The above identified patent application is available for licensing. Requests for information should be addressed to:

OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY
CODE OOCC3
ARLINGTON VA 22217-5660

DISTRIBUTION STATEMENT A
Approved for public release
Distribution unlimited
SITE-CONTROLLED LOCKING DEVICE

SPECIFICATION

Background of the Invention

This invention relates generally to locking devices and more specifically to locking devices for transportable containers.

There are many instances when a transportable container, such as, for example, an attache case, or a freight car, needs to be moved to another location. The container is often locked to prevent it from being opened en route and to guard against theft of its contents. There are many kinds of locking devices that can be used to lock the container. Key locks require a key to be opened. Combination locks are opened by turning a dial to a correct combination of numbers. All of these locks suffer from the disadvantage that they can be opened while the container is en route by a thief who finds the key or learns the combination. The theft may not be discovered until much later when the container arrives at its destination.

Summary of the Invention

It is therefore one object of the invention to improve locking devices.

It is another object to provide a locking device that cannot be opened except at a site at which it has been set to be openable.
These and other objects of the invention are achieved by a locking device comprising a normally closed lock having means for opening the lock. The locking device also includes means for disabling the opening means except when the lock is located at a preset site.

In another aspect, the invention involves a locking method comprising the steps of closing a lock having opening means therefor, and disabling the opening means except when the lock is located at a preset site.

The locking device has the advantageous result that when used in combination with a transportable container the locking device can be set to be openable only when the container has arrived at its destination. In addition, the locking device cannot be opened while the container is en route to its destination.

Additional advantages and features will become apparent as the subject invention becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein:

**Brief Description of the Drawings**

FIG. 1 is a perspective view of a transportable container with an embodiment of the locking device mounted thereto.

FIG. 2 is a front view of the locking device of FIG. 1.

FIGS. 3a, 3b, 3c, and 3d are diagrammatic cross-sections
through the locking device of FIG. 1 showing steps in its operation.

Detailed Description

Referring to the drawings, wherein like reference numerals designate like or corresponding parts throughout the several views, the FIGS. illustrate one embodiment of a locking device according to the invention. The locking device 11 may be used in combination with a transportable container 13 as shown in FIG. 1. The locking device 11 includes a normally closed lock 15 which seals the container 13. The lock 15 has a means for opening the lock that is contained in a housing 17 mounted on the container 13. The locking device also includes a means for disabling the opening means except when the lock is located at a preset site. The disabling means is also contained in the housing 17. While the lock 15 and the opening means may take a variety of forms, conveniently the lock 15 may have a locking bolt 19 engaging a bolt-receiving locking block 21, and the opening means may include a D.C. motor 23 connected to the bolt 19 for moving the bolt back and forth, and input means 25 for receiving and supplying power from a battery to the motor 23. A control panel 27 is provided in the housing 17 for activating the opening means. The disabling means may also take a variety of forms. Conveniently, it may take the form of a Global Positioning System (GPS) receiver 29 and a relay 31 which has isolated input and output circuits. A GPS
receiver is a device for continuously tracking and using a constellation of satellites orbiting the earth at a very high altitude to compute and update the position of the receiver. GPS receivers are well-known devices for which a fuller description is not considered to be needed. One example of a GPS receiver is described in U.S. Pat. No. 4,785,463, whose disclosure is hereby incorporated by reference. A preferred GPS receiver 29 is the Model GPS 65 Personal Navigator sold by GARMIN International of Lenexa, Kansas, and described in their Model GPS 65 User Manual, the disclosure of which is also incorporated by reference. The GPS receiver has a memory for storing the coordinates of a preset site and means for comparing the coordinates of the receiver with those of the preset site and outputting an alarm voltage signal when there is a match. The GPS receiver 29 is contained in the input circuit of the relay 31, and the alarm signal from the GPS receiver functions as the control signal for the relay. The motor 23 and the input means 25 for receiving and supplying power from the battery are contained in an output circuit of the relay 31.

Briefly, the operation of the locking device 11 starts with the lock in its open state and includes the steps of storing the coordinates of a preset destination, closing the lock, and disabling the opening means. The lock is now in its normally closed state. To restore the lock to its open state, the operation of the locking device includes the steps
of moving the lock to the site of its preset destination,
comparing the coordinates of the lock and preset destination,
enabling the opening means, and opening the lock. The
operation of the locking device 11 will now be described in
more detail.

1-LOCK IN OPEN STATE - See FIG.3a

With the locking bolt 19 in its open, withdrawn from the
locking block 21, position, battery power available at
terminals 25 is turned on at the control panel 27 by
activating a pushbutton power switch 33 and so closing
normally-open contacts 35. The power-on condition is
confirmed by a Power On light 37.

Also confirmed after the locking device power is
switched on, is the status of the locking bolt 19 in the
unlock position by a Control Unlock light 39 as a result of
the engagement of a switch-engaging arm 41 of the translating
bolt support block 43 with a limit actuating switch 45, thus
closing normally-open contacts 47. The bolt support block 43
is capable of translation between lock and unlock position
limits by means of a rack and pinion gear assembly 50, driven
by the D.C. motor 23 through a gear reduction drive (not
shown).

Note that this engagement of the arm 41 with the switch
45 has also opened normally-closed contacts 49 and assures
keeping electrical power from the D.C. motor 23 and so
preventing the motor from continued operation after the bolt
support block 43 reaches the unlock limit limit position. Use of
the gear reduction drive (not shown) with the D.C. motor 23
provides the useful features of assuring sufficient torque
for lock operation and assuring sufficient reverse driving
gear train friction which serves to prevent the motor shaft
from being rotated and, consequently the bolt moved, by means
other than by provision of electrical power to the motor.

With locking device power on, the GPS receiver 29 is
then turned on and destination data is entered into the GPS
receiver using its own panel display and controls 30, after
which the GPS receiver is turned off and the entered
destination data is stored and retained in memory by means of
the GPS receiver's own internal low-power, long-life battery.

2-TRANSITION TO CLOSED STATE - See FIG.3b

The locking bolt 19 can then be driven into the bolt-
receiving block 21 (the lock position) by moving the arm of
the toggle switch 51 on the control panel 27 from its normal
center-off position to the lock position. This toggle switch
action provides D.C. power of the correct polarity to the
motor 23 by closing normally-open contacts 53 and 55.

Provision of power to the motor 23 is also enabled by
the previous closure of normally-closed contacts 57 of a
limit actuating switch 59 upon disengagement of the switch-engaging arm 41 of the bolt support block 43 from the limit switch 59 on the previous occasion of lock opening.

3-LOCK IN CLOSED STATE - See FIG.3c

Upon reaching the lock position, electrical power to the motor 23 is cut off and maintained off by the engagement of the switch-engaging arm 41 of the bolt support block 43 with the limit actuating switch 59, thus opening the normally closed contacts 57. This switch engagement also closes the normally open contacts 61 of the limit switch 59 and so provides power to the Lock light 63.

The arm of the toggle switch 51 can then be returned to its normal center-off position. This return-to-center switch action opens the normally open contacts 53 and 55 and so further removes electrical power from the D.C. motor 23. Locking device electrical power is then turned off by activating the pushbutton power switch 33.

The normally open contacts 65 of the relay 31, which can only be closed by the GPS receiver 29 being on and its having determined that destination arrival has occurred, specifically assures that power is unavailable for driving the locking bolt 19 to its unlock position during the period from lock closing to destination arrival.

With the locking device now in the lock condition, a
transportable container 13 using the lock 15 of the present invention is ready for transfer to the preset destination location, with the lock being unopenable until the container has arrived and is located at the preset destination location.

4-TRANSITION TO OPEN STATE - See FIG. 3d

Upon arrival at the destination location, locking device electrical power can be turned on by activating the pushbutton power switch 33. This action turns on the GPS receiver 29, enabling it to determine its location and if it has arrived at the preset destination.

Upon confirmation of destination arrival by its calculation means, the GPS receiver 29 provides an output relay-actuating signal to the relay 31, thus closing the normally-open contacts 65 and 67. Closure of the contacts 65 serves as the primary enabling function for subsequent lock opening by provision of electrical power to the D.C. motor 23. Closure of the contacts 67 provides power to an Unlock Ready light 69, thus visually confirming to the locking device operator that lock opening can be performed by moving the arm of the toggle switch 51 to the unlock position.

Movement of the arm of toggle switch 51 to the unlock position makes available D.C. electrical power of the correct polarity (now reversed) through the now closed normally-open
contacts 71 and 73 of the toggle switch 51 and further, through the contacts 49 of the now-disengaged unlock limit switch 45. This set of contact closures provides power to the D.C. motor 23, enabling the motor to drive the locking bolt 19 out of the bolt-receiving block 21, thus unlocking the lock.

On completion of lock opening, the switch-engaging arm 41 of the bolt support block 43 engages the limit switch 45 at the unlock limit position, thus opening the normally closed contacts 49 and closing the normally open contacts 47. Opening the contacts 49 removes power from the D.C. motor 23. Closing the contacts 47 provides power to the Control Unlock light 39, thus providing visual confirmation of unlock status and that the toggle switch 51 may be returned to its center-off position.

As a result of unlock status confirmation, complete locking device electrical power may be turned off by again activating the pushbutton power switch 33 to open the contacts 35. The power-off action is visually confirmed at the control panel 27 by the turned-off Power On light 37. Such power removal will also turn off the Control Unlock light 39 and the Unlock Ready light 69. The lock will remain unlocked as long as locking device power remains off. The described embodiment of the invention provides for subsequent lock closing by turning electrical power on by activating the pushbutton power switch 33 and repeating the above described
sequence of operation.

It is obvious that many modifications and variations of the present invention are possible in light of the above teachings. For example, the coordinates of the preset destination may be entered by a remote encoded transmission of the data to the locking device after the lock has been closed and is being moved. Also, the locking device can be modified so that instead of being unopenable except at the preset site, it will be unclosable except at the preset site. Further, the method of determining the coordinates of the lock is not limited to the Global Positioning System, but may include the GLONASS System of satellites established by the U.S.S.R.; the GPS related location accuracy enhancement system referred to as the Differential GPS, or DGPS System; any of the radio wave systems, such as LORAN, generally used as electronic aids for aircraft and ship navigation; or any other manual or automatic electronic or optical, i.e., laser, system of sensor-based location determination. It is therefore to be understood that

the invention may be practiced otherwise than as described.
ABSTRACT

A locking device for a transportable container. The locking device can only be opened when the container has arrived at its destination. The locking device includes a lock having a movable bolt, a motor for moving the bolt and inputs for connecting a power source to the motor. The locking device also includes a relay having isolated input and output circuits. The output circuit contains the motor and the power source inputs. The input circuit contains a Global Positioning System receiver. The Global Positioning System receiver determines the coordinates of the lock, compares them to those of the preset destination, and outputs a signal to the relay to supply power to the motor only when there is a match.
FIG. 1
FIG. 2
FIG. 3a
FIG. 3c
FIG. 3d