April 9, 1968 S. LEVINE 3,376,721

ELECTROMECHANICAL COMBINATION LOCK

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Fig. 1

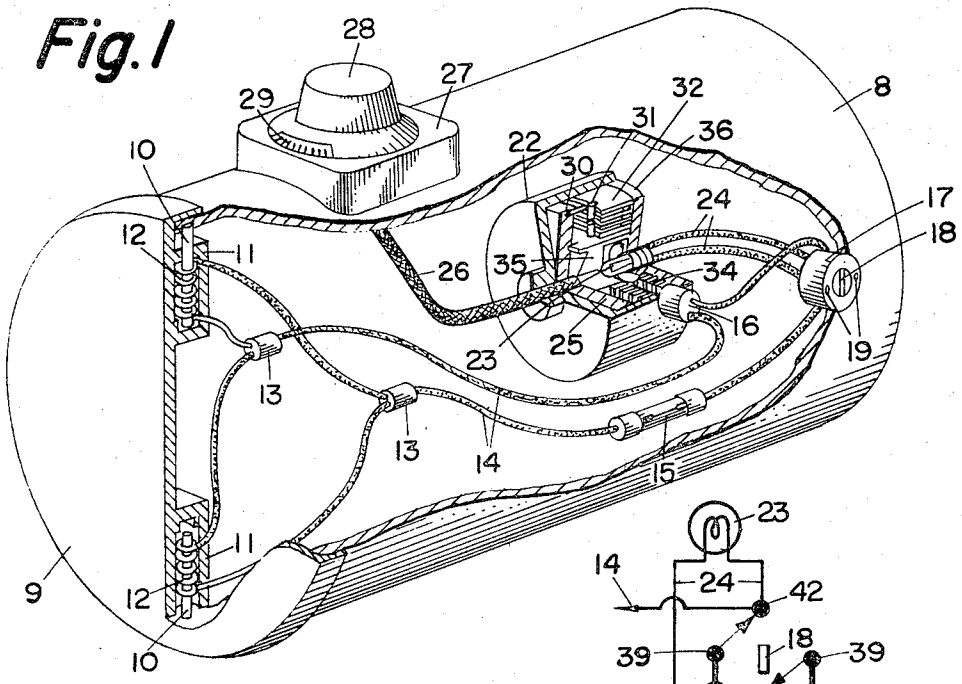


Fig. 3

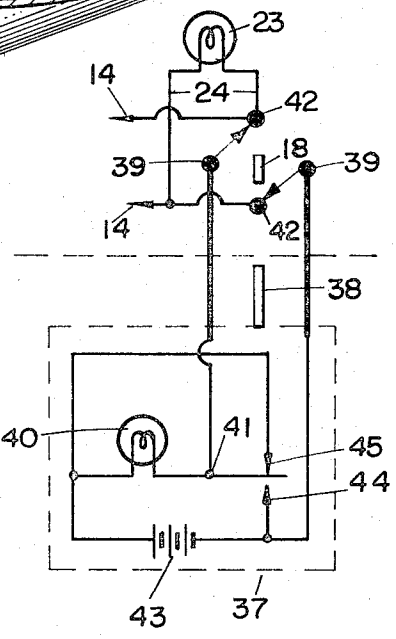
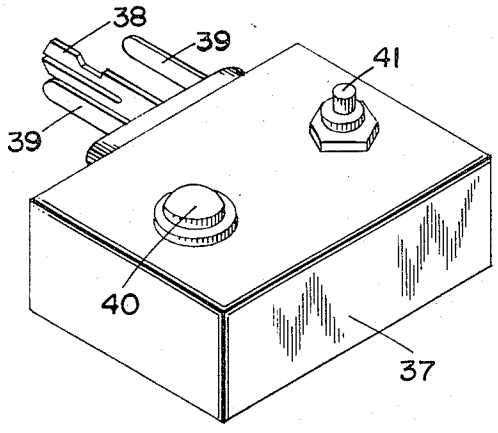


Fig. 2



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Fig.4

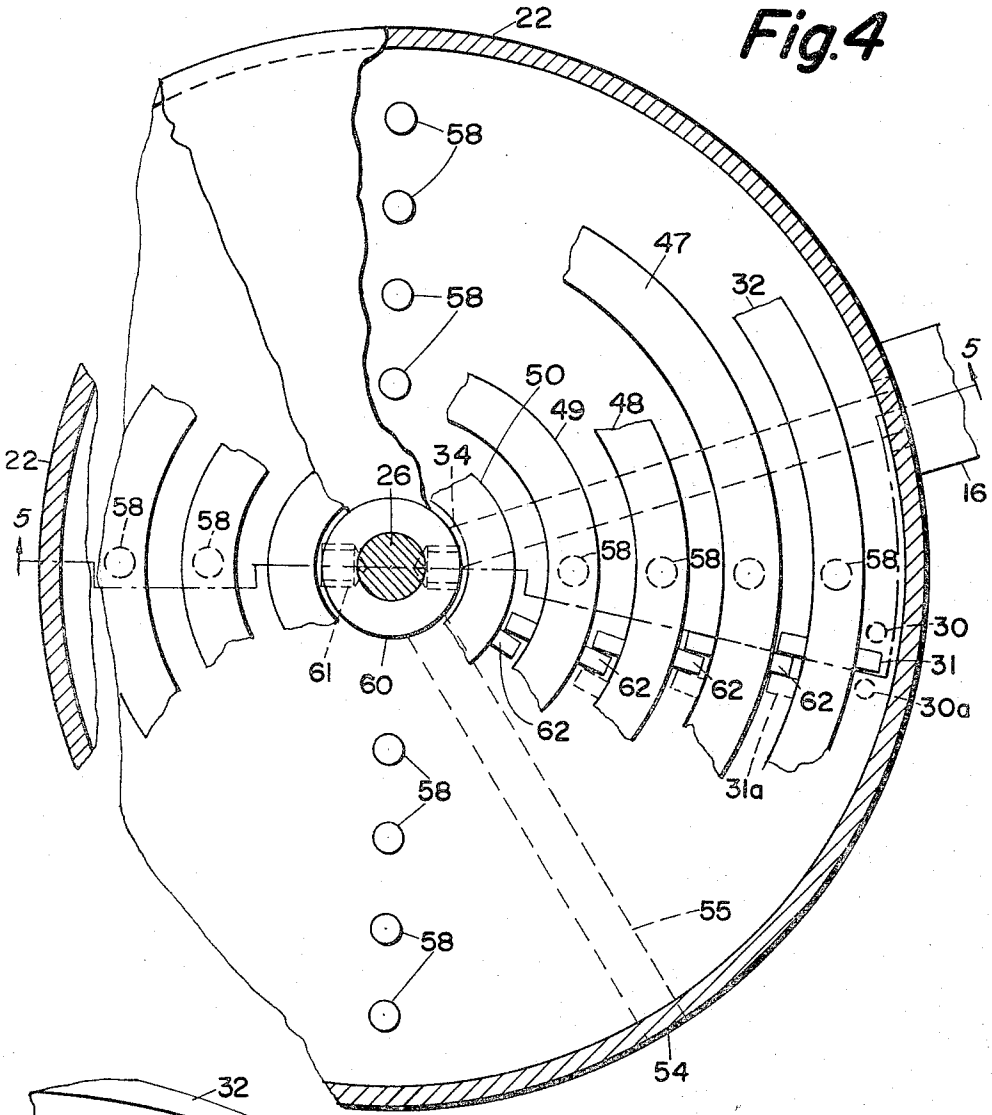
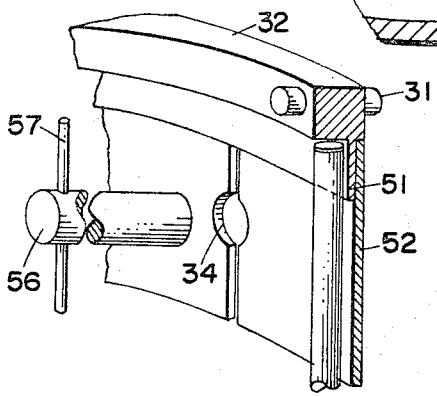


Fig.4A



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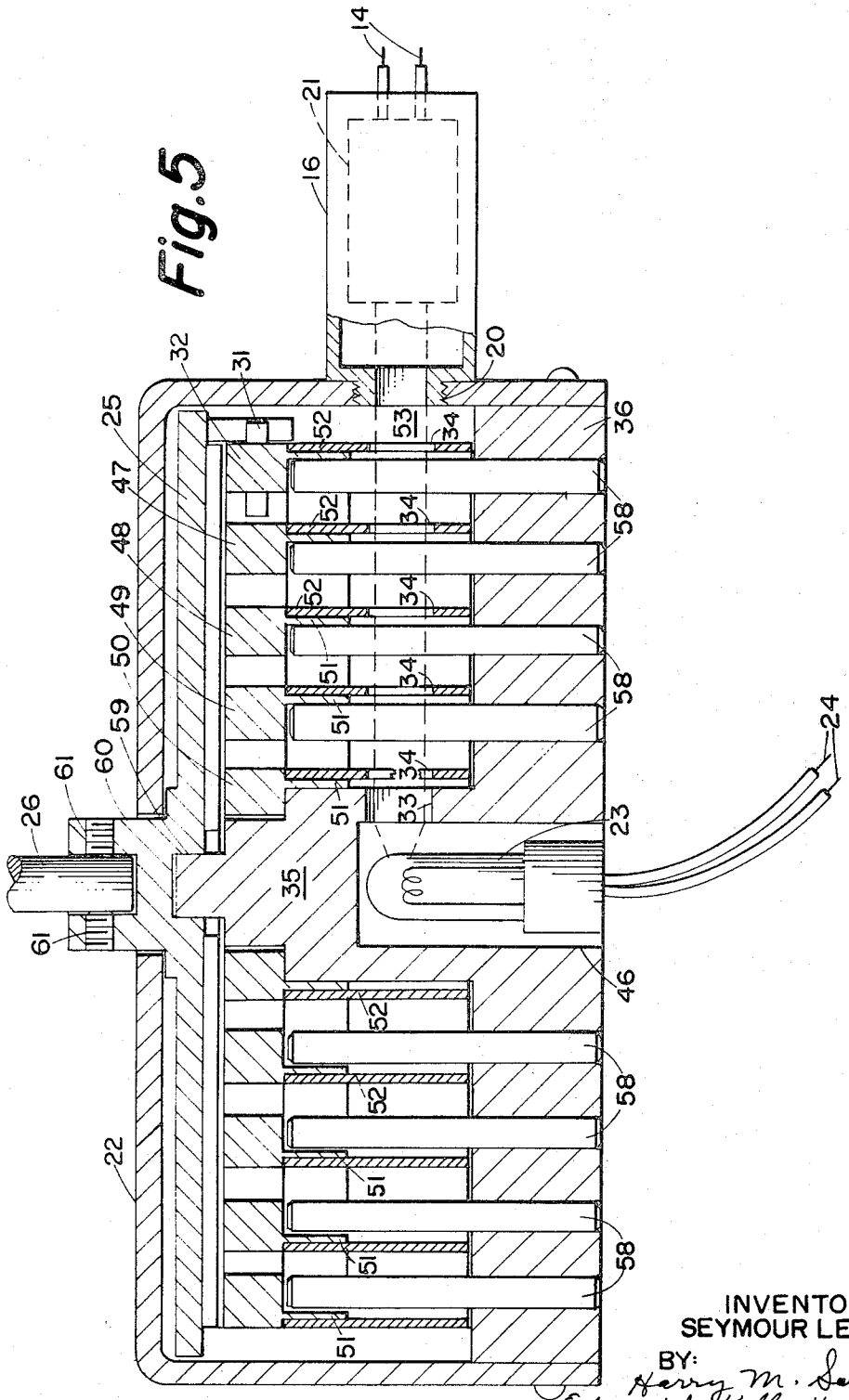
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Filed Jan. 5, 1966 3 Sheets-Sheet 3

Fig. 5



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United States Patent Office 3,376,721 Patented Apr. 9, 1968

3,376,721

ELECTROMECHANICAL COMBINATION LOCK

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Filed Jan. 5, 1966, Ser. No. 519,172
4 Claims. (Cl. 70—277)

ABSTRACT OF THE DISCLOSURE

An electromechanical combination lock for storage rooms, safes and the like in which the door lock is electrically unlocked under control of a photo electric cell which receives light through aligned apertures in a series of co-axial disks that are rotated by the unlocking knob or device according to a combination known to the user. Operating current for the lock is applied through a removable key unit having electrical connection prongs for engaging and turning a receptacle type connecting element on the lock. The key box includes a small battery sufficient to energize an interior lamp which provides the light for projection through the disk apertures and for operating the unlocking means. A test lamp and switch are included in the key unit for testing the operating condition of the battery and the circuit continuity through the lock lamp.

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

The present invention relates to combination locks for closed containers, cabinets, vaults and the like having a removable cover section or door which may be bolted closed internally and controlled by external dial means offering a combination of precisely numbered settings on the dial for actuating the unlocking mechanism.

More particularly, the present invention relates to an electromechanical combination lock wherein the locking means or bolts are actuated by electromechanical means having a control circuit responsive to the setting of the combination element therein.

Electromechanical locking means for various types of closed containers, vaults, safes and the like have been provided in the past, and many are both complicated in structure and operation and to a degree subject to failure or manipulation depending upon the complication of the internal mechanism.

It is the primary object of this invention to provide an improved electromechanical combination lock which is of simplified construction and adapted to be mounted within the container of casing of the apparatus which it controls thereby to provide additional protection. The system adapted is to be controlled electrically from an external power supply unit detachable therefrom as an added security feature.

It is also a further object of this invention to provide an improved electromechanical combination lock which may be actuated by a controlled light beam with a plurality of cylinders in the lock for controlling the beam and its action upon suitable photoelectric means acting as a switch for the unlocking elements. In addition it is contemplated that the system will be further protected by the application of external power means through a second locking element introduced into the supply connection and forming a part thereof.

In accordance with one form of the invention, a detachable cover or cap for a closed casing or the removable door element of a cabinet or safe is provided with electromechanical locking bolts actuated by a solenoid element through an electrical circuit containing a photoelectric cell as the switching means. The photoelectric cell receives light from an internal light element contained within an

internal casing having a driving wheel connected with an external dial or control element. A series of cylinders under control of the drive wheel provides a series of aligned openings through which the light beam is applied to the photoelectric cell when the proper combination is set. An external power supply means is provided with a key and two or more electrical contact elements for supplying operating current to the internal mechanism and locking bolts in addition to the lamp or light and is actuated by the insertion of the key into a rotatable receptacle external to the casing or vault or other container to be locked whereby the entire locking mechanism is prevented from being actuated by ordinary current supply means. Means are also provided for determining the condition of the light elements, that is to say the continuity of the filaments whereby it is known that each internal lamp is in proper operating condition.

The container, vault or safe may be of any size and contain as many locking elements as desired for actuation by electrical current, the solenoid type being the more simple and effective an therefore at present preferred. A multiwheel or cylinder combination lock employs a light and photosensitive device to sense the proper location of the wheels or cylinders and when properly set, activates the electromechanical devices to withdraw the bolts and enable opening of the container or vault or other casing locked thereby. It has the further advantage that all elements are internal to the casing except for the power supply unit which is effectively a small key and battery container and an internal dial for setting the cylinders. The entire mechanical construction of the locking unit per se is designed for maximum manufacturing facility and simplicity of operation and assembly.

The invention will further be understood from the following description, when considered in connection with the accompanying drawings, and its scope is pointed out in the appended claims.

In the drawings,

FIG. 1 is a view in perspective and partly broken away showing an electromechanical combination lock embodying the invention as applied to a casing having a removable end cap or cover such as a vault,

FIG. 2 is also a view in perspective of an external power supply unit and locking device required to activate the system of the locking mechanism and is constructed also in accordance with the invention,

FIG. 3 is a schematic circuit diagram of one of several possible circuit configurations for the power supply given for FIG. 2,

FIG. 4 is a plan view and partly broken away of the internal electromechanical combination lock unit shown in FIG. 1 and on an enlarged scale therefrom to show certain details thereof in accordance with the invention,

FIG. 4*a* is a detailed view in perspective of a portion of the mechanism of the locking unit of FIG. 4 showing details thereof in accordance with the invention for making adjustments in setting up the combination, and

FIG. 5 is a cross-sectional view in elevation of the locking unit of FIG. 4 taken on the section line 5—5 thereof and showing further details in accordance with the invention.

Referring to the drawings wherein like parts throughout the various figures are designated by the like reference numerals, and referring particularly to FIGS. 1 and 2, a closed cylindrical vault or container comprises an enlongated cylindrical casing **8** having a flanged end cap or cover element **9** seated thereon and locked in place by two oppositely disposed retractable bolts **10** carried by the cover on bracket element **11** which contain solenoid windings **12** surrounding the bolt and operable to withdraw the bolts when energized by electric current.

The solenoid windings 12 are connected in parallel through suitable connectors 13 for two supply leads 14 one of which contains a series fuse or circuit breaker element 15 and the other of which includes a series photoelectric cell 16. The circuit terminals are brought to a power receptacle 17 mounted externally to the casing or vault 8. The receptacle is rotatable and includes a key slot 18 and two electroprobe or contact socket openings 19 on the outer face thereof as indicated in FIG. 1.

The internal combination lock unit is indicated at 22 with a closed casing of cylindrical form having an internal lamp 23 therein along the axis for activating the photoelectric cell 16 which is mounted on the outer periphery in radial alignment with the lamp for receiving activating light therefrom to actuate the solenoids and unlock the casing. The lamp is supplied with operating current through supply leads 24 which are also connected with the input power receptacle 17 for receiving current therefrom.

The combination lock 22 is provided with an internal drive wheel 25 which rotates on the axis of the casing and is driven by a flexible or rigid operating shaft 26 extending from the casing 22 to an external combination control unit 27. This has an operating or setting dial 28 and a scale 29 which is calibrated to read in units from 0 to 100 in the present example. Turning the combination setting dial 28 to different numbered positions according to the scale 29 correspondingly adjusts the internal drive wheel 25 of the lock unit 22 through the medium of the connection provided by the flexible shaft 26. A drive pin 30 on the wheel or disc 25 engages a lug 31 on the first of a series of cylinder elements of which the outer one 32 is shown in FIG. 1. In the present example five cylinder elements are provided concentrically about a central arbor or stud 35 which is counterbored to receive the lamp 23 and base therefor and which is mounted on a base flange 36 which forms a closure for the rear end of the inner lock unit or casing 22 all as indicated in FIG. 1 and further described hereinafter.

An external power supply unit 37 is provided with a key element 38 and two electrical probe or contact pins or elements 39 extending therefrom as indicated in FIG. 2. The unit also includes pilot or test lamp 40 and a test switch 41 adapted for external operation.

Referring to FIG. 3 along with FIGS. 1 and 2, the external power supply or control unit 37 includes, in addition to the indicating lamp 40 the control switch 41, an operating battery or power source 43 for the lock and the switch is provided with two contacts 44 and 45. It is normally closed to the latter contact as indicated in FIG. 3. The switch or switch arm 41 is connected with one of the contact pins 39 and with one terminal of the internal indicating lamp 40 and the other terminal of the lamp 40 is connected with the contact 45 and with the battery 43 at one terminal thereof. The other terminal of the battery is connected with the contact 44 and with the remaining pin or contact element 39 of the unit 37.

The internal contacts 42 of the power receptacle 17 on the apparatus to be adjusted are connected with the lamp 23 and with the supply leads 14 as indicated. When the key 38 is inserted in the slot or receptacle 18 and the pins 39 are inserted into the receptacle they are rotated into engagement with contacts 42 as indicated in FIG. 3 to provide a connection with the internal lamp 23 and the circuit 14. With this arrangement it will be seen that the battery or power source 43 is then normally connected with the lamp 23 and the leads 14 to energize the internal circuitry of the locked unit. The lamp 40 is short circuited by closure of the contact 41 with the contact 45 while the lamp 23 is illuminated or activated at all times. When the test switch 41 is operated to move from the contact 45 to the contact 44, in the mid position it will provide for testing both the internal and external lamp circuits for continuity as will be seen by tracing the circuitry provided. This circuit is traced from the power source of battery 43 through the lamp 40, thence to the switch arm 41 and one probe or pin 39 and through the lamp 23 back to the opposite pin 39 and returning to the battery 43. Thus both lamps are in series and illuminated if the circuit is completed and the lamps are in operating condition. When the switch arm 41 closes with the contact 44 the lamp 40 is placed directly across the battery 43 and is illuminated with full brilliance depending upon the strength of the battery and indicating its strength by the degree of brilliance of the illumination. Closure of the arm 41 with the contact 44 serves to short circuit the two probes 39 one with the other thereby cutting out power supply to the internal lamp 23 and the internal circuitry for the moment of testing. Upon release of the switch button or switch 41 is returns to the normal closed position shown in FIG. 3 for normal operation.

It will be noted that the central spindle or arbor 35 has an opening 33 radially therein extending from the lamp 23 in the direction of the photoelectric cell 16 and adapted to have aligned therewith a series of openings 34 in the successive cylinder elements 32 as indicated in FIGS. 1 and 5. When in this aligned position by adjustment of the dial 28 the electrical circuits are energized and the solenoids unlock the pin 10 to permit the casing to be opened. At all times except when operating to lock or unlock the casing the external power supply unit 37 is removed from the power receptacle 17. This power supply unit may be relatively small in size and compact, and adapted to be used as a relatively small unlocking key unit.

Referring now to FIGS. 4, 4*a* and 5 along with the preceding figures, the internal construction of the combination lock unit 22 will be considered more in detail. The outer casing is closed at the bottom by the base flange 36 which carries the central arbor or stud 35. The lamp 23 is located in a central bore 46 in the stud 35 as indicated more clearly in FIG. 5. Surrounding the arbor 35 in concentric relation are the successive cylinder elements beginning with the outer element 32 already referred to and successive inner cylinder elements 47, 48, 49 and 50. These are effectively concentric annular rings each having an integral relatively short and thin depending flange or web 51 and each in turn surrounded and tightly gripped by a thin cylindrical depending split band of spring material which extend to the base 36. They thus form a series of light masking elements between the central lamp 23 and the photoelectric cell unit 16. The radial opening 34 in the central arbor 35 is brought into alignment with openings 34 in the series of masking elements 52 to provide a light conducting path 53 between the lamp and the photoelectric cell unit 16 as indicated in FIGS. 4 and 5. As indicated in FIG. 4*a*, each of the openings 34 is traversed by a longitudinal slot or split in the ring 52 whereby it may be spread for adjustment on the flange element 51 by rotary movement to bring the openings 34 into alignment in accordance with particular readings on the scale 29 of the setting dial 28 as will hereinafter appear.

The openings 34 may also be aligned individually with an outer opening 54 in the casing 22 of the locking unit along an adjusting path 55 as indicated and into which a combination setting tool 56 may be introduced as indicated in FIG. 4*a*. The tool is an elongated rod adapted to reach from the exterior of the casing 22 through the opening 54 to the innermost one of the adjusting bands 52, and is of oval cross section to fit within each opening and to spread the bands 52 at the transverse split or slot 57 extending through each opening 34 as shown in FIG. 4*a*.

The upper annular ring elements of the successive cylinder elements 32, 47, 48, 49 and 50 have the respective depending short annular flange or web elements 51, seated on a series of angularly spaced guide pins or posts 58 which are mounted in the base 36 and extend upwardly therefrom in concentric annular rows corresponding to the cylinder elements as shown more clearly in FIG. 4.

The manner in which the studs **58** guide the annular rings is shown in FIG. *4a*. The internal drive wheel **25** for the combination lock unit **22** is rotatably mounted on a short axial stud **59** on the post **35** and is provided with an outwardly extending central hub **60** into which the flexible shaft **26** is seated at its inner end and secured by suitable set screws **61**. Like the ring **32** the remaining annular rings **47–50** are provided with similar adjusting lugs **62** corresponding to the lug **31** on the ring **32**. These are provided in alignment to meet and drive one against the other as indicated in FIG. 4 in providing a setup for the locking unit as will hereinafter be described.

It will also be noted that the photoelectric cell unit **16** is secured to the casing **22** in alignment with the light path **53** through the medium of a threaded hub **20** and the photoelectric cell **21** therein as indicated in FIG. 5 is connected with the circuit leads **14** as previously described.

The electromechanical combination lock of the present invention is a multiwheel or cylinder combination lock that employs a light or lamp **23** and a photosensitive device **16** to sense the proper location of the wheels or cylinders, that is, the light-opening carrying elements, and when properly set, activate the electromechanical devices **11–12** to withdraw the bolts and enable the opening of a container or vault door such as that indicated in FIG. 1.

The operation will now be considered in more detail. Turning the adjusting dial **28** drives the flexible shaft **26**, which may be of any suitable length, to rotate the drive wheel **25** within the casing **22** of the internal combination lock unit. The pin **30** of the drive wheel **25** engages a lug **31** on the outer cylinder **32** of the lock. As the cylinder **32** is rotated the lug will engage the lug **62** of the next cylinder **47**. The lug from the cylinder **47** will in turn engage the lug of the cylinder **48**, and so forth, until all cylinders are rotating. The cylinders are stopped at the proper first number of a selected series of five in which the hole **34** in the cylinder element **50** is in line with the light or lamp **35** and photosensitive device **16**. The process is now reversed until the four remaining cylinders **47**, **48** and **49** are picked up and stopped at the proper second number. When the five selected numbers have been dialed properly, the hole **34** in each cylinder element **52** will be in line as indicated in FIG. 5 and FIG. 4 to permit a light beam along the path **53** from the lamp **35** to activate the photosensitive device **21** in the casing **16**.

The photosensitive device serves as a switch to permit power to reach the electromechanical solenoids **12** and thereby activate them after the control or locking unit **37** is in place and rotated into position for operation. A fuse or circuit breaker **15** in the line precludes the possibility of high voltage being applied to the circuit to break down the photoelectric switch. The fuse may have the characteristic of opening the circuit under excessive current and resetting itself when the current is reduced.

Combination changes are accomplished by the construction shown wherein the cylinder elements are made in two parts, an upper annular ring driver section with a lug and a thin depending coaxial flange, and a lower thin cylindrical depending skirt or masking section of spring material which grips the outer surface of the flange of each element. The upper part of the cylinder or annular ring is thus the drive section on which the lugs are mounted and the lower section or skirt contains the light opening and is made of spring material (plastic or metal) which may be compressed about the upper ring flange elements. To change a combination, the existing combination is dialed to an offset index thereby aligning the light-conducting openings **34** with the keyhole **54** in the casing. The oval-shaped key **56** is then inserted into the oval-shaped hole and rotated 90 degrees which spreads the spring material of the lower half of the cylinder element. With the key in this position a new

combination is dialed using the offset index. When the combination has been dialed as desired the key is then rotated to its original position permitting the sprung shoulders to close on the upper rings and restoring the operation in readiness for further use under the new dialing arrangement.

The system is further protected by the use of the external power supply unit which may be removed when the apparatus is not in use thereby preventing its operation under any circumstances regardless of whether the dial combination is known or not. Furthermore, the control unit is adapted for testing the continuity of the circuitry within the casing and the lamps for continuity. This is a desirable safety feature.

Furthermore, it will be seen that this electromechanical combination lock provides increased security over known locks of this type, since the lack of sound or feel associated with a light beam precludes the use of the usual techniques for manipulating combination locks by professionals outside the law in this field.

I claim:

1. An electromechanical combination lock for storage rooms, safes, vaults and like closed containers comprising in combination, internal current-responsive locking means, an internal combination lock unit, said unit comprising an outer casing and a plurality of concentric cylinder elements mounted therein for rotation about a common axis, said cylinder elements each comprising an annular flanged ring and a coaxial depending thin spring cylinder element seated on and frictionally gripping said ring, an electric lamp providing a light source in said axis for projection radially in a light path through said concentric cylinder elements, said cylinder elements having alignable light-conducting openings providing said light path, each of said light-conducting openings being alignable with an opening in the casing for receiving an expansion tool therethrough to frictionally release each of the cylinder elements from the annular ring element, photosensitive switch means mounted on said casing externally thereof and in alignment with said light path for receiving light from said lamp through said light path to effect closure thereof and operation of said internal locking means, means for setting said cylinder elements to align said openings along said light path including an internal drive wheel rotatable on said central axis and adapted to drive said individual cylinder elements through interlocking means carried thereby, external setting dial means for moving said internal drive wheel and having an extended shaft connection therewith, an external power receptacle connected with said lamp and internal locking means through said photosensitive switch means, and an external power supply unit having electrical and mechanical connecting elements for engaging said external power receptacle and rotating therein to energize the internal circuits thereof.

2. An electromechanical combination lock for storage rooms, vaults and like closed containers comprising in combination, an external power receptacle rotatable in part for making power connections internally of said lock, an external power supply unit of relatively small size having contact elements for engaging said power receptacle and rotating therewith into operating contact, an internal combination lock unit having a rotatable drive wheel and a plurality of concentric cylinder elements, external setting dial means connected with said drive wheel to rotate said cylinder elements into preset positions for light projection therethrough from a central source, a photoelectric cell positioned for receiving said light projection as a photosensitive switch means for said lock unit, current-responsive internal locking means connected in circuit with said switch means and said power receptacle for receiving current therefrom, an external power supply unit adapted to plug in and rotate on said power receptacle for energizing the internal circuits therefor, a plurality of angularly spaced parallel guide pins

for each of said cylinder elements, and means providing a progressive driving connection between said drive wheel and said cylinder elements for effecting progressive setting movement thereof, an indicator lamp in said external power supply unit, and a switch on said external power supply unit for testing said lamps.

3. An electromechanical combination lock as defined in claim 2, wherein a central electric lamp provides said light source and is connected with said power receptacle for receiving operating current therefrom, and wherein the indicator lamp and the test switch in said external power supply unit are adapted for testing both lamps and the operating voltage of said unit.

4. An electromechanical combination lock as defined in claim 2, wherein the cylinder elements comprise an annular ring and a depending spring cylinder in gripping engagement with said annular ring, and wherein said depending cylinder elements are slotted transversely through a light-projecting opening therein to receive an expansion tool for setting up a dialing sequence.

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