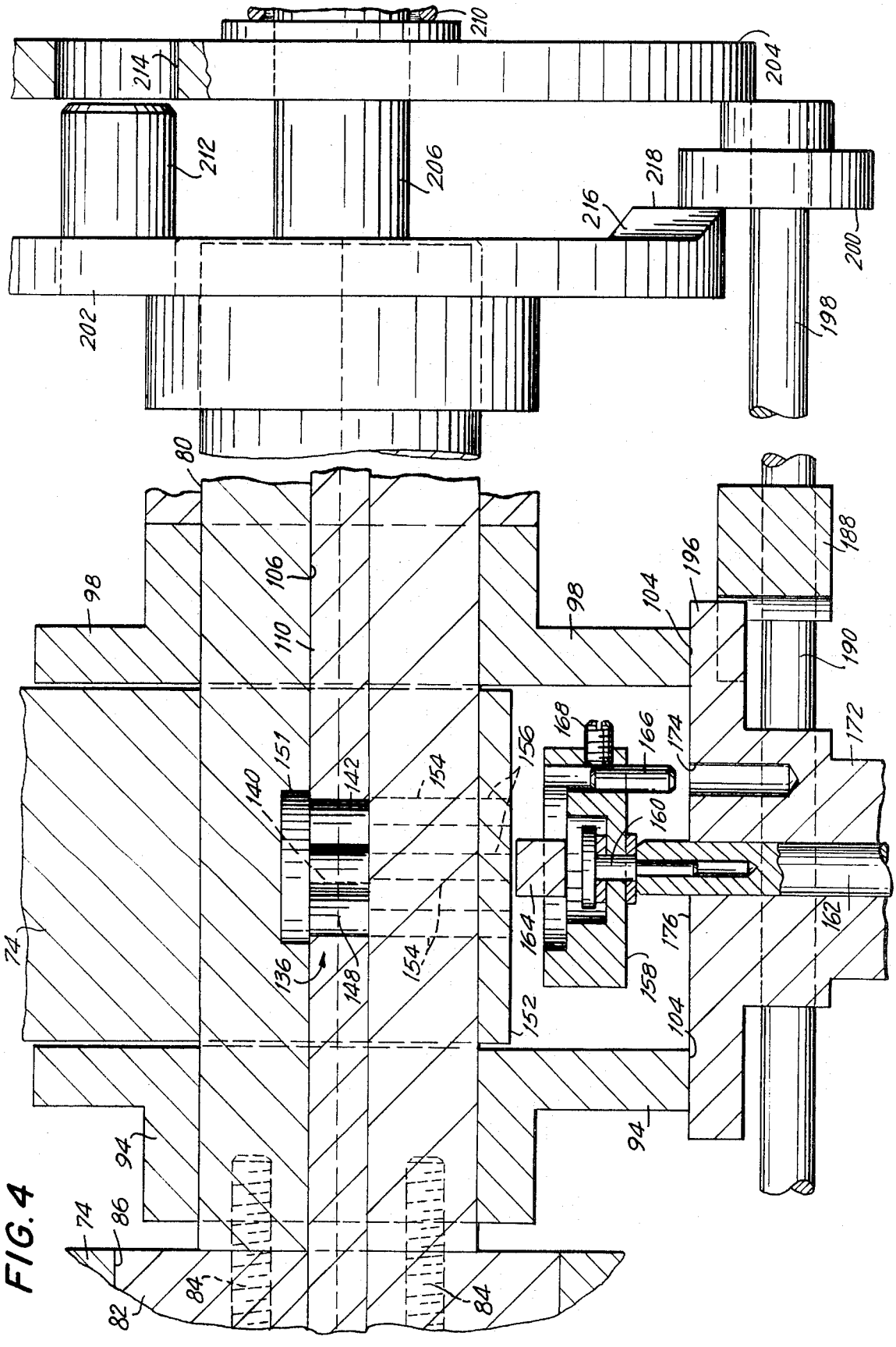
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FIG. 4

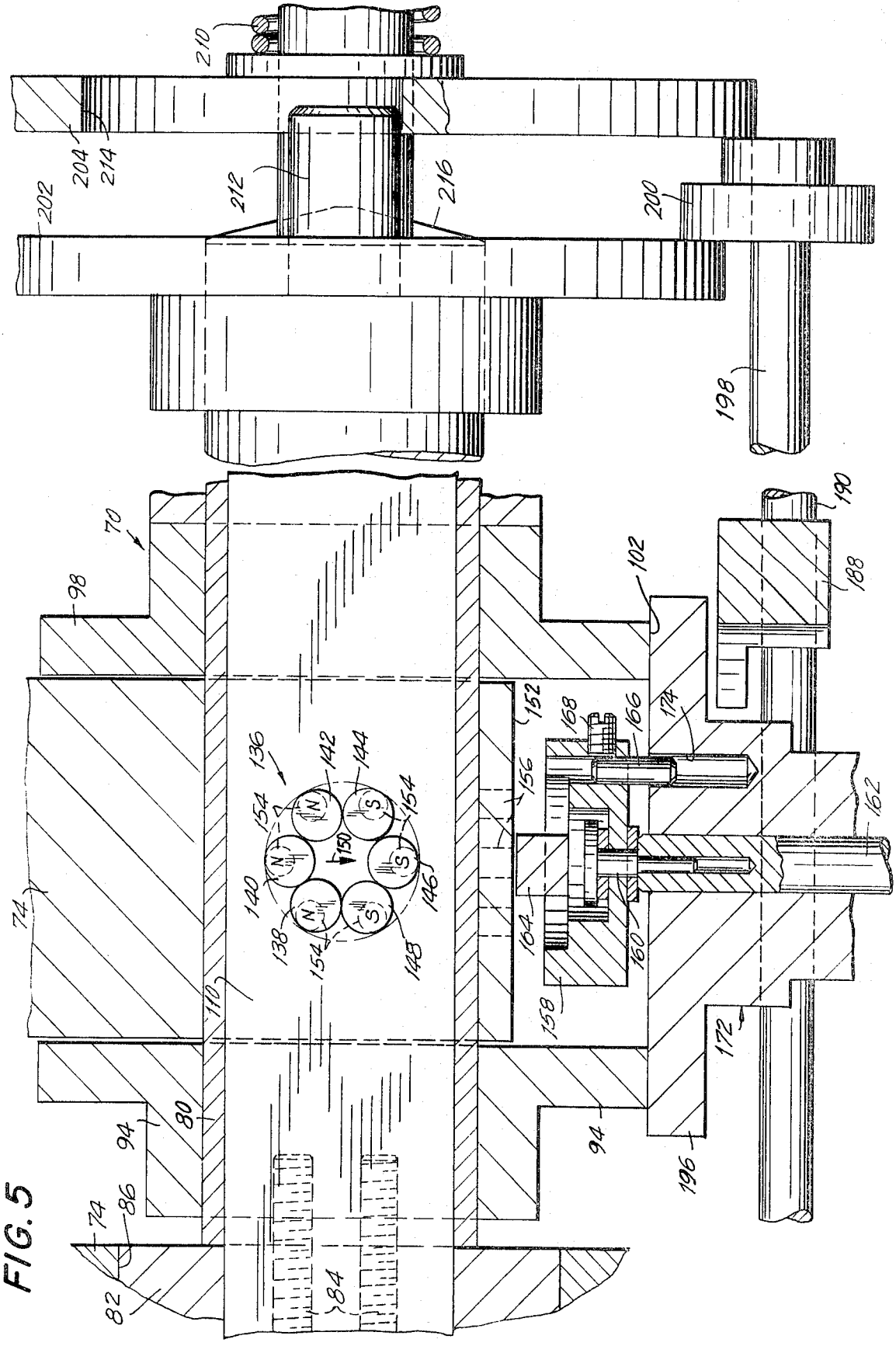
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FIG. 5

FIG. 6

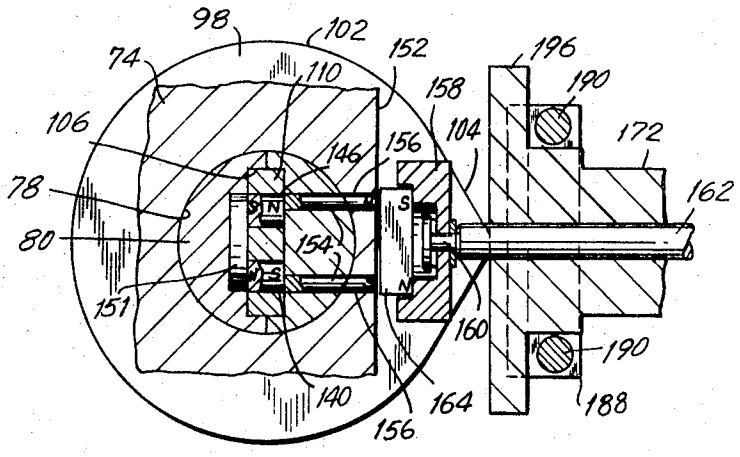


FIG. 7

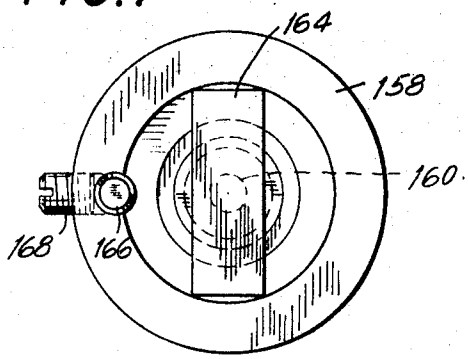


FIG. 10

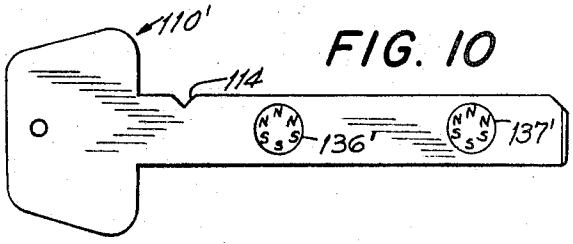


FIG. 8

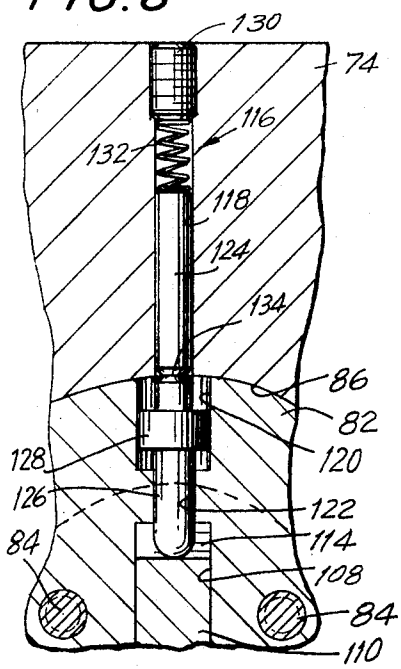
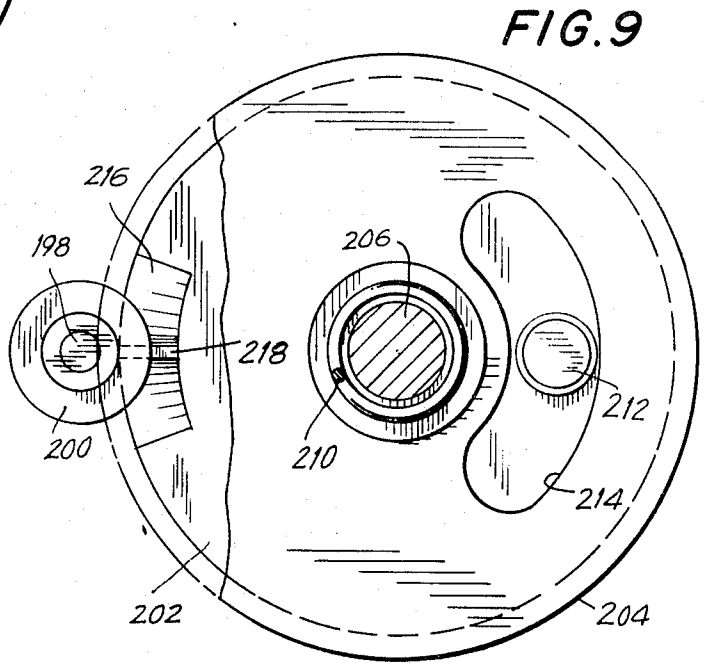


FIG. 9



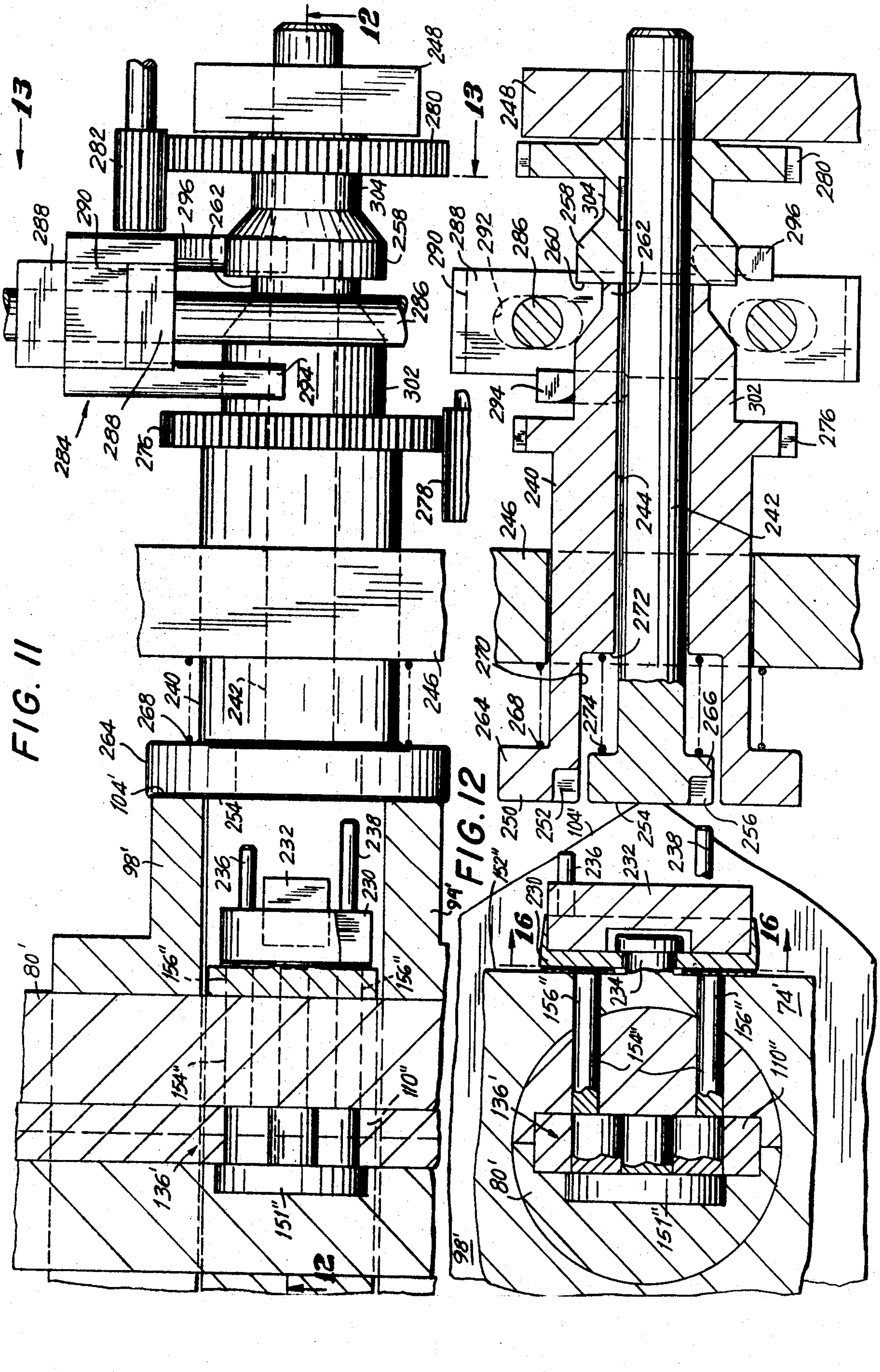


FIG. 11

FIG. 12

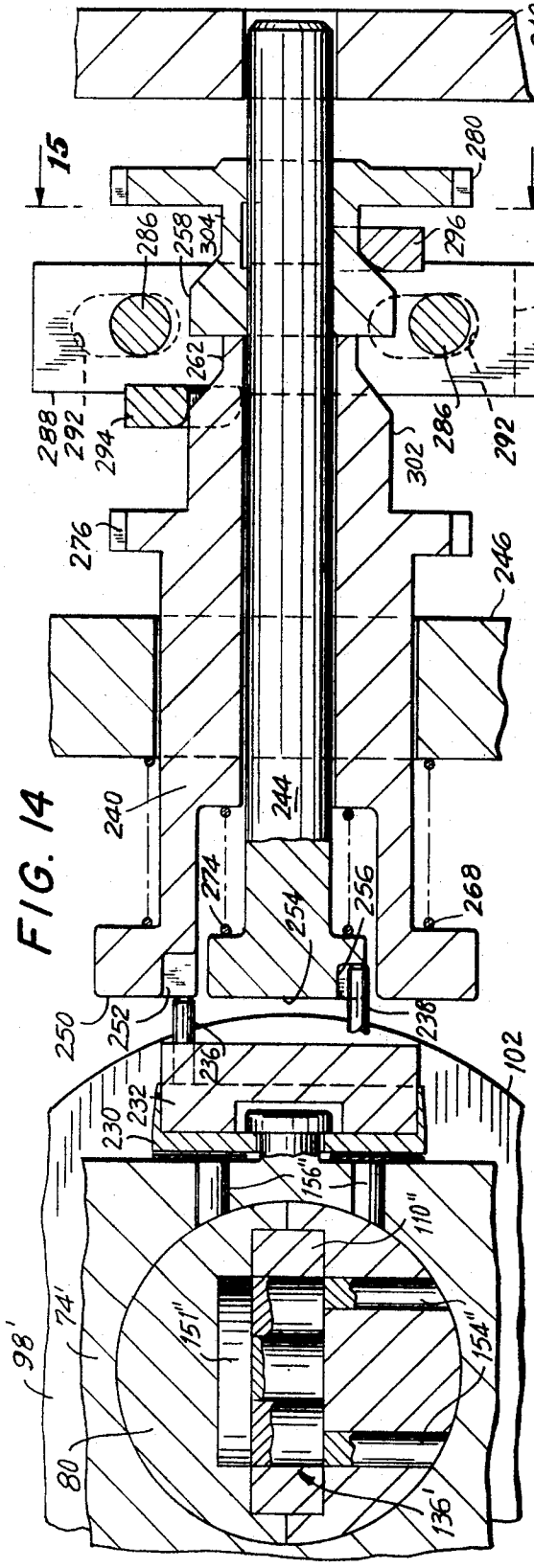


FIG. 14

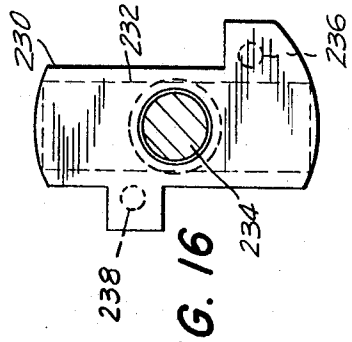


FIG. 16

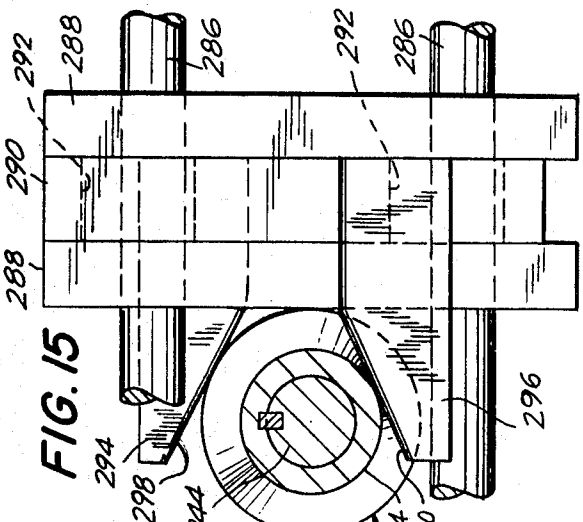


FIG. 15

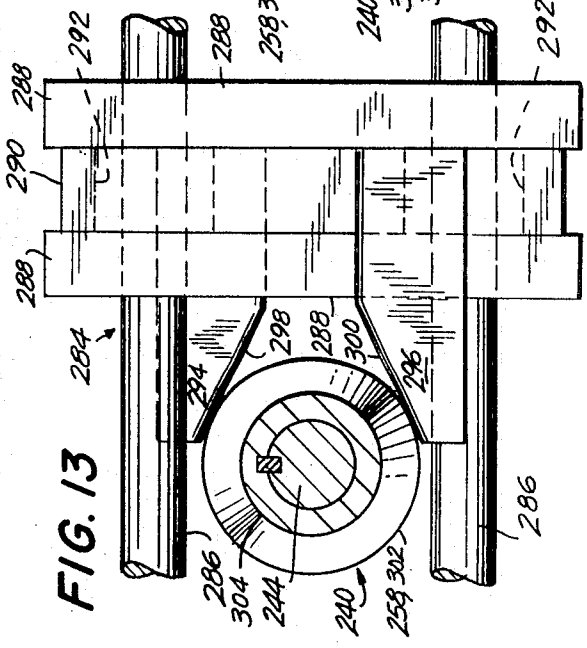


FIG. 13

REMOTELY PROGRAMMABLE LOCK

BACKGROUND OF THE INVENTION

This invention relates to locking devices particularly adapted for application to hotels, security areas, and the like wherein it is desirable to periodically change the configuration of the key which will open one or more locks. For example, in the case of hotels, room keys are frequently lost, stolen or copied presenting substantial risks of theft to hotel guests. Both economic and practical considerations preclude the manual changing of lock combinations in an effort to prevent such theft. Electronic lock systems wherein the key consists of a card having a magnetic, punched hole or embossed code thereon have also been proposed, but such systems are not suitable for hotel operations since power is generally required to release the door latch, thereby presenting both practical and safety problems in case of power failure.

Further, most conventional locks are based on a cylinder coupled to the latch which is prevented from rotation by pins disposed in the parting line. The keys of such arrangements serve to displace the pins out of the parting line. By the application of large forces to the cylinder, such locks can be broken and the latch displaced to open the door.

By presenting a truely remotely programmable lock arrangement wherein the cylinder is not normally coupled to the latch, all of the foregoing difficulties are avoided.

SUMMARY OF THE INVENTION

Generally, in accordance with the invention, a programmable lock for use with a key having at least one permanent magnet means adapted to produce a magnetic field of a predetermined orientation is provided, having latch means, a fixed lock member, a displaceable lock member formed for receipt of said key and displaceable relative to said fixed member independent of said latch means, means selectively coupling said displaceable lock member and said latch means and means for normally blocking the operation of the coupling means and for selectively permitting such operation in response to said predetermined orientation of said magnetic field produced by said key permanent magnet. Lock programming means is coupled to said blocking means for selecting the magnetic field orientation in response to which the displaceable lock member and latch means are coupled. Key programming means is provided for disposing the permanent magnet means of said key means so as to produce a magnetic field of an orientation corresponding to the orientation of the coupling means, said lock programming means and key programming means being coordinately operable.

The permanent magnet means in said key may consist of an array of permanent magnets, said key programming means being adapted to establish the polarity of said permanent magnets so as to produce a magnetic field of the desired orientation. The displaceable lock member may consist of a cylinder rotatably mounted in a housing. The blocking means includes a magnetic rotor freely rotatably mounted in registration with the permanent magnet means of a key received within said cylinder for rotational positioning in accordance with the configuration of the magnetic field produced by said key means permanent magnet means.

Said blocking means further includes a programmable coupling member, a first registration means on said rotor positioned by the rotary position of said rotor, and second registration means on said programmable coupling member. Said programmable coupling member is selectively rotatably displaceable to position said second registration member at any of a plurality of positions and is biased axially toward said rotor for axial displacement toward said rotor when said first and second registration means are aligned. A coupling assembly couples said latch means and said cylinder when said programmable coupling member is axially displaced.

The programming means may include a remotely actuable motor and gear means coupling said motor and said coupling member. The lock may include a plurality of said rotors, programmable coupling members and programming means for cooperation with a key having a corresponding plurality of said permanent magnet means, said coupling means including one of said coupling assemblies for the coupling of said cylinder and latch means when all of the programmable coupling members are displaced toward their respective rotors.

A pair of concentrically mounted programmable coupling members may be provided each being independently rotatably and axially displaceable and each being provided with one of said second registration means, the corresponding rotor being provided with two of said first registration means, each of said first registration means being adapted for selective registration with one of the second registration means, said coupling assembly being operable in response to the axial displacement of either of the programmable coupling members.

Accordingly, it is an object of this invention to provide a lock structure which is remotely programmable.

A further object of this invention is to provide a programmable lock structure which cannot be opened by forceably rotating the cylinder.

Another object of the invention is to provide a programmable lock system wherein a plurality of lock structures are independently programmable from a remote central station.

Still other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification and drawings.

The invention accordingly comprises the features of construction, combinations of elements, and arrangements of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference is had to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a block diagram of a remotely programmable lock system in accordance with the invention;

FIG. 2 is a side elevational view of a first embodiment of the remotely programmable lock in accordance with the invention;

FIGS. 3, 6, 7, 8 and 9 are fragmentary sectional views taken along lines 3—3, 6—6, 7—7, 8—8 and 9—9 of FIG. 2 respectively;

FIG. 4 is an exploded fragmentary sectional view taken along lines 4—4 of FIG. 3;

FIG. 5 is a fragmentary sectional view corresponding to FIG. 4 with the lock in the open position;

FIG. 10 is a side elevational view of a key for use with the lock in accordance with the invention;

FIG. 11 is a fragmentary side elevational view of a second embodiment of the programmable lock in accordance with the invention;

FIGS. 12 and 13 are sectional views taken along lines 12—12 and 13—13 respectively of FIG. 11;

FIG. 14 is a view corresponding to FIG. 12 with the lock in the open position;

FIG. 15 is a sectional view taken along lines 15—15 of FIG. 14; and

FIG. 16 is a sectional view taken along lines 16—16 of FIG. 12.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, a programmable lock system 10 is depicted, of the type such as might be installed in a hotel or the like. Such a hotel would be provided with a plurality of rooms usually grouped by floor and a wing. In the embodiment depicted in FIG. 1, the rooms are divided into two groups, for the purposes of this system denominated as Group I and Group II. Each room of each group would have a door 12 provided with a programmable lock 14 in accordance with the invention. Each of the programmable locks, as will more particularly be described below, is adapted to be remotely programmed for operation by similarly programmed key. The programming is accomplished by the establishing of the rotational orientation of a programmable coupling member so that a coordinately configured key will position a corresponding plurality of freely rotatable rotors for registration with said programmable lock members. When proper registration is achieved, the latch, which is normally disconnected from the lock cylinder is coupled with the lock cylinder to permit opening of the door. Each lock would include a programming device for the programming of the programmable coupling member, as more particularly described below, in response to a remotely generated signal.

This remotely generated signal is transmitted to each of the locks 14 from a central control 16 by means of multiplexing techniques. Thus, central control 16 would include conventional multiplexing and demultiplexing devices for communication with data line 18, one branch of which is connected to each of sector distributors 20 and 22, associated respectively with Groups I and II. Said sector distributors are in the nature of repeaters and submultiplexers for transmitting the portion of the signal from data line 18 associated with the rooms of its group along its data line. Thus, sector distributor 20 is connected to the rooms of Group I along data line 24 while sector distributor 22 is connected to the rooms of Group II along data line 26. Each room would be provided with a room electronics module 28 provided with suitable multiplexing and demultiplexing equipment for detecting signals associated therewith from the associated data line and for applying data to the associated data line in suitable time slots of the multiplexed signal. In this manner, by means of multiplexing techniques, a single central control can communicate with a plurality of room electronic modules on an essentially simultaneous basis. Coded portions of the multiplex signal would identify the data associated with each room. Similarly, a coded signal would represent the configuration into which the programmable coupling member of each programmable lock 14 is to be placed. This coded signal would be transmitted from the room electronics module 28 along line 30 to a room-door transformer having a portion 32 mounted in the door jamb and another portion mounted in a door electronics module 34 associated with each programmable lock 14. The room-door transformer may consist of a transformer having one winding in one-half of its core embedded in the door jamb and the remainder in the door. The transformer half in the door may be tongued and spring loaded so that when the door is closed there is a minimum core gap. The coded signal received in the door electronics module 34 is decoded by said door electronics module and applied to the programming device of the magnetic lock to set the configuration of the programmable coupling member as will be more particularly described below.

Central control 16 would be provided with a manual input device 36 connected thereto by line 38 for the operaion thereof. The operator of the system 10 would punch a code representative of the particular room having a lock to be reprogrammed. The actual coded signal representative of the program may be manually generated at manual input 36 or may be randomly generated by a random code generator within central control 16. In either event, a record of the code would be stored in data storage and processing device 40 coupled to central control 16 by line 42. In addition, the code can be displayed by a display device 44 coupled to central control 16 by line 46. In the embodiment of the system depicted in FIG. 1, the central control is coupled to an automatic key maker device 48 by line 50. The automatic key maker device is adapted to place a key in a configuration corresponding to the configuration of the programmable coupling member of the designated lock 14, so that that key can open that reprogrammed lock. Thus, in order to operate system 10, a key blank would be placed in key maker 48, the operator would designate the room in which the lock is to be reprogrammed by means of manual input 36, and both said lock and key would be simultaneously and coordinately reprogrammed in response to a coded signal either manually applied through manual input 36 or automatically produced in a random code generator within central control 16. Central control 16 and manual input 36 may be located at a hotel desk so that, at the time that each new occupant of a room checks in, the lock for that room and the key associated therewith are coordinately reprogrammed.

In addition to the programming function, other uses can be made of the multiplex communications system provided between each room and the central control. Thus, a plurality of utilization circuits 52 in each room may be remotely actuated by coded signals transmitted from central control 16 to the room electronics module 28 of a particular room. Said utilization circuits would be connected to said room electronics module for operation thereby along line 54. Examples of such utilization circuits would be message at desk indicators in each room, and remote controls for lights, air conditioning and/or television in each room. Further, monitoring devices 56 could be disposed in each room for

detecting fire, smoke and other emergencies. Monitors **56** would be connected to the room electronics module **28** by line **58,** which connection would permit the transmission of the various monitors' status back along the data lines to the central control, as well as the specific actuation of a monitor in response to an instruction from the central control. Monitors **56** may also include devices for monitoring the status of indicator switches in each room, the position of which would indicate whether a room is available for a housekeeper, whether the housekeeper has cleaned the room so that the room is available for a new guest, or whether the guest wishes bellman or valet services. All of the signals associated with the control of utilization circuits **52** and the operation of monitors **56** are transmitted along data lines **24, 26** and **18** on a multiplexed time sharing basis without interfering with the operation of the programmable lock system. The door electronics module **34** may include sensing devices for identifying the actual program to which a lock is set or to identify each key used in the lock, which information would be transmitted across the room-door transformer to room electronics module **28,** which would incorporate the information into the multiplexed signal on the associated data line for transmission to central control **16.**

Display **44** could be adapted to display the outputs of the various monitors **56,** either on a continuing or on a selectable basis, while the various data outputs of monitors **56** and of the door electronics module **34** may be stored and processed by data storage and processing device **40.** To control the status of a particular utilization circuit, the room code, utilization circuit code and status code would be applied to the central control **16** by manual input **36** or would be applied automatically from data storage and processing device **40** in accordance with a automatic program.

Referring now to FIGS. **2–9,** a first embodiment **70** of the programmable lock in accordance with the invention is depicted. This embodiment is provided with a housing block **72** having a cylinder support portion **74** projecting from a base plate portion **76.** Cylinder support portion **74** is formed with an axial bore **78** dimensioned to receive a cylinder **80,** said cylinder being rotatable within bore **78.** An end plate **82** is secured to the outer end of cylinder **80** by means of bolts **84** (FIG. **4**), said end plate being cylindrical and being received in a correspondingly shaped bore **86** in the outer end region of cylinder support portion **74** of housing block **72.** Said cylinder support portion of said housing block is also formed with three cut-out regions **88, 90** and **92** which extend laterally from axial bore **78.** Cut-out regions **88** and **92** are each dimensioned to respectively receive one of cams **94** and **96** mounted on cylinder **80,** cut-out region **90** being dimensioned to receive two such cams **98** and **100.** Cams **94, 96, 98** and **100** are essentially identical, the camming surface thereof being depicted in FIG. **6.** Said camming surface consists of a circular portion **102** and a projecting portion **104.**

Cylinder **80** is formed with an essentially rectangular key hole **106** which extends axially theralong and which registers with a corresponding rectangular hole **108** in end plate **82** which together are dimensioned to receive a key **110.** Said key is formed with an enlarged head **112** and a V-shaped notch **114** which cooperates with a detent arrangement **116** to insure proper positioning of the key and cylinder in the lock. The notch is illustrated in FIG. **10** in conjunction with an alternate embodiment **110'** of said key which will be discussed below. The detent arrangement, more particularly depicted in FIG. **8,** consists of a passage **118** extending through cylinder support portion **74** in a lateral direction relative to the axis of cylinder **80** and in registration with the bore **86** receiving end plate **82.** Said end plate is likewise provided with a laterally extending bore between the peripheral surface thereof and key hole **108,** said bore having a wide portion **120** adjacent said periphery and a narrow portion **122** opening on said key hole. Received within said bores are a first pin **124** and a second pin **126** formed with a collar **128** for receipt within wide bore portion **120.** Finally, said detent includes a set screw **130** for closing the outer end of passage **118** and a coil spring **132** held in compression between first pin **124** and said set screw. The detent arrangement is depicted in FIG. **8** with a proper dimensioned key received within the key hole. At this position, second pin **126** rests in notch **114** of said key to position said pins so that the parting line **134** of said pins is in registration with the parting line between bore **86** and end plate **82** to permit the rotation of the cylinder and end plate by turning the key. In the absence of such a key or the presence of an incorrect key, parting line **134** would be out of registration with the parting line between end plate **82** and bore **86,** so that the cylinder cannot rotate. When a proper key is inserted and turned, it cannot be removed until the key is returned to the position depicted in FIG. **8** by reason of second pin **126.**

Key **110** is provided with two arrays of permanent magnets **136** and **137,** each of said arrays consisting of six permanent magnets extending laterally relative to the axis of the cylinder. Said permanent magnets are disposed in a circular array and are polarized in their longitudinal direction. The purpose of the arrays of permanent magnets **136** and **137** are to establish a magnetic field which extends essentially parallel to the end of each array. Thus, permanent magnets **138, 140** and **142** of array **136** (FIG. **5**) are magnetized so that the end faces visible in said figure are all north poles. Similarly, permanent magnets **144, 146** and **148** are all magnetized so that the ends visible in FIG. **5** are south poles. While the actual configuration of the magnetic field is complex, generally, it can be stated that a magnetic field is created aligned with and extending in the direction of arrow **150** between the strongest north concentration represented by permanent magnet **140** and the strongest south concentration represented by permanent magnet **146.** Permanent magnet array **137** would be similarly constructed, but the polarity of the permanent magnets thereof would preferably not be the same so that the orientation of the magnetic field produced would, while lying at least in part on a plane extending parallel to the end of the array, would be differently oriented within that plane. For example, such a different orientation could be produced by having the poles of permanent magnets **142, 144** and **146** visible in FIG. **5** as north poles, and magnetizing permanent magnets **138, 140** and **148** so that the visible poles in FIG. **5** are south poles. By insuring that each three adjacent permanent magnets are identically magnetized a strong directional magnetic field is produced.

As more particularly shown in FIGS. **2** and **6,** cylinder **80** is formed with a recess opening on key hole **106** in registration with each of the permanent magnet arrays and receiving a disc **151** formed of a material of

high magnetic permeability which will close the path of the field created by the corresponding array of permanent magnets.

The magnetic field generated by each array of permanent magnets **136, 137** is transmitted to a plane outer surface **152** of cylinder support portion **74** of housing block **72** by means of a corresponding array of flux tubes. Said flux tubes are formed of material of high magnetic permeability so as to conduct the magnetic field. Specifically, six first flux tubes **154** are mounted in a circular so as to extend between key hole **106** and the cylindrical surface of the cylinder. Six second flux tubes **156** are mounted in a corresponding circular array to extend from the circular inner surface of bore **78** to the plane outer surface **152** of the cylinder support portion of housing block **72.** As shown in FIGS. **2** and **6,** when cylinder **80** is positioned at the normal locked position, respective first and second flux tubes are in alignment with each other, and positioned for alignment with the corresponding array of permanent magnets **136** when key **110** is inserted in key hole **106.**

The magnetic circuit thus defined produces a magnetic flux extending substantially parallel to surface **152** and aligned in an orientation dependent upon the polarity of the array of permanent magnets. Thus, referring to FIG. **6,** if permanent magnets **140** and **146** are polarized as depicted in FIG. **5** and as marked on FIG. **6,** a magnetic field is created adjacent surface **152** extending between the south (S) end of the second flux tube **156** aligned with permanent magnet **140** and the north (N) end of the second flux tube aligned with permanent magnet **146.** Said magnetic field serves to orient a rotor **158** which is freely rotatable on stub **160** of shaft **162.** Rotor **158** is positioned by means of a permanent bar magnet **164** mounted on rotor **158** so as to lie within the magnetic field produced at the outer faces of second flux tubes **156.** Bar magnet **164,** and therefor rotor **158** tends to align with the orientation of the magnetic flux. As more particularly shown in FIGS. **4** and **5,** a registration pin **166** is held in position by set screw **168** on rotor **158.** Shaft **162** is mounted on a support bracker **170** projecting from base plate portion **76** of housing block **72.**

A programmable coupling member **172** is also mounted on shaft **162** so as to be rotatable about said shaft and axially displaceable therealong toward rotor **158.** The surface of programmable coupling member **172** facing said rotor is formed with a registration aperture **174** (FIG. 4) dimensioned to receive registration pin **166.** Both said pin and said aperture are spaced at an equal distance from the axis of shaft **162** for registration if in alignment.

End face **176,** in which aperture **174** is formed, is biased against the camming surfaces of cams **94** and **98** by a coil spring **178** mounted coaxially on shaft **162** between bracket **170** and programmable coupling member **172.** Said programmable coupling member is formed with a spur gear portion **180** in meshing angagement with a drive gear **182** mounted on a shaft **184** also supported by bracket **170.** Drive gear **182** is rotationally positioned by a remotely actuated motor **186** shown schematically in FIG. **2,** to rotationally position programmable coupling member **172,** and therefore aperture **174.**

The lock construction depicted in FIG. **2** is shown, by way of example, as being actuated by a key having two permanent magnet arrays **136** and **137.** The structure associated with permanent magnet array **137** is identical to the structure discussed above in connection with permanent magnet array **136** and like components have been given like reference numerals primed to distinguished therebetween. Thus, surface **176'** of programmable coupling member **172'** is biased against cams **100** and **96** by spring **178',** the aperture therein being rotatably positioned about shaft **162'** by motor **186'** in response to commands provided by room electronics **28.** While lock **70** is adapted to respond to two permanent magnet arrays, more than two such arrays and associated lock structure may be provided, depending on the number of combinations required. To conserve space, some of the programmable coupling members and associated structure would be mounted on the opposite side of cylinder **80** to that depicted in FIG. **2.**

A shoe **188** is mounted for longitudinal displacement on a pair of rods **190** which are in turn are fixedly supported on bracket portions **192** and **194** of housing block **72.** Shoe **188** engages the peripheral surface of a disc-shaped portion **196** of programmable coupling member **172.** A central rod **198** (FIGS. **2–5**) is journalled through bracket **194** of housing block **72** and is fixed to shoes **188** and **188'.** A cam follower **200** is mounted on the end of central rod **198.** A cylinder coupling member **202** is fixedly mounted on the inner end of cylinder **80** in facing relation to latch member **204.** The latch member is mounted for both rotatable and axial displacement on shaft **206** which is in turn supported on bracket portion **208** of housing block **72.** Latch member **204** would be connected to a latch or bolt (not shown) to displace said latch or bolt upon the rotation thereof. The latch member is biased toward cylinder coupling member **202** by coil spring **210.** Cam follower **200** extends laterally from shaft **198** into the space between cylinder coupling member **202** and latch member **204** and is engaged therebetween by the force of spring **210.** As best shown in FIG. **9,** cylinder coupling member **202** is formed with a pin **212** projecting toward and in registration with an arcuate slot **214** in latch member **204.** Also projecting toward latch member **204** on cylinder coupling member **202** is an inclined camming surface **216** having a plateau portion **218** representing the maximum projection thereof.

The operation of the lock **70** is accordance with the invention will be described in conjunction with FIGS. **4** and **5.** FIG. **4** depicts the lock in the locked position while FIG. **5** depicts said lock in its open position

When a key **110** having permanent magnet arrays polarized to produce magnetic fields of the proper orientation is inserted in key hole **106,** rotors **158** and **158'** are aligned so that the respective pins **166** and **166'** are in registration with the corresponding apertures **174** and **174'** in the corresponding programmable coupling members **172** and **172'.** When key **110** is turned by the user, cylinder **80** and cams **94, 96, 98** and **100** are likewise rotated. Since the programmable locking members **172** and **172'** are biased against the projecting camming surface portions **104,** they are displaced toward their respective rotors as said cylinder and cams are rotated. Since pins **166** and **166'** are in registration with apertures **174** and **174',** each of the programmable coupling members is displaced axially along its respective shaft until said pins are received within said apertures and disc-shaped portions **196** and **196'** are

displaced clear of their respective shoes **188** and **188'** to permit said shoes and central rod **198** to be displaced to the left as depicted in FIG. **5.** This displacement is permitted because camming surface **216** has been displaced out of registration with cam follower **200** by the rotation of cylinder **80** so that spring **210** can force latch member **204** towards cylinder coupling member **202,** carrying with it cam follower **200,** central rod **198** and shoes **188** and **188'**. At the position depicted in FIG. **5,** pin **212** projects into slot **214** and engages against an end thereof so that latch member **204** is rotated with cylinder **80** and key **110** to open the latch or bolt (not shown).

As shown in FIG. **4,** the latch member **204** is held in position by the engagement of cam follower **200** against plateau portion **218** of camming surface **216** and by the engagement of shoes **188** and **188'** against the corresponding disc-shaped portions **196** and **196'** of the corresponding programmable coupling members. The coupling of the latch member to the cylinder requires the axial displacement of both programmable locking members **172** and **172'** to clear both shoes **188** and **188'**. Thus, for example, if the permanent magnets of permanent array **136** were magnetized so as to align rotor **158** so that registration pin **166** was out of alignment with registration aperture **174,** when cylinder **80** was rotated the axial displacement of programmable coupling member **172** would be stopped by the engagement of registration pin **166** against surface **176** so that shoe **188** would not be cleared.. If this occurs, while the cylinder can rotate, and while cam follower **200** is no longer supported by camming surface **216,** the latch member is held in the locked position by the interaction of shoe **188** and programmable coupling member **172.** Since the cylinder is free to rotate despite the fact that the key is not programmed to correspond to the lock, the latch cannot be forced by pressure applied to the cylinder.

The programming of the lock **70** may be accomplished by the remote actuation of motors **186** and **186'** to rotatably position the respective programmable coupling members. Said motors are preferably stepping motors for incremental positioning of the programmable coupling members in each of a plurality of discrete locations. In the embodiment depicted, the provision of an array of six permanent magnets permits six discrete orientations of the magnetic field, so that the stepping motor would be adapted to position the registration aperture **174** of programmable coupling member **172** in each of six positions corresponding to the six orientations of the magnetic field. The programming of the permanent magnets of each permanent magnet array of key **110** merely requires a corresponding array of strong electro-magnets which may be selectively energized to the desired polarity to impress a strong magnetic field on each of the permanent magnets to dispose that permanent magnet in the desired polarity. An array of six such electro-magnets aligned in registration with each permanent magnet array in key maker **48** would permit the simultaneous programming of the key and the programmable coupling discs.

FIG. **10** depicts an alternate embodiment **110** of the key in accordance with the invention wherein, in place of each array of permanent magnets, single discs of magnetic material **136'** and **137'** are mounted on key **110'**. The material of the discs is characterized by the capability of magnetizing regions thereof. As illustrated in FIG. **10,** the regions marked with an "N" are magnetized so that north poles appear at the surface depicted, while the regions marked with an "S" are polarized so that south poles appear in said surface regions. The reverse face of discs **136'** and **137'** would be oppositely polarized. The array of electromagnets referred to above could be used to program the discs of FIG. **10.** In all other respects, the key of FIG. **10** functions in the same manner as key **110** described above.

For many lock applications, it is desirable to provide for the opening of a number of different locks by a single master key, such as a maids' key. In the lock art, this result has been achieved by providing a series of concentric cylinders with separate parting lines actuated by such master keys. A similar multilevel construction is depicted in the embodiment of the lock in accordance with the invention shown in FIGS. **11–16.** By way of illustration, only the mechanism associated with a single array of permanent magnets **136'** is depicted. Cylinder **80'**, cams **94'** and **98'** and the magnetic circuit formed by disc **151''** and flux tubes **154''** and **156''** are similar in construction to the embodiment of FIGS. **1–9** as is key **110'**, like reference numerals being applied to like components.

A rotor **230** carrying a permanent bar magnet **232** is rotatably mounted on a stub shaft **234** (FIG. **12**) projecting from plane surface **152''** of cylinder support portion **74'**. Said rotor supports a first registration pin **236** and a second, longer registration pin **238,** first registration pin **236** being spaced a greater distance from the axis of stub shaft **234** then second registration pin **238** (FIG. **16**).

In place of a single programmable coupling member, the lock of FIGS. **11–16** is provided with a first outer programmable coupling member **240** and a second inner programmable coupling member **242** mounted within an axial bore **244** in said first outer coupling member. The first outer programmable coupling member is supported on a bracket portion **246** while the second inner programmable coupling member is supported by said first outer programmable coupling member and a bracket portion **248** of the housing block. End surface **250** of first outer programmable coupling member **240** is formed with a registration recess **252** dimensioned to receive first pin **236** and spaced from the axis of the second outer programmable coupling member a distance equal to the spacing of said first pin from the axis of stub shaft **234.** Similarly, end surface **254** of second inner programmable coupling member **242** is formed with a registration recess **256** for registration with and receipt of second pin **238.** Projecting camming surfaces **104'** of cams **94'** and **98'** engage against end surface **250.**

Second inner coupling member **242** is formed with an enlarged region **258** spaced from end surface **254** and defining a lateral annular wall **260** against which the inner end **262** of first outer programmable coupling member **240** abuts. The end of said second inner programmable coupling member itself abuts bracket portion **248** of the housing block. The respective ends of said first and second programmable coupling members **240** and **242** are respectively formed with laterally projecting flanges **264** and **266.** A coil spring **268** extends between flange **264** and bracket portion **246** to bias the first outer programmable coupling member toward rotor **230** against cams **94'** and **98'**. Bore **244** is formed with a region **270** of increased diameter defining a lat-

eral wall 272 in first outer programmable coupling member 240. A second coil spring 274 is compressed between wall 272 and flange 266 to bias second inner programmable coupling member 242 toward rotor 230 relative to said first outer programmable coupling member.

The first outer programmable coupling member is selectively rotatably positionable by means of a spur gear portion 276 formed on the outer surface thereof for cooperation with drive gear 278 operatively coupled to a motor not shown. Similarly, second inner programmable coupling member 242 may be selectively rotatably positioned by means of a spur gear portion 280 formed on the peripheral surface thereof in the region of bracket portion 248 which cooperates with drive gear 282 couples to a motor not shown.

The lock of FIGS. 11–16 would be provided with a latch member, cylinder coupling member and cam follower arrangement similar to that depicted in connection with the embodiment of FIGS. 1–9. However, in place of the shoe arrangement for displacing the cam follower, the embodiment of FIGS. 11–16 is provided with an assembly 284 for coupling said latch member and said cylinder coupling member by displacing said cam follower when first registration pin 236 is received within registration recess 252 or second registration 238 is received within registration recess 256.

As shown in FIG. 13, coupling assembly 284 includes a carriage formed from a pair of spaced rods 286 fixed to and carrying a pair of spaced plates 288. The entire carriage would be mounted on the housing block and secured to the cam follower for displacement of said cam follower. Sandwiched between plates 288 is a slide plate 290 formed with two slots 292 dimensioned to receive rods 286 and to permit said slide plate to move up and down as viewed in FIGS. 12 and 13. Secured to opposite sides of slide plate 290 are a pair of fingers 294 and 296, positioned so as to extend across opposite sides of said first and second programmable coupling members. Fingers 294 and 296 are respectively provided with inclined camming surfaces 298 and 300 which engage against surfaces of said first and second programmable coupling members in a manner described below.

FIGS. 11, 12 and 13 depict the lock in the locked position. At said position, finger 296 engages the annular surface of enlarged portion 258 of second inner programmable coupling member 242 while finger 294 engages the enlarged annular surface region 302 of first outer programmable coupling member 240. As best illustrated in FIG. 13, the diameter sensed by the inclined camming surfaces of fingers 294 and 296 is large and the entire carriage of coupling assembly 284 is displaced to the right as viewed in FIG. 13, at which position the latch member is prevented from engaging with the cylinder coupling member.

If, as shown in FIGS. 14 and 15, the key 110'' received within the cylinder has a permanent magnet array 136' magnetized to orient rotor 230 so that second registration pin 238 is aligned with recess 266 in second inner programmable coupling member 242, then said first and second programmable coupling members are displaced as a unit to the left as viewed in FIG. 14 until end surface 250 of first outer programmable coupling member 240 engages the end of first registration pin 236. At this position, as shown in FIGS. 14 and 15, finger 294 still rides on the periphery of region 302 of enlarged diameter of said first outer programmable locking member. However, finger 296 is in registration with a portion 304 of said second inner programmable locking member, region 304 having a diameter less than the diameter of enlarged portion 258. The total diameter sensed by the inclined camming surfaces 298 and 300 of fingers 294 and 296 is less than the diameter sensed at the locked position and the carriage of coupling assembly 284 is displaced to the left as viewed in FIG. 15 to displace the cam follower and engage the lock member against the cylinder coupling member.

If the configuration of the magnetic field produced by the magnetic array 136' were such as to position rotor 230 so that first registration pin 236 were in registration with recess 252, then the axial displacement of second inner programmable coupling member 242 would be stopped by engagement with pin 238 while finger 296 still engaged region 258 of larger diameter. However, first outer programmable coupling member 240 would be displaced to the left as viewed in FIG. 11 so that pin 236 is received within recess 252 due to the action of spring 268 which is selected to overcome spring 274. At this position of first outer programmable coupling member 240, finger 294 rests on the end region 262 thereof which is of a diameter smaller than region 302 so that the total diameter sensed by the fingers is less than the diameter sensed at the locked position illustrated in FIGS. 12 and 13. While in the case of FIG. 15, the slots 292 permitted slide plate 290 to be displaced upwardly so that the fingers engage the respective surfaces of the first and second programmable coupling members, where first pin 236 is received within recess 252 said slide plate is displaced downwardly as viewed in FIG. 12. However, the entire carriage portion of coupling assembly 284 is displaced to the left as viewed in FIG. 13 due to the narrow diameter sensed by the fingers and the latch member is coupled to the cylinder coupling member. In order to increase the displacement of said carriage portion, the inner portion of the inclined camming surfaces 290 and 300 can be cut off at points corresponding to the respective points of engagement with the programmable coupling members shown in FIG. 15 to define a slot of the narrow diameter described above.

As in the case of the embodiment of FIGS. 1—9, the first and second programmable coupling members of FIGS. 11–16 are released for longitudinal displacement by the rotation of the cylinder and cams mounted thereon. A commercial embodiment of the lock depicted in FIGS. 11–16 would include a number of such mechanisms and the carriage portion of coupling asembly 284 would be displaced to the left as viewed in FIG. 13 only where the fingers of each of the mechanisms detected a smaller diameter, a condition analogous to the clearance of all of the shoes in the embodiment of FIGS. 1–9. The precise number of magnetic arrays and associated mechanisms will depend on the number and complexity of the combinations required for opening the lock. Each of the levels of each mechanism would be separately programmable through drive gears corresponding to drive gears 278 and 282.

It will thus be seen that the objects set forth above, and those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from the spirit and scope of the invention, it is

intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. A programmable lock for use with a key having at least one permanent magnet means adapted to produce a magnetic field of a predetermined orientation comprising latch means; a fixed lock member; a displaceable lock member mounted on said fixed lock member and formed for receipt of said key means; said displaceable lock member being selectively displaceable relative to said fixed member independent of said latch means; means for selectively coupling said displaceable lock member and said latch means for the operation of said latch means in response to the displacement of said displaceable lock member; means for normally blocking the operation of said coupling means and for selectively permitting such operation in response to said predetermined orientation of said magnetic field; and remotely actuable lock programming means operatively connected to said blocking means for selecting the magnetic field orientation in response to which said coupling means is permitted to operate.

2. A remotely programmable lock as recited in claim **1,** including key programming means for receipt of said key for selectively magnetizing said permanent magnet means for the selection of the orientation of the magnetic field produced thereby; and control means operatively coupled to said key programming means and lock programming means for the coordinate actuation thereof to produce a key capable of operating said lock.

3. A remotely programmable lock as recited in claim **1,** wherein said blocking means includes first and second registration means, said first registration means being positioned by the orientation of said magnetic field, said second registration means being selectively positioned by said lock programming means, said coupling means being adapted to couple said displaceable lock member to said latch means when said first and second registration means are in alignment.

4. A remotely programmable lock as recited in claim **3,** for use with a key having at least two of said permanent magnet means, said blocking means including one of said first and second registration means actuated by the magnetic field orientation of each of said permanent magnet means, and one of said lock programming means coupled to each of said second registration means for the independent positioning thereof, said coupling means being adapted to couple said displaceable lock member and said latch means when at least two of said first and second registration means are respectively in alignment.

5. A remotely programmable lock as recited in claim **4,** including a rotor means mounted for free rotation in the magnetic field of each of said permanent magnet means, each of said permanent magnet means being selectively magnetizable so as to produce each of a plurality of discrete magnetic field orientations selected to rotationally position said rotor means at each of a plurality of rotational positions, said blocking means further including a programmable coupling member rotatably mounted on the axis of rotation of each of said rotor means and selectively rotatably positioned at each of a corresponding plurality of rotational positions by said lock programming means, said first and second registration means being respectively mounted on said rotor means and programmable coupling member for alignment at selected corresponding rotational positions thereof.

6. A remotely programmable lock as recited in claim **5,** whereein one of said first and second registration means is a pin and the other of said first and second registration means is an aperture dimensioned to receive said pin, said programmable coupling member being axially displaceable toward said rotor means when said first and second registration means are in registration, said coupling means including a coupling assembly for coupling said displaceable lock member and said latch member when at least two of said programmable lock members are axially displaced toward the corresponding rotor means.

7. A remotely programmable lock as recited in claim **6,** including third and fourth registration means associated with each of said permanent magnet means; a second programmable coupling member mounted coaxially with each of said first-mentioned programmable coupling members for rotatable and axial displacement, said third registration means being on said rotor means, said fourth registration means being on said second programmable coupling member, one of said third and fourth registration means being a pin, the other of said third and fourth registration means being an aperture dimensioned to receive said pin when in alignment; and a second lock programming means associated with each of said second programmable coupling members for the selective rotational positioning thereof independent of said first-mentioned programmable coupling member, said coupling assembly being adapted to couple said displaceable lock member and said latch means when one of the first and second or third and fourth registration means associated with at least two of said permanent magnet means are in alignment so that one of the first-mentioned or second of said programmable coupling members associated with each of said permanent magnet means is axially displaced toward its respective rotor means.

8. A remotely programmable lock as recited in claim **7,** wherein said coupling assembly includes carriage means mounted for displaceemnt laterally relative to the axis of said programmable coupling members between a locked position and an open position, said first-mentioned and second programmable coupling members being each formed with a region of a first diameter and a region of a second diameter smaller than said first diameter in the path of displacement of said carriage means, said carriage means including a block associated with each of said permanent magnet means and mounted thereon for slideable displacement in a direction lateral to both the path of displacement of said carriage means and the axis of the associated programmable coupling members, a pair of projecting fingers mounted on said slide block in spaced relation on oppposed sides of said programmable coupling members and formed with converging inclined camming surfaces for engagement against said programmable coupling members, one of said fingers normally engaging said first region of each of said first-mentioned and second programmable coupling members when said program-

mable coupling members and carriage means are at said locked position, one of said fingers engaging the second region of the associated programmable coupling member when said programmable coupling member has displaced axially towards the associated rotor means to permit displacement of said carriage means from said locked to said open position if one of the programmable coupling members associated with each of said permanent magnet means have been axially displaced.

9. A remotely programmable lock as recited in claim **8,** wherein said carriage means is operatively coupled to said latch means for displacement therewith, registration means mounted on said displaceable lock member and said latch means for the coupling thereof when said carriage means is in said open position, cam follower means mounted on said carriage means, camming surface means mounted on said displaceable lock member for engagement with said cam follower means to return said carriage means and latch means to said locked position at a locked position of said displaceable lock member.

10. A remotely programmable lock as recited in claim **6,** wherein said coupling assembly includes carriage means displaceable between a locked and an open position, said carriage means including shoe means associated with each of said programmable lock members, said programmable lock members being formed with a portion positioned to block the displacement of said carriage means from said locked to said open position before axial displacement of said programmable coupling member towards said rotor and to permit displacement of said carriage means upon axial displacement of said programmable coupling member toward the associated rotor means.

11. A remotely programmable lock as recited in claim **10,** wherein said carriage means is operatively coupled to said latch means for diplacement therewith, registration means mounted on said displaceable lock member and said latch means for the coupling thereof when said carriage means is in said open position, cam follower means mounted on said carriage means, camming surface means mounted on said displaceable lock member for engagement with said cam follower means to return said carriage means and latch means to said locked position at a locked position of said displaceable lock member.

12. A remotely programmable lock as recited in claim **6,** wherein said programmable coupling members are formed with a gear portion, said lock programming means each including a drive gear in meshing engagement with said gear portion of said programmable lock member and motor means operatively coupled to said drive gear.

13. A remotely programmable lock as recited in claim **12,** wherein said drive motor means is a stepping motor.

14. A remotely programmable lock as recited in claim **6,** wherein said displaceable lock member includes a cylinder rotatably mounted in said fixed lock member and formed with a longitudinally extending key hole dimensioned to receive said key, and including magnetic circuit means in said cylinder and fixed lock member associated with each of said permanent magnet means for conveying the magnetic field orientation of said permanent magnet means through said cylinder and fixed lock member to the region of the associated rotor means.

15. A remotely programmable lock as recited in claim **14,** wherein said magnetic circuit means includes a first array of flux tube means extending from said key hole in the vicinity of each of said permanent magnet means to the periphery of said cylinder, and a second array of flux tube means in said housing means positioned for registration with said first array at a locked position of said cylinder extending from said cylinder to the vicinity of said rotor means.

16. A remotely programmable lock as recited in claim **14,** including at least one cam means mounted on said cylinder for rotation therewith and positoned in the path of axial displacement of each of said programmable coupling members, said cam means including a projecting portion engaged by said programmable coupling members when said cylinder is in said locked position, said coupling means including means for biasing said programmable coupling member against the associated cam means for the axial displacement of said programmable coupling member in response to the rotation of said cylinder and cam means, provided the corresponding first and second registration means are in alignment.

17. A remotely programmable lock as recited in claim **13,** wherein said latch member is mounted for rotational displacement with said cylinder when coupled thereto and displacement toward and away from said cylinder between a locked and an open position, said lock including registration means on said latch member and cylinder for engagement and coupling when said latch member is in said open position, said latch member being coupled to said coupling assembly for displacement between said locked and open positions in response thereto.

18. A remotely programmable lock as recited in claim **2,** including a plurality of said remotely programmable locks and a plurality of said keys, said control means being adapted to selectively and coordinately program each of said locks and associated key.

19. A remotely programmable lock as recited in claim **6,** wherein said permanent magnet means includes an array of separate permanent magnets.

20. A remotely programmable lock as recited in claim **19,** wherein said array of permanent magnets is circular, a first group of adjacent permanent magnets being disposable at one polarity, a second group of adjacent permanent magnets being disposable in the opposite polarity to define said magnetic field orientation.

21. A remotely programmable lock as recited in claim **6,** wherein said permanent magnet means includes a member formed of a material such that an array of regions thereof may be discretely polarized.

22. A remotely programmable lock as recited in claim **21,** wherein said array of discrete regions is circular, a first adjacent group of said regions being polarized to one polarity and a second adjacent group of said regions being polarized to an opposite polarity to define said magnetic field orientation.

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