

An Electronic Combination Lock

BACKGROUND OF THE INVENTION

5 Typical conventional locking devices, such as padlocks and luggage locks, require user to manually enter a sequence of numbers by adjusting multi-rotating dials inscribed with numeric digits to open a lock. This type of locking devices is commonly known as Combination Locks and they usually do not require a mechanical key. Instead users need to preset a combination digit code and remember this code when unlocking such
10 locks. In contrast, existing electronic locks are usually designed with a bulky and relatively large numeric keypad for entering access codes. These keypads are not suitable for used in small size electronic combination locks.

The invention is concerned with small size electronic combination locks. In particular, the invention relates to miniaturization and an easy-to-use electronic identification
15 method for setting locking and unlocking combination access code of electronic combination locks such as padlocks, chain locks, luggage locks, wire locks and bicycle locks.

The method of adjusting mechanical combination codes to unlock conventional locking devices is cumbersome and time consuming. The problems of using such combination
20 locks are as follows: (1) reading and adjusting small size of inscribed digits on the rotating dials become tedious and time consuming (2) limited numeric digits from 0 to 9

resulted little choices of access code that can be formed by user (3) memorizing multiple numeric digits of access codes can be difficult to some users.

25 In addition to above shortcomings of conventional combination locks, there has been a need for a small electronic lock operated by an electronic identification device with characteristics as follows: easy to use due to its simplicity, increased variety of choices of combination codes, very low battery power consumption, and relatively inexpensive construction.

U.S. Pat. Nos. 4,495,540, describes an electronic combination lock for luggage. The
30 electronic combination lock described in this patent comprises several buttons which emulate the mechanical adjustable rings in conventional combination locks. It is a replicate of multi-digit mechanical adjustable rings to several electronic push buttons. These multiple buttons method of entering access code is not suitable for application in small electronic combination locks. The patent is incorporated here for reference.

35 The followings additional patents are believed to have relevance to the invention: U.S. 3,754,164, U.S. 4,931,789, U.S. 5,021,776, U.S. 5,153,561, U.S. 5,373,718,

To address the weaknesses and the needs described above, the inventor proposed an alternative electronic combination lock which provides the public with a useful choice.

SUMMARY OF INVENTION

The invention provides an electronic combination lock comprising an electronic system
45 unit, a mechanical housing, a miniaturized latch and a set of switches or sensor to
manually and automatically turn on/off the electronic system. The electronic system
consist of a visual display unit, a small Joystick switch or a set of switches or a touch
sensor or a plurality of optical sensor, to provide a means of entering and setting access
code, a microcontroller programmed with software in combination with electronic
50 circuitry to drive a miniaturized toggle solenoid or a micro motor to perform locking and
unlocking functions. The compact electronic system unit fit to the mechanical housing to
form a unitary embodiment of electronic locking device.

Using a set of mechanical switches or a sensor and software protocol, an automatic
device "waking-up" method is derived to prevent unnecessary turning on its electronic
55 system when not in used to conserve battery power. The electronic system is normally
programmed to automatically power off and can be manually turned off using a press
button. The electronic system can be activated by the following actions: 1). manually
press an on/off button, 2). automatically triggered by a displacement sensor (e.g.
acceleration sensor, vibration sensor, movement sensor) when an appropriate
60 movement or combination of movements of the lock detected.

The combination of electronic display, a 5-way switch Joystick or a touch sensor and
the software in conjunction with an electronic controller, enable a vast variety and
choices of access codes are constructed by an user. Access codes can be stored in
memory of the electronic system. Alphanumeric characters, colors graphics, shapes,

65 symbols, patterns and other language characters, and their combinations to form words, names, and others combination to produce a vast variety of high security access codes that are meaningful, user-friendly, and easy for user to remember. More than one access code can be set to enable several users to use one electronic combination lock with different access code set for the convenient of each particular user.

70 When using a touch sensor for access code entry, user can touch and scroll to search for the alphanumeric characters or patterns displayed on screen and click the choice for performing access code entry actions. The display unit (e.g. LCD display) can be illuminated to ease reading of access code in a less illuminated environment.

A separate battery operated electronic key unit, which contents a programmed access
75 code and electronic circuitry, can be used in conjunction with the electronic combination lock. The electronic key can serve as: (1) a proximity controller to perform locking and unlocking actions (2) an alternative power source to boot up the electronic combination lock with a flatten battery. (3) Backup access code storage.

The invention thus provides a miniature, compact, easy for entering/setting vast choices
80 of access code, user-friendly locking and unlocking features, low power consumption, easy to use electronic combination lock and can advantageously replace the use of conventional combination locks. These and other objects, advantages and features of the invention will be apparent from the following description of a preferred embodiment, considered along with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The details of the electronic combination lock and electronic key will be understood more clearly with reference made to the accompanying drawings, in which:

90 FIG. 1 is a front elevational view of one embodiment of the digital combination lock of the present invention;

FIG. 2 is a bottom elevational view of the present invention showing a battery compartment and a key way;

FIG. 3 is a back elevational view of the interior of the digital combination lock in closed
95 position showing a solenoid locking into the shackle bar;

FIG. 4 is a back elevational view of the interior of the digital combination lock in opened position showing a solenoid releasing from the shackle bar;

FIG. 5 is a front perspective view of the overall view showing a touch screen as the controller for the input of access codes into the invention;

100 FIG. 6 is a front perspective view of the overall view showing a joystick as the controller for input of access code into invention;

FIG. 7 is the front perspective view of the overall view showing the electronic combination lock embedded on a luggage bag.

FIG. 8 is a top elevational of the electronic key showing a button extended the contact
105 point out of the casing;

FIG. 9 is a top elevational of the electronic key showing the contact retracted into the casing;

FIG. 10 is a front elevational of the electronic key showing the contact and infra red;

FIG. 11 is a top elevational of the electronic key showing the interior of the lock with all

l10 the components

DESCRIPTION OF PREFERRED EMBODIMENTS

l15 An embodiment of an electronic combination padlock can best be appreciated by referring to **FIG. 1** and **2**. The electronic combination lock having a mixture of metal and plastic material to form a housing structure **1**, preferably elongated, consists of metal plates **2** on the top and bottom of the housing **1** to reinforce the structure. The lock has a shackle-type locking bar **3** that is held lock in position within the housing **1**. The front
l20 side of the housing **1** has a back-lighted touch screen Liquid Crystal Display (LCD) **4** either by color pixels or dot matrix which is capable of displaying combination of alphanumeric characters, symbols and patterns. The touch feature on the LCD screen **4** allows entering and controlling locking features. The LCD screen **4** is automatically turned off within a short duration to conserve battery power. In this preferred form
l25 described herein, the electronic combination lock uses six "digital dials" access code (a smaller or larger number of dials can also be used). An On/Off push button **5** is situated below the LCD screen **4** to turn on or off the lock electronic system. Alternative method

of turning On the device is achieved by shaking the lock which will trigger the movement sensor **16** and thus activating the electronic system of the electronic combination lock

130 **17**. An infra red receiver **6** is situated to the right of the LCD screen **4** to receive signal from the electronic key for performing locking and unlocking functions. The bottom of the housing **9** is the battery compartment which is enclosed by the battery cap **7**. It permits two batteries **10** to be contained in the compartment. To the right of the battery cap **7** is the key hole **8** for the electronic key to be inserted in to unlock the electronic

135 combination lock as an alternative method. When the electronic combination lock battery **10** has drained off completely, the battery source **22** from the electronic key can be used to power up the electronic combination lock.

Referring to **FIG. 3** and **4**, the inner section of the housing **1** is preferably made from metal and the components are secured to the housing. The shackled bar **3** is held within

140 the inner section by a solenoid **11** actuated bar **12** or a miniature motor. The shackled bar **3** is spring loaded **21** at one end. The shackle bar **3** is held by a shaft **12** secured into the groove **13** of the shackle bar **3**. When an access code is entered by user to perform locking action, a signal is sent to the microcontroller **23** held on the circuit board, it drives the solenoid **11**. The solenoid **11** will in turn actuate the shaft **12** to move

145 forward. Upon actuation shaft **12** will move into the groove **13** of the shackle bar **3** thereafter a second spring loaded bar **14** will move into the hole **15** of the bar **12**. The spring bar **14** acted as safety barrier to prevent the shaft **12** from unintentionally release from the latched position. A spring load ball bearing **18** is used to assist holding the shackle bar **3** in position for the shaft **12** to insert in and move out to accommodate

150 latching and unlatching actions.

When an access code is entered on the electronic combination lock or a pre-programmed electronic key with access code is inserted into connector **8**, a signal is sent to the microcontroller **23** to release the shackle bar to trigger the toggle solenoid **19** which in turn retracts the bar **14**. Upon retraction, solenoid **11** will actuate to move the shaft **12** backward. Shackle bar **3** will spring out of the holding position into unlock position. After a certain duration solenoid **19** will release bar **14** into latching hole **20** to keep the shaft **12** from moving during unlocking state.

Referring to **FIG. 6**, it shows another preferred embodiment using the joystick mechanism **34** as the input device. Access code **33** displayed on LCD screen can be in the forms of alphanumeric characters, symbols and patterns. On the right of the joystick mechanism is the mode button **32** to select a particular feature required. On the left is the On/Off button **31** to power On or Off the electronic system within the electronic combination lock.

FIG. 7 illustrates another preferred embodiment of the electronic combination lock embedded in a luggage bag **40**. The zip holders **41** of the luggage are to be inserted into the metal hooks **37** of the mechanical housing **38**. Numerical **35** is the mode button to select a specific feature of the electronic luggage lock. On the right side of the mode button **35** is the On/Off button **36** to power on or off the electronic system. A LCD screen **39** is available for displaying access code and other features such as displaying lock status, wrong access code, selected type of code etc.

Referring to **FIG.8 to 10**, the electronic key module comprises a plastic housing **24**, unlock push buttons **25**, lock push button a retractable connector **27** and infra red

transmitter **28**. The electronic key has two ways to open the electronic combination lock. Referring to **FIG. 7**, connector **27** is pushed out and inserted into the key hole **8** of the housing. The pre-programmed unlocking access code for the electronic lock is stored in memory of the integrated circuit **29**. Upon insertion into the key hole **8**, it sends a signal to the microcontroller **23** once the access code validated, the unlocking sequences is activated. This method of unlocking the electronic combination lock can be performed regardless the presence of battery source **10**. Alternative method of unlocking the electronic combination lock is to use the infra red transmitter **30**. Within a proximity range of the circuit, with a press on the unlock button **26**, a signal from the transmitter **30** sends to the receiver of the electronic combination lock **6** which then triggers the microcontroller to perform locking and unlocking sequences.

CLAIMS

The invention has been described with reference to the illustrated preferred embodiments. The invention is not unduly limited by this disclosure of the preferred embodiment described. Instead, it is intended that the invention be defined and their
5 equivalents, set forth in the following claims:

What is claimed is:

1. A miniature electronic combination lock comprising an electronic system unit, a mechanical housing, a miniaturized latch, a plurality of switches and sensors, to form a unitary locking device. The electronic system unit consists of a visual
10 display unit, a miniature 5-way switch referred as Joystick, or a set of five directional switches (i.e. up-down-left-right and center switches) or a touch sensor (e.g. touch screen or touch panel or track-pad panel) or a plurality of optical sensor, to provide a means of entering access codes, a controller programmed with software in combination with electronic circuitry to drive a
15 toggle solenoid or a miniaturized motor to perform latching and unlatching functions. The compact electronic system unit fit to the mechanical housing to form a unitary embodiment of electronic locking device.
2. The electronic combination lock defined in claim 1, in conjunction with a set of mechanical switches, movement sensors and software protocol, to form a
20 method to activate the electronic system of the electronic combination lock. This method is to prevent unnecessary powering the electronic system continuously. Thus, the method conserves battery power and hence extending battery life of the locking device.

- 25 3. The electronic combination lock defined in claim 1, wherein a vast variety of access codes can be constructed by users and saved in the memory of the electronic system. The variety and types of access codes may content one or more of alphanumeric characters, colors graphics, shapes, patterns and other language characters and their combination to form words, numbers, names, and other mixture to create user defined access codes that are meaningful and easy
30 to memorize.
4. The electronic combination lock defined in claim 3, wherein the use of a miniature Joystick and an electronic display unit (e.g. LCD) in conjunction with software can be combined to serve as a method of entering access code.
- 35 5. The electronic combination lock defined in claim 3, wherein the use of a touch sensor and an electronic display unit in conjunction with software can be combined to serve as a method of entering access code.
6. The electronic combination lock defined in claim 3, wherein the use of a set of 5 positional switches (e.g. Up-Down-Left-Right-Centre) and an electronic display unit in conjunction with software can be combined to serve as a method of
40 entering access code.
7. The electronic combination lock defined in claim 3, wherein the use of an optical sensor with a switch and an electronic display unit in conjunction with software can be combined to serve as a method of entering access code.
- 45 8. The electronic combination lock defined in claim 1, wherein a battery powered electronic key unit comprising an electronic system, a mechanical housing, a plurality of mechanical contacts and pre-programmed access code, can be

paired to form a set of locking devices. This electronic key is an alternative means of delivering a pre-programmed access code to unlock an electronic combination lock.

- 50 9. The electronic combination lock defined in claim 8, wherein the electronic key can be used to perform an unlocking function achieved by inserting the electronic key connector into the electronic combination lock to enable the transfer of a pre-programmed access code.
- 55 10. The electronic combination lock defined in claim 1, wherein the electronic system unit may be incorporated with infra-red receiver or radio frequency receiver system to enable proximity access by an electronic key.
- 60 11. The electronic combination lock defined in claim 8, wherein the electronic key can be used to perform an alternative means of locking and unlocking function. The electronic key can transmit the pre-programmed access code to the electronic combination lock by means of Infra-red or radio frequency.
12. The electronic combination lock defined in claim 8, wherein the electronic key can be used as alternative power source to the electronic combination lock by inserting the electronic key connector into the electronic combination lock.
- 65 13. The electronic combination lock defined in claim 1, regardless of whether the battery is being removed or completely discharged, the status of the lock and access code remain as its initial state as stored in electronic system memory.
14. The electronic combination lock defined in claim 1, wherein the use a buzzer beep to indicate access code is properly entered.

15. The electronic combination lock defined in claim 1, wherein a toggle solenoid is
70 used to perform latching and unlatching functions to form a locking system.

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